



Government of the People's Republic of Bangladesh
Bangladesh Economic Zones Authority

REGIONAL ENVIRONMENTAL AND SOCIAL ASSESSMENT FOR NATIONAL SPECIAL ECONOMIC ZONE



DRAFT RESA REPORT

November 2024

DOCUMENT DETAILS

Document Title	Regional Environmental and Social Assessment for National Special Economic Zone
Document Type	Draft Report
Project Ref. No.	2051230658
Date	7 November 2024
Author	EQMS Consulting Limited
Client Name	Bangladesh Economic Zone Authority
Country	Bangladesh

DISTRIBUTION LIST

Hardcopy	Softcopy	CDs	Other form
x	✓	x	x

DOCUMENT HISTORY

Version	Date	Description	Reviewed by	Approved by
V-0	15 Jul 2024	Initial draft version	MZI	KFI
V-1	7 Nov 2024	Draft Final Report	MZI	KFI

SIGNATURE PAGE

7 November 2024

REGIONAL ENVIRONMENTAL AND SOCIAL ASSESSMENT FOR NATIONAL SPECIAL ECONOMIC ZONE

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ACRONYMS AND ABBREVIATIONS

AAQ	Ambient Air Quality
AIDS	Acquired Immunodeficiency Syndrome
ANL	Ambient Noise Level
ATMs	Automated teller machines
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BDHS	Bangladesh Demographic and Health Survey
BDT	Bangladesh Taka
BEPZA	Bangladesh Export Processing Zone Authority
BEZA	Bangladesh Economic Zones Authority
BFD	Bangladesh Forest Department
BITAC	Bangladesh Industrial Technical Assistance Center
BIWTA	Bangladesh Inland Water Transport Authority
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BOD	Biochemical Oxygen Demand
BPDB	Bangladesh Power Development Board
BR	Bangladesh Railway
BREB	Bangladesh Rural Electrification Board
BRTA	Bangladesh Road Transport Authority
NSEZ	National Special Economic Zone
BSRM	Bangladesh Steel Re-Rolling Mills Ltd.
BTCL	Bangladesh Telecommunications Company Limited
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CBO	Community Based Organization
CDM	Clean Development Mechanism
CEMS	Continuous Emission Monitoring System
CETP	Common Effluent Treatment Plant
CGS	City Gate Station
CHTs	Chittagong Hill Tracts
CIA	Cumulative Impact Assessment

CNG	Compressed Natural Gas
CoC	Code of Conduct
COD	Chemical Oxygen Demand
CPP	Cyclone Preparedness Programme
CPR	Community Property Resource
CR	Critically Endangered
CRVA	Climate Risk and Vulnerability Assessment
CSL	Clear Standing Length
CSO	Civil Society Organization
CTC	Centralized Traffic Control
CUFL	Chittagong Urea Fertilizer Limited
dB(A)	Decibels
DC	Deputy Commissioner
DEM	Digital Elevation Model
DFO	Divisional Forest Officer
DG	Director General
DIFE	Department of Inspection for Factories and Establishments
DO	Dissolved Oxygen
DOE	Department of Environment
DPHE	Department of Public Health Engineering
DRMP	Disaster Risk Management Plan
DRSs	District Regulator Stations
DYD	Department of Youth Development
EC4J	Export Competitiveness for Jobs
ECA	Ecologically Critical Areas
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rules
EHS	Environment, Health and Safety
EHSG	Environment, Health, and Safety Guidelines
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
EPA	Environmental Protection Agency
EPZ	Export Processing Zone
ES	Environmental and Social

ESA	Environmental and Social Assessment
ESF	Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environment and Social Management Plan
ESMS	Environmental and Social Management System
ESS	Environmental and Social Standards
EZ	Economic Zone
FAO	Food and Agriculture Organization
FFWC	Flood Forecasting and Warning Center
FGDs	Focus Group Discussions
FP	Family Planning
GBV	Gender Based Violence
GHG	Green House Gases
GIIP	Good International Industry Practice
GIS	Geographic Information System
GM	Grievance Mechanism
GOB	Government of Bangladesh
GPS	Global Positioning System
GRA	General Relief Activities
GSB	Geological Survey of Bangladesh
GTCL	Gas Transmission Company Limited
GWQ	Groundwater Quality
HCR	Headcount Rate
HH	Household
HIES	Household Income and Expenditure Survey
HIV	Human Immunodeficiency Virus
HQ	Headquarter
HR	Human Resource
IBA	Important Bird and Biodiversity Area
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labor Organization
IMDMC	Inter-Ministerial Disaster Management Committee
IOR	Indian Ocean Region

IP	Internet Protocol
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IWM	Institute of Water Modelling
KAFCO	Karnaphuli Fertilizer Company Limited
KGDCL	Karnaphuli Gas Distribution Company Limited
KII	Key Informant Interviews
kV	Kilovolt
LC	Least Concern
LILO	Line In Line Out
LMP	Labor Management Procedure
LPG	Liquefied Petroleum Gas
LRP	Livelihood Restoration Plan
MCA	Multiple Correspondence Analysis
MCH	Maternal and Child Health
MEZ	Mirsharai Economic Zone
Mg	Magnesium
MLD	Millions of Liters Per Day
MMCFD	Million Cubic Feet Per Day
MMSCFD	Million Standard Cubic Feet per Day
MOEFCC	Ministry of Environment, Forest, and Climate Change
MOFL	Ministry of Fisheries and Livestock
MOL	Ministry of Land
MOLE	Ministry of Labor and Employment
MOU	Memorandum of Understanding
MOWR	Ministry of Water Resources
MPAs	Marine Protected Areas
MSL	Mean Sea Level
MSW	Municipal Solid Waste
MUDP	Mirsharai Upazila Development Plan
MVA	Mega-volt-amperes
MW	Megawatt
NAAQ	National Ambient Air Quality
NDMC	National Disaster Management Council
NGOs	Non-Governmental Organizations

NICDC	National Industrial Corridor Development Corporation
NNW	North-North-West
NOC	No Objection Certificate
NT	Near Threatened
NTU	Nephelometric Turbidity Unit
NWMP	National Water Management Plan
O&M	Operations and Maintenance
ODS	Ozone Depleting Substance
OFC	Optical Fiber Cables
OHS	Occupational Health and Safety
OPGW	Optical Ground Wire
OSS	One Stop Service
PD	Power Division
PGCB	Power Grid Company of Bangladesh
PM	Particulate Matter
PPEs	Personal Protection Equipment
PPP	Public Private Partnership
PRIDE	Private Investment and Digital Entrepreneurship Project
PTWC	Pacific Tsunami Warning Center
PTZ	Pan Tilt Zoom
PWD	Public Works Department
RAP	Resettlement Action Plan
RD	Rural Dispensary
RESA	Regional Environmental and Social Assessment
RF	Reserved Forest
ROW	Right of Way
RPF	Resettlement Policy Framework
SEA	Strategic Environmental Assessment
SEA	Sexual Exploitation and Abuse
SEP	Stakeholder Engagement Plan
SPS	Sikalbaha Power Station
SQ	Soil Quality
SRDI	Soil Resources Development Institute
SRTM	Shuttle Radar Topography Mission
SSE	South-South-East

SSPs	Share Socio-economic Pathways
STDs	Sexually transmitted diseases
STP	Sewage Treatment Plant
SWM	Solid Waste Management
SWQ	Surface Water Quality
TBS	Town Board Station
TDS	Total Dissolved Solids
TIN	Taxpayer Identification Numbers
TMP	Traffic Management Plan
TOR	Terms of Reference
TSS	Total Suspended Solids
TUP	Targeting Ultra Poor
UDD	Urban Development Directorate
UEO	Upazila Education Office
UH&FWC	Union Health & Family Welfare Centre
UHC	Upazila Health Complex
UNDP	United Nations Development Programme
UNO	Upazila Nirbahi Officer
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VAW	Violence Against Women
VES	Visual Encounter Survey
VESC	Valued Environmental and Social Components
VGD	Vulnerable Group Development
VGF	Vulnerable Group Feeding
VU	Vulnerable
WARPO	Water Resources Planning Organization
WB	World Bank
WBG	World Bank Group
WHO	World Health Organization
WTP	Water Treatment Plant
ZDP	Zero Discharge Plan

EXECUTIVE SUMMARY

E-1 Introduction

The Bangladesh Government's long-term development plans under "Vision 2031" and "Vision 2041" are to grow the country into a middle-income country by 2031 as well as a developed and prosperous country by 2041 respectively. To achieve the goal of the plan needs to create jobs and employment opportunities through a competitive business environment, increased human capital and skilled labor force, efficient infrastructure, and a policy environment that attracts private investments. In this regard, the Government of Bangladesh (GOB) has launched an initiative to provide industrial land and infrastructure to increase private investments with the support of the Bangladesh Economic Zones Authority (BEZA). NSEZ is one of the major development projects of the GOB planned in Feni and Chattogram Districts. NSEZ is developing by the BEZA with the support of the World Bank (WB) under the project termed "Bangladesh Private Investment and Digital Entrepreneurship Project".

NSEZ will be a part of the long-term development goals and support to overcome the challenges to achieve Vision 2041 through infrastructure development, capacity building of manpower, and significant investment from private sectors and international donors. NSEZ on its completion will consist of a trade zone, industrial zone, residential zone, and tourism zone among others.

E-1.1 Objectives of Regional Environmental and Social Assessment

The main objective of the RESA is to examine the associated environmental and social risks and impacts due to the development and operation of the NSEZ in the region. It will pay particular attention to potential cumulative risks and impacts of multiple activities in a region but may not include the site-specific analysis of a specific project.

E-2 Description of the NSEZ

E-2.1 Location of the Proposed NSEZ

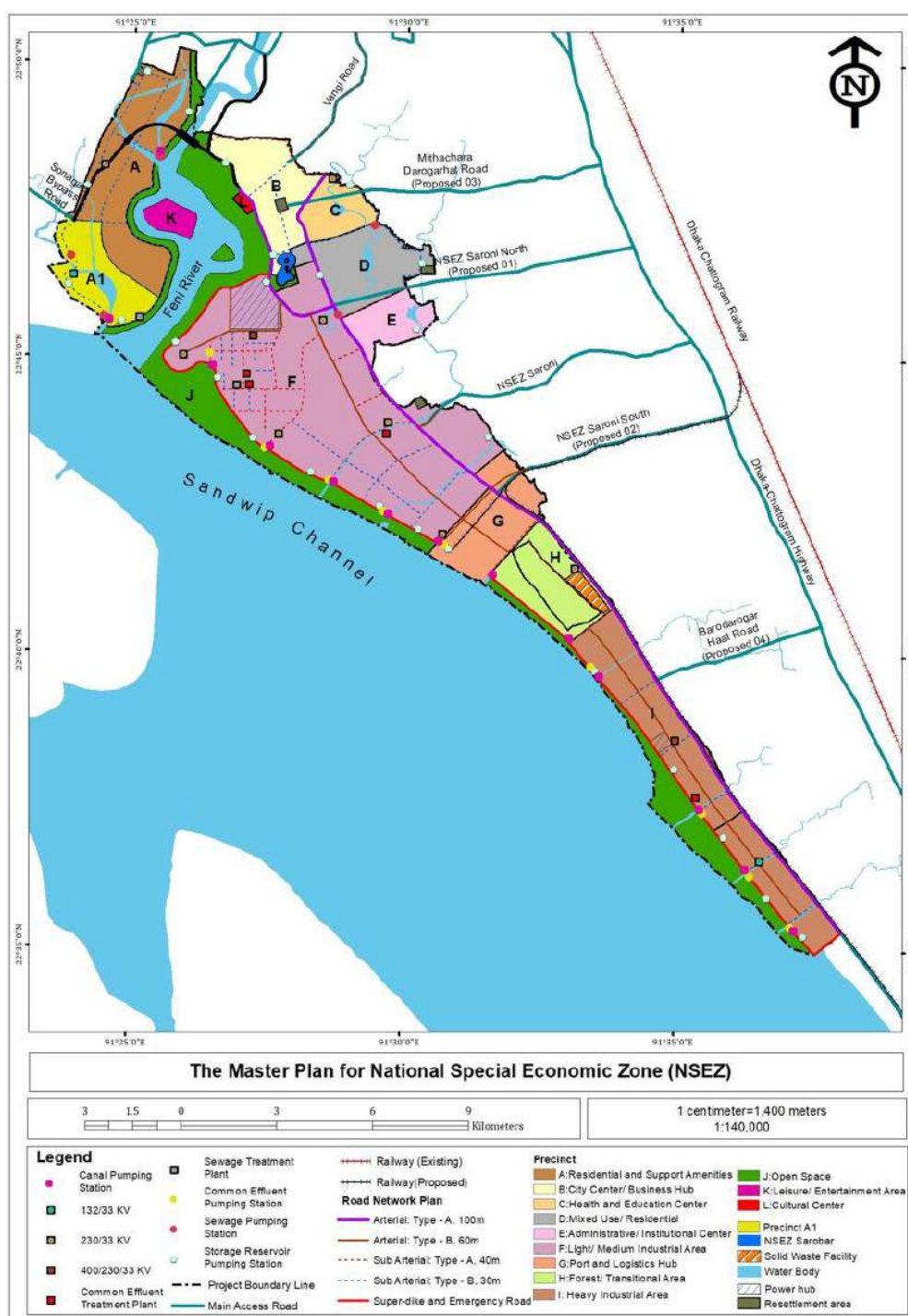
The NSEZ has been proposed to be located in Mirsharai Upazila (Saherkhali and Ichakhali Union) and Sitakunda Upazila (Muradpur and Saidpur Union) in Chattogram and Sonagazi Upazila (Sonagazi and Char Chandia Union) in Feni district. NSEZ site is located 200 km from the capital Dhaka, 60 km from Chattogram, 70 km from Chattogram Port, and Shah Amanat International Airport.

E-2.2 Master Plan of NSEZ

NSEZ has a total land area of 33,805 acres (mostly reclaimed land) with a 25 km coastline along the Sandwip Channel in the Bay of Bengal. The masterplan sets out: i) land uses, ii) access and transport networks, iii) precinct boundaries and characteristics, iv) zoning and permitted uses, v) development guidelines, and iv) environmental and green resilient rules to follow when implementing the zone. The NSEZ site has been divided into 12 separate precincts, which have their own land uses. A map of the NSEZ master plan is shown in Figure E-1.

E-2.3 Phasing of NSEZ

All the land within NSEZ has not yet been acquired and some lands have been allocated to investors, it is more complicated to accurately phase the site according to best practices. The Master Plan of the NSEZ has divided the total area into three phases. The execution period is divided into three phases i.e., a) Phase-I: years 0-5 (2020-2025), b) Phase-II: years 6-10 (2026-2030), and c) Phase-III: years 11-20 (2031-2040).

Figure E-1: Master Plan for National Special Economic Zone

Source: BEZA

E-2.4 Key NSEZ Infrastructure

Various types of infrastructure/utilities will be developed following international standards within NSEZ to provide world-class networks, structures, and services, which will make NSEZ a competitive, sustainable, and resilient zone. These infrastructures/utilities differ in their structural characteristics, services and functions, and performance standards. Table E-1 provides an overview of the types of general infrastructure envisioned for NSEZ.

Table E-1: Key Types of Infrastructure Services and Assets Planned for NSEZ

Key Infrastructure, Services, and Functions	Types of Infrastructure/Utility Assets
Flood Protection and Management	Coastal embankments, river dykes, pumps, gates, stormwater drainage, etc.
Transport	Roads, Bridges, Ports, Rail, Light Rapid Transit, etc.
Buildings	Factory Shells, Administration Buildings, Residential/Commercial/ Retail/Educational/Medical Buildings, Fire Services, etc.
Telecommunication	Towers, Cables, Fiber Optics, Backbone, Switches, etc.
Water Supply and Sanitation	Water System (Potable/Grey), Sewage Treatment Plants (STP), Water Treatment Plants (WTP), Water Reservoirs, Desalination Plants, etc.
Energy	Power Plants, Sub-Stations, Solar Panels (including Floating Solar) Renewable, etc.
Waste Management	Waste Treatment Plants (CETP), Bio-Gas Plants, etc.

Source: BEZA

E-2.4.1 Transport Networks

E-2.4.1.1 Road Networks

On-Site Road Network within NSEZ

A hierarchy of roads has been designed within NSEZ. All road networks will have services and utilities integrated into their design. The hierarchy of roads will be an emergency road - super dyke (100m ROW), arterial roads - Type A (100m ROW), arterial roads - Type B (60m ROW), sub arterial roads - Type A (40m ROW), sub arterial roads - Type B (30m ROW), and collector street - (20m ROW).

External Road Network

At present, the capacity of the local access roads adjacent to NSEZ is quite limited and the number of existing links to NSEZ is inadequate to cater to the additional volume of traffic likely to be generated by NSEZ. Considering the functional characteristics of NSEZ and the anticipated movement pattern of passenger and freight, Dhaka - Chattogram Highway and Feni - Sonagazi Road are likely to assume greater importance. The connecting roads are mainly from Dhaka-Chattogram Road and can be listed as Muhuri Project Road (Zorarganj - Muhuri Project), Bamonsundar Road, NSEZ Sarani, and Mohan Nagar Barodarogarhat Road.

E-2.4.1.2 Railway Network

Bangladesh Railway (BR) has planned a new railway line to establish connectivity between the NSEZ and the existing Dhaka-Chattogram railway line. The proposed railway line will take off from the existing Bartakia railway station having a length of 13.4 km.

E-2.4.1.3 Water Transport

According to the consultation with BIWTA, a permanent jetty will be constructed at the Sandwip channel for carrying the materials/goods. The capacity of the jetty will be 2,500 to 3,000 tons.

E-2.4.2 Power

NSEZ requires about 3,248 MWh (maximum) of power. To supply power to the NSEZ, a reliable transmission infrastructure has been proposed to be constructed internally in the industrial hub by the BEZA through the PGCB along with the upgradation of the existing grid network. The power will be supplied through the centralized power facility meant for the whole NSEZ. BR Powergen Limited has already established a 150 MW Dual Fuel (Gas/HFO) Engine Based Power Plant in the NSEZ. An MOU

has been also signed with the Bangladesh Rural Electrification Board for power network distribution within the NSEZ.

E-2.4.3 Gas

Karnaphuli Gas Distribution Company Limited (KGDCL) will provide gas to the NSEZ. They have initiated a project to upgrade the KGDCL existing gas distribution network capacity and make arrangements for supplying 200 MMSCFD gas to the upcoming industrial customers in NSEZ from the national gas network.

E-2.4.4 Water

The anticipated gross water demand is 360 MLD by 2025, 506 MLD by 2030, 717 MLD by 2035, and 1,013 MLD by 2040 (BEZA, 2020b). About 100 MLD of water will be supplied from the Feni reservoir during the 1st phase. About 40 MLD from 25 nos. of DTW was established to supply water in construction activities. Another 50 MLD of water from Feni Reservoir is in the planning for the next phase of activities. Approximately 500 MLD water from Meghna River, Chandpur through 132 km long transmission lines is in consideration. Additional water will be managed by using the treatment of seawater (desalination) and other sources.

E-2.4.5 Waste Management

The entire quantum of liquid waste likely to be generated from NSEZ shall be treated in two Sewage Treatment Plants (STPs) having a capacity of capacity 45 MLD and 80 MLD respectively, and four Common Effluent Treatment Plants (CETPs) having a capacity of 16 MLD, 32 MLD, 150 MLD, and 370 MLD respectively. Individual industry in the NSEZ will have their own ETP, after primary treatment they will send liquid waste to the CETPs for further treatment.

An area of 185 acres of land for a municipal solid waste landfill has been considered. In addition, about 274 acres of land have been considered for composting plants, different infrastructure, an area for biomedical waste, and a separate area for hazardous waste storage and management.

E-2.4.6 Telecommunication Network

Bangladesh Telecommunications Company Limited (BTCL) is developing a 22 km Optical Fiber Cable from Dhaka-Chattogram highway to NSEZ. Besides, another 15 km of OFC will be laid from Sonagazi of Feni to Mirsharai EZ through Dasherhat (Charchandia).

E-2.4.7 NSEZ Plantation Plan

A comprehensive plantation plan has been proposed along the road and rail networks, natural water channels, coastal area along the Bay of Bengal and the Feni Reservoir, open spaces, and in Precincts K and L of the NSEZ Master Plan. According to the consultation with BEZA, the Bangladesh Rural Advancement Committee (BRAC) has already planted approximately 42 thousand trees on 68 acres of land in Mirsharai, part of NSEZ, financed by HSBC Bank. BEZA has planted 4 lakh trees so far in the NSEZ site and the closest road networks of NSEZ. Forest Department also planted trees along the super dyke with their own financing. In the NSEZ Sorobor area (a 112-acre dighi nearby), BEZA has planted trees on approximately three acres of land. In the Sonagazi part, they have already planted some trees along the road.

E-2.4.8 Embankment/Super Dyke

Bangladesh Water Development Board (BWDB) has constructed a super dyke having a length of approximately 22.5 km and 9 nos. of the sluice to protect the NSEZ from flood, saline intrusion, erosion caused by tidal surge, and natural disasters. In addition, a 30 km re-excavation of khal has been done. A 12.5 km embankment will be constructed along the coastline from Domkhali in Mirsharai to Guliyakhali in Sitakunda. Besides, an embankment will also be developed in the Feni site later.

E-3 Applicable Legal and Policy Framework

This RESA is developed in line with the relevant national legislation, policy, and guidelines as well as World Bank Environmental and Social Standards (ESS1-10) under Environmental and Social Framework 2018, relevant WBG EHS guidelines, & other Good International Industry Practices (GIIP).

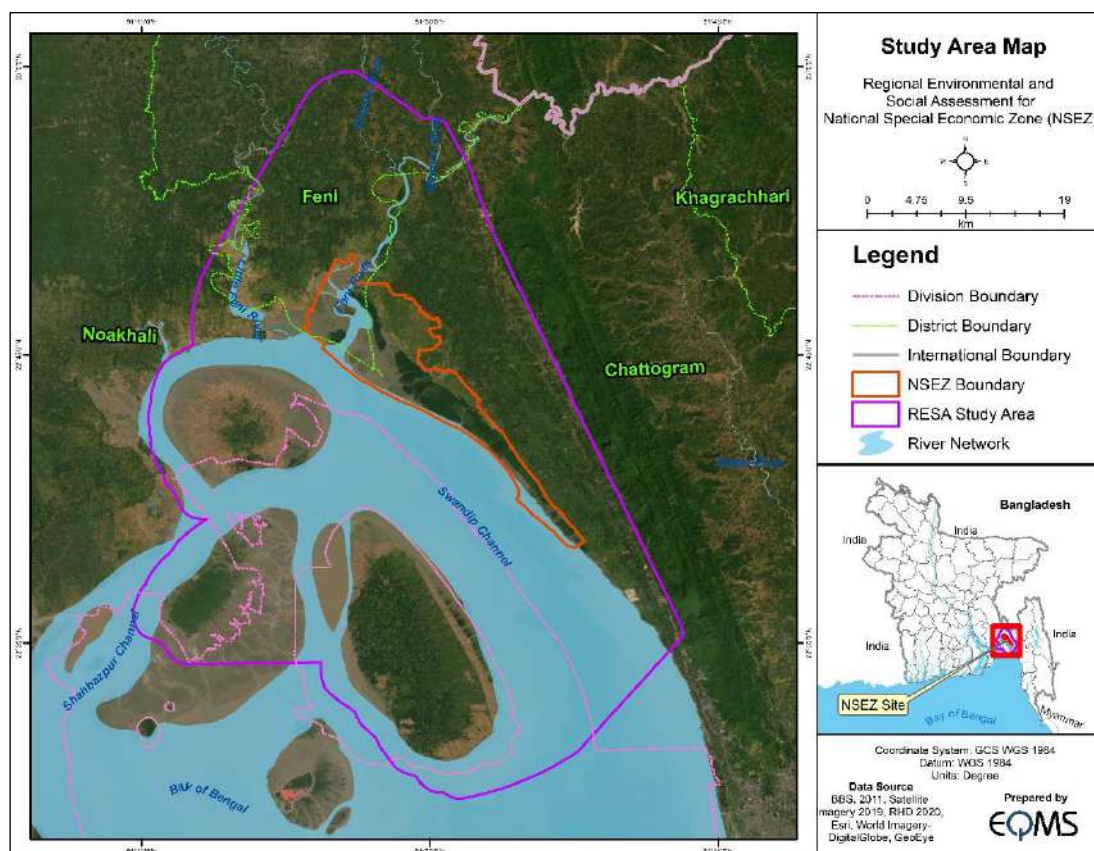
E-4 ES Baseline of the Region

The study area of the RESA for the NSEZ has been selected based on the location of the EZ and related facilities, their footprint, nature, and spatial distribution of potential environmental and social risks and impacts. The study area includes the project footprint area and area of influence (AOI). The AOI is comprised of areas of direct and indirect impacts as follows:

- **Direct area of influence:** considers the physical footprint of the development activities such as the site layout, work staging areas, and areas affected during development and operation works (e.g., traffic patterns).
- **Indirect area of influence:** includes an area that may experience project-related changes combining with activities, not under the direct control of the development activities (e.g., labor influx, induced development, access to employment, etc.).

For determining the study area, all the geospatial data regarding the NSEZ footprint was collected from BEZA and superimposed using GIS software. It helps to identify physical elements, aspects, and facilities that are likely to generate environmental and social risks and impacts in the context of the NSEZ footprint area and area of influence. A map of the study area is shown in Figure E-2.

Figure E-2: Map of the Study Area



Source: Geospatial data from BEZA and map prepared by EQMS

E-4.1 Meteorology

According to the climatic sub-regions of Bangladesh, the study area is located in the South-East Region having a small range of temperatures, and rarely goes over a mean of 32.0°C and below a mean of

13.0°C. Rainfall is heavy, usually over 2,540 mm. In winter, dewfall is heavy. Like other parts of the country, the study area is heavily influenced by the Asiatic monsoon.

E-4.2 Geology

According to Alam et. Al., 1990, the study falls under the geological unit of beach and dune sand, valley alluvium and colluvium, bhuban formation (Miocene), boka bill formation (Neogene), tidal mud, estuarine deposits, chandina alluvium, tidal deltaic deposits, and tipam sandstone geology units¹.

E-4.3 Topography

The study region is generally flat and low-lying towards the Bay of Bengal and Sandwip Channel. The site belongs to the sea-land interactive sedimentary plain, and the terrain appears to be relatively flat. No hilly area has been found inside the NSEZ boundary and its immediate surroundings. From the spatial analysis of the region, the topographic elevation ranges between -11.07mMSL to 23.7mMSL.

E-4.4 Soil

According to the SRDI, the study area falls under the unit of calcareous alluvium, old meghna estuarine floodplain soils, mainly deep brown soils on low hills, grey piedmont soils, deep and shallow brown soils on very steep, high hills ranges.

E-4.5 Physiography

According to the physiography of Bangladesh, the study area falls under the physiographic unit of Chittagong Coastal Plain, Old Meghna Estuarine Floodplain, Young Meghna Estuarine Floodplain, High Hill Ranges, and Low Hill Ranges.

E-4.6 Land Use and Landcover

In the study area, the major share of the land is under the water bodies which is about 188,929.07 acres covering 37.21% of the total land cover. Agricultural land is also present in the study area, which consists of 140,105.62 acres, and accounts for only 27.59% of the total area. The mudflat and settlement with Homestead Vegetation area cover 15.04% and 13.89% of the total study region.

E-4.7 Geomorphology

According to Ahmed, et. al., 2004, there are three geomorphologic divisions of Bangladesh vis-à-vis its soil formation. These are Tertiary Hills, Pleistocene Uplands, and Holocene Plains (Piedmont Plains, Flood Plains, Deltaic Plains, Depressed Lands, and Coastal Plains)². The study area falls under the geomorphic unit of Tertiary Hills, Holocene Plains - Deltaic Plains, and Coastal Plains.

E-4.8 Surface Water Hydrology and Drainage

Feni and Little Feni are the two major rivers that flow down to the Bay of Bengal on the northwest of the proposed NSEZ area. These two major rivers make a confluence near Char Chandia. The major Khals which flow through the proposed NSEZ area are Ichakhali, Bamon Sundar, Saherkhali, and Domkhali Khal. Others are Daborkhali, Khutakhali, Hoania, and Donakhali Khals. Most of the Khals receive water from hills on the east of the Dhaka-Chattogram Highway.

E-4.9 Groundwater Hydrology

Hydrogeological investigation shows that the topsoil in the study area is composed of mainly silty clay. The depth of the deep aquifer varies between ~50m to ~150m and is increasing towards the southeast.

¹ Alam, M.K., Hasan, A.K.M.S., Khan, M.R., and Whitney, J.W. (1990). Geological Map of Bangladesh. Geological Survey of Bangladesh (GSB) and United States Geological Survey (USGS).

² Ahmed, K.M., Bhattacharya, P., Hasan, M.A., Akhter, S.H., Alam, S.M.M., Byuyian, M.A.H., Imam, M.B., Khan, A.A., and Sracek, O. (2004). Arsenic Enrichment in Groundwater of the Alluvial Aquifers in Bangladesh: An Overview. Applied Geochemistry 19:181-200.

It is observed that shallow or deep aquifers in the study area are interrupted by discontinuous clay deposition at multiple depth levels of different thicknesses.

E-4.10 Agroecology

According to the data from BARC, the major types of agro-ecological units reported from the study area include Chittagong Coastal Plain, Young Meghna Estuarine Floodplain, Old Meghna Estuarine Floodplain, and Northern and Eastern Hills.

E-4.11 Erosion and Sedimentation

Sandwip is an off-shore island along the southeastern coast of Bangladesh in the Chattogram District, located in the Meghna estuary, which is very dynamic and unique in nature due to its geographical position and hydro-geomorphic settings. The islands of Urirchar, Shwarno Dwip, Bhashan Char, and Sandwip had a higher accretion rate, and each had a different setting from the other areas. Southward erosion and northward accretion were seen in these areas. The most accretion-prone areas of the Meghna Estuary are the Sandwip, Urirchar, and Shwarno Dwip areas where about 0.22m/year deposition is found (IWM, 2010³). Another study was carried out in 2013 to plan and detail design of the Urirchar-Noakhali Cross-dam and predicted that about 11,000 hectares of land could be reclaimed in seven years (HaskoningDHV, 2014⁴).

E-4.12 Traffic

A total of 8,103 nos. of vehicles were recorded at the road traffic monitoring station. Vehicular movement has been counted for both directions (Borotakia to NSEZ and NSEZ to Borotakia) on the road. As per the observation made for traffic density, on average 337 nos./hr. was recorded at the location. It was observed that Baby Taxi/CNG/Auto are predominant on the road. It was observed that vehicle movement increased from 6-7 AM and it was the peak at 3-4 PM. The number of vehicles on the road decreased after 8-9 PM and it was a minimum at midnight.

E-4.13 Environmental Quality

E-4.13.1 Ambient Air Quality

The primary ambient air quality was monitored at ten different locations covering the whole study area during the baseline data collection. The PM_{2.5} and PM₁₀ are observed to vary from 10.84 µg/m³ to 46.38 µg/m³ and 19.49 µg/m³ to 79.51 µg/m³ respectively. NAAQ stipulated standard for PM_{2.5} for 24 hr. average is 65 µg/m³. NAAQ stipulated standard for PM₁₀ for 24 hr. average is 150 µg/m³. The SO₂ and NO₂ are observed to vary from 11.63 µg/m³ to 39.9 µg/m³ and 15.17 µg/m³ to 33.06 µg/m³ respectively. NAAQ stipulated standard for SO₂ for 24 hr. average is 80 µg/m³. NAAQ stipulated standard for NO₂ for 24 hr. average is 80 µg/m³. The CO is observed to vary from 0.06 mg/m³ to 0.22 mg/m³. NAAQ stipulated standard for CO for 8 hr. average is 5 mg/m³. The O₃ is observed to vary from 20.02 µg/m³ to 36.19 µg/m³. NAAQ stipulated standard for O₃ for 8 hr. average is 100 µg/m³.

E-4.13.1 Ambient Noise Level

The primary ambient noise monitoring has been conducted at ten different locations covering the whole study area. Daytime noise levels were found to vary from 48.0 dB(A) to 69.6 dB(A). All the observed values except ANL-2 and ANL-3 were within the Noise Pollution (Control) Rules 2006 nighttime standards as well as IFC standards set for the respective zone. Night-time noise levels were found to vary from 39.4 dB(A) to 58.4 dB(A). All the observed values except ANL-2 and ANL-3 were within the Noise Pollution (Control) Rules 2006 nighttime standards as well as IFC standards set for the respective zone.

³ IWM (2010), Updating of Hydrodynamic & Morphological Models to Investigate Land Accretion & Erosion in the Estuary Development Program (EDP) Area, Final Report.

⁴ Royal HaskoningDHV, DEVCON, and IWM (2014), Feasibility Study of the Urir Char Noakhali Cross Dam, Final Report

E-4.13.1 Surface Water Quality

Fourteen surface water samples were collected and analyzed from various water sources around the NSEZ including two samples from Sandwip Channel (marine water) and twelve from Feni River (Muhuri Reservoir), and different khals including Ichakhali, Daborkhali, Bamansundar, Hoania, Saherkhali, and Domkhali. The analysis results indicate that all the parameters were within the permissible limit of the ECR, 2023 standard except the Chemical Oxygen Demand and Phosphate.

E-4.13.1 Groundwater Quality

Five groundwater samples were collected and analyzed from various water sources around the NSEZ. The analysis results indicate that all the parameters were within the permissible limit of the ECR, 2023 standard, and WHO Guidelines value except the Boron, Iron, Magnesium, Sodium, and Total Dissolved Solids.

E-4.14 Flora

A comprehensive inventory of plant species was conducted within the study area, resulting in the identification of a total of 56 distinct species. It was revealed that 43 of them belonged to the category of homestead species, 10 species were classified as fallow land species, and 3 species of mangroves.

E-4.15 Fauna

A total of 18 species of mammals were found within the study area. Among them, Rhesus Macaque (*Macaca mulatta*) is categorized as Vulnerable (VU); Jungle Cat (*Felis chaus*), Irrawaddy Dolphin (*Orcaella brevirostris*) are categorized as Near Threatened (NT); and Fishing Cat (*Prionailurus viverrinus*) is listed as Endangered (EN) in the IUCN Red List of Threatened Species of Bangladesh 2015.

A total of 185 bird species were recorded in the study area. Among them, Black-headed Ibis (*Threskiornis melanocephalus*) is categorized as Vulnerable (VU), Grey-headed Fish Eagle (*Ichthyophaga ichthyaetus*) is categorized as Near Threatened (NT) according to the IUCN Red List of Threatened Species of Bangladesh 2015.

A total of 28 species of reptiles are found in the study area. Among them, Asian water monitor (*Varanus salvator*) is categorized as Vulnerable (VU), while the Bengal Monitor (*Varanus bengalensis*), Yellow Monitor (*Varanus flavescens*), Monocled Cobra (*Naja kaouthia*), Red-necked Keelback (*Rhabdophis subminiatus*), and Spectacled Cobra (*Naja naja*) are classified as Near Threatened (NT) according to the IUCN Red List of Threatened Species of Bangladesh 2015.

A total of 9 species of amphibians were found within the study area. Among these species, the Cascade Frog (*Amolops marmoratus*) is categorized as Vulnerable (VU) according to the IUCN Red List of Threatened Species of Bangladesh 2015.

A total of 30 species of coastal fisheries and 16 species of culture fish and crustacean species were recorded in the study area.

As part of RESA a comprehensive Critical Habitat Assessment (CHA) was conducted following the ESS6 of the WB ESF and its Guidance Note (2018), none of the wild flora and faunal species in the study area meet the threshold limit for Criterion (a). Moreover, the species found in the study area do not qualify for CH Criteria (b) to (e) and do not fully or partially overlap with any internationally or nationally designated area. So, the proposed NSEZ site and study area is not a Critical Habitat for any of the identified species.

E-4.16 Ecologically Sensitive Areas

The NSEZ site as well as the study area doesn't hold any protected area, marine protected area, marine reserve, ecologically sensitive area, and hilsha sanctuary. However, a hilsha spawning ground boundary point is located within the study area namely Mayani Point, Mirsharai, Chattogram. In addition,

in the study area, two Important Bird and Biodiversity Areas have been found, namely the Ganges-Brahmaputra-Meghna delta and Muhuri Dam.

E-4.17 Socio-Economic Issues

The information on socio-economic aspects of the study area has been compiled from secondary sources as well as primary surveys. The salient features of the demography and socio-economic profile are as follows:

- Mirsharai Upazila has a population of 472,777 followed by Sitakunda Upazila 4,57,368 while Sonagazi shares the lowest population size of 67,320.
- The population comprises 48% of males and 52% females.
- Majority (~40%) of the population were aged between 20-49 years.
- Agriculture, comprising crop cultivation, fisheries, direct farming, sharecropping, agricultural laborers, and so on, is the most common source of employment in the study region.
- Electricity: 88% of households have grid electricity connections. The union-wise variation shows most households have access, except in Muradpur.
- Cooking Fuel: 19.40% use wood, 35% use wood/cow dung mix, 42% use wood/cow dung/LPG mix, and 2.5% use LPG. Others use a mix of electricity, cylinders, and other sources.
- Drinking Water: 59.45% use tube-well water, 28.36% use both tube-well and deep tube-well, and 12.19% access deep tube-wells.
- Lighting: Nearly 90% use electricity for lighting and fanning, 10.45% use solar panels, and less than 1% use kerosene lamps.
- Sanitation: 31% have water-sealed sanitary latrines, and 69% have non-water-sealed sanitary latrines, indicating widespread access to sanitation facilities.
- Archaeological, Heritage, and Cultural Structure: None of the sites are located within or around the NSEZ.
- Tourist spots: one spot located inside of the proposed NSEZ boundary.

E-5 Stakeholder Mapping and Public Consultation

An extensive stakeholder consultation was undertaken as part of the RESA. During the RESA, the key stakeholders were categorized into three categories i.e., Project Affected Parties, Other Interested Parties, and Disadvantaged/Vulnerable Individuals or Groups are consulted. The stakeholders included but were not limited to the host community (Mirsharai, Sitakunda, and Sonagazi area) and other stakeholders i.e., landowners/users, female groups, different occupational groups, educational institutes, health institutes, workers, youth community, investors, local government (Union and Upazila), upazila administration, district administration, elected representatives (Member of Parliament, Upazila Chaiman) and major political representatives, chamber of commerce and industry government departments/institutes i.e., DOE, FD, DOF, DAE, UDD, RHD, LGED, DPHE, BWDB, BIWTA, BR, CWASA, BTCL, BITAC, KGDCL, GTCL, MOSW, UHFPO, UHC, CPP, BEPZA, BGMEA, BREB, PGCB, EC4J, Fire service, Police Force, NGOs, CBOs, press clubs, print and broadcasting media, etc. Validation workshops were conducted at different levels including the Union, Upazila, District, and regional level to disseminate project-related information, disclose the outcome of the draft RESA including the CIA report, and environmental concerns, and seek information on appropriate mitigation for negative impacts.

The key concerns and recommendations from the consultation process are given below:

- The compensation and rehabilitation must be ensured prior to the starting of construction work as per applicable national legislation for any further development in the region.
- Fisherman and livestock-dependent communities will be impacted. Therefore, the rehabilitation of fishermen and livestock-dependent communities should be ensured on a priority basis.
- Groundwater crisis already exists in the NSEZ region. NSEZ should focus on surface water resources to avoid conflicts between different water users. Rainwater harvesting in each industry should be mandatory.

- Wildlife residing in the NSEZ area including deer, monkeys, etc. is suggested to be rehabilitated in alternative forest areas. If there is any endangered species, it requires to take steps to save them.
- Generation and management of solid waste in NSEZ will be a critical task. Currently, there is no mentionable waste management system in the region. Even the local municipal authority has a lack of ability to handle waste in the region.
- Plastic pollution in the marine environment is an issue and it should be ensured that solid waste/plastic waste is not disposed to the aquatic environment.
- Liquid waste can pollute water resources if adequate mitigation measures are not considered. ETPs should be established and ensure the operation and functionality of the ETPs.
- Social infrastructure i.e., educational institutes, medical facilities, roads, housing and infrastructure, drainage and culverts, waste management facilities, graveyards, playgrounds, community centers, recreational facilities, fire stations, townships, etc. need to be established and improved.
- The rainwater naturally drains out through the khals. Stakeholders suggested considering drainage facilities parallel to the road network and keeping existing khals functional at any cost.
- There are many tourist spots and natural resources surrounding the NSEZ. There is great scope for developing and promoting these potential tourist places.
- Job placement should be prioritized with skill-developing training. Industry should prefer local employees during recruitment.

E-6 Potential ES Risks and Impacts

Impact analysis entailed identification of impacts, classification of impacts into positive and negative, and impact ratings. Impact identification was carried out through field visits, literature reviews, and stakeholders' input. Below is a summary of the positive impacts anticipated from the proposed NSEZ development and operation:

E-6.1 Potential Positive Impacts

The nation and region will have the following benefits from the development and operation of the NSEZ:

- Approximately 1.4 million direct job opportunities by 2040
- An increase in land and property values in the region
- Skill development and training for the local people
- Transfer of relevant technical skills and tools
- Boost national foreign exchange reserves and bring in foreign currency
- Increase the revenue and profitability of the business sector
- Development of local infrastructure, notably the transport infrastructure.
- Better social amenities including education facilities, health facilities, recreational facilities, and markets among others
- Improved security in the region
- Increased number of tourists visiting the area
- Benefit to local retail businesses
- Increased market for local agricultural products
- Improved public transportation system in the region
- Improved quality of life in the region
- Income to material/equipment suppliers and contractors will be increased.

E-6.2 Potential Negative Impacts

E-6.2.1 Impacts during the Development Phase

A summary of potential negative environmental and social risks and impacts anticipated from the development of the NSEZ has been given below:

- **Air Quality:** during the development of the NSEZ, particulate matter (PM_{2.5}, PM₁₀) will be the major pollution that will be generated from site development activities such as levelling on land, cutting and filling activities to the site, rock breaking, crushing, traffic movement, etc. In addition, emissions will occur due to the operation of diesel fuel generators and exhaust emissions from transport vehicles. This has the potential to cause temporary impacts on the ambient air quality.
- **Noise Level:** major sources of noise during the development phase will be dredging activities, vehicular traffic and operation of heavy construction equipment like dozers, scrapers, concrete mixers, cranes, compressors, generators, pumps, rock drills, pneumatic tools, saws, vibrators, etc. However, these impacts will be short-term and intermittent in nature. The increased noise level can impact workers' health and safety, and residents close to access roads are at higher risk of noise nuisance.
- **Surface water:** Surface water may be impacted due to non-point discharges of solids from soil loss and sewage generated by the construction workforce stationed at the site. During dredging, oxygen-demanding compounds, nutrients, and sediments from the seabed will enter the marine water column. Since concentrations of oxygen-demanding compounds are normally much higher in pore water than in the water column it will cause a depletion in oxygen concentration. Nutrients may stimulate primary production when light and temperatures are sufficient and may cause eutrophication problems when released in favorable conditions.
- **Groundwater:** all the water required during the construction phase is arranged from groundwater sources, and to date about 25 nos. of tubewell has been established considering the demand of construction phase water requirement. About 40 MLD of water is produced to supply in different construction sites. The Hydro-Geological Survey under the Mirsharai Upazila Development Plan 2018 recommends that the aquifer condition in the EZ area is not suitable for the heavy groundwater withdrawal required for the project. Heavy pumping from that aquifer would cause the compression of the aquitard and result in land subsidence. Besides, there is a high risk of later intrusion of seawater (salinity intrusion) into groundwater from the adjacent sea.
- **Topography and Soil:** topography will be changed due to the activities such as dredging, land development, super dyke, roads, stormwater drainage, pipelines, industries, etc. Soil quality may be impacted if any contaminated sediment is used for land development. Rainfall and surface runoff can cause soil erosion.
- **Changes in Land Use:** land use of an area of 33,805 acres will be changed to an industrial area due to the development of the EZ.
- **Impacts on Khals and Drainage:** excavation, earthwork, and levelling activities in the ES site and development activities surrounding the area by the local community change the natural topography of the land which disrupts the natural drainage. This may lead to waterlogging in the upper catchment areas of the khals during heavy rainfall, with the situation worsening during high tide periods. In addition, the flood control infrastructures, if not well maintained, will be subject to negative impacts such as local flooding. Furthermore, these khals were traditionally used by local fishermen for sea access. However, the development of NSEZ has disrupted this vital access for the fishermen.
- **Traffic:** the increased traffic volumes will increase the potential of incidents on the internal road as well as access roads within the study region.
- **Flora:** development activities will impact local vegetation, reducing area greenery, including mangroves and common tree species. Dust created by development activities will affect plant growth by interrupting physiological processes like transpiration when lodged on leaf surfaces

thereby blocking their stomata. Emissions from stacks can corrode plant surfaces and contribute to the acidification of aquatic ecosystems, further impacting plant health and growth.

- **Fauna:** clearance of vegetation will reduce food resources, impacting foraging success and potentially leading to ecosystem disruption and population declines among local fauna, including crabs, fish, and birds. Vehicle movement on approach roads at dawn and dusk may increase roadkill risk for nocturnal animals. Noise and vibrations from heavy machinery could disrupt the foraging, ranging, breeding, and nesting behaviors of wildlife species. Additionally, artificial lighting and noise may interfere with nocturnal species' movement patterns, affecting their foraging, reproduction, and migration behaviors.
- **Land Acquisition, Resettlement, and Rehabilitation:** development of the EZ has led to significant impacts related to land acquisition, resettlement, and rehabilitation, resulting in both immediate and long-term effects on local communities. Approximately 76 households, primarily consisting of poor fishermen, have already been displaced due to land acquisition for access road construction, highlighting the economic displacement faced by local residents, including buffalo owners and gazers. Future plans for railway and road development are anticipated to further affect numerous residential and commercial structures, necessitating additional land acquisition and resettlement measures.
- **Community Health, Safety, and Security:** construction activities may increase dust and noise pollution, leading to respiratory issues, while the influx of workers raises concerns about communicable diseases, particularly HIV/AIDS. Additionally, heavy machinery traffic could increase accident risks, especially near schools. The rise in migrant workers may also contribute to higher crime rates and perceptions of insecurity.
- **Occupational Health, Safety, and Security:** common injuries include cuts, falls, and traffic accidents, with the potential for serious outcomes. Exposure to pollutants may worsen respiratory issues and chronic health conditions, while stress and substance abuse could increase among workers. Poor hygiene practices may facilitate the spread of diseases like malaria, dengue, and HIV/AIDS. Fire hazards from flammable materials also pose risks. It is crucial for project owners to provide first-aid facilities and ensure timely access to medical care for serious injuries.
- **Labor Influx:** development of the EZ is expected to trigger a significant labor influx, attracting a diverse workforce from local, regional, national, and international markets. While this provides employment opportunities for skilled and unskilled laborers, it may also lead to conflicts between construction workers and local communities due to cultural differences and varying lifestyles. Additionally, the pressure on the existing social infrastructures and services will be embedded due to the influx of laborers as well as their families and followers.
- **Child Labor and Forced Labor:** development of the EZ poses a significant impact due to the potential for child labor and forced labor. The recruitment process may inadvertently include individuals under the age of 14, violating Bangladesh's Labor Act of 2006, which prohibits the employment of children and hazardous work for those under 18.
- **Gender-Based Violence and Sexual Harassment:** an influx of predominantly young male construction workers, often separated from their families, may lead to inappropriate behaviors such as sexual harassment and exploitative relationships with local women and girls. This situation increases the risks of human trafficking and the spread of sexually transmitted diseases, including HIV/AIDS. The prolonged construction activities, expected to continue until 2040, further exacerbate the vulnerability of local communities, particularly youth and women, to GBV and SEA/SH.
- **Infrastructure:** an influx of workers and their families and followers will increase demand for public services like healthcare, education, housing, sanitation, etc. This strain on local infrastructure may disrupt daily life for nearby communities, as existing facilities such as

schools, health centers, and roads are currently inadequate to meet rising needs. Expanding and improving these services in advance will be essential to accommodate future demand.

- **Fisherman and Fishery Activity:** development of the EZ is expected to significantly impact the livelihoods of fishing and land-dependent communities in Mirsharai, Sitakunda, and Sonagazi Upazilas, where fishing is a key economic activity. Construction and dredging activities have already reduced fish catch rates in the Sandwip Channel, with fishermen reporting damage to nets due to increased marine traffic and relocations of essential fish landing stations, leading to accessibility issues. Traditional fishermen, reliant on shallow waters, may lose access to fishing areas and cyclone shelters, resulting in loss of income and long-term socioeconomic challenges. Local fishermen, especially the Jaladash community, are not easily employable in the NSEZ, as they lack formal education for higher-skilled jobs.
- **Livestock Population and Dependent Community:** development of EZ has an impact on local livestock-dependent communities by reducing grazing land, leading many buffalo owners to sell their animals or shift to other areas for grazing. The livestock population, particularly buffalo and sheep, has dropped from 20,000 to around 8,000 due to these restrictions. This decline affects livelihoods tied to livestock, including buffalo owners, herders, and dairy businesses, posing a long-term socioeconomic challenge.

E-6.2.2 Impacts during the Operation Phase of the NSEZ

A summary of potential negative environmental and social risks and impacts anticipated from the operation of the NSEZ has been given below:

- **Air Quality:** PM_{2.5}, PM₁₀, SO_x, NO_x, CO_x, CH₄, VOCs, NH₃, and heavy metals i.e., Cr, Ni, Pb, and Hg will be increased in the region from the operation of industry, vehicles, vessels, jetty operation, etc. Transportation will be one of the major sources of GHGs. GHGs from transportation will be CO₂, CO, CH₄, VOCs, NO_x, SO₂, and Hydrocarbons. Solid waste management and wastewater treatment facilities will emit CO₂, CH₄, and N₂O.
- **Noise Level:** ambient noise level will be increased in the region from activities including traffic movement and industry and facilities operation, jetty operation, ship movement, etc.
- **Surface Water:** major threats to surface water quality will be pollution from sewage, effluents from the operation of industries, accidental leaks or spills of hydrocarbons, etc. Two desalination plants are proposed to meet the water demand in the EZ. Brine effluent from the desalination plant will be injected into the water discharge pipe and ejected into the Sandwip Channel. Discharging brine effluent from the desalination plant may lead to elevated levels of salinity in the direct vicinity of the discharge. Effluent may also contain biocides, chlorine, and lower levels of dissolved oxygen, which will influence water chemistry and quality.
- **Groundwater:** accidental spillage or leaks of chemicals, hydrocarbons (oil, fuel, or other substances), and leachate from the landfill site could percolate into the subsurface and potentially contaminate the groundwater. Any leachate in the groundwater would have adverse impacts on the hydrology. Sewage disposal from workers facilities and solid waste deposits in case of lack of proper management will impact groundwater. Solid waste management facilities including landfill sites may impact the regional groundwater quality.
- **Sediment Quality:** activities i.e., piling, excavation, concreting work, construction of jetties, accidental spillage of hazardous chemicals, improper storage and disposal of waste may mix with rainfall water, and it can accumulate on the adjacent surface water bodies through runoff. Dredging disturbance of sediments can release contaminants into the water column.
- **Changes in Land Use:** during the development of the EZ, a large number of workers will be influx into the EZ surrounding area. Therefore, the demand for social infrastructures will be increased which will change the land use in NSEZ's surrounding region.
- **Solid Waste:** it is estimated that the total amount of industrial solid waste to be generated from the operation of the EZ in the year 2040 will be 288,925 tons out of which 250,751 tons will be non-hazardous industrial solid waste and 38,174 tons will be hazardous in nature. Waste

originating from the marine jetty may include inert solid waste from administrative offices, as well as hazardous or potentially hazardous waste associated with vehicle and equipment maintenance operations.

- **Liquid Waste:** it is estimated that approximately 118.32 MLD of sewage wastewater will be generated by the year 2040. untreated wastewater, if discharged into nearby surface waters may affect the surface water and/or if disposed of on land without treatment may pollute the ground and surface water.
- **Traffic:** it is assumed that the maximum one-way passenger traffic by 2040 towards Dhaka-Chattogram Road and Sonagazi will be around 9,000 passenger car units/hour and 3,200 passenger car units/hour respectively.
- **Flora:** operation of the EZ will significantly impact native flora. Habitat fragmentation from infrastructure can isolate plant populations, reducing genetic diversity and resilience. Industrial emissions may cause soil acidification and nutrient imbalance, harming native flora. Increased human activity could introduce invasive species, outcompeting local plants and reducing biodiversity, while habitat fragmentation will limit natural connectivity, further threatening ecosystem balance.
- **Fauna:** operation of the EZ will impact terrestrial fauna in the region and aquatic fauna in the Sandwip Channel in various ways. Habitat fragmentation, pollution, and noise may disrupt the feeding, breeding, and migration patterns of terrestrial wildlife, leading to biodiversity loss. For aquatic fauna, industrial runoff and emissions can degrade water quality, harming fish, crustaceans, and other marine species. Increased human activity, light pollution, and vibrations will further disturb both terrestrial and aquatic ecosystems.
- **Community Health Safety and Security:** emissions and waste from industries could increase air, soil, and water pollution, affecting public health. Increased transportation and infrastructure demand may heighten the risks of road accidents, while inadequate sanitation and public health services could strain local resources. Additionally, the influx of labor may raise the risk of spreading communicable diseases.
- **Occupational Health and Safety:** operation of the EZ poses significant occupational health and safety risks, particularly for unskilled workers. Potential hazards include machinery accidents, high temperatures, chemical exposure, and confined spaces, with risks of injuries, chronic illnesses, or fatalities. Specific industries such as steel, power, and petrochemicals carry additional risks of fires, explosions, and toxic leaks. Workers may also face psycho-social challenges, including stress and mental health issues, while poor sanitation may increase susceptibility to diseases.
- **Labor Influx:** labor influx may lead to social issues, including local price inflation, increased risk of gender-based violence, crime, and disturbances in public order, as well as environmental pollution from inadequate waste disposal by migrant workers. Labor influx would create additional pressure on existing social amenities and infrastructure. Local communities could experience crowding out of resources, social disorder, and deteriorating living conditions.
- **Child Labor and Forced Labor:** operation of the EZ may pose potential risks of child and forced labor, especially among unskilled and semi-skilled workers, due to prevailing socio-economic challenges in Bangladesh.
- **Fisherman and Fishery Activity:** operation of the EZ may directly impact fishermen and fishery activities due to increased shipping. The presence of larger vessels can obstruct the visibility of artisanal fishermen, create safety hazards with large bow waves, and impede the safe crossing of established shipping channels. Additionally, operational activities may modify coastlines, reduce access to fishing areas, and enforce exclusion zones, limiting fishermen's access to resources. Increased risks to fishing equipment from larger vessels may also arise without knowledge of local fishing practices.
- **Livestock Population and Dependent Community:** operation of the EZ will directly impact livestock populations and dependent communities by reducing available grazing lands due to

boundary fencing and industrial operations. This will result in the complete loss of feeding grounds and economic losses for livestock-dependent households.

E-7 Cumulative Impact Assessment

CIA was carried out following the principles of the IFC Good Practice handbook for CIA and Management to identify the potential cumulative impacts associated with the development and operation of NSEZ and other applicable third-party projects in the region. The spatial boundary demarcation for the CIA has been done based on the location of economic zone and their likely impacts on potential VECs within their Area of Influence. The temporal boundaries for the CIA have been considered for 16 years, considering the foreseeable projects planned in the NSEZ area.

A VEC screening process was applied, using a logical analytical framework, to determine ones which of the preliminarily identified VECs can be reasonably expected to be affected by some combination of other projects and/or external stressors and the project. The key VECs selected for this CIA land use, topography & drainage, air quality, groundwater resource, marine water quality, mangrove, and mud-flood habitat, aquatic and migratory bird species, protected marine fauna, livelihood (land-based & fisherman), social well-being.

Key and relevant stakeholders were identified as a part of the CIA study process and consultations were undertaken with them to gather information on VECs, understanding past and present conditions, obtaining inputs on potential cumulative impacts identified by the study team, and what stakeholders thought would be appropriate mitigation measures.

The study has considered the following external stressors or drivers that have the potential to have an impact on selected VECs:

- **Industrialization**: Presently, there are no accommodation facilities in the EZ. However, it is planned to construct accommodation facilities in the Zone of the EZ. It is estimated that 0.41 million working population in the year 2040.
- **Natural Stressors**: Natural influences and environmental drivers include those linked to climate change. These include floods, cyclones, coastal floods, etc. comprise major stressors that reportedly affect the surface water resource and aquatic biodiversity, livelihood, physical infrastructure, and properties in the EZ.

The cumulative impacts on the VECs accounting for the NSEZ, other past, present, and future developmental projects as well as external drivers/stressors have been assessed and a summary of the cumulative impacts and recommended mitigation measures are provided below.

- **Land Use Change**: impact of land use change in terms of loss of land and wetland is assessed as high and the Project Under Consideration (PUC) contribution as low. To mitigate the impacts, ensure phase-wise development, after the completion of one phase and develop the next phase land. Develop a land use plan for the region considering future industry development and induced development.
- **Topography and Drainage**: impact of topography and drainage in terms of loss of land and wetland is assessed as medium and the PUC contribution as low. To mitigate the impact, a regional-level drainage study needs to be conducted to understand the impact of drainage and prepare a regional drainage plan.
- **Air Quality**: impact of air quality in terms of concentration of PM and NO_x is assessed as high and medium respectively and the PUC contribution as low. To mitigate the impacts, a regional air quality monitoring program needs to be established, and based on the review of regional monitoring data the DOE will need to consider appropriate steps to regulate industries by linking it with the issue of Environmental Clearance or decisions about new industries in the region.
- **Groundwater Resources**: impact of groundwater resources on the groundwater depletion rate is assessed to be high and the PUC contribution as low. To mitigate this, regular monitoring of

groundwater tables should be ensured, and permission should be taken from WARPO for the abstraction of groundwater.

- **Surface Water Quality:** impact of surface water quality in terms of concentration of DO, BOD, and toxic metals is assessed as medium the PUC contribution as low. To mitigate this, a program for regional water quality monitoring including provision of infrastructure and manpower requirements should be prepared and implemented.
- **Mangrove and Mud-flood Habitat:** impact of mangrove and mud-flood habitat is assessed to be high and the PUC contribution as low. To mitigate this, Phase-wise land development: Phase III land development should start after the allotment of the entire land developed for Phase I. In addition, implementing the plantation plan should be ensured.
- **Aquatic and Migratory Bird Species:** impact of migratory birds and aquatic bird species is assessed as medium the PUC contribution is low. To mitigate this, periodical monitoring of bird species with special emphasis on endangered and migratory birds.
- **Livelihood (Land-based and Fisherman):** impact of livelihood (land-based and fisherman) is assessed to be medium and contribution from PUC is low. To mitigate the impact, job and economic opportunities for the local people, especially project-affected families, and unemployed youths should be ensured. In addition, regional-level fishery study focuses on fish species, endangered fish species, trends in fish yield and species composition, fishermen's livelihood, and fish conservation. Additionally, phase-wise development so that grazing can be done in undisturbed areas.
- **Social Well-being:** impact of social well-being is assessed to be medium and contribution from PUC is low. To mitigate this, participatory planning and improvement of social infrastructures should be ensured.

E-8 Alternative Analysis

In the analysis of alternatives, options were explored including 'no' go alternatives, location alternatives, access roads, sources of construction materials, water supply, gas supply, electricity supply, hazardous/non-hazardous waste management and disposal, wastewater pre-treatment, discharge, treatment and reuse, types of industries, phasing of development, drainage management, and dredging and landfilling alternatives.

1. **'No' go Alternatives:** considering the number of job opportunities (1.4 million by 2040), business/investment opportunities, future local economy, improved quality of life, infrastructural development, road connectivity, rail connectivity, local export, and overall national economic development this alternative option was rejected.
2. **Location Alternative:** location is selected considering the accessibility by road and waterways and availability of land. The selected site is mostly reclaimed land from the sea and a very small amount of private land. Sensitive areas such as national parks, wildlife sanctuaries, marine protected areas, marine reserves, cultural heritage sites, key biodiversity areas, etc. are not present.
3. **Sources of Construction Materials:** construction materials sources from national sources/markets are preferred considering the benefits and income generation capacity of local suppliers, contribution to the economy's growth, government revenue (TAX and VAT), and atmospheric emissions during the transport of construction materials.
4. **Access Roads:** has been selected by avoiding settlement areas, environmentally sensitive areas, socially acceptable, future traffic conditions, and connection with other road networks.
5. **Water Resources:** considering the water requirement and availability in the region water from both surface and groundwater sources are recommended including water from the Meghna River and the desalination plant.
6. **Electricity Supply:** power plants within EZ are perfect for the use of LPG, natural gas, and/or LNG. However, renewable energy sources such as solar and wind could be considered as additional energy supply sources besides the installed electrical power source.

7. **Gas supply:** gas supply using a pipeline is preferred and the size of the pipe will consider the delivery of the required volume of gas to the EZ by avoiding E&S sensitive areas.
8. **Waste Management:** source-segregated waste collection in color-coded bins. Organic waste is treated at a compost plant; recyclable materials are sent to recycling units. Hazardous waste is disposed of in a lined landfill cell within NSEZ. Private sector involvement for waste management under NSEZ oversight.
9. **Effluent and Sludge Management:** sludge with organic matter reused as a soil conditioner; hazardous sludge disposed of in lined cells.
10. **Phased Development:** the implementation of EZ should follow phase-wise development and the new phase should not begin until 90% of the previous phase of a project is completed and sold out/leased to the investors.
11. **Dredging and disposal:** Hence considering the required production rate and disposal site location, a Trailer Suction Hopper Dredger (TSHD) can be preferred for dredging. However, a Cutter Suction Dredger (CSD) is preferred over TSHD at locations where the depth is shallow. Regarding the disposal of dredge spoil, the priority will be landfill if the sediment is not contaminated.

E-9 Disaster Risk Assessment and Disaster Risk Management Plan

A detailed inventory of different natural disasters in the NSEZ region has been prepared through an extensive literature review and consultation with the relevant stakeholders and local community. From the analysis, it has been observed that the NSEZ site is highly vulnerable to cyclones and tidal surges, earthquakes, tsunamis, flood/flash floods, and medium vulnerable to lightning and tornadoes. Finally, a Disaster Risk Management Plan has been prepared to establish and maintain procedures to address or prevent such situations in the EZ region, as well as to test the effectiveness/review/revise such procedures periodically. The details plan has been given in Appendix J.

E-10 ES Management Procedure

Due to the nature of some of the proposed activities during development and operation of the NSEZ in the region and their potential environmental and social impacts, the different activities/projects will fall into different project categories (red, orange, yellow, green) according to Environment Conservation Rules 2023 and World Bank environmental and social risk classification (high, substantial, moderate, and low), which will require initial ES screening, EMP/ESMP, IEE, and in some cases detail EIA/ESIA. Therefore, the ES management plan is prepared based on the following principles that can lead to the development and implementation of the activities/projects in the region.

- BEZA HQ at the national level and the Project Director of NSEZ at the project level are responsible for compliance with national policies, regulations, and WB ESSs and guidelines.
- PD of NSEZ in coordination with the other institutions including RHD, LGED, BWDB, BIWTA, PGCB, BR, KHDCL, etc. as well as investors/industries in the NSEZ is responsible for obtaining environmental clearance from DOE, local government agencies, and WB as required.
- IEE, EIA/ESIA, and EMP/ESMP need to be prepared for activities upon screening. In case the requirements of DOE's EIA guidelines differ from those of WB ESF, the more stringent standards and requirements will apply.
- If any activities/projects with impacts are identified in ESIA which may categorize the project as High risk (according to ESF) will not be eligible for WB's financing.
- Activities requiring Free, Prior, Informed Consent (FPIC) from small ethnic communities will not be eligible for implementation in the region under WB financing.
- Activities with significant environmental impacts, including those that significantly increase greenhouse gas emissions and impact on natural habitats and biodiversity will not be eligible for implementation in the region under WB financing.
- Planning and design of any additional activities should ensure minimal assessment of cumulative impacts.

- Environmentally sensitive areas, cultural heritage sites, and restricted or disputed lands (if identified during project implementation) should be handled with appropriate mitigation or compensation measures during implementation following the chance find procedure.
- Participation of stakeholders (especially local communities) should be ensured by the HSE team of NSEZ in the planning, implementation, and monitoring of project activities.
- NSEZ management will ensure appropriate institutional set up for implementing E&S management plans and inter-agency coordination. They will also ensure that bidding/agreement/contract documents for construction contractors, and PPP operators have specific clauses to ensure implementation of E&S management plans, as required.
- Contractors to be engaged in construction/renovation/expansion/repair and maintenance/operation workers under the NSEZ should be conversant with OHS standards, labor laws, SEA/SH issues, incidence response, and reporting mechanisms.
- NSEZ management will inform project stakeholders about project interventions and their potential impacts on the surrounding ES elements.

E-11 Institutional Arrangements, Capacity Assessment, and Strengthening

Bangladesh Economic Zone Authority has established an Environment and Development Unit under the planning and development wing based at its HQ in Dhaka. Currently, the unit consists of three officers including one Director, one Deputy Director, and one Assistant Director. To support the unit, seven environmental and social councilors are working in different EZs and supporting the HQ team for environmental management, grievance, consultation with the community, implementation of CSR activities, etc. Regarding NSEZ, one environment specialist, one social specialist, and one occupational health & safety specialist/consultant are working under the Project Implementation Unit of NSEZ at the head office on a contractual basis. In addition, three environmental and social councilors are working in NSEZ on a project-based contract under the Private Investment and Digital Entrepreneurship Project of BEZA.

Under this RESA, one HSE Manager/ESG Manager, two environment safeguard specialists, four social safeguard specialists, two occupational health and safety specialists, and two lab technicians are recommended to be recruited for NSEZ to ensure the overall environmental, social, and health and safety risk management for the first phase development. They will be responsible for coordination with other institutions/authorities including but not limited to DOE, FD, DOF, local administration, municipal authorities, NGOs, etc. to implement environmental, social, gender, land acquisition, compensation, resettlement, grievance management, stakeholder engagement plans, etc. In addition, a full-fledged environmental laboratory equipped with ambient air, ambient noise, drinking/groundwater, wastewater, soil quality, and sediment quality monitoring system should be established to ensure proper environmental management in the NSEZ and the surrounding region.

The introduction of Environment, Social, and Governance (ESG) Digital Tools in the Monitoring System has been recommended, which will enable BEZA management to accurately, efficiently, and transparently track and report on environmental, social, and governance performance in different economic zones as well as NSEZ. Digitalization can significantly improve operational efficiency, leading to a reduced environmental footprint.

E-12 Conclusion and Recommendations

E-12.1 Conclusion

The NSEZ proposed by the BEZA has strategic value on many fronts. As Bangladesh believes that the establishment of industrial zones throughout the country will contribute to the development of the national economy, it could also be said that the Project is strategic in the economic sense. The Project will contribute to the economic development of the Chattogram region as well as the economic development of the country.

The NSEZ will seek to develop the socio-economic conditions of the people living in the region. There is no denying that, once the Project is implemented, it will substantially enhance international trade. It also has the huge potential of attracting investors from inside and outside the country by establishing a favorable investment environment. At the micro-economic level, the NSEZ will promote entrepreneurship and create job opportunities.

Individual industries in the NSEZ will carry out environmental assessment and or environmental management plans including adequate mitigation measures and monitoring plans to reduce the negative impacts and consider necessary budget allocation for the industry.

E-12.2 Recommendations

The following is a highlight of some of the key recommendations of this RESA report:

- To mitigate air pollution, a regional air quality monitoring program needs to be established. DOE needs to establish continuous air quality monitoring stations in the region. Based on the review of regional monitoring data, DOE will need to consider appropriate steps to regulate industries by linking it with the issue of Environmental Clearance or decisions about new industries in the region.
- To mitigate water pollution, regional water quality monitoring needs to be prepared and implemented. DOE will need to establish an integrated continuous and online base monitoring system at the CSTPs and CETPs outlet for water quality monitoring.
- Regular monitoring of groundwater tables in the region should be ensured and permission should be taken from WARPO for the abstraction of groundwater. In addition, a groundwater quality monitoring program should be established particularly for landfill sites.
- Segregation of solid waste at sources is strongly recommended and all waste management should comply with the requirements of Solid Waste Management Rules 2021.
- A desalination plant can be considered an important alternative water resource in the region. An EIA needs to be conducted before initiating the activity.
- Develop a land use plan for the region considering future industry development and induced development and ensure phase-wise development, after the completion of one phase and develop the next phase land.
- Construction of green structures, use of climate-friendly construction materials, renewable energy, electric vehicles, adoption of carbon trading for high-emission industries, and emission monitoring for the industries.
- A green belt development is strongly recommended outside of the existing super dyke to protect the super dyke as well as NSEZ from severe cyclones and associated tidal surges.
- BWDB shall prepare a regional drainage plan and monitor the function of drainage in the region specifically before the monsoon and take precautionary measures to reduce flood and waterlogging.
- Compensation for the land, loss of income, and other investment loss as per the national legislation and WB ESSs.
- A livelihood restoration plan should be developed and adopted for the fishermen and livestock-dependent communities.
- A township development for the workers considering the distance between living and working sites.

1 INTRODUCTION

1.1 Background

Bangladesh has an impressive track record of growth and development. It has been among the fastest-growing economies in the world over the past decade, supported by a demographic dividend, strong ready-made garment exports, remittances, and stable macroeconomic conditions. Bangladesh sets a target to reach a middle-income country by 2031. To achieve its vision of attaining upper middle-income status by 2031, Bangladesh needs to create jobs and employment opportunities through a competitive business environment, increased human capital and skilled labor force, efficient infrastructure, and a policy environment that attracts private investments. In this regard, the Government of Bangladesh (GOB) has launched an initiative to provide industrial land and infrastructure to increase private investments with the support of the Bangladesh Economic Zones Authority (BEZA).

National Special Economic Zone (NSEZ) at Chattogram, Bangladesh is a successful initiative of BEZA to fulfill the dream of regeneration of that congregational tradition in modern Bangladesh. NSEZ with multi-dimensional features is a great junction of domestic and foreign investment, industrialization, and economy at the entrance of the southeastern part of the country. One of the largest economic and industrial zones in South Asia, NSEZ will be a state-of-the-art industrial city. It is one of the priority projects of the government for industrialization and job creation. Among the initiatives taken by the GOB to establish 100 economic zones in the country, NSEZ has got the highest priority.

Smart Bangladesh is the bold flagship slogan as well as the outcome of the new vision of the GOB, "Vision 2041" aiming to create a more resilient, innovative, smart, and digitally equipped nation by 2041. The smart Bangladesh will be built on four pillars i.e., developing smart citizens, assuring a smart government, managing a smart economy, and building a smart society. It will help the country to achieve its long-term development goals, such as becoming a developed and prosperous country by 2041, boosting economic growth and prosperity by attracting foreign investment and creating new jobs, more attractive destination for businesses and investors, and improving the quality of life for all Bangladeshis by providing them with access to better education, healthcare, and other essential services. The NSEZ will be a part of the long-term development goals and support to overcome the challenges to achieving Smart Bangladesh 2041 through infrastructure development, capacity building of manpower, and significant investment from private sectors and international donors.

1.2 Objectives of the RESA

The main objective of the RESA is to examine the associated environmental and social risks and impacts due to the implementation of the master plan of NSEZ. It will pay particular attention to potential cumulative risks and impacts of multiple activities in a region but may not include the site-specific analysis of a specific project. The specific objectives of the RESA are as follows:

- Assess potential environmental and social risks and impacts due to the implementation of the NSEZ master plan in the region including cumulative impacts of the other planned and/or ongoing projects/activities/related facilities in the region.
- Assess potential risks and vulnerabilities associated with climate change, natural hazards, and other external factors to the NSEZ, marginalized communities, and ecologically sensitive areas.
- Recommend broad measures to mitigate adverse environmental and social impacts, enhance positive outcomes, and promote sustainable development within the region. This includes identifying best practices, technologies, and strategies for minimizing environmental degradation and addressing social challenges.
- Facilitate meaningful participation and engagement of stakeholders, including local communities, civil society organizations, government agencies, private sector actors, and development partners, throughout the assessment process. Ensure transparency, inclusivity, and accountability in decision-making processes.

- Contribute to the sustainable development of the region by mainstreaming environmental and social considerations into development planning and implementation of the NSEZ master plan. Foster partnerships and collaboration among stakeholders to promote responsible and inclusive growth while safeguarding environmental and social well-being.
- Assess the present institutional arrangement of BEZA and propose a capacity-strengthening arrangement for NSEZ to ensure that the implementation of the master plan will meet the Environmental and Social rules and regulations of the country and World Bank's Environmental and Social Framework during the lifecycle of the industrial city.

Overall, the objective of the regional environmental and social assessment of NSEZ is to support sustainable and inclusive development that balances economic growth with environmental protection, social equity, and resilience-building efforts in the region. By addressing environmental and social challenges holistically, the assessment aims to contribute to the long-term prosperity and well-being of the NSEZ community and the broader Bay of Bengal region.

1.3 Scope of Work

As per the Terms of Reference (TOR), the scope of work for the assignment is as follows:

- Collection, review, and analysis of the environmental and social (E&S) baseline information of the region. The baseline would be mainly captured on the basis of authentic secondary information. Primary data collection would also be required in cases of the absence of reliable secondary data. Some primary data collection might also be required to validate secondary information as necessary.
- Analysis of the institutional and legal framework for the assessment and management of E&S risks and impacts in the region, identify institutional and jurisdictional gaps against the GOB rules and regulations and World Bank's Environmental and Social Framework (ESF) and Environment, Health, and Safety Guidelines (EHSG) and recommend measures to address the gaps.
- Assessment of potential E&S risks and impacts, including Occupational Health and Safety (OHS) of the proposed activities/land use plan as mentioned in the master plan of NSEZ, and recommend mitigation measures as per the BEPZA Labor Law 2019 (adapted by BEZA), Occupational Safety and Health Policy 2013, ESS2, and ILO conventions.
- Assessment of potential cumulative impacts of other planned and/or ongoing projects/activities in the region and recommend mitigation measures.
- Assessment of the susceptibility of the region to various natural disasters such as cyclones, earthquakes, water surges, and/or other climatic events, etc. their possible impacts and provide a Disaster Risk Management Plan (DRMP) for combating such events.
- Analysis of the existing procedures of BEZA for assessment and management of E&S risks and impacts and recommend procedures (including the implementation of a formalized ESMS) to be followed to ensure ES compliance with national laws and ESF. This would include a) screening criteria for the selection of investment in NSEZ, (b) setting up of environmental, health, and safety standards for the industrial city in line with GOB and the World Bank requirements, (c) general guidelines for long-term E&S monitoring and evaluation, (d) recommendations to strengthen social inclusion aspects for the future investments.
- Assessment of the present E&S management capacity of BEZA and recommend necessary measures/institutional structures for the implementation of the master plan.
- Identification of key national, regional, and project-level stakeholders relevant to the project; organize public consultation meetings at various stages of the preparation of the RESA and incorporate the feedback of consultations in the final report.
- Review, update, and validate the utility (water, gas, power) sources that have already been identified by BEZA for the implementation of the NSEZ Master Plan and prepare environmental and social impact for all utilities.

- Analysis of the Mirsharai Upazila Development Plan (MUDP) prepared by the Urban Development Directorate (UDD) for Mirsharai and its implementation challenges in regard to E&S aspects.
- Analysis of the E&S impact for 1.4 million jobs opportunity as per the Master Plan especially social aspects e.g., housing, education, livelihood, planned urbanization, planning of influence area and its management.
- Suggest implementation plan including budget to execute RESA recommendations.
- Review development plans of other agencies for this region and assess the impacts of those plans.
- Organize six validation workshops before the finalization of the RESA (one for each Upazila - Mirsharai, Sitakunda, and Sonagazi, one District level at Feni, one regional level at Chattogram, and one national level at Dhaka) as per the stakeholder engagement plan of the NSEZ.
- Mapping of all social aspects e.g., education, health, training, road, security, etc., and providing specific suggestions.

1.4 Reference Framework

As per the TOR, the reference framework for the assignment will include:

- Bangladesh's national legal framework
- International environmental conventions adopted by the Government of Bangladesh
- World Bank's Environmental and Social Standards
 - ESS1: Assessment and Management of Environmental and Social Risks and Impacts
 - ESS2: Labor and Working Conditions
 - ESS3: Resource Efficiency and Pollution Prevention and Management
 - ESS4: Community Health and Safety
 - ESS5: Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement
 - ESS6: Biodiversity Conservation & Sustainable Management of Living Natural Resources
 - ESS7: Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities
 - ESS8: Cultural Heritage
 - ESS9: Financial Intermediaries
 - ESS10: Stakeholder Engagement and Information Disclosure
- IFC Good Practice Handbook on Cumulative Impact Assessment
- World Bank Group Environmental, Health, and Safety (EHS) General Guidelines
- World Bank Group Environmental, Health, and Safety Guidelines for Construction Materials Extraction, 2007.

Additional Reference Materials:

- World Bank's Good Practice Note on Labor Influx Management
- World Bank's Good Practice Note on Addressing Gender-Based Violence
- World Bank's Good Practice Note on Addressing Sexual Exploitation and Abuse and Sexual Harassment
- World Bank's Good Practice Note on Non-Discrimination and Disability
- World Bank Environment and Social Incident Response Toolkit.

1.5 Approach and Methodology

The RESA was based on the collection of both the secondary and primary baseline environmental and social information, impact assessment, and delineation of the environmental and social management plan. The following approach and methodology are proposed to complete the RESA.

- The **literature review** encompassed existing documentation and reports related to the NSEZ from various agencies, as well as relevant national and international guidelines, to understand

environmental and social sensitivities and gather baseline data for informed planning and assessment.

- Delineate any specific **baseline information** required to be collected for the study area with reference to the physical, biological, and social components of the environment.
- **Consult with stakeholders** and integrate their views planning and implementation of NSEZ.
- Systematically **predict and evaluate the positive and negative changes** in these baseline conditions.
- The **cumulative impact assessment** involved evaluating the combined effects of past, present, and reasonably foreseeable future activities on the environmental and social components of the NSEZ region.
- **Disaster Risk Assessment** identified potential natural disasters in the region, analyzed risks using collected data, and proposed protective measures for effective management.
- Develop **Environmental and Social Management Procedure** that outlines measures to mitigate identified impacts, specifying actions, monitoring requirements, responsibilities, and timelines to ensure the sustainability of NSEZ development.

The methodology followed to complete RESA is elaborated in the subsequent sections below.

1.5.1 Literature Review

Existing literature related to the NSEZ was reviewed, including the available documentation on the proposed NSEZ and related facilities from the BEZA and other agencies including the Bangladesh Forest Department (BFD), Bangladesh Water Development Board (BWDB), Roads and Highways Department (RHD), Local Government Engineering Department (LGED), Bangladesh Inland Water Transport Authority (BIWTA), Power Grid Company of Bangladesh (PGCB), Bangladesh Rural Electrification Board (BREB), Karnaphuli Gas Distribution Company (KGDCL), Department of Public Health Engineering (DPHE), Urban Development Directorate (UDD), Chattogram Water Supply and Sewerage Authority (CWASA), Bangladesh Railway (BR), Bangladesh Telecommunications Company Limited (BTCL), etc. The documents like the Master plan, IEE, EIA, and Feasibility reports of different components of the NSEZ were collected and reviewed. In addition, existing literature on the NSEZ site and surrounding area was also collected and reviewed to understand any sensitive environmental and social receivers and to compile all available secondary baseline data.

All the applicable national rules, regulations, policies, and guidelines relating to the implementation of the NSEZ master plan were reviewed. In addition, the RESA team also reviewed international standards and guidelines such as World Bank Environmental and Social Standards 1-10 under the World Bank Environmental and Social Framework and other international conventions, agreements, and treaties that are ratified by the Government of Bangladesh. The review outcome of the legal and regulatory framework has been provided in Chapter 9 of this report.

1.5.2 Environmental and Social Baseline Conditions

The baseline conditions in respect of regional physical, biological, and socio-economic environment were collected from both the primary and secondary sources. All information available in publications and unpublished data available with various governments, educational, and other institutions for each discipline was analyzed to understand the environment of the region. The physical environmental baseline data mainly covers the meteorology, geology, topography, soil, physiography, land use and landcover, geomorphology, surface water hydrology, groundwater hydrology, agroecology, erosion and sedimentation, seismicity, and environmental quality (ambient air quality, ambient noise level, surface water quality, groundwater quality, soil quality, and sediment quality). The biological baseline data covers the bioecological zone, ecosystem and habitat, flora, fauna, aquatic monitoring (phytoplankton, zooplankton, and benthos), protected areas, ecologically critical areas, mangrove forest, Hilsha sanctuary and spawning ground, important bird and biodiversity areas, and RAMSAR site. Finally, the socio-economic baseline covers demography, gender, age, land ownership and tenure, community

structure, employment, education and skill, housing, religion, income, livelihoods, common property resources, community health and safety, disadvantage and vulnerable groups, gender-based violence, traffic, ethnic minority, cultural and heritage sites, and tourist spots. The collected primary, as well as secondary baseline data have been incorporated in Chapter 4 of this report.

1.5.3 Stakeholder Consultation and Public Disclosure

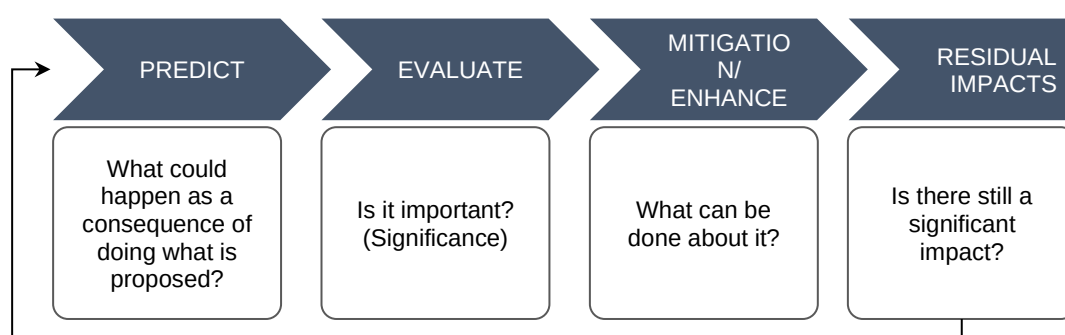
Stakeholder consultations were carried out throughout the whole RESA process. Consultations ensure that all stakeholder concerns are incorporated into the planning and implementation of NSEZ. This is in line with the statutory consultation requirements under World Bank Environmental and Social Standards, as well as the national regulations. Consultations were done at local, union, upazila, district, regional, and national levels. Stakeholders and methods of data collection include Key Informant Interviews (KII), Focus Group Discussions (FGDs), questionnaires with household heads, three validation workshops at the union parishad level, and six validation workshops at upazila, district, regional, and national levels. A summary of the outcome of the stakeholder consultation has been provided in Chapter 5 of this report.

1.5.4 Impact Assessment

RESA evaluated potential environmental and social risks and impacts using a methodology based on the evaluation of the “significance” of identified issues and impacts on baseline parameters. Analysis of the baseline results and the incremental impacts of the NSEZ were assessed in accordance with the national guidelines for air, water, and noise emissions standards mentioned in the Air Pollution (Control) Rules 2022, Environment Conservation Rules 2023, and Noise Pollution (Control) Rules 2006. World Bank’s Environmental and Social Standards (1-10) under the Environmental and Social Framework, WBG EHS Guidelines will also be followed during risk and impact assessment.

The risk and impact assessment covered the full NSEZ lifecycle, including preconstruction, construction, operation, and decommissioning (Past, Present, and Future) activities. The risk and impact assessment were involved in the prediction, evaluation, and mitigation of impacts, and reported on impacts including residual impacts and cumulative impacts. Impact prediction was taken into account control measures that are part of the NSEZ design. Additional mitigation measures aimed at further reducing predicted impacts were proposed where necessary or appropriate. The impact assessment process for the RESA is shown in Figure 1-1.

Figure 1-1: Impact Assessment Process for the RESA



1.5.5 Cumulative Impact Assessment

A cumulative impact assessment was carried out following the six steps process in line with the “IFC Good Practice Handbook: Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets Handbook” to identify cumulative impacts on various physical, biological, and social environments parameters in the region.

- Step 1: Scoping Phase I – Valued Environmental and Social Components (VESC), Spatial and Temporal Boundaries.
- Step 2: Scoping Phase II – Other Activities and Environmental Drivers.

- Step 3: Establish Information on the Baseline Status of Valued Environmental and Social Components (VESC).
- Step 4: Assess Cumulative Impacts on Valued Environmental and Social Components (VESC).
- Step 5: Assess the Significance of Predicted Cumulative Impacts.
- Step 6: Management of Cumulative Impacts – Design and Implementation.

The cumulative impact assessment report has been prepared and submitted as a standalone document.

1.5.6 Disaster Risk Assessment and Disaster Risk Management Plan

The potential of various natural disasters such as floods, cyclones, earthquakes, tidal surges, tsunamis, lightning, tornadoes, landslides, droughts, and other climatic events, etc. in the region was identified, and risk analysis was undertaken. Both the primary and secondary data relevant to the natural disasters were collected during the site visit and from the desktop review. Protective measures required to prevent the occurrence of any disaster shall also be suggested and a Disaster Risk Management Plan has been prepared and incorporated in Appendix J.

1.5.7 ES Management Procedure

An outline of the proposed ES management system indicating principals and and decision-making process to address ES risk assessment and management issues for the development and operation of the NSEZ. A screening criterion for selection of investment in NSEZ, an exclusion list of the activities, EHS standards for industrial city have been developed in line with the national and world bank requirements. In addition, recommendations for preferred alternatives considering ES aspects to reach ultimate development goals with PPP projects, monitoring the implementation of PPPs, and auditing framework has been developed.

1.5.8 RESA Report

The First Draft RESA Report has been prepared and submitted upon completion of the above tasks as per the prescribed Terms of Reference (TOR) shared by BEZA. Based on comments and feedback from the BEZA and World Bank, this first draft RESA report will be updated and resubmitted as the Final RESA Report.

1.6 Limitations

This RESA report is based on scientific principles and professional judgment applied to facts with resultant subjective interpretations. Professional judgments expressed herein are based on the analysis of available data and information. The RESA report was prepared with the following limitations:

- The assessment of the environment and social risks is limited to the NSEZ information available at this stage of the development of NSEZ, discussion with stakeholders, primary and secondary data collected, consultation with the local community, and observations made during the site survey. Professional judgment and interpretation of facts have been applied to presenting inferences from the collected information. If information to the contrary is discovered, the findings in this RESA report need to be modified accordingly.
- The information contained in this report was sourced from information, data, and reports supplied by BEZA, investors/individual industries, utility providers, related facility owners, and the local community that are assumed to be complete, valid, and true.
- The existing masterplan area covers 33,805 acres in the Feni and Chattogram Districts. There is uncertainty in getting the total land area from the relevant authorities and modification of NSEZ boundaries may be required in the future. If the NSEZ boundary is changed, in such cases, revision of this report will be required following the revised area and planning.
- Currently, the NSEZ master plan is implementing phase by phase. Changes in the existing master plan may occur due to unanticipated situations. Adaptive changes may also occur

during the course of the NSEZ master plan implementation. The RESA, and any associated plans/documents, are therefore intended to be 'living documents' that can be refined and modified as situations change.

1.7 Structure of the RESA Report

The RESA report has been divided into the following three volumes:

- **Volume-1:** Main RESA Report
- **Volume-2:** Cumulative Impact Assessment
- **Volume-3:** Appendices

Volume-1 consists of the main text of RESA, which identifies and elaborates on the impact assessment and mitigation, management, and monitoring measures.

Volume-1: RESA report consists of twelve chapters and the content is briefly described in this section.

Chapter 1: Introduction: discusses the background, objectives, scope of work, standards, approach and methodology of the RESA interim report, limitations, etc.

Chapter 2: Description of the NSEZ: discusses the location, master plan of NSEZ, phasing of NSEZ, key infrastructures, transport network, power network, gas, water, waste management, telecommunication, and plantation plan of the NSEZ.

Chapter 3: ES Baseline of the Region: describes the details of primary and secondary environmental and social baseline conditions with detail on physical, ecological, and socio-economic conditions.

Chapter 4: Stakeholder Mapping and Public Consultation: provide stakeholders consultation undertaken as part of the assessment process and the key issues identified from the same.

Chapter 5: Potential ES Risks and Impacts: provides the key environmental, ecological, and social risks and impacts in the region due to the implementation of the NSEZ master plan.

Chapter 6: Scenario Development: provide scenario development considering low, moderate, and high growth scenarios.

Chapter 7: Alternative Analysis: provides an analysis of alternatives for the NSEZ.

Chapter 8: ES Management Procedure: provides the management procedure for the identified impacts and risks in the region and planned mitigation and enhancement measures, monitoring requirements, responsible authorities, timeframe, and estimated implementation cost.

Chapter 9: Existing Legal and Regulatory Framework: discusses the policy, legal, and administrative framework describing the relevant policy and legal frameworks for the RESA process.

Chapter 10: Institutional Arrangements, Capacity Assessment, and Strengthening: identify institutional requirements and capacities to implement the mitigation measures.

Chapter 11: Conclusions and Recommendations: provide concluding remarks and recommendations.

2 DESCRIPTION OF THE NSEZ

This chapter describes the details of the location, master plan, development phasing, key infrastructures, transportation network (internal, external road, railways, water transport-jetty), power network (source, transmission, and distribution), gas transmission, water demand and sources, waste management, stormwater drainage system, telecommunication, and plantation area of NSEZ. All this information has been taken from the master plan report of the NSEZ shared by BEZA as well as reports from the utility providers and investors.

2.1 Location of the Proposed NSEZ

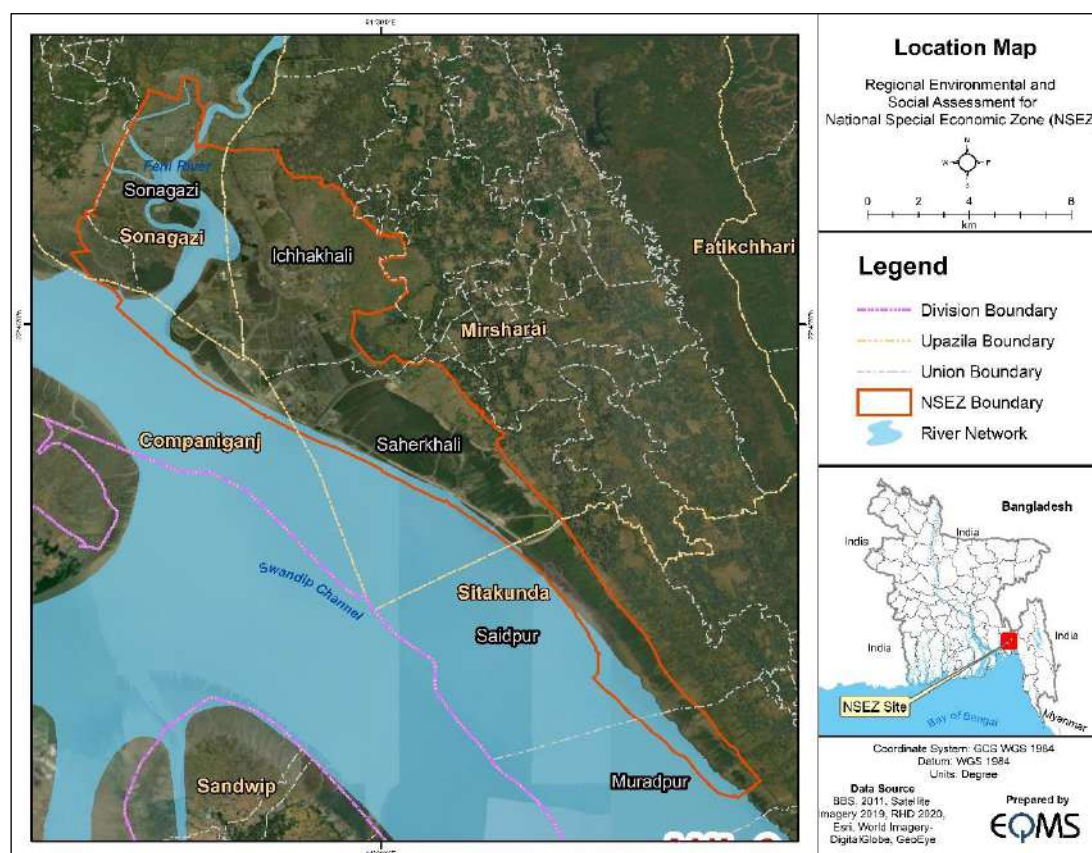
The NSEZ has been proposed to be located 200 km away from the capital Dhaka, 60 km from Chattogram, 70 km from Chattogram Port, and Shah Amanat International Airport. The NSEZ Master Plan area is covered two Districts, three Upazila, and six Unions and is comprised of 26 Mouzas. Details of the NSEZ location are given in Table 2-1 and a location map of the proposed site is given in Figure 2-1.

Table 2-1: Location of NSEZ

District	Upazila	Union
Chattogram	Mirsharai	Saherkhali and Ichhakhali
	Sitakunda	Muradpur and Saidpur
Feni	Sonagazi	Sonagazi and Char Chandia

Source: Master Plan of NSEZ, September 2020

Figure 2-1: Location Map of the NSEZ



Source: EQMS Consulting Limited, September 2023

2.2 Master Plan of NSEZ

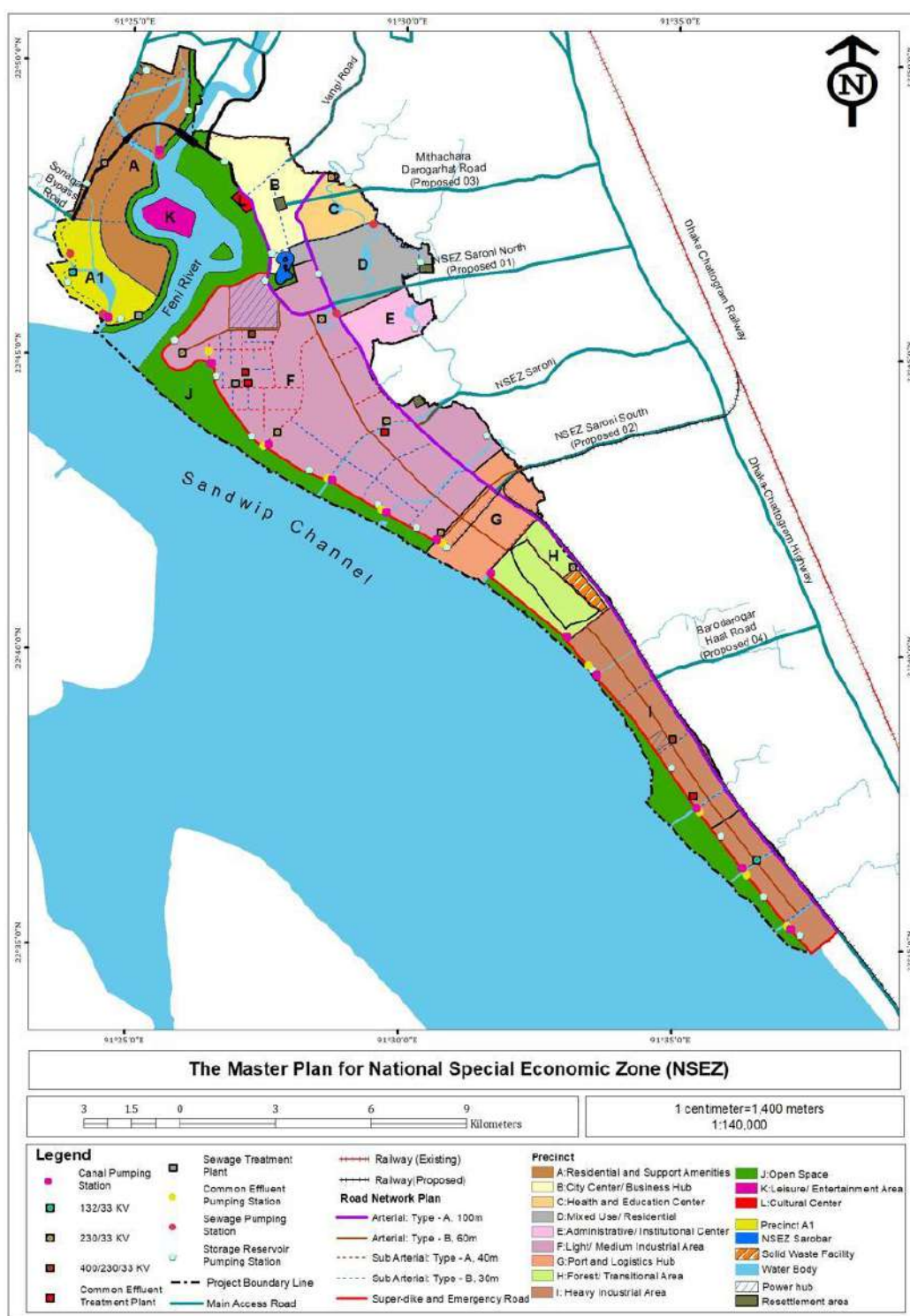
NSEZ has a total land area of 33,805 acres or 136.86 km² (mostly reclaimed land) with a 25 km coastline along the Sandwip Channel in the Bay of Bengal. The masterplan sets out: i) land uses, ii) access and transport networks, iii) precinct boundaries and characteristics, iv) zoning and permitted uses, v) development guidelines, and iv) environmental and green resilient rules to follow when implementing the zone. The NSEZ site has been divided into 12 separate precincts, which have their own land uses. Although specific plots have not been assigned in the master plan, it is intended that real estate projects following the designated land uses and design guidelines will be constructed over time and sold/leased at competitive market rates. The precincts for NSEZ are identified in Table 2-2 and a map of the NSEZ master plan has been shown in Table 2-2.

Table 2-2: NSEZ Precincts and Land Use by Size

Precinct	Land Use Designation	Land Use	Size in Acres	Size in %
A	Residential and Support Amenities	Low-scale residential units, convenience retail, and educational/ health	4,606.57	13.63
B	City Center/ Business Hub	Commercial, retail, administrative, and technology/ICT-related uses, high-rise residential towers, and support amenities	1,732.91	5.13
C	Health and Education Center	Health clinics, hospitals, educational uses, support amenities, short-term residences/ dormitories, hotels, and parking facilities	837.35	2.48
D	Mixed-Use/ Residential	Low and medium residential typologies (apartments, dormitories, rowhouses, etc.), support amenities, convenient retail, and alike	1,778.59	5.26
E	Administrative/ Institutional Center	Government buildings, libraries, museums, galleries, shopping/retail, commercial facilities, support amenities, etc.	880.68	2.61
F	Light/Medium Industrial Area	Light & medium industries, & a chemical hub only if buffered with landscaped boundaries	10,043.12	29.71
G	Port and Logistics Hub	Port and logistics-related activities and transport support amenities	1,802.29	5.32
H	Forest/Transitional Area	Forest conservation purposes but transitional to port, logistics, and/or heavy industrial uses, if required. Utility facilities are permitted	1,778.75	5.26
I	Heavy Industrial Area	Heavy industrial uses and associated support amenities	3,956.35	11.70

Precinct	Land Use Designation	Land Use	Size in Acres	Size in %
J	Open Space	Active and passive parks and open spaces. Limited development permitted	5,980.42	17.69
K	Leisure/ Entertainment Area	A variety of leisure and entertainment uses and support amenities	350.89	1.04
L	Cultural Center	Performing arts facilities, a cultural complex, sporting events, festivals, and large outdoor gatherings	56.85	0.17
Total Area			33,804.76	100

Source: BEZA, 2020a

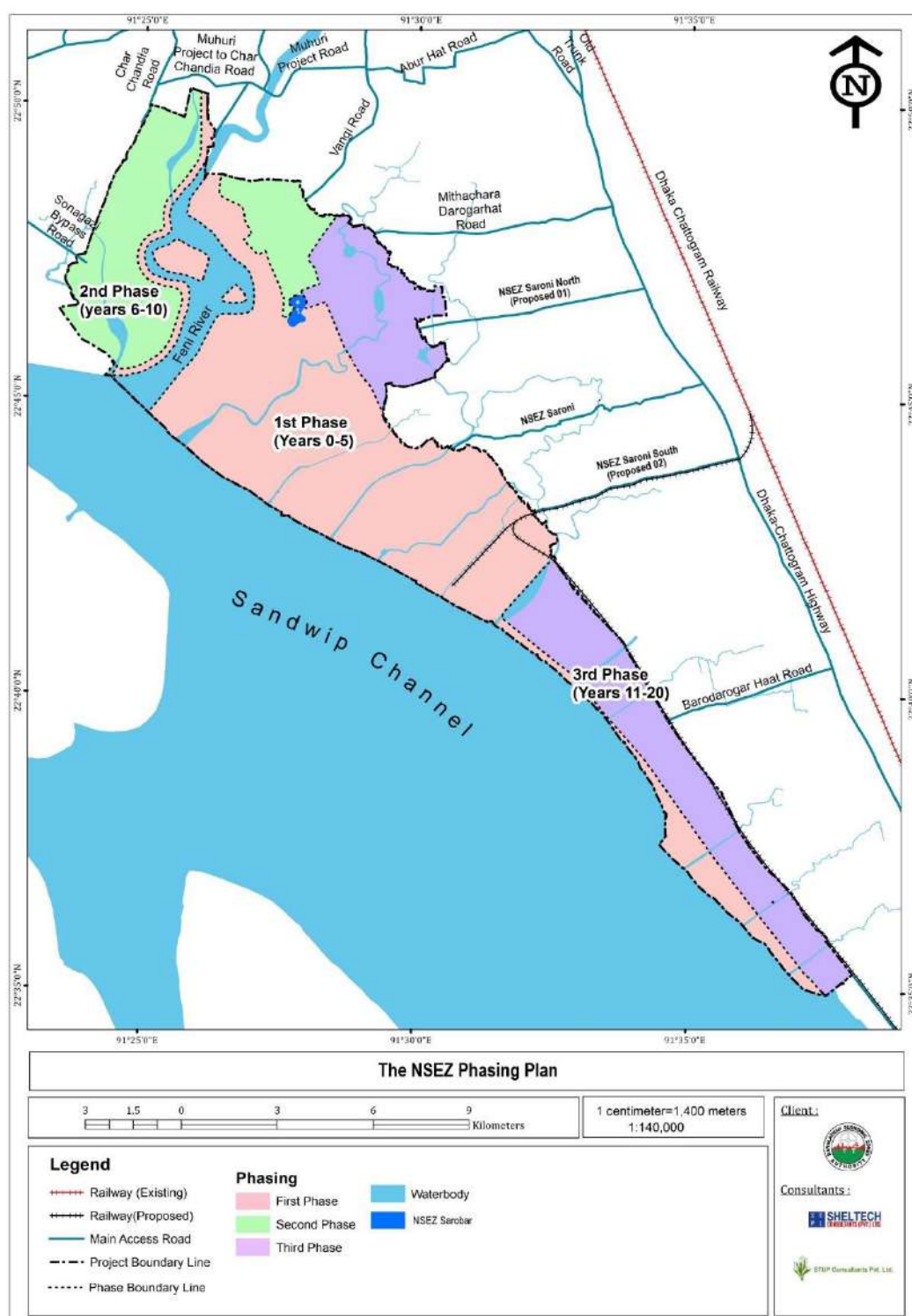
Figure 2-2: Master Plan for National Special Economic Zone

Source: BEZA, 2020a

2.3 Phasing of NSEZ

All the land within NSEZ has not yet been acquired and some lands have been allocated to investors, it is more complicated to accurately phase the site according to best practices. Considering the above facts, the Master Plan area has been divided into three phases. The execution period is divided into three phases i.e., a) Phase-I: years 0 - 5, b) Phase-II: years 6 -10, and c) Phase-III: years 11-20. A map of the NSEZ phasing plan has been shown in Figure 2-3.

Figure 2-3: NSEZ Phasing Plan



Source: BEZA, 2020a

2.4 Key NSEZ Infrastructure

Various types of infrastructure/utilities will be developed following international standards within NSEZ to provide world-class networks, structures, and services, which will make NSEZ a competitive, sustainable, and resilient zone. These infrastructures/utilities differ in their structural characteristics, services and functions, and performance standards. Table 2-3 provides an overview of the types of general infrastructure envisioned for NSEZ.

Table 2-3: Key Types of Infrastructure Services and Assets Planned for NSEZ

Key Infrastructure, Services, and Functions	Types of Infrastructure/Utility Assets
Flood Protection and Management	Coastal embankments, river dykes, pumps, gates, stormwater drainage, etc.
Transport	Roads, Bridges, Ports, Rail, Light Rapid Transit, etc.
Buildings	Factory Shells, Administration Buildings, Residential/Commercial/Retail/Educational/Medical Buildings, Fire Services, etc.
Telecommunication	Towers, Cables, Fiber Optics, Backbone, Switches, etc.
Water Supply and Sanitation	Water System (Potable/Grey), Sewage Treatment Plants (STP), Water Treatment Plants (WTP), Water Reservoirs, Desalination Plants, etc.
Energy	Power Plants, Sub-Stations, Solar Panels (including Floating Solar) Renewable, etc.
Waste Management	Waste Treatment Plants (CETP), Bio-Gas Plants, etc.

Source: BEZA, 2020a

2.4.1 Transport Network

2.4.1.1 Road Network

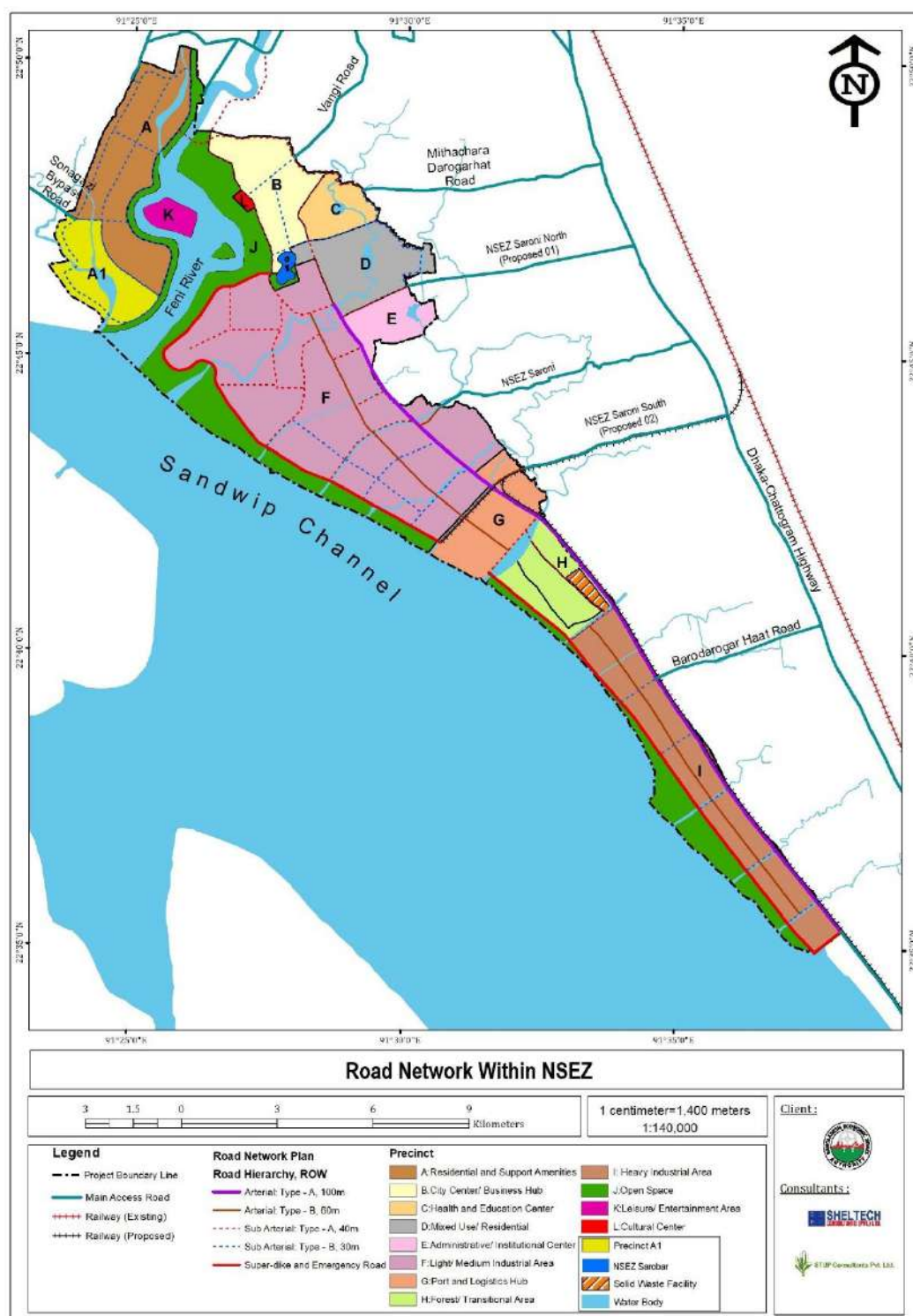
2.4.1.1.1 On-Site Road Network within NSEZ

A hierarchy of roads has been designed within NSEZ. All road networks will have services and utilities integrated into their design. The hierarchy of roads within NSEZ are:

- **An Emergency Road - Super Dyke (100m ROW)** - Road on the high embankment along the seaside offering limited access and acts as an emergency exit from NSEZ, if required.
- **Arterial Roads - Type A (100m ROW)** - For traffic moving along the periphery of NSEZ to have quicker access to Precincts.
- **Arterial Roads - Type B (60m ROW)** - For through traffic on a continuous route within NSEZ.
- **Sub Arterial Roads - Type A (40m ROW)** - For collection and distribution of traffic connecting to the arterial road network, however, offering a lower level of service than an arterial road.
- **Sub Arterial Roads - Type B (30m ROW)** - For collection and distribution of traffic connecting to the arterial road network, however offering a lower level of service than an arterial road. Providing access to large plots of land within Precincts F, G, H, and I.
- **Collector Street - (20m ROW)** - For collection and distribution of local traffic and providing access to arterial and sub-arterial roads. Most common in Precincts A, B, C, D, E, and K.

The road network plan within NSEZ is shown in Figure 2-4.

Figure 2-4: Road Network Within NSEZ



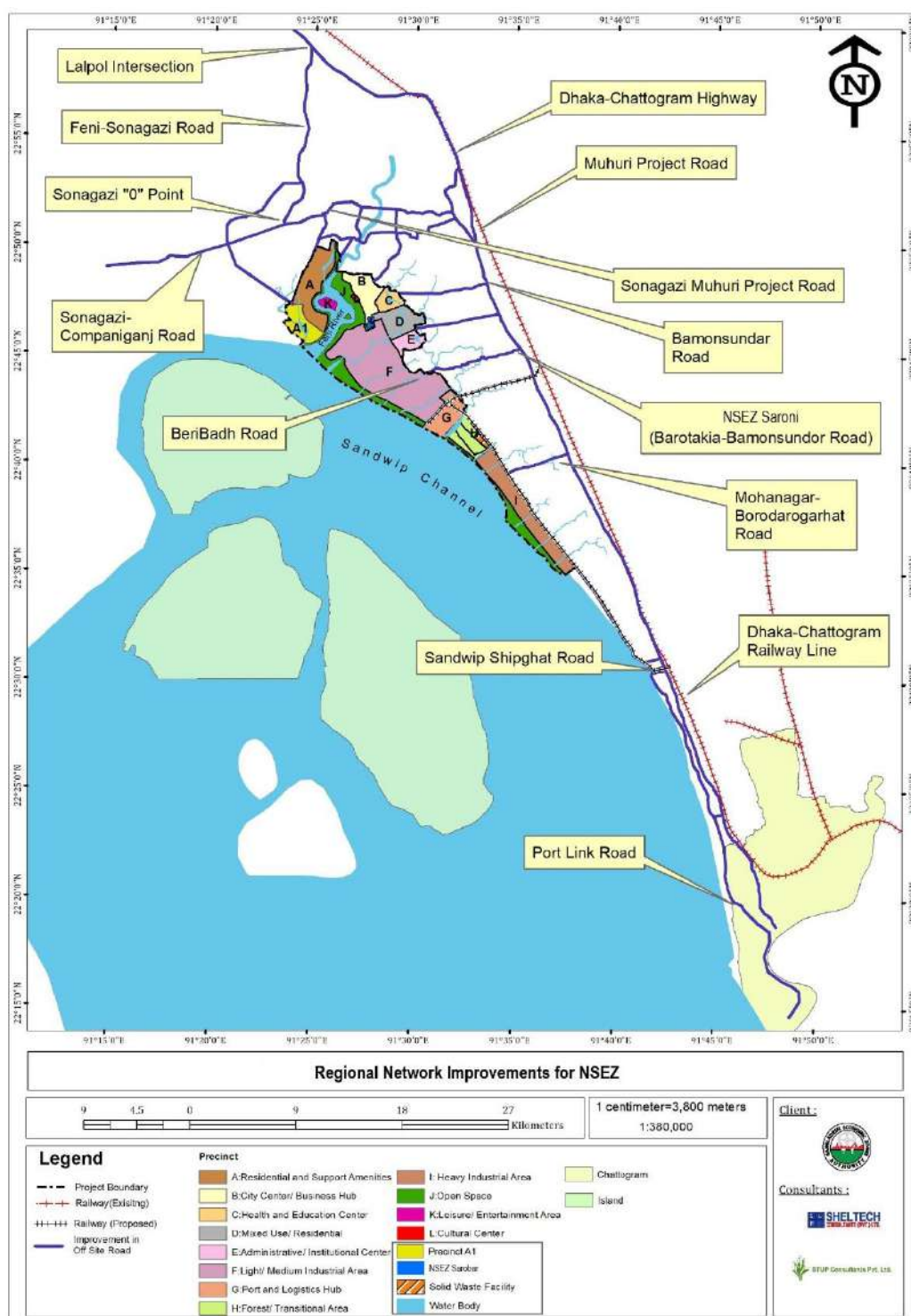
Source: BEZA, 2020a

2.4.1.1.2 External Road Network

At present, the capacity of the local access roads adjacent to NSEZ is quite limited and the number of existing links to NSEZ is inadequate to cater to the additional volume of traffic likely to be generated by NSEZ. Hence, the road network will need to be upgraded and improved. Considering the functional characteristics of NSEZ and the anticipated movement pattern of passenger and freight, Dhaka - Chattogram Highway (N1) and Feni - Sonagazi Road are likely to assume greater importance, especially for predominant north-south movement. The connecting roads are mainly from Dhaka-

Chattogram Road and can be listed as Muhuri Project Road (Zorarganj - Muhuri Project), Bamonsundar Road, NSEZ Sarani, and Mohan Nagar Barodarogarhat Road. A map of the external network is shown in Figure 2-5

Figure 2-5: Regional Network Improvements for NSEZ



Source: BEZA, 2020a

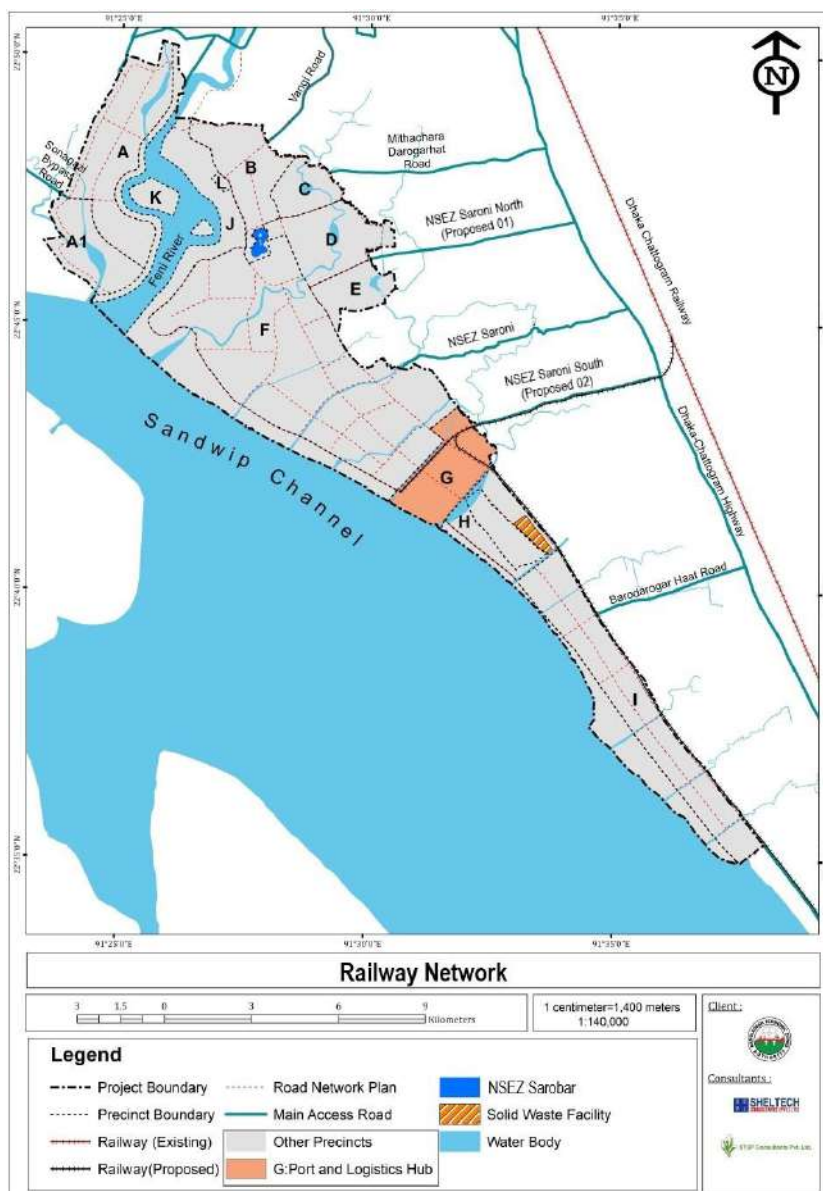
2.4.1.2 Railway Network

According to the Feasibility Study and Detail Design for Construction of Railway Link to Mirsharai-Feni Economic Zone (November 2018), a new railway line has been proposed to establish the connectivity

between the NSEZ and the existing Dhaka-Chattogram railway line. The proposed railway line will take off from the existing Bartakia railway station having a length of 13.4 KM. Under this project, 6 new bridges, 11 culverts, and one station building will be constructed. The project area will cover a total of seven mauzas in Mirsharai Upazila. The land requirement for the project is approximately 89 acres.

A new railway station will be constructed at the NSEZ, which will be a “B” class station as per railway standards. Bartakia railway station yard needs to be rearranged by providing one loop line behind the present station building and one on the other side of the station building. This loop will be connected with the proposed track to the NSEZ. For efficient operation facilities at the proposed NSEZ station, provisions will be made for one main line and three loop lines with Clear Standing Length (CSL) of 880 m, 720 m, and 620 m. In addition to that one marshaling yard will be kept on the left side of the proposed station with four siding lines (each with a minimum 720 m CSL).

A total of 14 level crossing gates will be required along the alignment, one on Dhaka-Chattogram highways and 13 on local government roads- one special, 12 B, and one C class level crossing gates. In addition to Bartakia railway station, NSEZ station will be provided with a non-interlocked color light signaling system. The Centralized Traffic Control (CTC) System shall be provided for the whole section. A location map of the proposed railway line to connect NSEZ is shown in Figure 2-6**Error! Reference source not found..**

Figure 2-6: Proposed Alignment of Railway Line to Connect NSEZ

Source: Bangladesh Railway, November 2018

2.4.1.3 Water Transport Please incorporate the Private Jetty

According to the consultation with BIWTA, a permanent jetty will be constructed at Sandwip channel for carrying the materials/goods and it will be operated by BIWTA. The capacity of the jetty will be 2,500 to 3,000 tons. The jetty will have provisions like a terminal building, parking yard, boundary wall, etc. Capitan and maintenance dredging and land development will be required during the jetty construction and operation.

According to the Feasibility Study report, the required jetty stem length at the proposed site was first 1.5 km with an available draft of 4.1 m - 5 m. However, decreasing the jetty stem to 1 km, for instance, would decrease the available draft to 3.1 m - 4 m and, thus, would require capital and maintenance dredging. The final jetty location and related information are shown in Figure 2-7 **Error! Reference source not found..**

Figure 2-7: Jetty location at NSEZ, Mirsharai



Source: BIWTA, June 2019

The details of the points are provided below:

- Point A (Bank Line): 22°42'44.72"N; 91°28'25.07"E
- Point B (3.1-4 m draft, at ~1 km from Bankline): 22°42'16.92"N; 91°28'6.02"E
- Dyke Point C: 22°42'53.95"N; 91°28'30.53"E
- Jetty Stem Length: 1000 m

Information on different jetty features, such as, the length, width, and exact location of the jetty head and stem is provided in Table 2-4. **Error! Reference source not found..**

Table 2-4: Location and relevant information for the jetty site

Parameter	Jetty at NSEZ, Mirsharai
Coordinates of Jetty Stem starting point (A)	22°42'44.72"N and 91°28'25.07"E
Jetty Type	Multi-purpose
Jetty Head Length	118m
Jetty Head Width	40.3m
Jetty Stem Length	1000m
Jetty Stem Width	13.5m (6 m for Pedestrians +7.5m for non/motorized vehicles)
Available Draft	4.1m – 5m (3.1-4 for 1 km)

Source: BIWTA, June 2019

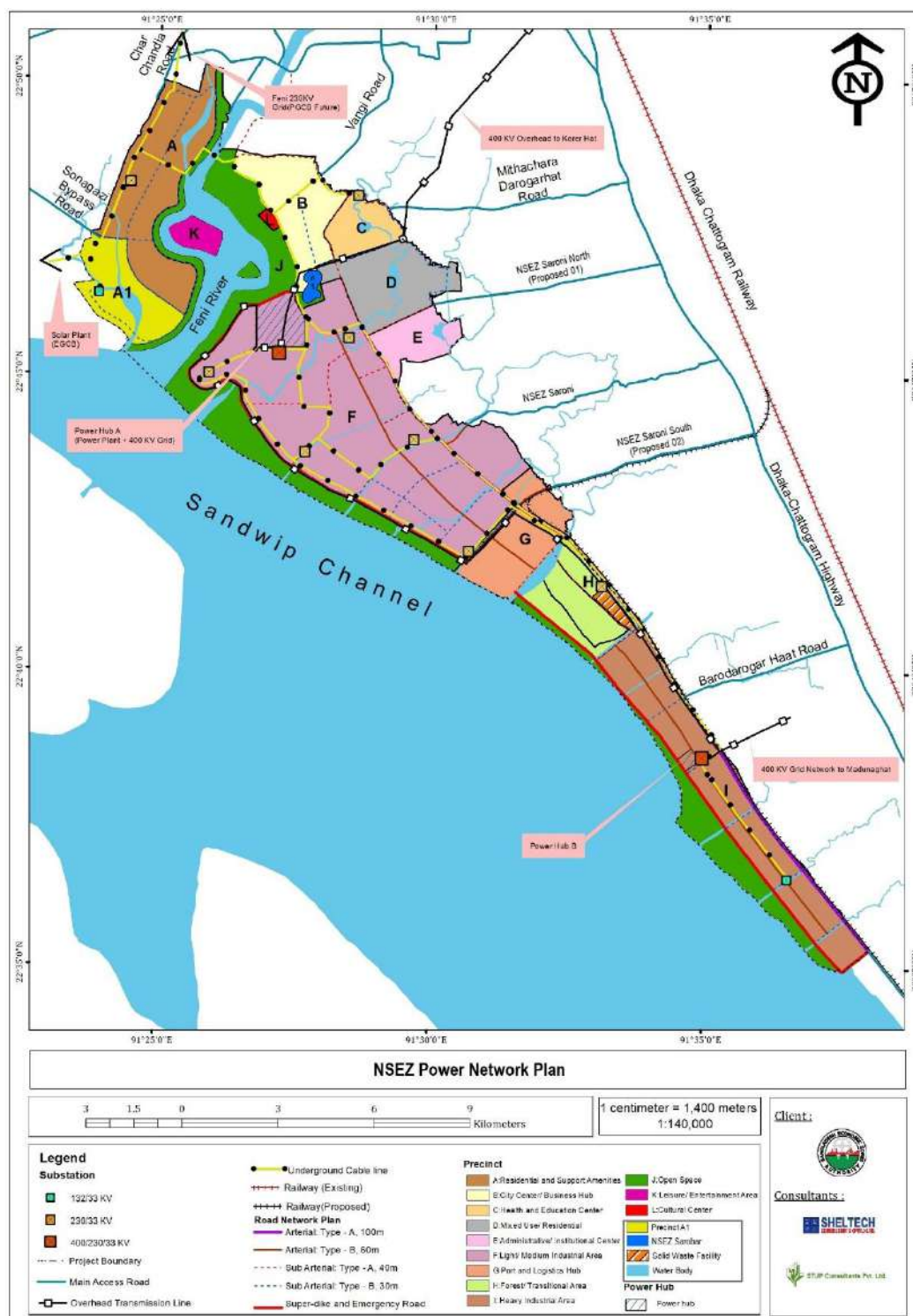
This particular site is situated on the eastern part of the Sandwip channel. Mirsharai would be a vibrant economic zone generating tremendous job and tourism opportunities exploiting its various industries, unique natural beauty of river channel and mangrove forest. The proposed jetty would be the gateway to all future opportunities. Moreover, the economic zone is expected to generate a notable amount of

job opportunities for the Sandwip people as well, and the proposed jetty would be their prime need for their daily commuting. And more importantly, it could be their vital business hub due to good transportation.

2.4.2 Power Network Within NSEZ

According to the discussion with BEZA, a memorandum of understanding (MOU) has been signed with the Bangladesh Rural Electrification Board (BREB) for power network distribution within the NSEZ. BREB provides all sorts of electrical services for the NSEZ. Apart from installing and providing electrical services, BREB also built substations from the BEZA fund. Further, the organization is constructing a 10 MVA substation from its own fund for the NSEZ. According to the Master plan, based on the demand forecast and load center the following primary transmission network is outlined (Figure 2-8).

Figure 2-8: Power Network Plan Within NSEZ



Source: BEZA, 2020a

2.4.2.1 Power Demand

The power demand for NSEZ is presented in Table 2-5.

Table 2-5: Demand of electricity for NSEZ

Precinct	Area (in Acres)	KVA/Acres	Demand KVA		Demand Factor	Max. Demand (MW)
			KVA	KW		
A	4606.57	182	958439.30	862595.37	0.6	517.56
B	1682.91	182	323930.88	291537.79	0.7	204.08
C	837.35	182	148202.60	133382.34	0.7	93.37
D	1778.59	182	367710.98	330939.88	0.6	198.56
E	880.68	182	159082.56	143174.30	0.7	100.22
F	10043.12	182	1836875.04	1653187.54	0.8	1322.55
G	1802.29	121	217591.88	195832.69	0.7	137.08
H	1778.75	121	213014.45	191713.01	0.7	134.20
I	3956.35	182	720055.70	648050.13	0.8	518.44
J	6030.42	-	0.00	0.00	0	0.00
K	350.89	100	35089.00	31580.10	0.7	22.11
L	56.85	-	0.00	0.00	0	0.00
Total	33804.76					3248.17

Source: Master Plan of NSEZ, 2020

2.4.2.2 Sources of Power

NSEZ requires about 3,248 MWh (maximum) of power. To supply power to the NSEZ, a reliable transmission infrastructure has been proposed to be constructed internally in the industrial hub by the BEZA through the PGCB along with the upgradation of the existing grid network. After conducting the total load demand assessment through, the feasibility study, and proposed specific transmission infrastructure interventions for NSEZ are given in Table 2-6.

Table 2-6: Proposed Project Interventions

S/N	Name of the Substation	Associated Transmission Line	Bay Extension	Implementation Agency	Status of Implementation
A.	Phase-1 (2022 – 2027)				
1.	Bashundhara IEZL 230 kV substation (Zone-15)	Existing Mirsharai 230/33 kV grid substation (Hub A) to Bashundhara IEZL 230 kV four circuit overhead (O/H) line (two circuits for Bashundhara): xy1 km	2 no's of 230 kV GIS bay extension at Mirsharai 230/33 kV grid substation	Consumer	Proposed

S/N	Name of the Substation	Associated Transmission Line	Bay Extension	Implementation Agency	Status of Implementation
2.	PHP Steel Works 230 kV substation (Zone-20)	Bashundhara to PHP Steel 230 kV four circuit O/H line (two circuits for PHP): xy km	2 no's of 230 kV GIS bay extension at Mirsharai 230/33 kV substation	Consumer	Not yet done
3.	BSRM 230 kV substation (Zone-3)	Mirsharai 230/33 kV grid substation to BSRM 230 kV D/C underground line: xy km	2 no's of 230 kV GIS bay extension at Mirsharai 230/33 kV substation	Consumer	Not yet done
4.	ACI 132/33 kV substation (Zone-2A)	Mirsharai grid substation to ACI 132 kV D/C underground line: xy km	2 no's of 33 kV GIS bay extension at Mirsharai 230/33 kV substation	BEZA & Consumer	Not yet done
5.	BEPZA 132/33 kV Substation (Zone-14)	Mirsharai grid substation to BEPZA 132 kV D/C line: xy km	2 no's of 33 kV GIS bay extension at Mirsharai 230/33 kV substation	BEZA & Consumer	Not yet done
6.	Mango Teleservices Limited 132 kV substation (Zone-4)	Mirsharai grid substation to Mango 132 kV D/C underground line: xy km	2 no's of 33 kV GIS bay extension at Mirsharai 230/33 kV substation	Consumer	Not yet done
7.	Capacity upgradation of Mirsharai 230/33 kV grid substation with 2x140 MVA Transformer (3 rd & 4 th)	-	-	PGCB	Not yet done
8.	Upgradation of Mirsharai 230/33 kV substation with 400/230kV, 2x1000 MVA transformer	-	-	PGCB	Not yet done
B	Phase-2 (2028-40)				

S/N	Name of the Substation	Associated Transmission Line	Bay Extension	Implementation Agency	Status of Implementation
1.	Upgradation of Mirsharai 400/230/33 kV substation to 400/230/132/33 kV grid substation: 400/132kV, 3x325 MVA transformer additions	-	-	PGCB	Proposed
2.	400/230 kV, 3x750 MVA Mirsharai-2 grid substation	Mirsharai-2 substation to planned Mirsharai 765/400 kV grid substation: xy km	2 no's of 400 kV GIS bay extension at Mirsharai 765/400 kV grid	PGCB	Proposed
3.	ACI 132/33 kV substation, 3x80/120 MVA GIS grid substation (Zone-2A)	2 no's of 132 kV GIS bay extension at Mirsharai substation (Hub A)	-	BEZA & Consumer	Proposed
4.	BEPZA 132/33 kV substation, 3x80/120 MVA GIS grid substation (Zone-14)	2 no's of 132 kV GIS bay extension at Mirsharai substation (Hub A)	-	BEZA & Consumer	Proposed
5.	Mango Teleservices Limited 132 kV substation (Zone-4)	-	2 no's of 132 kV GIS bay extension at Mirsharai substation (Hub A)	Consumer	Proposed
6.	230/132/33 kV Common grid substation at Zone 20 (230/132 kV, 2x300/450 MVA, 132/33 kV, 3x80/120 MVA) (Zone 20)	Mirsharai-2 substation to Zone-20 230 kV D/C line: xy km	2 no's of 230 kV GIS bay extension at Mirsharai-2 substation 230 kV Bus and Bay extension at PHP for Zone 20	BEZA & Consumer	Proposed

S/N	Name of the Substation	Associated Transmission Line	Bay Extension	Implementation Agency	Status of Implementation
			common grid substation		
7.	230 consumer substations at Zone 25 (Zone 25)	Mirsharai-2 substation to zone-25 consumers substation 230 kVD/C line: xy km	2 no's of 230 kV GIS bay extension at Mirsharai-2 substation	Consumer	Proposed
8.	Mirsharai Residential Area 132/33 kV, 2x80/120 MVA GIS grid substation (Zone 29)	Mirsharai grid substation (Hub A) to residential area 132 kV D/C line: xy km	2 no's of 132 kV GIS bay extension at Mirsharai substation (Hub A)	BEZA	Proposed
9.	Zone-7 132/33 kV, 3x80/120 MVA GIS grid substation (Zone-7)	Mirsharai grid substation (Hub A) to Zone-7 132 kV D/C line: xy km	2 no's of 132 kV GIS bay extension at Mirsharai grid substation (Hub A)	BEZA	Estimation ongoing
10.	Indian Economic Zone 132 kV substation (Zone-19)	Zone 20 common grid to Indian Economic zone 132 kV D/C underground line: 1.20 km	2 no's of 132 kV GIS bay extension at PHP common grid	Consumer	Yet to be tender floating
11.	Zone 22 Consumer 132 kV substation (Zone-22)	Zone 20 common grid to Zone 22 Consumer 132 kV D/C underground line: 1.46 km	2 no's of 132 kV GIS bay extension at PHP common grid	Consumer	Proposed

NB: Line length xy shall be finalized after the route survey and consultation with BEZA.

Source: PGCB, 2023.

2.4.2.3 Transmission and Distribution Network

To provide a reliable power supply to NSEZ, transmission utilities have already been extended to the grid network by constructing a 7 km dedicated 400 kV overhead line, presently powered by 230 kV voltage and 230/33 kV substation from at the site. In infrastructure planning, more links in 400 kV and 230 kV voltage levels may be considered with the national grid network to enhance the power supply reliability.

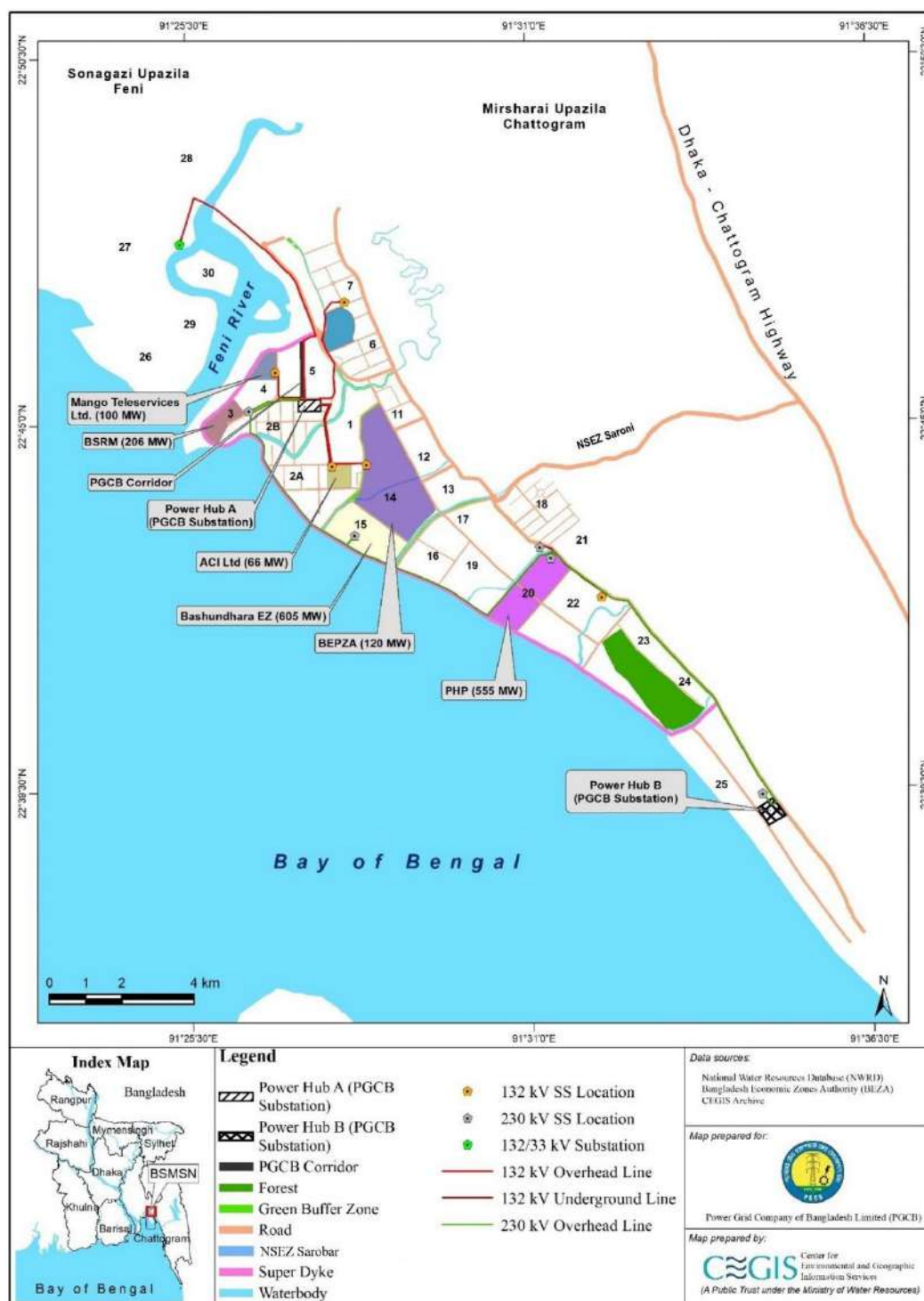
A 230/33 kV Substation having a capacity of 2 x 120/140 MVA (+ Future: 2x120/140 MVA) has been commissioned on 20th May 2020 feeding through a 400 kV architecture transmission line for reliable power supply in the NSEZ. The substation is for 400/230/33 kV substation, the rest 400/230kV substation section with 2x1000 MVA capacity. The present power supply capacity through the Mirsharai-BSRM 230kV Double circuit line is around 1100 MW (conductor: Twin ACCC, 3000 Amp).

Currently, power is mainly supplied through the existing Baroirhat-Hathazari 132 kV double circuit line link from Baroirhat and Sitakundu substations. The distribution utility of PBS is supplying power through a 33 kV feeder at NSEZ. The link will be strengthened in the near future by making Line IN Line Out (LILO) at Korerhat and Fatikchari having a capacity of 120 MW (ACSR Finch, 630 Amp).

There are two 33 kV source lines with a 477 sq mm conductor getting power from the Baroirhat 132/33 kV grid substation. One 2x20/28 MVA substation has already been established by Bangladesh Steel Re-Rolling Mills Ltd. (BSRM). Three substations are under construction, having a capacity of 2x10/14 MVA, 2x20/28 MVA, and 2x20/28 MVA respectively.

The way of the corridor of cable lines and the right of way of the overhead line shall also be accommodated in the road plan and site plan of the precincts. The utilities shall develop their electrical infrastructure over the development period on the land and roadways reserved for electrical lines. All project interventions inside of NSEZ have been shown in Figure 2-9.

Figure 2-9: Map showing all projects interventions inside NSEZ



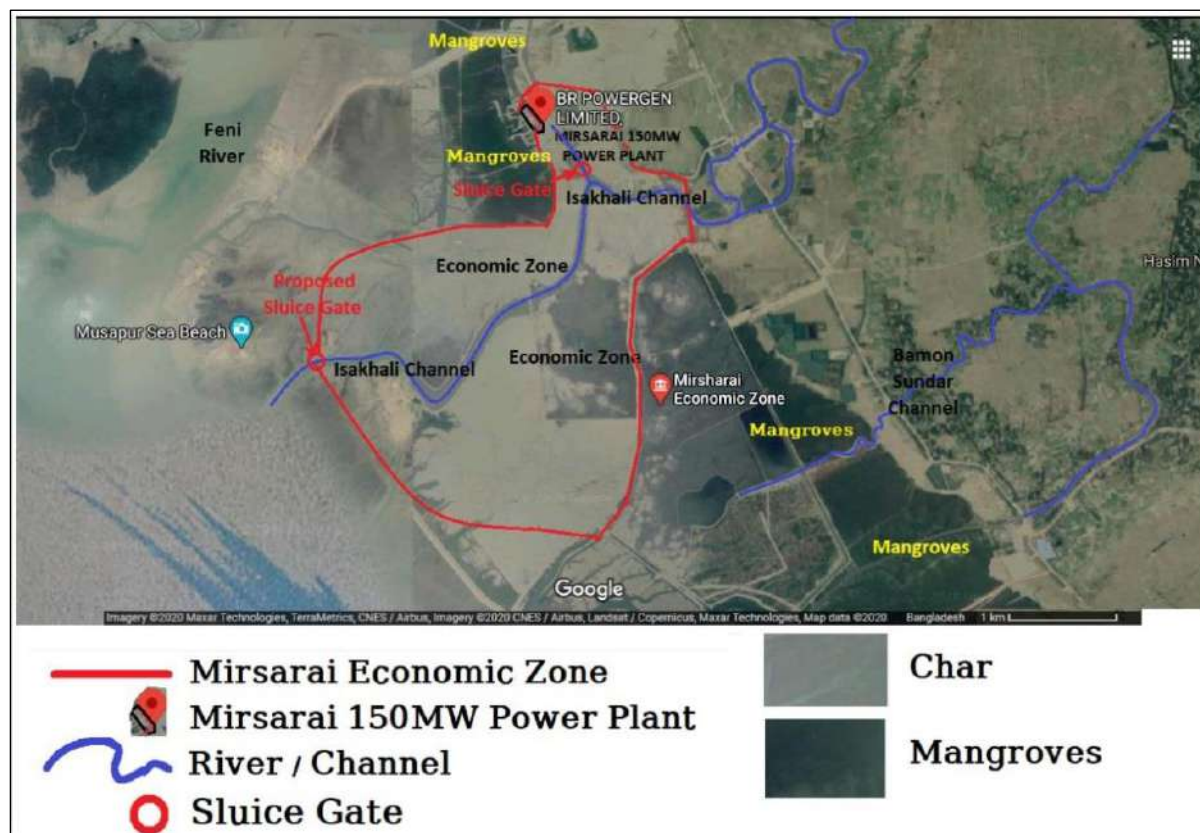
Source: PGCB, 2023

2.4.2.4 Power Generation

BR Powergen Limited (BRPL) has established a 150 MW Dual Fuel (Gas/HFO) Engine Based Power Plant in the NSEZ. The powerplant started its operation in December 2018 and will be operated for 20 years (PPA tenure). The main objective of the power plant is to ensure reliable and quality electricity to developers and unit investors as an Independent Power Producer (IPP). The total land area of the power plant is approximately 16 acres. Natural gas and HFO are the main raw materials for the power plant. Net plant capacity is 150±10% MW. Electricity generated in the power plant is supplied to the

PGCB's 230KV/33KV Grid Substation at Mirsharai. A Map Showing the Surroundings of the Mirsharai 150 MW Power Plant Site is given in Figure 2-10.

Figure 2-10: Map Showing Surroundings of the Mirsharai 150 MW Power Plant Site



Source: Environmental Aspects, Impacts, and Mitigation Measures for Mirsharai 150 MW Power Plant (Operation Phase)

2.4.3 Gas

2.4.3.1 Gas Demand

The demand of gas for NSEZ is presented in Table 2-7.

Table 2-7: Gas Demand for Different Industrial Categories in NSEZ

Industrial Category	Area (in Hectares)	Area (in Acres)	Gas Demand (in m ³ /day/acre)	Total Gas Demand (m ³ /day)	Total Gas Demand (in mmcf/d)
Chemical Hub					
Chemical	34.52	85.31	99	4222.64	0.15
Chemical, Foam	8.34	20.61	99	1020.37	0.04
Chemical, Paints	20.35	50.28	3,700.00	93014.45	3.28
Garments	4.11	10.15	3,642.17	18482.21	0.65
Sub Total	67.32	166.35		116739.66	4.12
Heavy Industrial					
Sub Total	1,565.56	3,868.50	606.32	938221.25	33.13
Light/ Medium Industrial					
Auto Mobile, Mango	48.16	119.01		0	14.42
Bashundhara	228.67	565.03		0	79.79
Chemical	4.59	11.33	99	504.89	0.02
Food and Beverage	18.22	45.03	404.69	9111.93	0.32
Garments	383.66	948.02	3,642.17	1726421.55	60.96
Garments Accessories	2.03	5.02	99	248.36	0.01
Light and Medium Industrial Area	2,620.72	6,475.80	226.05	585541.58	20.68
Light Engineering	4.19	10.35	95	491.48	0.02
LNG Petro Chemical	22.71	56.11		0	0
Pharmaceuticals	12.22	30.19	99.96	1508.81	0.05

Industrial Category	Area (in Hectares)	Area (in Acres)	Gas Demand (in m ³ /day/acre)	Total Gas Demand (m ³ /day)	Total Gas Demand (in mmcf/d)
Power Plant, B-R Power	6.49	16.04	99	0	40.25
Power Plant, B-R Power Extension	20.23	50			107.75
Power Plant, BSRM Power	7.87	19.44		0	52.97
Steel Industry, BSRM	80.92	199.96		0	2.06
Steel Industry, PHP	246.76	609.76		0	121.7
Steel Product	43.27	106.91	300	16036.52	0.57
Textile	277.25	685.08	3,642.17	1247592.86	44.05
Utility	13.35	33		0	0
Sub Total	4,041.31	9,986.08		3587457.98	545.61
Port/ Logistics/ Light/Medium Industrial					
Sub Total	236.67	584.81	226.05	33049.06	1.17
Grand Total	5,910.86	14,605.74		0	584.03

Source: NSEZ, 2020

2.4.3.2 Sources of Gas

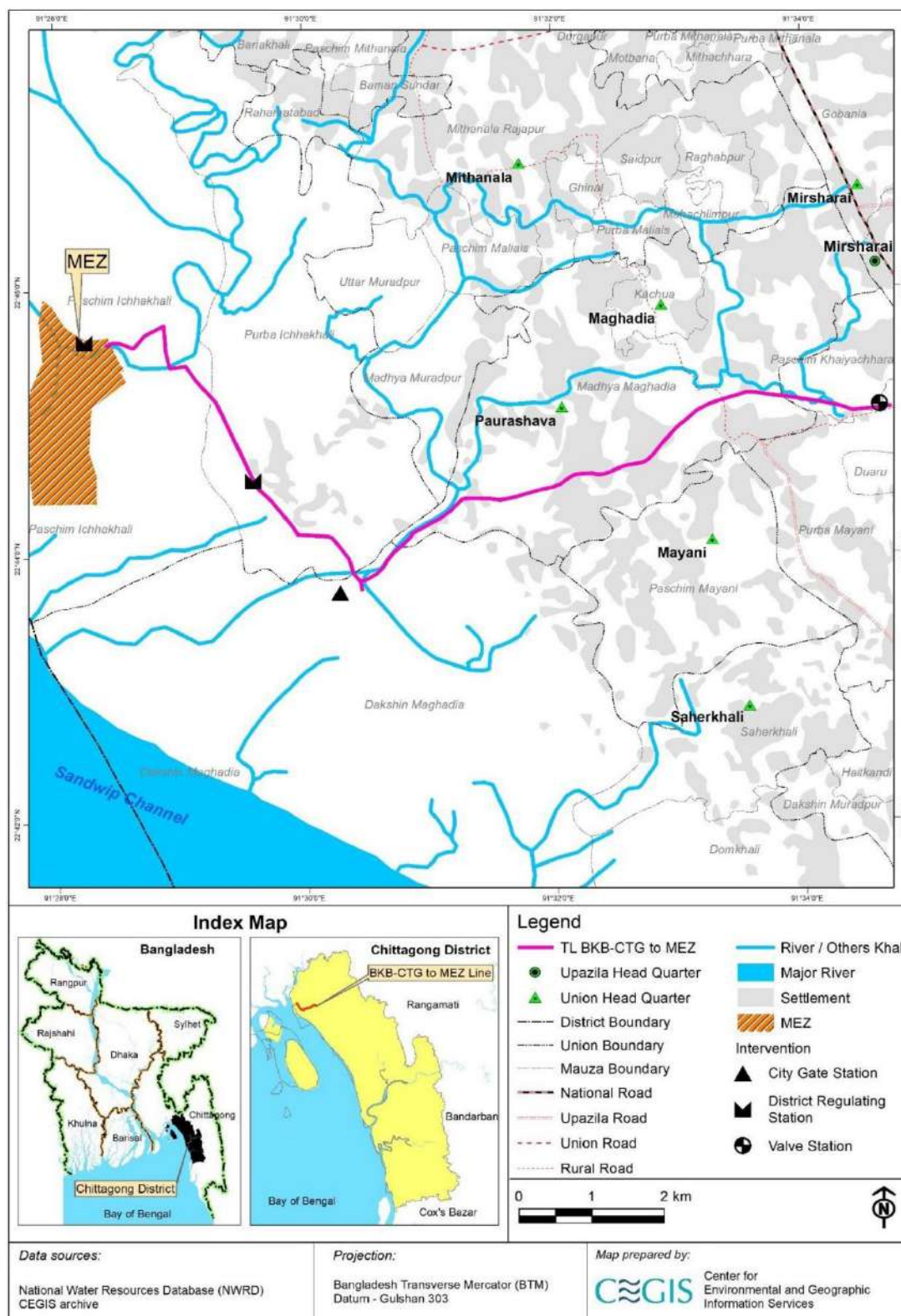
According to the NSEZ, Karnaphuli Gas Distribution Company Limited (KGDCL) under the Ministry of Power, Energy, and Mineral Resources has initiated a project entitled “Construction of Gas Pipeline for Mirsharai Economic Zone and KGDCL, Gas Distribution Network Up-gradation Project by KGDCL”. Objectives and targets of the project are to upgrade the KGDCL existing gas distribution network capacity from 350 MMSCFD to 500 MMSCFD to facilitate adequate gas supply to bulk and industrial customers of KGDCL, make arrangements for supplying 200 MMSCFD gas to the upcoming industrial customers in NSEZ from national gas network, and construct dedicated pipelines to supply of gas from Anowara CGS to three bulk customers like KAFCO, CUFL & Sikalbaha Power Station (SPS), isolating them from the existing ring main, to make necessary arrangements/modifications at Shahmirpur manifold station of KGDCL to receive R-LNG from GTCL's offtake to facilitate supply to the existing ring main. Officially, the gas distribution started on 30 August of 2019.

There will be two high-pressure Transmission Pipelines (Bakhrabad - Chattogram to Mirsharai Economic Zone and Anowara to Shikalbaha) and associated installations i.e., City Gate Station (CGS), District Regulator Stations (DRSs), Valve Station, etc. (GTCL, 2021). The physical components/interventions of the two transmission lines are given in Table 2-8. The location of gas transmission pipelines and associated installation alignments are shown in Figure 2-11 and Figure 2-12, respectively.

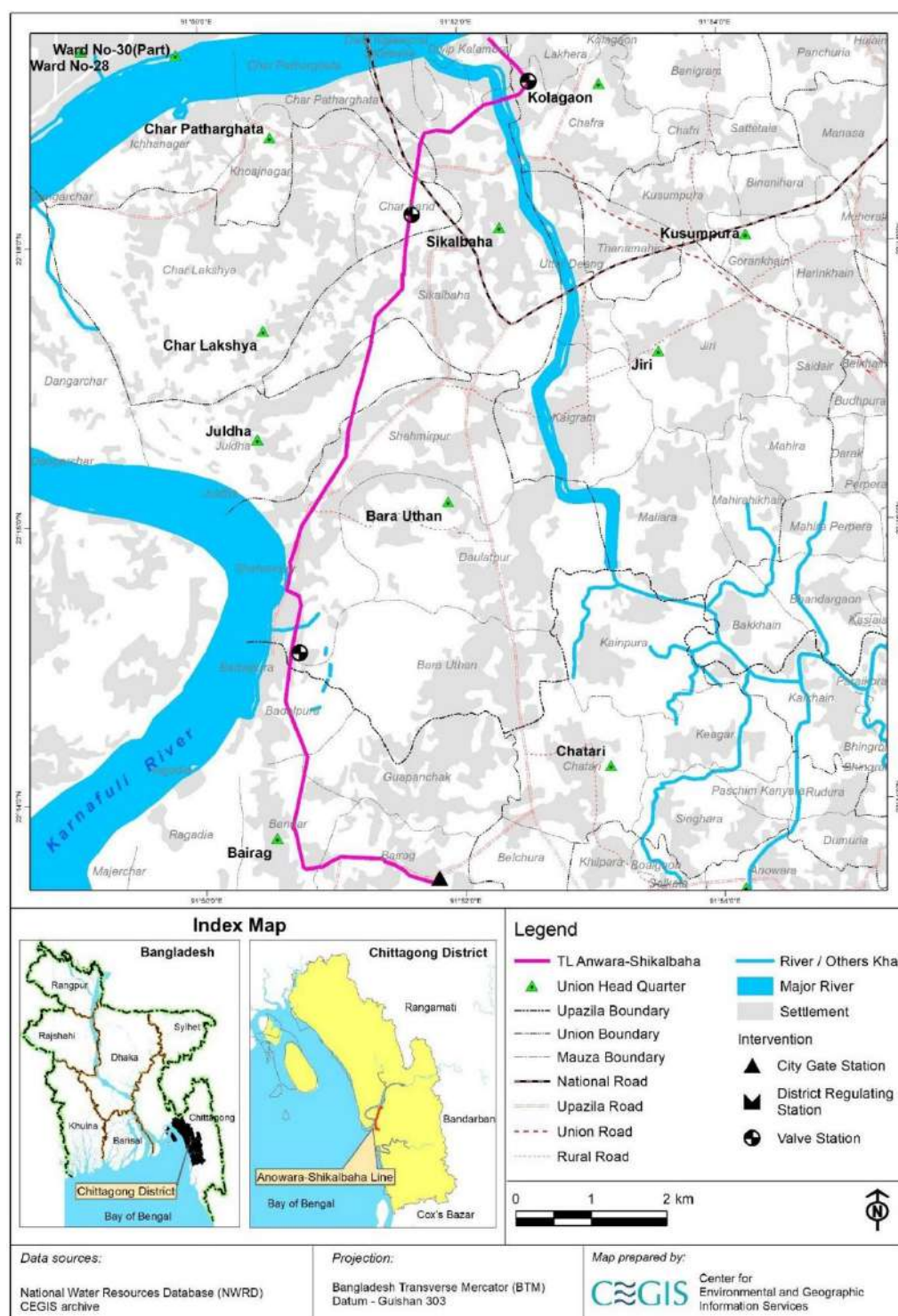
Table 2-8: Physical Components/Interventions of the Two Transmission Lines

Proposed Gas Transmission line	Diameter (inch)	Gas Pressure	Length	Associated Installations
Gas Transmission Line 1 (Mirsharai Economic Zone (BKB to MEZ))	16	1050 psig	17 km	• DRS located at Ichhakhali Village • DRS located at Char Sadar Bangla Bazar Village • Valve Station - 4 at Mirsharai • CGS located at Noapara
Gas Transmission Line 2 [Karnafuli Gas Distribution Company Limited (KGDCL) Gas Distribution Network (Anowara to Sikalbaha Upazila)]	16	350 psig	20 km	• Valve Station-1 located at Shahmirpur • Valve Station - 2 located at Char Patharghata • Valve Station - 3 located at Lakhera

Source: GTCL, 2021

Figure 2-11: Location of GTCL Gas Transmission Pipeline 1 and Associated Installations

Source: GTCL, 2021

Figure 2-12: GTCL Gas Transmission Pipeline 2 and Associated Installations

Source: GTCL, 2021

2.4.4 Water

2.4.4.1 Water Demand

According to the water demand and water availability assessment for NSEZ, for the evaluation of gross water demand (Table 2-9 and Figure 2-13), an additional provision of the following losses has been considered over the net water requirement for industrial, domestic, and non-domestic water usages:

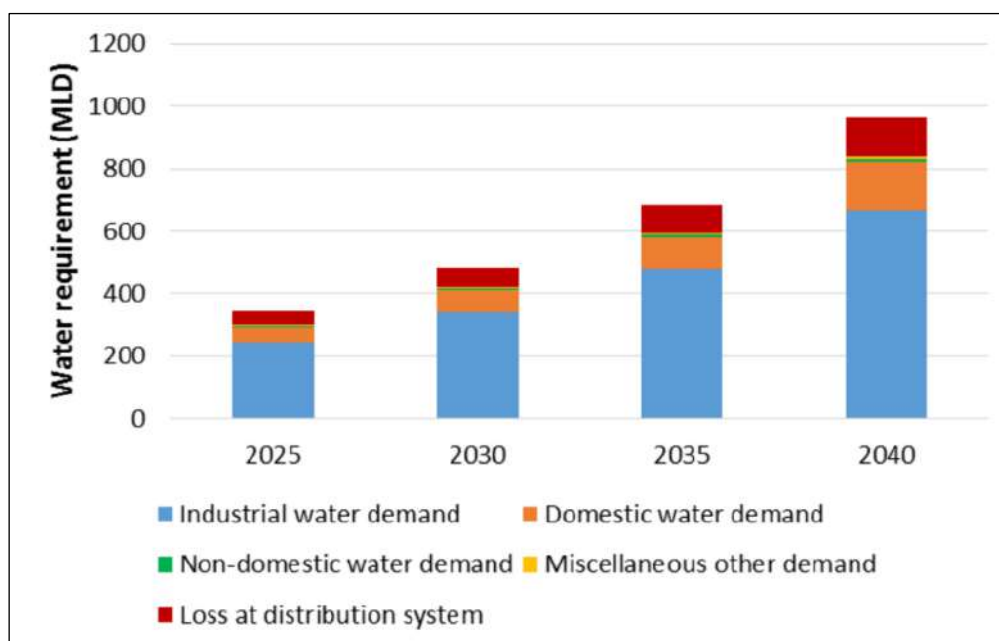
- Loss along the raw water transmission main and distribution system: 15%

- Loss at the water treatment plant and along the raw water transmission main: 5.0%

Table 2-9: Gross Water Demand for National Special Economic Zone

S/N	Description	Cumulative Water Requirement (MLD)			
		2025	2030	2035	2040
1	Industrial water demand	242	337	474	665
2	Domestic and non-domestic water demand	57	82	119	174
3	Net water requirement at user end	299	419	594	839
4	Required production Capacity	343	482	683	965
5	Water is required to be withdrawn for treatment	360	506	717	1,013
	Gross Water Demand	360	506	717	1,013

Source: BEZA, 2020b

Figure 2-13: Estimated Water Demand for NSEZ

Source: BEZA, 2020b

2.4.4.2 Source of Raw Water

According to the water demand and water availability assessment for NSEZ, various sources of raw water and the expected quantum of raw water that can be utilized/withdrawn to meet the water requirement of NSEZ are summarized below.

First Phase

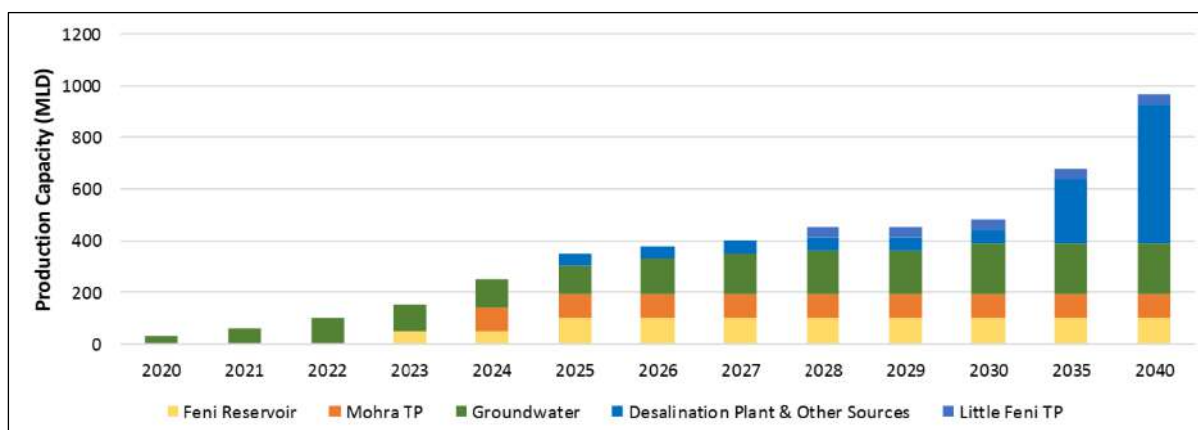
- About 100 MLD of water will be supplied from the Feni reservoir.
- In the 1st phase, a 40 MLD treatment plant with 25 nos. DTW will be constructed to supply water in priority zone 2A, 2B, 3, 4, & 5.

Second Phase

- Another surface water treatment plant from Feni Reservoir will be constructed for the next priority zones. The location for the 50 MLD water treatment plant (phase II) has been selected adjacent to phase I.
- 500 MLD water from Meghna River, Chandpur through 132 km long transmission lines is in consideration.
- Additional water will be managed by using the treatment of seawater (desalination) and other sources.

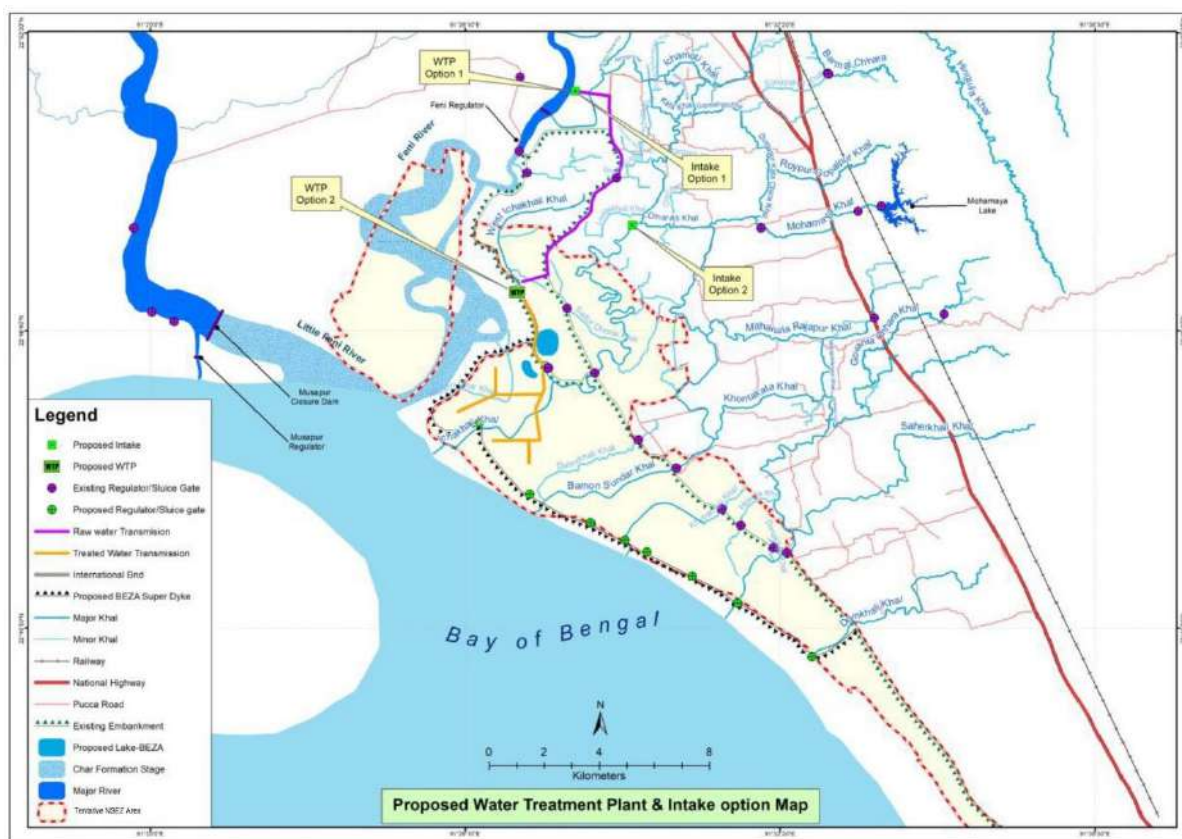
In the Master Plan, the development of the NSEZ area has been divided into three main time horizons- 2020-2025, 2026-2030, and 2031-2040. Accordingly, the production of water from surface water, groundwater, and desalination plants has been planned for NSEZ as shown in Figure 2-14.

Figure 2-14: Future Sources of Supply for NSEZ



Source: BEZA, 2020b

The location of the proposed intakes and water treatment plant map considering the source of the Feni Reservoir is shown in Figure 2-15.

Figure 2-15: Proposed Intake and WTP Map Considering Source Feni Reservoir

Source: BEZA, 2020b

2.4.4.3 Water from the Meghna River

According to the TOR for the transaction advisory service for the supply of treated water from Meghna River to NSEZ prepared by the CWASA (as contracting authority), the water demand in NSEZ will increase to 98.1 crore liters (981 MLD) by the year 2040 (BEZA Master Plan). In order to meet the water demand, CWASA sent a concept note to the local government department mentioning a source of water supply to NSEZ through a transmission line after extracting and purifying water from the Meghna River. A review of the said concept notes shows that after extraction and purification of 95 crores liters (500 MLD) of water from the Meghna River in Chandpur is possible to supply water to NSEZ through 132 km long transmission lines. The water intake point for this water supply project has been selected as a point along the left bank of the Meghna River in the area of Mathavanga in Chandpur District. A location map of the water supply pipeline project from Chandpur to NSEZ is shown in Figure 2-16.

Figure 2-16: Location Map of the Water Supply Pipeline Project

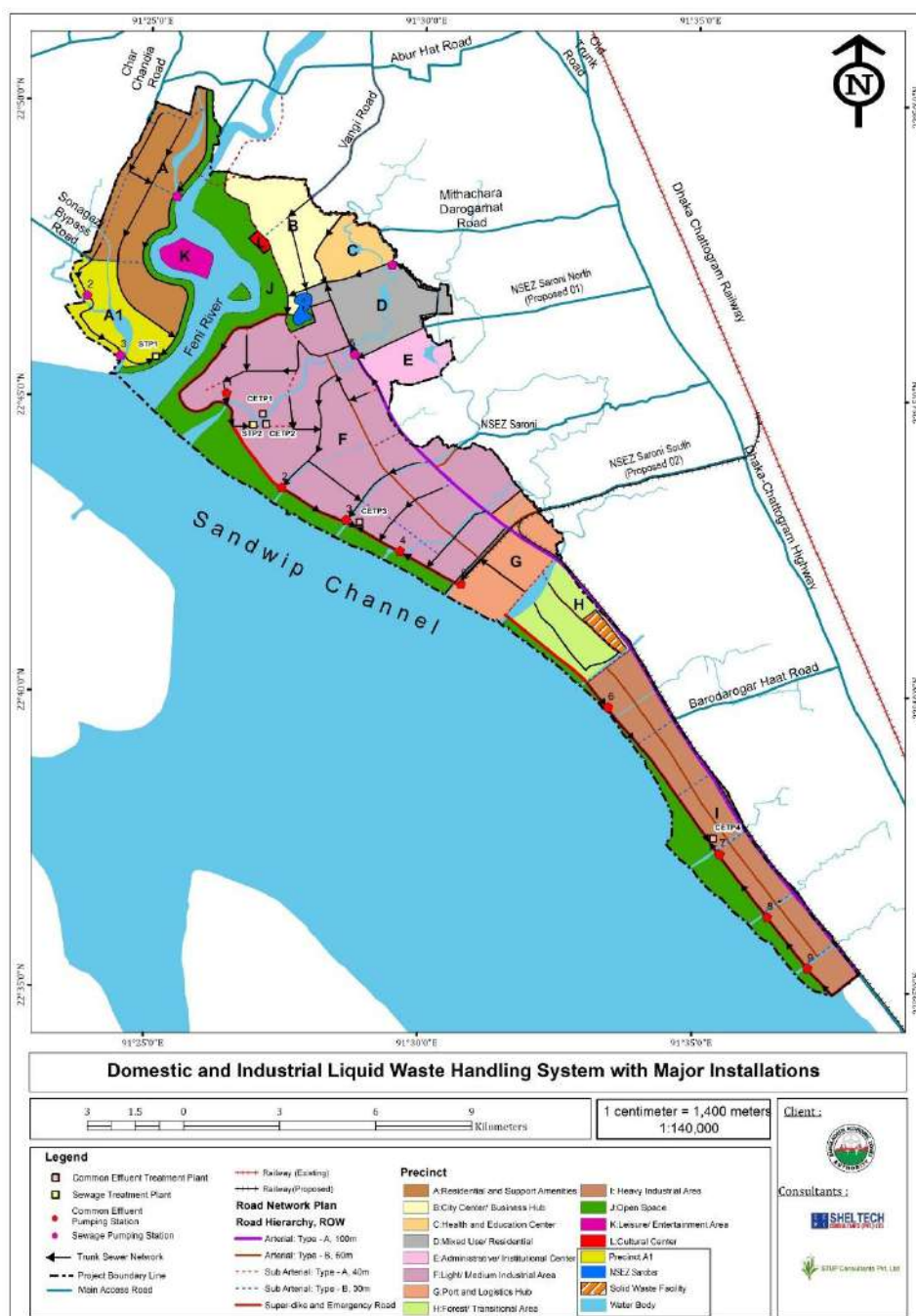
Source: <https://thefinancialexpress.com.bd/trade/korean-cos-awarded-preferential-rights-for-water-supply-project-in-bangladesh>

2.4.5 Waste Management

2.4.5.1 Domestic and Industrial Effluent Collection and Disposal System

The entire quantum of liquid waste (biological waste and/or industrial waste, as the case may be) likely to be generated from NSEZ shall be catered to two Sewage Treatment Plants (STPs) and four Common Effluent Treatment Plants (CETPs) aided by intermediate pumping stations. Strategically the pumping stations shall be located in proximity to natural drainage channels to minimize the lengths of pumping mains. The different drainage channel crossings shall be affected by pipe-supporting structures. In addition, terminal pumping stations shall be provided at the location of all the treatment plants. Figure 2-17 shows the sewerage system planning together with the locations of different pumping stations.

Figure 2-17: Liquid Waste Handling System with Major Installations



Source: BEZA, 2020a

2.4.5.2 Management of Municipal Solid Waste

Based on the review of the documents, the average characteristics of the municipal solid waste (MSW) to be generated from the NSEZ have been presented in Table 2-10. It indicates that 83% of the materials are biodegradable materials and 17% are non-biodegradable materials.

Table 2-10: Average Composition of MSW Anticipated in NSEZ

S/N	Components	% Composition
1.	Food and vegetable waste	69.0
2.	Bones	0.75

S/N	Components	% Composition
3.	Paper products	9.30
4.	Plastic	4.75
5.	Rags/Textiles/Jute	3.06
6.	Glass	0.83
7.	Leather/Rubber	0.50
8.	Metals	0.2
9.	Ceramics	0.2
10.	Soil/Ash	3.8
11.	Wood/Grass/Leaves	3.78
12.	Medicinal/Chemical	0.87
13.	Rocks/Dirt/Misc	3.35

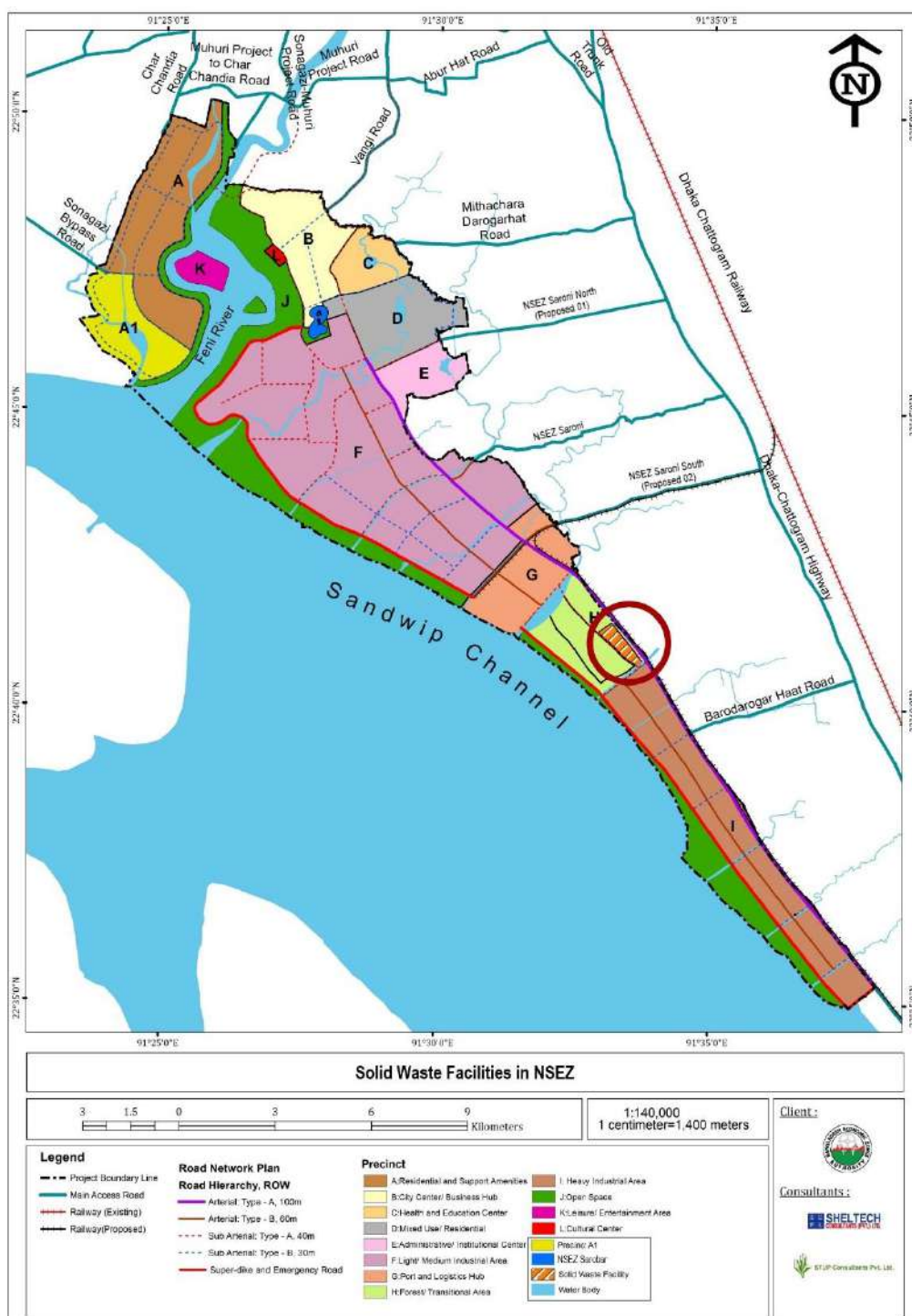
Source: BEZA, 2020a

It may be mentioned based on Table 2-10 that food and vegetable waste will dominate (69%) the MSW followed by paper products (9.3%) and plastic (4.5%). Out of total waste generation, 25% of the material will be recycled, 10% of the material will be composted, 13% of the material will be used for combustion for energy generation or as fuel in other industries and 52% of the material will be sent to landfill site for disposal.

It has been estimated that total waste generation in 20 years (in 2040) will be 11.27x10⁶ tons considering the population of 4.41 million in 2040 and waste generation of 0.350 kg/capita/day.

It has also been estimated that the area required for only the MSW landfill will be 185 acres and the total land requirement considering other facilities like a composting plant, different infrastructure, an area for biomedical waste and a separate area for hazardous waste storage and management will be about 274 acres (Figure 2-18). If the industrial city authorities adopt the 3R/4R/5R strategy and global trend in developed countries as reported by the Environmental Protection Agency (EPA) the land demand for landfills will be reduced to 52% i.e., 142.5 acres.

Figure 2-18: Solid Waste Facilities in NSEZ



Source: BEZA, 2020a

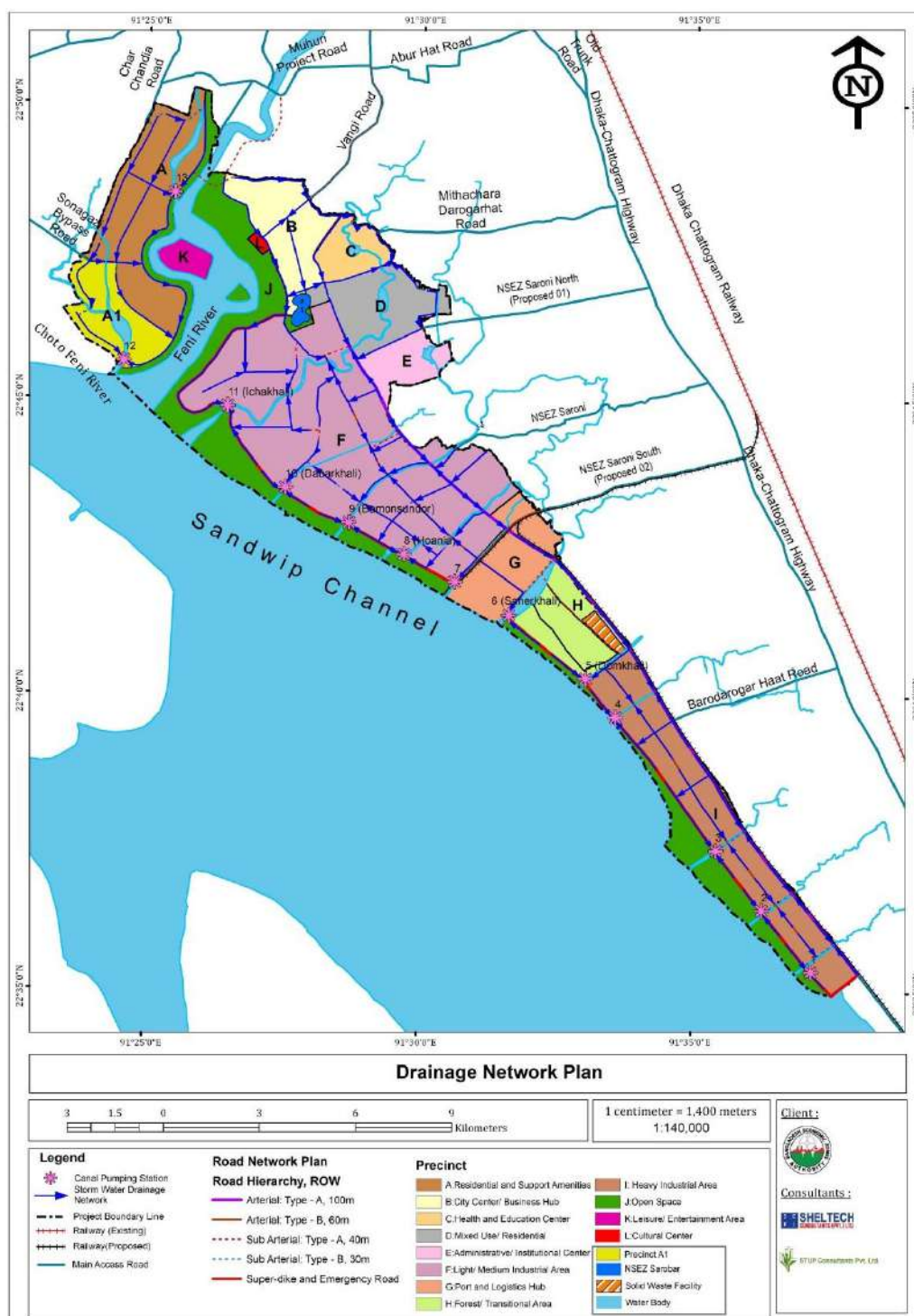
2.4.5.3 Storm Water Drainage System

Stormwater drains shall be provided on either side of the proposed road network of the area to collect the storm runoff generated from the catchment and get it discharged to the drainage channel for ultimate disposal to the sea.

An assessment of storm runoff contribution from NSEZ and areas outside NSEZ for individual drainage catchment areas has been made considering rainfall intensity of 34.4 mm/hr. and average runoff coefficient of 0.60 (keeping into consideration that rainwater harvesting will be extensively practiced in

NSEZ for the area within NSEZ and an average runoff coefficient of 0.40 for the area outside NSEZ. The drainage network plan of NSEZ is given in Figure 2-19.

Figure 2-19: NSEZ Drainage Network Plan



Source: BEZA, 2020a

NSEZ site is sloping from north-east to south-west. Currently, storm runoff generated from the entire area of NSEZ, and its surrounding areas gets drained to the Sandwip Channel through a number of natural drainage channels passing through the NSEZ viz. Ichakhali, Daborkhali, Bamansundar, Hoania, Saherkhali, Domkhali, etc. According to the consultation with BWDB, they have re-excavated khals including Ichakhali, Bamansundar, and Daborkhali as well as planned to excavate other local khals in

the region to maintain proper drainage systems. Sluice gates are also developed at different khals at the point of entry of the khal in the NSEZ from the seaside to control the flow of seawater.

During heavy rainfall or high tide events, challenges arise due to both the condition of the drainage canals and the function of the sluice gates that regulate water flow. In situations of intense flooding, seawater may enter through the downstream gates. While the gates are typically closed during extreme high tides to prevent seawater from flowing upstream, the gates at the upstream sections of these canals are in deteriorated condition, limiting their effectiveness. Conversely, the downstream gates are newly constructed and better able to control water flow at the entry points to the NSEZ from the sea. This discrepancy in gate conditions between upstream and downstream locations results in an inconsistent drainage system that struggles to handle stormwater efficiently.

Due to the current condition of the drainage canals and the uneven functionality of the sluice gates, waterlogging issues persist, especially outside the NSEZ area. The upstream gates' poor condition allows water to back up during high tides or heavy rains, affecting nearby communities outside the zone. These drainage limitations highlight the need for targeted improvements, such as:

- **Repairing and Upgrades to Upstream Gates:** Strengthening or replacing the existing upstream gates will improve their resilience and ability to control water levels effectively, minimizing backflow and enhancing the drainage performance within and beyond NSEZ boundaries.
- **Canal Capacity and Condition Improvements:** Regular excavation and reinforcement of the canal walls would improve drainage efficiency, helping to prevent sediment buildup and reducing erosion within the canals.
- **Comprehensive Drainage Management Strategy:** A coordinated approach between NSEZ, BWDB, and local authorities would help ensure that the drainage infrastructure within NSEZ development area and its surrounding areas can manage storm runoff effectively, addressing the waterlogging issues that affect communities outside NSEZ.

2.4.6 Telecommunication Network

According to the consultation with Bangladesh Telecommunications Company Limited (BTCL), a 22 km Optical Fiber Cable (OFC) will be laid from the main road of the Dhaka-Chattogram highway to NSEZ at both sides of the access road. Besides, another 15 km of OFC will be laid from Sonagazi of Feni to Mirsharai EZ through Dasherhat (Charchandia) to ensure more redundancy. DWDM equipment will be installed at Mirsharai EZ which will be connected to Chattogram. Telephone and internet facilities for 20,000 subscribers will be required. To provide internet facilities and bandwidth of 150 Gbps capacity, core router, and switch with redundancy (1+1), access switches will be installed. BTCL requested BEZA to provide approximately 1,600 square meters of area in a suitable place inside NSEZ to build a telecom compound. Now, the construction activities of a 4 storied telecom building are ongoing which will house all telecom, transmission, IP, and power systems equipment, offices and customer service centers, engine and substation rooms, residential buildings, etc. BTCL will also install an access network with universal duct systems as well as overhead OFC to facilitate telephone and internet using GPON technology.

2.4.7 NSEZ Plantation Plan

There are a number of ways to make green NSEZ in order to create pleasant environments, which are sustainable and resilient to climate change. A comprehensive plantation plan has been proposed along the road and rail networks, natural water channels, coastal area along the Bay of Bengal and the Feni Reservoir, open spaces, and in Precincts K and L of the NSEZ Master Plan.

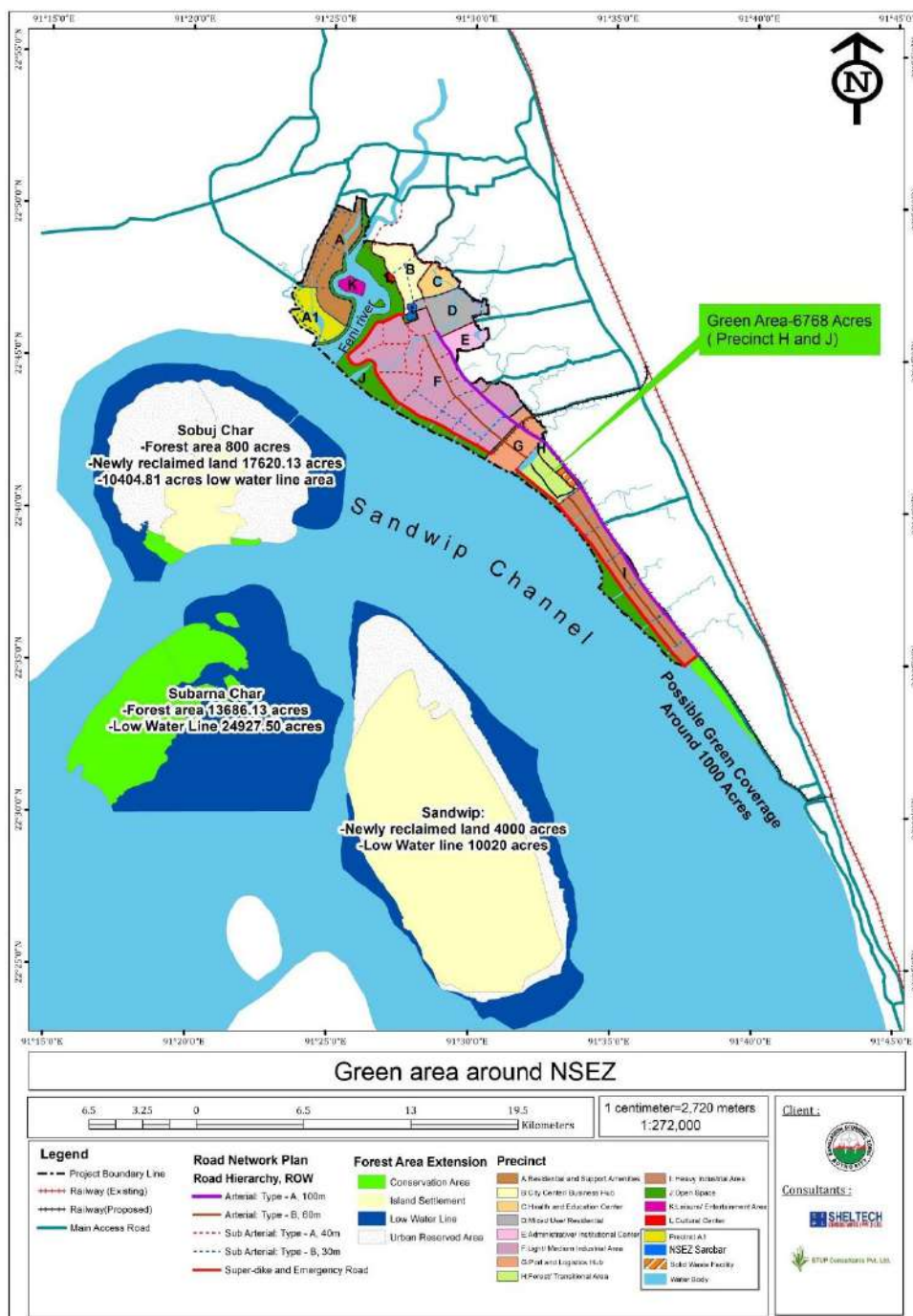
After a detailed consultation with the Divisional Forest Officer (DFO) Coastal Plantation, Chattogram it was suggested that BEZA can take the initiative for plantation in other potential areas which are shown in Table 2-11 and Figure 2-20. The total plantation costs are estimated at approximately 107 million BDT, considering the per square meter cost at 70 BDT.

Table 2-11: Other Potential Areas for Plantation

Plantation Locations	Area to Be Planted (Acres)
Total Subarna Char - low line water line area of Subarna Char will be kept for green coverage	24,924.00
40% of the reclaimed Sabuj – Char	7048.00
Sabuj Char - low line water line area of Sabuj Char will be kept for green coverage	10,404 .00
60% - low line water line area of Sandeep Char will be kept for green coverage	6,000.00
Total Proposed Plantation Area	48,376.00

Source: BEZA, 2020a

Figure 2-20: Green Areas Around NSEZ



Source: BEZA, 2020a

2.4.7.1 Progress of Plantation

According to the Consultation with Sitakunda O&M Subdivision of BWDB, reveal that the existing super dyke length is 22.5 km, and they have a plan to extend it by an additional 12.5 km length towards Sitakunda. Within the existing 22.5 km, they don't have any plans for green zone development on this specific land. However, they agreed to finance the Bangladesh Forest Department (BFD) for planting trees in an area of 100 acres to create a green zone along the coastline of the Bay of Bengal as well as NSEZ. In addition, the officials from the Coastal Afforestation Division of Sitakunda and Mirsharai range of BFD confirmed that currently they are implementing their coastal afforestation program, which began in 1966 and continued since then to protect the population in the coastal areas from cyclones and storm surges and maintain environmental balance, as well as to stabilize newly accrued Charlands. Currently,

BFD has no specific green development plan focusing on NSEZ. However, they have a plantation plan under their coastal afforestation program along the coastline of the Bay of Bengal as well as NSEZ.

According to the consultation with BEZA, the Bangladesh Rural Advancement Committee (BRAC) has already planted approximately 42 thousand trees on 68 acres of land in Mirsharai, part of NSEZ, financed by HSBC Bank. BEZA has planted 4 lakh trees so far in the NSEZ site and the closest road networks of NSEZ. Forest Department also planted trees along the super dyke with their own financing. In the NSEZ Sorobor area (a 112-acre dighi nearby), BEZA has planted trees on approximately 3 acres of land. In the Sonagazi part, they have already planted some trees along the road. In the Sitakunda part, they still haven't acquired any land for tree planting. However, as soon as they acquire the land, they will begin to plant trees in the Sitakunda part as well. The plantation program that already implemented by the Department of Forest and Bangladesh Water Development Board has been given in Table 2-12.

Table 2-12: Plantation by Department of Forest and Bangladesh Water Development Board

S/N	Name of Department/CSR Partner	Planted Year	Area (Hectares/ KM /Acres)	Total Number of Trees planted	Name of Tress
1.	Department of Forest under the SUFAL project	2020-2023	400	2,000,000	Bain, Kewra, Geawa, & Jhau
2.	Department of Forest's Char Afforestation project	2021-2022	200	1,000,000	Bain, Kewra, Geawa, & Jhau
3.	BWDB with the help of DOF	2021-2022	100	500,000	Bain, Kewra, Geawa, & Jhau
Total			700	3,500,000	

Source: BEZA, April 2024

2.4.8 Embankment/Super Dyke

According to the NSEZ⁵, the Bangladesh Water Development Board (BWDB) under the Ministry of Water Resources (MOWR) has constructed a coastal embankment (suer dyke) with slope protection of 18.488 km., hydraulic structures, etc. for protection of the NSEZ area from flood, saline intrusion, erosion caused by tidal surge and natural disaster. The length of the embankment is approximately 22.5 km and 9 nos. of sluice has been constructed. In addition, a 30 km re-excavation of khal has been done.

According to the consultation with BWDB, a 12.5 km embankment will be constructed along the coastline from Domkhali in Mirsharai to Guliyakhali in Sitakunda. The embankment, 27 meters high with a 60-meter base and 9.8-meter top, will host a two-lane road. Additionally, 6 to 8 sluice gates will be constructed.

In addition, BWDB also will construct super dyke for protecting Feni EZ.

⁵ <https://beza.gov.bd/economic-zones-site/government-owned-sites/mirsorai-chittagong/>

3 ES BASELINE OF THE REGION

This chapter describes the previous and present condition of the physical, biological, and socioeconomic environment of the study region. This would help in the understanding of the resources available and environmental and social issues in the region. The outline of the baseline conditions would establish benchmarks to assist in the assessment of potential risks and impacts (both positive and negative) of the NSEZ. The issues identified in this chapter are linked with the primary profile of the region described in subsequent chapters.

The parameters of environmental and social impact are identified by elaborating on the various aspects of the environment, which can be divided as:

- **Physical environments** include meteorology, geology, topography, soil, physiography, land use and land cover, geomorphology, surface water hydrology and drainage, groundwater hydrogeology, agroecology, erosion and sedimentation, seismicity, and environmental quality aspects (ambient air quality, ambient noise level, surface water quality, groundwater quality, soil, and sediment quality, etc.) test to evaluate the existing condition.
- **Biological environments** include the bioecological zone, ecosystem and habitat, flora and fauna, aquatic monitoring (phytoplankton, zooplankton, and benthos), protected areas, ecologically critical areas, mangrove forests, Hilsha sanctuary and spawning ground, marine protected areas, important bird and biodiversity areas, and RAMSAR sites.
- **Socio-economic and cultural environment** relating to demographic and socioeconomic conditions of the population in the study area and surrounding environment.

3.1 Area of Influence

For a good understanding of the process of risks and impacts assessment and management, it is worthwhile to clarify the difference between NSEZ area, area of influence, and study area, as these overlap, but are not identical. This is described below.

- **NSEZ Area (NSEZ Footprint):** an area where the development activities are realized. In other words, where development and operation take place.
- **Area of Influence:** an area where impacts from the development activities may manifest, which can be larger than the NSEZ area, and considered areas that might be affected by indirect effects.
- **Area of Study:** the area that will be studied for the baseline and impact assessment. It may be justifiable to study only certain parts of the AOI if these parts are representative of the wider area.

3.1.1 Area of NSEZ

The area that may reasonably be expected to be physically touched by development and operation activities across all phases. NSEZ site is located on the coastline of Bangladesh. Administratively, the area falls in Mirsharai and Sitakunda Upazila of Chattogram District and Sonagazi Upazila under Feni District.

The footprint for the NSEZ includes land used for the flood protection and management (embankments, dykes, pumps, sluice gates, stormwater drainage, etc.), transport (roads, bridges, ports, rail, light rapid transit, etc.), buildings (factory shells, administration buildings, residential/commercial/retail/educational/medical buildings, fire services, etc.), telecommunication (towers, cables, fiber optics, backbone, switches, etc.), water supply and sanitation (potable/grey water system, sewage treatment plants, water treatment plants, water reservoirs, desalination plants, etc.), energy (power plants, substations, solar panels, etc.), waste management (waste treatment plants, bio-gas plants, etc.), power transmission and distribution line, gas transmission and distribution line, dredging area, and plantation area.

3.1.2 Area of Influence

The Area of Influence (AOI) for the NSEZ is defined as the area over which the impacts of the NSEZ are likely to be felt including all its related facilities as identified above as well as any reasonably foreseen unplanned developments induced by the NSEZ or cumulative impacts. Most of the impacts will occur within the NSEZ footprint area. The consultant provided an AOI considering their previous experience and a map of the study area for conducting the RESA study has been prepared and shared with the BEZA. As per discussion with BEZA on 08 June 2023, the AOI could be revised during a detailed RESA study (reduced or enlarged) considering the possible impacts in the region due to the NSEZ interventions. It is to be noted that the AOI will be finalized after discussion with BEZA.

The AOI is comprised of areas of direct and indirect impacts as follows:

- **Direct area of influence:** considers the physical footprint of the development activities such as the site layout, work staging areas, and areas affected during construction and operation works (e.g., traffic patterns).
- **Indirect area of influence:** includes an area that may experience project-related changes combining with activities, not under the direct control of the development activities (e.g., labor influx, induced development, access to employment, etc.).

The AOI is generally larger than the NSEZ area in order to address all possible relevant risks and impacts. In this context, the impact area is the geographic area that may experience impacts on the physical, biological, or socio-economic environments from the development and operation of the NSEZ components. This area includes the lands permanently and temporarily affected by the NSEZ features.

The effects of the NSEZ activities on a particular resource or receptor will have spatial (distance) and temporal (time) dimensions. Some activities would impact a larger radius than other identified impact sources. The scale of which is dependent on a number of factors, including:

- Nature of the activity
- Specific resource or receptor
- Sensitivity of that resource or receptor
- Whether the impact is direct or indirect (e.g., a secondary effect)

The AOI for the NSEZ with respect to the environmental, biological, and social resources was determined considering the following spatial and temporal dimensions and possible risks and impacts:

Environmental Parameters

The AOI for individual environmental attributes is as below:

- **Air Quality:** dust emissions, fugitive dust, etc. are typically observed within 200-500 meters of the construction area. A minimum of 500 meters AOI has been taken to capture all sources of these emissions including vehicular movement across access roads. It is assumed that during the operation phase, impacts on air quality would manifest in a 5 km radius of the NSEZ boundary, and therefore different aspects in the area need to be studied further in detail in the RESA stage.
- **Noise pollution:** noise can often be detected up to 400-500 meters from any construction and operation.
- **Surface Water Resources:** fresh water bodies located in the vicinity of NSEZ and adjacent (Ichakhali, Daborkhali, Bamon Sundor, Khutakhali, Haonia, Saherkhali, and Domkhali canals and Feni reservoir) may get impacted due to activities at the NSEZ footprint and allied sites. The drainage condition of the NSEZ footprint may be impacted. In addition, marine water bodies i.e., Sandwip Channel and the Bay of Bengal may be impacted due to the vessel's movement and dredging activities in the navigation channel.
- **Groundwater Resources:** impact on groundwater quality and quantity - on the groundwater acquirer of the NSEZ region.

- **Land resources:** impact on soil and land are often restricted to the NSEZ footprint area. An AOI of 500 meters taking into account indirect effects usually occurs due to vehicular/heavy machinery movements and activities at allied sites.

Ecological Parameters:

- Terrestrial Flora and Fauna - this includes the areas immediately adjacent to the NSEZ footprint within which a zone of ecological disturbance is created through increased dust, human presence, and related activities (e.g., trampling, and transportation activities). This kind of disturbance has been estimated to occur within 2 km to 5 km of the NSEZ footprint.
- An AOI of a 5 km radius is considered for ecological study. The 5 km radius provides an understanding of the use of forested habitat around the proposed NSEZ.
- Marine ecology - the nearest water bodies i.e., Sandwip Channel and Feni reservoir are sensitive to Hilsa fish and Dolphins. These resources could be impacted due to the jetty construction and operation, ship movement, and dredging activities in the channel. Therefore, the Feni reservoir and Sandwip channel including islands i.e., Urirchar, Sandwip, and Jahajjar Char have been included in the AOI. Protected areas⁶ including IBAs in the study area will be identified and analyzed during the data collection stage.

Socio-economic Parameters:

- Consists of the social aspects within the NSEZ site, the surrounding settlements, and receptors within the 500 meters corridor along the NSEZ access roads, gas transmission, and electricity transmission line that will potentially be affected by the NSEZ development activities and operations and cumulative impacts of nearby communities and projects.
- Potential impacts on the availability of natural resources for use by the community, demographics and economic activities in the area, community health, and culturally significant sites and activities. It is assumed that within the 1 to 2 km radius, most of the social impacts would manifest, and therefore different social aspects in the area need to be studied further in detail in the RESA stage.
- With respect to potential impacts related to the required labor during construction and operation, has been set at a wider radius of 10 km, to include Mirsharai, Sonagazi, and Sitakunda Upazila Headquarters within its reach. The reason for this is that workers may be housed in the Upazila area, which means that the impacts of a worker influx (e.g., demand for services, perceptions of community safety, local demographics, etc.), could extend. This is not to say that impacts necessarily manifest in this wider radius, but that due consideration should be given to this possibility.
- The potential social changes will be assessed such as the study will cover any impact on the local school, service facilities, graveyard, religion, etc.
- A primary survey will be conducted following a determined sample size for the collection of socio-economic data emphasize demographic and socioeconomic features of the targeted areas of four main concentrated unions namely Shaher Khali, Ichhakhali, Mogadia, and Sonagazi. Stakeholder consultation will also cover issues like employment opportunities, loss of livelihoods (grazing and agricultural land), and increased anthropogenic/ vehicular activity in remote areas.

3.1.3 Study Area

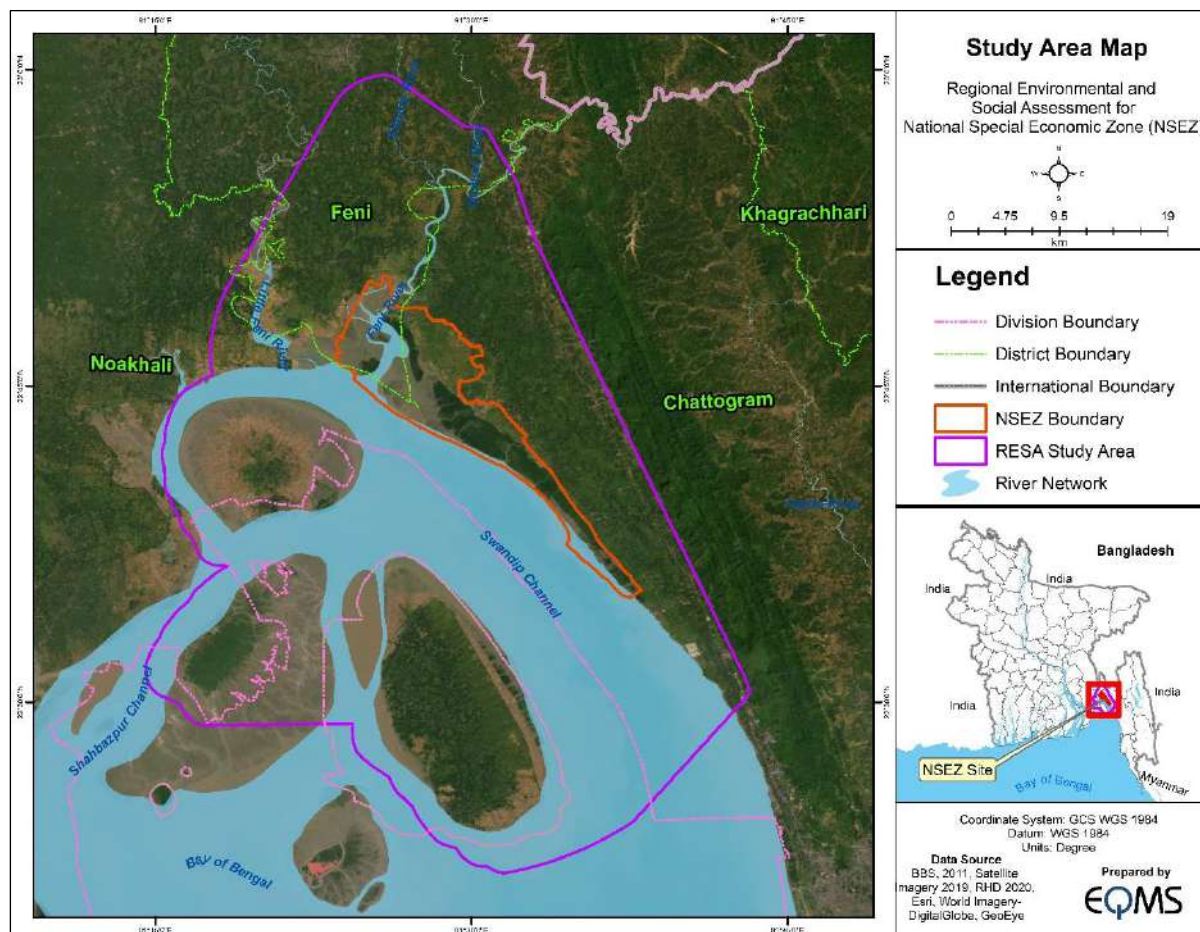
The study area of the Regional Environmental and Social Assessment for the National Special Economic Zone has been selected based on the location of the EZ and related facilities their footprint,

⁶ According to the Wildlife (Protection and Security) Act 2012, in Bangladesh Protected Areas (PAs) include sanctuaries, national parks, community conservation areas, safari parks, eco-parks, botanical gardens, special biodiversity conservation area, and traditional heritage and kunjaban.

nature, and spatial distribution of potential environmental and social risks and impacts. The study area includes the NSEZ footprint area and area of influence described above.

For determining the study area, all the geospatial data regarding the NSEZ footprint was collected from BEZA and superimposed by the consultant using GIS software. It helps to identify physical elements, aspects, and facilities that are likely to generate environmental and social risks and impacts in the context of the NSEZ footprint area and area of influence. A map of the study area is shown in Figure 3-1.

Figure 3-1: Map of the Study Area



Source: Geospatial data from BEZA and map prepared by EQMS

3.2 Physical Environment

3.2.1 Meteorology

Although less than half of Bangladesh lies within the tropics, the presence of the Himalaya Mountain range has created a tropical macroclimate across most of the East Bengal landmass (Rashid, 1991). Brammer, 1996 has identified four distinct seasons resulting from this weather pattern, namely:

1. **Pre-Monsoon Season (March to May):** Characterized by the highest temperatures of the year - up to 36°C. Some rainfall may occur, with tropical cyclones occasionally affecting coastal areas.
2. **Monsoon Season (June to September):** Period of highest rainfall (up to 80% of the annual rainfall), humidity, and cloud cover. Increased rain and cloud cover generally cause a small reduction in mean daily temperatures.

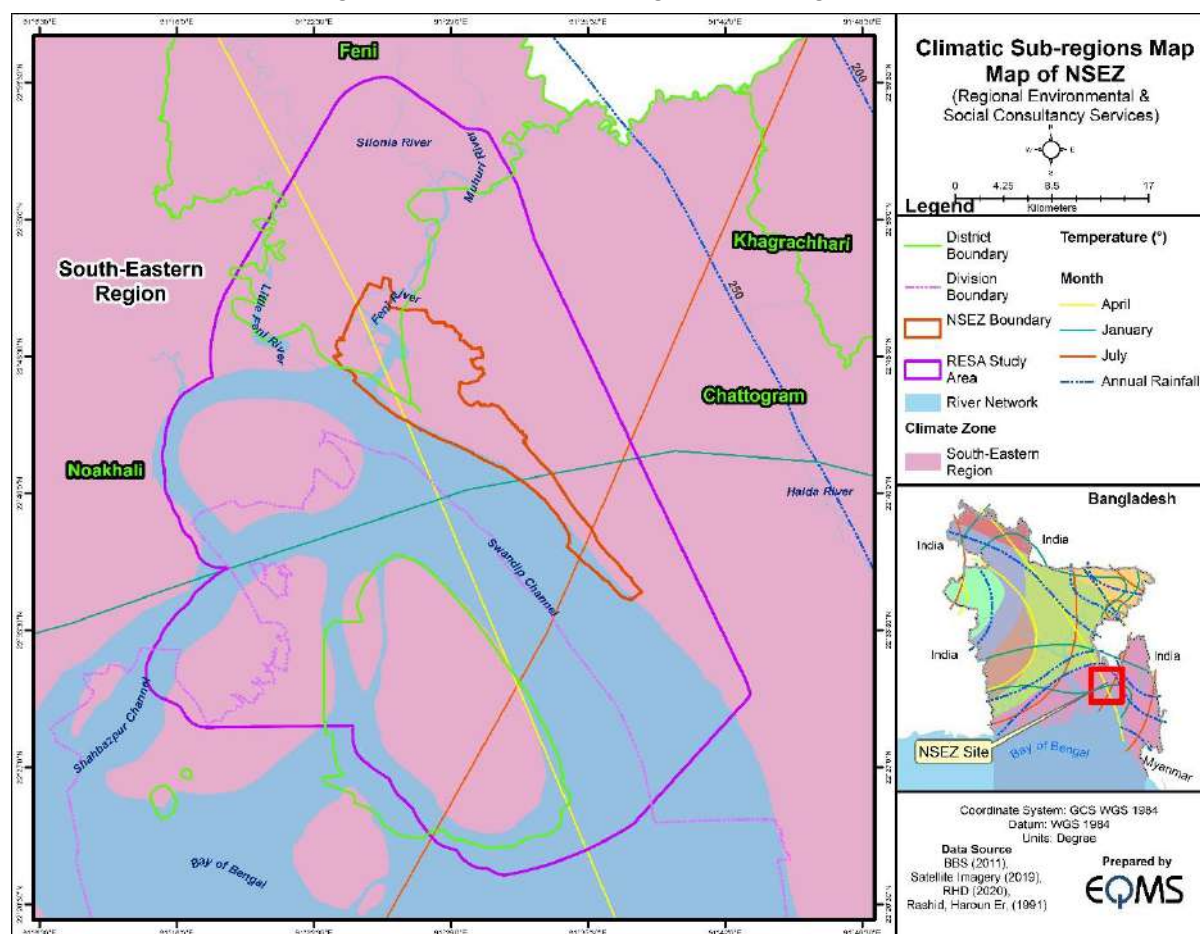
3. **Post-Monsoon Season (October to November):** Temperature remains hot and humid, though cloud cover decreases in this season. Limited tropical thunderstorms may still occur, particularly in coastal areas.
4. **Dry Winter Season (December to February):** Coolest time of the year with mean minimum temperatures falling below 10°C in some areas. Reduced humidity and cloud cover. Rainfall is scarce.

Despite the general predictability of the seasons in Bangladesh, local conditions may still vary widely across the country. As such, Bangladesh can be divided into seven climatic sub-zones based on differences in a range of factors including rainfall, temperature, evapotranspiration, and local seasonality (Rashid, 1991). According to the climatic sub-regions of Bangladesh, the NSEZ region is located in the South-East Region (Figure 3-2). The climatic data for the study area was obtained from three meteorological stations i.e., Sitakunda, Sandwip, and Feni of the Bangladesh Meteorological Department.

3.2.1.1 South-East Region

It comprises the Chattogram sub-region and a strip of land extending from southwest Sundarbans to the south of Cumilla. The hills over 300m in height have a North-Eastern zone climate. The rest of the area has a small range of temperatures, and rarely goes over a mean of 32.0°C and below a mean of 13.0°C. Rainfall is heavy, usually over 2,540 mm. In winter, dewfall is heavy. Like other parts of the country, the NSEZ areas are heavily influenced by the Asiatic monsoon.

Figure 3-2: Climatic Sub-regions of Bangladesh

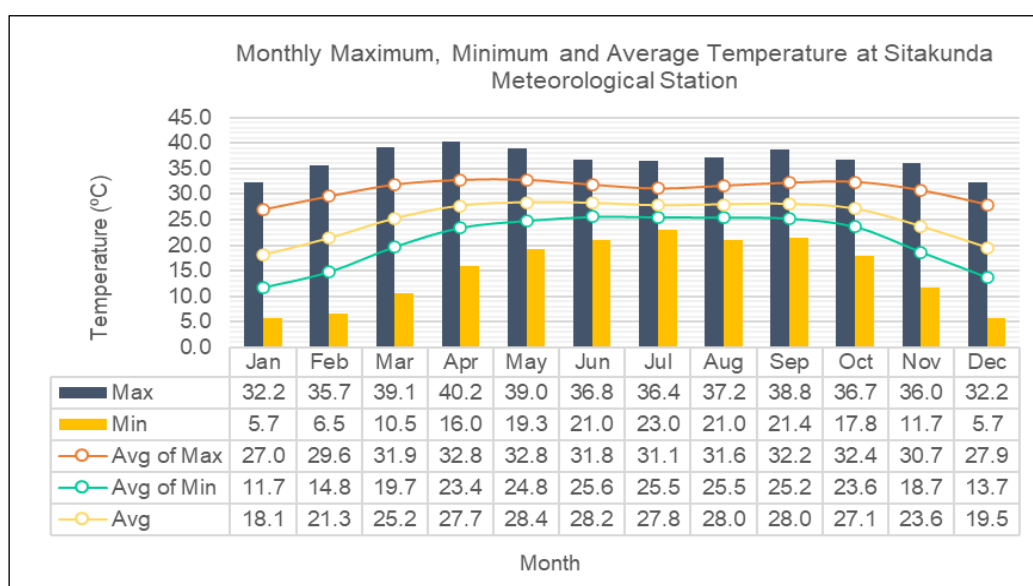


Source: Rashid, 1991

3.2.1.1.1 Temperature

Based on the temperature recorded at Sitakunda Meteorological Station for the last 30 years (1992-2021), the maximum and minimum ambient temperatures are observed to range from 32.2°C to 40.2°C and 5.7°C to 23.0°C, respectively. The lowest average temperature was in January 2013 (12.0°C). The highest average temperature reached 32.1°C in April 2014. May is the hottest month of the year with an average maximum and minimum temperature (in May) of 32.8°C and 24.8°C, respectively. From November onwards, both the day and night temperatures decrease, and January is the coldest month, with average monthly maximum and minimum temperatures of 27.0°C and 11.7°C, respectively. The monthly variation of the maximum, minimum, and average temperature at Sitakunda Meteorological Station is shown in Figure 3-3.

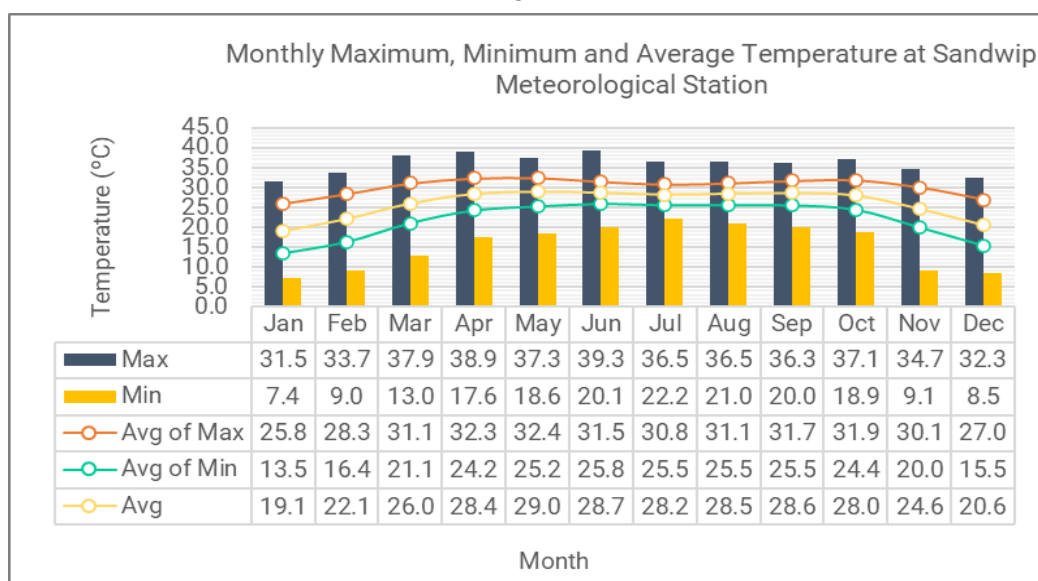
Figure 3-3: Monthly Maximum, Minimum, and Average Temperatures at Sitakunda Meteorological Station



Source: Meteorological Data from Bangladesh Meteorological Department (BMD)

Based on the temperature recorded at Sandwip Meteorological Station for the last 30 years, the maximum and minimum ambient temperatures are observed to range from 23.3°C to 34.7°C and 11.5°C to 28.1°C, respectively. The lowest average temperature was in January 2001 (16.9°C). The highest average temperature reached 30.1°C in May 2019. May is the hottest month of the year with an average temperature of 29.0°C. From November onwards, both the day and night temperatures decrease, and January is the coldest month, with average monthly maximum and minimum temperatures of 25.8°C and 13.5°C, respectively. The monthly variation of the maximum, minimum, and average temperature at Sandwip Meteorological Station is shown in Figure 3-4.

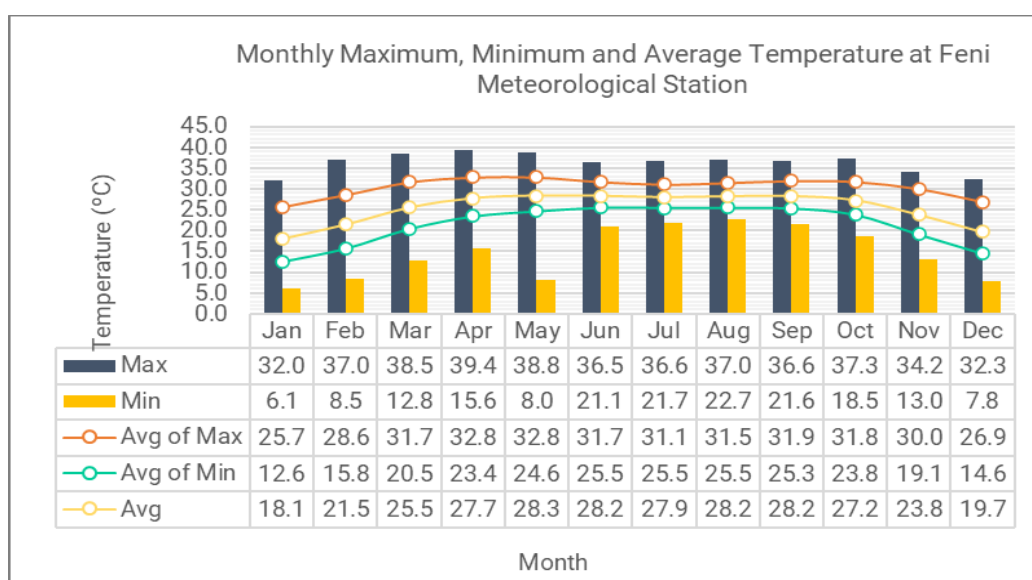
Figure 3-4: Monthly Maximum, Minimum, and Average Temperatures at Sandwip Meteorological Station



Source: Meteorological Data from Bangladesh Meteorological Department (BMD)

Based on the temperature recorded at Feni Meteorological Station for the last 30 years, the maximum and minimum ambient temperatures are observed to be ranging from 23.5°C to 36.0°C and 10.9°C to 26.7°C, respectively. The lowest average temperature was in January 2013 (17°C). The highest average temperature reached 29.6°C in June 1998. May is the hottest month of the year with an average temperature of 28.3°C. From November onwards, both the day and night temperatures decrease, and January is the coldest month, with average monthly maximum and minimum temperatures of 25.7°C and 12.6°C, respectively. The monthly variation of the maximum, minimum, and average temperature at Feni Meteorological Station is shown in Figure 3-5.

Figure 3-5: Monthly Maximum, Minimum, and Average Temperatures at Feni Meteorological Station



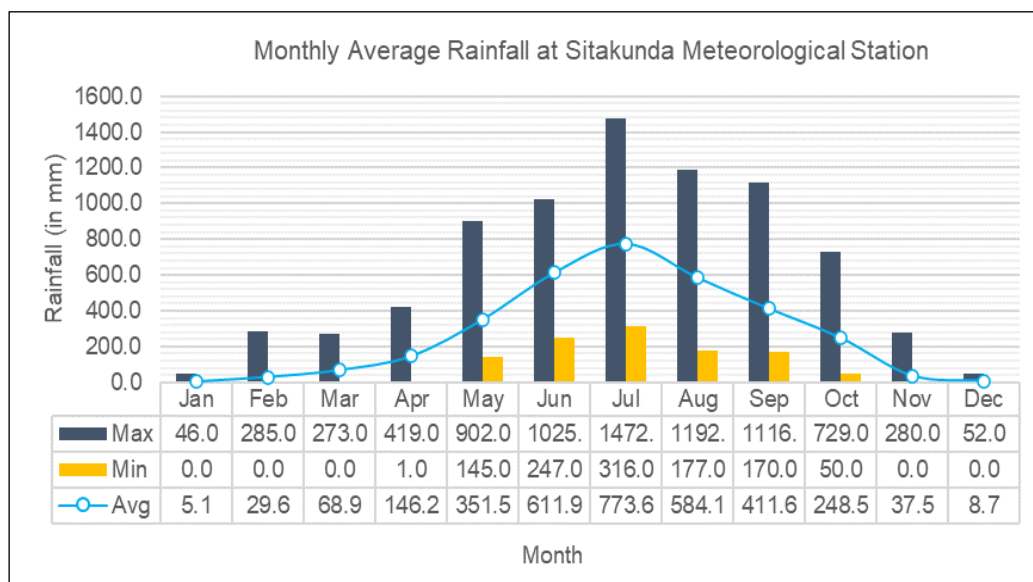
Source: Meteorological Data from Bangladesh Meteorological Department (BMD)

3.2.1.1.2 Rainfall

The annual rainfall based on rainfall data recorded at Sitakunda Meteorological Station for the last 30 years is 3,277.1 mm. Annual rainfall shows considerable variability from year to year. The rainfall also

varies considerably within a year (Figure 3-6) with 91.0% of rainfall occurring within the six months from May to October. The highest rainfall was recorded in July 2019 (1,472.0 mm). An insignificant amount of rainfall has also been recorded in winter (November to February).

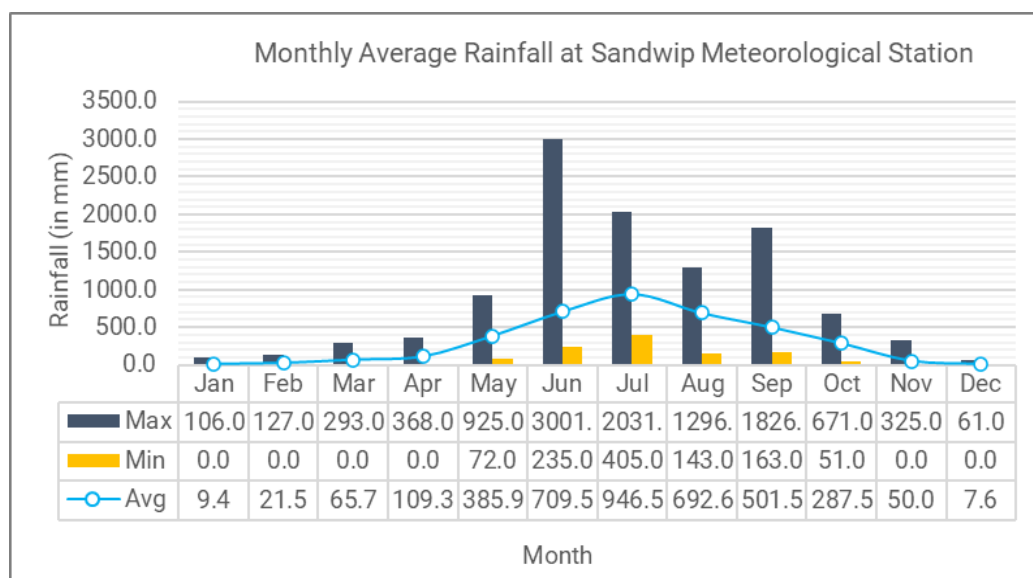
Figure 3-6: Monthly Maximum, Minimum, and Average Rainfall at Sitakunda Meteorological Station



Source: Meteorological Data from Bangladesh Meteorological Department (BMD)

The annual rainfall based on rainfall data recorded at Sandwip Meteorological Station for the last 30 years is 3,734.1 mm. Annual rainfall shows considerable variability from year to year. The rainfall also varies considerably within a year (Figure 3-7) with 94.4% of rainfall occurring within the six months from May to October. The highest rainfall was recorded in June 2001 (3001 mm). An insignificant amount of rainfall has also been recorded in winter (November to February).

Figure 3-7: Monthly Maximum, Minimum, and Average Rainfall at Sandwip Meteorological Station

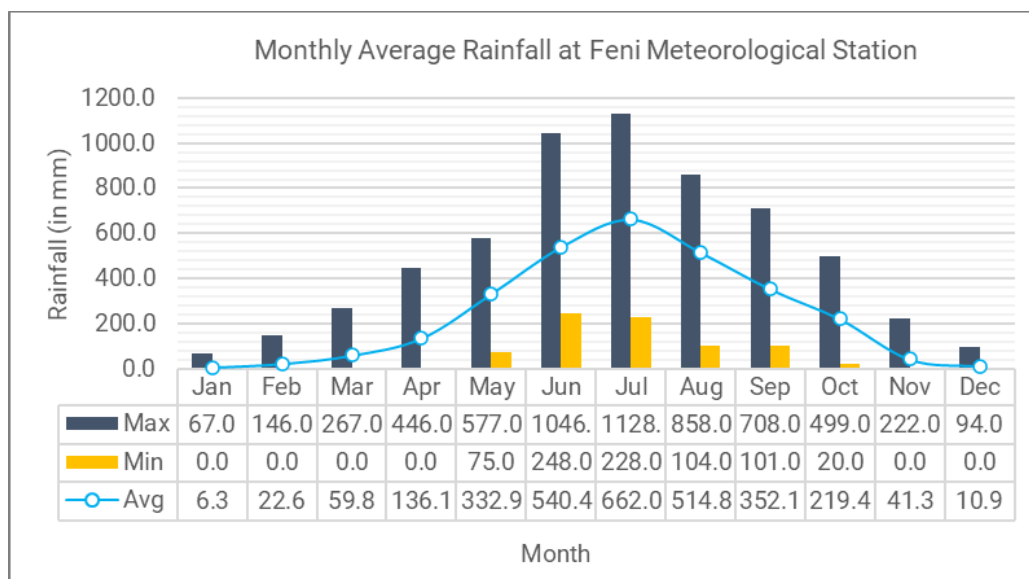


Source: Meteorological Data from Bangladesh Meteorological Department (BMD)

The annual rainfall based on rainfall data recorded at Feni Meteorological Station for the last 30 years is 2,898.6 mm. Annual rainfall shows considerable variability from year to year. The rainfall also varies considerably within a year (Figure 3-8) with 90.4% of rainfall occurring within the six months from May

to October. The highest rainfall was recorded in July 2015 (1,128 mm). An insignificant amount of rainfall has also been recorded in winter (November to February).

Figure 3-8: Monthly Maximum, Minimum, and Average Rainfall at Feni Meteorological Station

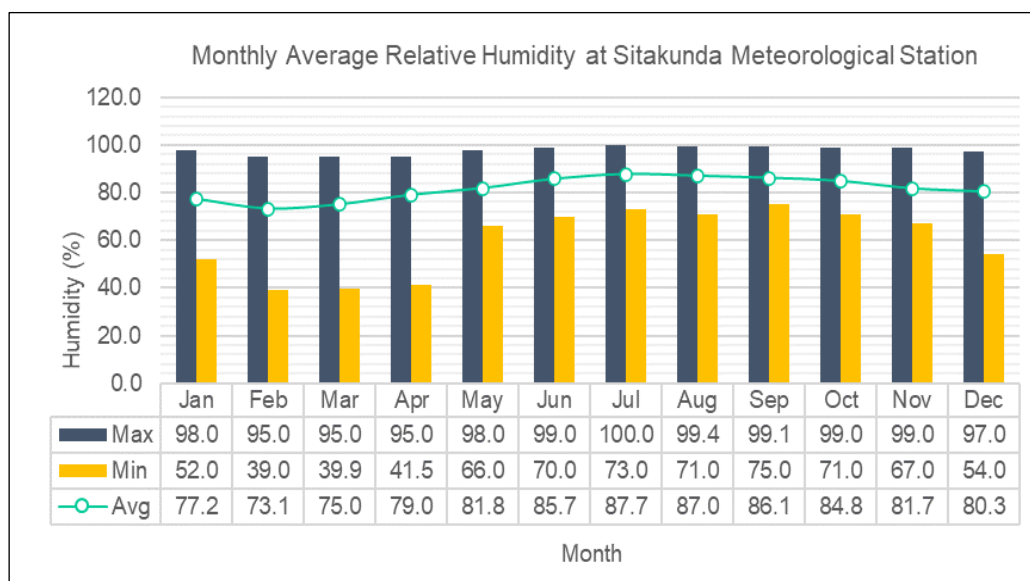


Source: Meteorological Data from Bangladesh Meteorological Department (BMD)

3.2.1.1.3 Humidity

Due to the heavy rainfall and proximity to the Bay of Bengal, the humidity levels in Bangladesh remain high. Based on humidity data recorded at Sitakunda Meteorological Station for the last 30 years, relative humidity is generally above 77% throughout the year except in February and March. The monthly average relative humidity varies from 73.1% to 87.7% with average humidity at 81.6%. Humidity remains higher in the monsoon (June to October) season and comparatively lower in the winter season. The month of February is the driest with a relative humidity of around 73.1%. The monthly average relative humidity at the Sitakunda Meteorological Station is shown in Figure 3-9.

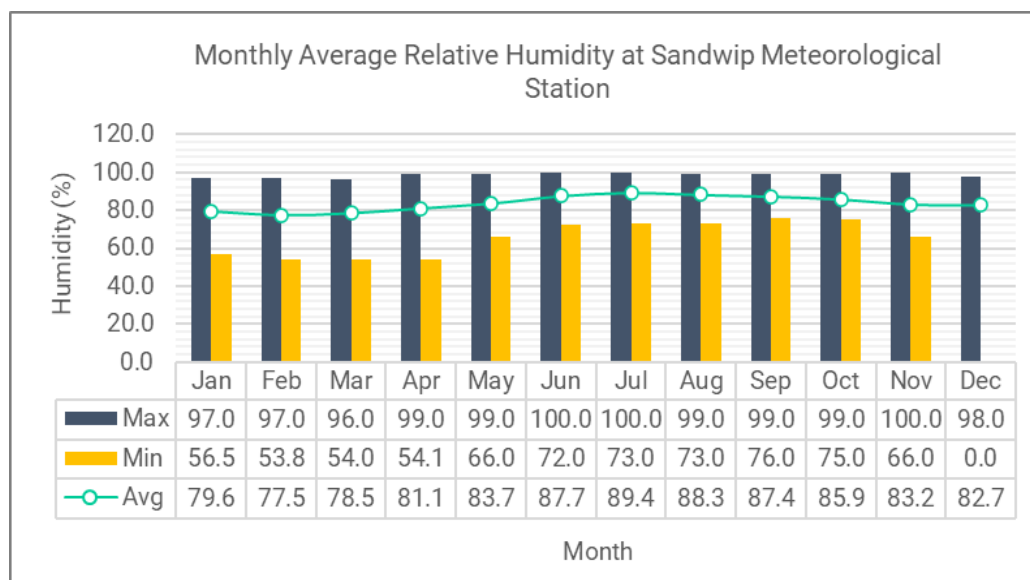
Figure 3-9: Monthly Maximum, Minimum, and Average Relative Humidity at Sitakunda Meteorological Station



Source: Meteorological Data from Bangladesh Meteorological Department (BMD)

Based on humidity data recorded at Sandwip Meteorological Station for the last 30 years, relative humidity is generally above 81% throughout the year except in January, February, and March. The monthly average relative humidity varies from 77.5% to 89.4% with average humidity at 83.7%. Humidity remains higher (85.9% to 89.4%) in the monsoon (June to October) season and comparatively lower in the winter season. The month of February is the driest with a relative humidity of around 77.5%. The monthly average relative humidity at the Sandwip Meteorological Station is shown in Figure 3-10.

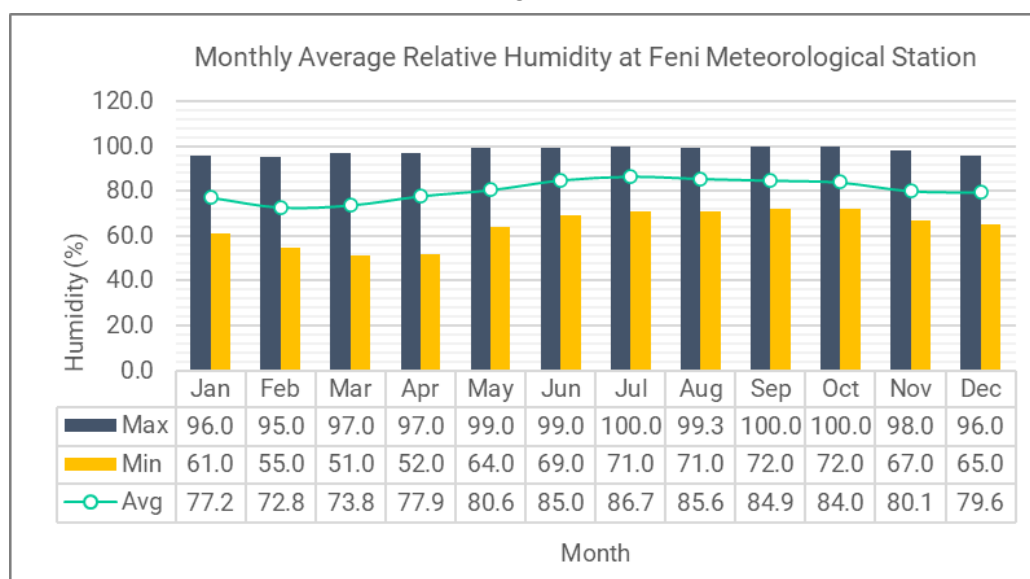
Figure 3-10: Monthly Maximum, Minimum, and Average Relative Humidity at Sandwip Meteorological Station



Source: Meteorological Data from Bangladesh Meteorological Department (BMD)

Based on humidity data recorded at Feni Meteorological Station for the last 30 years, relative humidity is generally above 80% throughout the year except in January to April and December. The monthly average relative humidity varies from 64.6% to 90.8% with average humidity at 80.7%. Humidity remains higher (84.0% to 86.7%) in the monsoon (June to October) season and comparatively lower in the winter season. The month of February is the driest with a relative humidity of around 72.8%. The monthly average relative humidity at the Feni Meteorological Station is shown in Figure 3-11.

Figure 3-11: Monthly Maximum, Minimum, and Average Relative Humidity at Feni Meteorological Station



Source: Meteorological Data from Bangladesh Meteorological Department (BMD)

3.2.2 Geology

According to Alam et. Al., 1990, the NSEZ site falls under the geological unit of “Beach and Dune” and “Tidal Deltaic Deposit”. Table 3-1 shows the geological units and the covered areas for the NSEZ site.

Table 3-1: Geology unit within NSEZ

S/N	Geology Unit	Area		
		sq km	Acres	%
1	Beach and Dune	121.99	30143.24	84.01
2	Tidal Deltaic Deposits	23.23	5739.10	15.99

Source: EQMS Consulting Limited, 2024

The study region falls under the geological unit of “Tidal Deltaic Deposits”, “Beach and Dune”, “Tidal Mud”, “Valley Alluvium and Colluvium”, “Estuarine Deposits”, “Chandina Alluvium”, “Bhuban Formation”, and “Boka Bil Formation”. Table 3-2 shows the geological units and the covered areas for the study area.

Table 3-2: Geology unit within the study area

S/N	Geology Unit	Area		
		sq km	Acres	%
1	Tidal Deltaic Deposits	676.37	167134.18	32.92
2	Beach and Dune	590.71	145968.40	28.75
3	Tidal Mud	384.11	94914.68	18.69
4	Valley Alluvium and Colluvium	180.25	44540.73	8.77
5	Estuarine Deposits	175.19	43291.12	8.53
6	Chandina Alluvium	41.57	10272.15	2.02
7	Bhuban Formation	3.42	845.71	0.17
8	Boka Bil Formation	3.07	759.25	0.15

Source: EQMS Consulting Limited, 2024

A brief description of the geology units is given below.

3.2.2.1 Beach and Dune Sand

Light to whitish-grey sand. Medium to fine, well-sorted, subrounded; contains concretions, shell fragments, heavy minerals, and rare clasts. Includes small mud-flat deposits. Unconformable overlies late tertiary formations (Alam, et. al., 1990).

3.2.2.2 Tidal Deltaic Deposits

Among tidally influenced sedimentary environments, tide-dominated deltas are perhaps the most variable and difficult to characterize. This variability is due in part to the major role that fluvial systems play in defining their delta, with rivers differing widely in discharge, sediment load, seasonality, and grain size. Tide-dominated deltas also tend to be large systems that can extend hundreds of kilometers across and along the continental margin. The associated sediment transport regimes are typically high energy, but they vary considerably at the scale of tidal cycles and seasonal river discharge. As a consequence of varying transport energy, the sedimentary successions formed in tide-dominated deltaic settings tend to be heterolithic, with interbedded sands, silts, and clays and both fining- and coarsening upward facies associations.

3.2.2.3 Tidal Mud

Dark to bluish grey saturated silty clay containing shell fragments; bioturbated. Contains scattered lenses of beach sand. Zone defined by high and low tides. Tidal mudflat deposits are areas of active deposition (Alam, et. al., 1990).

3.2.2.4 Valley Alluvium and Colluvium

Medium to dark-grey or light brown silt, clayey silt, and fine to medium sand; locally contains coarse debris derived from local bedrock and organic matter. Colluvium is flushed into narrow valleys and reworked by alluvial processes. In the Comilla region, includes small alluvial deposits, derived from the Tripura Hills, that overlie the Chandina Alluvium. Unit is susceptible to mass movement processes such as landslides, earth slumps, and mud flows (Alam, et. al., 1990).

3.2.2.5 Estuarine Deposits

Light grey to brownish- and yellowish-grey silty clay to clayey silt. Cross bedded; locally herringbone cross-bedded, laminated, and bioturbated; contains shell fragments. Thin lenticular deposits of yellowish brown, fine to very fine sand are found along channels and edges of islands and represent ephemeral levee deposits. Most estuarine islands are actively eroding on the upstream side and aggrading on the downstream end (Alam, et. al., 1990).

3.2.2.6 Chandina Alluvium

The soil type is usually grey where rice is grown, brown where other crops are grown, and dark grey where sugarcane or other vegetables are heavily manured. Most topsoils are calcareous, but some are non-calcareous. The reaction usually is moderately alkaline but may be slightly acidic to mildly alkaline, if the topsoil is decalcified. The subsoil is olive brown. The prismatic structure is developed in relatively heavier soils and thin, grey, subsoil coatings are sometimes found. Soil texture on the higher ridges usually is silt loam and occasionally sandy loam. Lower sites usually have silt loams or silty clay loams with a finer texture in the topsoil than in the subsoil. The agricultural potential of these soils ranges from high to low. The potentiality is highest in deep loamy soils where irrigation is available, and lowest in shallow ridge soils and soils affected by salinity or strong alkalinity. Most of these soils belong to chromic-calcaric gleysols (Biswas, et. al., 2010).

3.2.2.7 Bhuvan Formation (Miocene)

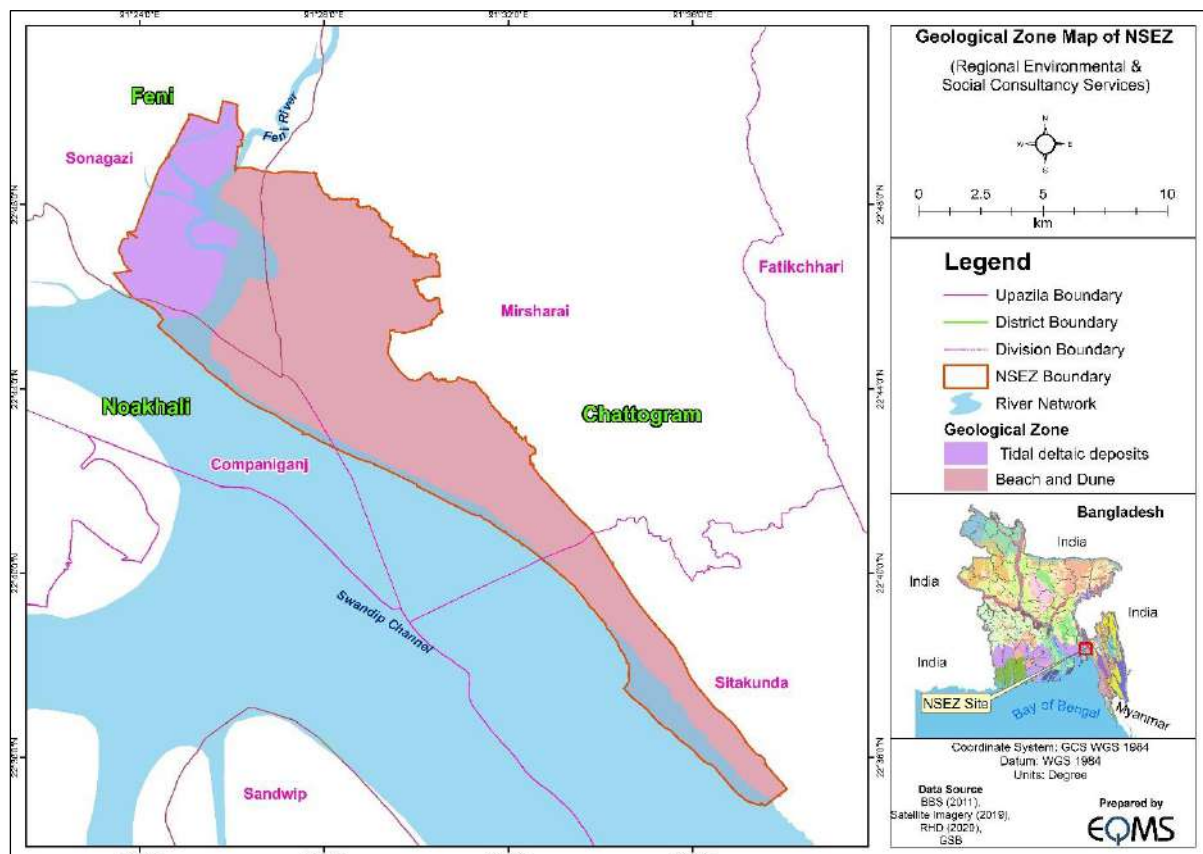
Grey to bluish grey, locally variegated, fine-to-medium-grained sandstone, siltstone, and claystone. Massive to thin-bedded, in places calcareous, cross-bedded, ripple marked, hard. The upper part is predominantly sandstone intercalated with siltstone and claystone; in places contains lenses of hard fossiliferous conglomerate. The middle part is predominantly claystone interbedded with siltstone and sandstone. The lower part is dominantly sandstone interbedded with siltstone and claystone (Alam, et. Al., 1990).

3.2.2.8 Boka Bill Formation (Neogene)

Greenish- to bluish-grey and yellowish-grey shale, siltstone, and sandstone. Sandstone is very fine to medium-grained; flaser bedding and starved ripple marks are common. In the upper and lower parts, shale commonly dominates and is interbedded with siltstone and sandstone; the middle part is dominated by massive, hard, locally calcareous, conglomeratic sandstone. The middle and lower parts contain calcareous lenses and concretion. Locally contains some fossiliferous beds (Alam, et. Al., 1990).

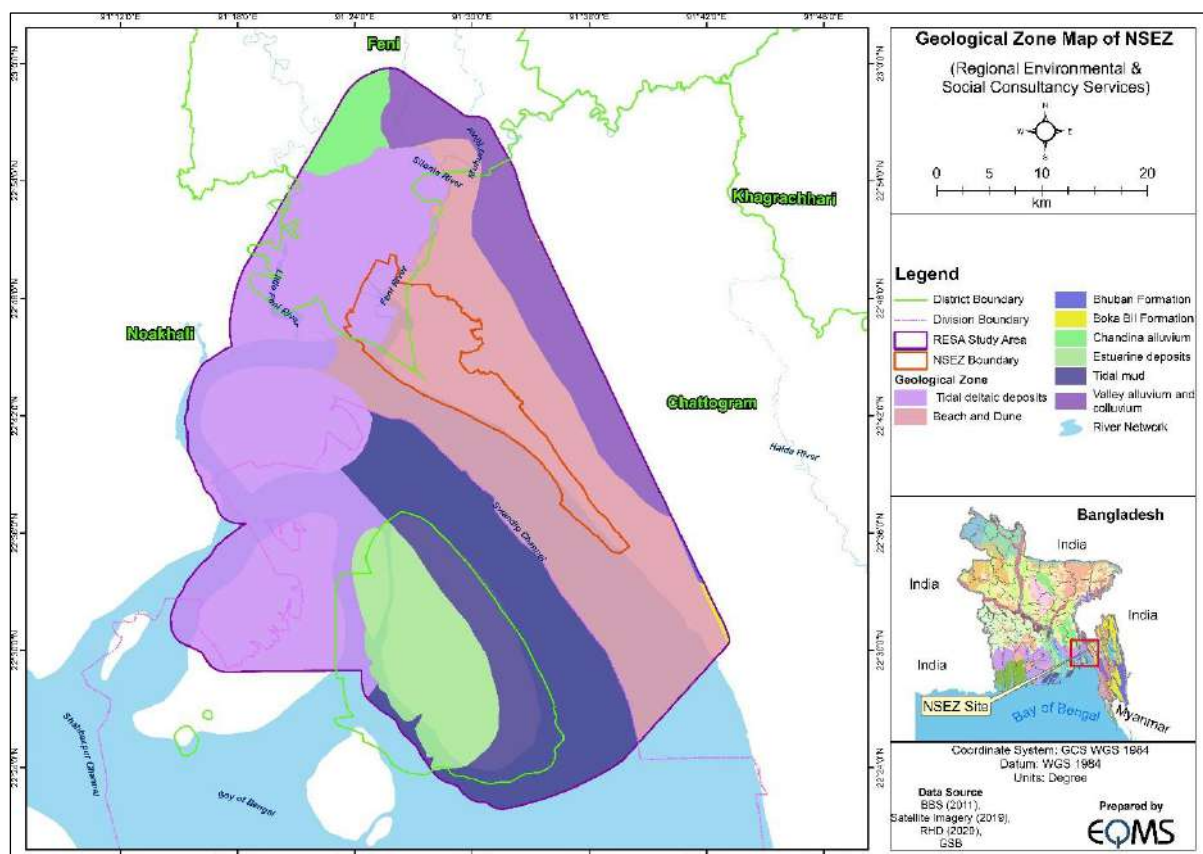
The geological map of the NSEZ and study area is presented in Figure 3-12 and Figure 3-13, respectively.

Figure 3-12: Geology Map of Bangladesh showing NSEZ site



Source: GSB, 1990

Figure 3-13: Geology Map of Bangladesh showing the Study Area



Source: GSB, 1990

3.2.3 Topography

The study area is generally flat and low-lying towards the Bay of Bengal and Sandwip Channel. The site belongs to the sea-land interactive sedimentary plain, and the terrain appears to be relatively flat. No hilly area has been found inside the NSEZ site and its immediate surroundings.

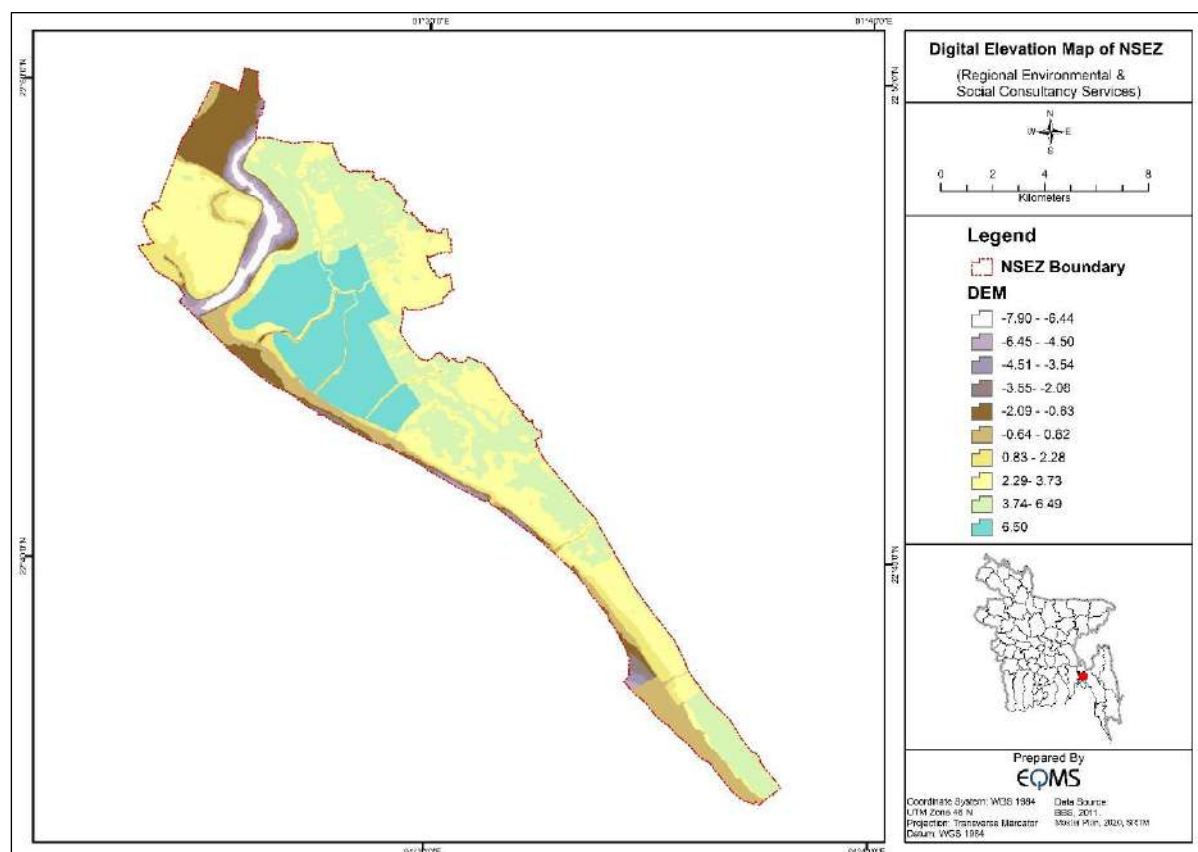
For the preparation of the Digital Elevation Model (DEM) of the NSEZ site as well as the study region, different types of elevation data were used like Copernicus-based FABDEM which was a satellite-based elevation data comprising the land topography excluding the tree and building heights. In addition, land surveyed data from the Institute of Water Modelling (IWM), data from BEZA, and ocean bathymetric data were used and finally, two maps have been produced with spatial analysis. The data provided was recently collected within the past few years. The resolution of the data was 30 meters at the equator. Table 3-3 shows the elevation ranges and the covered area for the NSEZ site.

Table 3-3: Topographic Elevation Profiles within the NSEZ Site

S/N	Elevation Range (mMSL)	Area (km ²)	Area (Acre)	Area (%)
1	-7.90 - -6.44	2.66	656.06	1.83
2	-6.45 - -4.50	2.47	610.64	1.70
3	-4.51 - -3.54	2.34	578.29	1.61
4	-3.55 - -2.08	2.27	561.45	1.56
5	-2.09 - -0.63	9.74	2,406.65	6.71
6	-0.64 - 0.82	11.34	2,801.48	7.81
7	0.83 - 2.28	9.70	2,397.78	6.68
8	2.29 - 3.73	42.76	10,565.36	29.44
9	3.74 - 6.49	37.54	9,275.63	25.85
10	6.50	24.40	6,029.03	16.80

Source: EQMS Consulting Limited, 2024

In the NSEZ site, topographic elevation ranges between -7.90 mMSL to 6.50 mMSL. In the downstream of Feni River and the low-lying area, topographic elevation ranges in negative values like -7.90 mMSL to -0.64 mMSL. Over the NSEZ land site, topographic elevation ranges between 2.28 mMSL to 6.50 mMSL. The NSEZ site DEM is shown in Figure 3-14.

Figure 3-14: Digital Elevation Model of the NSEZ Site

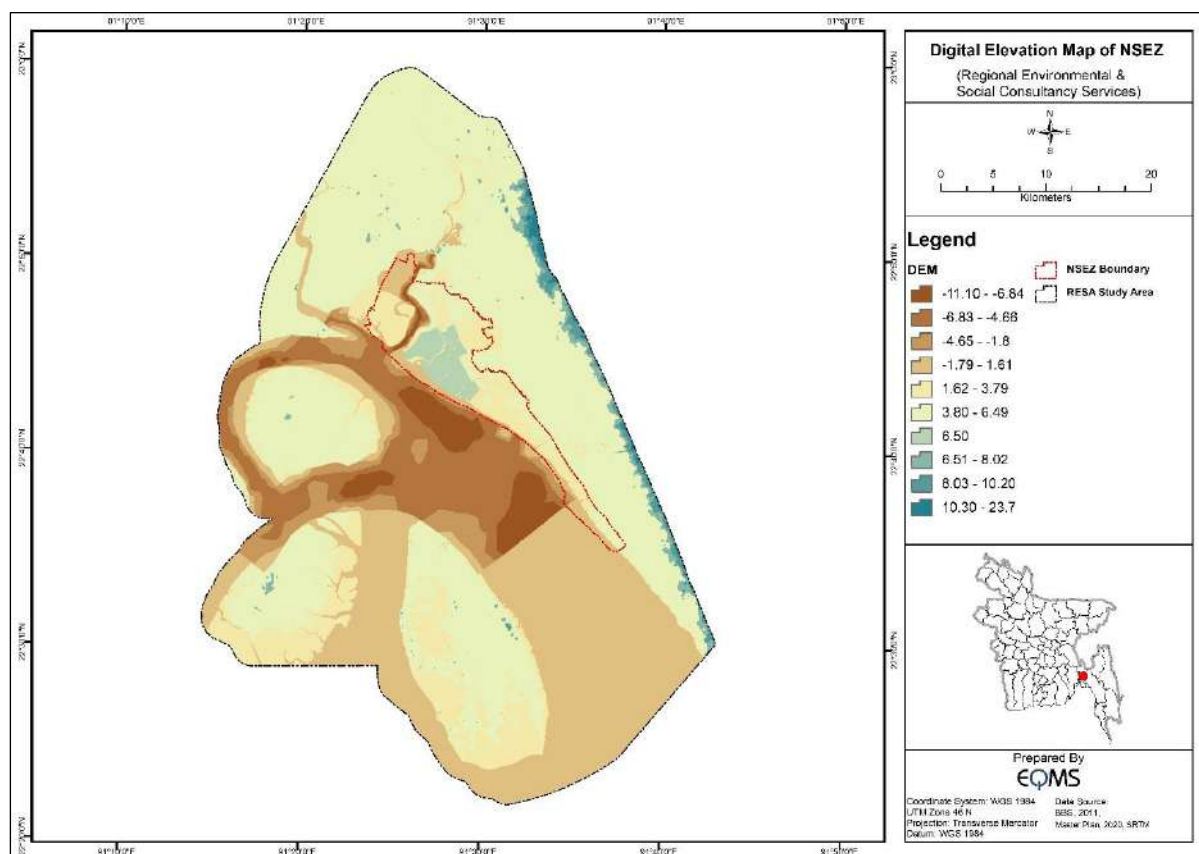
Source: EQMS Consulting Limited, March 2024

From the spatial analysis of the study region, the topographic elevation ranges between -11.07 mMSL to 23.7 mMSL. The DEM of the study region is shown in Figure 3-15. Ocean front areas like Sandwip channel, NSEZ site, and the surrounding area's elevation profile and their covered area have been shown in Table 3-4. The lowest elevation range indicates the bathymetric area like the Sandwip channel, downstream of the Feni River, and Muhuri Closure. Similarly, the highest elevation range indicates the flat and undulating area except the hill area which was not covered in the study region.

Table 3-4: Topographic Elevation Profiles within the NSEZ Site

S/N	Elevation Range (mMSL)	Area (km ²)	Area (Acre)	Area (%)
1	-11.10 - -6.84	59.97	14,817.21	2.94
2	-6.83 - -4.66	181.54	44,857.99	8.89
3	-4.65 - -1.8	89.14	22,024.97	4.37
4	-1.79 - 1.61	536.64	132,601.36	26.28
5	1.62 - 3.79	219.68	54,281.40	10.76
6	3.80 - 6.49	880.20	217,495.17	43.11
7	6.50	24.67	6,095.05	1.21
8	6.51 - 8.02	25.61	6,328.36	1.25
9	8.03 - 10.20	18.32	4,527.70	0.90
10	10.30 - 23.7	6.07	1,500.67	0.30

Source: EQMS Consulting Limited, March 2024

Figure 3-15: Digital Elevation Model of the Study Region

Source: EQMS Consulting Limited, March 2024

3.2.4 Soil

The SRDI has identified about 500 soil series in Bangladesh and FAO-UNDP has identified 21 different general soil types based on the diagnostic horizons and diagnostic properties of the soil (FAO-UNDP, 1988). According to the SRDI soil database of Bangladesh, the NSEZ site falls under “Grey Piedmont Soils” and “Calcareous Alluvium”. Table 3-5 shows the soil types and the covered areas for the NSEZ site.

Table 3-5: Soil type within NSEZ

S/N	Soil Type	Area		
		sq km	Acres	%
1	Grey Piedmont Soils	87.10	21522.85	70.57
2	Calcareous Alluvium	36.32	8975.48	29.43

Source: EQMS Consulting Limited, 2024

The study area falls under the unit of calcareous alluvium, old meghna estuarine floodplain soils, mainly deep brown soils on low hills, grey piedmont soils, deep and shallow brown soils on very steep, high hills ranges. Table 3-6 shows the soil types and the covered areas for the study area.

Table 3-6: Soil types in the study area

S/N	Soil Type	Area		
		sq km	Acres	%
1	Calcareous Alluvium	819.35	202464.62	63.43

S/N	Soil Type	Area		
		sq km	Acres	%
2	Grey Piedmond Soils	404.94	100062.20	31.35
3	Old Meghna Estuarine Floodplain Soils	67.41	16656.39	5.22

Source: EQMS Consulting Limited, 2024

A brief description of the soil units is given below.

3.2.4.1 Grey Piedmont Soils

These soils occur on alluvial outwash fans at the foot of the northern and eastern hills and locally on the Chittagong coastal plain. Seasonal flooding is shallow, but they are severely affected by occasional flash floods caused by heavy rainfall. The topsoil has a 5–10 cm thick cultivated layer. They are grey to pale brown when dry and grey to olive-grey when wet. These layers are strongly to extremely acidic when dry, but neutral in reduced conditions. The subsoils vary from 15 cm to more than 60 cm in thickness. They are grey with yellow-brown, brown, or red mottles. The structure is prismatic and blocky. The substratum comprises stratified material. Most soils are loamy in texture. They usually are more sandy close to hills, and more silty and clayey on the lower parts of the piedmont slopes. The topsoil usually is lighter in texture than that of the subsoil. The agricultural productivity of these soils is mainly moderate to low. Most soils except sandy ridge soils are much better suited for paddy cultivation than dryland crops (Huq and Shoaib, 2013).

3.2.4.2 Calcareous Alluvium

These are young soils formed on freshly deposited alluvium of the Ganges and Lower Meghna Rivers that are stratified within 25 cm from the ground surface and contain lime. Soils are stratified or there is raw alluvium throughout or below the cultivated layer. They are calcareous throughout or part of it and lack a diagnostic subsoil horizon. This alluvium on the active Ganges floodplain mainly comprises brownish-grey to pale brown sandy and silty deposits, which are moderately calcareous. The topsoil is found to have a greyer color and be iron-stained along root channels in places where rice is cultivated. The soil of the Ganges floodplains is moderately to deeply flooded by river water during the rainy season, whereas the soils of the Meghna estuary are flooded by tidal water from the sea. Soils on the Lower Meghna estuarine floodplain are slightly calcareous grey to olive, finely stratified silts. They are mainly calcaric fluvisols.

The agricultural productivity of these soils ranges between moderate and poor. They are more productive, and the potentiality is higher than the noncalcareous alluvium. New loamy and clayey Ganges River deposits are more friable and more easily suitable for crop cultivation, especially for dry land Robi (dry season) crops and jute. Large areas of relatively older soils on the Young Meghna estuarine floodplain are well suited for paddy cultivation, especially transplanted Aman (Huq and Shoaib, 2013).

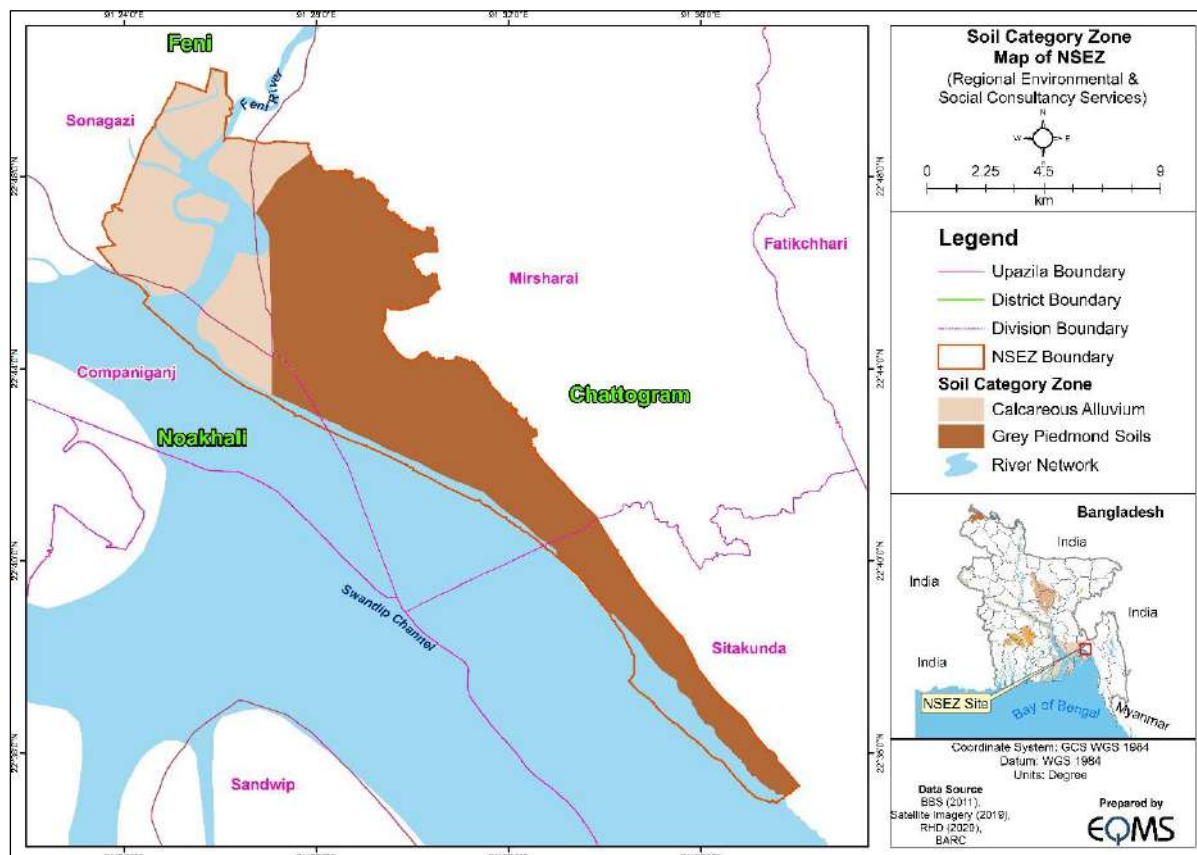
3.2.4.3 Old Meghna Estuarine Floodplain Soils

These are the most extensive soils in the country, occupying most of the Tista, Jamuna, Karatoya-Bangali, eastern Surma-Kushiyara, and Middle Meghna River floodplains and the Ganges tidal floodplain as well as part of the Old Brahmaputra floodplain, Old Meghna estuarine floodplain, Sylhet basin, and the Chittagong coastal plain. The topsoil consists of 5-10 cm thick layers. These layers are grey or olive-grey when dry, but darker when wet, and are medium to very strongly acidic in reaction when dry, but neutral in the reduced condition. The subsoils are 15-50 cm thick and have a coarse prismatic structure. Clay subsoils have a blocky structure. The soil texture varies both within the profile and at different positions of the floodplain relief. The topsoil generally is lighter in texture than the subsoil. On most floodplains, the highest ridge soils have a silt loam texture, and the basin soils are silty clay loam to silty clays. These soils are seasonally flooded. In most areas, flooding is caused by rainwater or raised groundwater table. The moisture holding capacity is moderate to high in silt loam

and silty clay loam soils. Shallow-depth soils or soils with a plow pan have a low moisture-holding capacity. These soils are among the most productive soils in the country. In general, they are suitable for both dryland crops as well as paddy cultivation (Huq and Shoaib, 2013).

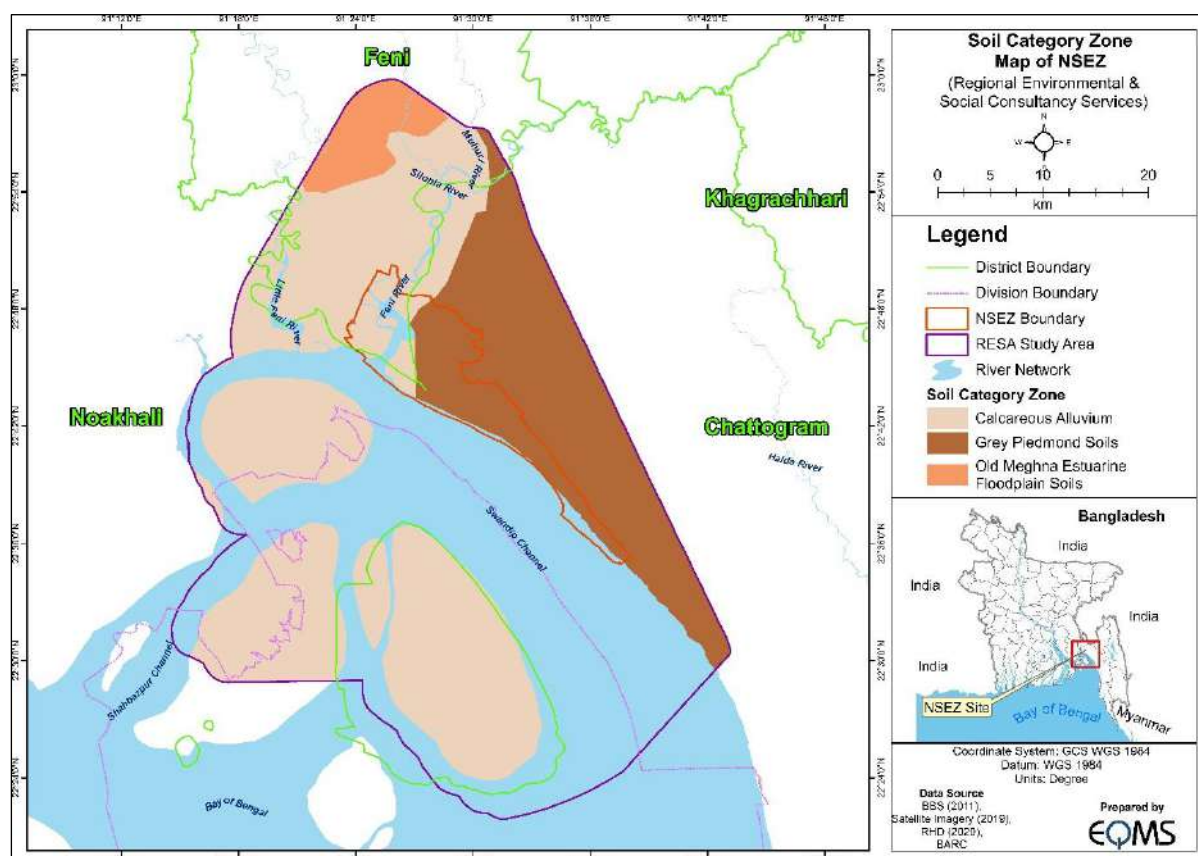
Soil map of the NSEZ site and the study area is shown in Figure 3-16 and Figure 3-17.

Figure 3-16: Soil map of NSEZ



Source: Data from SRDI and map prepared by EQMS

Figure 3-17: Soil map of the study area



Source: Data from SRDI and map prepared by EQMS

3.2.5 Physiography

According to the physiography of Bangladesh, the NSEZ site falls under the physiographic unit of “Chittagong Coastal Plain” and “Young Meghna Estuarine Floodplain”. Table 3-7 shows the physiographic units and the covered areas for the NSEZ site.

Table 3-7: Physiographic unit within NSEZ

S/N	Physiographic Unit	Area		
		sq km	Acres	%
1	Chittagong Coastal Plain	116.22	28719.74	83.71
2	Young Meghna Estuarine Floodplain	22.62	5589.52	16.29

Source: EQMS Consulting Limited, 2024

The study area falls under the physiographic unit “Young Meghna Estuarine Floodplain”, “Chittagong Coastal Plain”, “The Low Hill Ranges”, and “Old Meghna Estuarine Floodplain”. Table 3-8 shows the physiographic units and the covered areas for the study area.

Table 3-8: Physiographic unit within the study area

S/N	Physiographic Unit	Area		
		sq km	Acres	%
1	Young Meghna Estuarine Floodplain	819.43	202485.65	56.14
2	Chittagong Coastal Plain	527.90	130447.49	36.17

S/N	Physiographic Unit	Area		
		sq km	Acres	%
3	The Low Hill Ranges	64.61	15965.71	4.43
4	Old Meghna Estuarine Floodplain	47.56	11752.80	3.26

Source: EQMS Consulting Limited, 2024

A brief description of the physiographic units is given below.

3.2.5.1 Chittagong Coastal Plain

Chittagong coastal plain along the coast extends from the Feni River to the mouth of the Matamuhuri delta, a distance of 121 km. It comprises gently sloping piedmont plains near the hills, river floodplains alongside the Feni, Karnafuli, Halda, and other rivers, tidal floodplains along with the lower courses of these rivers, a small area of a young estuarine floodplain in the north, adjoining subregional Young Meghna estuarine floodplain and sandy beach ridges adjoining the coast in the south. Sediments near the hills are mainly silty, locally sandy, with clays more extensive in floodplain basins. The whole of the mainland area is subjected to flash floods. Flooding is mainly shallow and fluctuates in-depth with the tide (except where this is prevented by a river or coastal embankments). The average daily rise in the tide is about two meters. Some soils on tidal and estuarine floodplains become saline in the dry season.

3.2.5.2 Young Meghna Estuarine Floodplain

Young Meghna estuarine floodplain occupies almost the level land within and adjoining the Meghna estuary. It includes both island and mainland areas. New deposition and erosion are constantly taking place on the margins, continuously altering the shape of the land areas. The sediments are deep silts, which are finally stratified and are slightly calcareous. In many, but not all parts, the soil surface becomes saline to varying degrees in the dry season. Seasonal flooding is mainly shallow but fluctuates tidally and is caused mainly by rainwater or non-saline river water. Flooding by saltwater occurs mainly on the lamed margins and during exceptionally high tides during the monsoon, also when storm surges associated with tropical cyclones occur.

3.2.5.3 Low Hill Ranges

The low hills occupy synclinal areas between the high hill ranges as well as isolated areas outside the main hill areas, such as the Lalmai Hills near Cumilla and the hills stretching across the north of the former Sylhet, Mymensingh, and Jamalpur Districts. Their crests are generally below 150 m MSL; some rise only a few meters above the level of the surrounding plains.

These hills are formed over Dupi Tila and Dihing rocks of the mid-Miocene to Pliocene age. They mainly comprise unconsolidated sandstones, but they include soft siltstones and clays, and there are conglomerate and limestone beds in the north of Sylhet. They generally give rise to deep, brown, loamy soils with a very strong acid reaction. Small patches of hard ironstone occur locally. The relief varies from level (as on the summit of the Lalmai Hills) to very steeply sloping (as on the sides of valleys cut into the Lalmai Hills). The greater extent is very closely dissected and has very steep slopes.

3.2.5.4 Old Meghna Estuarine Floodplain

The Old Meghna estuarine floodplain occupies an almost-level landscape of smooth, broad ridges and basins which are underlain by deep silty deposits. In some basins, those silts have been buried by a layer of clay which usually is less than 50 cm thick. Seasonal flooding is mainly caused by accumulated rainwater. It is moderately deep or deep in the north and west, but it is shallow in the southeast. Only a few rivers such as the Gumti, Dakatia, and Little Feni cross the subunit, bordered by a narrow strip of their own, more variable, floodplain deposits.

Analysis of the sand mineralogy of these older sediments suggests that they were derived mainly from the Brahmaputra River. Originally, the Bay of Bengal must have extended into the Sylhet Basin. It was

gradually pushed back by the deposition of Brahmaputra sediments, just as the present-day Meghna estuary is being filled up with young Meghna sediments. When they were deposited, the Brahmaputra was in its channel flowing east of the Madhupur Tract and the Ganges followed a more westerly course. The Ganges only cut off the southwestern parts of the Old Meghna Floodplain in recent centuries: the most recent change occurred in the 1840s.

Deposition of the Meghna sediments occurred over a period of several thousand years. A buried organic clay layer within them in the north of Barisal District was dated by CIA analysis at about 3,000 years before the present. Samples from organic layers in two Madhupur Tract valleys south-east of Dhaka, where Old Meghna sediments overlie tidal clays containing remains of mangrove trees, were dated at about 1,430 and 6,700 years before the present respectively.

A physiography map of the NSEZ site and the study area is presented in Figure 3-18 and Figure 3-19, respectively.

Figure 3-18: Physiography Map of Bangladesh showing the NSEZ site

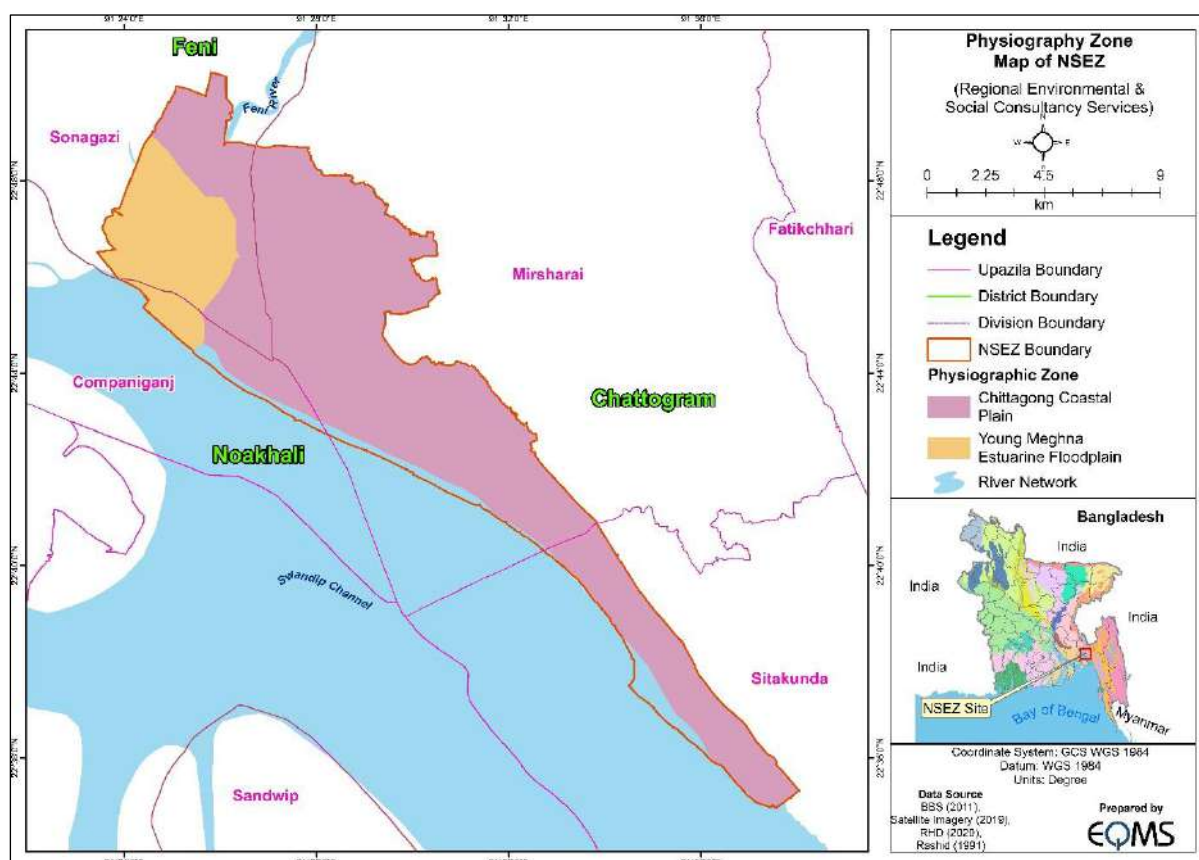
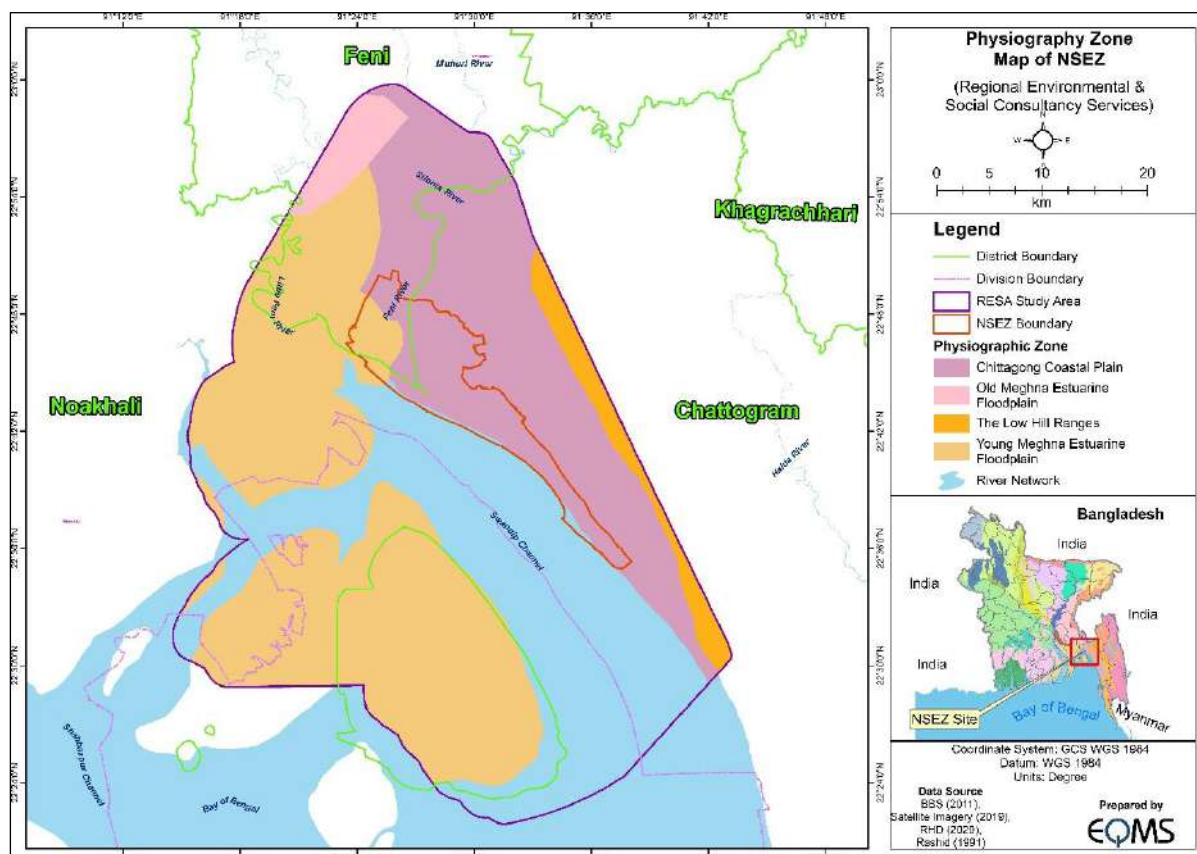


Figure 3-19: Physiography Map of Bangladesh showing the Study Area

Source: SRDI, 1997, Rashid 1991, and Reimann, 1933

3.2.6 Land Use and Land Cover

In the study area, the major share of the land is under the water bodies which is about 188,929.07 acres covering 37.21% of the total land cover. Agricultural land is also present in the study area, which consists of 140,105.62 acres, and accounts for only 27.59% of the total area. The mudflat and Settlement with Homestead Vegetation area cover 15.04% and 13.89% of the total study area. Besides, Mangrove Plantation, aquaculture, developed land, built-up area, mixed hill forest, and railway area covering 3.03% (15402.09 acres), 1.76% (8952.48 acres), 0.70% (3534.19 acres), 0.40% (2048.77 acres), 0.30% (1503.99 acres), 0.07% (378.50 acres) respectively. The land use and land cover pattern of the study area is given in Table 3-9. A land use and land cover map of the study area is given in Figure 3-20.

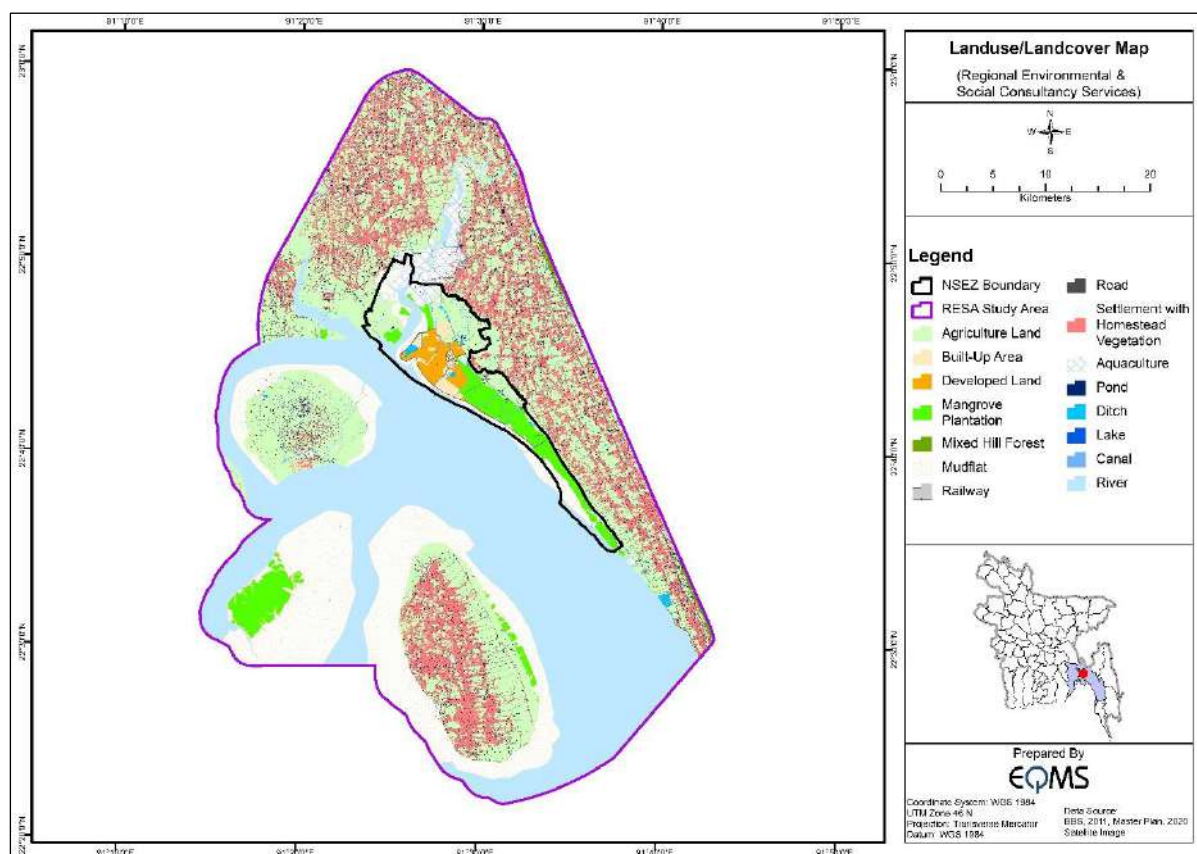
Table 3-9: Existing Land Use and Land Cover Pattern of the Study Area

S/N	Land Use Type	Area (km ²)	Area (Acre)	Area (%)
1	Waterbodies	764.57	188,929.07	37.21
2	Agriculture Land	566.99	140,105.62	27.59
3	Mudflat	308.98	76,351.51	15.04
4	Settlement with Homestead Vegetation	285.39	70,521.93	13.89
5	Mangrove Plantation	62.33	15402.09	3.03
6	Aquaculture	36.23	8952.48	1.76
7	Developed Land	14.30	3534.19	0.70
8	Built-Up Area	8.29	2048.77	0.40

S/N	Land Use Type	Area (km ²)	Area (Acre)	Area (%)
9	Mixed Hill Forest	6.09	1503.99	0.30
10	Railway	1.53	378.50	0.07
Total		2,054.71	507,728.16	100

Source: EQMS Consulting Limited, September 2023

Figure 3-20: Existing Land Use Map of the Study Area



Source: EQMS Consulting Limited, September 2023

3.2.7 Geomorphology

According to Ahmed, et. al., 2004, there are three geomorphologic divisions of Bangladesh vis-à-vis its soil formation. These are Tertiary Hills, Pleistocene Uplands, and Holocene Plains (Piedmont Plains, Flood Plains, Deltaic Plains, Depressed Lands, and Coastal Plains). The NSEZ site falls under the geomorphic unit of “Holocene Plains – Coastal Plains and Deltaic Plains”. Table 3-10 shows the geomorphology units and the covered areas for the NSEZ site.

Table 3-10: Geomorphology unit within NSEZ

S/N	Geomorphology Unit	Area		
		sq km	Acres	%
1	Coastal Plains	124.06	30654.93	99.91
2	Deltaic Plains	0.11	28.35	0.09

Source: EQMS Consulting Limited, 2024

The study area falls under the geomorphic unit of “Holocene Plains – Coastal Plains and Deltaic Plains” and “Tertiary Hills”. Table 3-11 shows the geomorphology units and the covered areas for the study area.

Table 3-11: Geomorphology unit within the study area

S/N	Geomorphology Unit	Area		
		sq km	Acres	%
1	Coastal Plains	1088.92	269078.13	78.16
2	Deltaic Plains	303.64	75030.87	21.79
3	Tertiary Hills	0.65	160.50	0.05

Source: EQMS Consulting Limited, 2024

A brief description of the geomorphic units is given below.

3.2.7.1 Coastal Plains

Delta plain is tide-dominated and is considered the active part of the delta. The landforms are characterized by tidal low land with weakly developed natural levees distributed in an irregular pattern. Numerous rivers, channels, and tidal creeks have crisscrossed the area. Swamps and depressions are also present in the area. Estuarine deposits of silt and silty clay dominate this area. Mangrove swamps of the Sundarbans and many salt fields and shrimp culture farms have developed in the area. The landforms in the area are temporal as they are changing due to cyclones and other natural calamities.

3.2.7.2 Deltaic Plains

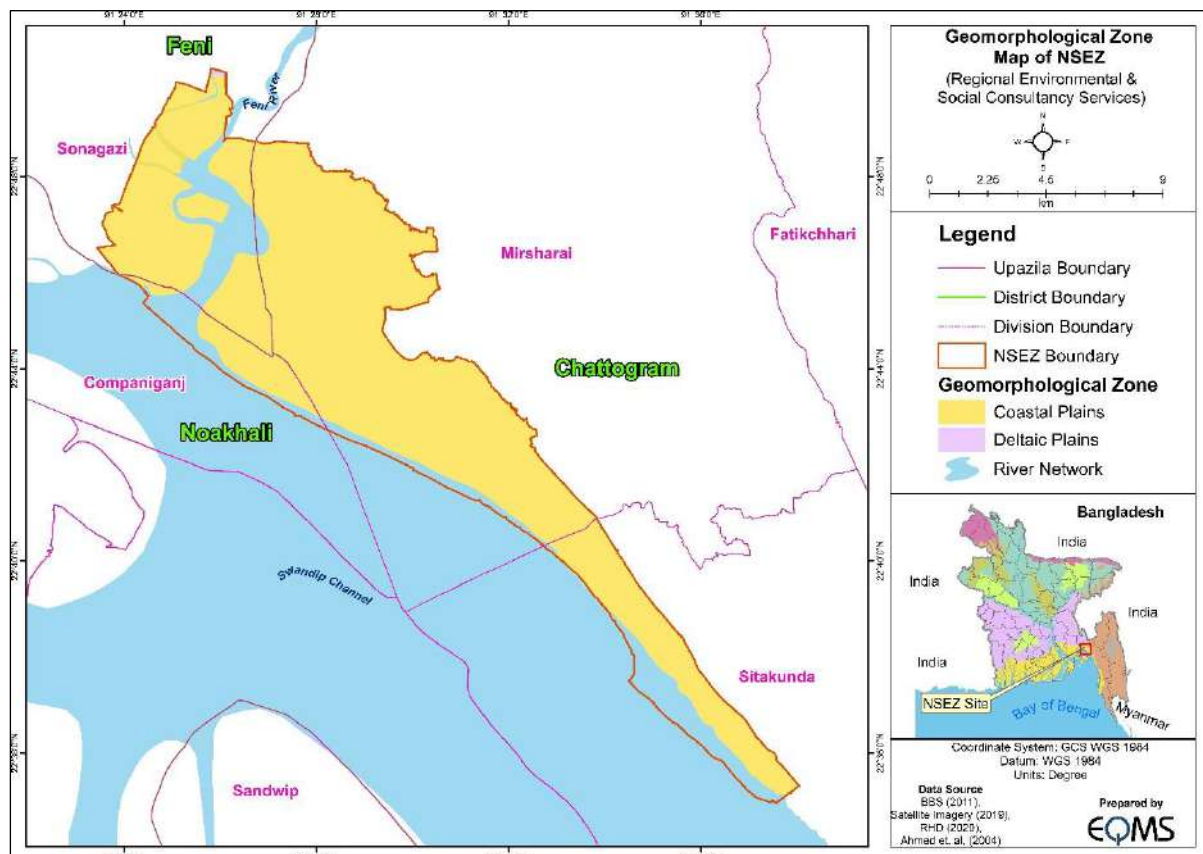
Delta complex covers about 32% of Bangladesh. The area south of a line drawn from Ganges-Padma as far as the lower course of the Feni River in the southeast belongs to the delta of the Ganges, Brahmaputra, and Meghna Rivers. The Ganges is the greatest builder of the delta (70-80%). The Ganges delta located in the south of the Barind and Madhupur Tract also includes part of West Bengal. The Bangladesh portion of the delta occupies about 46,620 sq. km. In the southwest, a part of the delta has been classified as the inactive delta but the major part in the south and southeast is very active. The elevation of the delta is about 15 to 20 m from the sea level in the northwest and 1 to 2 m in the south. The elevation increases within the upper reaches of the delta. Many swamps (depressions) have developed in the substantial part of the delta. Clay, silty clay, and occasionally peat are the major constituents of the delta plain.

3.2.7.3 Tertiary Hills

The tertiary hills areas constitute 12% of the total land surface of Bangladesh. Northern and eastern tertiary hills cover most of the Chittagong Hill Tracts, some small parts of southern Habiganj, and the southern and eastern borders of Moulavibazar. The overall pattern of the northern and eastern hill ranges are long ridges running generally north-south along the eastern border of Bangladesh.

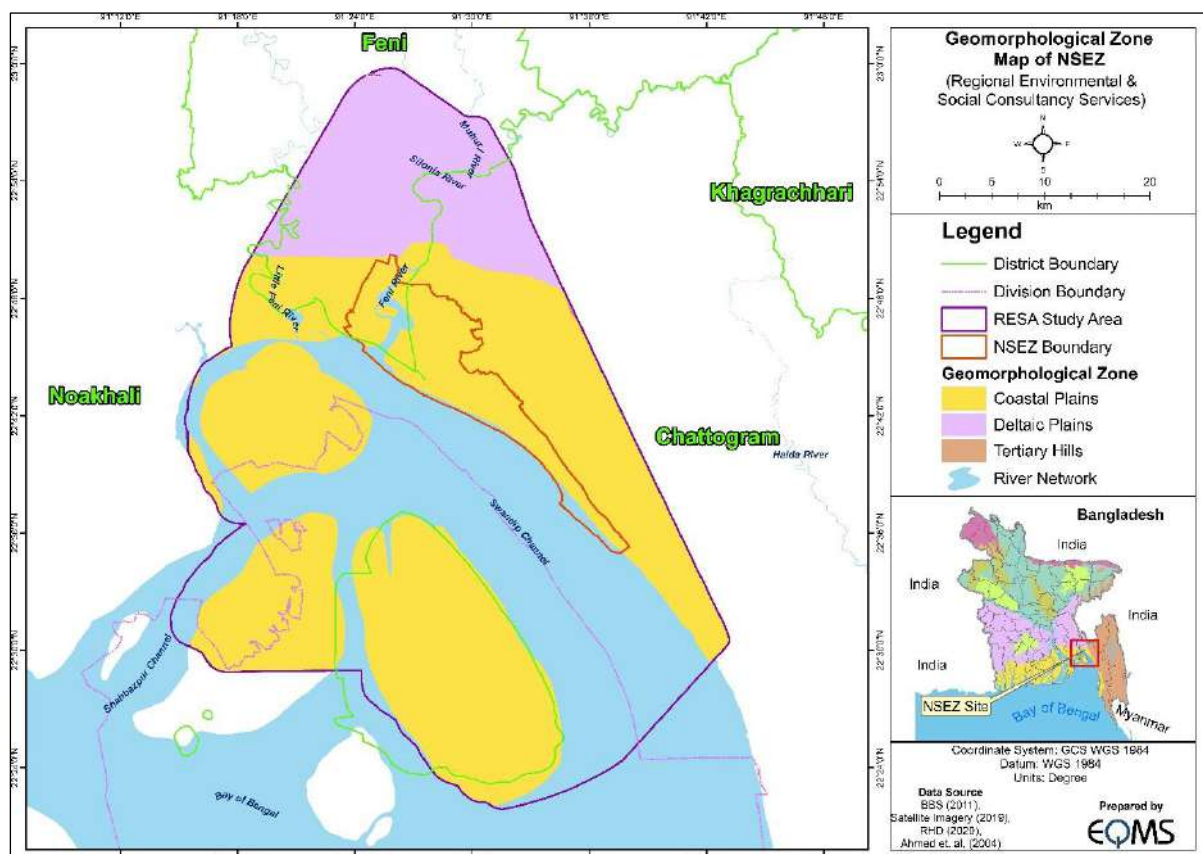
The geomorphology map of Bangladesh showing the NSEZ site and the study area is given in Figure 3-21 and Figure 3-22, respectively.

Figure 3-21: Geomorphology Map of Bangladesh showing NSEZ site



Source: Ahmed, et al., 2004

Figure 3-22: Geomorphology Map of Bangladesh showing the Study Area



Source: Ahmed, et al., 2004

3.2.8 Surface Water Hydrology and Drainage

Feni and Little Feni are the two major rivers that flow down to the Bay of Bengal on the northwest of the proposed NSEZ area. These two major rivers make a confluence near Char Chandia. The char land at the confluence of these two major rivers has been considered as part of NSEZ. The major khals which flow through the proposed NSEZ area are Ichakhali, Bamon Sundar, Saherkhali, and Domkhali Khal. Others are Daborkhali, Khutakhali, Hoania, and Donakhali Khals. Most of the Khals receive water from hills on the east of the Dhaka-Chattogram highway.

3.2.8.1 Feni River

Feni River is a transboundary river that originated in the eastern hills of Tripura and enters Bangladesh at Belchhari of Matiranga Upazila of Khagrachhari District. It flows through Ramgarh (Khagrachhari), Fatikchhari (Chattogram), and then flows along the border of Chattogram (Mirsharai Upazila) and Feni (Chhagalnaiya, Feni, Sonagazi Upazilas) Districts and discharges into the Bay of Bengal near Sonagazi Upazila. The length of the river is approximately 108 km.

During the monsoon season when there are heavy rains in the region, it does not lack water quantity but when there are excessive rains the river gains more energy and creates whirling eddies and currents at its sharp turns. The water level difference between high tide and low tide is a maximum of 1.2 m. It is a perennial river but has tidal influence when it is fully inflated during the monsoon months (July to September) and the measured flow rate is 10,800 m³/s (at Kaliachari) at that time. The flow decreased from February to April and the flow rate was identified at that time as 1.35 m³/s (at Kaliachari). The course of this river is meandering, and the flood flow slope is nearly 15 cm/km. The water level of the Feni River is considered a Non-tidal Water Level at Ramgarh and Kaliachari and a Tidal Water Level at Dhumghat and Sonapur.

3.2.8.2 Little Feni River

Little Feni River is a transboundary river in Bangladesh. It originates from the Hill Tripura in India and enters Bangladesh near Cumilla district and after running over the southeastern direction it crosses over Noakhali district. Flowing further south, the Little Feni debouches into falling into the Bay of Bengal at 22°45'49"N and 91°23'16"E. The river contains a lot of meanders. A number of streams, e.g., the Dakatia and Gumti meet the river on its course. It flows closely along the west and south border of Sonagazi Upazila. The original course of Little Feni River has a closure on it and a 23-vent regulator on its diversion channel at Musapur. Upstream of the Musapur closure serves as a reservoir and recreation place as well (BEZA, 2020b).

3.2.8.1 Domkhali Khal

Domkhali Khal originates from Komoldoho waterfalls in the eastern hills in Bangladesh. After flowing from its original source, it crosses the Dhaka-Chattogram highway near Choto Komoldoho in Bangladesh. Domkhali khal bifurcates upstream of the existing BWDB embankment and they again meet immediately downstream of the embankment. A three-vent regulator has been constructed on the main channel and a two-vent regulator on its branch channel. Regulators are provided with flap gates downstream to prevent intrusion of seawater (BEZA, 2020b). This canal has been used to maintain the natural drainage system of the catchment inside and outside of the NSEZ. Heavy rainfall flow reached to the Sandwip channel through this canal and restricted the flow of water from Sandwip channel during tidal saline water flow.

3.2.8.2 Saherkhali Khal

Gobania Chhara and Saherkhali Khal are the two major Khals that make the Saherkhali Khal system with some other secondary Khals. Gobania chhara originates from Boalia waterfall in the eastern hills of Bangladesh. The valley in the hills surrounding the Boalia waterfall may be considered as a reservoir subject to its study for viability. The Gobania Khal crosses the Dhaka-Chattogram highway at Mirsharai

Bazar. After crossing the Dhaka-Chattogram highway, the Khal traverses about 5 km over the land. Thereafter, Gobania Khal flows along the north side of the proposed NSEZ avenue and crosses the avenue at Abutorab Bazar. Gobania Khal meets Saherkhali Khal near the upstream of the existing embankment. Gobania Khal has a distributary, Haonia with a one vent regulator on it.

Saherkhali Khal, the main course originates from Napittachora waterfalls at Ujainnapara and crosses the Dhaka-Chattogram highway at 1 km south of Boro Takia Bazar. A six-vent regulator with flap gates has been constructed on Saherkhali Khal crossing the embankment. In-stream storage in Saherkhali Khal is observed as significant. A small khal namely Golla Donakhali Khal originates from open land and meets with Saherkhali Khal after crossing the embankment. A one-vent regulator has been constructed on Golla Donakhali Khal (BEZA, 2020b).

3.2.8.3 Bamon Sundar Khal

Mohamaya Khal, Mithanala Rajapur Khal, and Khontakata Khal are the major tributaries of Bamon Sundar Khal. These tributaries convey water from the eastern hills to Bamon Sundar Khal. Mohamaya Khal conveys its catchment runoff and releases from Mohamaya Lake to Bamon Sundar Khal at Sattar Bhuiyar Hat. Mithanala Rajapur Khal conveys its catchment runoff extending from the vicinity of Mohamaya Lake and flows to Bamon Sundar Khal near Sufia Bazar. Khontakata Khal takes the distributary flows from Mithanala Rajapur Khal through Mohachilimpur Khal and that from Gobania Khal through Moghadia Khal, and the Khontakata Khal conveys the total flow to Bamon Sundar.

The Mohamaya khal originates from Mohamaya Lake which releases its irrigation water through an under sluice during the dry season and a spillway during the wet season. A rubber dam has been constructed on Mohamaya Khal. Bamon Sundar Khal traverses through Sattar Bhuiyar hat, Bamon Darogar hat, Sufia Bazar and flows down across the existing BWDB embankment. A nine-vent regulator with flap gates has been constructed on Bamon Sundar Khal. In-stream storage in Bamon Sundar Khal is observed significant (BEZA, 2020b).

3.2.8.4 Daborkhali Khal

Daborkhali Khal is located inside the NSEZ and flows through the Ichakhali Union (besides the BEPZA economic zone under NSEZ) in Mirsharai Upazila of Chattogram District. The khal is directly linked to the Sandwip Channel/Bay of Bengal, and so protects the area from waterlogging as it carries the rainwater almost instantly to the bay during monsoon. This khal meets the Sandwip channel downstream at the west side of the NSEZ super dyke area. The upstream of Daborkhali khal is connected with the upper catchment of the watershed through a culvert and sluice gate and at the upper catchment area outside of the NSEZ. Daborkhali khal is connected with Shusham khal through Ichakhali khal. At the downstream over the super dyke area there is a regulatory sluice gate to control tidal saline water and inside drainage water from NSEZ. Some drainage construction works have been done over the khal to prepare it for better drainage conditions during heavy monsoon and hydraulic structures like sluice/regulatory gates have been connected to it for drainage advancement.

Major industrial plots area is surrounded by the Daborkhali khal on the north side of zone-2A, zone-1, zone-14, and zone-12, and on the south side zone-15, zone-14, and zone-13 is located.

3.2.8.5 Hoania Khal

Hoania khal is located inside the NSEZ in Mirsharai Upazila of Chattogram District. It is located beside the Indian economic zone and south of NSEZ Shoroni. Downstream Hoania khal meets with the Sandwip channel with a sluice gate to control the tidal saline water and upstream heavy monsoon water. At the upstream of this khal, it meets with NSEZ road. There is a sluice gate at the upstream and downstream of this khal to control the monsoon flood water from the upper catchment and to prevent the saline water during tidal surges.

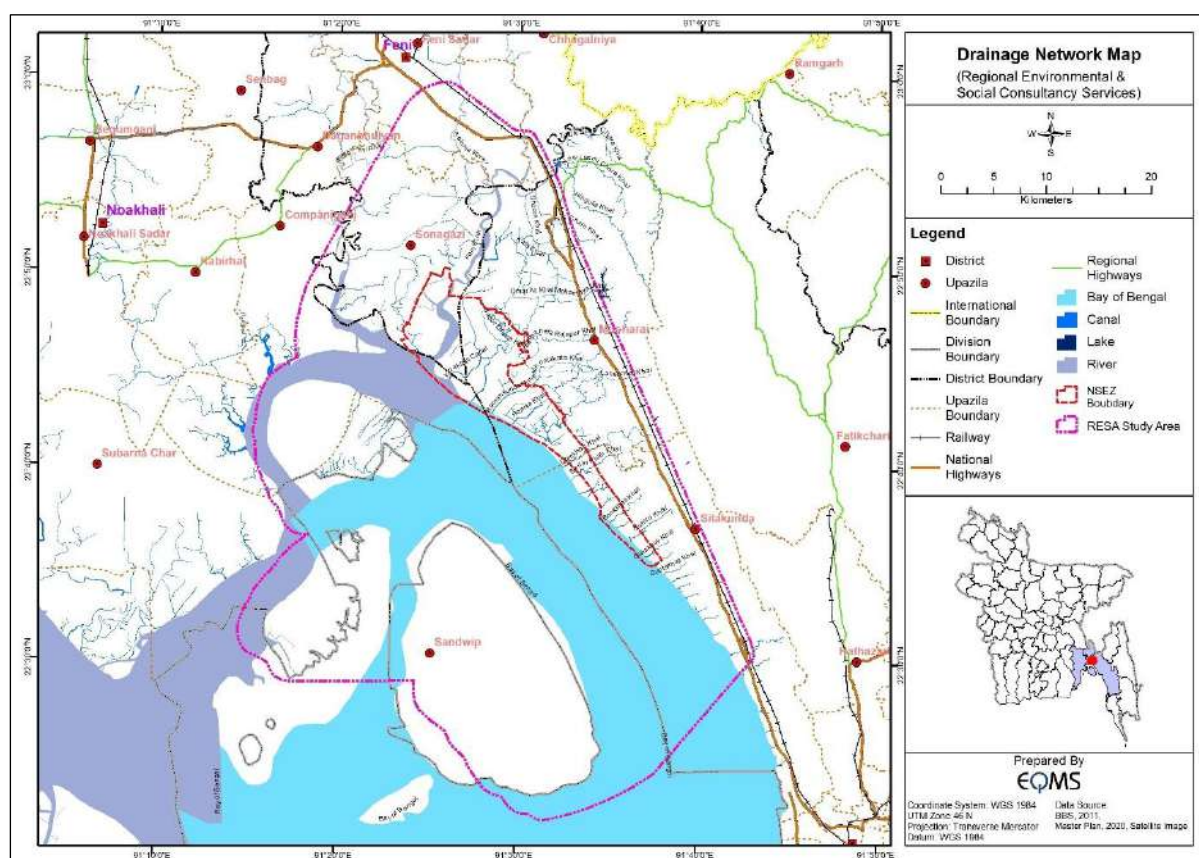
At the north and south sides of the Hoania khal NSEZ industrial zones like zone-19, zone-20, zone-18, and part of zone-21 are located.

3.2.8.6 Ichakhali Khal

Ichakhali Khal receives water from the Feni reservoir site for irrigation purposes. Excess water at the reservoir site may be considered to pass to the Ichakhali Khal for meeting its additional requirement. Barmai Chhara, Roypur Gopalpur Khal, and Mohamaya Khal convey water from the eastern hills and make distributary contributions in Ichakhali Khal. Ichamoti Khal, Gopinathpur Khal, and Omar Ali Khal are relatively significant distributaries of Barmai Chhara, Roypur Gopalpur Khal, and Mohamaya Khal respectively which contribute to Ichakhali Khal.

The main course of Ichakhali Khal has been closed off with BWDB embankment and a diversion channel has been made with the construction of 9 vent regulators on the diversion. The abandoned course of Ichakhali Khal both upstream and downstream of the embankment shows a pool of water and can be considered for a planned reservoir. Purba Ichakhali Khal is a major drainage Khal in the countryside that crosses the embankment and flows down to Ichakhali Khal. It has a 5-vent regulator on it (BEZA, 2020b). The drainage system of the study area is shown in Figure 3-23.

Figure 3-23: Drainage System of the Study Area



Source: EQMS, 2023

3.2.9 Groundwater Hydrology

Groundwater is one of the major natural resources of Bangladesh. It has been developed advantageously as a source of domestic, industrial, and irrigation supplies. UNDP, 1982 studied the hydrogeology of Bangladesh intending to increase the development of groundwater and to make a general appraisal of the groundwater resources of Bangladesh including collection, compilation, processing, and analysis of existing data.

In the United Nations Development Programme (UNDP) study, the country has been divided into 15 (fifteen) groundwater development zones (A-Q), based on aquifer characteristics and land development units. Each zone has been classified and rated as to its development potential in relation to the other

zones. The study area constitutes Zone L and Zone N. A short description of different zones is given below:

ZONE L

Zone L covers the Piedmont deposits of the Chattogram District and the Meghna estuarine floodplains of the Noakhali District. It includes Feni Sadar and Daganbhuyan Upazilas of Feni district; Mirsharai, Fatikchhari, Hathazari, Raojan, Boalkhali, Patiya, Anowara, Banshkhali Upazilas of Chattogram district. The area is not considered favorable for extensive groundwater development. Aquifers in the area are generally confined. At places, semi-confined conditions exist but leakage from the overlying water-bearing formations is negligible. Transmissivities average about 400 m²/day. Hydrogeological analyses indicate that well discharge of 28.3 lit/sec (1 cusec) is considered as maximum with optimum values ranging from 14.2 to 21.2 lit/sec (0.5 to 0.75 cusecs).

Zone N

Zone N covers the coastal areas of the Noakhali and Chattogram districts. Daganbhuyan Upazila of Feni district; Mirsharai, Boalkhali, Patiya, Anowara, Banshkhali of Chattogram district; and Moheshkhali of Cox's Bazar district. It comprises the floodplains of the Ganges-Padma and Meghna Rivers as well as the Chattogram coastal plain. Groundwater conditions are highly variable, and development is highly impaired by the low quality of water affected by the intrusion of brackish and saline water. The development of the main and composite aquifers is limited to isolated freshwater areas. The groundwater potential of the coastal zone depends upon the development of the deep aquifer. The potential of the deep aquifer is relatively unknown but there are indications that fresh water may be encountered.

According to the detailed study on total water demand & water availability assessment for NSEZ, hydrogeological investigation shows that the topsoil in the study area is composed of mainly silty clay. The shallow (10m to 121m) aquifer consists of very fine to fine sand that is mainly brackish in nature and shows a resistivity range between 0.9 Ω m to 12 Ω m. The aquitard thickness is highly variable and varies from ~15m to ~100m. The resistivity of the aquitard ranges between 1.24 Ω m to 17 Ω m and is composed of clay or silty clay. The deep aquifer shows a resistivity range varying between 23 Ω m to 73 Ω m and confirms having fine to medium sand with fresh pore water. The depth of the deep aquifer varies between ~50m to ~150m and is increasing towards the southeast.

It is observed that shallow or deep aquifers in the study area are interrupted by discontinuous clay deposition at multiple depth levels of different thicknesses.

Aquifers containing saline water show low resistivity value and it is difficult to identify lithology or pore water quality unless direct information about the texture of the formation or the water quality of the formation water is available.

3.2.10 Agroecology

A study carried out by the United Nations Development Program (UNDP) in 1988 has classified Bangladesh into a series of Agro-ecological Zones based on an assessment of commonalities in characteristics such as physiography, soil types, climate, and drainage. In total, 34 regions were identified and characterized, however, this information has been updated and further refined on numerous occasions since the original study was undertaken.

According to the data from BARC, the NSEZ site falls under the agro-ecological unit of "Chittagong Coast Plain" and "Young Meghna Estuarine Floodplain". Table 3-12 shows the agroecology units and the covered areas for the NSEZ site.

Table 3-12: Agroecology unit within NSEZ

S/N	Agroecology Unit	Area		
		sq km	Acres	%
1	Chittagong Coastat Plain	63.85	15777.43	50.19
2	Young Meghna Estuarine Floodplain	63.37	15658.85	49.81

Source: EQMS Consulting Limited, 2024

The major types of agro-ecological units reported from the study area include “Young Meghna Estuarine Floodplain”, “Chittagong Coastat Plain”, “Old Meghna Estuarine Floodplain”, and “Northern and Eastern Hills”. Table 3-13 shows the agroecology units and the covered areas for the study area.

Table 3-13: Agroecology unit within the study area

S/N	Agroecology Unit	Area		
		sq km	Acres	%
1	Young Meghna Estuarine Floodplain	893.87	220878.96	61.80
2	Chittagong Coastat Plain	388.93	96105.61	26.89
3	Old Meghna Estuarine Floodplain	106.47	26309.83	7.36
4	Northern and Eastern Hills	57.13	14115.92	3.95

Source: EQMS Consulting Limited, 2024

A brief description of the agroecology units is given below.

3.2.10.1 Chittagong Coastal Plain

This region occupies the plain land in the greater Chattogram District and the eastern part of the Feni District. It is a compound unit of Piedmont, river, tidal, and estuarine floodplain landscapes. The major problem in these soils is high salinity during the dry season (October to May). Grey silt loams and silty clay loam soils are predominant. Acid sulphate soils occur in mangrove tidal floodplains. The general fertility level of the soils is medium, but N and K are limiting. Organic matter content is low to moderate.

3.2.10.2 Young Meghna Estuarine Floodplain

This region occupies young alluvial land in and adjoining the Meghna estuary. The major soils are grey to olive, deep calcareous silt loam, and silty clay loams, and are stratified either throughout or at shallow depth. Calcareous alluvium and non-calcareous grey floodplain soils are the dominant general soil types. The topsoil and subsoils of the area are mildly alkaline. General fertility is medium but low in N and organic matter.

3.2.10.3 Old Meghna Estuarine Floodplain

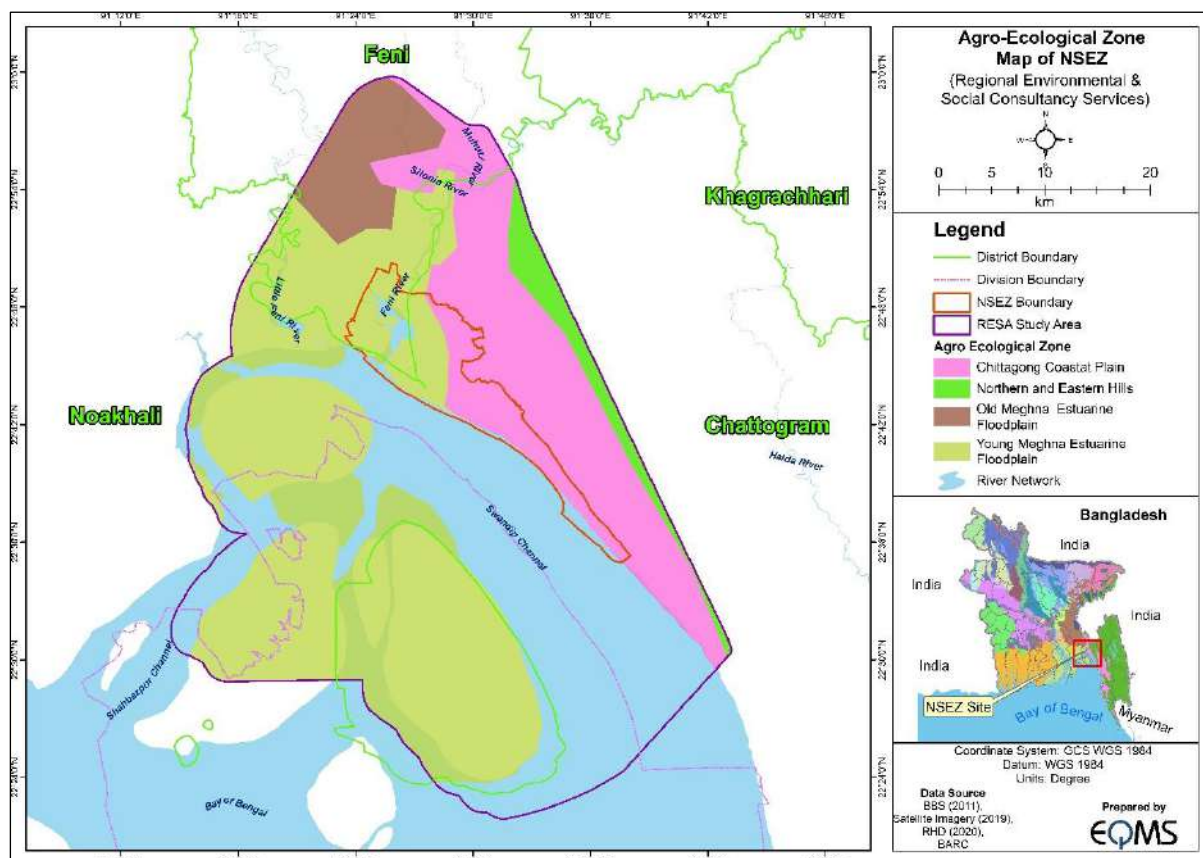
This region occupies a large area, mainly low-lying land between the south of the Surma-Kushiyara floodplain and the northern edge of the young Meghna estuarine floodplain. Silt loam soil predominates on highlands and silty clay to clay on lowlands. The organic matter content of the soil is moderate. Topsoil is moderately acidic, but subsoils are neutral in reaction. The general fertility level is medium.

3.2.10.4 Northern and Eastern Hills

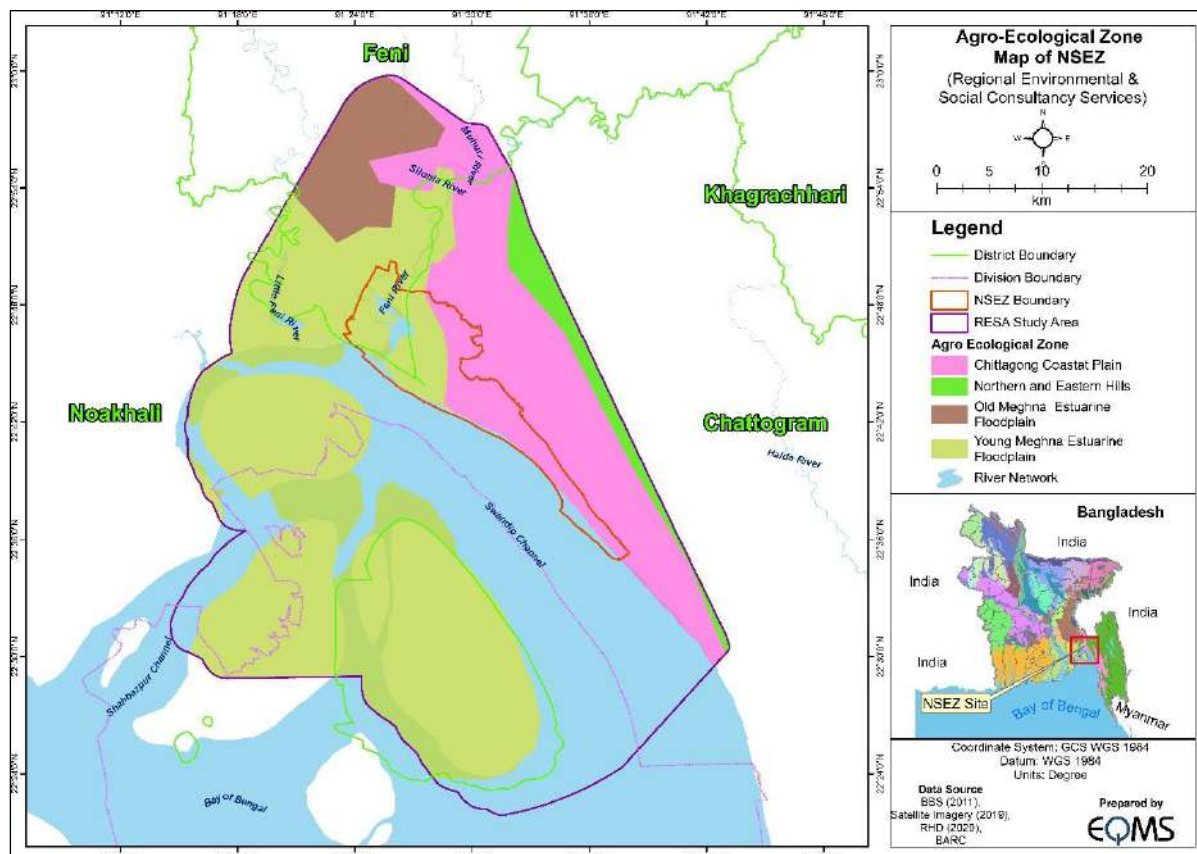
This region includes the country's hill areas. Relief is complex. Hills have been dissected to different degrees over different rocks. In general, slopes are very steep, and a few low hills have flat summits. Brown hill soils are the predominant general soil type of the area. Organic matter content and general fertility level are low.

The agroecology map of the NSEZ site and the study area is given in Figure 3-24 and Figure 3-25, respectively.

Figure 3-24: Agro-ecological Map of Bangladesh showing the NSEZ site



Source: Data from Bangladesh Agricultural Research Council and map prepared by EQMS

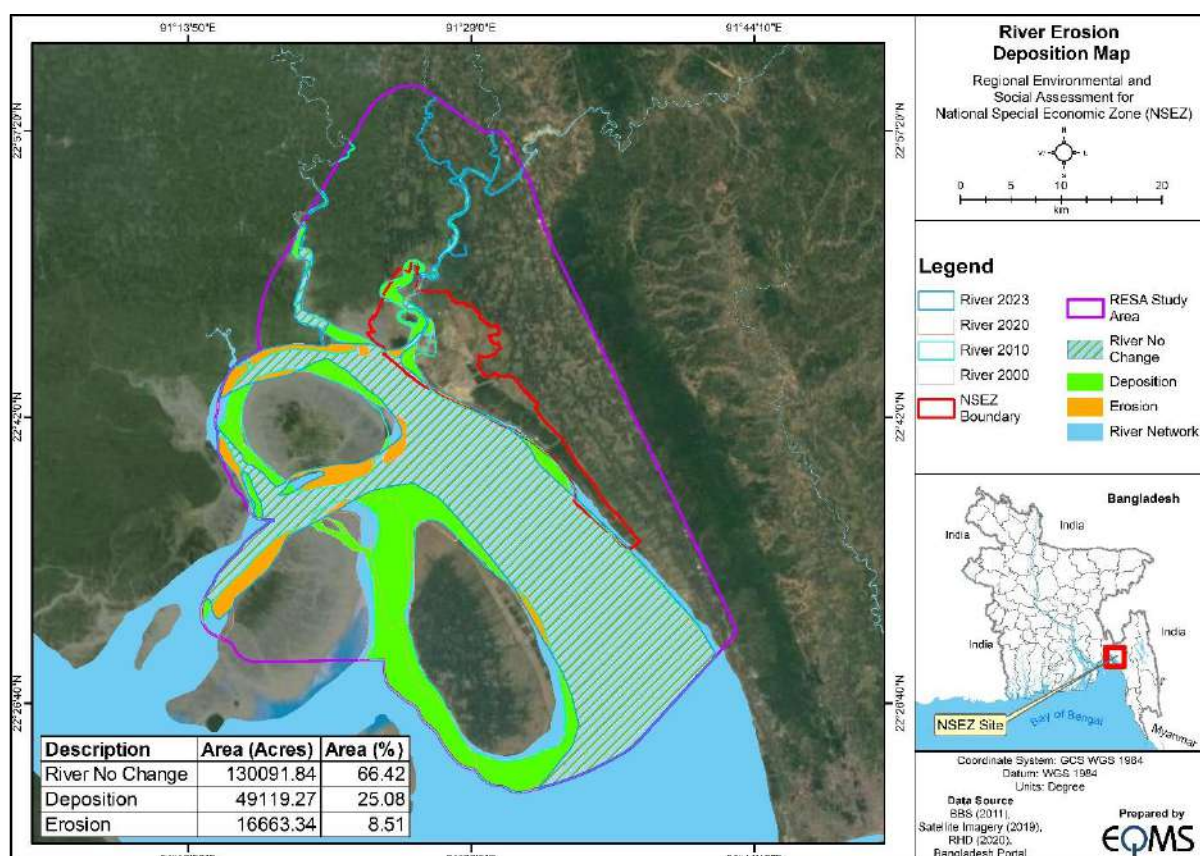
Figure 3-25: Agro-ecological Map of Bangladesh showing the Study Area

Source: Data from Bangladesh Agricultural Research Council and map prepared by EQMS

3.2.11 Erosion and Sedimentation

Sandwip is an off-shore island along the southeastern coast of Bangladesh in the Chattogram District, located in the Meghna estuary, which is very dynamic and unique in nature due to its geographical position and hydro-geomorphic settings. The island has been experiencing severe morphological and hydrological changes over time due to the combination of the effects of the estuary and tidal effects of the Bay of Bengal. Different parts of Sandwip Island exhibit cyclic accretion and erosion. The erosion accretion of the island resulted from physical and anthropogenic causes. The water depth around the island exhibits similar dynamics in response from/to the erosion-accretion of the shoreline (Emran et al 2019).

In the Meghna estuary region, a distinct sedimentation is observed in the region between Sandwip and Uirichar which will eventually join these two landforms (WARPO and BUET, 2020). The islands of Uirichar, Shwarno Dwip, Bhashan Char, and Sandwip had a higher accretion rate, and each had a different setting from the other areas. Southward erosion and northward accretion were seen in these areas (Sultana et al 2023). The most accretion-prone areas of the Meghna Estuary are the Sandwip, Uirichar, and Shwarno Dwip areas where about 0.22m/year deposition is found (IWM, 2010). Another study was carried out in 2013 to plan and detail design of the Uirichar-Noakhali Cross-dam and predicted that about 11,000 hectares of land could be reclaimed in seven years (HaskoningDHV, 2014). A map showing the erosion and sedimentation in the study region is given in Figure 3-26.

Figure 3-26: Erosion and Sedimentation in the Study Region

Source: EQMS, December 2023

3.2.12 Seismicity

Bangladesh has a high risk of earthquakes because the Dauki, Jamuna, and Chattogram-Myanmar faults are still active (Reza et al. 2023). Bangladesh is located where two active Indo-Burmese tectonic plates meet. When these plates move or push against each other, they can cause earthquakes (Steckler et al. 2016; Rahman et al. 2020). Therefore, numerous destructive massive earthquakes have been well-recognized around Bangladesh (Alam 2019; Tabassum and Ansary 2020). Though the country has not witnessed any major earthquakes in recent decades, the probability of earthquakes cannot be underestimated (Haque et al. 2020; Kamal et al. 2021).

The historical seismic data of Bangladesh and adjoining areas indicate that Bangladesh is vulnerable to earthquake hazards. The record of approximately 150 years shows that Bangladesh and the surrounding regions experienced seven major earthquakes. In the recent past, a number of tremors of moderate to severe intensity had already taken place in and around Bangladesh. The Sylhet earthquake ($M_b = 5.6$) on 8th May 1997, the Bandarban earthquake ($M_b = 6.0$) of 21st November 1997, Moheshkhali earthquake ($M_b = 5.1$) of 22nd July 1999, Barkal (Rangamati) earthquake ($M_b = 5.5$) of 27th July 2003, Meghalaya earthquake ($M_b = 5.2$) of 2nd March 2013, and many more shakes in the recent years may be cited as examples. Bangladesh and the northeastern Indian states have long been one of the seismically active regions of the world and have experienced numerous large earthquakes during the past 200 years. Many seismic-tectonic studies have been undertaken on the area comprising the Indo-Burman ranges and their western extension and in northern India. A list of occurrences of large earthquakes in history around Bangladesh is given in Table 3-14.

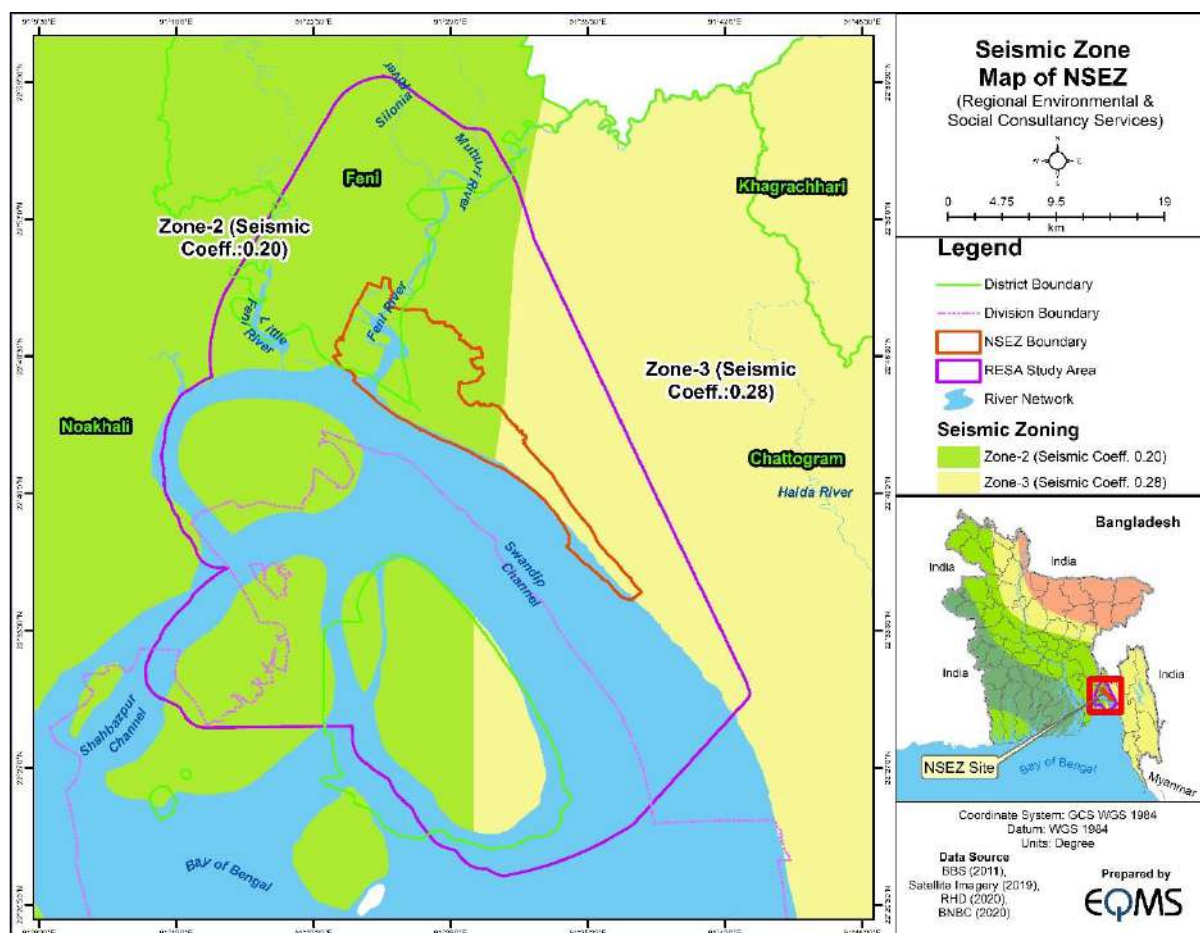
Table 3-14: Occurrence of Large Earthquakes in History Around Bangladesh

Date	Name of Earthquake	Latitude/Longitude	Affected regions	Magnitude	Death/Injuries
19/2/1663	Assam earthquake	26.1/92.56	Assam, India, and Bangladesh	8	-
2/4/1762	Chattogram earthquake	22/92	India, Bangladesh, and Myanmar	7.8	200
10/1/1869	Cachar earthquake	24.75/93.25	India and Bangladesh	7.5	-
14/7/1885	Bengal earthquake	24.8/89.5	Bangladesh and India	7.0	75
12/6/1897	Great Indian earthquake	26/91	India and Bangladesh	8.7	1626
1923	Meghalaya earthquake	24.3/91.7	Bangladesh and India	7.6	9
2/7/1930	Dhubri earthquake	25.8/90.2	India and Bangladesh	7.1	1
15/1/1934	Bihar-Nepal earthquake	26.5/86.5	Nepal, India, and Bangladesh	8.3	13,772
15/8/1950	Assam earthquake	28.12/94.05	Assam, India, and Northern Bangladesh	8.3	-
22/3/1954	North Myanmar	24.5/95.3	Myanmar and Bangladesh	7.3	-
12/5/1977	Bangladesh-Myanmar	21.75/92.99	Myanmar and Bangladesh	5.7	-
6/8/1988	Myanmar	25.14/95.12	Myanmar and Bangladesh	7.3	-
21/8/1988	Bihar-Nepal	26.7/86.8	Nepal, India, and Bangladesh	7.8	998
18/9/2011	Sikkim Earthquake	27.73/88.15	India and Bangladesh	6.9	97

Source: Akhtar, 2010; Alam 2019; and Kamal et al. 2021

Major active fault zones of the country have been delineated through geological trenching and dating methods. A seismic zoning map of Bangladesh was proposed in 1979 by the Geological Survey of Bangladesh (GSB) dividing the country into three seismic zones which was accompanied by an outline of a code for earthquake-resistant design. Later, a new updated seismic zoning map and detailed seismic design provisions were incorporated into the Bangladesh National Building Code (BNBC 2020). According to the BNBC 2020, the country has been divided into four seismic zones with different levels of ground motion. Each zone has a seismic zone coefficient (Z) which represents the maximum considered peak ground acceleration on very stiff soil/rock in units of g (acceleration due to gravity). The NSEZ site and study region fall in a severe seismic intensity zone (zone 3) with coefficients of 0.28 and moderate seismic intensity zone (Zone 2) with coefficients of 0.20. Seismic map of the study region is given in Figure 3-27.

Figure 3-27: Seismic Map of the Study Region



Source: EQMS, August 2024

3.2.13 Traffic

To understand the traffic load, a road traffic survey was conducted continuously for 24 hours, one time during the study period at one location beside Borotakia to NSEZ road. For the traffic survey, two video cameras were established at the monitoring locations and later the record of vehicles was input in an Excel file manually from the recorder file. Vehicular movement has been counted for both directions (Borotakia to NSEZ and NSEZ to Borotakia) on the road. The road traffic survey was conducted from 7th December 202 (7:00 AM) to 8th December 2023 (7:00 AM). Different types of vehicles were counted such as heavy trucks (3-axle), medium truck (2-axle), light trucks (pickup/small truck), standard/large bus/double decker (>40 seats and >36 feet chassis), mini-bus (16-39 seats and <36 feet chassis), microbus (up to 16 seats), utility (Jeep/SUV/Pajero), private car, baby taxi/CNG/auto, tempo/human hauler/leguna, motorcycle, bicycle, rickshaw, and rickshaw van. The details of the road traffic survey locations are shown in Table 3-15 and photographs of the traffic survey are shown in Figure 3-28.

Table 3-15: Road Traffic Monitoring Locations

Code	Locations	Road Name	Date	Geographical Coordinates
T-1	Borotakia, EZ Gate, Mirsharai	Borotakia to NSEZ	07/12/2023	22.75506 & 91.58576

Source: Field Survey by EQMS Team, December 2023

Figure 3-28: Photographs of the Traffic Survey

Daytime traffic monitoring



Nighttime traffic monitoring



Daytime traffic monitoring



Nighttime traffic monitoring

Source: Field Survey by EQMS Team, December 2023

3.2.13.1 Present Condition of Traffic Load

The traffic data between Borotakia and NSEZ indicates a high volume of daily vehicular movement, with a total of 3,997 PCUs traveling from Borotakia to NSEZ and 3,848 PCUs in the reverse direction. A summary of the traffic survey results is presented in Table 3-16.

Table 3-16: Status of Traffic

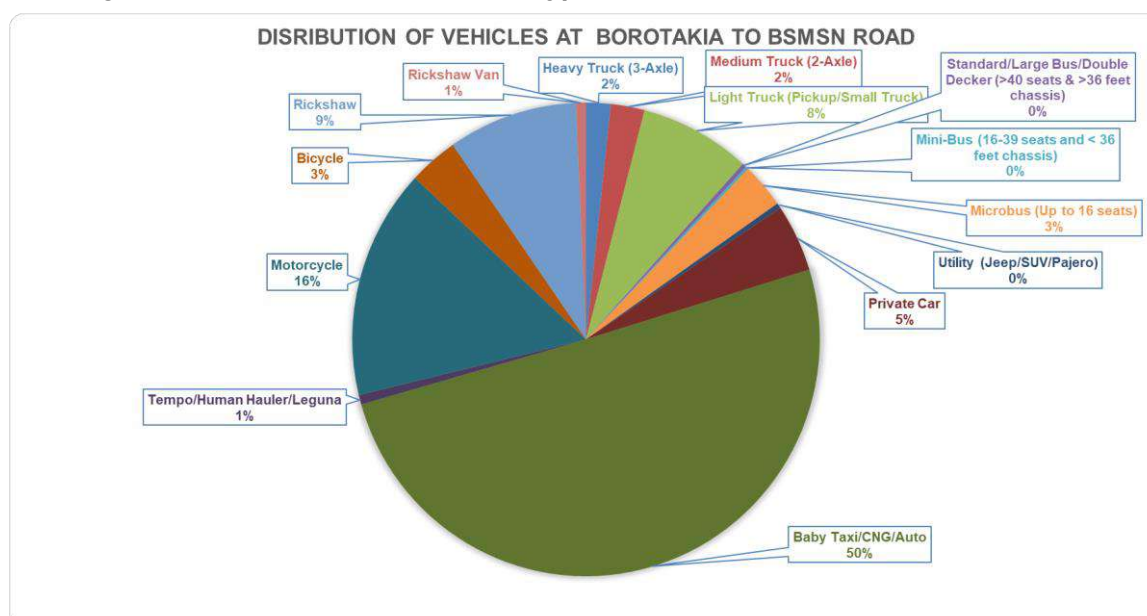
Types of vehicles	Borotakia to NSEZ (PCU/day)	NSEZ to Borotakia (PCU/day)
Heavy Truck (3-axle)	201	213
Medium Truck (2-axle)	165	119
Light Truck (Pickup/Small Truck)	310	312
Standard/Large Bus/ Double Decker (>40 seats and >36 feet chassis)	36	36
Mini-Bus (16-39 seats and < 36 feet chassis)	24	21
Microbus (Up to 16 seats)	124	125
Utility (Jeep/SUV/Pajero)	14	15
Private Car	176	198
Baby Taxi/CNG/Auto	1,577	1,482
Tempo/Human Hauler/Leguna	19	21

Types of vehicles	Borotakia to NSEZ (PCU/day)	NSEZ to Borotakia (PCU/day)
Motorcycle	452	503
Bicycle	73	65
Rickshaw	776	678
Rickshaw Van	50	60
Total	3,997	3,848

Source: Field Survey by EQMS Team, December 2023

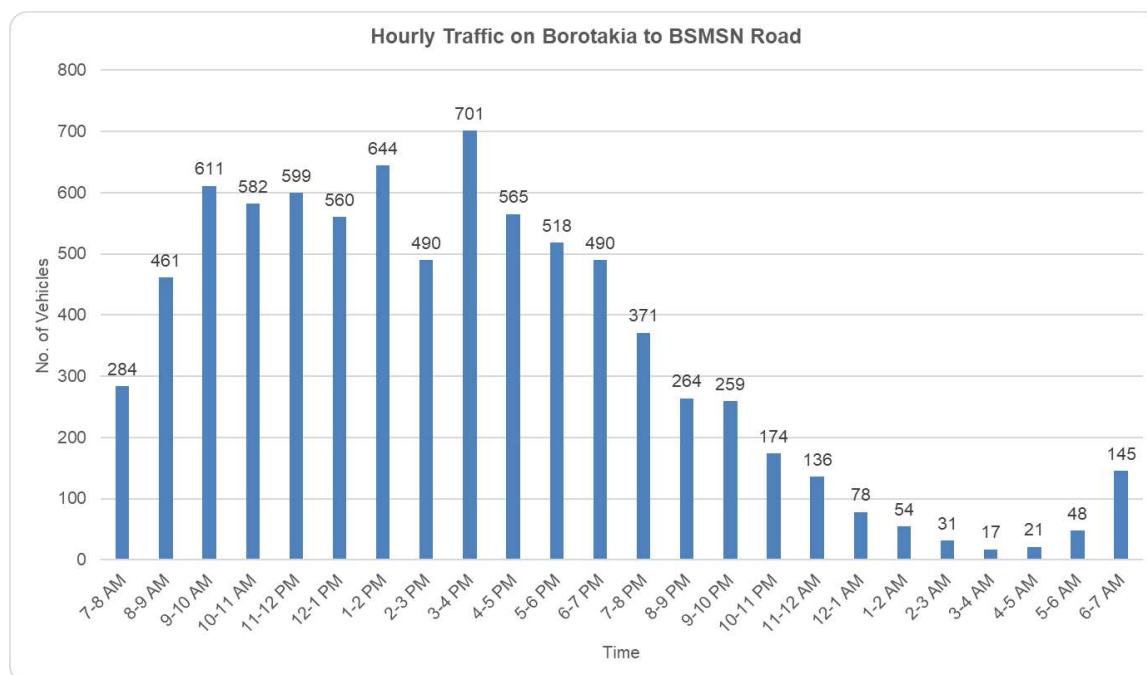
It was observed that the largest contributors to traffic in both directions are Baby Taxi/CNG/Auto vehicles, followed by motorcycles, rickshaws, and light trucks. These four categories dominate the traffic, reflecting a heavy reliance on smaller, more versatile vehicles for daily transportation. The distribution of various types of vehicles on Borotakia - NSEZ Road is shown in Figure 3-29.

Figure 3-29: Distribution of Various Types of Vehicles on Borotakia - NSEZ Road



Source: Field Survey by EQMS Team, December 2023

It was observed that vehicle movement increased from 6-7 AM and it was the peak at 3-4 PM. The number of vehicles on the road decreased after 8-9 PM and it was a minimum at midnight. It is expected that the current traffic volume will be increased during the full-fledged construction and operational activities in the NSEZ. The incremental traffic volume in the study region will principally result from the movement of passenger vehicles carrying construction and operation personnel to/from the NSEZ site, overall improved road conditions, business opportunities, etc.

Figure 3-30: Hourly Traffic on Borotakia - NSEZ Road

Source: Field Survey by EQMS Team, December 2023

3.2.14 Environmental Quality

3.2.14.1 Ambient Air Quality – Secondary

In general, there are two key factors affecting the ambient air concentration of a certain pollutant emitted from a certain source(s) in a selected area. These are:

- Intensity of the emissions (e.g., concentration and flow rate) from the sources.
- Uncontrollable atmospheric dispersion conditions which include but are not limited to wind speed and direction, temperature, humidity, rainfall, solar radiation intensity, atmospheric turbulence, and atmospheric pressure.

To understand the historical ambient air quality baseline condition of the study region, an extensive secondary documentation review was conducted by the RESA Consultant. From the secondary literature review, a total of 28 ambient air quality monitoring results have been identified in the study region. Location details of ambient air quality monitoring are given in Table 3-17. Details of baseline data have been provided in Appendix A.

Table 3-17: Locations of Ambient Air Quality Monitoring

Monitoring Code	Geographical Coordinates	Location Details	Date of Monitoring
AAQ-1	22°45'08.7" N 91°29'08.8" E	Barotakia Bazar, Mirsharai, Chattogram	24-27/12/2018
AAQ-2	22°42'22.5" N 91°32'25.5" E	Dakhin Magadia, Mirsharai, Chattogram	
AAQ-3	22°48'29.2" N 91°28'02.7" E	Moddho Moghadia, Mirsharai, Chattogram	
AAQ-4	22°48'30.6" N 91°23'14.0" E	CP More, Mirsharai, Chattogram	
AAQ-5	-	Mirsharai Site 1	4-5/06/2018

Monitoring Code	Geographical Coordinates	Location Details	Date of Monitoring
AAQ-6	-	Mirsharai Site 2	
AAQ-7	22°43'24.3" N 91°30'44.3" E	11 No. South Mougadia Union, Mirsharai	22-23/11/2021
AAQ-8	22°40'45.7" N 91°32'26.4" E	5 No. Jetty, Dhomkhali Sea Beach Mirsharai	
AAQ-9	22°43'2700" N 91°27'2500" E	1 No. Jetty, Helipad, Mirsharai	
AAQ-10	22°48'14.2" N 91°26'48.8" E	Cyclone Shed, Mirsharai	
AAQ-11	22°51'21.6" N 91°28'16.1" E	Feni River, Osmanpur Union	
AAQ-12	22°47'30.9" N 91°27'16.3" E	Poshchim Ichakhali	18-19/3/2021
AAQ-13	22°45.7040 N 91°28.2430 E	Mirsharai 2 Economic Zone	
AAQ-14	22°44'37.5" N 91°32'37.8" E	Moghadia Nurul Absar Chowdhury High School	16/07/2016
AAQ-15	22°44'31.5" N 91°26'55.9" E	Within 2A & 2B Zones	
AAQ-16	22°44'01.7" N 91°30'12.2" E	Near Bamon Sundar Khal	
AAQ-17	22.777200° N 91.570790° E	Beside Foot Over Bridge, Mirsharai	
AAQ-18	22.777110° N 91.569850° E	In front of the Municipal Office, Mirsharai	June 2017
AAQ-19	22.748060° N 91.557270° E	Abu Torab Bazaar (Bazar Mor)	
AAQ-20	22.748880° N 91.555350° E	Abu Torab Bazaar (In front of Moghadiya Union Parishad Bhaban)	
AAQ-21	22°47'27.4" N 91°21'56.2" E	NSEZ Area (Dry)	
AAQ-22	22°47'27.4" N 91°21'56.2" E	NSEZ Area (Wet)	October 2018
AAQ-23	22°48'09.5" N 91°22'55.4" E	Adarsha Village (Dry)	
AAQ-24	22°48'09.5" N 91°22'55.4" E	Adarsha Village (Wet)	
AAQ-25	22°47'50.5" N 91°21'43.4" E	Purbo Barodhuli Village (Dry)	
AAQ-26	22°47'50.5" N 91°21'43.4" E	Purbo Barodhuli Village (Wet)	

Monitoring Code	Geographical Coordinates	Location Details	Date of Monitoring
AAQ-27	22°46'24.0" N 91°21'07.3" E	Musapur Civic (Dry)	
AAQ-28	22°46'24.0" N 91°21'07.3" E	Musapur Civic (Wet)	

3.2.14.1.1 Ambient Air Quality Monitoring Results

The result of the ambient air quality is presented in Table 3-18.

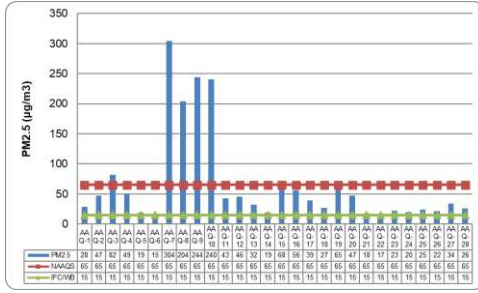
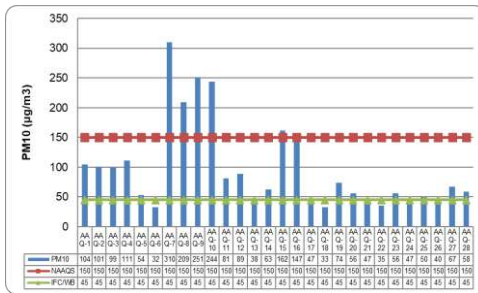
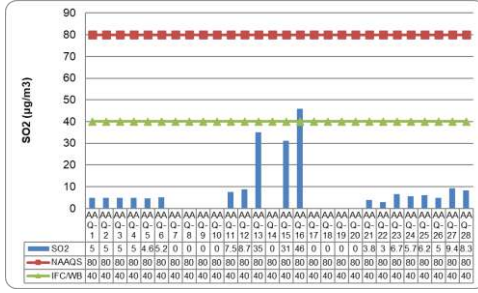
Table 3-18: Ambient air quality monitoring results

Monitoring Code	Parameters						
	PM _{2.5}	PM ₁₀	SO ₂	NO ₂	CO	Pb	O ₃
AAQ-1	28.25	104.17	5.0	-	Nil	0.052	-
AAQ-2	47.09	101.19	5.0	-	Nil	0.0313	-
AAQ-3	81.74	98.92	5.0	-	Nil	0.0616	-
AAQ-4	49.42	111.11	5.0	-	Nil	0.0347	-
AAQ-5	19.15	53.66	4.6	28.5	0.34	-	24.5
AAQ-6	14.8	32.4	5.2	20.5	0.41	-	16.6
AAQ-7	304.0	310.0	-	-	-	-	-
AAQ-8	204.0	209.0	-	-	-	-	-
AAQ-9	244.0	251.0	-	-	-	-	-
AAQ-10	240.0	244.0	-	-	-	-	-
AAQ-11	42.7	81.4	7.5	28.6	0.58	-	20
AAQ-12	45.7	88.5	8.7	32.2	0.67	-	20
AAQ-13	32.3	38.3	35.0	-	<0.3	-	-
AAQ-14	18.9	62.96	LOO	-	Nil	-	-
AAQ-15	68.17	161.9	31.22	-	Nil	-	-
AAQ-16	55.74	147.29	45.98	-	Nil	-	-
AAQ-17	39	47	-	-	-	-	-
AAQ-18	27	33	-	-	-	-	-
AAQ-19	65	74	-	-	-	-	-
AAQ-20	47	56	-	-	-	-	-
AAQ-21	18.3	47.4	3.8	-	<1	-	-
AAQ-22	16.8	35.4	3.0	-	<1	-	-
AAQ-23	22.5	56.2	6.7	-	<1	-	-
AAQ-24	19.5	46.8	5.7	-	<1	-	-
AAQ-25	24.5	50.1	6.2	-	<1	-	-
AAQ-26	21.6	40.1	5.0	-	<1	-	-

Monitoring Code	Parameters						
	PM _{2.5}	PM ₁₀	SO ₂	NO ₂	CO	Pb	O ₃
AAQ-27	34.1	66.8	9.4	-	1	-	-
AAQ-28	25.8	58.4	8.3	-	<1	-	-

The summary of the ambient air quality results is presented in Table 3-19.

Table 3-19: Summary of Analysis of the Ambient Air Quality (Secondary)

Parameters	Observation and Interference	Graphical Representation
Particulate Matter (PM _{2.5})	PM _{2.5} concentration in ambient air in the study region was recorded in the range of 14.8 - 304.0 µg/m ³ . The concentration of PM _{2.5} was observed to be a minimum (14.8 µg/m ³) at Mirsharai Site 2 (AAQ-6) and a maximum (304.0 µg/m ³) at 11 No. South Mougadia Union, Mirsharai (AAQ-7). Observed values at AAQ-7, AAQ-8, AAQ-9, and AAQ-10 exceeded the Air Pollution (Control) Rules 2022 standard (65 µg/m ³) for 24 hours. All observed values except AAQ-6 exceed the IFC/WB standard (15 µg/m ³) for 24 hours.	
Particulate Matter (PM ₁₀)	PM ₁₀ concentration in ambient air in the study region was recorded in the range of 32.4 - 310.0 µg/m ³ . The concentration of PM ₁₀ was observed to be a minimum (32.4 µg/m ³) at Mirsharai Site 2 (AAQ-6) and a maximum (310.0 µg/m ³) at 11 No. South Mougadia Union, Mirsharai (AAQ-7). Observed values at AAQ-7, AAQ-8, AAQ-9, AAQ-10, and AAQ-15 exceeded the Air Pollution (Control) Rules 2022 standard (150 µg/m ³) for 24 hours. All observed values except AAQ-6, AAQ-13, AAQ-18, AAQ-22, and AAQ-26 exceed the IFC/WB standard (45 µg/m ³) for 24 hours.	
Sulphur Dioxide (SO ₂)	SO ₂ concentration in ambient air in the study region was recorded in the range of 3.0 - 45.98 µg/m ³ . The concentration of SO ₂ was observed to be a minimum (3.0 µg/m ³) at NSEZ Area (Wet) (AAQ-22) and a maximum (45.98 µg/m ³) at Near Bamon Sundar Khal (AAQ-16). All the observed values were within the Air Pollution (Control) Rules 2022 standard (80 µg/m ³) for 24 hours. However, observed values at AAQ-16 exceed the IFC/WB standard (40 µg/m ³) for 24 hours.	

Parameters	Observation and Interference	Graphical Representation
Oxides of Nitrogen (NO ₂)	NO ₂ concentration in ambient air in the study region was recorded in the range of 20.5 - 32.2 µg/m ³ . The concentration of NO ₂ was observed to be a minimum (20.5 µg/m ³) at Mirsharai Site 2 (AAQ-6) and a maximum (32.2 µg/m ³) at Poshchim Ichakhali (AAQ-12). All the observed values were within the Air Pollution (Control) Rules 2022 standard (80 µg/m ³) for 24 hours. However, observed values at AAQ-5, AAQ-11, and AAQ-12 exceed the IFC/WB standard (25 µg/m ³) for 24 hours.	
Carbon Monoxide (CO)	CO concentration in ambient air in the study region was recorded in the range of <0.3 - 1 mg/m ³ . The concentration of CO was observed to be minimum (<0.3 mg/m ³) at Mirsharai 2 Economic Zone (AAQ-13) and maximum (1 mg/m ³) at Musapur Civic (Dry) (AAQ-27). All the observed values were within the Air Pollution (Control) Rules 2022 standard (5 mg/m ³) and IFC/WB (10 mg/m ³) for 8 hours.	
Lead (Pb)	Pb concentration in ambient air in the study region was recorded in the range of 0.0313 - 0.0616 µg/m ³ . The concentration of SO ₂ was observed to be minimum (0.0313 µg/m ³) at Dakhin Maghadia, Mirsharai, Chattogram (AAQ-2) and maximum (0.0616 µg/m ³) at Moddho Moghadia, Mirsharai, Chattogram (AAQ-3). All the observed values were within the Air Pollution (Control) Rules 2022 standard (0.05 µg/m ³) for 24 hours and IFC/WB have no standards.	
Ozone (O ₃)	O ₃ concentration in ambient air in the study region was recorded in the range of 16.6 - 24.5 µg/m ³ . The concentration of O ₃ was observed to be a minimum (16.6 µg/m ³) at Mirsharai Site 2 (AAQ-6) and a maximum (24.5 µg/m ³) at Mirsharai Site 1 (AAQ-5). All the observed values were within the Air Pollution (Control) Rules 2022 standard (100 µg/m ³) and IFC/WB (100 µg/m ³) for 8 hours.	

Previous secondary baseline data indicates that the ambient air quality of the study region is generally good with most of the parameters within the prescribed standards except the particulate matter level. Related development activities are likely to add on to existing particulate matter and dust levels in the region. Other than the emissions generated by vehicles, currently, there are few sources of air pollutants

present in the proposed NSEZ region. However, it will be increased during the operation of all industries in the NSEZ.

3.2.14.2 Ambient Air Quality – Primary

The objective of the ambient air quality monitoring program was to establish the baseline ambient air quality in the study region. The profile of the study region is mixed, which has a mix of scattered settlements, industry, and agriculture areas. Generally, air pollution sources in the NSEZ area consist of road dust, brick kilns, black smoke from diesel engine vehicles, emissions from industries, windblown dust from agricultural lands, domestic heating, cooking, etc. The study team has determined ten ambient air quality monitoring locations in and around the NSEZ site based on prevailing wind direction and the importance of the receptors. Logistics such as the consent of villagers, mainly the house owners, power connection, accessibility, security, etc. were also taken into account.

3.2.14.2.1 Methodology

Using the HAZ Scanner and Oceanus AQM-09 air quality monitoring system, the ambient air quality of the study region was monitored at ten locations. The monitoring parameters were Particulate Matter (PM₁₀ and PM_{2.5}), Sulphur Dioxide (SO₂), Nitrogen di Oxide (NO₂), Carbon Monoxide (CO), Lead (Pb), Ozone (O₃), and Ammonia (NH₃). HAZ Scanner and Oceanus AQM-09 have done automatic sampling and analysis every minute.

3.2.14.2.2 Selection of Sampling Locations

The baseline status of ambient air quality has been established through a scientifically designed ambient air quality monitoring network. The ambient air quality monitoring locations were selected taking into account the following:

- Meteorological conditions of the area based on information from the Bangladesh Meteorological Department observatory at Sitakunda, Feni, and Sandwip stations.
- Topography of the study region.
- Location of sensitive receptors such as major settlements.
- Future development plans in the region such as road networks, railways, etc.
- Representativeness of regional background air quality for obtaining baseline status.
- Representativeness of likely impact areas.

Details of the monitoring locations are presented in Table 3-20 and a map of the ambient air quality monitoring locations is shown in Figure 3-31. The photographs of ambient air monitoring are presented in Appendix A-6.1.

Table 3-20: Ambient Air Quality Monitoring Locations

Sampling Code	Sampling Locations	Sampling Date	Geographical Coordinates
AAQ-1	Near BADC sluice gate, Char Chandia, Sonagazi, Feni	12/12/2023	22°47'36.148"N 91°23'34.199"E
AAQ-2	Near 7 no. Sonagazi Union parishad, Sonagazi, Feni	11/12/2023	22°51'02.332"N 91°24'14.888"E
AAQ-3	East side of the road, Bishumiyarhat, Zorarjong, Mirsharai	07/12/2023	22°51'35.380"N 91°30'31.534"E
AAQ-4	Near BEZA Administrative Building, NSEZ	14/12/2023	22°45'37.566"N 91°28'05.761"E
AAQ-5	South Maghadia, Mirsharai	10/12/2023	22°42'49.566"N 91°31'34.458"E

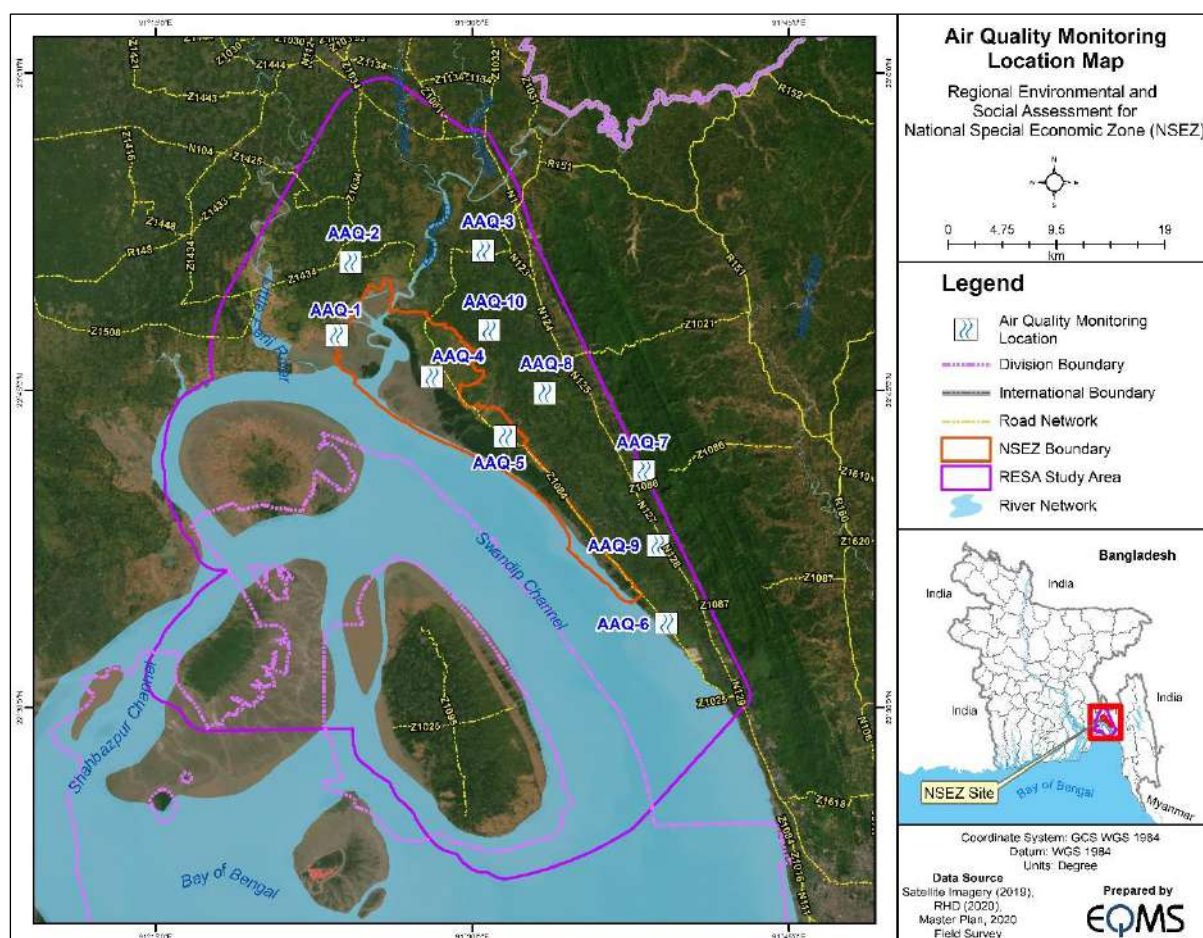
Sampling Code	Sampling Locations	Sampling Date	Geographical Coordinates
AAQ-6	Beribadh Road, Infront of Unigas Plant, Barabkunda, Sitakunda	08/12/2023	22°33'57.532"N 91°39'12.960"E
AAQ-7	Goll Chatter of Komor Ali Bazar, Mirsharai	9/12/2023	22°41'11.543"N 91°38'08.382"E
AAQ-8	Middle Abu Turab Bazar, Mirsharai, Chattogram	15/12/2023	22°44'52.103"N 91°33'26.088"E
AAQ-9	In front of the Government Technical School & College, Sitakunda	16/12/2023	22°37'39.974"N 91°38'46.504"E
AAQ-10	In front of the Kazi company market, CNG station, Bamansundor, Darogarhat, Mirsharai	13/12/2023	22°47'51.090"N 91°30'47.515"E

Source: EQMS, December 2023

3.2.14.2.3 Duration of Sampling

All parameters (PM₁₀, PM_{2.5}, SO₂, NO₂, Pb, and NH₃) were monitored on a 24-hour basis during the duration of the study except CO and O₃. The CO and O₃ were monitored for 8 hours. This is to allow a comparison with the present standards mentioned in the Air Pollution (Control) Rules 2022 and IFC/WB/WHO Guidelines.

Figure 3-31: Ambient Air Quality Monitoring Locations



Source: Field Survey by EQMS Team, December 2023

3.2.14.2.4 Summary of Ambient Air Quality Monitoring Result

Monitoring data were stored in the HAZ scanner and Oceanus AQM-09 memory. This data has been transferred via a USB drive and processed to see the ambient air quality monitoring results. Oceanus AQM-09 air quality monitoring data are presented in Table 3-21 along with the ambient air quality standard of Bangladesh and IFC/WB/WHO Guidelines. The laboratory test report has been presented in Appendix D.

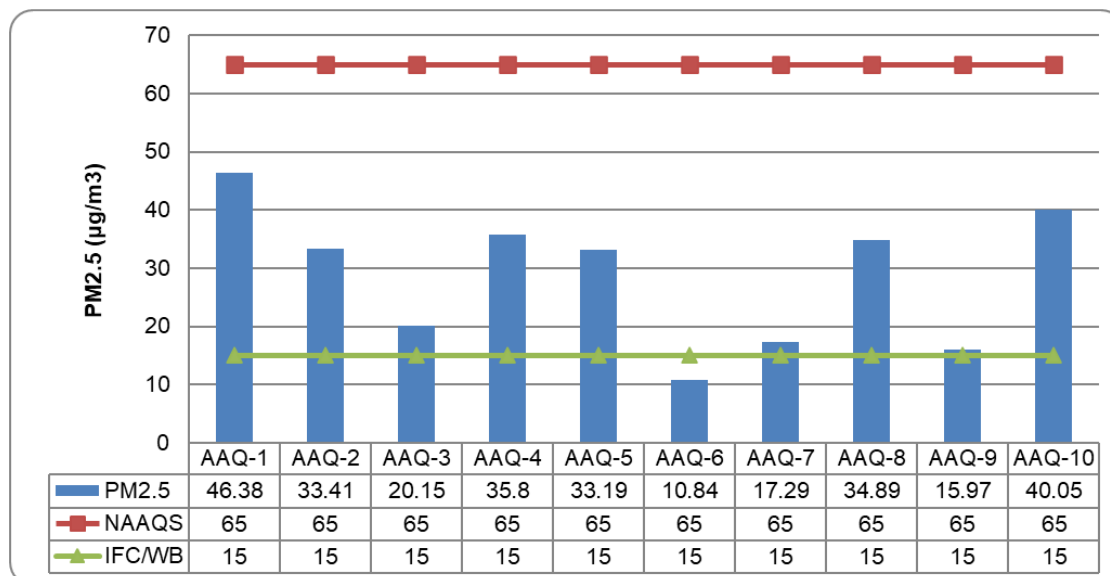
Table 3-21: Ambient Air Quality Analysis Results

Sampling Code	Parameters							
	PM _{2.5}	PM ₁₀	SO ₂	NO ₂	CO	Pb	O ₃	NH ₃
	µg/m ³	µg/m ³	µg/m ³	µg/m ³	mg/m ³	µg/m ³	µg/m ³	µg/m ³
AAQ-1	46.38	79.51	11.63	21.18	0.08	<0.05	27.04	0
AAQ-2	33.41	55.75	25.45	29.24	0.07	<0.05	31.77	0
AAQ-3	20.15	33.90	24.38	31.06	0.12	<0.05	36.19	0
AAQ-4	35.80	59.48	21.55	27.14	0.11	<0.05	29.01	0
AAQ-5	33.19	54.32	15.40	17.91	0.06	<0.05	25.89	0
AAQ-6	10.84	19.49	26.44	19.47	0.10	<0.05	24.83	0
AAQ-7	17.29	31.67	31.52	15.98	0.14	<0.05	21.59	0
AAQ-8	34.89	58.16	22.21	18.59	0.17	<0.05	23.13	0
AAQ-9	15.97	25.65	39.90	33.06	0.22	<0.05	35.42	0
AAQ-10	40.05	71.22	18.62	15.17	0.11	<0.05	20.02	0
Duration (hours)	24	24	24	24	8	24	8	24
Air Pollution (Control) Rules 2022	65	150	80	80	5	0.50	100	400
IFC/WB/WHO Guidelines	15	45	40	25	10	-	100	-

Source: Laboratory Analysis, December 2023

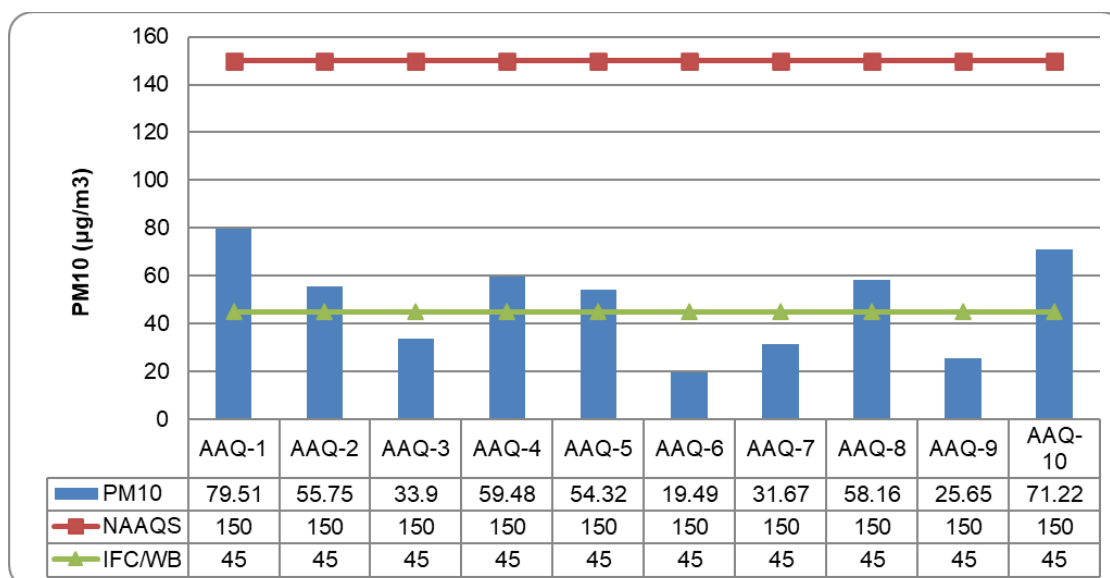
3.2.14.2.5 Results and Discussion

Concentration of Particulate Matter (PM_{2.5}): The 24-hourly PM_{2.5} concentration in ambient air in the study region was recorded in the range of 10.84 µg/m³ to 46.38 µg/m³. During the monitoring period, the maximum PM_{2.5} concentration was reported from AAQ-1 as 46.38 µg/m³ and the minimum concentration was reported from AAQ-6 as 10.84 µg/m³. All the monitoring locations were within the National Ambient Air Quality Standards (NAAQS) for PM_{2.5} in Bangladesh. However, except AAQ-6 all the monitoring location's results exceed the stipulated standards for PM_{2.5} mentioned in the IFC/WB Guidelines. Concentration of particulate matter (PM_{2.5}) in the Ambient Air Quality Monitoring data for the study area is presented in Figure 3-32.

Figure 3-32: Concentration of Particulate Matter (PM_{2.5})

Source: Field Survey by EQMS Team, December 2023

Concentration of Particulate Matter (PM₁₀): The 24-hourly PM₁₀ concentration in ambient air in the study region was recorded in the range of 19.49 µg/m³ to 79.51 µg/m³. During the monitoring period, the maximum PM₁₀ concentration was reported from AAQ-1 as 79.51 µg/m³ and the minimum concentration was reported from AAQ-6 as 19.49 µg/m³. All the monitoring locations results was within the NAAQS for PM₁₀ in Bangladesh. However, monitoring results at AAQ-1, AAQ-2, AAQ-4, AAQ-5, AAQ-8, and AAQ-10 exceed the stipulated standards for PM₁₀ mentioned in the IFC/WB Guidelines. Concentration of particulate matter (PM₁₀) in the Ambient Air Quality Monitoring data for the study area is presented in Figure 3-33.

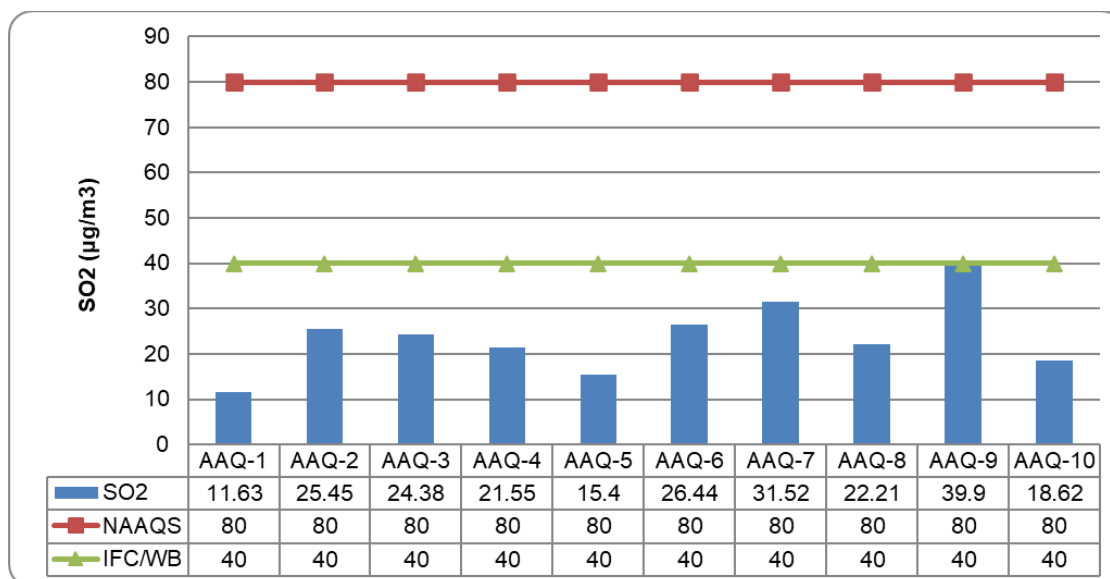
Figure 3-33: Concentration of Particulate Matter (PM₁₀)

Source: Field Survey by EQMS Team, December 2023

Concentration of Sulphur Dioxide (SO₂): The 24-hourly SO₂ concentration in ambient air in the study region was recorded in the range of 11.63 µg/m³ to 39.9 µg/m³. During the monitoring period, the maximum SO₂ concentration was reported from AAQ-9 as 39.9 µg/m³ and the minimum concentration was reported from AAQ-1 as 11.63 µg/m³. All the monitoring location's results were within the NAAQS for SO₂ in Bangladesh and standards for SO₂ mentioned in the IFC/WB Guidelines. The concentration

of Sulphur Dioxide (SO₂) in the Ambient Air Quality Monitoring data for the study area is presented in Figure 3-34.

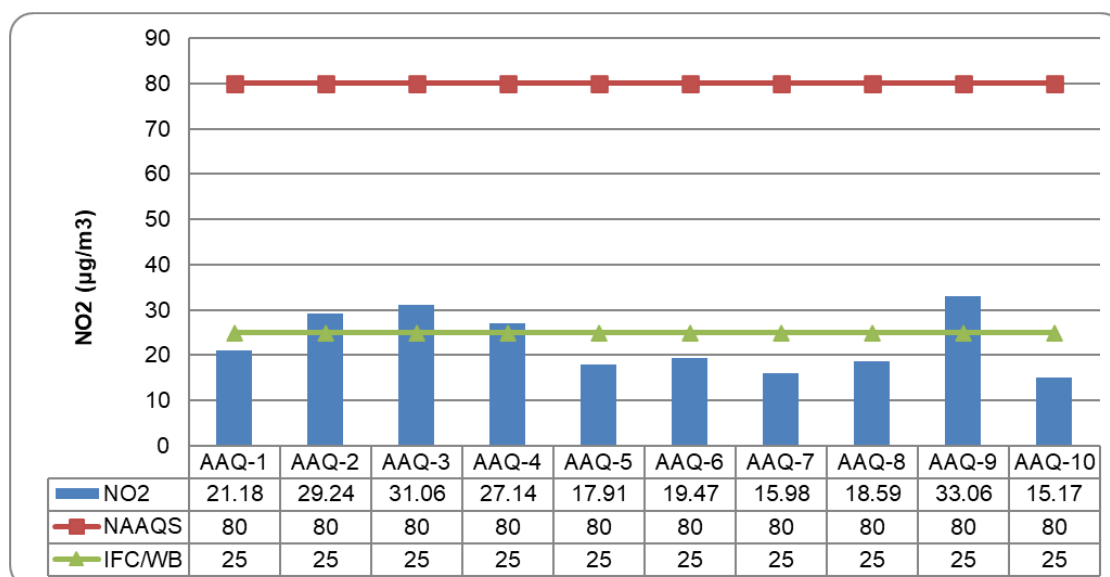
Figure 3-34: Concentration of Sulphur Dioxide (SO₂)



Source: Field Survey by EQMS Team, December 2023

Concentration of Oxides of Nitrogen (NO₂): The 24-hourly NO₂ concentration in ambient air in the study region was recorded in the range of 15.17 µg/m³ to 33.06 µg/m³. During the monitoring period, the maximum NO₂ concentration was reported from AAQ-9 as 33.06 µg/m³ and the minimum concentration was reported from AAQ-10 as 15.17 µg/m³. All the monitoring locations results was within the NAAQS for NO₂ in Bangladesh. However, monitoring results at AAQ-2, AAQ-3, AAQ-4, AAQ-8, and AAQ-9 exceed the stipulated standards for NO₂ mentioned in the IFC/WB Guidelines. The concentration of Oxides of Nitrogen (NO₂) in the Ambient Air Quality Monitoring data for the study area is presented in Figure 3-35.

Figure 3-35: Concentration of Oxides of Nitrogen (NO₂)

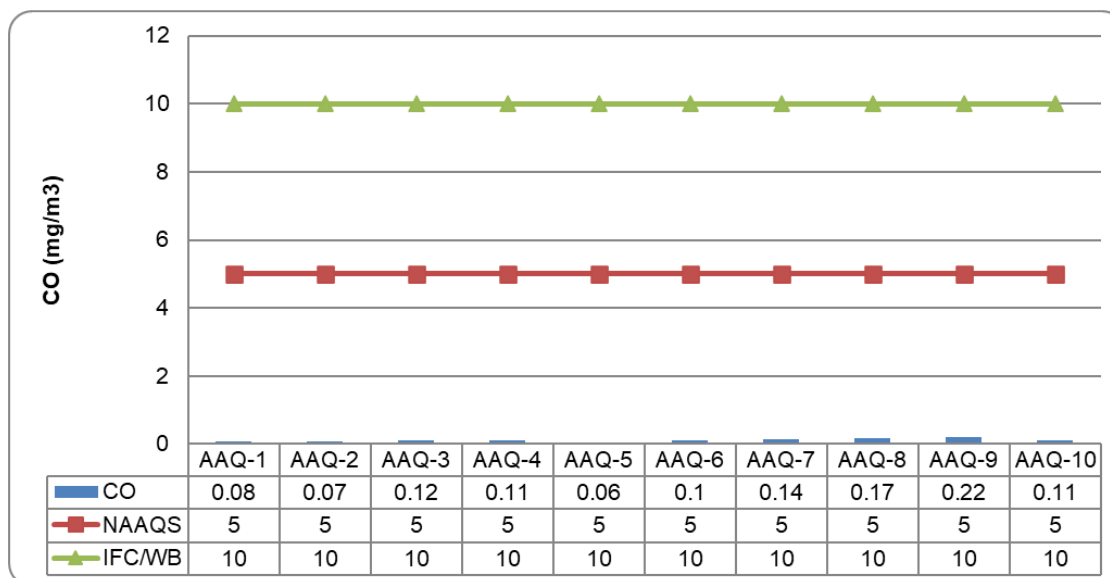


Source: Field Survey by EQMS Team, December 2023

Concentration of Carbon Monoxide (CO): The 8-hourly CO concentration in ambient air in the study area was recorded in the range of 0.06 mg/m³ to 0.22 mg/m³. During the monitoring period, the maximum CO concentration was reported from AAQ-9 as 0.22 mg/m³ and the minimum concentration

was reported from AAQ-5 as 0.06 mg/m³. All the monitoring results was within the NAAQS for CO in Bangladesh and IFC/WB Guidelines. Concentration of Carbon Monoxide (CO) in the Ambient Air Quality Monitoring data for the study area is presented in Figure 3-36.

Figure 3-36: Concentration of Carbon Monoxide (CO)

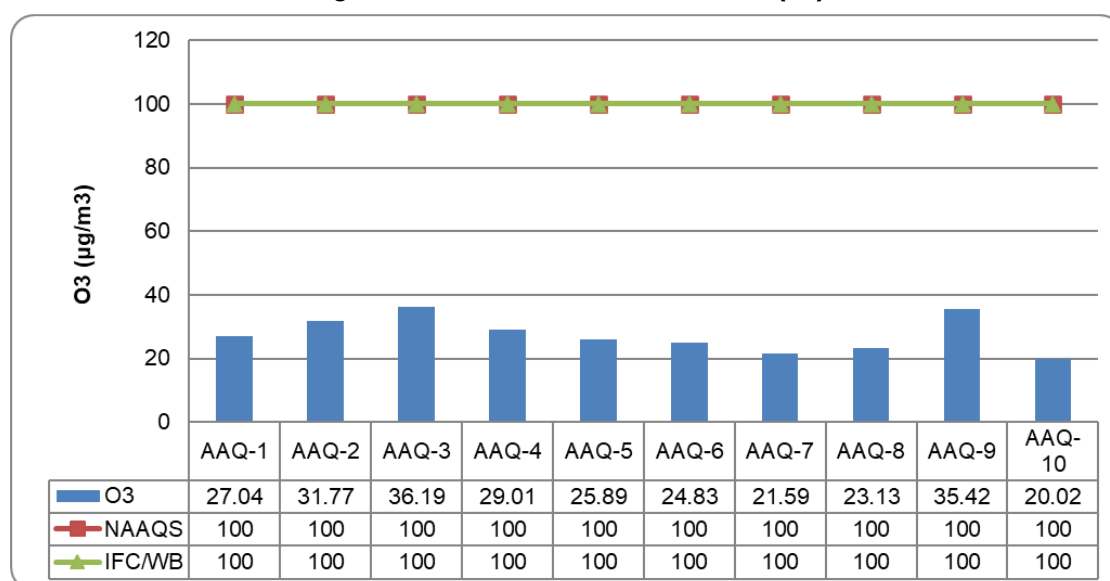


Source: Field Survey by EQMS Team, December 2023

Concentration of Lead (Pb): The 24-hour Pb concentration in ambient air of the study region was recorded as <0.05 µg/m³. All the monitoring locations results were within the national ambient air quality standards for Pb in Bangladesh and the IFC/WB Guidelines have no standard value for Pb.

Concentration of Ozone (O₃): The 8-hourly O₃ concentration in ambient air in the study region was recorded in the range of 20.02 µg/m³ to 36.19 µg/m³. During the monitoring period, the maximum O₃ concentration was reported from AAQ-3 as 36.19 µg/m³ and the minimum concentration was reported from AAQ-10 as 20.02 µg/m³. All the monitoring results were within the NAAQS for O₃ in Bangladesh and IFC/WB Guidelines. The concentration of Ozone (O₃) in the Ambient Air Quality Monitoring data for the study area is presented in Figure 3-37.

Figure 3-37: Concentration of Ozone (O₃)



Source: Field Survey by EQMS Team, December 2023

Concentration of Ammonia (NH₃): The 24-hourly NH₃ concentration in ambient air in the study region was recorded as 0.00 µg/m³. All the monitoring location's results were within the national ambient air quality standards for NH₃ in Bangladesh and the IFC/WB Guidelines have no standard value for NH₃.

3.2.14.3 Ambient Noise Level – Secondary

To understand the historical ambient noise level baseline condition of the study region, an extensive secondary documentation review was conducted by the RESA Consultant. From the secondary literature review, a total of 26 ambient noise level monitoring results have been identified in the study region. A summary of the analysis of the secondary ambient noise level has been provided in Table 3-22 and a summary of collected baseline data has been provided in Appendix A.

Table 3-22: Summary of Analysis of the Ambient Noise Level (Secondary)

Parameters	Observation and Interference	Graphical Representation
Daytime Noise Levels (Leqday)	The daytime noise levels at all the locations range between 52.2 dB(A) to 68.4 dB(A). The maximum value of 68.4 dB(A) was recorded at the starting of NSEZ Avenue (Dhaka Chattogram Highway to EZ Road) (ANL-24) and the minimum value of 52.2 dB(A) was recorded at NSEZ Avenue (ANL-22). All the observed values except ANL-5, ANL-6, and ANL-24 were within the Noise Pollution (Control) Rules 2006 daytime standard (60 dBA of mixed area). IFC/WB has no standard for mixed areas.	
Nighttime Noise Levels (Leqnight)	The night-time noise levels at all the locations ranged between 39.3 dB(A) to 59.81 dB(A). The maximum value of 59.81 dB(A) was recorded at Purbo Moghadia (ANL-6) and the minimum value of 39.3 dB(A) was recorded at Feni River, Osmanpur Union (ANL-25). All the observed values except ANL-1, ANL-2, ANL-3, ANL-5, and ANL-6 were within the Noise Pollution (Control) Rules 2006 nighttime standard (50 dBA of mixed area). IFC/WB has no standard for mixed areas.	

The study region of NSEZ is characterized as a mixed area including residential areas, agricultural land, commercial areas, etc. The day and nighttime monitored noise level exceeds the prescribed standards in some locations due to the temporary construction works in the area, construction equipment operation, huge number of heavy vehicle movement and other commercial vehicles, etc.

3.2.14.4 Ambient Noise Level – Primary

The study area is located in Chattogram and Feni Districts. NSEZ implementation activities are ongoing. Presently there are few industries as well as sources of noise pollution. The sources of noise are vehicular movement on the internal and external road and river traffic (boats, ships, trawlers, dredgers, etc.) in the Sandwip Channel/Bay of Bengal and associated rivers and khals.

3.2.14.4.1 Noise Sampling Locations

Ambient noise levels were monitored at ten locations considering the different categories of area/receptor i.e., silent, residential, mixed, commercial, and industrial areas in the study region using a sound level meter. Noise levels were recorded in the form of sound pressure levels with the help of a digital sound level meter. The purpose of ambient noise level measurement was to determine sound intensity at the monitoring locations. These locations are chosen in such a way that representative data can be recorded all over the study region. The sound level is recorded in the form of A-weighted equivalent continuous sound pressure level values with the use of A-weighting filters in the noise measuring instrument. The environment setting of each noise monitoring location is given in Table 3-23 and the map is depicted in Figure 3-38. The photographs of noise monitoring are presented in Appendix A-6.2. The ambient noise level monitoring locations were selected taking into account the following:

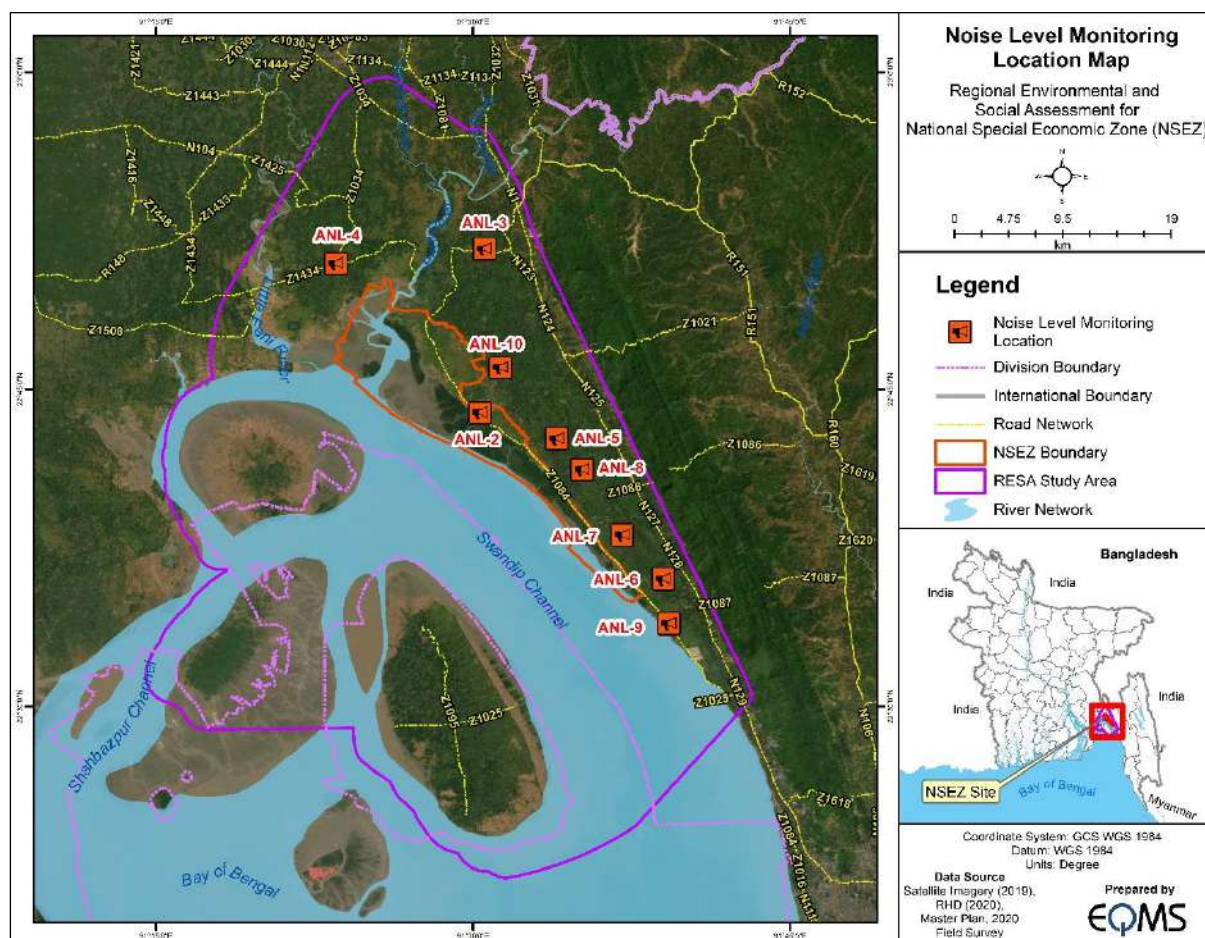
- Location of sensitive receptors such as major settlements, schools, mosques, bazar, etc.
- Future development plans in the region such as road networks, railways, etc.
- Representativeness of regional background noise level for obtaining baseline status.
- Representativeness of likely impact areas.

Table 3-23: Ambient Noise Level Monitoring Locations

Sampling Code	Sampling Location	Geographical Coordinates	Monitoring Date	Category of Area/Receptor
ANL-1	In front of the BEZA Administrative Building, NSEZ	22°45'38.607"N 91°28'05.447"E	10/12/2023	Industrial
ANL-2	Beribadh Road, near CP Mor, NSEZ	22°43'52.935"N 91°30'18.620"E	10/12/2023	Mixed
ANL-3	In front of Oli Khan Govt, Primary School, Ichakhali, Mirsharai	22°51'38.371"N 91°30'31.029"E	07/12/2023	Silent
ANL-4	Zero Point, Sonagazi municipality, Sonagazi, Feni	22°50'57.149"N 91°23'30.014"E	11/12/2023	Commercial
ANL-5	Junction of 4 roads at Vorer Bazar, Saherkhali, Mirsharai	22°42'39.605"N 91°33'56.550"E	09/12/2023	Commercial
ANL-6	East Muradpur Deli Bazar, Muradpur Sandwip Ghatghor Road, Mirsharai	22°36'01.149"N 91°38'59.053"E	08/12/2023	Commercial
ANL-7	3 Rastar mor, Brickfield Bazar, Sitakunda, Chattogram	22°38'06.503"N 91°37'03.158"E	13/12/2023	Commercial
ANL-8	Gol Circle of Komor Ali Bazar, Mirsharai	22°41'11.472"N 91°35'08.581"E	09/12/2023	Commercial
ANL-9	Beside Uni Gas Central Jame Mosque, Barabkunda, Sitakunda	22°33'54.628"N 91°39'15.329"E	08/12/2023	Industrial
ANL-10	Junction of 3 Road at Banatoli Vor Bazar, Mirsharai	22°46'01.597"N 91°31'17.428"E	07/12/2023	Commercial

Source: EQMS, December 2023

Figure 3-38: Ambient Noise Level Monitoring Locations



Source: Field Survey by EQMS Team, December 2023

3.2.14.4.2 Method of Monitoring

The monitoring was carried out for a duration of 24 hours as mentioned in the Noise Pollution (Control) Rules 2006 and IFC guidelines (daytime: 6:00 am to 9:00 pm and nighttime: 9:00 am to 6:00 am) and IFC guidelines (daytime: 07:00 to 22:00 and nighttime: 22:00 to 07:00). The sound level meter was placed at a height of about 1.5 m above the ground on a tripod and was kept 3.5m away from any sound-reflecting surfaces. The sound level meter was calibrated onsite each day before the first measurement is taken and after the final measurement is complete. The noise level data will be downloaded to the computer for further analysis.

3.2.14.4.3 Presentation of Results

The statistical analysis was done for measured noise levels at eight locations during the baseline study. Parameters like Leq_{day} , Leq_{night} , L_{max} , and L_{min} were analyzed. The results of the ambient noise level monitoring are given in Table 3-24. The laboratory test report has been presented in Appendix D.

Table 3-24: Ambient Noise Level Analysis Results

Sampling Code	Category of Area/Receptor	Parameters				National Standards		IFC Standards	
		Leq_{day}	Leq_{night}	L_{max}	L_{min}	Day	Night	Day	Night
ANL-1	Industrial	48.0	44.0	66.4	31.6	75	70	70	70
ANL-2	Mixed	62.2	53.5	83.4	40.4	60	50	55	45

Sampling Code	Category of Area/Receptor	Parameters				National Standards		IFC Standards	
		Leq _{day}	Leq _{night}	L _{max}	L _{min}	Day	Night	Day	Night
ANL-3	Silent	60.6	48.4	88.1	34.0	50	40	55	45
ANL-4	Commercial	69.6	58.4	92.1	43.2	70	60	70	70
ANL-5	Commercial	60.2	39.4	84.7	30.8	70	60	70	70
ANL-6	Commercial	65.0	51.6	86.7	40.0	70	60	70	70
ANL-7	Commercial	61.0	51.9	85.7	30.8	70	60	70	70
ANL-8	Commercial	61.1	57.9	85.3	32.1	70	60	70	70
ANL-9	Industrial	60.7	46.4	88.6	31.6	75	70	70	70
ANL-10	Commercial	56.5	47.0	76.1	31.6	70	60	70	70

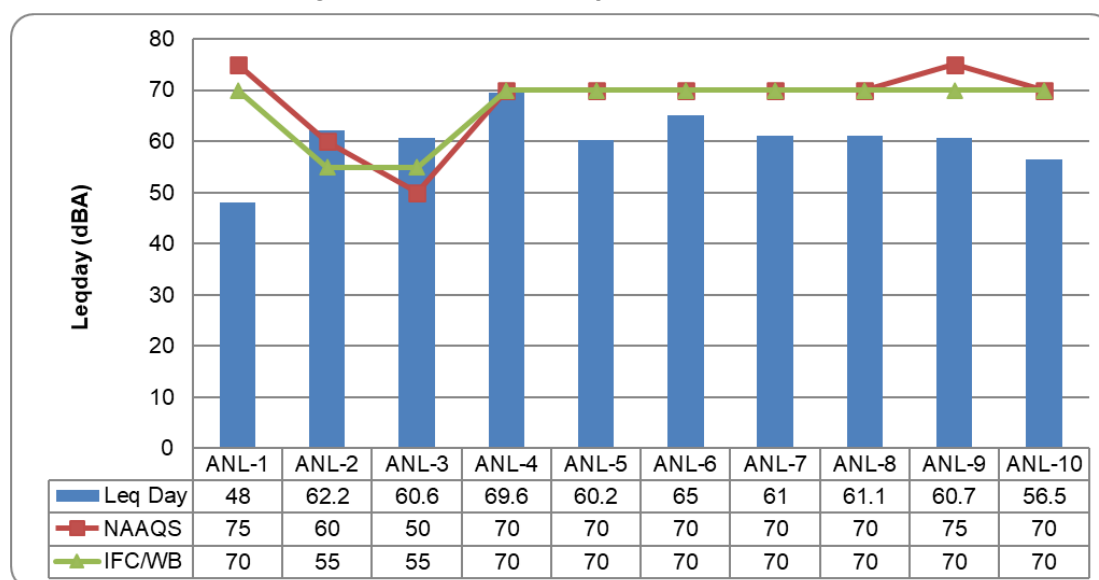
Source: Field Survey by EQMS Team, December 2023

3.2.14.4.4 Results and Discussion

Daytime Noise Levels (Leq_{day}):

The daytime noise levels at all the locations ranged between 48.0 dB(A) to 69.6 dB(A). The maximum value of 69.6 dB(A) was recorded at the commercial area (Zero Point, Sonagazi municipality, Sonagazi, Feni) (ANL-4) and the minimum value of 48.0 dB(A) was recorded at the industrial area (In front of the BEZA Administrative Building, NSEZ) (ANL-1). All the observed values except ANL-2 and ANL-3 were within the Noise Pollution (Control) Rules 2006 daytime standards as well as IFC standards set for the respective zone. The comparison of day equivalent noise levels with the respective National and WB/IFC stipulated noise standards for various categories of area/receptors is presented in Figure 3-39.

Figure 3-39: Ambient Daytime Noise Levels



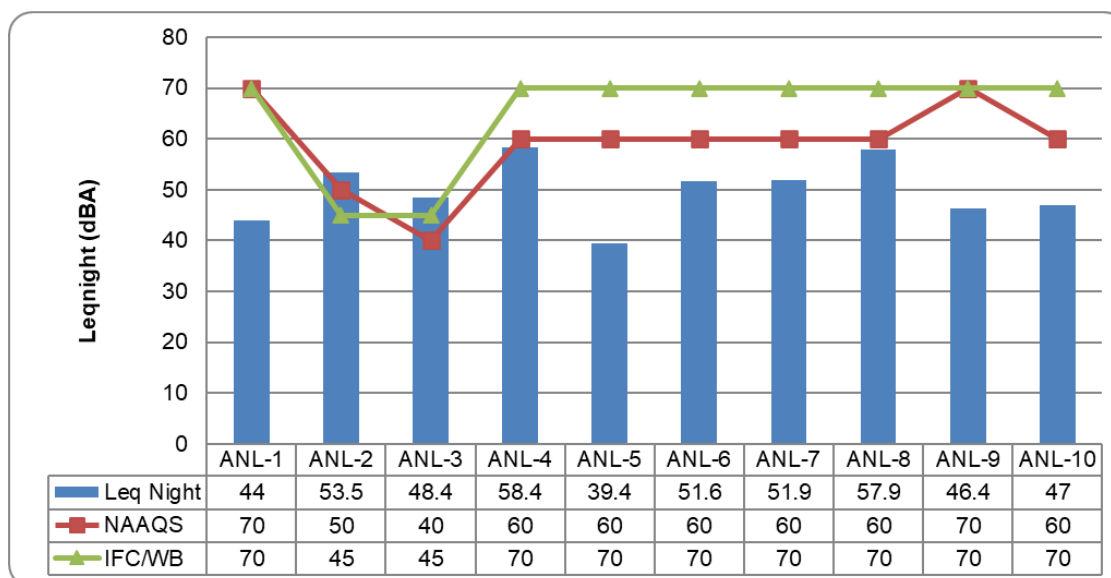
Source: Field Survey by EQMS Team, December 2023

Nighttime Noise Levels (Leq_{night}):

The night-time noise levels at all the locations ranged between 39.4 dB(A) to 58.4 dB(A). The maximum value of 58.4 dB(A) was recorded in the commercial area (Zero Point, Sonagazi municipality, Sonagazi, Feni) (ANL-4), and the minimum value of 39.4 dB(A) was recorded in the commercial area (Junction of 4 roads at Vorer Bazar, Saherkhali, Mirsharai) (ANL-5). All the observed values except ANL-2 and ANL-

3 were within the Noise Pollution (Control) Rules 2006 nighttime standards as well as IFC standards set for the respective zone. The comparison of night equivalent noise levels with the respective National and WB/IFC stipulated noise standards for various categories of area/receptors is presented in Figure 3-40.

Figure 3-40: Ambient Nighttime Noise Levels



Source: Field Survey by EQMS Team, December 2023

3.2.14.5 Surface Water Quality – Secondary

To understand the historical surface water quality baseline condition of the study region, an extensive secondary documentation review was conducted by the RESA Consultant. From the secondary literature review, a total of 41 surface water quality monitoring results have been identified in the study region. A summary of the analysis of the secondary surface water quality has been presented below and a summary of collected baseline data has been provided in Annex-B.

- **pH:** pH values of the surface water samples ranged between 6.7 to 8.5. All samples were in compliance with Schedule 2A of the Environment Conservation Rules (ECR) 2023 standard.
- **Dissolve Oxygen (DO):** DO was observed to be in the range of 4.18 to 9.5 mg/L. All samples were in compliance with Schedule 2A of ECR, 2023. High DO levels in surface water are good for the existing aquatic life of the area.
- **Biochemical Oxygen Demand (BOD):** BOD was observed to be in the range of 0.4 to 192.6 mg/L. BOD concentrations in all samples except SWQ-2, SWQ-11, SWQ-15, SWQ-33, SWQ-34, SWQ-35, SWQ-36, and SWQ-37 were less than 12 mg/L, which were compliant with the Schedule 2A of ECR, 2023.
- **Nitrate (NO₃^{-N}):** Nitrate concentrations of all samples ranged between 0.03 to 4.22 mg/L, which were compliant with Schedule 2A of ECR, 2023.
- **Ammonia (NH₄^{-N}):** Ammonia concentrations of all samples ranged between 0.13 to 1.48 mg/L, which were compliant with Schedule 2A of ECR, 2023.
- **Phosphate (PO₄^{-P}):** Phosphate concentrations of all samples ranged between 0.0253 to 6.48 mg/L. Phosphate concentrations in samples SWQ-12, SWQ-13, SWQ-38, SWQ-39, and SWQ-41 were more than 2 mg/L, which were not compliant with the Schedule 2A of ECR, 2023.
- **Total Chromium (TC):** Total Cr concentrations of all samples ranged between 0.01 to 0.04 mg/L, which were compliant with Schedule 2A of ECR, 2023.
- **Lead (Pb):** Lead concentrations of all samples ranged between 0.012 to 0.07 mg/L, which were compliant with Schedule 2A of ECR, 2023.

- **Total Coliform (TC):** TC concentrations of all samples ranged between 38 to 26,000 CFU/100 mg, which were compliant with Schedule 2A of ECR, 2023.
- **Total Dissolved Solids (TDS):** TDS concentrations of all samples ranged between 0.402 to 20,844 mg/L. TDS concentrations in samples SWQ-1, SWQ-2, SWQ-3, SWQ-4, SWQ-7, SWQ-8, SWQ-9, SWQ-11, SWQ-12, SWQ-15, SWQ-31, SWQ-34, SWQ-38, SWQ-39, SWQ-40, and SWQ-41 were more than 1,000 mg/L, which was not compliant with the Schedule 2A of ECR, 2023.
- **Chemical Oxygen Demand (COD):** COD concentrations of all samples ranged between 2 to 122 mg/L. DO concentrations in samples SWQ-1, and SWQ-2 were more than 100 mg/L, which were not compliant with Schedule 2A of ECR, 2023.

3.2.14.6 Surface Water Quality – Primary

Selected water quality parameters of surface water resources within the study region have been studied for assessing the water environment and evaluating the anticipated impacts of the NSEZ operation. Understanding water quality is essential in the preparation of the RESA and in identifying critical issues to suggest appropriate mitigation measures for implementation. The purpose of this study is to:

- Assess the water quality characteristics for critical parameters.
- Predict the impact of water quality by NSEZ operation and related activities.

Seven surface water samples were collected and analyzed during the baseline survey from the study region. The samples were analyzed as per the standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by the American Public Health Association (APHA). Surface water quality parameters are checked against Schedule 2 of the Environment Conservation Rules, 2023.

3.2.14.6.1 Surface Water Sampling Locations

Surface water samples were collected from Feni River (Muhuri Reservoir), Sandwip Channel, and different khals including Ichakhali, Daborkhali, Bamansundar, Hoania, Saherkhali, and Domkhali. The environment setting of each surface water sampling location is given in Table 3-25 and the map is depicted in Figure 3-41. The photographs of surface water sampling are presented in Appendix A-6.3. The surface water quality monitoring locations were selected taking into account the following:

- Need for samples upstream and downstream of the khals flowing through NSEZ.
- Safe access to sampling locations.
- Location of sensitive receptors such as fish, marine mammals, birds, and invertebrates in the marine environment.
- Future development plans in the region including residential areas and heavy industrial areas.
- Representativeness of regional surface water quality for obtaining baseline status.
- Representativeness of likely impact areas.

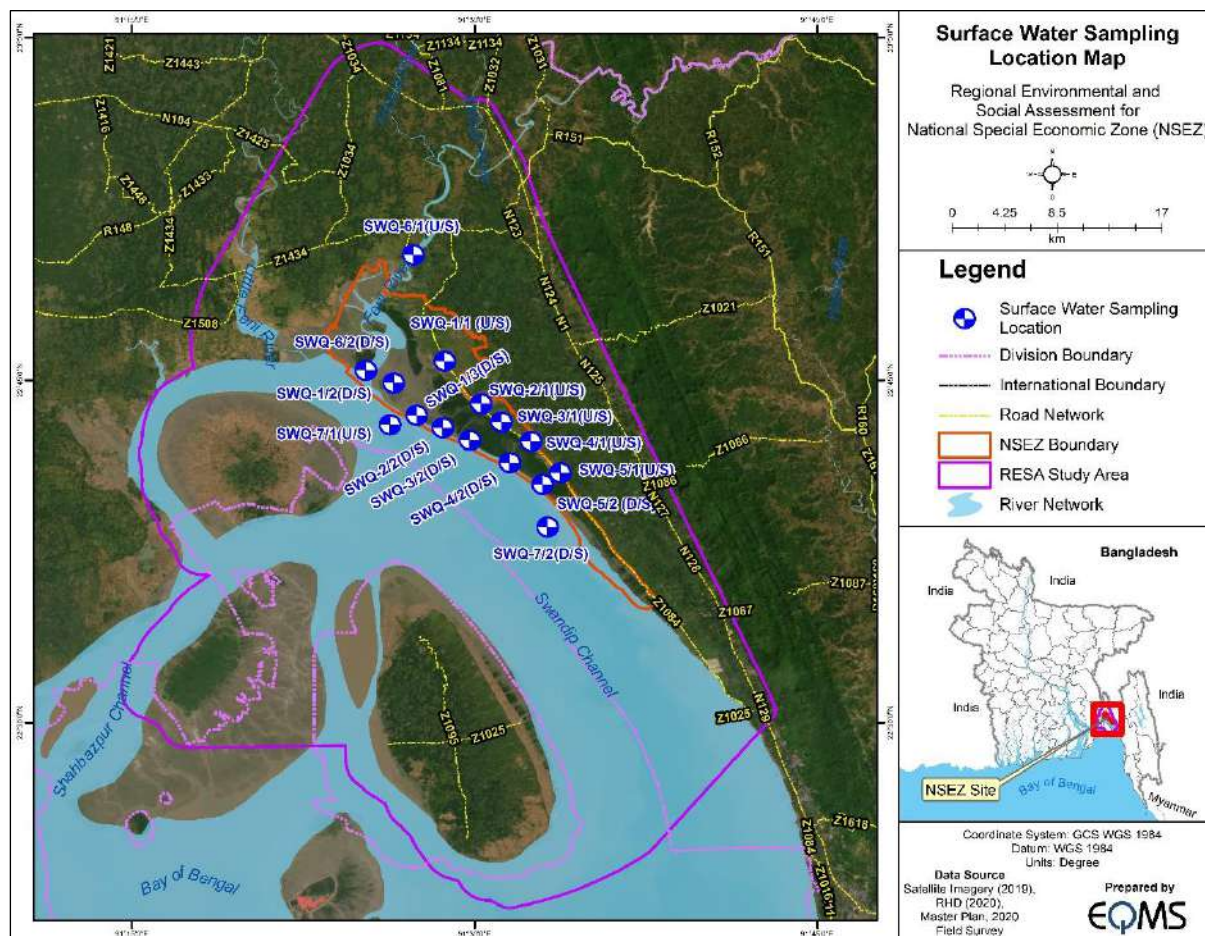
Table 3-25: Surface Water Sampling Locations

Sampling Code	Sampling Locations	Geographical Coordinates	Sampling Date
SWQ-1/1 (U/S)	Close to Ichakhali Khal Sluice Gate in Upstream	22°45'50.064"N 91°28'41.982"E	15/12/2023
SWQ-1/2 (D/S)	Near Ichakhali Khal Sluice gate in downstream	22°44'52.65"N 91°26'27.95"E	15/12/2023
SWQ-1/3 (D/S)	Close to Daborkhali Khal Sluice gate in downstream	22°43'27.576"N 91°27'28.481"E	15/12/2023
SWQ-2/1 (U/S)	Near Bamansundar Khal Sluice gate in Upstream	22°43'57.992"N 91°30'17.918"E	15/12/2023

Sampling Code	Sampling Locations	Geographical Coordinates	Sampling Date
SWQ-2/2 (D/S)	Near Bamansundar Khal Sluice gate in downstream	22°42'54.626"N 91°28'36.85"E	15/12/2023
SWQ-3/1 (U/S)	Near Hoania Khal Sluice gate in Upstream	22°43'10.113"N 91°31'11.309"E	15/12/2023
SWQ-3/2 (D/S)	Near Hoania Khal Sluice gate in downstream	22°42'21.837"N 91°29'48.274"E	15/12/2023
SWQ-4/1 (U/S)	Near Saherkhali Khal Sluice gate in upstream	22°42'19.117"N 91°32'28.728"E	15/12/2023
SWQ-4/2 (D/S)	Near Saherkhali Khal Sluice gate in downstream	22°41'23.281"N 91°31'32.998"E	15/12/2023
SWQ-5/1 (U/S)	Near Domkhali Khal Sluice gate in upstream	22°40'56.512"N 91°33'46.037"E	15/12/2023
SWQ-5/2 (D/S)	Near Domkhali Khal Sluice gate in Downstream	22°40'26.007"N 91°32'59.339"E	15/12/2023
SWQ-6/1 (U/S)	Just behind of New Muhuri Bridge, Muhuri Reservoir, Feni	22°50'29.859"N 91°27'19.327"E	15/12/2023
SWQ-6/2 (D/S)	Feni River (Muhuri Reservoir)	22°45'25.711"N 91°25'14.407"E	30/11/2023
SWQ-7/1 (U/S)	Sandwip Channel	22°43'3.094"N 91°26'17.988"E	30/11/2023
SWQ-7/2 (D/S)	Sandwip Channel	22°38'34.304"N 91°33'11.849"E	30/11/2023

Source: Field Survey by EQMS Team, December 2023

51°50'E	9°42.0'E



Source: Field Survey by EQMS Team, December 2023

Table 3-26: Surface Water Quality Analysis Results (River and Khals)

Sampling Code	Parameters																			
	pH	Salinity	Dissolved Oxygen (DO)	Chemical Oxygen Demand (COD)	Biochemical Oxygen Demand (BOD)	Total Suspended Solids (TSS)	Ammonia (NH ₃)	Phosphate (PO ₄ ³⁻)	Nitrate (NO ₃ ⁻)	Lead (Pb)	Mercury (Hg)	Total Coliform (TC)	Fecal Coliform (FC)	Chromium (Cr)	Cadmium (Cd)	Nickel (Ni)	Iron (Fe)	Manganese (Mn)	Zinc (Zn)	Oil and Grease
	-	ppt	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	n/100 mL	n/100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SWQ-1/1 (U/S)	7.11	2.58	5.7	18	3.6	129	0.44	1.3	2.3	<0.01	<0.001	15	7	0.004	<0.001	0.001	<0.01	<0.01	<0.01	0.57
SWQ-1/2 (D/S)	7.18	2.90	6.2	135	5.8	125	0.65	0.4	0.2	<0.01	<0.001	20	11	0.001	<0.001	0.009	<0.01	<0.01	<0.01	0.85
SWQ-1/3 (D/S)	7.91	2.86	6.3	78	4.5	144	0.30	1.0	4.3	<0.01	<0.001	35	14	0.008	<0.001	0.008	<0.01	<0.01	<0.01	1.14
SWQ-2/1 (U/S)	7.60	2.60	6.1	50	3.2	130	2.99	2.7	1.2	<0.01	<0.001	20	12	0.001	<0.001	0.008	<0.01	<0.01	<0.01	1.14
SWQ-2/2 (D/S)	7.46	2.42	6.8	48	4.0	175	1.86	2.6	0.3	<0.01	<0.001	25	11	0.001	<0.001	0.007	<0.01	<0.01	<0.01	1.20
SWQ-3/1 (U/S)	7.92	1.96	7.2	28	2.5	130	0.35	2.5	<0.01	<0.01	<0.001	35	13	0.008	<0.001	0.001	<0.01	<0.01	<0.01	1.42
SWQ-3/2 (D/S)	7.64	2.61	7.0	31	3.0	163	<0.01	3.5	0.3	<0.01	<0.001	40	27	0.009	<0.001	0.008	<0.01	<0.01	<0.01	1.48
SWQ-4/1 (U/S)	7.62	3.23	6.8	38	2.8	152	0.27	2.3	0.9	<0.01	<0.001	25	14	0.004	<0.001	0.007	<0.01	<0.01	<0.01	1.28
SWQ-4/2 (D/S)	7.65	4.21	7.4	42	2.1	202	0.02	2.1	0.2	<0.01	<0.001	15	7	0.007	<0.001	0.008	<0.01	<0.01	<0.01	1.48
SWQ-5/1 (U/S)	7.65	2.46	7.2	31	2.4	119	1.61	3.9	3.0	<0.01	<0.001	15	9	0.001	<0.001	0.001	<0.01	<0.01	<0.01	1.71
SWQ-5/2 (D/S)	7.61	1.51	7.7	42	2.7	167	1.11	1.2	1.0	<0.01	<0.001	10	4	0.007	<0.001	0.001	<0.01	<0.01	<0.01	2.0
SWQ-6/1 (U/S)	7.64	0.22	7.6	28	3.1	199	0.92	0.9	2.0	<0.01	<0.001	18	8	0.003	<0.001	0.001	<0.01	<0.01	<0.01	1.22
SWQ-6/2 (D/S)	7.12	15.7	6.6	31	2.5	208	<0.01	0.8	2.0	<0.01	<0.001	21	10	0.001	<0.001	0.008	<0.01	<0.01	<0.01	1.28
ECR 2023																				
1. Source of drinking water for supply only after disinfecting	6.5-8.5	-	≥6	10	≤2	-	0.1	0.1	7.0	0.03	0.001	≤100	-	0.02	-	-	-	-	-	-
2. Water usable for recreational activity	6.5-8.5	-	≥5	10	≤3	-	0.3	0.5	7.0	0.05	0.001	≤50	-	0.2	-	-	-	-	-	-
3. Source of drinking water for supply after conventional treatment	6-9	-	≥5	25	≤3	-	0.3	0.5	7.0	0.03	0.001	≤5000	-	0.02	-	-	-	-	-	-
4. Water usable by fisheries	6-9	-	≥5	50	≤6	-	0.3	0.5	7.0	0.1	0.004	≤5000	-	0.05	-	-	-	-	-	-
5. Water usable by various process and cooling industries	6.5-8.5	-	≥1	100	12	-	2.7	-	0	0.1	0.05	-	-	0.1	-	-	-	-	-	-
6. Water usable for irrigation	6.5-8.5	-	-	100	≤12	-	1.5	2.0	5.0	0.1	0.002	≤50000	-	0.1	-	-	-	-	-	-

Source: Laboratory Analysis

Table 3-27: Surface Water Quality Analysis Results (Sandwip Channel)

Sampling Code	Parameters																			
	pH	Salinity	Dissolv ed Oxygen (DO)	Chemic al Oxygen Demand (COD)	Bioche mical Oxygen Demand (BOD)	Total Suspen ded Solids (TSS)	Ammon ia (NH ₃)	Phosph ate (PO ₄ ³⁻)	Nitrate (NO ₃ ⁻)	Lead (Pb)	Mercury (Hg)	Total Colifor m (TC)	Fecal Colifor m (FC)	Chromi um (Cr)	Cadmiu m (Cd)	Nickel (Ni)	Iron (Fe)	Mangan ese (Mn)	Zinc (Zn)	Oil and Grease
	-	ppt	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	n/100 mL	n/100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SWQ-7/1 (U/S)	6.87	16.8	6.0	37	2.3	130	0.11	2.3	0.6	<0.01	<0.001	24	9	0.001	<0.001	0.008	<0.01	<0.01	<0.01	2.28
SWQ-7/2 (D/S)	7.05	16.3	6.3	44	2.4	132	0.21	2.0	0.6	<0.01	<0.001	28	4	0.002	<0.001	0.004	<0.01	<0.01	<0.01	3.14
ECR 2023																				
Coral Community	7.5-8.5	-	≥ 5	2	-	2	-	0.04	-	0.05	0.0001	1000	200	0.05	0.005	-	-	-	-	0.01
Natural Area	6.5-8.5	-	≥ 5	8	-	25	-	0.05	-	0.05	0.0001	1000	200	0.05	0.005	-	-	-	-	0.01
Industries and Others	6.5-9.0	-	≥ 4	5	-	100	-	0.1	-	-	0.0001	-	-	0.1	0.005	-	-	-	-	5.0

Source: Laboratory Analysis

3.2.14.6.2 Result Discussion

The results for the surface water samples of khals were compliant with the use for different purposes as per the standards of ECR 2023, Schedule 2(A): Standards for Surface Water (Inland Surface Water). The results for the surface water samples of Sandwip Channel were compared with standards for coastal water (Schedule 2(B), ECR 2023). The laboratory test report has been presented in Appendix D.

3.2.14.6.2.1 Water Quality of River and Khals

- **pH:** pH concentrations in the surface water samples were in the range between 7.11 to 7.92. The maximum pH (7.92) was observed at SWQ-3/1 (U/S) and the minimum (7.11) was observed at SWQ-1/1 (U/S). All the sampling results were within the permissible limit of ECR, 2023 standard for inland surface water pH.
- **Salinity:** Salinity concentrations in the surface water samples were in the range between 0.22 ppt to 15.7 ppt. The maximum salinity (15.7 ppt) was observed at SWQ-6/2 (D/S) and the minimum (0.22 ppt) was observed at SWQ-6/1 (U/S). There are no standards in ECR 2023 for inland surface water salinity.
- **Dissolve Oxygen (DO):** DO concentrations in the surface water samples were in the range between 5.7 mg/L to 7.7 mg/L. The maximum DO (7.7 mg/L) was observed at SWQ-5/2 (D/S) and the minimum (5.7 mg/L) was observed at SWQ-1/1 (U/S). All the sampling results met the permissible limit of the ECR, 2023 standard for inland surface water DO.
- **Chemical Oxygen Demand (COD):** COD concentrations in the surface water samples were in the range between 18 mg/L to 135 mg/L. The maximum COD (135 mg/L) was observed at SWQ-1/2 (D/S) and the minimum (18 mg/L) was observed at SWQ-1/1 (U/S). Values at SWQ-1/2 (D/S) exceeded the permissible limit of the ECR, 2023 standard.
- **Biochemical Oxygen Demand (BOD):** BOD concentrations in the surface water samples were in the range between 2.1 mg/L to 5.8 mg/L. The maximum BOD (5.8 mg/L) was observed at SWQ-1/2 (D/S) and the minimum (2.1 mg/L) was observed at SWQ-4/2 (D/S).
- **Total Suspended Solids (TSS):** TSS concentrations in the surface water samples were in the range between 119 mg/L to 208 mg/L. The maximum TSS (208 mg/L) was observed at SWQ-6/2 (D/S) and the minimum (119 mg/L) was observed at SWQ-5/1 (U/S). There are no standards in ECR 2023 for inland surface water TSS.
- **Ammonia (NH₃):** Ammonia concentrations in the surface water samples were in the range between <0.01 mg/L to 2.99 mg/L. The maximum NH₃ (2.99 mg/L) was observed at SWQ-2/1 (U/S) and the minimum (<0.01 mg/L) was observed at SWQ-3/2 (D/S) and SWQ-6/2 (D/S). All the sampling results were within the permissible limit of the ECR, 2023 standard for inland surface water NH₃.
- **Phosphate (PO₄³⁻):** Phosphate concentrations in the surface water samples were in the range between 0.4 mg/L to 3.9 mg/L. The maximum PO₄³⁻ (3.9 mg/L) was observed at SWQ-5/1 (U/S) and the minimum (0.4 mg/L) was observed at SWQ-1/2 (D/S). Values at SWQ-2/1 (U/S), SWQ-2/2 (D/S), SWQ-3/1 (U/S), SWQ-3/2 (D/S), SWQ-4/1 (U/S), SWQ-4/2 (D/S), and SWQ-5/1 (U/S), exceeded the permissible limit of ECR, 2023 standard.
- **Nitrate (NO₃⁻):** Nitrate concentrations in the surface water samples were in the range between <0.01 mg/L to 4.3 mg/L. The maximum NO₃⁻ (4.3 mg/L) was observed at SWQ-1/3 (D/S) and the minimum (<0.01 mg/L) was observed at SWQ-3/1 (U/S). All the sampling results were within the permissible limit of ECR, 2023 standard for NO₃⁻.
- **Lead (Pb):** Lead concentrations in all the surface water samples were observed as <0.01 mg/L. All the sampling results were within the permissible limit of the ECR, 2023 standard for Pb.

- **Mercury (Hg):** Mercury concentrations in all the surface water samples were observed as <0.001 mg/L. All the sampling results were within the permissible limit of ECR, 2023 standard for Hg.
- **Total Coliform (TC):** Total Coliform concentrations in the surface water samples were in the range between 10 n/100 mL to 40 n/100 mL. The maximum TC (40 n/100 mL) was observed at SWQ-3/2 (D/S) and the minimum (10 n/100 mL) was observed at SWQ-5/2 (D/S). All the sampling results were within the permissible limit of ECR, 2023 standard for TC.
- **Fecal Coliform (FC):** Fecal Coliform concentrations in the surface water samples were in the range between 4 n/100 mL to 27 n/100 mL. The maximum FC (27 n/100 mL) was observed at SWQ-3/2 (D/S) and the minimum (4 n/100 mL) was observed at SWQ-5/2 (D/S). There are no standards in ECR 2023 for inland surface water FC.
- **Chromium (Cr):** Chromium concentrations in all the surface water samples were in the range between 0.001 mg/L to 0.009 mg/L. The maximum Cr (0.009 mg/L) was observed at SWQ-3/2 (D/S) and the minimum (0.001 mg/L) was observed at SWQ-1/2 (D/S), SWQ-2/1 (U/S), SWQ-2/2 (D/S), SWQ-5/1 (U/S), and SWQ-6/2 (D/S). All the sampling results were within the permissible limit of ECR, 2023 standard for Cr.
- **Cadmium (Cd):** Cadmium concentrations in all the surface water samples were observed as <0.001 mg/L. There are no standards in ECR 2023 for inland surface water Cd.
- **Nickel (Ni):** Nickel concentrations in all the surface water samples were in the range between 0.001 mg/L to 0.009 mg/L. The maximum Ni (0.009 mg/L) was observed at SWQ-1/2 (D/S) and the minimum (0.001 mg/L) was observed at SWQ-1/1 (U/S), SWQ-3/1 (U/S), SWQ-5/1 (U/S), SWQ-5/2 (D/S), and SWQ-6/1 (U/S). There are no standards in ECR 2023 for inland surface water Ni.
- **Iron (Fe):** Iron concentrations in all the surface water samples were observed as <0.01 mg/L. There are no standards in ECR 2023 for inland surface water Fe.
- **Manganese (Mn):** Manganese concentrations in all the surface water samples were observed as <0.01 mg/L. There are no standards in ECR 2023 for inland surface water Mn.
- **Zinc (Zn):** Zinc concentrations in all the surface water samples were observed as <0.01 mg/L. There are no standards in ECR 2023 for inland surface water Zn.
- **Oil and Grease:** Oil and grease concentrations in all the surface water samples were in the range between 0.57 mg/L to 2.0 mg/L. The maximum oil and grease (2.0 mg/L) was observed at SWQ-5/2 (D/S) and the minimum (0.57 mg/L) was observed at SWQ-1/1 (U/S). There are no standards in ECR 2023 for inland surface water Oil and grease.

3.2.14.6.2.2 Water Quality of Sandwip Channel

- **pH:** pH concentrations in the surface water samples of Sandwip Channel were in the range between 6.87 to 7.05. All the sampling results were within the permissible limit of ECR, 2023 standard for coastal surface water pH.
- **Salinity:** Salinity concentrations in the surface water samples of Sandwip Channel were in the range between 16.3 ppt to 16.8 ppt. There are no standards in ECR 2023 for coastal surface water salinity.
- **Dissolve Oxygen (DO):** DO concentrations in the surface water samples were in the range between 6.0 mg/L to 6.3 mg/L. All the sampling results met the permissible limit of the ECR, 2023 standard for coastal surface water DO.
- **Chemical Oxygen Demand (COD):** COD concentrations in the surface water samples were in the range between 37 mg/L to 44 mg/L. Values at both samples exceeded the permissible limit of the ECR, 2023 standard.

- **Biochemical Oxygen Demand (BOD):** BOD concentrations in the surface water samples were in the range between 2.3 mg/L to 2.4 mg/L. There are no standards in ECR 2023 for coastal surface water BOD.
- **Total Suspended Solids (TSS):** TSS concentrations in the surface water samples were in the range between 130 mg/L to 132 mg/L. The values of both samples exceeded the permissible limits of the coastal water standards in ECR 2023.
- **Ammonia (NH₃):** Ammonia concentrations in the surface water samples were in the range between 0.11 mg/L to 0.21 mg/L. There are no standards in ECR 2023 for coastal surface water NH₃.
- **Phosphate (PO₄³⁻):** Phosphate concentrations in the surface water samples were in the range between 2.0 mg/L to 2.3 mg/L. Values of both samples exceeded the permissible limit of ECR, 2023 standard.
- **Nitrate (NO₃⁻):** Nitrate concentrations in the surface water samples were 0.6 mg/L. There are no standards in ECR 2023 for coastal surface water NO₃⁻.
- **Lead (Pb):** Lead concentrations in all the surface water samples were observed as <0.01 mg/L. All the sampling results were within the permissible limit of the ECR, 2023 standard for Pb.
- **Mercury (Hg):** Mercury concentrations in all the surface water samples were observed as <0.001 mg/L. All the sampling results were within the permissible limit of ECR, 2023 standard for Hg.
- **Total Coliform (TC):** Total Coliform concentrations in the surface water samples were in the range between 24 n/100 mL to 28 n/100 mL. All the sampling results were within the permissible limit of ECR, 2023 standard for coastal surface water TC.
- **Fecal Coliform (FC):** Fecal Coliform concentrations in the surface water samples were in the range between 4 n/100 mL to 9 n/100 mL. All the sampling results were within the permissible limit of ECR, 2023 standard for coastal surface water FC.
- **Chromium (Cr):** Chromium concentrations in all the surface water samples were in the range between 0.001 mg/L to 0.002 mg/L. All the sampling results were within the permissible limit of ECR, 2023 standard for coastal surface water Cr.
- **Cadmium (Cd):** Cadmium concentrations in all the surface water samples were observed as <0.001 mg/L. All the sampling results were within the permissible limit of ECR, 2023 standard for coastal surface water Cd.
- **Nickel (Ni):** Nickel concentrations in all the surface water samples were in the range between 0.004 mg/L to 0.008 mg/L. There are no standards in ECR 2023 for coastal surface water Ni.
- **Iron (Fe):** Iron concentrations in all the surface water samples were observed as <0.01 mg/L. There are no standards in ECR 2023 for coastal surface water Fe.
- **Manganese (Mn):** Manganese concentrations in all the surface water samples were observed as <0.01 mg/L. There are no standards in ECR 2023 for coastal surface water Mn.
- **Zinc (Zn):** Zinc concentrations in all the surface water samples were observed as <0.01 mg/L. There are no standards in ECR 2023 for coastal surface water Zn.
- **Oil and Grease:** Oil and grease concentrations in all the surface water samples were in the range between 2.28 mg/L to 3.14 mg/L. Values of both samples exceeded the permissible limit of ECR, 2023 standard.

3.2.14.7 Groundwater Water Quality – Secondary

To understand the historical groundwater quality baseline condition of the study region, an extensive secondary documentation review was conducted by the RESA Consultant. From the secondary literature review, a total of 30 groundwater quality monitoring results have been identified in the study region. A summary of the analysis of the secondary groundwater quality has been presented below and a summary of collected baseline data has been provided in Annex-B.

- **Arsenic (As):** Arsenic concentrations in the groundwater samples were in the range between <0.001 mg/L to 0.4 mg/L. The maximum As (0.4 mg/L) was observed at GWQ-26 (TTW-8 Chunimidhir Tek) and the minimum (<0.001 mg/L) was observed at GWQ-1 (Barotakia Bazar), GWQ-3 (Moddho Maghadia), and GWQ-4 (CP More). Values at GWQ-2 (Dakhin Maghadia) and GWQ-26 (TTW-8 Chunimidhir Tek) exceeded the permissible limit of ECR, 2023 standard of 0.05 mg/L. In addition, values at GWQ-2 (Dakhin Maghadia), GWQ-15 (Sample-2 Muhuri Irrigation Project), and GWQ-26 (TTW-8 Chunimidhir Tek) exceeded the permissible limit of WHO guideline of 0.01 mg/L.
- **Boron (B):** Boron concentrations in the groundwater samples were in the range of 0.2 mg/L to 0.22 mg/L. The maximum Boron (0.22 mg/L) was observed at GWQ-16 (Muhuri Irrigation Project) and the minimum (0.2 mg/L) was observed at GWQ-14 and GWQ-15 (Muhuri Irrigation Project). Boron concentration in all the samples was in compliance with the ECR, 2023 standard of 1.0 mg/L and WHO guideline of 2.4 mg/L.
- **Cadmium (Cd):** Cadmium was observed to be <0.001 mg/L. Cd concentration in the samples was in compliance with the ECR, 2023 standard of 0.003 mg/L and WHO standard of 0.003 mg/L.
- **Calcium (Ca):** Calcium concentrations in the groundwater samples were in the range of 9 mg/L to 132 mg/L. The maximum Ca (132 mg/L) was observed at GWQ-11 (Site 1 - Ground Water Quality (EZ)) and the minimum (9 mg/L) was observed at GWQ-14 and GWQ-16 (Muhuri Irrigation Project). Ca concentration in all the samples except GWQ-11 (Site 1-Ground Water Quality (EZ)) and GWQ-12 (Site 2-Ground Water Quality (EZ)) were in compliance with the ECR, 2023 standard of 75 mg/L.
- **Chloride (Cl-):** Chloride concentrations in the groundwater samples were in the range of 11 mg/L to 12,275 mg/L. The maximum Cl- (12,275 mg/L) was observed at GWQ-18 (Musapur Bridge, Little Feni River) and the minimum (11 mg/L) was observed at GWQ-19 (TTW-1 Banatoli) and GWQ-20 (TTW-2 Dhumkhali). Cl- concentration in the samples at GWQ-8 (Intake Point Osmanpur), GWQ-11 (Site 1-Ground Water Quality (EZ)), GWQ-12 (Site 2-Ground Water Quality (EZ)), GWQ-13 (Site 3- Ground Water Quality (EZ)), GWQ-18 (Musapur Bridge, Little Feni River), GWQ-26 (TTW-8 Chunimidhir Tek), GWQ-27 (TTW-9 NW Side of Cyclone Centre), and GWQ-29 (TTW-DPHE-01) exceeds the permissible limit of ECR, 2023 standard of 250 mg/L.
- **Chromium (Cr):** Chromium concentrations in the groundwater samples were in the range of <0.001 mg/L to 0.108 mg/L. The maximum Cr (0.108 mg/L) was observed at GWQ-17 (Musapur Bridge, Little Feni River) and the minimum (<0.001 mg/L) was observed at GWQ-18 (Musapur Bridge, Little Feni River). Cr concentration in all the samples except GWQ-17 (Musapur Bridge, Little Feni River) was in compliance with the ECR, 2023 standard of 0.05 mg/L and WHO standard of 0.05 mg/L.
- **Copper (Cu):** Copper was observed to be 0.006 mg/L at GWQ-17. Cu concentration in the samples was in compliance with the ECR, 2023 standard of 1.5 mg/L and WHO standard of 2.0 mg/L.
- **Fecal Coliform (FC):** FC was observed to be 128 CFU/100 mL at GWQ-18. FC concentration in the sample exceeds the permissible limit of ECR, 2023 standard of 0 CFU/100 mL.
- **Fluoride (F-):** Fluoride was observed to be 0.14 mg/L at GWQ-7. F- concentration in the sample was in compliance with the ECR, 2023 standard of 1.0 mg/L and WHO standard of 1.5 mg/L.
- **Hardness:** Hardness concentrations in the groundwater samples were in the range of 36 mg/L to 3,750 mg/L. The maximum Hardness (3,750 mg/L) was observed at GWQ-18 (Musapur Bridge, Little Feni River) and the minimum (36 mg/L) was observed at GWQ-14 (Sample-1 Muhuri Irrigation Project). Hardness concentration in all the samples except GWQ-18 (Musapur Bridge, Little Feni River) was in compliance with the ECR, 2023 standard of 500 mg/L.

- **Iron (Fe):** Iron concentrations in the groundwater samples were in the range of 0.5 mg/L to 31.02 mg/L. The maximum Fe (31.02 mg/L) was observed at GWQ-5 (Ichhakhali) and the minimum (0.5 mg/L) was observed at GWQ-22 (TTW-4 Near CP more). Fe concentration in the samples GWQ-7 (Near Ichhakhali Sluice Gate), GWQ-9 (WTP Site NSEZ), GWQ-10 (Mirsharai 2 Economic Zone), GWQ-17 (Musapur Bridge, Little Feni River), and GWQ-22 (TTW-4 Near CP more) were in compliance with the ECR, 2023 standard of 0.3-1.0 mg/L. Except these all samples exceed the permissible limit of the ECR, 2023 standard.
- **Lead (Pb):** Lead concentrations in the groundwater samples were in the range of <0.001 mg/L to 0.068 mg/L. The maximum Pb (0.068 mg/L) was observed at GWQ-7 (Near Ichhakhali Sluice Gate) and the minimum (<0.001 mg/L) was observed at GWQ-1 (Barotakia Bazar), GWQ-2 (Dakhin Maghadia), GWQ-3 (Moddho Moghadia), GWQ-4 (CP More), GWQ-17 (Musapur Bridge, Little Feni River), and GWQ-18 (Musapur Bridge, Little Feni River). Pb concentration in all the samples except GWQ-7 (Near Ichhakhali Sluice Gate) was in compliance with the ECR, 2023 standard of 0.01 mg/L and WHO standard of 0.01 mg/L.
- **Magnesium (Mg):** Magnesium concentrations in the groundwater samples were in the range of 6 mg/L to 789.6 mg/L. The maximum Mg (789.6 mg/L) was observed at GWQ-18 (Musapur Bridge, Little Feni River) and the minimum (6 mg/L) was observed at GWQ-7 (Near Ichhakhali Sluice Gate) and GWQ-14 (Sample-1 Muhuri Irrigation Project). Mg concentration in all the samples except GWQ-12 (Site 2- Ground Water Quality (EZ)), GWQ-13 (Site 3- Ground Water Quality (EZ)) and GWQ-18 (Musapur Bridge, Little Feni River) was in compliance with the ECR, 2023 standard of 30-35 mg/L.
- **Manganese (Mn):** Manganese concentrations in the groundwater samples were in the range of 0.04 mg/L to 0.4 mg/L. The maximum Mn (0.4 mg/L) was observed at GWQ-26 (TTW-8 Chunimidhir Tek) and the minimum (0.04 mg/L) was observed at GWQ-7 (Near Ichhakhali Sluice Gate). Mn concentration in all the samples except GWQ-18 (Musapur Bridge, Little Feni River) was in compliance with the ECR, 2023 standard of 0.40 mg/L.
- **Mercury (Hg):** Mercury concentrations in the groundwater samples were in the range of <0.001 mg/L to 0.0017 mg/L. The maximum Hg (0.0017 mg/L) was observed at GWQ-1 (Barotakia Bazar) and the minimum (0.001 mg/L) was observed at GWQ-17 and GWQ-18 (Musapur Bridge, Little Feni River). Hg concentration in all the samples was in compliance with the ECR, 2023 standard of 0.001 mg/L and WHO standard of 0.006 mg/L.
- **Nickel (Ni):** Nickel was observed to be 0.011 mg/L at GWQ-18 (Musapur Bridge, Little Feni River). Ni concentration in the sample was in compliance with the ECR, 2023 standard of 0.05 mg/L and WHO standard of 0.07 mg/L.
- **Nitrate (NO₃):** Nitrate concentrations in the groundwater samples were in the range of 0.1 mg/L to 1.5 mg/L. The maximum NO₃ (1.5 mg/L) was observed at GWQ-6 (Shonagazi, Feni) and the minimum (0.1 mg/L) was observed at GWQ-18 (Musapur Bridge, Little Feni River). NO₃ concentration in all the samples was in compliance with the ECR, 2023 standard of 45 mg/L and WHO standard of 50 mg/L.
- **pH:** pH of the groundwater samples was recorded in the range of 6.45 to 8.15. pH values of all samples were in compliance with the Schedule 2B of ECR, 2023 standard of 6.5 - 8.5.
- **Potassium (K):** Potassium concentrations in the groundwater samples were in the range of 3.3 mg/L to 4.1 mg/L. The maximum K (4.1 mg/L) was observed at GWQ-15 (Sample-2 Muhuri Irrigation Project) and the minimum (3.3 mg/L) was observed at GWQ-14 (Sample-1 Muhuri Irrigation Project). K concentration in all the samples was in compliance with the ECR, 2023 standard of 12 mg/L.
- **Sodium (Na):** Sodium concentrations in the groundwater samples were in the range of 50.6 mg/L to 87.3 mg/L. The maximum Na (87.3 mg/L) was observed at GWQ-15 (Sample-2 Muhuri Irrigation Project) and the minimum (50.6 mg/L) was observed at GWQ-14 (Sample-1 Muhuri Irrigation Project). Na concentration in all the samples was in compliance with the ECR, 2023

standard of 200 mg/L. In addition, values at GWQ-14 (Sample-1 Muhuri Irrigation Project), GWQ-15 (Sample-2 Muhuri Irrigation Project), and GWQ-16 (Sample-3 Muhuri Irrigation Project) exceed the permissible limits of WHO standard of 50 mg/L.

- **Total Coliform (TC):** Total Coliform was observed to be 262 CFU/100 mL at GWQ-17 (Musapur Bridge, Little Feni River). TC concentration in the sample exceeded the permissible limits of the ECR, 2023 standard of 0 CFU/100 mL.
- **Total Dissolved Solids (TDS):** Total Dissolved Solids concentrations in the groundwater samples were in the range of 171 mg/L to 22,068 mg/L. The maximum TDS (22,068 mg/L) was observed at GWQ-18 (Musapur Bridge, Little Feni River) and the minimum (171 mg/L) was observed at GWQ-4 (CP More). Na concentration in all the samples except GWQ-18 (Musapur Bridge, Little Feni River) was in compliance with the ECR, 2023 standard of 1,000 mg/L.
- **Turbidity:** Turbidity values of groundwater samples were recorded in a range of 2.22 to 616 NTU. The maximum turbidity (616 NTU) was observed at GWQ-18 (Musapur Bridge, Little Feni River) and the minimum (2.22 NTU) was observed at GWQ-6 (Shonagazi, Feni). Turbidity concentration in all the samples except GWQ-17 (Musapur Bridge, Little Feni River) and GWQ-18 (Musapur Bridge, Little Feni River) was in compliance with the ECR, 2023 standard of 5 NTU.
- **Zinc (Zn):** Zn values of groundwater samples were recorded in a range of <0.001 to 0.128 mg/L. The maximum Zn (0.128 mg/L) was observed at GWQ-17 (Musapur Bridge, Little Feni River) and the minimum (0.001 mg/L) was observed at GWQ-18 (Musapur Bridge, Little Feni River). Zn concentration in all the samples was in compliance with the ECR, 2023 standard of 5 mg/L.

3.2.14.8 Groundwater Water Quality – Primary

Groundwater is most important for drinking, household uses, commercial activities, and irrigation purposes. Five groundwater samples were collected from the study region. After collection, the groundwater samples were sent to the laboratory for further examination of the groundwater parameters. The groundwater quality monitoring locations were selected taking into account the following:

- Location of sensitive receptors such as major settlements.
- Future development plans in the region such as road network, railways, water extraction, etc.
- Future use of groundwater in different upcoming projects in the region.
- Representativeness of regional groundwater quality for obtaining baseline status.
- Representativeness of likely impact areas.

Details of the groundwater sampling locations are presented in Table 3-28 and the groundwater sampling location map is shown in Figure 3-42. The photographs of groundwater sampling are presented in Appendix A-6.4.

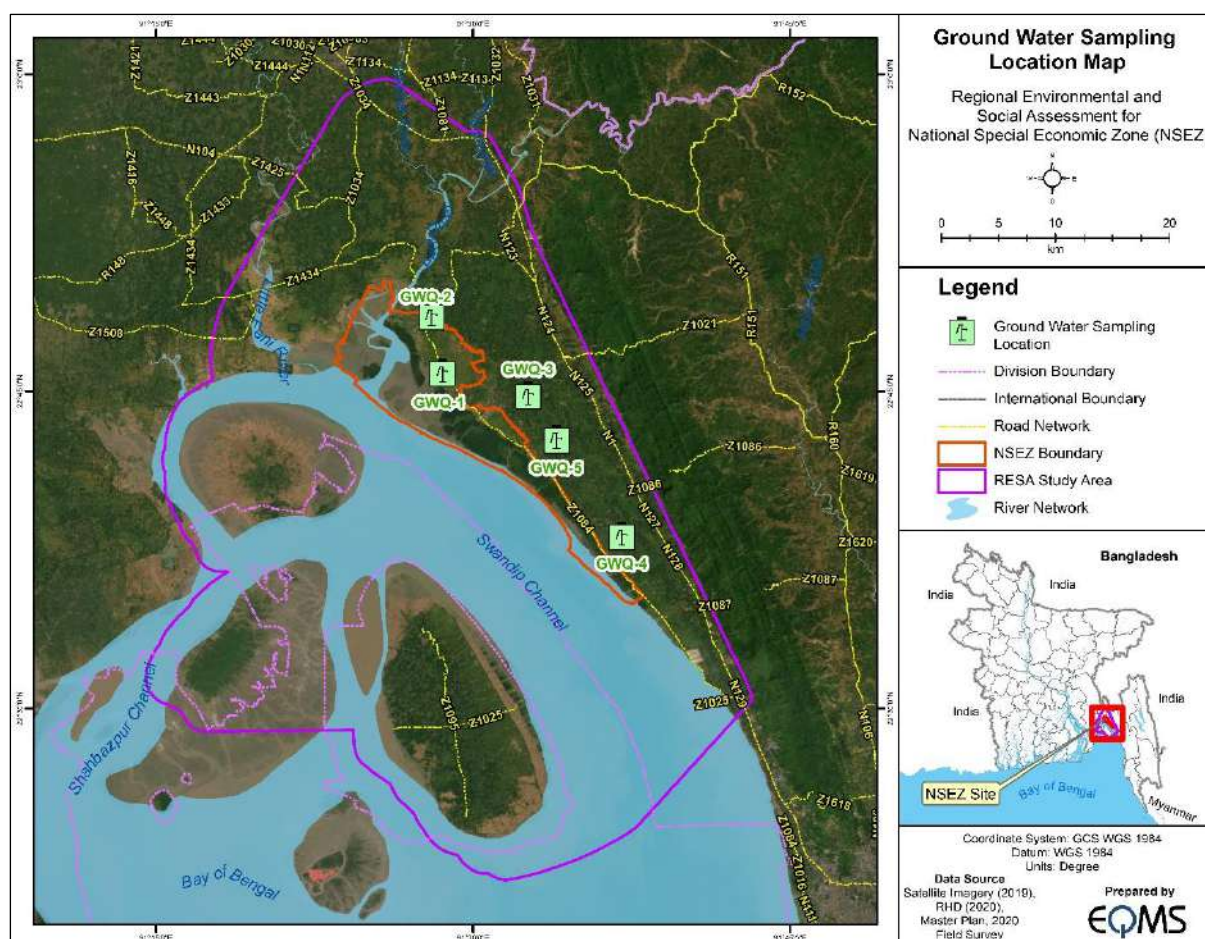
Table 3-28: Groundwater Sampling Locations

Sampling Code	Sampling Locations	Geographical Coordinates	Sampling Date
GWQ-1	Inside of Assistant Engineer Office, DPHE, NSEZ	22°45'48.471"N 91°28'33.781"E	16/12/2023
GWQ-2	In front of the cyclone center, Takerhat Bazar, Jorargong, Mirsharai, Chattogram	22°48'29.496"N 91°28'02.632"E	16/12/2023
GWQ-3	Hamidul Hoque Mistry House, Mia Para, Maghadia, Mirsharai, Chattogram	22°44'44.213"N 91°32'36.254"E	16/12/2023

Sampling Code	Sampling Locations	Geographical Coordinates	Sampling Date
GWQ-4	New house of Abul Khayar, North-West Saidpur, Sitakunda, Chattogram	22°38'05.053"N 91°37'01.750"E	16/12/2023
GWQ-5	In front of Madina Supermarket (20 meters away from East Saherkhali Govt. Primary School), Saherkhali Bazar Circle, Mirsharai, Chattogram	22°42'39.819"N 91°33'56.480"E	16/12/2023

Source: Field Survey by EQMS Team, December 2023

Figure 3-42: Groundwater Sampling Locations



Source: Field Survey by EQMS Team, December 2023

The results for the groundwater samples analyzed are presented in Table 3-29.

Table 3-29: Groundwater Quality Analysis Results

Parameters	Unit	Sampling Code					Standards	
		GWQ-1	GWQ-2	GWQ-3	GWQ-4	GWQ-5	ECR '23	WHO
Aluminum (Al)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.2	-
Ammonia (NH ₃)	mg/L	0.03	0.21	0.08	0.13	0.14	1.5	-
Arsenic (As)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.01

Parameters	Unit	Sampling Code					Standards	
		GWQ-1	GWQ-2	GWQ-3	GWQ-4	GWQ-5	ECR '23	WHO
Boron (B)	mg/L	<0.2	0.67	1.03	<0.2	<0.5	1	-
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.003
Calcium (Ca)	mg/L	51	57	47	45	48	75	-
Chloride	mg/L	9	60	150	24	6	250	-
Chromium (Cr)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	0.05	0.05
Copper (Cu)	mg/L	0.02	0.09	0.09	0.16	0.05	1.5	2
Fecal Coliform	n/100 mL	0	0	0	0	0	0	0
Total Coliform	n/100 mL	0	0	0	0	0	0	0
Fluoride	ppm	0.02	0.06	0.04	0.04	0.06	1	1.5
Hardness (as CaCO ₃)	mg/L	148	176	169	90	64	500	-
Iron (Fe)	mg/L	0.7	2.31	0.27	0.14	0.11	0.3-1.0	-
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01
Magnesium (Mg)	mg/L	32	35	37	26	21	30-35	-
Manganese (Mn)	mg/L	0.2	0.4	0.2	0.1	0.1	0.4	-
Mercury (Hg)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001
Nickel (Ni)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.02
Nitrate (NO ₃ ⁻)	mg/L	0.8	35	9.5	1	3.8	45	50
Nitrite (NO ₂ ⁻)	mg/L	<0.01	0.09	0.05	<0.01	0.08	1	3
pH	-	8.41	8.4	8.5	8.48	8.46	6.5-8.5	6.5-8.5
Potassium (K)	mg/L	10.1	9.5	8.6	7.7	6.8	12	-
Salinity	ppt	0.27	0.83	1.53	0.56	0.39	-	-
Sodium (Na)	mg/L	74.2	240	171	248	176	200	-
Total Dissolved Solids (TDS)	mg/L	290	850	1590	600	410	1000	-
Turbidity	NTU	1.8	4.4	0.6	0.4	0.1	5	-
Zinc (Zn)	mg/L	0.2	0.4	0.3	0.2	0.5	5	-

Source: Laboratory Analysis

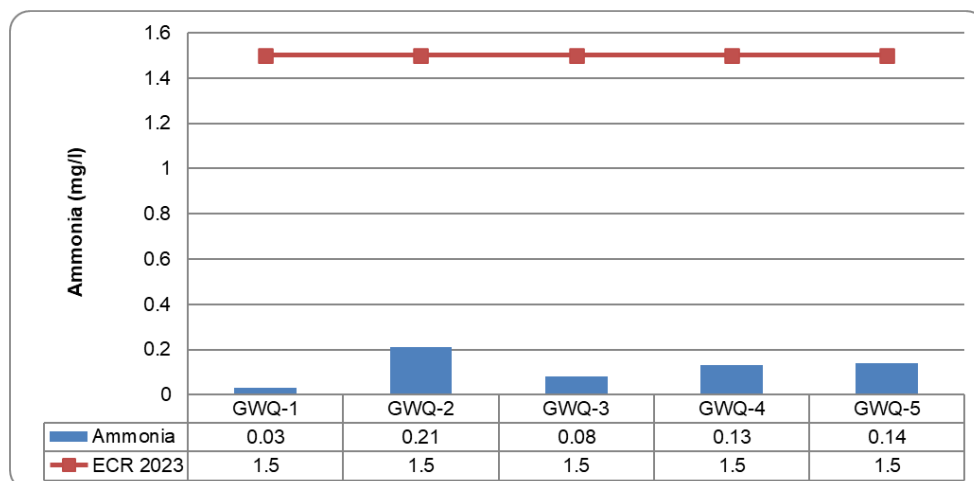
3.2.14.8.1 Result Discussion

The results were compared with the standards of ECR 2023, Schedule-2 (2) (Standards for Drinking Water), and WHO standards. The laboratory test report has been presented in Appendix D.

- **Aluminum (Al):** Aluminum concentrations in all the groundwater samples were observed as <0.01 mg/L. All the sampling results were within the permissible limit of the ECR, 2023 standard of 0.2 mg/L. In addition, WHO Guidelines has no standard value for Al.

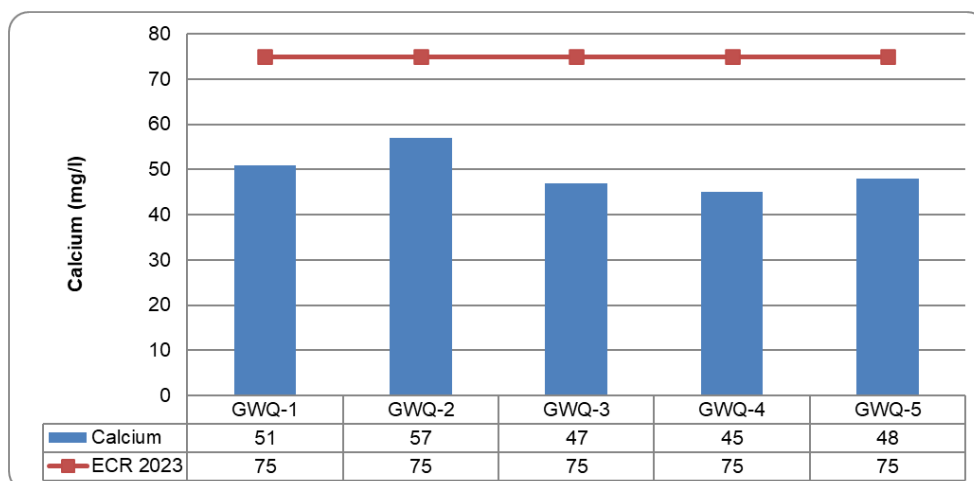
- **Ammonia (NH₃):** Ammonia concentrations in the groundwater samples were in the range between 0.03 mg/L to 0.21 mg/L. The maximum NH₃ (0.21 mg/L) was observed at GWQ-2 and the minimum (0.03 mg/L) was observed at GWQ-1. All the sampling results were within the permissible limit of the ECR, 2023 standard of 1.5 mg/L. In addition, WHO Guidelines has no standard value for NH₃. The concentration of NH₃ in the Groundwater is presented in Figure 3-43.

Figure 3-43: Concentration of Ammonia



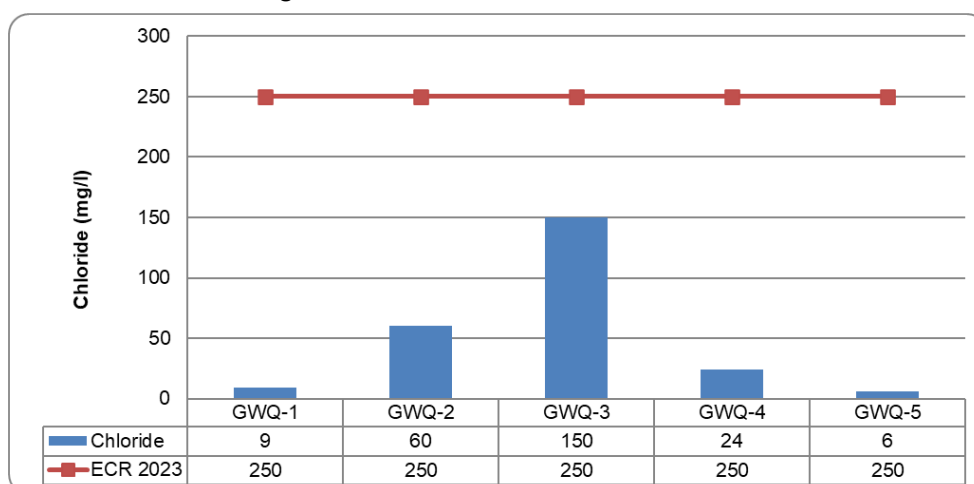
Source: Field Survey by EQMS Team, December 2023

- **Arsenic (As):** Arsenic concentrations in all the groundwater samples were observed as <0.01 mg/L. All the sampling results were within the permissible limit of ECR, 2023 standard of 0.05 mg/L and the WHO Guidelines of 0.01 mg/L for As.
- **Boron (B):** Boron concentrations in the groundwater samples were in the range between <0.2 mg/L to 1.03 mg/L. The maximum B (1.03 mg/L) was observed at GWQ-3 and the minimum (<0.2 mg/L) was observed at GWQ-1 and GWQ-4. Values at GWQ-3 exceeded the permissible limit of the ECR, 2023 standard of 1 mg/L. In addition, WHO Guidelines has no standard value for B.
- **Cadmium (Cd):** Cadmium concentrations in all the groundwater samples were observed as <0.001 mg/L. All the sampling results were within the permissible limit of ECR, 2023 standard of 0.003 mg/L and the WHO Guidelines of 0.01 mg/L for Cd.
- **Calcium (Ca):** Calcium concentrations in the groundwater samples were in the range between 45 mg/L to 57 mg/L. The maximum Ca (57 mg/L) was observed at GWQ-2 and the minimum (45 mg/L) was observed at GWQ-4. All the sampling results were within the permissible limit of the ECR, 2023 standard of 75 mg/L for Ca. In addition, WHO Guidelines has no standard value for Ca. The concentration of Ca in the Groundwater is presented in Figure 3-44.

Figure 3-44: Concentration of Calcium

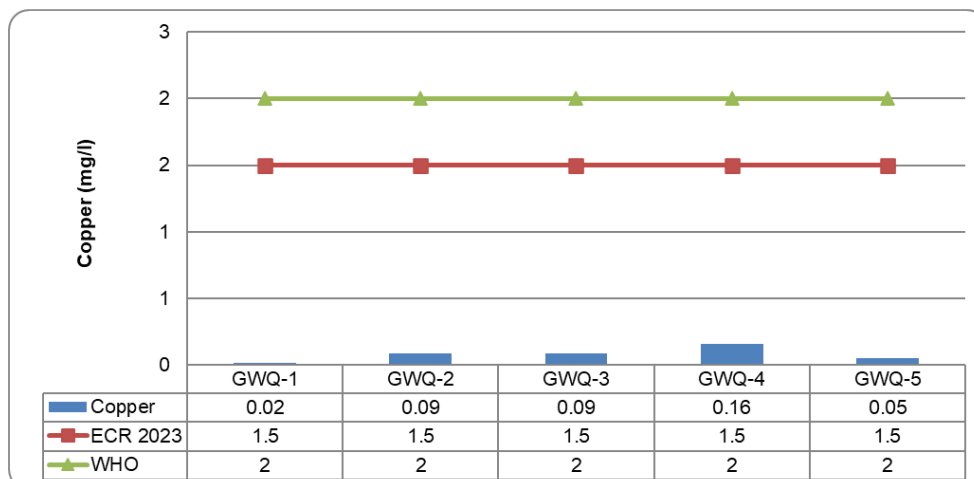
Source: Field Survey by EQMS Team, December 2023

- Chloride (Cl⁻):** Chloride concentrations in the groundwater samples were in the range between 6 mg/L to 150 mg/L. The maximum Cl⁻ (150 mg/L) was observed at GWQ-3 and the minimum (6 mg/L) was observed at GWQ-5. All the sampling results were within the permissible limit of the ECR, 2023 standard of 250 mg/L for Cl⁻. In addition, WHO Guidelines has no standard value for Cl⁻. The concentration of Cl⁻ in the Groundwater is presented in Figure 3-45.

Figure 3-45: Concentration of Chloride

Source: Field Survey by EQMS Team, December 2023

- Chromium (Cr):** Chromium concentrations in all the groundwater samples were observed as <0.005 mg/L. All the sampling results were within the permissible limit of ECR, 2023 standard of 0.05 mg/L and the WHO Guidelines of 0.05 mg/L for Cr.
- Copper (Cu):** Copper concentrations in the groundwater samples were in the range between 0.02 mg/L to 0.16 mg/L. The maximum Cu (0.16 mg/L) was observed at GWQ-4 and the minimum (0.02 mg/L) was observed at GWQ-1. All the sampling results were within the permissible limit of ECR, 2023 standard of 1.5 mg/L and the WHO Guidelines of 2 mg/L for Cu. The concentration of Cu in the Groundwater is presented in Figure 3-46.

Figure 3-46: Concentration of Copper

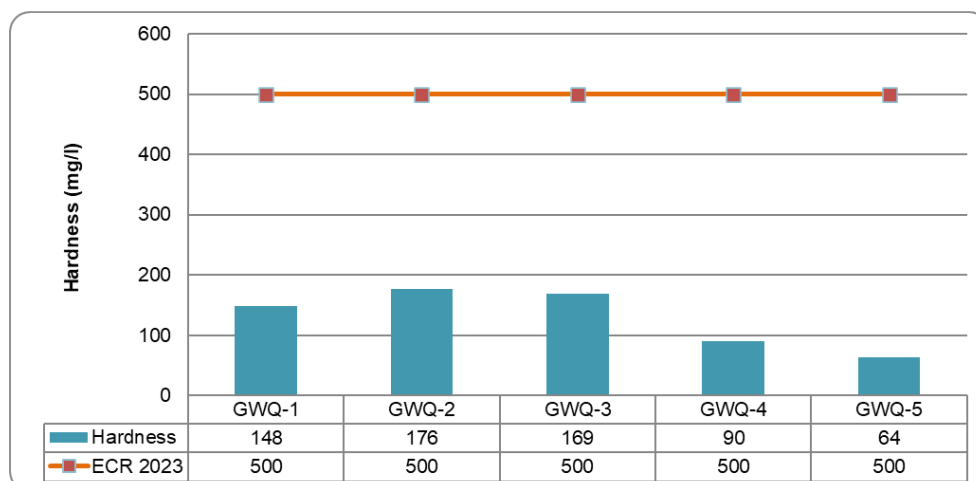
Source: Field Survey by EQMS Team, December 2023

- **Fecal Coliform (FC):** Fecal Coliform was absent in all the groundwater samples.
- **Total Coliform (TC):** Total Coliform was absent in all the groundwater samples.
- **Fluoride (F-):** Fluoride concentrations in the groundwater samples were in the range between 0.02 ppm to 0.06 ppm. The maximum F- (0.06 mg/L) was observed at GWQ-2 and GWQ-5, and the minimum (0.02 ppm) was observed at GWQ-1. All the sampling results were within the permissible limit of ECR, 2023 standard of 1 ppm and the WHO Guidelines of 1.5 for F-. The concentration of F- in the Groundwater is presented in Figure 3-47.

Figure 3-47: Concentration of Fluoride

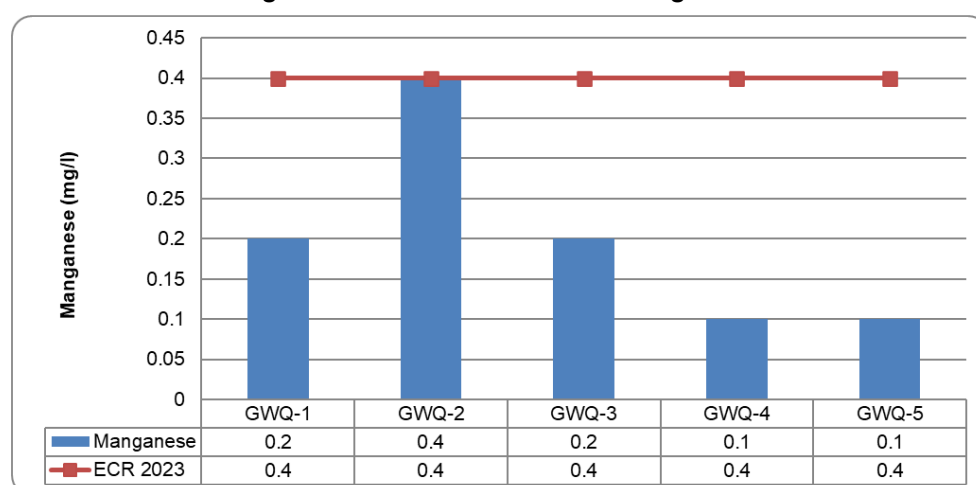
Source: Field Survey by EQMS Team, December 2023

- **Hardness (as CaCO₃):** Hardness concentrations in the groundwater samples were in the range between 64 mg/L to 176 mg/L. The maximum CaCO₃ (176 mg/L) was observed at GWQ-2 and the minimum (64 mg/L) was observed at GWQ-5. All the sampling results were within the permissible limit of the ECR, 2023 standard of 500 mg/L for CaCO₃. In addition, WHO Guidelines has no standard value for CaCO₃. The concentration of CaCO₃ in the Groundwater is presented in Figure 3-48.

Figure 3-48: Concentration of Hardness

Source: Field Survey by EQMS Team, December 2023

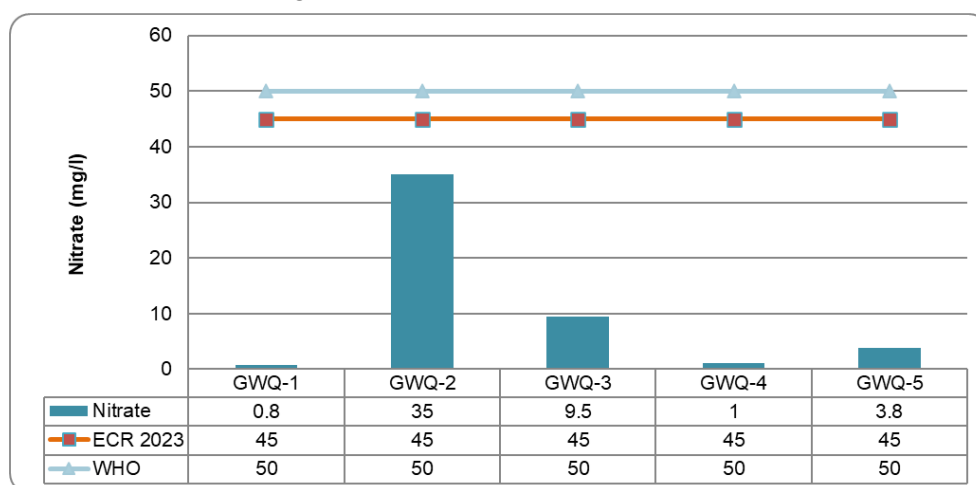
- Iron (Fe):** Iron concentrations in the groundwater samples were in the range between 0.11 mg/L to 2.31 mg/L. The maximum Fe (2.31 mg/L) was observed at GWQ-2 and the minimum (0.11 mg/L) was observed at GWQ-5. Values at GWQ-2 exceeded the permissible limit of ECR, 2023 standard of 0.3-1.0 mg/L. In addition, WHO Guidelines has no standard value for Fe.
- Lead (Pb):** Lead concentrations in all the groundwater samples were observed as <0.01 mg/L. All the sampling results were within the permissible limit of ECR, 2023 standard of 0.01 mg/L and the WHO Guidelines of 0.01 mg/L for Pb.
- Magnesium (Mg):** Magnesium concentrations in the groundwater samples were in the range between 21 mg/L to 37 mg/L. The maximum Mg (37 mg/L) was observed at GWQ-3 and the minimum (21 mg/L) was observed at GWQ-5. Values at GWQ-1, GWQ-2, and GWQ-3 exceeded the permissible limit of ECR, 2023 standard of 30-35 mg/L. In addition, WHO Guidelines has no standard value for Mg.
- Manganese (Mn):** Manganese concentrations in the groundwater samples were in the range between 0.1 mg/L to 0.4 mg/L. The maximum Mn (0.4 mg/L) was observed at GWQ-2 and the minimum (0.1 mg/L) was observed at GWQ-4 and GWQ-5. All the sampling results were within the permissible limit of the ECR, 2023 standard of 0.4 mg/L for Mn. In addition, WHO Guidelines has no standard value for Mn. The concentration of Mn is presented in Figure 3-49.

Figure 3-49: Concentration of Manganese

Source: Field Survey by EQMS Team, December 2023

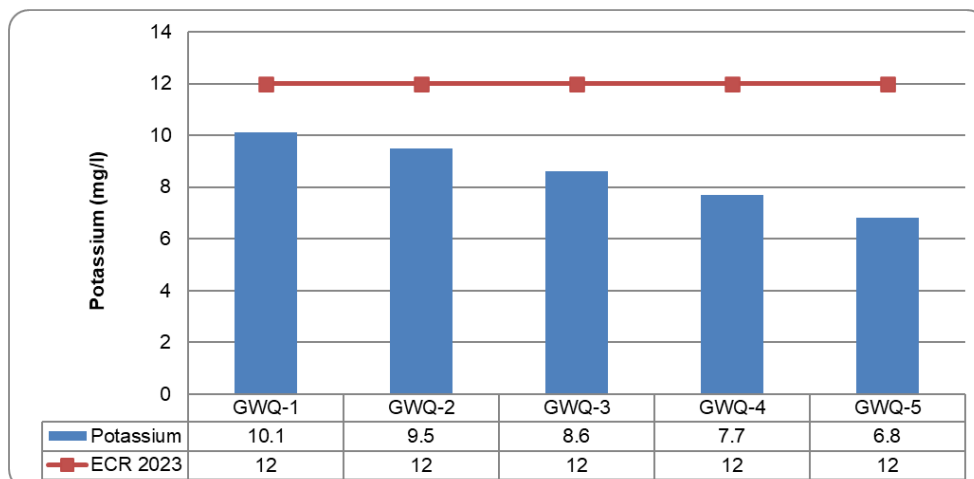
- **Mercury (Hg):** Mercury concentrations in all the groundwater samples were observed as <0.001 mg/L. All the sampling results were within the permissible limit of ECR, 2023 standard of 0.001 mg/L and the WHO Guidelines of 0.001 mg/L for Hg.
- **Nickel (Ni):** Nickel concentrations in all the groundwater samples were observed as <0.01 mg/L. All the sampling results were within the permissible limit of the ECR, 2023 standard of 0.05 mg/L and the WHO Guidelines of 0.02 mg/L for Ni.
- **Nitrate (NO₃⁻):** Nitrate concentrations in the groundwater samples were in the range between 0.8 mg/L to 35 mg/L. The maximum NO₃⁻ (35 mg/L) was observed at GWQ-2 and the minimum (0.8 mg/L) was observed at GWQ-1. All the sampling results were within the permissible limit of ECR, 2023 standard of 45 mg/L, and the WHO Guidelines of 50 mg/L for NO₃⁻. The concentration of NO₃⁻ in the Groundwater is presented in Figure 3-50.

Figure 3-50: Concentration of Nitrate



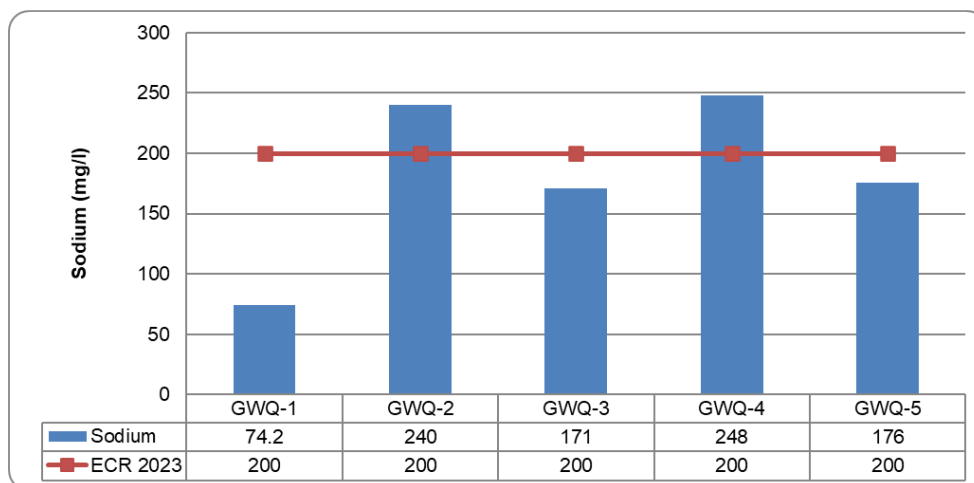
Source: Field Survey by EQMS Team, December 2023

- **Nitrite (NO₂⁻):** Nitrite concentrations in the groundwater samples were in the range between <0.01 mg/L to 0.09 mg/L. The maximum NO₂⁻ (0.09 mg/L) was observed at GWQ-2 and the minimum (<0.01 mg/L) was observed at GWQ-1 and GWQ-4. All the sampling results were within the permissible limit of ECR, 2023 standard of 1 mg/L and the WHO Guidelines of 3 mg/L for NO₂⁻.
- **pH:** pH concentrations in the groundwater samples were in the range between 8.4 to 8.5. The maximum pH (8.5) was observed at GWQ-3 and the minimum (8.4) was observed at GWQ-2. All the sampling results were within the permissible limit of ECR, 2023 standard of 6.5-8.5 and the WHO Guidelines of 6.5-8.5 for pH.
- **Potassium (K):** Potassium concentrations in the groundwater samples were in the range between 6.8 mg/L to 10.1 mg/L. The maximum K (10.1 mg/L) was observed at GWQ-1 and the minimum (6.8 mg/L) was observed at GWQ-5. All the sampling results were within the permissible limit of the ECR, 2023 standard of 12 mg/L for K. In addition, WHO Guidelines has no standard value for K. Concentration of Potassium (K) in the Groundwater Quality Monitoring data for the study area is presented in Figure 3-51.

Figure 3-51: Concentration of Potassium

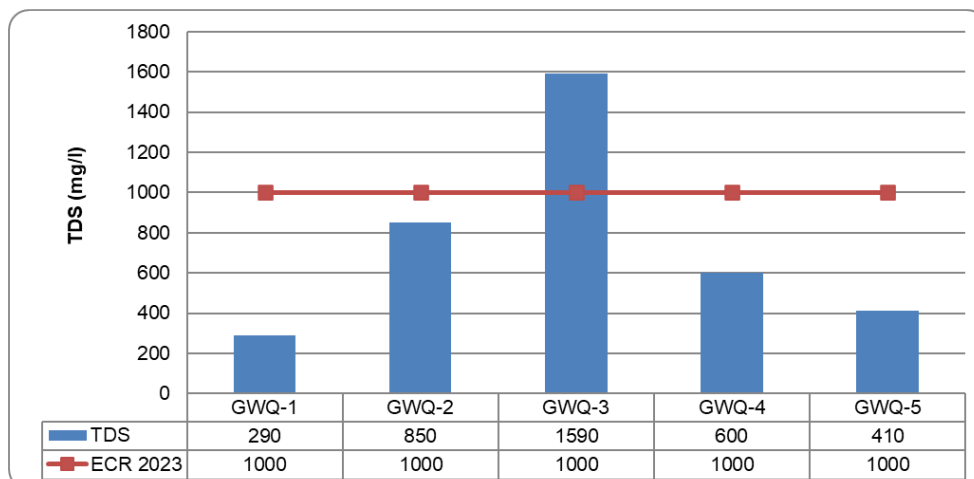
Source: Field Survey by EQMS Team, December 2023

- **Salinity:** Salinity concentrations in the groundwater samples were in the range between 0.27 ppt to 1.53 ppt. The maximum salinity (1.53 ppt) was observed at GWQ-3 and the minimum (0.27 ppt) was observed at GWQ-1. There are no standards for salinity in ECR 2023 and WHO Guidelines.
- **Sodium (Na):** Sodium concentrations in the groundwater samples were in the range between 74.2 mg/L to 248 mg/L. The maximum Na (248 mg/L) was observed at GWQ-4 and the minimum (74.2 mg/L) was observed at GWQ-1. Values at GWQ-2 and GWQ-4 exceeded the permissible limit of ECR, 2023 standard of 200 mg/L. In addition, WHO Guidelines has no standard value for Na. The concentration of Na in the Groundwater is presented in Figure 3-52.

Figure 3-52: Concentration of Sodium

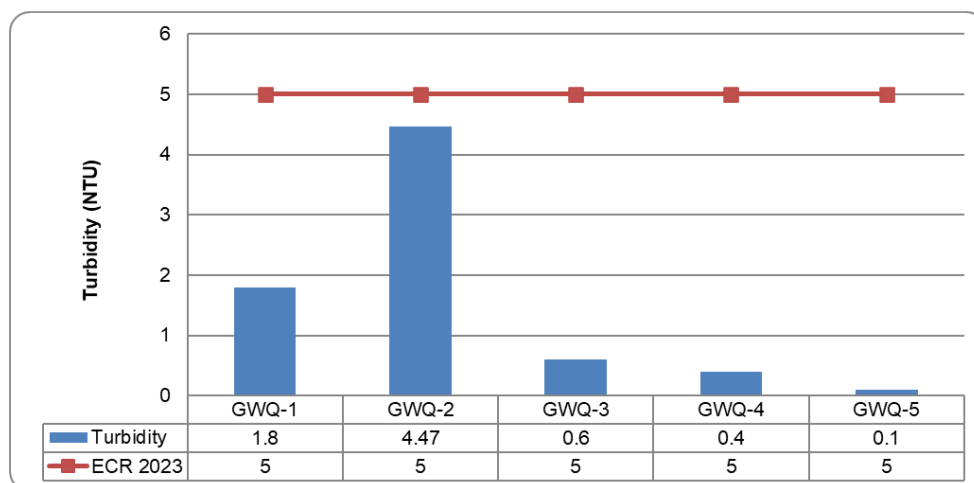
Source: Field Survey by EQMS Team, December 2023

- **Total Dissolved Solids (TDS):** TDS concentrations in the groundwater samples were in the range between 290 mg/L to 1,590 mg/L. The maximum TDS (1,590 mg/L) was observed at GWQ-3 and the minimum (290 mg/L) was observed at GWQ-1. Values at GWQ-3 exceeded the permissible limit of ECR, 2023 standard of 1,000 mg/L. In addition, WHO Guidelines has no standard value for TDS. The concentration of TDS in the Groundwater is presented in Figure 3-53.

Figure 3-53: Concentration of Total Dissolved Solids

Source: Field Survey by EQMS Team, December 2023

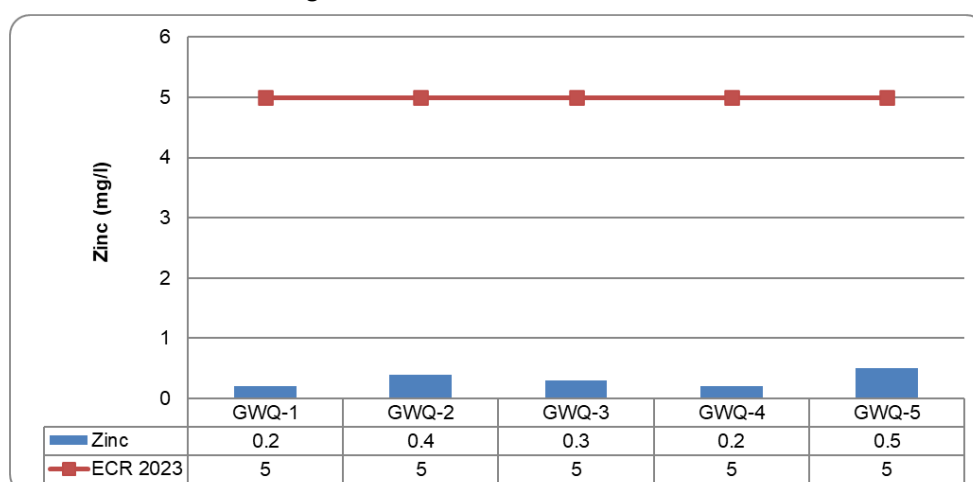
- Turbidity:** Turbidity concentrations in the groundwater samples were in the range between 0.1 NTU to 4.4 NTU. The maximum Turbidity (4.4 NTU) was observed at GWQ-2 and the minimum (0.1 NTU) was observed at GWQ-5. All the sampling results were within the permissible limit of the ECR, 2023 standard of 5 NTU for Turbidity. In addition, WHO Guidelines has no standard value for Turbidity. The concentration of Turbidity in the Groundwater is presented in Figure 3-54.

Figure 3-54: Concentration of Turbidity

Source: Field Survey by EQMS Team, December 2023

- Zinc (Zn):** Zinc concentrations in the groundwater samples were in the range between 0.2 mg/L to 0.5 mg/L. The maximum Zn (0.5 mg/L) was observed at GWQ-5 and the minimum (0.2 mg/L) was observed at GWQ-1 and GWQ-4. All the sampling results were within the permissible limit of the ECR, 2023 standard of 5 mg/L for Zn. In addition, WHO Guidelines has no standard value for Zn. The concentration of Zn in the Groundwater is presented in Figure 3-55.

Figure 3-55: Concentration of Zinc



Source: Field Survey by EQMS Team, December 2023

3.2.14.9 Soil Quality – Secondary

To understand the historical soil quality baseline condition of the study region, an extensive secondary documentation review was conducted by the RESA Consultant. From the secondary literature review, a total of 10 soil quality monitoring results have been identified in the study region. A summary of the analysis of the secondary soil quality has been presented below and a summary of collected baseline data has been provided in Annex-B.

- **pH:** pH of the soil samples collected ranges from 5.9 to 8.2.
- **Electrical conductivity (EC):** EC was observed to be in the range of 4.6 to 25 mg/kg.
- **Total Nitrogen (N):** Nitrogen was observed to be in the range of 0.035 to 31 mg/kg.
- **Phosphorus (P):** Phosphorus was observed to be in the range of 1.9 to 8.2 mg/kg.
- **Potassium (K):** Potassium was observed to be in the range of 0.31 to 1.54 mg/kg.
- **Calcium (Ca):** Calcium was observed to be in the range of 2.71 to 750 mg/kg.
- **Magnesium (Mg):** Magnesium was observed to be in the range of 6.02 to 138 mg/kg. Magnesium concentration in the soil samples was in compliance with the USEPA standard of 5,000 mg/kg (average concentration).
- **Sulphur (S):** Sulphur was observed to be in the range of 20.81 to 76.58 mg/kg.
- **Lead (Pb):** Lead was observed to be 18.41 mg/kg. Lead concentration in the soil sample was not in compliance with the USEPA standard of 10 mg/kg (average concentration).
- **Cadmium (Cd):** Cadmium was observed to be 1.09 mg/kg. Cadmium concentration in the soil sample was not in compliance with the USEPA standard of 0.06 mg/kg (average concentration).
- **Chromium (Cr):** Chromium was observed to be 53.57 mg/kg. Chromium concentration in the soil sample was in compliance with the USEPA standard of 100 mg/kg (average concentration).
- **Nickel (Ni):** Nickel was observed to be 36.94 mg/kg. Nickel concentration in the soil sample was in compliance with the USEPA standard of 40 mg/kg (average concentration).
- **Sulphate (SO₄²⁻):** Sulphate was observed to be in the range of 269.78 to 289.64 mg/kg.
- **Chloride (Cl):** Chloride was observed to be in the range of 440 to 476 mg/kg.

3.2.14.10 Soil Quality - Primary

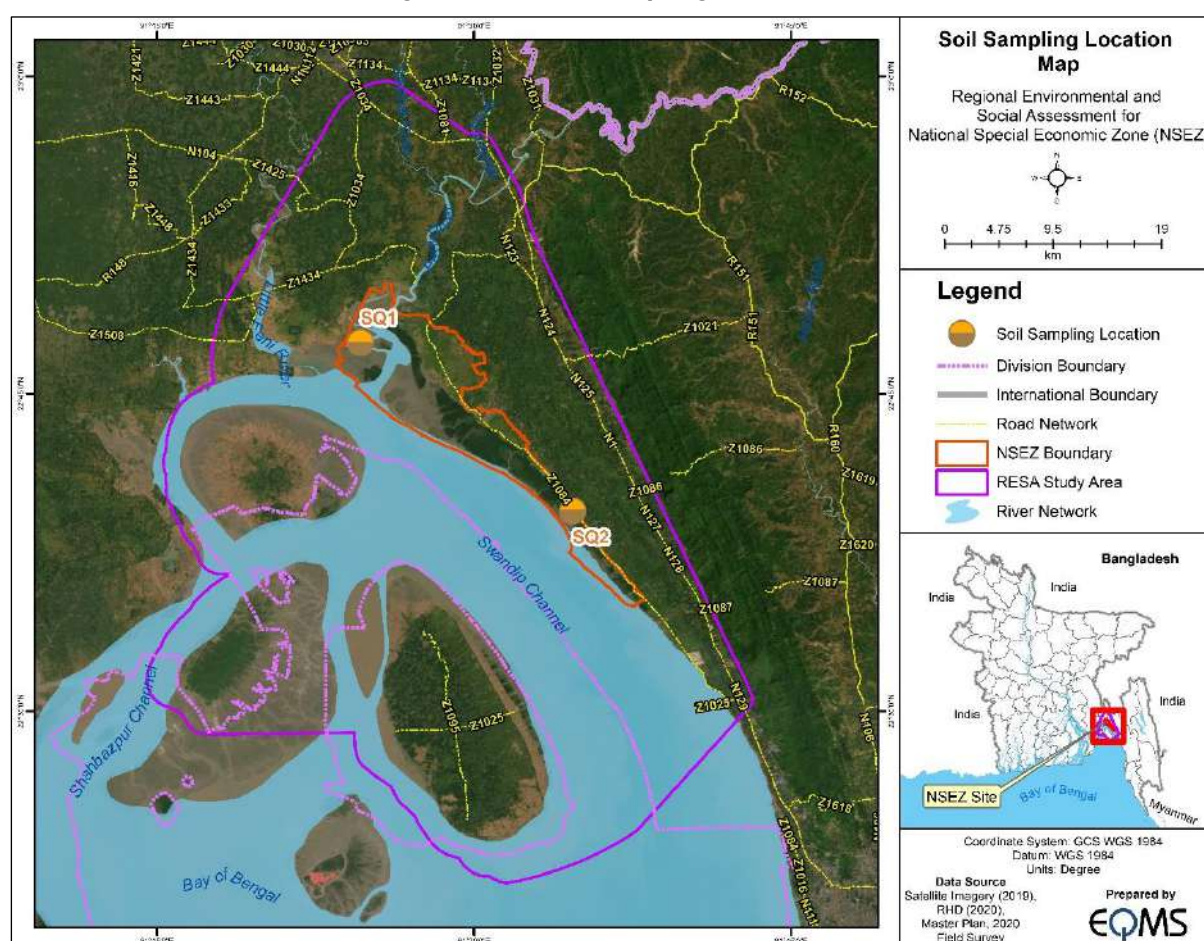
Two soil samples were collected from the NSEZ site during the baseline data collection. Soil samples were collected using a hand auger from the topsoil surface. After collecting soil samples, it was packed in plastic jars and sealed. The sealed samples were sent to the SRDI laboratory for analysis. A detail of the sampling locations is presented in Table 3-30 and the sampling location map is shown in Figure 3-56. Photographs of soil sample collection are given in Appendix A-6.5. The soil sampling locations were selected taking into account the following:

- Future development plan and possible impacted areas such as precincts A - residential and precincts I - heavy industrial development in NSEZ.
- Representativeness of regional soil quality for obtaining baseline status.
- Representativeness of likely impact areas.

Table 3-30: Soil Sampling Locations

Sampling Code	Sampling Locations	Geographical Coordinates	Sampling Date
SQ-1	Precincts A - Residential development in NSEZ	22°47'24.855"N 91°24'38.209"E	12/12/2023
SQ-2	Precincts I - Heavy Industrial Development in NSEZ	22°39'28.004"N 91°34'39.565"E	09/12/2023

Source: Field Survey by EQMS Team, December 2023

Figure 3-56: Soil Sampling Locations

Source: Field Survey by EQMS Team, December 2023

The analysis results of the physic-chemical parameters of soil samples are presented in Table 3-31. The laboratory test report has been presented in Appendix D.

Table 3-31: Soil Quality Analysis Results

Sampling Code	Parameters																	
	pH	Electrical Conductivity (EC)	Total Nitrogen (N)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Chloride (Cl-)	Phosphorus (P)	Copper (Cu)	Zinc (Zn)	Lead (Pb)	Cadmium (Cd)	Nickel (Ni)	Chromium (Cr)	Salinity	Sulfate (SO ₄ ²⁻)	Organic Matter	Texture
	-	dS/m	ppm	ppm	meq/100g	meq/100g	mg/kg	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppt	ppm	%	-
SQ-1	7.31	0.75	2.0	2.1	4.83	5.61	1083	1.2	4.22	0.68	21.00	0.20	44.39	30.82	0.48	137.48	0.647	Silty Clay Loam
SQ-2	7.28	0.85	2.4	3.0	4.47	6.16	1855	1.4	6.74	0.92	26.61	0.26	53.00	43.46	0.544	90.95	0.651	Silty Clay
USEPA Standards																		
Common Range	-	-	-	-	-	600-6000	-	-	2-100	100-300	2-200	0.01-0.7	5-500	1-1000	-	-	-	-
Average Concentration	-	-	-	-	-	5000	-	-	30	50	10	0.06	40	100	-	-	-	-

Source: Laboratory Analysis

3.2.14.10.1 Result Discussion

The results for the soil samples were compared with the USEPA standards.

- **pH:** pH concentrations in the soil samples were in the range between 7.28 to 7.31. There are no standards for salinity in USEPA standards.
- **Electrical conductivity (EC):** Electrical conductivity concentrations in the soil samples were in the range between 0.75 dS/m to 0.85 dS/m. There are no standards for EC in USEPA standards.
- **Total Nitrogen (N):** Nitrogen concentrations in the soil samples were in the range between 2.0 ppm to 2.4 ppm. There are no standards for N in USEPA standards.
- **Potassium (K):** Potassium concentrations in the soil samples were in the range between 2.1 ppm to 3.0 ppm. There are no standards for K in USEPA standards.
- **Calcium (Ca):** Calcium concentrations in the soil samples were in the range between 4.47 meq/100g to 4.83 meq/100g. There are no standards for Ca in USEPA standards.
- **Magnesium (Mg):** Magnesium concentrations in the soil samples were in the range between 5.61 meq/100g to 6.16 meq/100g. All the soil sampling results were within the permissible limit of USEPA standards – common range (600-6000 meq/100g), as well as average concentration (5000 meq/100g).
- **Chloride (Cl-):** Chloride concentrations in the soil samples were in the range between 1083 mg/kg to 1855 mg/kg. There are no standards for Cl- in USEPA standards.
- **Phosphorus (P):** Phosphorus concentrations in the soil samples were in the range between 1.2 ppm to 1.4 ppm. There are no standards for P in USEPA standards.
- **Copper (Cu):** Copper concentrations in the soil samples were in the range between 4.22 ppm to 6.74 ppm. All the sampling results were within the permissible limit of the USEPA standard for sediment Cu. All the soil sampling results were within the permissible limit of USEPA standards – common range (2-100 ppm), as well as average concentration (30 ppm).
- **Zinc (Zn):** Zinc concentrations in the soil samples were in the range between 0.68 ppm to 0.92 ppm. All the sampling results were within the permissible limit of the USEPA standard for sediment Zn. All the soil sampling results were within the permissible limit of USEPA standards – common range (100-300 ppm), as well as average concentration (50 ppm).
- **Lead (Pb):** Lead concentrations in the soil samples were in the range between 21 ppm to 26.61 ppm. All the soil sampling results exceeded the permissible limit of USEPA standards – common range (2-200 ppm), as well as average concentration (10 ppm).
- **Cadmium (Cd):** Cadmium concentrations in the soil samples were in the range between 0.20 ppm to 0.26 ppm. All the soil sampling results exceeded the permissible limit of USEPA standards – common range (0.01-0.7 ppm), as well as average concentration (0.06 ppm).
- **Nickel (Ni):** Nickel concentrations in the soil samples were in the range between 44.39 ppm to 53 ppm. All the soil sampling results exceeded the permissible limit of USEPA standards – common range (5-500 ppm), as well as average concentration (10 ppm).
- **Chromium (Cr):** Chromium concentrations in the soil samples were in the range between 30.82 ppm to 43.46 ppm. All the soil sampling results were within the permissible limit of USEPA standards – common range (1-1000 ppm), as well as average concentration (100 ppm).
- **Salinity:** Salinity concentrations in the soil samples were in the range between 0.48 ppt to 0.544 ppt. There are no standards for Salinity in USEPA standards.
- **Sulfate (SO₄²⁻):** Sulfate concentrations in the soil samples were in the range between 90.95 ppm to 137.48 ppm. There are no standards for Sulfate in USEPA standards.
- **Organic Matter:** Organic matter concentrations in the soil samples were in the range between 0.647% to 0.651%. There are no standards for organic matter in USEPA standards.
- **Texture:** Texture of the soil samples was silty clay loam and silty loam.

3.2.14.11 Sediment Quality - Secondary

To understand the historical sediment quality baseline condition of the study region, an extensive secondary documentation review was conducted by the RESA Consultant. From the secondary literature review, sediment sample collection, and testing were not found.

3.2.14.12 Sediment Quality - Primary

Eight sediment samples were collected from the Feni River, Little Feni River, and Sandwip Channel during the baseline data collection. Sediment samples were collected using an Ekman dredger. After collecting soil samples, it was packed in plastic jars and sealed. The sealed samples were sent to the SRDI laboratory for analysis. A detail of the sampling locations is presented in Table 3-32 and the sampling location map is shown in Figure 3-57. Photographs of soil sample collection are given in Appendix A-6.6. The sediment sampling locations were selected taking into account the following:

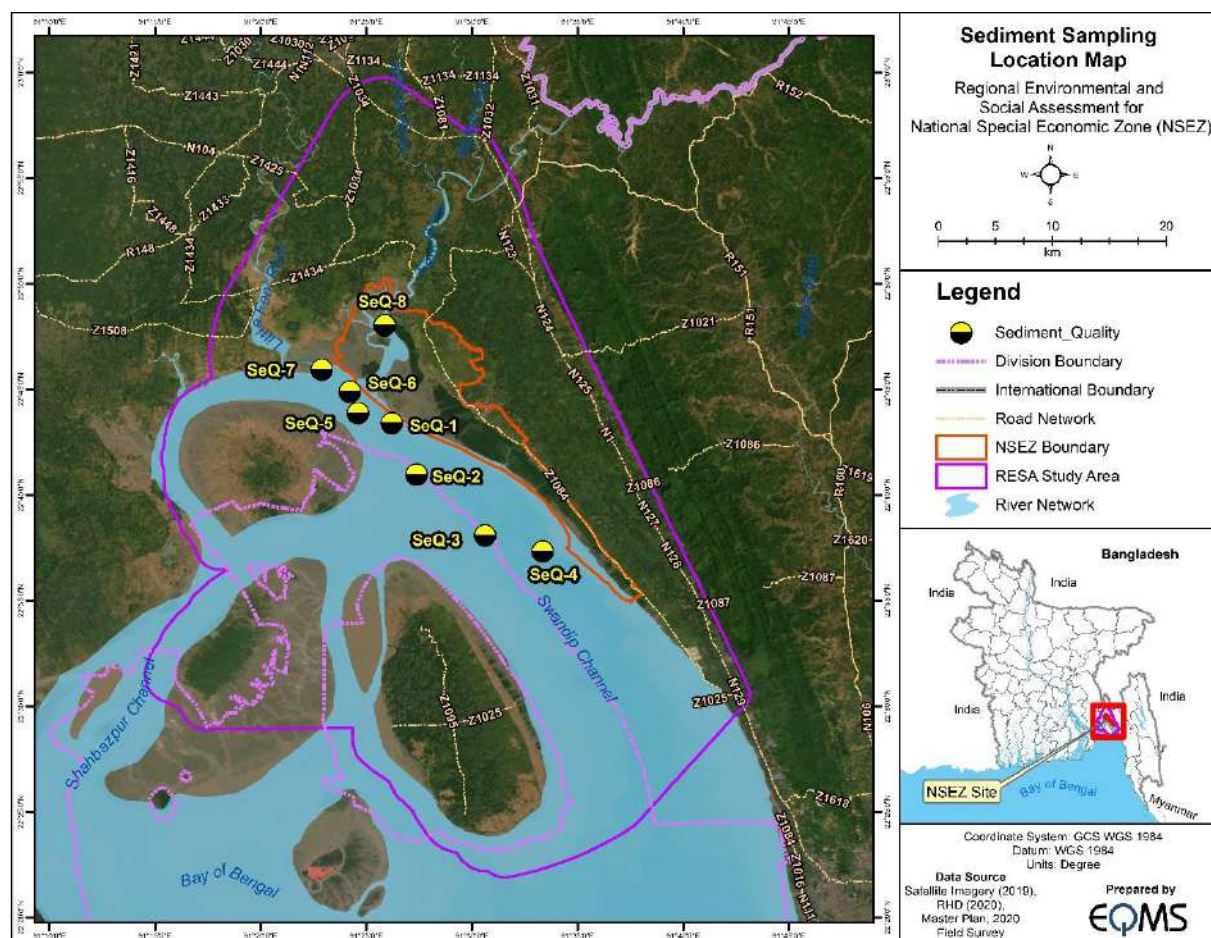
- A minimum distance of 1.5 km from the super dike in accordance with the Bangladesh Water Development Board guideline for dredging activities to protect the super dike.
- Confluence zone of freshwater and brackish water.
- Erosion-deposition area as per the existing bathymetry data and remote sensing analysis from the hydrological model.
- Proposed jetty in the Sandwip Channel and future impacts due to capital and maintenance dredging and vessel movement.
- Discharge point from Central Effluent Treatment Plant (CETP) in the Sandwip Channel.
- Representativeness of regional sediment quality for obtaining baseline status.
- Representativeness of likely impact areas.

Table 3-32: Sediment Sampling Locations

Sampling Code	Sampling Locations	Geographical Coordinates	Sampling Date
SeQ-1	Confluence of Ichakhali Khal	22°43'24.344"N 91°26'12.443"E	14/12/2023
SeQ-2	Sandwip channel	22°40'57.553"N 91°27'23.013"E	14/12/2023
SeQ-3	Confluence of Domkhali Khal/ Sandwip channel	22°38'05.206"N 91°30'36.946"E	14/12/2023
SeQ-4	Downstream of Fakirhat ghat, Saidpur/ Sandwip channel	22°37'19.419"N 91°33'21.117"E	14/12/2023
SeQ-5	Char in the Sandwip Channel (near Urirchar)	22°43'52.743"N 91°24'36.693"E	14/12/2023
SeQ-6	Confluence of Feni and Little Feni River	22°44'53.326"N 91°24'13.206"E	14/12/2023
SeQ-7	Near to Musapur Closure (Feni EZ)	22°45'56.389"N 91°22'53.920"E	14/12/2023
SeQ-8	Feni River	22°48'01.864"N 91°25'52.325"E	14/12/2023

Source: Field Survey by EQMS Team, December 2023

Figure 3-57: Sediment Sampling Locations



Source: Field Survey by EQMS Team, December 2023

The analysis results of the physic-chemical parameters of sediment samples are presented in Table 3-33. The laboratory test report has been presented in Appendix D.

Table 3-33: Sediment Quality Analysis Results

Sampling Code	Parameters																Textur e
	pH	Electric al conduc tivity (EC)	Total Nitroge n (N)	Potassi um (K)	Calciu m (Ca)	Magne sium (Mg)	Chlorid e (Cl-)	Phosp horus (P)	Copper (Cu)	Zinc (Zn)	Lead (Pb)	Cadmi um (Cd)	Nickel (Ni)	Chromi um (Cr)	Sulfate (SO ₄ ²⁻)	Organi c Matter	
	-	dS/m	ppm	ppm	meq/100g	meq/100g	mg/kg	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	
SeQ-1	7.17	1.40	1.2	2.1	5.67	7.46	6008	0.8	5.91	0.58	22.51	0.20	46.42	37.23	95.76	2.18	Silty Clay Loam
SeQ-2	7.21	2.28	1.8	2.4	4.97	6.94	7034	1.0	5.28	0.68	22.94	0.27	44.88	34.80	101.2	2.32	Silty Clay
SeQ-3	7.60	2.18	1.1	2.3	6.39	8.67	6040	1.2	5.75	0.55	23.59	0.27	43.10	32.45	84.08	2.064	Silty Clay
SeQ-4	7.42	1.38	2.1	2.4	6.39	8.34	7271	1.4	5.92	0.71	23.80	0.25	38.47	30.54	94.30	2.32	Silty Clay
SeQ-5	7.47	2.35	2.3	2.1	6.54	7.92	6824	0.9	5.76	0.58	23.81	0.29	41.70	30.54	100.16	2.32	Silty Clay
SeQ-6	7.38	2.25	2.2	2.2	6.73	8.01	6368	1.2	5.59	0.45	23.82	0.20	42.80	32.73	127.20	2.18	Silty Clay
SeQ-7	7.21	2.40	2.4	2.0	6.65	7.94	5973	1.1	6.06	0.43	23.15	0.27	47.31	34.17	90.15	2.44	Silty Clay
SeQ-8	7.31	1.44	1.3	2.4	5.01	9.47	6105	1.2	6.15	0.52	28.33	0.28	46.22	35.37	105.86	2.064	Clay
USEPA Standards																	
<i>Not Polluted</i>	-	-	-	-	-	-	-	-	<25	<90	<40	-	<20	<25	-	-	-
<i>Moderately Polluted</i>	-	-	-	-	-	-	-	-	25-50	90-200	40-60	-	20-50	25-75	-	-	-
<i>Heavily Polluted</i>	-	-	-	-	-	-	-	-	>50	>200	>60	>6	>50	>75	-	-	-

Source: Laboratory Analysis

3.2.14.12.1 Result Discussion

The results for the sediment samples were compared with the USEPA standards.

- **pH:** pH concentrations in the sediment samples were in the range between 7.17 to 7.60. The maximum pH (7.60) was observed at SeQ-3 and the minimum (7.17) was observed at SeQ-1. There are no standards for pH in USEPA standards.
- **Electrical conductivity (EC):** Electrical conductivity concentrations in the sediment samples were in the range between 1.38 dS/m to 2.40 dS/m. The maximum EC (2.40 dS/m) was observed at SeQ-7 and the minimum (1.38 dS/m) was observed at SeQ-4. There are no standards for EC in USEPA standards.
- **Total Nitrogen (N):** Nitrogen concentrations in the sediment samples were in the range between 1.1 ppm to 2.4 ppm. The maximum N (2.4 ppm) was observed at SeQ-7 and the minimum (1.1 ppm) was observed at SeQ-3. There are no standards for N in USEPA standards.
- **Potassium (K):** Potassium concentrations in the sediment samples were in the range between 2 ppm to 2.4 ppm. The maximum K (2.4 ppm) was observed at SeQ-2, SeQ-4, and SeQ-8 and the minimum (2 ppm) was observed at SeQ-7. There are no standards for K in USEPA standards.
- **Calcium (Ca):** Calcium concentrations in the sediment samples were in the range between 4.97 meq/100g to 6.73 meq/100g. The maximum Ca (6.73 meq/100g) was observed at SeQ-6 and the minimum (4.97 meq/100g) was observed at SeQ-2. There are no standards for Ca in USEPA standards.
- **Magnesium (Mg):** Magnesium concentrations in the sediment samples were in the range between 6.94 meq/100g to 9.47 meq/100g. The maximum Mg (9.47 meq/100g) was observed at SeQ-8 and the minimum (6.94 meq/100g) was observed at SeQ-2. There are no standards for Mg in USEPA standards.
- **Chloride (Cl-):** Chloride concentrations in the sediment samples were in the range between 5973 mg/kg to 7271 mg/kg. The maximum Cl- (7271 mg/kg) was observed at SeQ-4 and the minimum (5973 mg/kg) was observed at SeQ-7. There are no standards for Cl- in USEPA standards.
- **Phosphorus (P):** Phosphorus concentrations in the sediment samples were in the range between 0.8 ppm to 1.4 ppm. The maximum P (1.4 ppm) was observed at SeQ-4 and the minimum (0.8 ppm) was observed at SeQ-1. There are no standards for P in USEPA standards.
- **Copper (Cu):** Copper concentrations in the sediment samples were in the range between 5.28 ppm to 6.15 ppm. The maximum Cu (6.15 ppm) was observed at SeQ-8 and the minimum (5.28 ppm) was observed at SeQ-2. Cu concentration in all the sediment samples was in compliance with the USEPA standard of <25 ppm (not polluted).
- **Zinc (Zn):** Zinc concentrations in the sediment samples were in the range between 0.43 ppm to 0.71 ppm. The maximum Zn (0.71 ppm) was observed at SeQ-4 and the minimum (0.43 ppm) was observed at SeQ-7. Zn concentration in all the sediment samples was in compliance with the USEPA standard of <90 ppm (not polluted).
- **Lead (Pb):** Lead concentrations in the sediment samples were in the range between 22.51 ppm to 28.33 ppm. The maximum Pb (28.33 ppm) was observed at SeQ-8 and the minimum (22.51 ppm) was observed at SeQ-1. Pb concentration in all the sediment samples was in compliance with the USEPA standard of <40 ppm (not polluted).
- **Cadmium (Cd):** Cadmium concentrations in the sediment samples were in the range between 0.2 ppm to 0.29 ppm. The maximum Cd (0.29 ppm) was observed at SeQ-5 and the minimum (0.2 ppm) was observed at SeQ-1 and SeQ-6. Cd concentration in all the sediment samples was in compliance with the USEPA standard of >6 ppm (not polluted).
- **Nickel (Ni):** Nickel concentrations in the sediment samples were in the range between 38.47 ppm to 47.31 ppm. The maximum Ni (47.31 ppm) was observed at SeQ-7 and the minimum (38.47 ppm) was observed at SeQ-4. Ni concentration in all the sediment samples exceeded

the USEPA standard of <20 ppm (not polluted) and was found between 20-50 (moderately polluted).

- **Chromium (Cr):** Chromium concentrations in the sediment samples were in the range of 30.54 ppm to 37.23 ppm. The maximum Cr (37.23 ppm) was observed at SeQ-1 and the minimum (30.54 ppm) was observed at SeQ-4 and SeQ-5. Cr concentration in all the sediment samples exceeded the USEPA standard of <20 ppm (not polluted) and was found between 25-75 (moderately polluted).
- **Sulfate (SO₄²⁻):** Sulfate concentrations in the sediment samples were in the range between 84.08 ppm to 127.2 ppm. The maximum Sulfate (127.2 ppm) was observed at SeQ-6 and the minimum (84.08 ppm) was observed at SeQ-3. There are no standards for Sulfate in USEPA standards.
- **Organic Matter:** Organic matter concentrations in the sediment samples were in the range between 2.064% to 2.44%. There are no standards for organic matter in USEPA standards.
- **Texture:** Texture of the sediment samples was silty clay loam, silty loam, and clay.

3.3 Biological Environment

The term "biological environment" typically refers to the natural habitat or surroundings in which living organisms exist. It encompasses all the living and non-living components that interact to create a suitable and sustainable ecosystem for various forms of life. The biological environment can range from small-scale microenvironments to vast ecosystems such as forests, oceans, deserts, or grasslands. Living organisms, including plants, animals, microorganisms, and humans, are intimately connected with their biological environment. They depend on the environment for essential resources like food, water, shelter, and other conditions necessary for survival and reproduction.

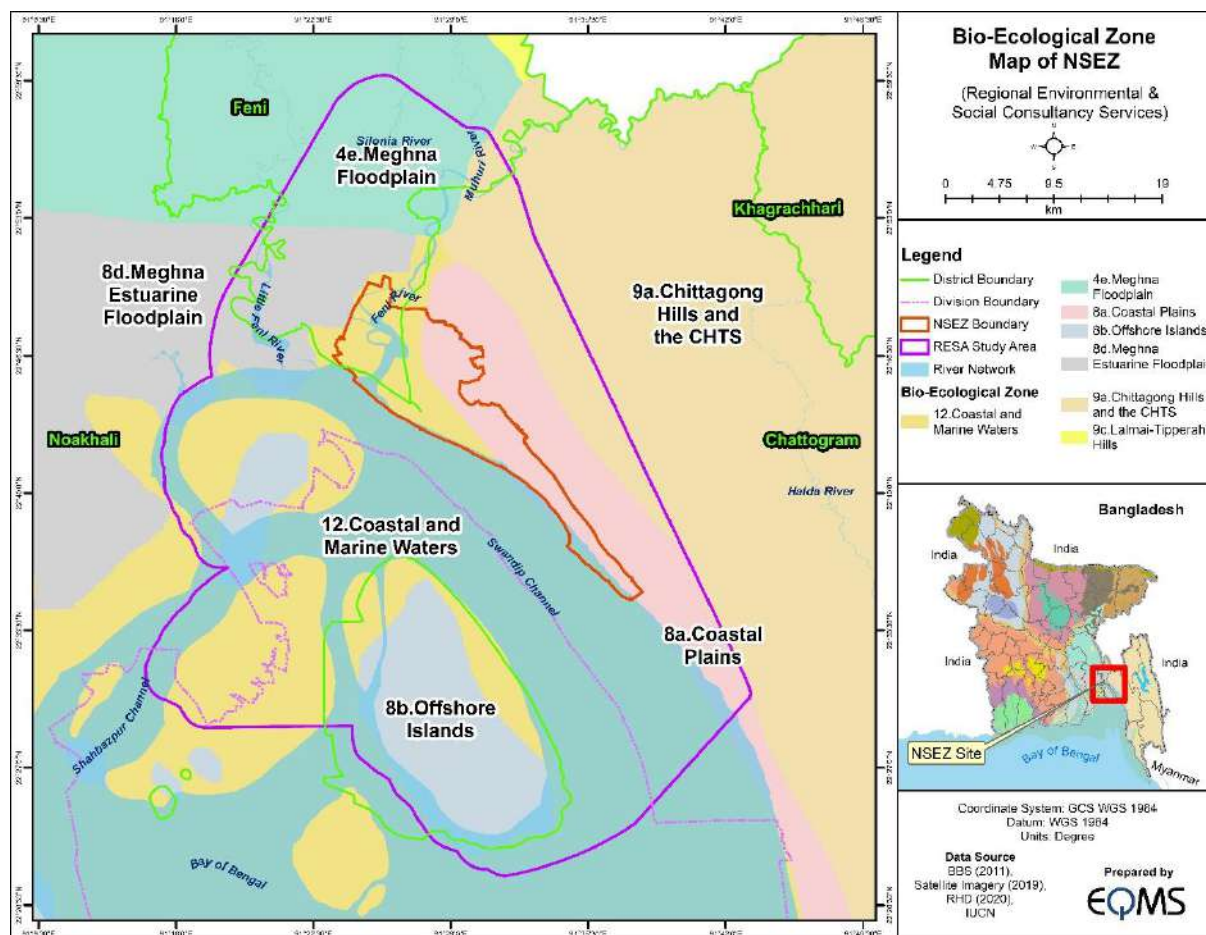
The primary goal of biological study is to examine and provide background information on the ecological status of floral and faunal composition within the study region. The specific objectives are as follows:

- Identify the vegetation cover and assess the current status of natural habitats or species in the study region.
- Identify and evaluate the ecological resources present within the study region.
- Conduct primary ecological surveys to identify endangered or protected species, as well as endemic floral and faunal species in the study region.
- Identify areas of conservation significance, including protected areas such as sanctuaries, national parks, ecologically critical areas, marine protected areas, RAMSAR sites, and important bird areas, that are relevant to terrestrial and aquatic biodiversity within the study region.

3.3.1 Bioecological Zone

The International Union for Conservation of Nature (IUCN) has classified Bangladesh into twenty-five Bio-ecological Zones considering parameters such as physiography, soil types, temperature, rainfall, floral and faunal diversity, as well as flooding depth (Nishat, et al., 2002) in the context of physiographic and biological diversity. The study area has fallen under six bio-ecological zones namely (i) Coastal Plains, (ii) Chittagong Hills and the CHTs, (iii) Coastal and Marine Waters, (iv) Meghna Floodplain, (v) Offshore Islands, and (vi) Meghna Estuarine Floodplain. The study area occupies terrestrial as well as aquatic (marine) ecosystems. Figure 3-58 shows the bio-ecological zones of Bangladesh. Brief descriptions of the bio-ecological zones are given below.

Figure 3-58: Bio-ecological Zones of Bangladesh



Source: Nishat, 2002

3.3.1.1 Coastal Plains

The coastal plains are underlain by heavy marine or tidal clays, but these have been buried under more sand or silty deposits near the foot of the hills and along with the courses of rivers and streams, which run across the plains. The eastern coastline, extending from the mouth of the Feni River to the southern tip of the mainland along with Chittagong, is regular and unbroken and protected along the sea by mudflats and submerged sands (Rizvi, 1975).

3.3.1.1.1 Floral Diversity

Trees: Narikel (*Cocos nicufera*), Supari (*Areca catechu*), Khejur (*Phoenix sylvestris*), and Bhadi (*Lannea coromandelica*), etc.

Herbs & Shrubs: Bashak (*Adhatoda vasica*), Pares (*Thespesia populnea*), Ulu (*Imperata cylindrica*), and Hargoza (*Acanthus illicifolius*), etc.

3.3.1.1.2 Faunal Diversity

Mammals: Asian elephant (*Elephas maximus*), Hoolock gibbon (*Hylobates hoolock*), Mainland serow (*capricornis sumatraensis*), Clawless otter (*Aonyx cinerea*), and Binturong (*Arctictis binturong*).

Birds: Ashy bulbul (*Hemixos flava*), Gull-billed tern (*Gelochelidon nilotica*), Spot-throated babbler (*Pellorneum albiventris*), Asian glossy starling (*Aplonis panayensis*).

Reptiles: Splender coral snake (*callophis melanurus*), Green pit viper (*Trimeresurus*), Banded krait (*Bungarus fasciatus*), and Ring lizard (*Varanus salvator*).

Amphibians: Ornate microhylid (*Microhyla ornate*), and Bullfrog (*Hoplobatrachus tigerinus*).

3.3.1.2 Chittagong Hills and the CHTs

The southeastern hill range of the country is composed of tropical evergreen and semi-evergreen forests, which are important watershed areas of the country. The majority of the species in the lower canopy are evergreen, and the upper canopy of the forest is deciduous type. The tropical evergreen forest is found in the valleys of this zone. Knowledge of the diversity of reptiles and amphibians in this zone is rather rudimentary, as few surveys of these animals have been made. This zone possesses the richest avifauna population in the country, mostly marine and shorebirds (Nishat, et al., 2002).

3.3.1.2.1 Floral Diversity

Trees: Garjan (*Dipterocarpus turbinatus*), Telshur (*Hopea odorata*), Shilbatna (*quercus velutina*), Goda (*Vitex pubescens*), and Civit (*Swintonia floribunda*).

Shrubs: Kurchi (*Holarrhena antidysenterica*), Silchaonri (*Mussaenda roxburghii*), Kestoma/Keura (*Glochidion multiloculare*), and Awet rangon (*Ixora parviflora*).

Herbs: Shothi (*Curcuma zeodaria*), Sharpagandha (*Rauwolfia serpentina*), and Staurogyne argentea.

Climbers: Guachcha lata (*Calycopteris floribunda*), Jhum alu (*Dioscorea pentaphylla*), and Kamkui/Kantakui (*Bridelia retusa*).

Orchids: Pholidota pallida, Acampe premorsa, Aerides odoratum.

3.3.1.2.2 Faunal Diversity

Mammals: Mainland serow (*Capricornis sumatraensis*), Asiatic wild dog/Dhole (*Cuon alpinus*), Leopard (*Panthera pardus*), Slow loris (*Nycticebus coucang*), Indian pangolin (*Manis crassicaudata*), Asian elephant (*Elephas maximus*), and Sambar (*cervus unicolor*).

Birds: Black francolin (*Francolinus francolinus*), Manipur bush quail (*Perdica manipurensis*), Alexandrine parakeet (*psittacula eupatria*), Brown crane (*Amaurornis akool*), and Great hornbill (*Buceros bicornis*).

Reptiles: Tawny cat snake (*Boiga ochraceus*), Green rat snake (*Coluber nigromarginatus*), King Cobra (*Ophiophagus Hannah*), and Large spotted can snake (*Boiga multimeculata*).

Amphibians: Puddle frog (*Occidozyga lima*), Balloon frog (*Uperodon globulosus*), Taipeh frog (*Rana taipehensis*), and Leaf frog (*Rana erythraea*).

3.3.1.3 Coastal and Marine Waters

There are over 25 million acres of marine area, which comprise the territorial waters and the exclusive economic zone of Bangladesh. The coastline along the Bay of Bengal is 1,200 km long including the coastlines of numerous islands, but not measuring minor indentations. A large area in the south, therefore, is the coastal zone, which has its dynamics and deserves special attention as a very distinct terrain (GOB, 1994). The coastal area, comprising the complex delta of the Ganges-Brahmaputra-Meghna River system, has immense biological resources. The river system, while flowing through Bangladesh on its way to the Bay of Bengal, carries an estimated annual sediment load of about 2.0 billion tons; these sediments are subjected to coastal dynamic processes generated mainly by river flow and tidal wind actions, leading to accretion and erosion in the coastal areas of Bangladesh. Knowledge-based on the status of the biological wealth, both in terms of flora and fauna, is very rudimentary in this zone.

3.3.1.3.1 Floral Diversity

Not available

3.3.1.3.2 Faunal Diversity

Mammals: Irrawaddy dolphin (*Orcaella brevirostris*), Short-finned pilot whale (*Globicephala macrorhynchus*), Melon-headed dolphin (*Peponocephala electra*), and Indo-Pacific hump-backed dolphin (*Sousa chinensis*).

Birds: Laggar falcon (*Falco jugger*), Oriental hobby (*Falco severus*), and Small pratincole (*Glareola lactea*).

Reptiles: Green turtle (*Chelonia mydas*), Olive ridley turtle (*Lepidochelys olivacea*), Loggerhead turtle (*Caretta caretta*), and Hawksbill turtle (*Eretmochelys imbricata*).

Amphibians: Common toad (*Bufo melanostictus*), and Cricket frog (*Limnonectes limnocharis*).

3.3.1.4 Meghna Floodplain

A major part of the Meghna floodplain was created by the deposition of sediments brought in by the Old Brahmaputra River before it changed its course to the west of the Madhupur Sal tract some 200 years ago. The rest of the sediments were laid down principally by the Meghna River itself and by some minor rivers draining down from the Tipperah hills. This floodplain occupies a low-lying landscape of chars and many broad meandering channels. This zone is mostly affected by seasonal flooding while riverbank erosion is considered the major environmental hazard (Brammer, 1996).

3.3.1.4.1 Floral Diversity

Trees: Debbaru (*Polyalthia longifolia*), Rendi koroi/Rain tree (*Samanea saman*), Gora neem (*Melia azadirach*), Barun (*Crataeva nuruala*), and Pilali (*Trewia nudiflora*).

Planted trees: Kanthal (*Artocarpus heterophyllus*), Aam (*Mangifera indica*), Narikel (*Cocos nucifera*), and Supari (*Areca catechu*).

Aquatic plants: Kachuripana (*Eichhornia crassipes*), Makhna (*Euryale ferox*), Shada shapla (*Nymphaea nouchali*), and Bara nukha (*Monochoria hastata*).

3.3.1.4.2 Faunal Diversity

Mammals: Thick-eared bat (*Eptesicus pachyotis*), Rhesus macaque (*Macaca mulatta*), Common tree shrew (*Tupaia glis*), and Small Indian civet (*Viverricula indica*).

Birds: Gray nightjar (*Caprimulgus indicus*), River lapwing (*Vanellus ducaulii*), Black-shouldered kite (*Elanus caeruleus*), Cattle egret (*Bubulcus ibis*), and Black kite (*Milvus migrans*).

Reptiles: Braluniny river turtle (*Hardella thurii*), Dark-bellied marsh snake (*Xenochrophis cerasogaster*), and Slender worm snake (*Typhlops porrectus*).

Amphibians: Luge tree frog (*Rhacophorus maximus*), Boulenger's frog (*Rana alticola*), Red microhylid (*Microhyla rubra*), and Ornate microhylid (*Microhyla ornata*).

3.3.1.5 Offshore Islands

This zone covers Bhola, Hatiya, Ghasiar char, Moulvir char, Shahebanir char, Char bata, Char kukri mukri, Niihum dweep, etc. The shapes of most of the islands are continuously changing as a result of erosion and tidal insurgence. Moreover, there are extensive inter-tidal mudflats composing parts of the islands. Most of these mudflats occur along inland creeks. There are also large shoals in this area; these may consolidate into large islands by the end of this century. The vast amount of sediment brought down by the Meghna made the estuary for a considerable distance (Rashid, 1991).

3.3.1.5.1 Floral Diversity

Trees: Narikel (*Cocos nucifera*), Supari (*Areca catechu*), Rendi koroi/Rain tree (*Samanea saman*), and Bhadi (*Lannea coromandelica*).

Aquatic plants: Toapapana (*Pistia strateotes*), Kolmi (*Ipomoea aquatica*), and Jhanji (*Utricularia exoleata*).

3.3.1.5.2 Faunal Diversity

Mammals: Bengal fox (*Vulpes bengalensis*), Fishing cat (*Prionailurus viverrinus*), Common palm civet (*Paradoxurus hermaphroditus*), Ganges River Dolphin (*Platanista gangetica*), Greater bandicoot rat (*Bandicota indica*).

Birds: Indian skimmer (*Rynchops albicollis*), Purple heron (*Ardea purpurea*), Painted stork (*Mycteria leucocephala*), and Eurasian thick-knee (*Burhinus oedicnemus*).

Reptiles: River terrapin (*Batasur baska*), and Glossy marsh snake (*Gerardia prevostianus*).

Amphibians: Boulenger's frog (*Rana alficola*), and Common toad (*Bufo melanostictus*).

3.3.1.6 Meghna Estuarine Floodplain

A huge newly accreted mudflat is the main physiographic feature of the Meghna estuarine floodplain, which is mainly situated in the districts of Noakhali and Lakshmipur. Depositions and erosions are constantly taking place on the land margins, thereby continuously altering the shape of the land. During the dry season, in many, but not all, parts of the zone, the soil surface becomes saline in varying degrees. Flooding by salt water occurs primarily on the land margins during exceptionally high tides in the monsoon season and when storm surges associated with tropical cyclones occur. On the other hand, seasonal flooding, usually by rainwater or non-saline river water, is mainly shallow but fluctuates tidally (Brammer, 1996).

3.3.1.6.1 Floral Diversity

Trees: Narikel (*Cocos nucifera*), and Supari (*Areca catechu*).

Trees Water: Bhui dumur (*Ficus heterophyllus*), Pitali (*Trewia nudiflora*), and Barun (*Crataeva nurvala*).

Aquatic plants: Binna ghash (*Vetiveria zizanioides*), Chechra (*Schenoplectus articulatus*), and Hogla (*Typha angustata*).

3.3.1.6.2 Faunal Diversity

Mammals: Jackal (*Canis aureus*), Common mongoose (*Herpestes edwardsi*), and Tickell's bat (*Hesperoptenus tickelli*).

Birds: Swamp francolin (*Francolinus gularis*), Indian skimmer (*Rynchops albicollis*), Black-headed stilt (*Threskiornis melanocephalus*), and Eurasian spoonbill (*Platalea leucorodia*).

Reptiles: Ring lizard (*Varanus salvator*), Bengal monitor (*Varanus bengalensis*), and Copper head trinket snake (*Elaphe radiata*).

Amphibians: Maculated tree frog (*Polypedates maculatus*), and frog (*Rana alticola*).

3.3.2 Ecosystem and Habitat

The NSEZ is located on the coastline of southeastern Bangladesh. The area is home to a diverse range of ecosystems and habitats due to its geographical features and climatic conditions. The NSEZ area encompasses various landforms, including hillocks, plains, rivers, and coastal areas, which contribute to the region's high biological diversity. It's important to note that the ecosystems and habitats of the study region are subject to human activities, such as deforestation, pollution, industrialization, and urbanization. An in-depth assessment is crucial to safeguard the region's biodiversity and ensure the long-term sustainability of these ecosystems.

3.3.2.1 Terrestrial Ecosystem

The terrestrial ecosystem of the study region encompasses a diverse range of flora and fauna. It is characterized by various landforms, including coastal plantations, agricultural lands, homestead

plantations, and riparian vegetation. The region supports a rich biodiversity with a wide variety of plant species such as trees, shrubs, and grasses. The fauna includes various mammals, birds, reptiles, and insects that inhabit the area. The terrestrial ecosystem of the study region plays a crucial role in maintaining ecological balance and providing habitats for numerous species. However, the majority of habitats within the study region have undergone alterations due to human intervention.

3.3.2.1.1 Coastal Plantation

Mangroves are highly productive coastal ecosystems that offer exceptional habitat opportunities for numerous species, serving as feeding sites and spawning grounds. In the NSEZ site's vicinity, particularly in the southern region, coastal plantations are prevalent along the shoreline and surrounding areas. *Avicennia* spp. and *Sonneratia apetala* are the primary mangrove species used for plantation in this area. Additionally, *Acanthus ilicifolius*, another common mangrove species, is widely distributed throughout this region.

3.3.2.1.2 Agricultural Habitat

Agricultural practices of the study region are mostly mono-cropping of paddy. Ropa Aman paddy is cultivated during monsoon season. During the dry season (November to May), different types of vegetables are grown in the agricultural lands of the study region. Rabi crops include Tomatoes (*Solanum lycopersicum*), Cauliflower (*Brassica oleracea*), Cabbage (*Brassica sp.*), Green Chili (*Capsicum frutescens*), Eggplants (*Solanum sp.*), Red amaranth (*Amaranthus sp.*), Spinach (*Spinacia oleracea*), and Indian spinach (*Basella alba*), which are grown around mid-November and harvested from April to May. Common tree species found near agricultural lands are Rain tree (*Samanea saman*), Coconut (*Cocos nucifera*), Dhol Kolmi (*Ipomea pes-carpa*), etc. Humans extensively modify agricultural habitats to increase crop productivity.

3.3.2.1.3 Homestead Plantation

A characteristic feature of the homestead landscape is the presence of a variety of plant and fruit trees. Common homestead vegetation is found in the study region and settlements, giving a green panoramic view. Common species include Coconut (*Cocos nucifera*), Jackfruit (*Artocarpus heterophyllus*), Mango (*Mangifera indica*), Guava (*Psidium guajava*), Papaya (*Carica papaya*), Lemon (*Citrus spp.*), Areca palm (*Areca catechu*), Banana (*Musa sapientum*), Raintree (*Samanea saman*), etc. In addition, this vegetation offers numerous wildlife species in the study region, such as birds, herpetofauna, and mammals. Compared to agricultural habitats, homestead plantation habitats are more diverse and host many native species. Also, species assemblage in homestead plantations, particularly floral diversity, is primarily controlled by human intervention.

3.3.2.1.4 Riparian Vegetation

Riparian vegetation is present along the riverbanks, and adjacent areas to ponds, canals, and other water bodies. The riparian vegetation species play an important role in the reduction of bank erosion which contributes to the maintenance of the depth of water bodies. The main plant species found in the study region are *Samanea saman*, *Cocos nucifera*, *Sonneratia apetala*, *Acanthus ilicifolius*, etc.

3.3.2.2 Aquatic Ecosystem

The aquatic ecosystem of the study region encompasses various water bodies, including the estuarine and marine habitat of the Bay of Bengal, Feni River, Khals, lentic waterbodies (Ponds), and coastal Mudflats. These aquatic habitats support a diverse range of flora and fauna, playing a crucial role in the regional ecosystem.

3.3.2.2.1 Bay of Bengal: Sandwip Channel

Bay of Bengal an extended northern arm of the Indian Ocean bounded in the west by the east coasts of Sri Lanka and India, on the north by the deltaic region of the Ganges-Brahmaputra-Meghna River system, and on the east by the Myanmar peninsula extended up to the Andaman-Nicobar ridges. The

study region occurs beside the coastal area of Sonagazi Upazila of Feni, Mirsharai, and Sitakunda Upazila of Chattogram adjacent to the Sandwip Channel of the Bay of Bengal.

3.3.2.2.2 Feni River

The Feni River originates in the South Tripura district and flows through Sabroom town and then enters Bangladesh. Muhuri River, also called Little Feni, from Noakhali District joins it near its mouth. The NSEZ site is situated on the southern side of the Feni River and an important portion of the confluence area falls within the study region.

3.3.2.2.3 Khals

In the study area, both natural and man-made drainage khals are prominently visible, serving as outlets that eventually drain into the Bay of Bengal. These khals play a vital role in providing water for aquatic life and establishing mangrove habitats. Commonly found species in these khals include *Periophthalmus* sp. (mudskippers), various types of crabs, and other aquatic organisms. Additionally, residential waterbirds and migratory birds utilize this habitat as a foraging ground, taking advantage of the abundant resources available in the region.

3.3.2.2.4 Mudflats

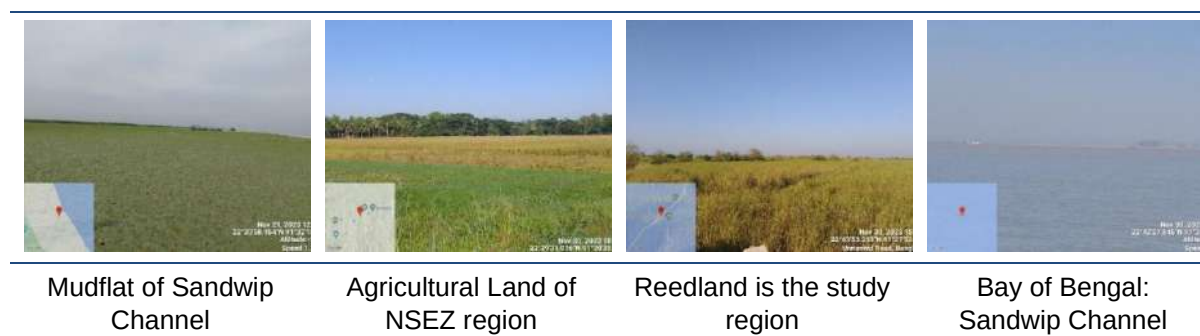
Mudflat areas are present in the adjacent areas of the NSEZ site and within the study region. A rich assemblage of marine invertebrates is found here. This makes it an important foraging area for some migratory avian species such as Common Sandpiper (*Actitis hypoleucos*), White Wagtail (*Motacilla alba*), Citrine Wagtail (*Motacilla citreola*), Common Greenshank (*Tringa nebularia*), Pacific Golden Plover (*Pluvialis fulva*), Whimbrel (*Numenius phaeopus*), etc. The mudflats also support a good number of crustacean species.

3.3.2.2.5 Lentic Waterbodies

Ponds are largely located at roadside areas and associated with individual houses or Mosques. Ponds are often maintained to fulfill the water requirement for household use and fish culture. In the study region, roadside ponds and other ponds are available for extensive, semi-intensive, intensive aquaculture. Major species cultured in the ponds are Rui (*Labeo rohita*), Catla (*Catla catla*), Silver carp (*Hypophthalmichthys molitrix*), Nile Tilapia (*Oreochromis niloticus*), etc.

Photographs of different types of habitats that are present in the study region have been shown in Figure 3-59.

Figure 3-59: Different Habitats Present in the Study Region



Source: EQMS Field Survey, November 2023

3.3.3 Flora

Baseline biodiversity study and secondary sources (Forest Department, scientific studies, and previous similar studies in the same region) are used for this study to investigate the biodiversity composition. The NSEZ site is a flat low land area covered with grey silty clay soil. The site has wetlands and remains inundated in water during monsoons and high tides. Water from the sea enters the site and nearby Mangroves Forest during high tides. This area serves as intertidal mud flats and thus provides a habitat

for mud crabs and water birds. These water birds and mud crabs occur in forest areas and other wet areas of the NSEZ site. A large variety of fishes and shrimps exists in the Susham Khal/channel passing through the NSEZ site and the Bamon Sundar channel abutting the site. The Mirsharai part of the NSEZ site does not support major vegetation. Some planted trees like Akashmoni (*Acacia auriculiformis*), Jhao Ghas (*Tamarix indica*), Karoi (*Albizia procera*), etc. are seen in this part of the NSEZ. A detailed checklist of flora represented in both the NSEZ site and study region is enclosed as Appendix B-1.

3.3.3.1 Methodology for Floral Survey

The quadrat sampling method was used for counting the vegetation structure in and around the NSEZ area. A quadrat is a frame that is laid down to mark out a specific area of the community to be sampled. Within the quadrat frame, the occurrence of plants is recorded using an appropriate measure of abundance. The quadrat method can be used in virtually any vegetation type to quantify the plant community.

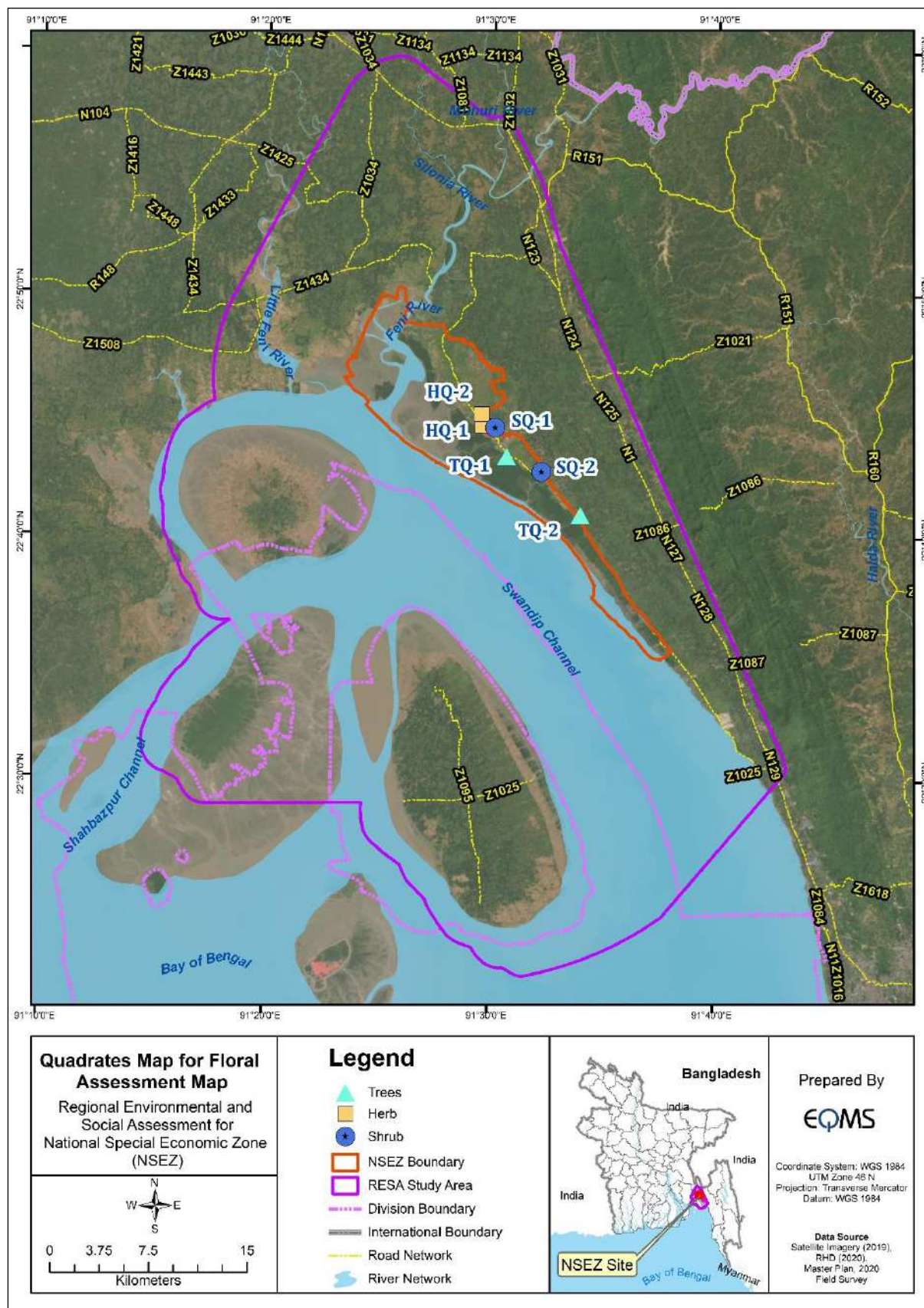
The field data collection was mainly included in the assessment of different life of floral elements such as trees, herbs, and shrubs. A total of six quadrats have been conducted in and around the study region, covering various floral aspects. The diversity index of floral study within the study region is given in Table 3-34 and Figure 3-60. Field activities during the quadrat survey are illustrated in Appendix B-2.

Table 3-34: Diversity Index of Floral Study within the Study Region

Land Use Class	Quadrates	Geographical Coordinate	Direction from the NSEZ Boundary
Trees (2 Quadrates each size of 10 x 10 m)	TQ-1	22°43'17.7"N 91°30'39.9"E	Inside the NSEZ. North-East side
	TQ-2	22°40'53.4"N 91°33'57.8"E	Outside the NSEZ. North-East side
Herb (2 Quadrates each size 5 x 5 m)	HQ-1	22°44'39.5"N 91°29'30.8"E	Outside the NSEZ. North-East side
	HQ-2	22°44'59.1"N 91°29'32.6"E	Outside the NSEZ. Northside
Shrub (2 Quadrates each size 1 x 1 m)	SQ-1	22°44'29.1"N 91°30'08.9"E	Outside the NSEZ. Northside
	SQ-2	22°42'40.7"N 91°32'13.0"E	Outside the NSEZ. Northside

Source: EQMS Field Survey, November 2023

Figure 3-60: Quadrates Map for Floral Assessment of NSEZ



Source: EQMS Field Survey, November 2023

3.3.3.2 Species Composition

During the field survey, a comprehensive inventory of plant species was conducted within the study region, resulting in the identification of a total of 56 distinct species. These encompassed a diverse array of vegetation, spanning trees, herbs, and shrubs. Upon closer examination of the recorded species, it was revealed that 43 of them belonged to the category of homestead species, indicative of plants commonly found in and around human settlements. Additionally, 10 species were classified as fallow land species, signifying their prevalence in areas that had undergone a period of abandonment or cultivation cessation. Furthermore, the survey identified three species of mangroves.

1.1.1.1 Floral Species Diversity

Shannon Diversity Index (H) is used to characterize species diversity for different quadrats. The biodiversity indices of different quadrats are presented in Table 4-22. The highest value of Shannon diversity index (H) was found for Quadrat SQ1 (2.046) followed by Quadrat HQ2 (1.937) and the lowest value was found for Quadrat HQ2 (0.932). The value of Evenness (E) was highest in Quadrat HQ2 (0.932) and the lowest evenness was found in TQ2 (0.848). The highest species richness was recorded in SQ1 (n=09) and the lowest in TQ2 (n=04). The results of the diversity index of floral study in the study region are given in Table 4-22.

Table 4-22: Results of Diversity Index of Floral Study in the Study Region

Quadrat study for floral composition within the study region						
Parameter	TQ-1	TQ-2	SQ-1	SQ-2	HQ-1	HQ-2
Shannon-Wiener Diversity Index (H)	1.878	1.176	2.046	1.827	1.663	1.937
Evenness (E)	0.903	0.848	0.931	0.939	0.928	0.932
Species Richness (S)	8	4	9	7	6	8
Total Abundance	20	36	21	18	29	18

Source: EQMS Field Survey, November 2023

3.3.3.3 Mangrove Forest

The NSEZ site includes the area of planted Mangroves Forest in NW and SE direction. Three species of Mangroves are planted in this forest, and they are Keora (*Sonneratia apetala*), Sada Bain (*Avicennia alba*), and Gewa (*Excoecaria agallocha*). Apart from these species, other weeds like Pan ghas, Lata shak, Noona Jhao, and Katar were also observed in the forest. A list of identified mangrove species in the study region is provided in Appendix B-1.3. Photographs of the vegetation observed in the study region are provided in Appendix B-2.4.

3.3.4 Fauna

The diverse landscape of Bangladesh acts as an important convergence of biological zones, a land bridge, and an ecological corridor for the flora and fauna between two major biotic subregions of the oriental region: the Indo-Himalayan and Indo-Chinese. This strategic location makes this region home to one of the most biologically diverse regions of the world. The species richness of Bangladesh is well recognized when compared with other areas. In addition, its proximity to biodiversity hotspots like India and Myanmar has led to spillover of species into Bangladesh, further contributing to its rich biodiversity.

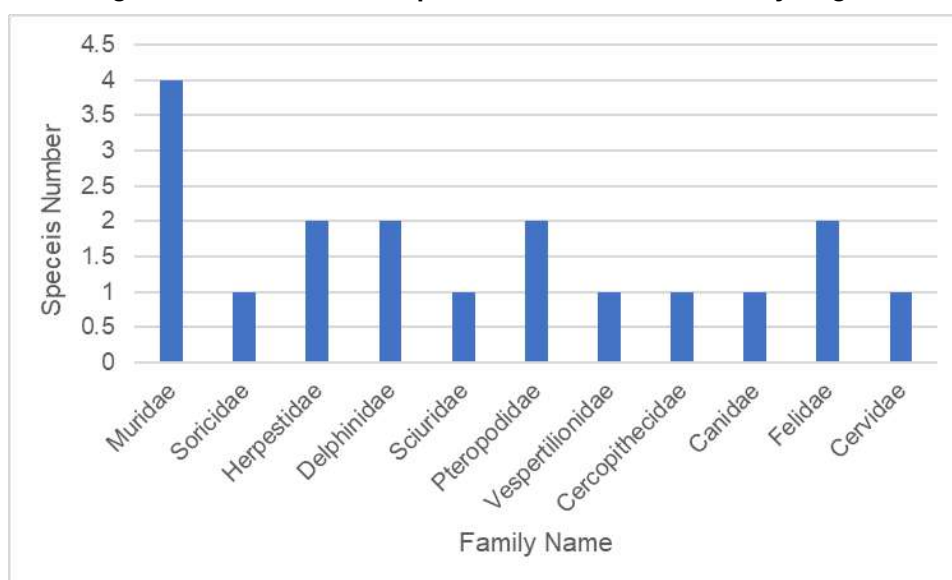
The habitat types in the study region can be classified into various categories based on its geographic location. The study area exhibits unique ecosystems including charlands, wetlands, forests, agricultural lands, mudflats, and urban areas, that support a rich variety of habitats and promote a diverse array of wildlife species. Based on the desktop review and primary baseline biodiversity study, the following categories of wildlife have been identified in the study region.

3.3.4.1 Mammals

Among the recorded species, the family Muridae represents the highest number of species ($n = 4$) (Figure 3-61). Out of the documented species, 11 species were observed in the NSEZ site. Some of the most frequently observed mammalian species found in the NSEZ site were the Small Indian Mongoose (*Herpestes auropunctatus*), Large Bandicoot Rat (*Bandicota indica*), Lesser Asiatic Yellow Bat (*Scotophilus kuhlii*), Jungle Cat (*Felis chaus*), Rhesus Macaque (*Macaca mulatta*), Spotted Deer (*Axis axis*), etc. Among the identified species, the Rhesus Macaque (*Macaca mulatta*) is categorized as Vulnerable (VU), and Fishing Cat (*Prionailurus viverrinus*) is listed as Endangered (EN) in the IUCN Red List of Threatened Species of Bangladesh 2015.

All the documented species of the NSEZ site also occurred in the study region of the NSEZ, with an additional seven species exclusively found within the study region. Some of the most frequently observed mammalian species found in the study region were the Common mongoose (*Herpestes edwardsii*), Irrawaddy dolphin (*Orcaella brevirostris*), Indian Fruit Bat (*Pteropus giganteus*), Irrawaddy Squirrel (*Callosciurus pygerythrus*), Golden Jackal (*Canis aureus*), Jungle Cat (*Felis chaus*), and Spotted Deer (*Axis axis*), etc. Photographs of the recorded mammalian species have been given in Appendix B-2.5. The study team did not observe any dolphin species during their survey in the Sandwip Channel. Nevertheless, secondary literature indicates that two species of dolphins, namely the Irrawaddy Dolphin (*Orcaella brevirostris*) and the Indo-Pacific Humpback Dolphin (*Sousa chinensis*) have been documented in the Sandwip Channel (Khan, 2018; IUCN Bangladesh, 2015). Consultation with local people has further affirmed the presence of these dolphin species in the aquatic ecosystem of the Sandwip Channel, adjacent to the NSEZ. Among the study region species, the Rhesus Macaque (*Macaca mulatta*) is categorized as Vulnerable (VU), and Fishing Cat (*Prionailurus viverrinus*) is listed as Endangered (EN) in the IUCN Red List of Threatened Species of Bangladesh 2015. On the other hand, the Jungle Cat (*Felis chaus*) and Irrawaddy Dolphin (*Orcaella brevirostris*) are categorized as Near Threatened (NT), and the rest of the 13 species are categorized as Least Concern (LC). A detailed checklist of mammals in the study region is enclosed as Appendix B-1.4.

Figure 3-61: Mammalian Species Recorded in the Study Region



Source: EQMS Field Survey, November 2023

3.3.4.2 Avifauna

The study region encompasses diverse habitat types that are home to a variety of bird species. Based on field surveys and secondary data, a total of 185 bird species belonging to 55 families were recorded in the study region. Among the recorded species, the family Accipitridae represents the highest number ($n = 12$) of species. Out of the documented species, 89 species were recorded from the NSEZ site.

Some of the notable species that are seen in the NSEZ site were the Asian Openbill (*Anastomus oscitans*), Asian Palm Swift (*Cypsiurus balasiensis*), Besra (*Accipiter virgatus*), Black Baza (*Aviceda leuphotes*), Black-headed Ibis (*Threskiornis melanocephalus*), Bronze-winged jacana (*Metopidius indicus*), Dusky Warbler (*Phylloscopus fuscatus*), Greater Painted-snipe (*Rostratula benghalensis*), Eurasian Curlew (*Numenius arquata*), Lesser Sandplover (*Charadrius mongolus*), etc. Among the recorded birds of the NSEZ site, the Black-headed Ibis (*Threskiornis melanocephalus*) is categorized as Vulnerable (VU), while all other species are categorized as Least Concern (LC) as per the IUCN Red List of Threatened Species.

All the bird species found in the NSEZ site were also present in the study region. However, there are 96 species exclusively identified within the study region that are not present in the NSEZ site. Some notable birds found in the study region are the Asian Openbill (*Anastomus oscitans*), Greater Flameback (*Chrysocolaptes lucidus*), Indian Roller (*Coracias benghalensis*), Pied Kingfisher (*Ceryle rudis*), Chestnut-headed Bee-eater (*Merops enelope Itia*), Green-billed Malkoha (*Phaenicophaeus tristis*), Large-tailed Nightjar (*Caprimulgus macrurus*), Black-headed Ibis (*Treskeornis melanocephala*), Crested Serpent Eagle (*Spilornis cheela*), Wood snipe (*Gallinago nemoricola*), Nordmann's Greenshank (*Tringa guttifer*), Eurasian wigeon (*Mareca penelope enelope*), Ferruginous Pochard (*Aythya ferina*), Eurasian Spoonbill (*Platalea leucorodia*), Spotted Greenshank (*Tringa guttifer*), Spotted Redshank (*Tringa erythropus*), etc. Among the recorded birds of the study region, the Black-headed Ibis (*Threskiornis melanocephalus*) is categorized as Vulnerable (VU), while the Grey-headed Fish Eagle (*Ichthyophaga ichthyaetus*) is categorized as Near Threatened (NT). All other bird species are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species of Bangladesh (2015). Photographs of the avian species of the study region are shown in Appendix B-2.6. A list of avian species that were found in the study region is given in Appendix B-1.5.

Migratory Bird

Bangladesh is in a unique geographical position in South Asia. The country's vast wetlands, spanning approximately 6.8 hectares, and its relatively less challenging terrain provide an ideal habitat for avian species seeking a comfortable home away from the challenges of seasonal transitions. Every year, birds from the farthest corners of the world, including Siberia, Mongolia, and the Tibetan plateau, migrate to Bangladesh to enjoy its temperate winter climate.

The aquatic habitat and mudflats of the study area are regarded as an important area for migratory birds due to its location along the migratory routes of many bird species. The vast wetlands, marshes, and mudflats of this area provide suitable habitats for many migratory bird species, offering them a place to rest and feed during their long journeys. The survey conducted in the study region recorded a total of 65 migratory bird species. Among the recorded species 21 species were found in the NSEZ site. Notable migratory species observed in the sites were Common Sandpiper (*Actitis hypoleucos*), Common snipe (*Gallinago gallinago*), Lesser whistling duck (*Dendrocygna javanica*), Black-headed Ibis (*Threskiornis melanocephalus*), Eurasian Curlew (*Numenius arquata*), Green Sandpiper (*Tringa ochropus*), Spotted Redshank (*Tringa erythropus*), Wood Sandpiper (*Tringa glareola*), etc. In the NSEZ site, the Black-headed Ibis (*Threskiornis melanocephalus*) is the only species that holds conservation significance as the species is categorized as Vulnerable (VU) (IUCN, 2015).

All the recorded species were also found in the study region of the NSEZ. However, 30 species were exclusively identified within the study region. Notable migratory birds recorded from the study region were the Common Sandpiper (*Actitis hypoleucos*), Green Sandpiper (*Tringa ochropus*), White Wagtail (*Motacilla alba*), Pied Avocet (*Recurvirostra avosetta*), Grey-headed lapwing (*Vanellus cinereus*), Pacific golden plover (*Pluvialis fulva*), Black-tailed godwit (*Limosa limosa*), Common snipe (*Gallinago gallinago*), Grey heron (*Ardea cinerea*), Eurasian curlew (*Numenius arquata*), Ruddy Shallduck (*Tadorna ferruginea*), Gadwall (*Mareca strepera*), Northern pintail (*Anas acuta*), Northern Shoveller (*Anas clypeata*), Eurasian Teal (*Anas crecca*), Baikal teal (*Sibirionetta formosa*), Marbled duck (*Marmaronetta angustirostris*), Eurasian wigeon (*Mareca penelope*), Long-toed stint (*Calidris subminuta*), Black-headed Ibis (*Threskiornis melanocephalus*), Sooty tern (*Onychoprion fuscatus*),

Black-naped tern (*Sterna sumatrana*), etc. Some of these birds start visiting the site in October and return in April. The early migrants are the Common Sandpiper (*Actitis hypoleucos*), White Wagtail (*Motacilla alba*), Lesser Sand plover (*Charadrius mongolus*), Common Whimbrel (*Numenius phaeopus*), Brown-headed gull (*Chroicocephalus brunnicephalus*), etc. Among the migratory birds of the study region, the Black-headed Ibis (*Threskiornis melanocephalus*) is categorized as Vulnerable (VU), and all other species don't hold any conservation significance as per the IUCN Red List of Threatened Species of Bangladesh (2015). An overview of the Migratory status of recorded birds is shown in Appendix B.

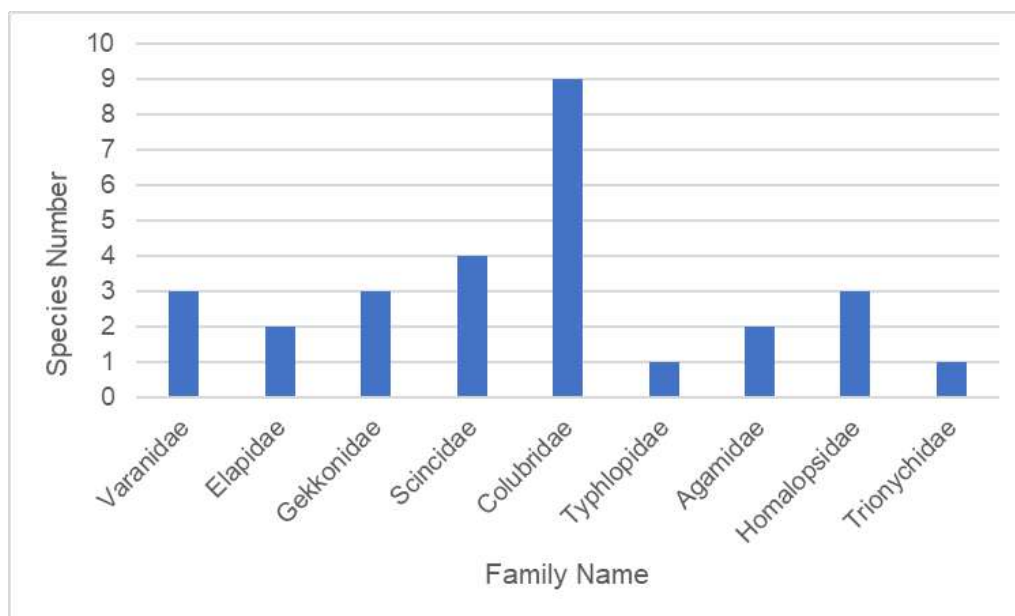
3.3.4.3 Herpetofauna

Herpetofauna refers to the collective group of reptiles and amphibians found in a particular region or habitat. Bangladesh is home to a diverse array of herpetofauna, which includes various species of reptiles and amphibians. The country's tropical climate and numerous waterways provide ideal habitats for these creatures. Some of the most commonly found reptiles in Bangladesh include various species of snakes, such as cobras, kraits, and vipers, as well as numerous species of lizards, including geckos and skinks (Khan, 2008, Hasan et. al., 2014). Bangladesh is also home to several species of turtles and crocodiles. In terms of amphibians, there are many species of frogs, toads, and caecilians that can be found throughout the country. Despite their ecological importance, many of these species are threatened due to habitat loss and over-harvesting. Due to its proximity to diverse habitat types, the study region sustains a broad spectrum of reptilian and amphibian species.

3.3.4.3.1 Reptiles

A total of twenty-eight species of reptilian fauna, belonging to nine families, were documented in the study region through a combination of primary and secondary data sources. The family Colubridae boasts the highest number of species (n=09) among the recorded reptilian group (Figure 3-62). Out of the documented species, 12 species were observed in the NSEZ site. Notable species recorded from the NSEZ site were Checkered Keelback (*Xenochrophis piscator*), Common Garden Lizard (*Calotes versicolor*), Common Smooth Water Snake (*Enhydryn enhydryn*), Spotted Litter Skink (*Sphenomorphus maculatus*), Yellow Monitor (*Varanus flavescens*), etc. As per the IUCN Red List of Threatened Species of Bangladesh 2015, the NSEZ site doesn't hold any species of Conservation significance.

Among the recorded species, 16 species are exclusively found in the study region of the NSEZ. Noteworthy among the reptilian fauna in the study region are the Asian water monitor (*Varanus salvator*), Bengal Monitor (*Varanus bengalensis*), Yellow Monitor (*Varanus flavescens*), Checkered Keelback (*Xenochrophis piscator*), Common Garden Lizard (*Calotes versicolor*), Dog-faced Water Snake (*Cerberus rynchops*), and Spectacled Cobra (*Naja naja*). Among the recorded species, the Asian water monitor (*Varanus salvator*) is categorized as Vulnerable (VU), while the Bengal Monitor (*Varanus bengalensis*), Yellow Monitor (*Varanus flavescens*), Monocled Cobra (*Naja kaouthia*), Red-necked Keelback (*Rhabdophis subminiatus*), and Spectacled Cobra (*Naja naja*) are classified as Near Threatened (NT) according to the IUCN Red List of Threatened Species of Bangladesh 2015.

Figure 3-62: Reptilian Species Recorded in the Study Region

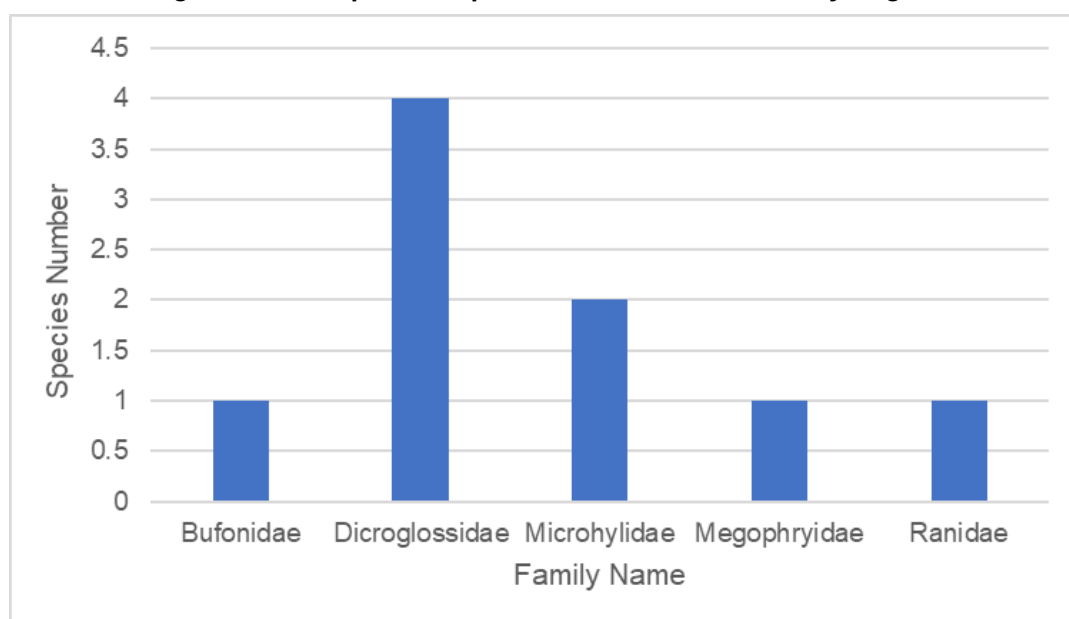
Source: EQMS Field Survey, November 2023

3.3.4.3.2 Amphibians

The baseline herpetofauna survey, along with supplementary data, revealed a collective presence of nine amphibian species from five distinct families within the study region. The family Dicoglossidae boasts the highest number of species (n=4) (Figure 3-63). Out of the documented species, five species are observed in the NSEZ site. However, all the recorded species of the NSEZ site are regarded as Least Concern (LC) as per the IUCN Red List of Threatened Species of Bangladesh 2015.

On the other hand, study regions of the NSEZ hold all the recorded species that are also found in the NSEZ site. However, four species are exclusively found within the study region. Notable among the amphibians in the study region are the Common Toad (*Duttaphrynus melanostictus*), Indian skipper frog (*Euphlyctis cyanophlyctis*), Indian Bullfrog (*Hoplobatrachus tigerinus*), Jerdon's bullfrog (*Hoplobatrachus crassus*), and others. Among these species, the Cascade Frog (*Amolops marmoratus*) is categorized as Vulnerable (VU) according to the IUCN Red List of Threatened Species of Bangladesh 2015, while the remaining species are classified as Least Concern (LC) in terms of conservation significance.

It is noteworthy that all reptilian and amphibia species receive legal protection under the Bangladesh Wildlife (Conservation and Security) Act, 2012, safeguarding them from hunting, killing, and capturing. A detailed list of herpetofauna species found in the study region is shown in Appendix B-1.6.

Figure 3-63: Amphibian Species Recorded in the Study Region

Source: EQMS Field Survey, November 2023

3.3.5 Aquatic Biodiversity

3.3.5.1 Ichthyofauna

The primary goal of the fisheries study was to assess the comprehensive status of fisheries, encompassing both captured and cultured fish species, within the study region. To determine the composition of fish species, methods such as fish market surveys, consultations with local residents, focus group discussions with fishermen, and key informant interviews with the Upazila Fisheries Officers were employed.

3.3.5.1.1 Fisheries Management in the Study Region

Following the field study, the study team observed three primary types of fishing activities within the study region. These are:

- Freshwater Aquaculture (extensive, semi-intensive)
- Fishing in Feni River, estuary, and adjacent Khal (Susham Khal, Saherkhali Khal)
- Fishing in the Bay of Bengal: Sandwip channel

Pond-based freshwater aquaculture practices, or cultured fisheries, are not very common in the study region. Some seasonal water bodies and reservoirs are observed in the region. However, mixed culture practices are commonly observed in Sonagazi, Mirsharai, Sitakunda, and Sandwip Upazila. Common fish species cultured in the ponds are Nile Tilapia (*Oreochromis niloticus*), Rui (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus cirrhosus*), Kalbaus (*Labeo calbasu*), Silver Carp (*Hypophthalmichthys molitrix*), Big head (*Hypophthalmichthys nobilis*), etc. Black tiger shrimp and Giant freshwater prawn species do not hold any separate culture techniques but are also cultured with carp species.

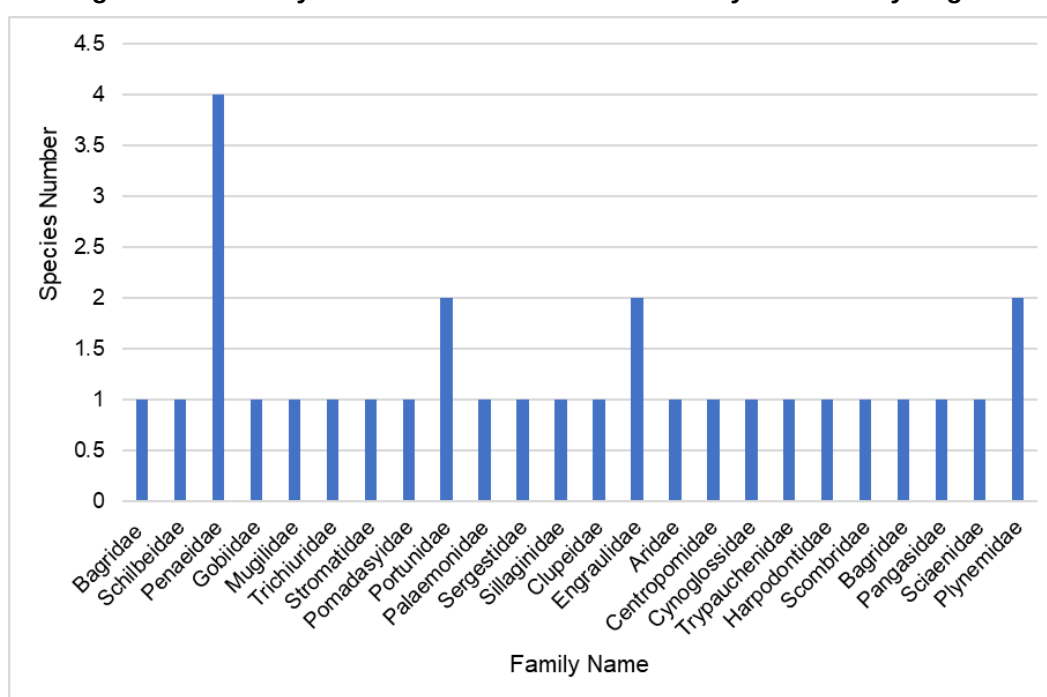
Fishing activities based on rivers are also noted in the study region which is defined as captured fisheries. When engaging in river fishing, fishermen utilize medium-sized mechanized fishing boats equipped with various types of fishing nets. The fishermen in the region are classified into three main groups: professional, seasonal, and subsistence. The majority belong to the professional group, relying on fishing as their primary source of income year-round. Seasonal fishermen participate in fishing during specific periods of the year, while the subsistence group fishes opportunistically primarily for household consumption.

Furthermore, the NSEZ is situated on the eastern side of the Sandwip Channel (Bay of Bengal). Substantial fishing activities have been observed in the Sandwip Channel, with marine and estuarine fish being caught in this area.

3.3.5.1.1.1 Coastal Fisheries Diversity

In Sonagazi, Mirsharai, Sitakunda, and Sandwip coasts that fall within the study region, baseline fisheries survey revealed a total of 30 species, comprising 22 species of finfish, 2 species of crab, and 6 species of shrimp. The recorded 30 species are distributed across 24 families. The highest number of species belongs to the family Penaeidae ($n = 04$), while Portunidae, Engraulidae, and Plynemidae each hold two species ($n = 02$) separately. The remaining 20 families each hold one species ($n = 01$) separately. Family-based coastal fisheries diversity is presented in Figure 3-64. A detailed list of coastal fisheries diversity that was found in the study region is provided in Appendix B-1.7.

Figure 3-64: Family-based Coastal Fisheries Diversity in the Study Region



Source: EQMS Field Survey, November 2023

3.3.5.1.1.2 Fish Farming

The supply of fish for household consumption in the study region primarily relies on aquaculture activities carried out in ponds, lakes, and reservoirs in the surrounding areas. A total of fourteen species of fish and two species of crustaceans are mostly cultured by the fish farmers of the study region. Among the culture species, farming of Nile tilapia (*Oreochromis niloticus*), Catla (*Catla catla*), Rui (*Labeo rohita*), Mrigal (*Cirrhinus cirrhosus*), Silver Carp (*Hypophthalmichthys molitrix*), Grass Carp (*Ctenopharyngodon idella*), Bighead Carp (*Hypophthalmichthys nobilis*), Pabda (*Ompok pabda*), Thai Pangus (*Pangasianodon hypophthalmus*) and Koi (*Anabas testudineus*), holds great potential for high productivity. Bagda Chingri (*Penaeus monodon*) and Golda Chingri (*Macrobrachium rosenbergii*) are also cultures along with the carp species in the same pond. A detailed checklist of cultured fish and crustacean species found in the study region has been presented in Appendix B-1.8.

3.3.5.1.1.3 Fishing Crafts and Gears

Fishermen use different types of crafts that differ in length, breadth, depth, shape, and size in the study region. Fishermen are widely using mechanized or motorized boats for fishing. Some fishing boats are manually operated by using paddles and pole propulsion with or without sails.

Different types of fishing gear are used to catch fish, ranging from traditional to unique, with mesh sizes and lengths that vary depending on the availability of fish species in different seasons and water depths. A total of eight types of gear including five types of nets were used in the Feni River estuary, khals, reservoirs, and Sandwip channel which were classified into four categories: fishing nets, fish traps, hooks-line, and wounding gear. Types of fishing gear used in the study region have been presented in Table 3-35.

Table 3-35: Fishing Gear Used in the Study Region

Category	Types of Gear	Name of gear
Fishing Net	Gill Net	Fash Jal, Current Jal, and Char Pata Jal
	Seine net	Ber Jal
	Cast net	Jhaki Jal
	Marine Set bag net	Behundi Jal
	Dragged Net	Thela jal and Moiya Jal
Trap	Fish Trap	Chai and Anta
Hooks-Line	Borshi	Chip Borshi
Wounding Gear	-	Koach

Source: EQMS Field Survey, November 2023

3.3.5.2 Plankton and Benthos

Plankton and benthos are two important components of aquatic ecosystems. Plankton refers to small organisms, including phytoplankton (plant-like organisms) and zooplankton (animal-like organisms), that float or drift in the water column and are unable to swim against the current. These tiny organisms are the base of the food chain for many aquatic animals and play a crucial role in the global carbon cycle by absorbing and releasing carbon dioxide. In contrast, benthos refers to organisms that live on or near the bottom of aquatic environments, including mollusks, crustaceans, and various species of fish. Benthic organisms play an important role in nutrient cycling and sediment transport, and they are also an important food source for many larger aquatic animals.

Both plankton and benthos are important indicators of the health of aquatic ecosystems. Changes in their populations can be caused by a variety of factors, including changes in water temperature, nutrient availability, and pollution levels. Understanding the roles and dynamics of these organisms is crucial for the management and conservation of aquatic environments.

Samples of plankton and benthos were collected from each predetermined sampling location near the confluence of the Feni River and the Sandwip Channel, in proximity to the NSEZ. The sampling points for the plankton and benthos are detailed in Table 3-36.

Collection and Identification of Planktonic Sample

For the qualitative study, plankton was collected by plankton net (no. 20 silk bottling cloth, mesh size: 45 µm) at predefined ten sample collection points of Feni River and Sandwip channel (Table 3-36 and Figure 3-65). After collection, they were preserved in 3% formalin and a few drops of Glycerin and Lugol's solution. Pictorial views of the plankton sample collection are shown in Appendix B-2.2. After adding preservatives, they were brought to the laboratory for species identification and numerical abundance.

Table 3-36: Sampling Points for Plankton and Benthos

Sampling Code	Geographical Coordinates	Location Details
PZ-1/PB-1	22°46'30.46"N, 91°26'18.02"E	Downstream of Feni River
PZ-2/PB-2	22°45'20.40"N, 91°25'17.46"E	Confluence of Feni River and Sandwip Channel
PZ-3/PB-3	22°44'3.60"N, 91°25'25.43"E	Upstream of the proposed Basundhara Jetty Area
PZ-4/PB-4	22°43'25.94"N, 91°26'24.79"E	Upstream of the proposed Basundhara Jetty Area
PZ-5/PB-5	22°42'58.97"N, 91°27'27.43"E	Upstream of the proposed Basundhara Jetty Area (Outlet of Daurkhali Khal)
PZ-6/PB-6	22°42'38.78"N, 91°27'44.29"E	Proposed Basundhara Jetty Area (Sandwip Channel)
PZ-7/PB-7	22°42'14.50"N, 91°28'30.24"E	Downstream of the proposed Basundhara Jetty Area (Outlet of Bamonsundor Khal)
PZ-8/PB-8	22°42'0.74"N, 91°29'21.16"E	Downstream of the proposed Basundhara Jetty Area (Sandwip Channel)
PZ-9/PB-9	22°41'28.72"N, 91°30'22.45"E	Downstream of the proposed Basundhara Jetty Area (Sandwip Channel)
PZ-10/PB-10	22°40'55.75"N, 91°31'13.80"E	Downstream of the proposed Basundhara Jetty Area (Outlet of Saherkhali Khal)

Source: EQMS Field Study, November 2023

Benthos and Plankton Sampling Locations Map

Regional Environmental and Social Assessment for National Special Economic Zone (NSEZ)

0 4.75 9.5 19 km

Legend

- Benthos Sampling Location
- International Boundary
- Road Network
- NSEZ Boundary
- RESA Study Area
- River Network

Swadip Channel

Bay of Bengal

Shahbazpur Channel

PB/PZ-1, PB/PZ-2, PB/PZ-3, PB/PZ-4, PB/PZ-5, PB/PZ-6, PB/PZ-7, PB/PZ-8, PB/PZ-9, PB/PZ-10

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

Data Source
Satellite Imagery (2019),
RHD (2020),
Master Plan, 2020
Field Survey

Prepared by
EQMS

Collection and Identification of Benthos Sample

An attempt has been made to identify the benthic macroinvertebrates up to genus or species level following the field identification guide - Heard Island and MC Donald Island benthic invertebrates (Hibberd and Moore, 2009) and identification of annelid, polychaeta (Holthe, 1992). Photographs of benthos sampling are given in Appendix B-2.3.

A total of nineteen species of phytoplankton were identified by sample analysis from ten predefined sample collection locations. The phytoplankton in the study region was represented by twelve groups and the dominant phytoplankton group was the Bacillariophyceae. In the case of species, *Melosira* sp. was dominant under Bacillariophyceae. Species composition and numbers of phytoplankton per liter have been presented in Table 3-37.

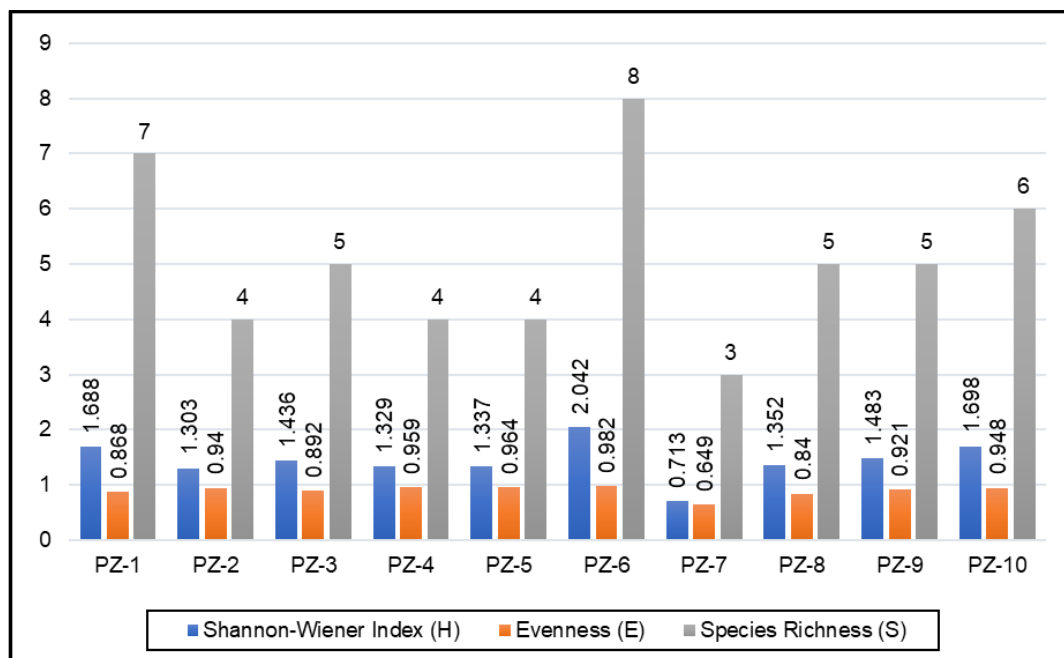
Table 3-37: Phytoplankton Profile in the Study Region

Class	Genus	Number (cells/L)									
		PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	PZ8	PZ9	PZ10
Bacillariophyceae	<i>Melosira sp.</i>	135	50	0	0	0	32	53	0	0	0
	<i>Amphora sp.</i>	0	23	0	0	0	34	0	2	0	0
	<i>Chaetoceros sp.</i>	12	23	0	0	29	27	0	0	55	13
	<i>Cyclotella sp.</i>	0	0	0	42	0	0	0	3	0	23
	<i>Nitzschia sp.</i>	32	0	41	65	0	0	0	0	0	0
	<i>Odontella sp.</i>	0	0	0	0	0	22	0	0	17	0
	<i>Fragilaria sp.</i>	0	0	0	0	0	0	18	0	37	0
Chlorophyceae	<i>Oocystis sp.</i>	0	0	14	0	19	29	0	0	0	23
Coscinodiscaceae	<i>Coscinodiscus sp.</i>	37	0	0	0	0	12	0	20	0	0
Cyanophyceae	<i>Anabaena sp.</i>	21	0	0	0	0	0	0	0	12	0
	<i>Raphidiopsis sp.</i>	0	0	43	0	0	0	0	0	0	0
Cymbellaceae	<i>Cymbella sp.</i>	0	0	0	0	0	0	3	0	0	0
Chrysophyceae	<i>Dictyocha sp.</i>	45	0	0	0	44	0	0	0	35	0
Dinophyceae	<i>Ceraatium sp.</i>	0	0	0	33	0	27	0	0	0	13
Lachnospiraceae	<i>Clostridium sp.</i>	0	0	0	0	0	0	0	17	0	0
Ulotrichaceae	<i>Ulothrix sp.</i>	0	0	21	0	0	0	0	0	0	38
Cryptophyceae	<i>Rhodomonas sp.</i>	0	19	0	27	0	0	0	0	0	0
Euglenophyceae	<i>Euglena sp.</i>	76	0	84	0	24	35	0	0	0	0
Zygnemataceae	<i>Zygnema sp.</i>	0	0	0	0	0	0	0	14	0	12

Source: Laboratory Analysis, December 2023

The Shannon-Wiener diversity indices by sampling location have been presented in Figure 3-66. The graph indicates that the Shannon-Wiener index (H) diversity of Phytoplankton is higher in PZ-6 ($H=2.042$) and lower in the sampling point PZ-7 ($H=0.713$). Evenness is higher in the sampling point PZ-6 ($E=0.982$) and Lower in PZ-7 ($E=0.649$). The higher Evenness value of PZ-6 indicates that the number of phytoplankton classes is more evenly distributed followed by PZ-5, PZ-4, PZ-10, PZ-2, PZ-9, PZ-3, PZ-1, PZ-8, and PZ-7, respectively.

Figure 3-66: Diversity Indices of Phytoplankton



Source: Laboratory Analysis, December 2023

3.3.5.2.2 Zooplankton Analysis

A total of fourteen species of zooplankton were identified by sample analysis from predefined sample collection locations of the Sandwip Channel, downstream of Feni River and its confluences adjacent to the NSEZ. *Moina* sp. was the highest abundant zooplankton species in the study region. Species composition and the number of zooplankton per liter have been presented in Table 3-38.

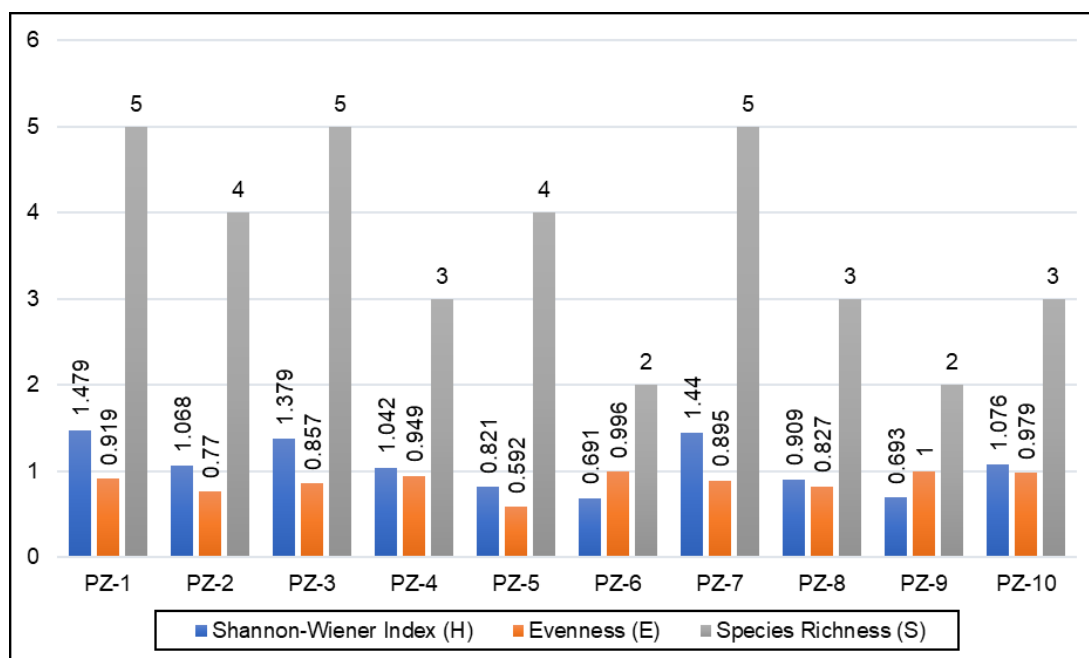
Table 3-38: Zooplankton Profile in the Study Region

Class	Species	Number (individuals/L)									
		PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	PZ8	PZ9	PZ10
Copepoda	<i>Diaptomus</i> sp.	18	37	0	25	80	0	0	0	22	0
	<i>Cyclops</i> sp.	0	26	0	24	0	0	21	13	0	0
Monogononta	<i>Brachionus</i> sp.	0	2	2	0	3	0	0	2	0	0
	<i>Felinia</i> sp.	0	0	0	0	0	0	0	0	0	22
	<i>Lecane</i> sp.	0	0	36	0	0	13	0	0	0	0
Branchiopoda	<i>Daphnia</i> sp.	42	0	0	0	0	0	20	0	0	0
	<i>Polyphemus</i> sp.	0	0	0	0	12	0	0	0	0	0
	<i>Moina</i> sp.	56	0	49	11	0	0	0	0	0	17
	<i>Bosmina</i> sp.	46	0	28	0	0	0	12	0	0	0
	<i>Cladocera</i>	0	0	17	0	0	0	0	0	0	13
Eurotatoria	<i>Asplanchna</i> sp.	0	0	0	0	13	0	0	0	0	0
Hexanauplia	<i>Calanus</i> sp.	0	0	0	0	0	15	0	10	0	0
	<i>Cyclops</i> sp.	12	9	0	0	0	0	7	0	0	0
Mysidae	<i>Mysis</i> sp.	0	0	0	0	0	0	43	0	23	0

Source: Laboratory Analysis, December 2023

The Shannon-Wiener diversity indices by sampling location have been presented in Figure 3-67. Shannon-Wiener index (H) is higher in the PZ-1 ($H=1.479$) sampling location and lower in PZ-6 ($H=0.691$). The evenness value is higher in the sampling points PZ9 ($E=1$) and Lower in PZ5 ($E=0.592$). A higher Evenness value of PZ-9 indicates that the number of Zooplankton classes is more evenly distributed among the other sampling points followed by PZ-6, PZ-10, PZ-4, PZ-1, PZ-7, PZ-3 PZ-8, PZ-2, and PZ-5 respectively.

Figure 3-67: Diversity Indices of Zooplankton



Source: Laboratory Analysis, December 2023

3.3.5.2.3 Benthos Analysis

A total of Sixteen species were identified from ten sampling locations. These genera belong to Crustaceans, Insecta, Polychaetas, Gastropoda, Bivalvia, etc. According to the analysis, three Species of Polychaeta, six species of Gastropoda, five species of Bivalvia, one species of Insecta, and one species of Crustacea were found in the study region. Benthos abundance varied between 755 to 33 individuals per square meter (individuals/m²) in the present study for the Sandwip Channel and its adjacent areas (Table 3-39).

Table 3-39: Benthos Profile in the Study Region

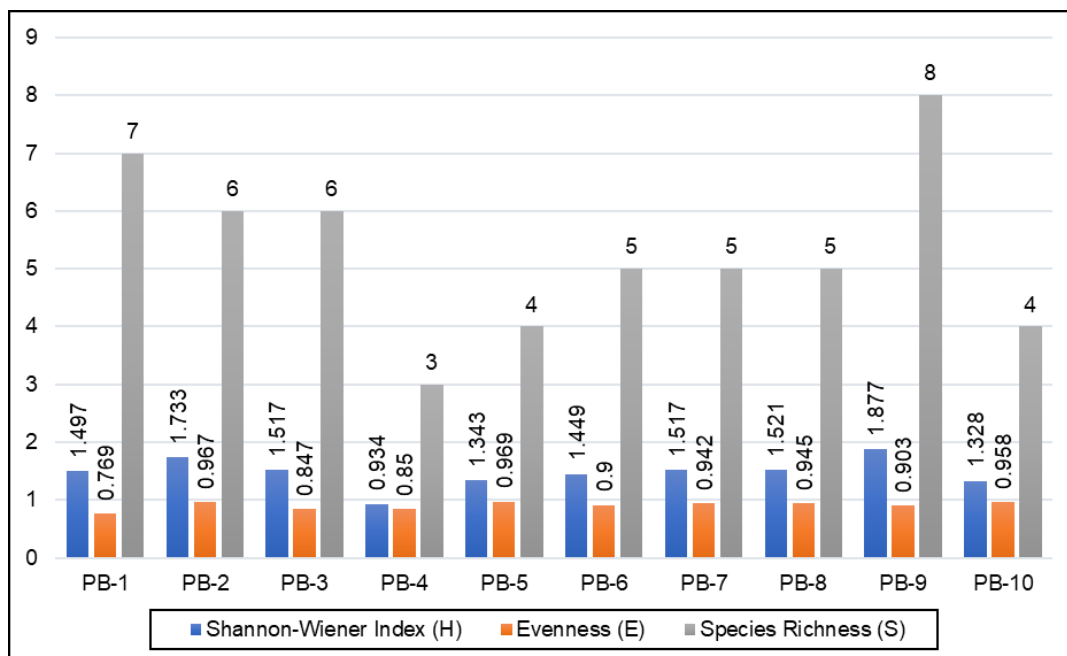
Groups	Species	Number (N) [Individuals/m ²]									
		PB1	PB2	PB3	PB4	PB5	PB6	PB7	PB8	PB9	PB10
Polychaeta	<i>Nereis lamellosa</i>	755	0	222	0	0	0	177	0	0	89
	<i>Namalycastis indica</i>	0	0	89	0	0	44	0	0	44	0
	<i>Lumbrineris sp.</i>	0	89	0	0	177	0	0	0	0	0
Gastropoda	<i>Bellamya sp.</i>	89	0	0	33	0	0	0	89	44	0
	<i>Architectonica laevigata</i>	0	0	44	0	0	0	0	44	0	44
	<i>Anachis miser</i>	33	88	0	0	89	33	0	44	89	0
	<i>Indoplanorbis exustus</i>	88	0	0	0	0	44	44	0	0	0
	<i>Melanoides sp.</i>	0	89	0	0	0	134	0	88	177	0
	<i>Cerithidea sp.</i>	0	89	0	0	89	0	0	0	89	0
Bivalvia	<i>Anadara sp.</i>	222	0	133	0	0	0	133	0	44	0
	<i>Trachycardium sp.</i>	0	0	88	134	0	0	88	0	0	44
	<i>Parreysia corrugata</i>	0	177	0	0	0	0	0	0	134	0
	<i>Mactra sp.</i>	89	0	0	177	0	44	0	0	0	0
	<i>Donax sp.</i>	0	0	0	0	0	0	89	0	0	0
Insecta	<i>Chironomus sp.</i>	222	177	0	0		0	0	134	0	0
Crustacea	<i>Shrimp larvae</i>	0	0	448	0	133	0	0	0	266	89

Note: Grab area for single sample = 0.0225 m²; N = Number of individuals/m²

Source: Laboratory Analysis, December 2023

The Shannon-Wiener diversity indices by sampling location have been presented in Figure 3-68. The graph indicates that macrobenthos diversity is higher in PB-9 ($H=1.877$) and lower in the sampling point PB-4 ($H=0.934$). The evenness value is higher in the sampling point PB-5 ($E=0.969$) and lower in PB-1 ($E=0.769$). A higher Evenness value of PB-5 indicates that the number of Benthos classes is more evenly distributed among the other sampling points.

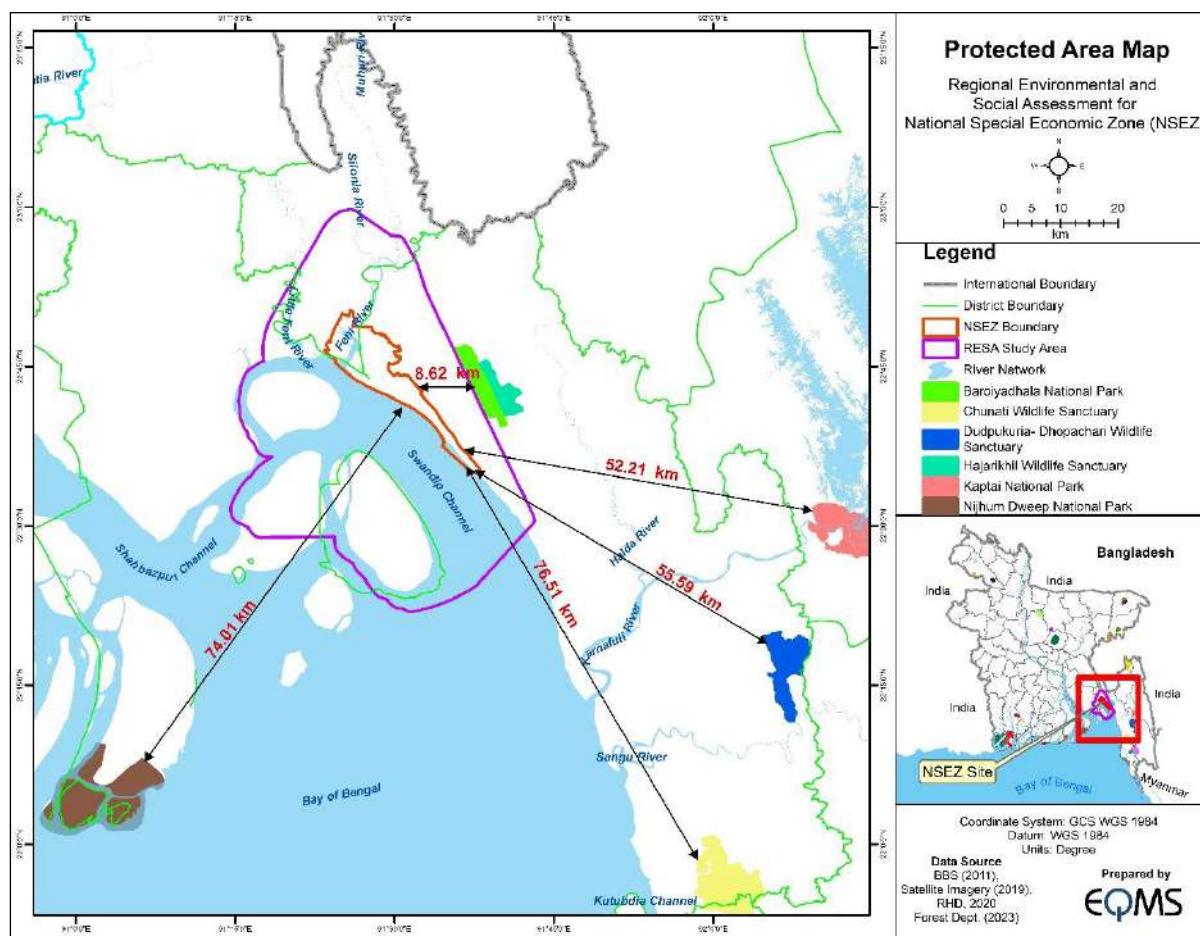
Figure 3-68: Diversity Indices of Benthos



Source: Laboratory Analysis, December 2023

3.3.6 Protected Areas

The protected area refers to an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity and natural and associated cultural resources and managed through legal or other effective means i.e., a protected area is predominantly a natural area established and managed in perpetuity, through legal or customary regimes, primarily to conserve their natural resources. According to the Wildlife (Conservation and Security) Act, 2012, types of protected areas are national parks, sanctuaries, eco-park, botanical gardens, community conservation areas, safari parks, Kunjaban, etc. The NSEZ site as well as the study region doesn't hold any protected area. Baroiyadhala National Park and Hazarikhil Wildlife are the closest protected areas from the NSEZ, but they fall outside the study region. A map of the protected areas in the region is given in Figure 3-69.

Figure 3-69: Protected Areas in the Study Region

Source: Data from the Forest Department and map prepared by EQMS

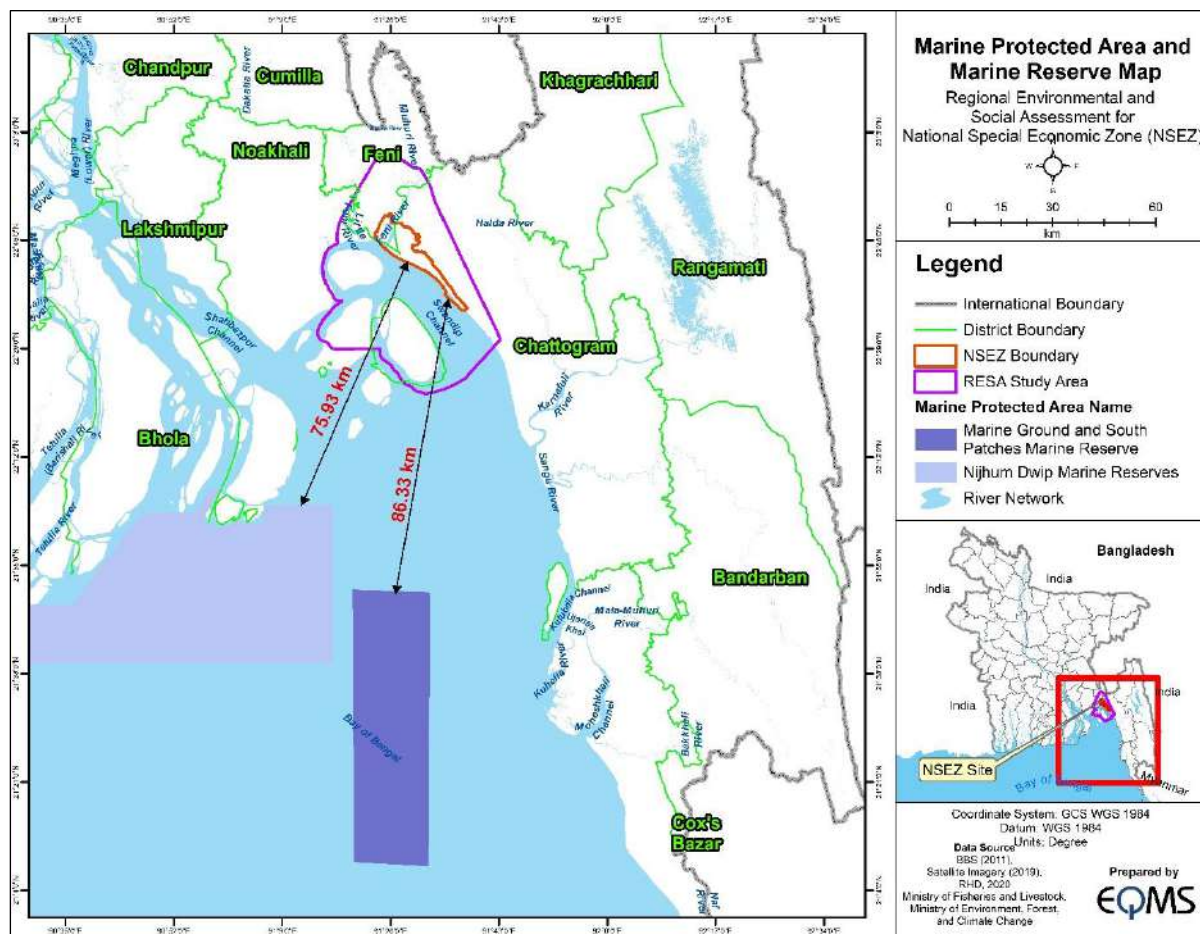
3.3.6.1 Marine Protected Areas

According to sections 13 (1) and 13 (2) of the Wildlife (Conservation and Security) Act-2012, the Ministry of Environment, Forest, and Climate Change (MOEFCC), Government of Bangladesh has declared two Marine Protected Areas in Bangladesh. These are 1) Swatch of No-Ground in the Bay of Bengal, and 2) Saint Martin Marine Protected Area (Figure 3-70). These two MPAs are located approximately 184.5 km and 162.7 km respectively from the boundary of the study region.

3.3.6.2 Marine Reserves

According to section 28 of the Marine Fisheries Ordinance 1983 (Ordinance No. 35 of 1983), the Ministry of Fisheries and Livestock (MOFL), the Government of Bangladesh has declared two marine reserves area in the territory of Bangladesh Fisheries Waters to date. The first marine reserve is “Middle Ground and South Patches” of the Bay of Bengal, declared on 29 October 2000. The total area of the Middle Ground and South Patches marine reserve is 698 sq km. The second marine reserve of the country is the “Nijhum Dwip Marine Reserves” of the Bay of Bengal, declared on 23 June 2019. The total area of the Nijhum Dwip Marine Reserves is 3,188 sq km. The nearest distance between Nijhum Dwip Marine Reserves and the NSEZ site is approximately 67 km. On the other hand, the nearest distance between Middle Ground and South Patches marine reserves and the NSEZ site is approximately 80 km (Figure 3-70).

Figure 3-70: Marine Protected Area and Marine Reserve in the Region

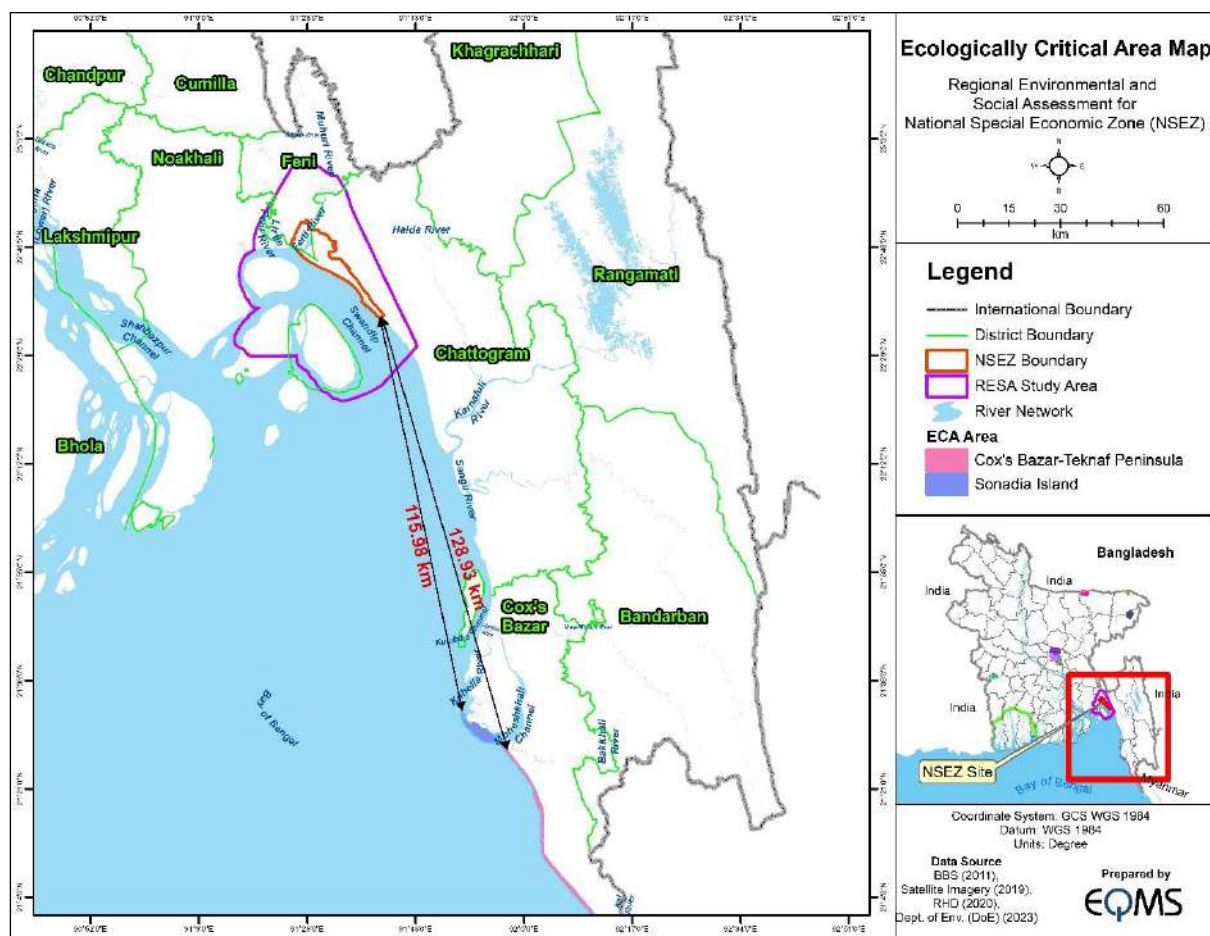


Source: Data from DOE & DOF and map prepared by EQMS

3.3.7 Ecologically Critical Areas

An Ecologically Critical Areas (ECA) is an environmental protection zone in Bangladesh. In 1995, specific areas in Bangladesh were deemed Ecologically Critical Areas as a result of the Environmental Conservation Act of 1995. The Government after considering the human habitat, ancient monument, archeological site, forest sanctuary, national park, game reserve, wild animals' habitat, wetland, mangrove, forest area, biodiversity, and other relevant factors of the area can declare it as ECA. As per the legal mandate, the MOEFCC has till now declared 13 areas as ECAs. The Department of Environment as a statutory body is entrusted to manage the ECAs. There is no ECA area located in the study region. The nearest ECA from the NSEZ site is Sonadia Island which has a distance of 95 km. A map showing the ECAs in the study region is given in Figure 3-71.

Figure 3-71: Ecologically Critical Areas in the Region



Source: Data from DOE and map prepared by EQMS

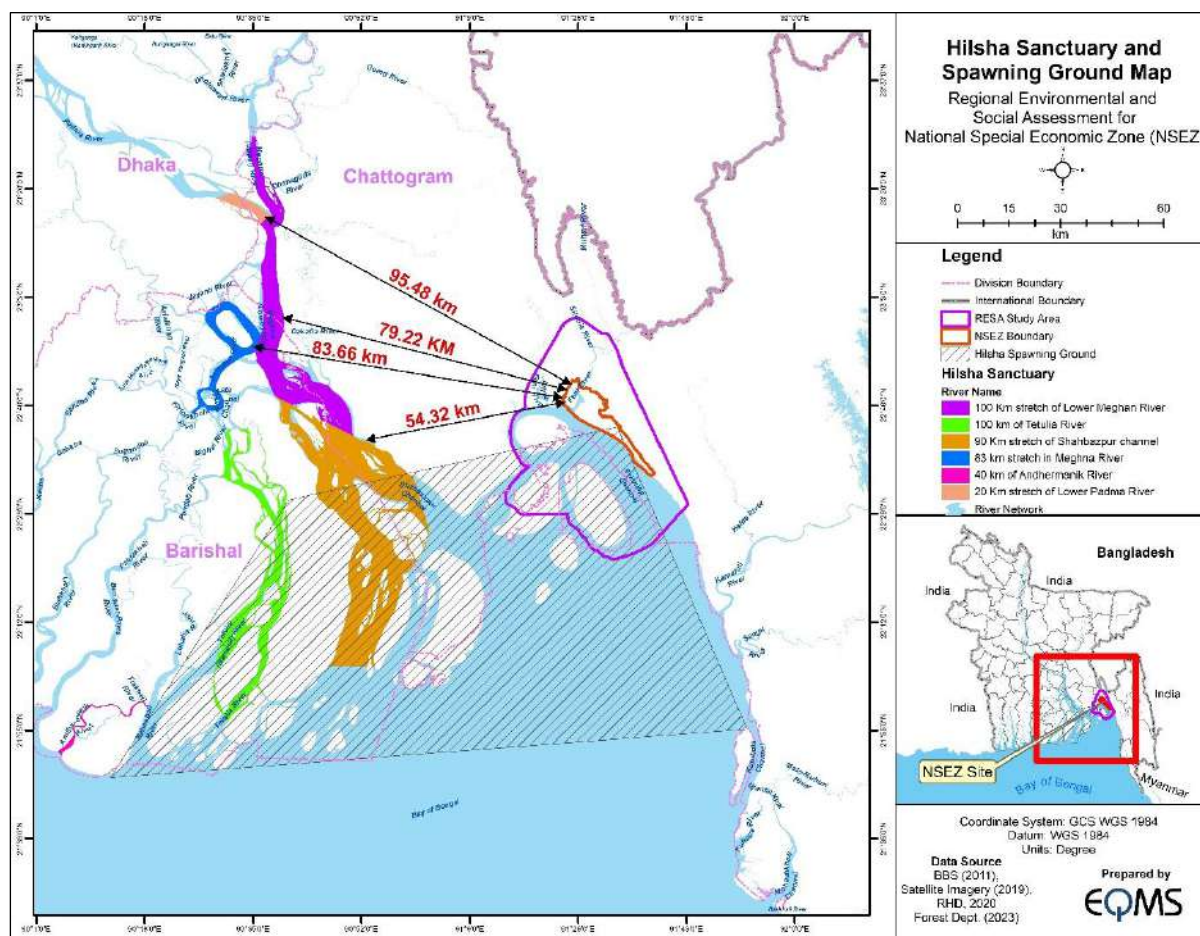
3.3.8 Hilsha Sanctuary and Spawning Ground

Hilsha (*Tenualosa ilisha*) comprises the largest and most valuable single fishery in Bangladesh. Hilsha is largely anadromous and fast-swimming euryhaline pelagic fish, occurring in brackish water and marine environments of the Bay of Bengal. Its marine distribution extends to 200–250 km in the Bay of Bengal off the coast of Bangladesh. Six Hilsha sanctuaries have been established under the 'Protection and Conservation of Fish Act 1950' for the effective conservation of Jatka and brood Hilsha in the major nursery and spawning areas. There are no hilsha sanctuaries within the study region. However, the nearest sanctuary, Char Ilsha to Char Pail of Bhola district (90 km stretch of Shahbazpur channel, a tributary of Meghna River) is located more than 21 km away from the study region.

Adult brood hilsha mainly spawn in Bangladesh's major deltaic rivers, estuaries, and coastal areas. Hilsha spawns throughout the year but the peak season is September and October. However, it has four main spawning grounds in Bangladesh (Halder and Islam, 2008). These are Dhalchar Island of Charfashion in Bhola (about 125 sq. km area), the surroundings of Monpura Island in Bhola (about 80 km area), Moulavichar of Hatia in Noakhali (about 120 sq. km area), and Kalirchar Island of Sandwip (about 194 sq. km area) of Bangladesh.

In addition, the Hilsha spawning ground boundary point is located within the study region namely Mayani Point, Mirsharai, Chattogram (91°32.15'E and 22°42.59'N). The peak spawning period is 3 (three) days before and 7 (seven) days after the full moon, including the day of the full moon, that is, a total of 11 (eleven) days of the moon which will first appear in the Bengali month of *Ashwin* each year. A map of the Hilsha sanctuaries and the spawning ground is shown in Figure 3-72.

Figure 3-72: Hilsha Sanctuary and Spawning Ground in the Study Area



Source: Data from DOF and map prepared by EQMS

3.3.9 Important Bird and Biodiversity Areas

According to Birdlife International (2023), there are twenty Important Bird and Biodiversity Areas (IBAs) in Bangladesh which encompasses an area of 544,438 ha. In the study region, a total of two Important Bird and Biodiversity Areas have been found, namely the Ganges-Brahmaputra-Meghna delta and Muhuri Dam. A brief description of the important bird and biodiversity areas has been given in Table 3-40.

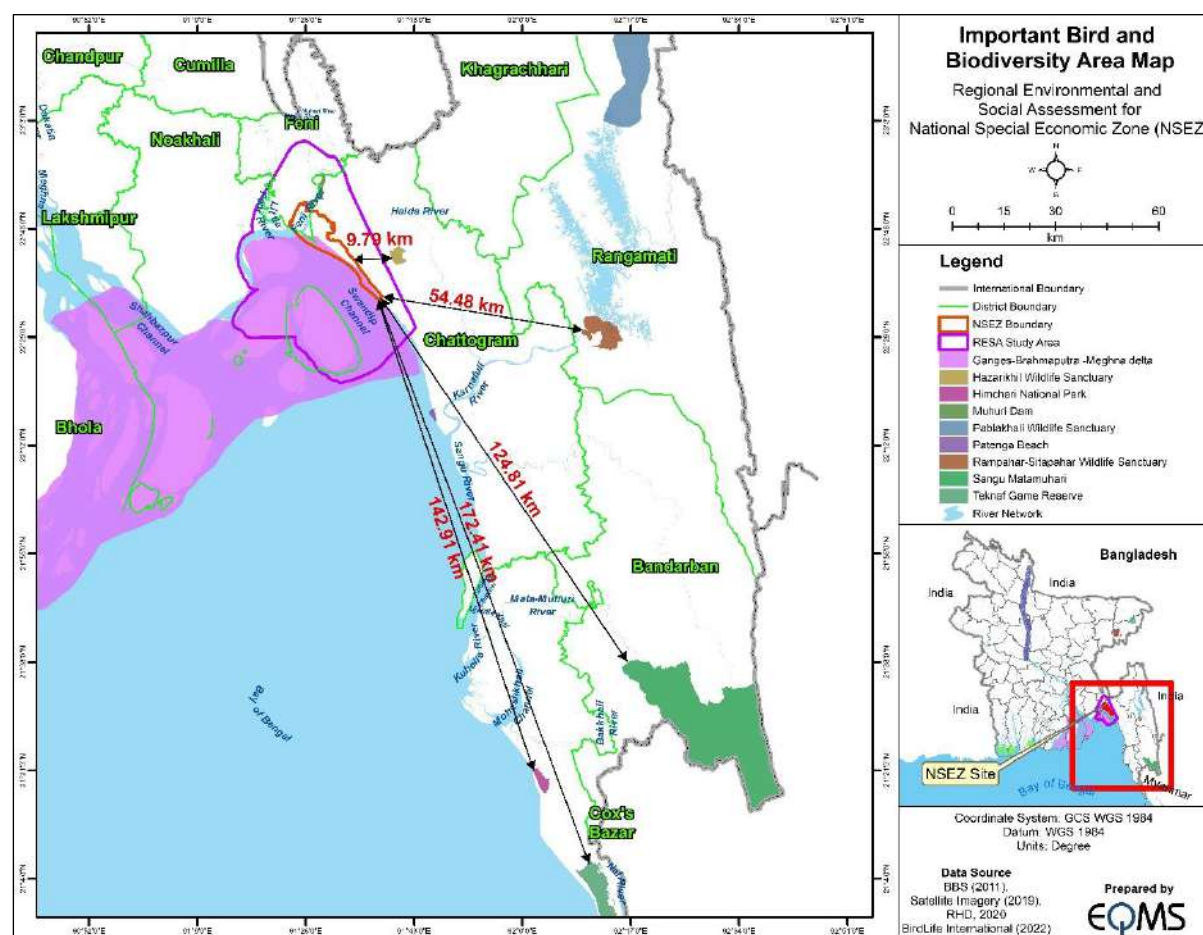
Table 3-40: Important Bird and Biodiversity Areas in the Study Area

Name	Area (ha)	Habitat	IUCN Red List species
Ganges-Brahmaputra-Meghna delta	75,000	Wetlands (inland), Forest	Bar-headed Goose <i>indicus</i> (LC), Common Shelduck <i>Tadoma tadoma</i> (LC), Eurasian Curlew <i>Numenius arquata</i> (NT), Spoon-billed Sandpiper <i>Calidris pygmaea</i> (CR), Spotted Greenshank <i>Tringa guttifer</i> (EN), Indian Skimmer <i>Rynchops a/bicollis</i> (EN)
Muhuri Dam	500	Wetlands (inland), Grassland	Ferruginous Duck <i>Aythya nyroca</i> (NT), Tufted Duck <i>Aythya fuligula</i> (LC), Garganey <i>Spatula querquedula</i> (LC), Gadwall <i>Mareca strepera</i> (LC), Eurasian Wigeon <i>Mareca Penelope</i> (LC), Northern Pintail <i>Anas acuta</i> (LC), <i>Anas crecca</i> (NR)

Source: BirdLife International (2023a) and BirdLife International (2023b)

A map of the important bird and biodiversity areas is given in Figure 3-73.

Figure 3-73: Important Bird and Biodiversity Area Map of the Study Region



Source: BirdLife International

3.3.10 RAMSAR Sites

Currently, there are two designated Ramsar sites/wetlands in Bangladesh. These are “Sundarbans Reserved Forest” and “Tanguar Haor”. The study area is quite far away from the two designated Ramsar sites. Hence, there will be no legal conflict in NSEZ implementation regarding the important wetland and its biodiversity.

3.4 Socio-economic Profile

As per the Master Plan of NSEZ, the region of the NSEZ area covers part of the three upazilas of Chattogram and Feni districts under the Chattogram Division. The upazilas are Mirsharai, Sitakunda under the Chattogram district, and Sonagazi Upazila under the Feni district. This section begins with a brief description of the Chattogram division and the three studied upazilas of the Chattogram and Feni districts.

Chattogram (Chattogram Division): The Chattogram is considered the business capital of Bangladesh. It is situated in the southern part of Bangladesh with an area of 5,282.92 sq km, located between 21°54' and 22°59' north latitudes and between 91°17' and 92°13' east longitudes. It is bounded by Khagrachari and Rangamati districts and Tripura state of India on the north, Cox's Bazar district on the south, Bandarban, Rangamati, and Khagrachari districts on the east and Noakhali district and the Bay of Bengal on the west. Chattogram District is quite different from other districts for its unique natural

beauty characterized by hills, rivers, seas, forests, and valleys. Bangladesh's first Export Processing Zone (EPZ), established in 1983, is situated here⁷.

Main Rivers/Canals: Krahulik River, Halda River, Sangu River, Murari canal, Chandakhali canal, Jalkandar canal, and Dhalai Beel are notable.

Mirsharai Upazila (Chattogram District): The total geographical area covering the upazila is 482.88 km² and is located between 22°39' and 22°59' north latitudes and between 91°27' and 91°39' east longitudes. It is bounded by Tripura state of India, Chagalnaiya and Feni Sadar upazilas of Feni District on the north, Sitakunda upazila of Chattogram District and Bay of Bengal on the south, Fatikchhari upazila of Chattogram District on the east, Sonagazi upazila of Feni District and Companiganj (Noakhali) upazila of Noakhali Districts on the west. Mirsharai Thana was formed in 1901 and it was turned further into declared as an upazila in 1983. Mirsharai Upazila consists of 2 municipalities, 16 Unions, and 113 Mouzas. Mirsharai, the combination of lake and hilly area contains attractive scenic beauty in the southernmost part of Bangladesh⁸.

Sitakunda Upazila (Chattogram District): The total geographical coverage of the upazila is 483.97 km² and it is located between 22°22' and 22°42' north latitudes and between 91°34' and 91°48' east longitudes. There are nine unions and a municipality in the upazila. It is bounded by Mirsharai and Fatikchhari upazilas of Chattogram district on the north, Pahartali thana of Chattogram district on the south, Fatikchhari upazila, Hathazari upazila and Panchlaish thana of Chattogram district on the east, Sawndip upazila and Sawndip channel on the west. The Bay of Bengal and Sawndip Channel are notable in the upazila. Sitakunda Thana was formed in 1979 and it was declared as an upazila in 1983⁹.

Sonagazi Upazila (Feni District): The total geographical coverage of the upazila is 285 km². It is located between twenty-two°44' and 22°58' north latitudes and between 91°19' and 91°28' east longitudes. There are fifteen unions in the upazila. It is bounded by Feni Sadar upazila on the north, Companiganj upazila of Noakhali district on the south, Mirsharai upazila of Chattogram district on the east, Companiganj upazila of Noakhali and Dagan Bhuiyan upazila of Feni district on the west¹⁰.

3.4.1 Approach and Methodology

To establish the socio-economic baseline for the NSEZ and undertake the regional social impact assessment of the NSEZ, a phased participatory approach was adopted. Through this approach, an attempt was made to integrate the local understanding and perspective into the assessment process and identification of the mitigation measures. The purpose of such an approach was to allow for:

- The triangulation of the information available from secondary sources through the information made available by the local community, both qualitative and quantitative.
- Formulation of the socio-economic baseline based on a combination of primary and secondary qualitative and quantitative data.
- An understanding developed of the local community's perception of the NSEZ and its activities the possible impacts from the same and the desirable mitigation measures.

3.4.2 Socio-economic Household Survey Methodology

A primary socio-economic household survey was conducted following a determined sample size for the collection of socio-economic data emphasizing demographic and socio-economic features of the targeted areas of six main concentrated unions namely Ichhakali, Saherkhali, Muradpur, Saidpur, Sonagazi, and Char Chandia. To complement the quantitative findings and get detailed information and recommendations; stakeholder consultations were conducted to cover the issues like complex socio-

⁷ <https://www.chittagong.gov.bd/en/>

⁸ <http://mirsharai.chittagong.gov.bd/>

⁹ <http://bbs.sitakunda.chittagong.gov.bd/bn/>

¹⁰ <http://sonagazi.feni.gov.bd/>

economic environment of the area, gender dimensions, employment opportunities, loss of livelihoods (grazing and agricultural land), and increased anthropogenic/vehicular activity in remote areas.

Following the latest available Population and Housing Census data (BBS 2011) and the annual growth rate (1.22 according to the BBS 2022), the target population from these six unions has been estimated to be 32,030 households. Cochran's formula¹¹ has been followed to determine the sample:

$$n = \frac{n_0}{1 + \frac{(n_0-1)}{N}}$$

Confidence Level considered 95%.

The margin of error is 5%.

The required minimum sample size according to the above consideration is n=380. For convenient distribution, the sample size was adjusted to n=402 households for the socioeconomic survey.

List of Studied villages

The sample was equally distributed among six unions namely Saherkhali, Ichakhali, Muradpur, Saidpur, Sonagazi, and Char Chandia. A total of twenty-six villages and paras(settlements) were covered by the sample survey (Table 3-41).

Table 3-41: List of Villages Covered in the Study

District	Upazila	Union	Village
Chattogram	Mirsharai	Ichakhali	Hafiz gram, Nondi gram
		Saherkhali	Bhorer Bazar, Hait Kandi, Kazipara, Paschim Haitkandi, Purba Saherkhali, and Saherkhali
	Sitakunda	Muradpur	Bater khil, Guliya Khali, Paschim Bater Khil, and Vaterkhil
		Saidpur	Muhuri para, Paschim Saidpur, Saidpur, Saidpur jele Para, and Saidpur Muhuri para
Feni	Sonagazi	Sonagazi	Chor Khowaz, Muhuri para, and Sujapur
		Char Chandia	Char Chandia, Char Khandakar, Chor Khowaz, Purbo Char Chandia, South Chor Khowaz, and Uttor Dokkhin Chor Chandia

Source: EQMS, 2023

Upazila and Unions under Study Area

The regional social baseline of NSEZ consists of the following areas depicted in Table 3-42. To determine the impact of NSEZ in the region, both primary and secondary analyses of these areas have been considered accordingly.

Table 3-42: Study Area

District	Upazila	Union
Chattogram	Mirsharai	Ichhakhali
		Saherkhali
	Sitakunda	Muradpur
		Saidpur

¹¹ Cochran, W. G. (1977). Sampling techniques (3rd ed.). New York: John Wiley & Sons.

District	Upazila	Union
Feni	Sonagazi	Sonagazi
		Char Chandia

Source: EQMS, 2023

3.4.3 Population and Demography of the Study Area

Socio-economic assessment of the study region was carried out by interpreting the Population and Housing Census 2011 and the summary of the Population and Housing Census 2022¹² report along with various other statistical data from the Bangladesh Bureau of Statistics, Bangladesh Demographic and Health Survey 2018 and 2022, Bangladesh Household Income and expenditure Survey 2016, and other related article & reports. The assessment was supplemented by the data from the primary sample survey to ensure the reliability and validity of the report, provide up-to-date information, and fill the gaps in secondary data to represent an organized assessment of the study region.

As per the Population and Housing Census 2022, National Report (Volume I) The total population of the Chattogram division is 3,32,02,326 with 7,528,333 households. Table 3-43 presents the demographic data for the Chattogram division. It is perceived that the region will be impacted by the NSEZ. The potentially impacted populations are in the Chattogram and Feni districts. In the Chattogram division, population density is 979 persons per square kilometer with the total population of the division being 33,202,326.

Table 3-43: Demographic Data of the Division

Division	Total Population	Male	Female	Hijra	Sex Ratio	Population Density/ km ²
Chattogram	33,202,357	16,035,140	17,165,884	1,333	93.41	979

Source: Population and Housing Census 2022, National Report (Volume I)

At the Upazila level, Mirsharai upazila shares the highest population (472,777) followed by Sitakunda Upazila (4,57,368) while Sonagazi shares the lowest population size (67,320) with the lowest sex ratio among all three upazilas (Table 3-44).

Table 3-44: Population Distribution by Upazila

District	Upazila	Total HHs	Total Population	Sex Ratio	Avg. HH size
Chattogram	Mirsharai	111,009	472,777	0.93	4.19
	Sitakunda	105,258	457,368	1.04	4.30
Feni	Sonagazi	67,320	290,664	0.86	4.28
Total		283,587	1,220,809	0.95	4.25

Source: Population and Housing Census 2022, National Report (Volume I)

Table 3-45 presents the available demographic data for the NSEZ adjacent unions. Data shows that the distribution of population varies among the unions where the highest number of the population resides at Char Chandia (40,592) Union of Sonagazi upazila and the lowest number is at Saherkhali Union of Mirsharai Upazila. In addition to the population size, household size, and sex ratio also differ among the unions as Table 3-45 shows. Data indicates that around 1,67,905 people with 32,030 households are likely to be impacted in diverse ways by the implementation of the NSEZ master plan.

¹² The preliminary report of Housing and Population Census 2022 were published and available during the RESA study period. (January 2024)

Table 3-45: Demographic Profile of the NSEZ Area

District	Upazila	Union	Total HHs	Total Population	Sex Ratio	Avg. HH size
Chattogram	Mirsharai	Ichhakhali	5,205	27,980	84	5.4
		Saherkhali	3,049	16,912	81	5.5
	Sitakunda	Muradpur	5,844	29,602	96	5.1
		Saidpur	6,357	30,655	88	4.8
Feni	Sonagazi	Sonagazi	4,299	22,164	90	5.2
		Char Chandia	7,276	40,592	93	5.5
Total			32,030	167,905	88.66	5.25

Source: Population and Housing Census, BBS 2011

Table 3-46 shows that 1.25% of the population are people with disability in the Chattogram Division. Additionally, the dependency ratio is 59.95% in the area. The total number of households in the division is 73,93,636 with an average household size of 4.35.

Table 3-46: Dependency Ratio, Literacy Rate, Disability Data of Chattogram Division

Division	Dependency Ratio	Literacy	Disability	Number of HH	Avg size of HH
Chattogram	59.95	75.72	1.25	73,93,636	4.35

Source: Population and Housing Census 2022, National Report (Volume I)

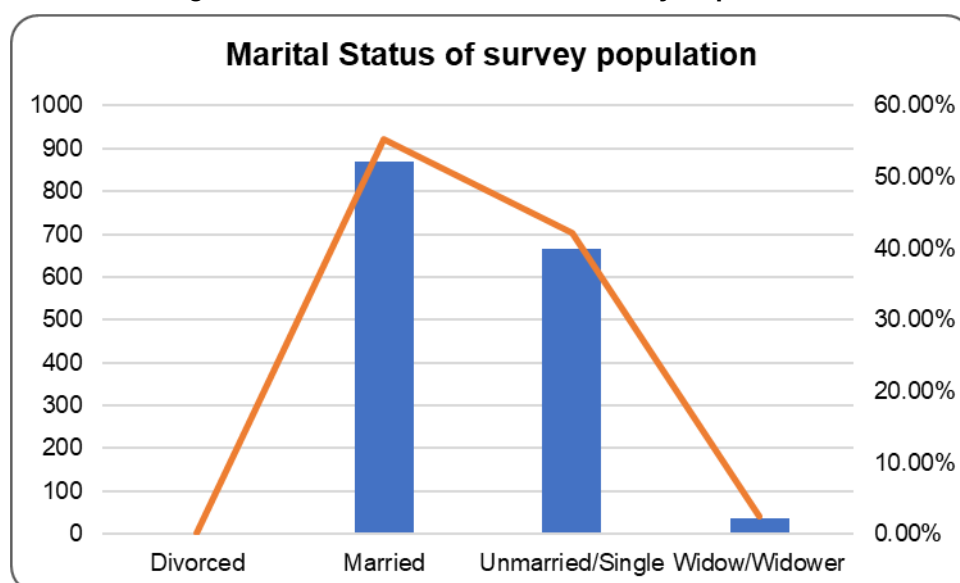
As per the primary socio-economic survey conducted during the study period, it was identified that 402 households with a population of 1,573 with an average household size of 3.91, a sex ratio of 0.89, disability rate is 1.03%, and a rate of literacy is 79.85%. The findings are consistent with regional data found from secondary sources. Table 3-47 depicts the dependency ratio, literacy rate, and disability status of the surveyed population.

Table 3-47: Dependency Ratio, Literacy Rate, Disability Data of Surveyed Population

Number of Households	Total Population	Average HH Size	Sex Ratio	Disability	Literacy
402	1,573	3.91	0.89	1.03	79.85%

Source: Household Survey conducted by EQMS 2023

Figure 3-74 shows the marital status of the surveyed population. More than half of the population is married and 42.28% are unmarried. The number of widows/widowers is low (2.42%).

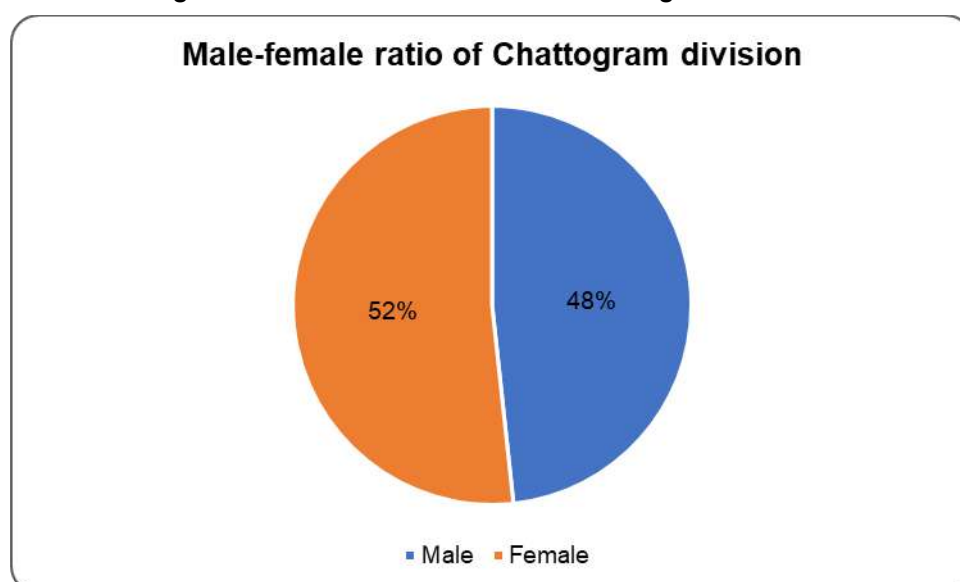
Figure 3-74: Marital Status of the Survey Population

Source: Household Survey conducted by EQMS 2023

3.4.4 Gender

The households in the study area are mostly male-headed and patrilocal. Generally, women's participation in paid work is lower than their counterparts men. They contribute substantially to household activities including child rearing. Household decisions are mostly taken by males and the society is largely male dominant. Women in the area struggle against child marriage, gender violence, sickness, malnourishment, and access to formal jobs. According to the Population and Housing Census 2022, the sex ratio of the Chattogram division is 93.41.

Figure 3-75 indicates that there is gender disparity regarding male-female ratio. The regional population comprises 48% of males and 52% females.

Figure 3-75: Male-female Ratio of Chattogram Division

Source: Population and Housing Census, BBS 2022

As per the Bangladesh Demographic and Health Survey 2018, around 43% of married women in the Chattogram division are observed to be able to control financial decisions while 49.75% reported to

have jointly and the rest 7.2% have no control over the same. Around 15.1% of women have bank accounts (BDHS 2018).

According to the findings of the survey, 96.52% of households are male-headed and only 3.48% of households are headed by females. Table 3-48 shows the gender-segregated data on household activities.

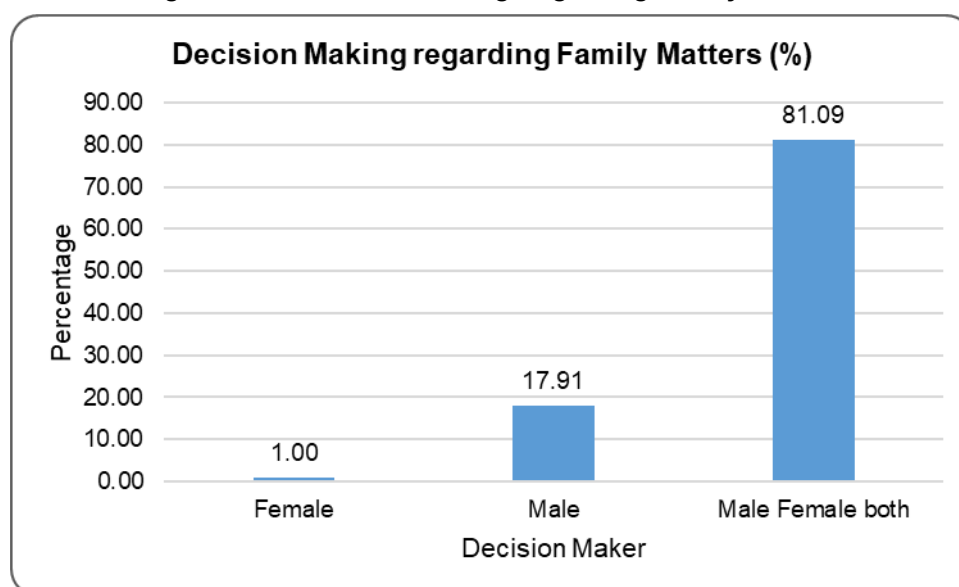
Table 3-48: Gender-wise Respondents

Household Head	Number	Percentage
Female	14	3.48%
Male	388	96.52%

Source: Household Survey conducted by EQMS 2023

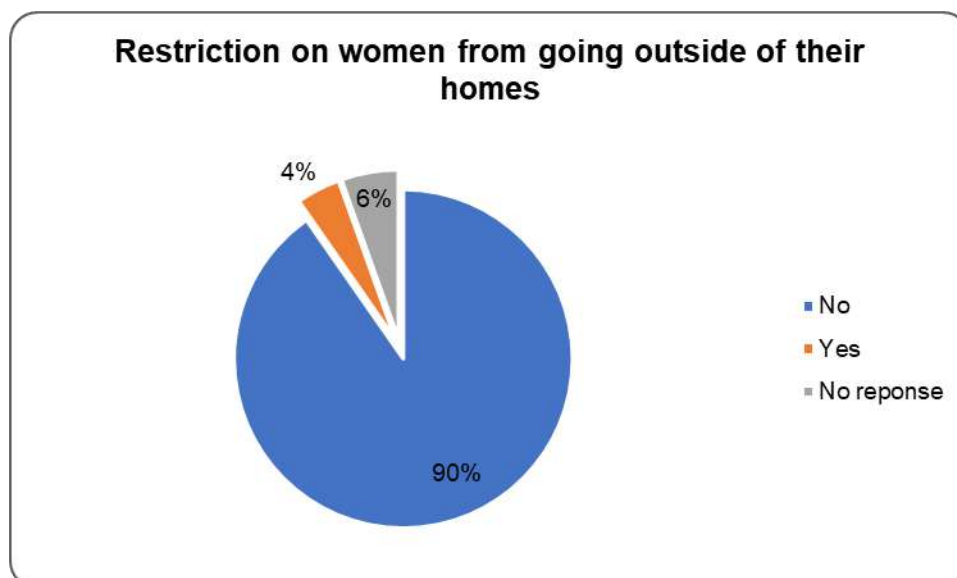
Decision-making and income generation are essential components of any household. It can create a significant impact on the household as well as on the community. The survey collected gender-segregated data on the household activities of the respondents. Figure 3-76 illustrates that in most of the households (81.09%), either male or female takes the decision. Only 1% of the females can make decisions independently. In addition, in 17.91% of the households, males take the decision. Consultation with female community members provided clarification about the fact that very few women can make major decisions in their households. They can make minor decisions independently which was reported in the quantitative survey as males and females both making decisions in households.

Figure 3-76: Decision-Making Regarding Family Matters



Source: Household Survey conducted by EQMS 2023

According to the primary socio-economic survey, female members of 90% of the HHs have access to go outside. On the contrary, only 4% of the respondents stated that female members of the HHs have minimal access to go outside of the home due to the conservative nature of the families. Around 6% refrained from providing any clear answer.

Figure 3-77: Restrictions on Women from Going Outside of Their Homes

Source: Household Survey conducted by EQMS 2023

3.5 Age Composition

The demographic information of the impacted populations has been analyzed as a part of the socio-economic profile of the population. This comprises the gender profile and age-sex distribution of the studied populations in the NSEZ area. More than one-third (>35%) of the total population were identified as children and adolescents. The majority (~40%) of the populations were aged between 20-49 years, which also means that the majority of studied populations are in their productive age. Table 3-49 represents the population distribution by different age groups.

Table 3-49: Age Distribution-District and Union Level

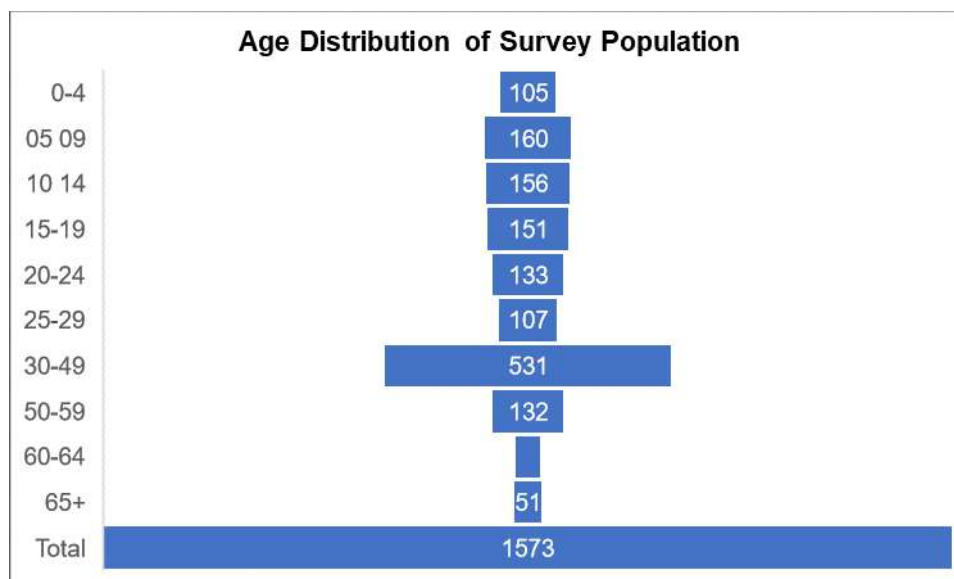
District/Unions	All Age	0-4	05-09	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
Chattogram	7616352	10	11.9	12	10.9	10.8	9.7	22.9	5.6	2.4	3.8
Feni	1437371	10.6	12.4	12.7	11.1	9.5	8.6	20.8	6	3	5.4
Unions											
Ichhakhali	27980	10.8	12.9	13.4	10.8	8.7	7.6	20.8	6.3	3.0	5.8
Saherkhali	16912	11.1	12.1	11.9	10.1	9.4	8.2	21.0	6.4	3.3	6.3
Muradpur	29602	10.1	11.2	12.0	11.4	10.3	9.1	22.2	5.7	2.9	5.2
Saidpur	30655	9.5	11.5	12.1	10.8	10.0	8.4	22.4	6.7	3.1	5.5
Sonagazi	40592	11.2	14.1	14.1	11.1	9.5	8.0	18.7	5.5	2.7	5.1
Char Chandia	22164	11.6	13.6	13.1	10.5	9.2	8.4	19.3	5.6	3.2	5.5
Total	167905	10.72	12.57	12.77	10.78	9.52	8.28	20.73	6.03	3.03	5.57

Source: Population and Housing Census, BBS, 2011

Every socio-economic study includes basic demographic characteristics like the age composition of the study participants, such as age, gender, and income. A population pyramid of the survey population is shown in Figure 3-78. Data shows the availability of a large working-age population. Around 30% of the population is between 30-49 years of age. Around one-fourth of the population are children below 15 years of age. About 5 % of the population is elderly. According to the 2022 preliminary census report,

Bangladesh's working age population – between 15 and 64 years – increased by 4.88% from 2011 to 2022, hitting 65.5% or 10.82 crore of the total population, according to the latest census data¹³.

Figure 3-78: Age Distribution of the Survey Population



Source: Household Survey conducted by EQMS 2023

3.6 Ethnic Composition

The primary socio-economic survey reveals no ethnic minority group in the NSEZ area.

3.7 Pattern of land ownership and tenure practices

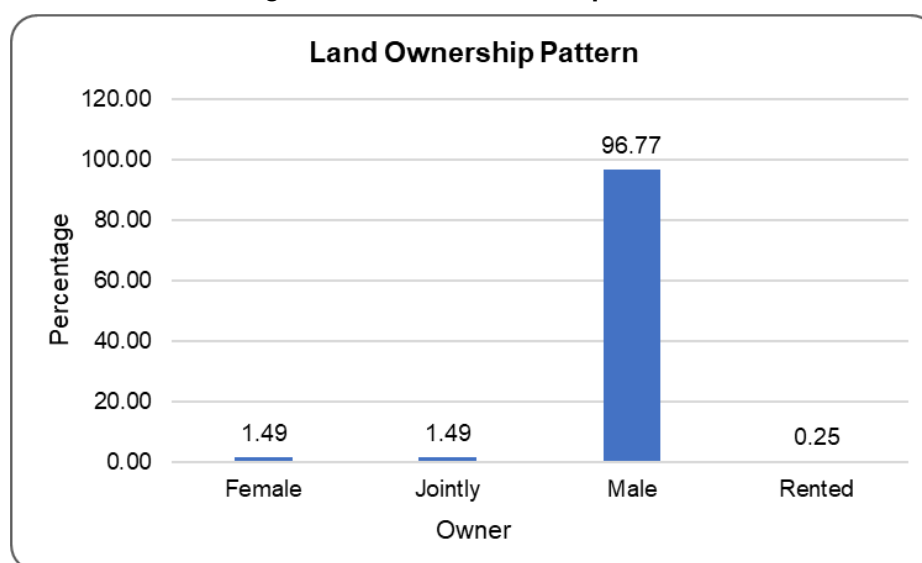
Traditionally, Family and kinship relations in Bangladesh have many features in common with the ideal-typical model of household arrangements described by Kandiyoti (1988) as 'classic patriarchy'. They are organized along corporate patriarchal lines, with authority vested in a senior male household head¹⁴.

Descent and property are transmitted through the male line, leaving women effectively with limited control over property and genealogically irrelevant (Kabeer, 2011). In the NSEZ area, the land is typically owned by the male head of the household, and properties are inherited/distributed according to Muslim/Hindu law.

Primary socio-economic survey data also reveal the same with the secondary data. Figure 3-79 shows that 97% of the households and associated farmlands are owned by males, only 2% are owned by females and 1% are owned jointly.

¹³ <https://businesspostbd.com/front/working-age-population-rises-2022-07-31>

¹⁴ Sajeda Amin 1998, Family Structure and Change in Rural Bangladesh

Figure 3-79: Land Ownership Pattern

Source: Household Survey conducted by EQMS 2023

According to HIES 2016 (Table 3-50), in the rural area of Bangladesh, 7.7% of the population does not own any homestead and 66.9% of the population own 0.01-0.49 acres of homestead land. On the other hand, 6.4% of the population does not own farming land (any land to operate)¹⁵.

Table 3-50: Rural Household by Size of Land (owned and operated), 2005-2016

Land size (in acre)	HIES 2016	HIES 2010	HIES 2005	HIES 2016	HIES 2010	HIES 2005
	Owned land			Operated land		
Total	100	100	100	100	100	100
Landless	7.7	4.6	5.3	6.4	3.6	4.1
0.01-0.49	66.9	60.5	55.2	64.5	55.4	52.9
0.50-0.99	11.1	11.6	12.4	13.1	14.2	14.2
1.00-2.49	10.4	14.6	17.6	12.4	18.3	19.1
2.50-7.49	3.4	7.6	8.7	3	7.8	8.6
7.50 and above	0.6	1.1	1.6	0.6	0.7	0.9

Source: HIES 2016

The socio-economic survey findings (Table 3-51) reveal that the majority (83%) of the households have land between 0.01 to 0.49 acres. Findings from primary data also support the secondary findings, as according to the survey around 9.70% of the population own land less than 0.01 acre.

Table 3-51: Households by Size of Land in Study Area

Land Size (in Acre)	Percentage
Landless	9.70
0.01-0.49	83.33

¹⁵ <http://data.gov.bd/dataset/household-income-and-expenditure-survey-hies-2016>

Land Size (in Acre)	Percentage
0.50-0.99	4.48
1.00-2.49	1.99
2.50-7.49	0.50
7.50 and above	0
Total	100

Source: Household Survey conducted by EQMS 2023

3.8 Community Structure Please use the result of census 2022

According to the Population and Housing Census 2011, there are 72 playgrounds and 78 Eid-Gah (Designated open spaces where Eid Prayers of the Muslim community are held annually) places in those three upazila of the NSEZ area which are mostly owned by the community and supported by the government. Some of these structures might be on government land (Table 3-52 and Table 3-53).

Table 3-52: Community Structures in the Upazila

Upazila	Mosque	Eid-Gah	Temple	Church	Pagoda	Others	Playground	Park
Mirsharai	540	15	13	4	8	0	21	0
Sitakunda	321	41	73	0	4	0	31	1
Sonagazi	291	22	21	0	0	0	20	0
Total	1,152	78	107	4	12	0	72	1

Source: Population and Housing Census, BBS 2011

Table 3-53: Community Structures in the District

District	Mosque	Eid-Gah	Temple	Church	Pagoda	Others	Playground	Park
Feni	2,094	457	215	0	0	0	155	3
Chattogram	7,021	931	992	126	153	77	738	20
Total	9,115	1,388	1,207	126	153	77	893	23

Source: Population and Housing Census, BBS 2011

According to the socio-economic survey findings (Table 3-54), there are playgrounds, graveyards, and crematoriums in the community. Nearly half of the respondents (50%) reported that they have playgrounds and graveyards in their locality.

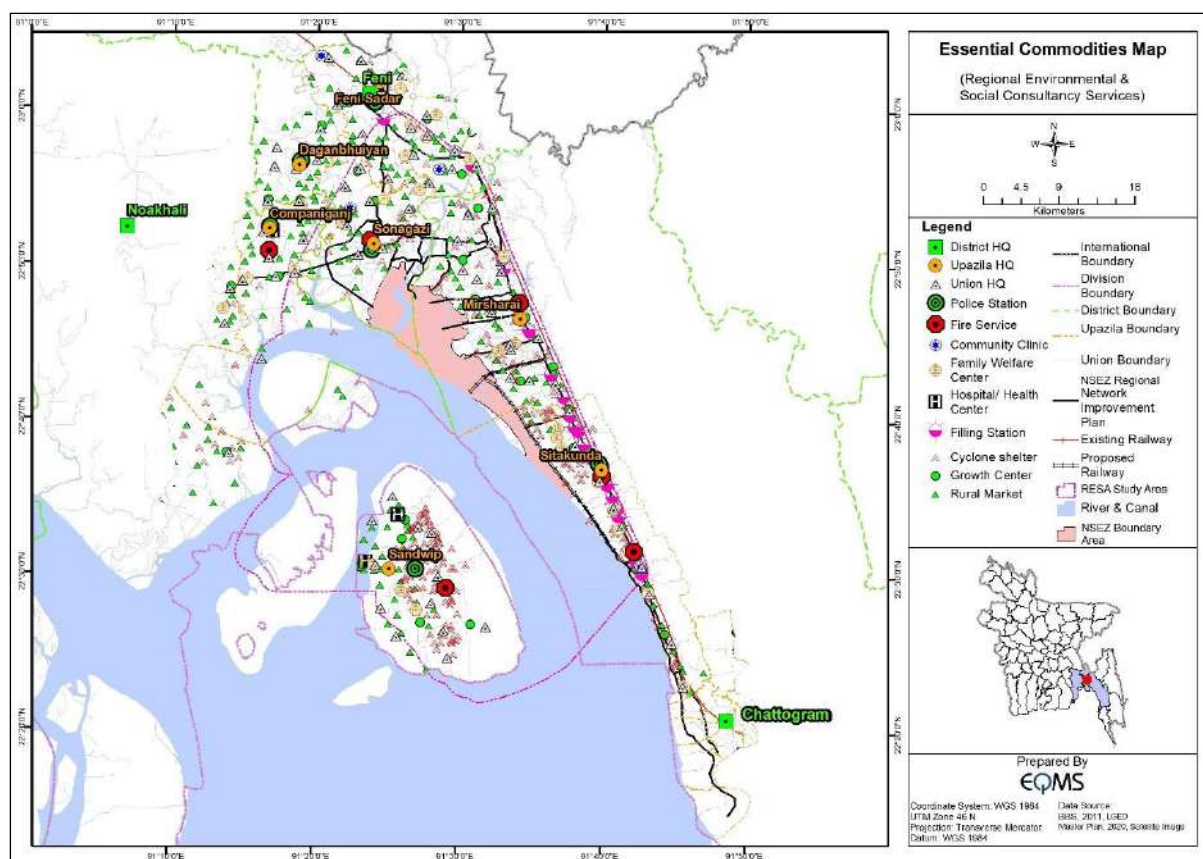
Table 3-54: Community Structures

Type of Community Structure	Percent of Cases
Playground	84.9%
Graveyard	93.2%
Crematorium	3.1%
Temple	6.0%

Source: Household Survey conducted by EQMS 2023

According to the Population and Housing Census 2011, there are 89 hat/bazars in the Mirsharai, Sitakunda, and Sonagazi upazila. These local markets also act as a social gathering point for community people. Different grocery items, fish and meats, fruit and vegetables, small agricultural tools, seeds and fertilizers, bakery items, etc. are sold in these markets. Figure 3-80 shows the locations of community structures like markets, growth centers, community clinics, union health centers, fire services stations, cyclone shelters, and union parishads.

Figure 3-80: Map of Community Structure and Essential Commodities



Source: EQMS GIS department

3.9 Employment

Agriculture, comprising crop cultivation, fisheries, direct farming, sharecropping, agricultural laborers, and so on, is the most common source of employment in the study area, according to the Population and Housing Census (2011). Agriculture employs approximately 2,26,035 males and 11,150 females of the population. Furthermore, a sizable proportion of the study area's population (76,778 males and 36,791 females) is employed in the service sector. In addition, the industrial sector employs 76,778 males and 53,298 females. Table 3-55 shows the number of males and females engaged in the main employment sectors in Chattogram and Feni districts.

Table 3-55: Sectoral Employment Status of the Region

District	Field of Activity					
	Agriculture		Industry		Service	
	Male	Female	Male	Female	Male	Female
Chattogram	188,033	10,294	69,862	36,073	221,082	50,246
Feni	38,002	856	6,916	718	31,962	3,052

District	Field of Activity					
	Agriculture		Industry		Service	
	Male	Female	Male	Female	Male	Female
Total	226,035	11,150	76,778	36,791	253,044	53,298

Source: Population and Housing Census, BBS 2011

Table 3-56 shows the population engaged in agriculture, industry, and service sectors respectively at the upazila level.

Table 3-56: Upazila-wise Employment Data

Upazila	Agriculture		Industry		Service	
	Male	Female	Male	Female	Male	Female
Mirsharai	16,664	620	1,210	243	9,745	659
Sitakunda	8,648	391	6,404	1,047	12,204	1,590
Sonagazi	10,531	262	943	162	4,642	245
Total	35,843	1,273	8,557	1,452	26,591	2,494

Source: Population and Housing Census, BBS 2011

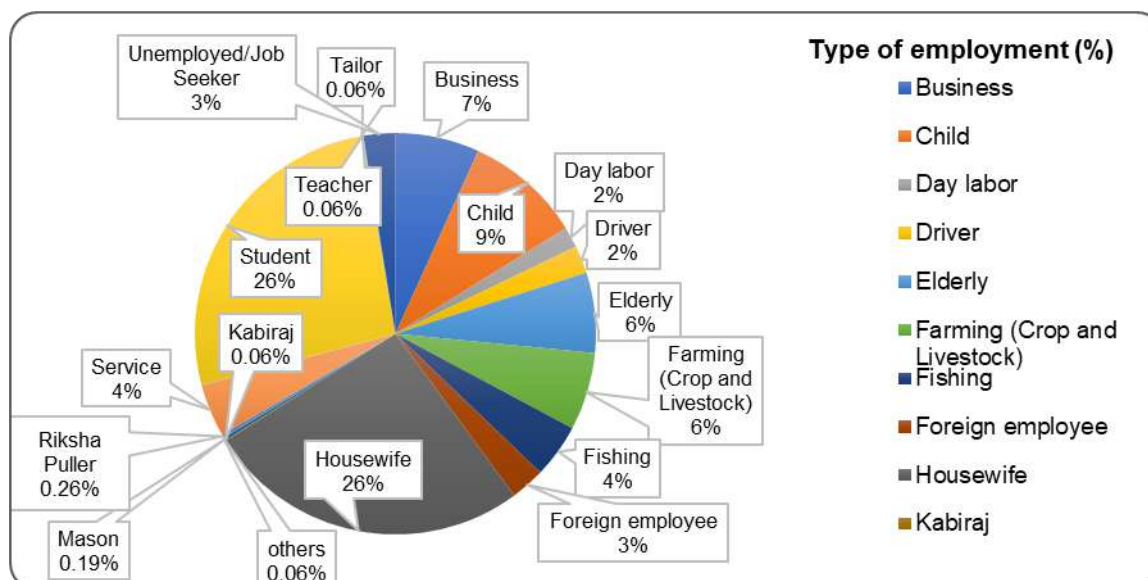
Table 3-57 displays the sector-wise employment data at the Union level. The number of males involved in agriculture is highest in the Char Chandia union (1,783) and lowest in the Saherkhali union (796). Involvement in the industrial sector is highest in Sitakunda among the six unions in the study area.

Table 3-57: Sectoral Employment Status of the Study Area

Upazila	Union	Field of Activity					
		Agriculture		Industry		Service	
		Male	Female	Male	Female	Male	Female
Mirsharai	Ichhakali	1,236	21	25	4	326	13
	Saherkhali	796	11	15	0	244	5
Sitakunda	Muradpur	1,319	19	147	20	686	54
	Saidpur	1,315	62	44	18	449	106
Sonagazi	Sonagazi	1,056	20	18	4	505	30
	Char Chandia	1,783	67	121	5	607	28
Total		7,505	200	370	51	2817	236

Source: Population and Housing Census, BBS 2011

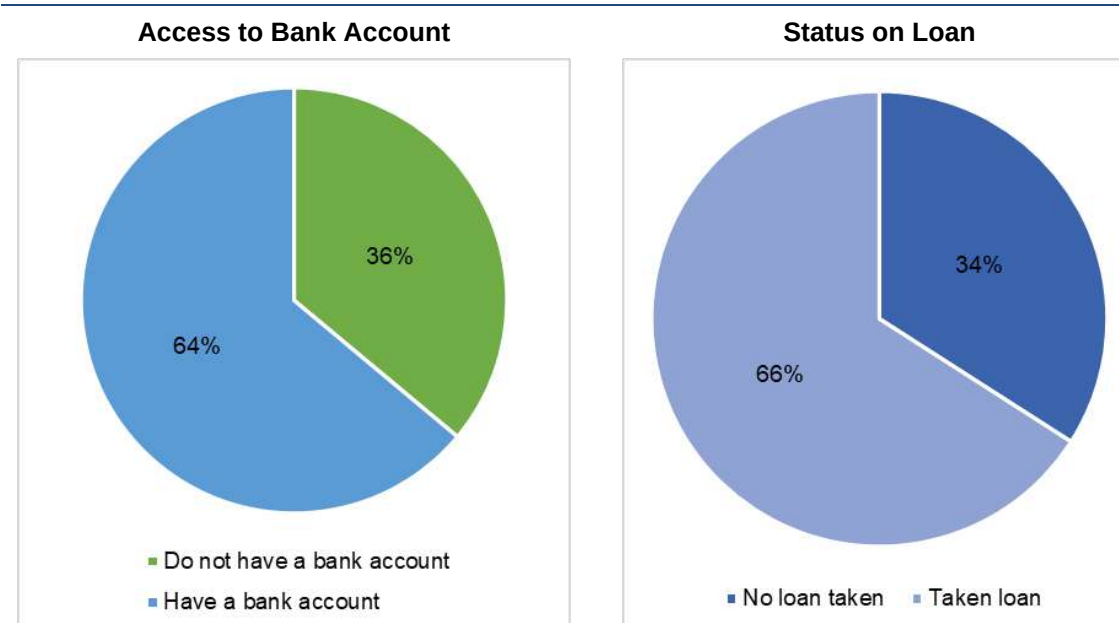
Regarding the source of employment, primary socio-economic survey findings (Figure 3-81) show that major sources of employment are farming 6%, fishing 4%, day labor 2%, business 7%, service 4%, and working abroad 3% (of the respondents in nearby areas). At present, 3% of the respondents are looking for employment. Near 25% are students, 26% are housewives, and 6% are elderly and they are not employed in any sector. Other sectors of employment include teaching, rickshaw pulling, tailoring, mason, etc. (less than 1%).

Figure 3-81: Type of Employment in Nearby Area Population

Source: Household Survey conducted by EQMS 2023

3.10 Access to the Financial Products

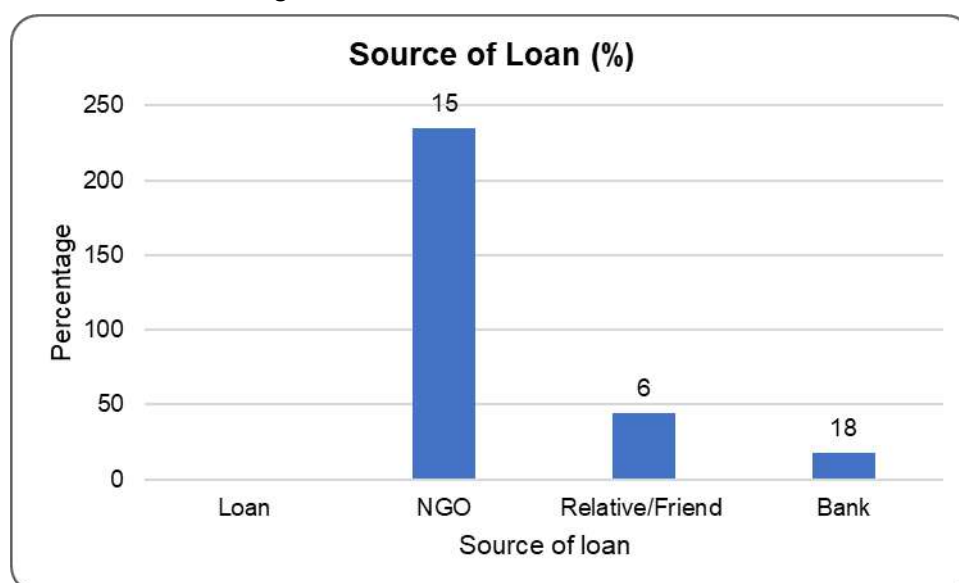
According to Institute of Microfinance data, the majority of households (75.62%) have access to any financial market in the Chattogram division. Around 40.75% have access to the formal market while 38.54% have access to the Microfinance Market (National Convention on Inclusive Finance in Bangladesh 2015). According to the Household survey (Figure 3-82), more than half of the households (64%) have an account in a bank, and two-thirds of the households (66%) have taken loans from various sources.

Figure 3-82: Access to Bank Account and Status Loan Among Surveyed Households

Source: Household Survey conducted by EQMS 2023

Additionally, the majority (79%) of the respondents (those who have a loan) revived loans from NGOs, around 6% have taken loans from banks and 15% have taken loans from the informal sector (Figure 3-83).

Figure 3-83: Source of household loan



Source: Household Survey conducted by EQMS 2023

3.10.1 Education and Skills

According to the Population and Housing Census 2011, there are 91 secondary schools in Mirsharai, Sitakunda, and Sonagazi Upazila¹⁶. There are 294 Government Primary Schools, 84 registered primary schools, 21 NGO schools, and 14 colleges found in these three upazilas. No government-approved Technical Training Centre (TTC) or Polytechnical institutions were found in the mentioned upazilas (Table 3-58).

Table 3-58: List of Educational Institutes

Type of Educational Institutions	Mirsharai	Sitakunda	Sonagazi	Total
Government primary school	145	73	76	294
Registered primary school	38	22	24	84
Private (non-registered) primary school	2	3	1	6
Kindergarten school	12	54	20	86
NGO Schools	16	5	0	21
Madrasa (under madrasah board)	16	14	14	44
Kawmi madrasah	20	3	6	29
Ebtedayee madrasah	12	15	3	30
Government secondary school	0	1	0	1
Non-government secondary school	46	27	17	90
School and college operating jointly	0	2	0	2
Government College	0	1	1	2
Non-government College	6	5	1	12
Technical and vocational institution	0	0	0	0

¹⁶https://banbeis.portal.gov.bd/sites/default/files/files/banbeis.portal.gov.bd/page/ba082bf6_4e34_4c07_b2e5_a7368db2c4ab/LIST%20OF%20SCHOOL.pdf

Source: Population and Housing Census, BBS 2011

Three high schools provide vocational education in the concerned upazilas which are listed in Table 3-59.

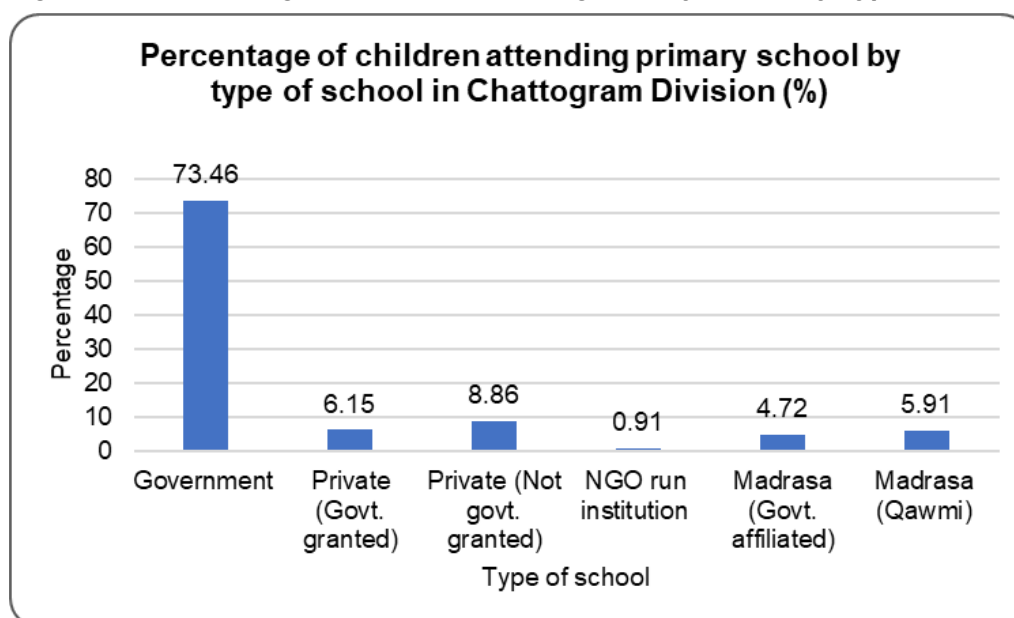
Table 3-59: List of Schools with Vocational Courses

Upazila	Name of school with vocational courses	Courses
Mirsharai	Moghadia N.A.C. High School	Refrigeration and Air-conditioning
Sitakunda	Zafar Nagar Aparna Charan High School	General Electrical Works
Sonagazi	Amirabad B.C Laha High School	Refrigeration and Air-conditioning

Source: sesip.gov.bd¹⁷

The Household Income and Expenditure Survey 2022 data (Figure 3-84) illustrates that the majority of the students are enrolled in government primary schools (73.46%). Private (non-government) schools accounted for 8.86%, NGO-run schools accounted for 0.91%, government-recognized Madrasah accounted for 4.72%, and Kawmi/Qawmi Madrasah accounted for 5.91% of primary school students in the Chattogram division.

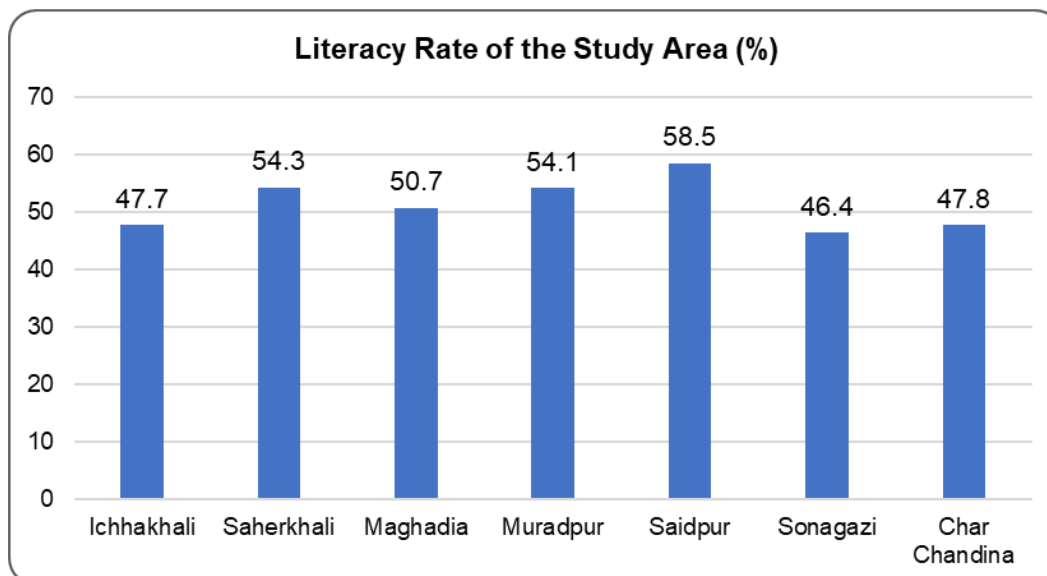
Figure 3-84: Percentage of Children Attending Primary School by Type of School



Source: Household income and expenditure Survey 2022

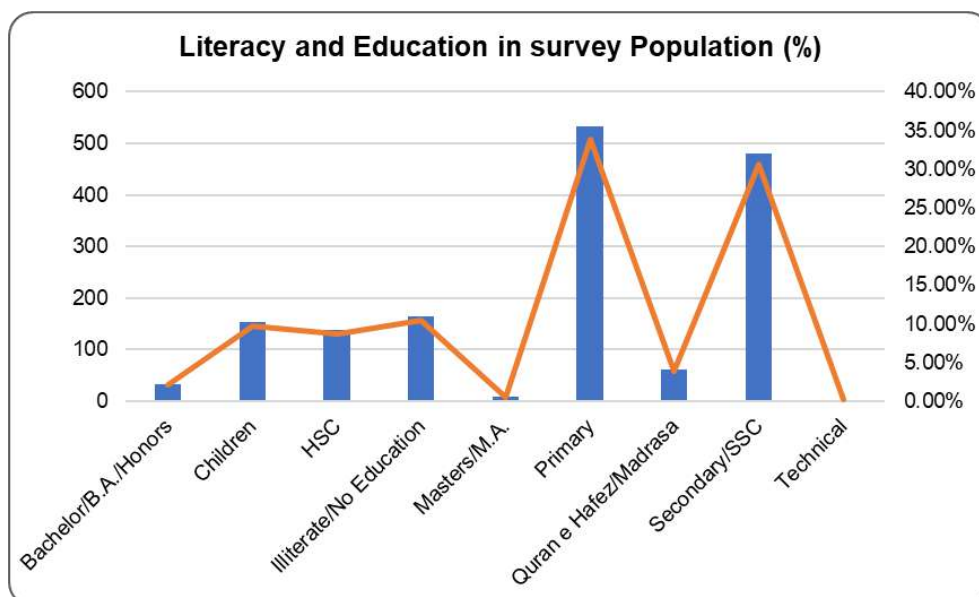
According to the Population and Housing Census (2011), the average literacy rate in the study area is 49.8%. Figure 3-85 shows the literacy rate of the unions of the NSEZ study area.

¹⁷ https://sesip.gov.bd/wp-content/uploads/2020/08/Vocational-Database-for-Student-Data-for-BTEB_23_07_2020.pdf

Figure 3-85: Literacy Rate of the Study Area

Source: Population and Housing Census, BBS 2011

Among the survey population, 9.37% are children who are too young to attend school and 8.7% are illiterate. One-third of the population completed primary education whereas 30.58% completed secondary education, and nearly 9% of the population passed higher secondary school (Figure 3-86). Nearly 5% of the population studied in madrasa.

Figure 3-86: Literacy and Education in Survey Population

Source: Household Survey conducted by EQMS 2023

Most of the survey respondents (90%) expressed their interest in receiving skill development training. Their preferences are mentioned in Figure 3-87.

Figure 3-87: Willingness to Participate in Training for Skill Development

Source: Household Survey conducted by EQMS 2023

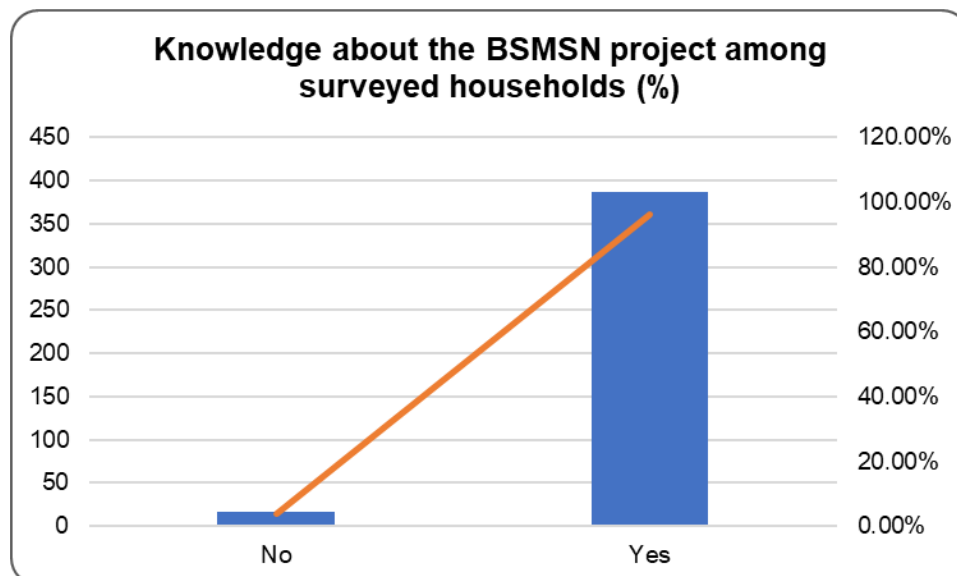
Additionally, primary survey data also reveals, that half of the population expressed their interest in receiving technical skill development training in computer/MS Office packages, and 40% are willing to receive mechanical and tailoring skill development training. Figure 3-88 shows detailed data on the preference of community people in receiving skill development training.

Figure 3-88: Expected Training/Skill Development Trades by Community

Source: Household Survey conducted by EQMS 2023

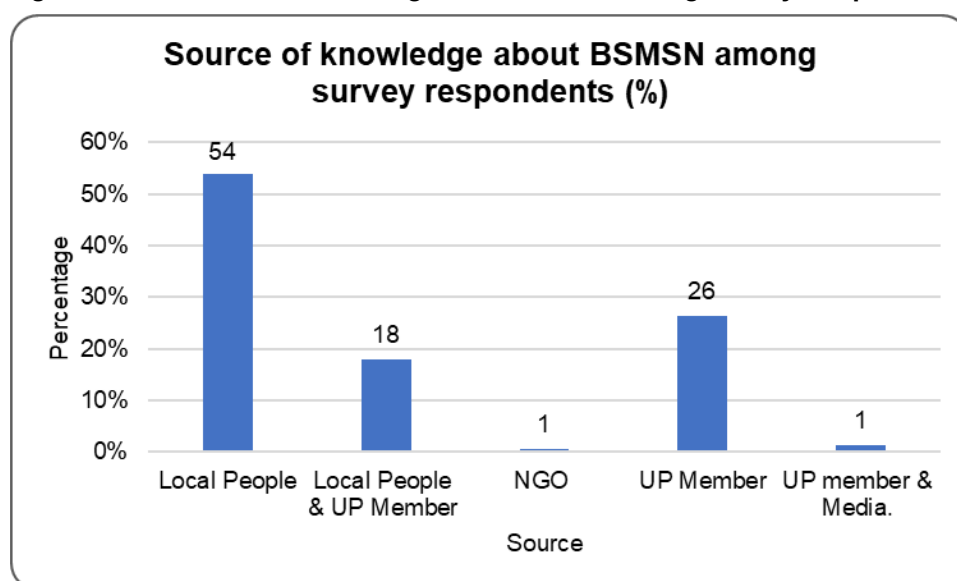
3.10.2 Knowledge and Perception of the NSEZ

The knowledge about the proposed NSEZ of the community people was administered during the primary socio-economic survey. Around 96% of the respondents had prior knowledge about the NSEZ (Figure 3-89).

Figure 3-89: Knowledge about the NSEZ Among Surveyed Households

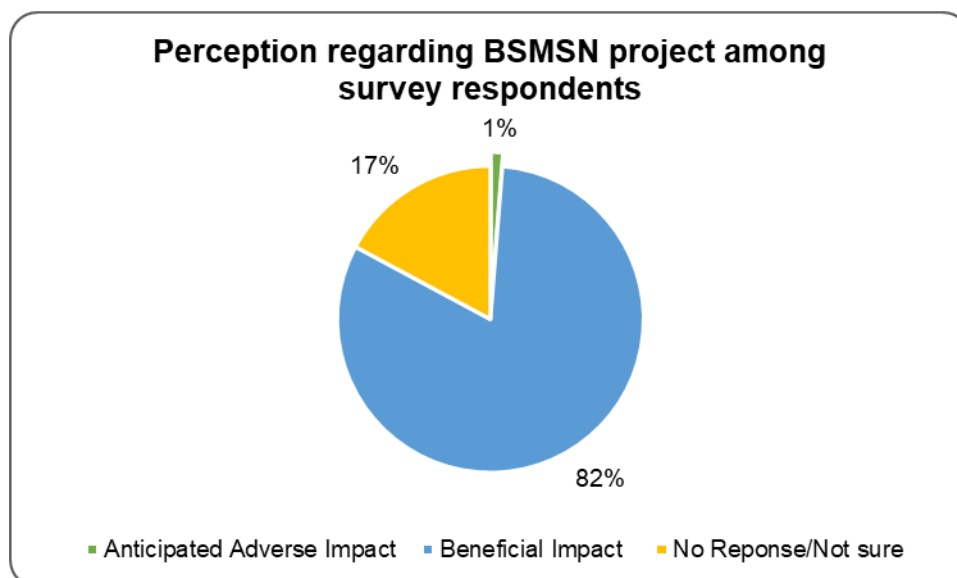
Source: Household Survey conducted by EQMS 2023

The community people obtained knowledge about the NSEZ from their peers, local union parishad members, NGOs, and media (Figure 3-90).

Figure 3-90: Source of Knowledge About NSEZ Among Survey Respondents

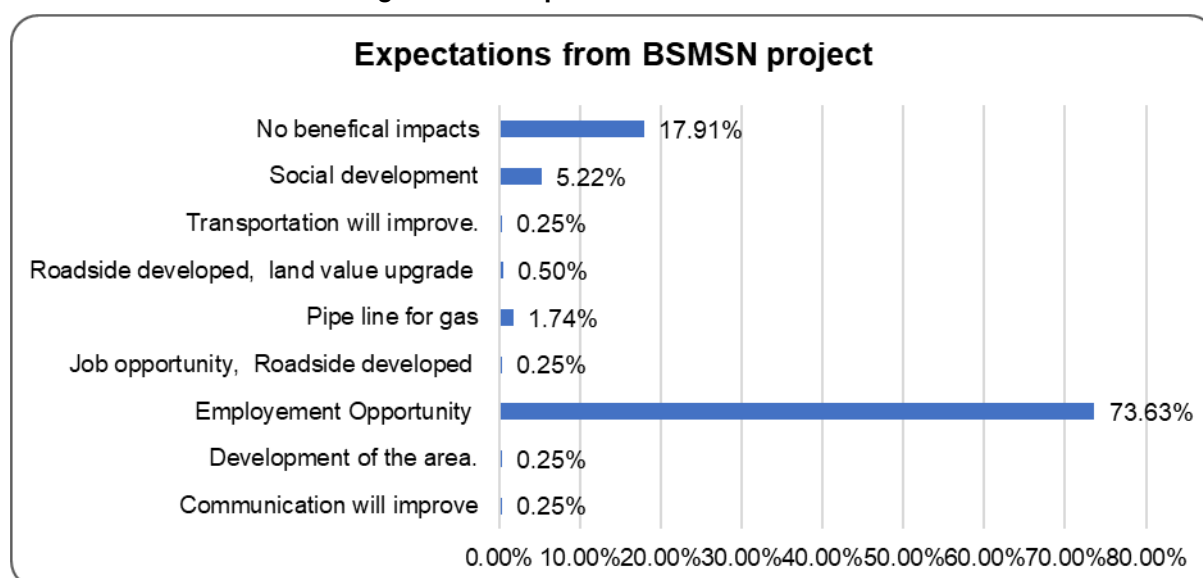
Source: Household Survey conducted by EQMS 2023

Around 82% of the respondents including day laborers, landowners, farmers, business owners, and other people perceive this NSEZ as favorable for the community (Figure 3-91).

Figure 3-91: Perception regarding the NSEZ among survey respondents

Source: Household Survey conducted by EQMS 2023

Figure 3-92 illustrates the expectations of community people from the NSEZ. According to the survey response data, the NSEZ will create more job opportunities for the local population which would result in social development and will also help in improving road communication, economic conditions, and utility services in the area.

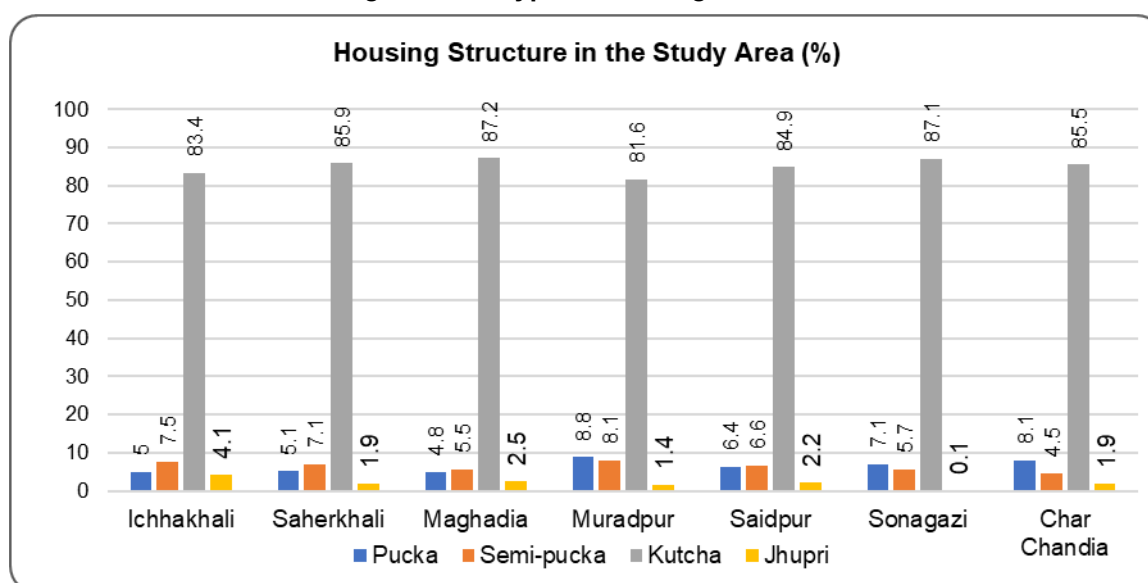
Figure 3-92: Expectations from the NSEZ

Source: Household Survey conducted by EQMS 2023

3.11 Housing pattern

Residential dwellings in the study area were generally classified into Kutcha (Huts), Semi Pucca, and Pucca (Concrete house) houses. Data from the Population and Housing Census (2011) shows the predominant structure of these study areas is Kutcha (84.7%) followed by Semi-pucca (6.6%), Pucca, and Jhupri (6.8% and 1.9%). The housing tenancy of the study area is owned by (96.5%), rented (1.7%), and rent-free (1.8%). Figure 3-93 shows the type of structure and housing tenancy in the NSEZ study area.

Figure 3-93: Type of Housing Structure



Source: Population and Housing Census, BBS, 2011

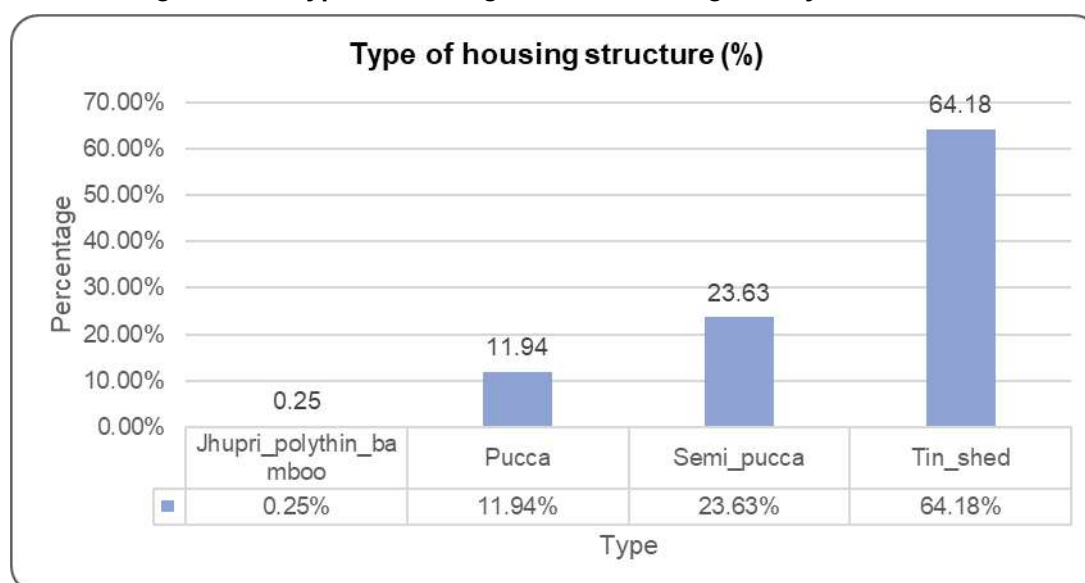
Table 3-60 provides an understanding of housing tenancy and ownership. Overall, around 96.3% of the population in the six mentioned unions own the household in which they reside, 1.7% dwell in a rented house, and 2% live in a rent-free homestead.

Table 3-60: Housing Ownership Pattern

Upazila	Union	Number of HHs	Housing Tenancy (%)		
			Owned	Rented	Rent free
Mirsharai	Ichhakhalai	5,205	95.9	0.8	3.3
	Saherkhalai	3,049	98.2	0.7	1.1
Sitakunda	Muradpur	5,844	91.2	6.8	2
	Saidpur	6,357	97.8	0.9	1.3
Sonagazi	Sonagazi	4,299	98.5	0.2	1.2
	Char Chandia	7,276	97.6	0.5	2
Total		32,030	96.3	1.7	2.0

Source: Population and Housing Census, BBS 2011

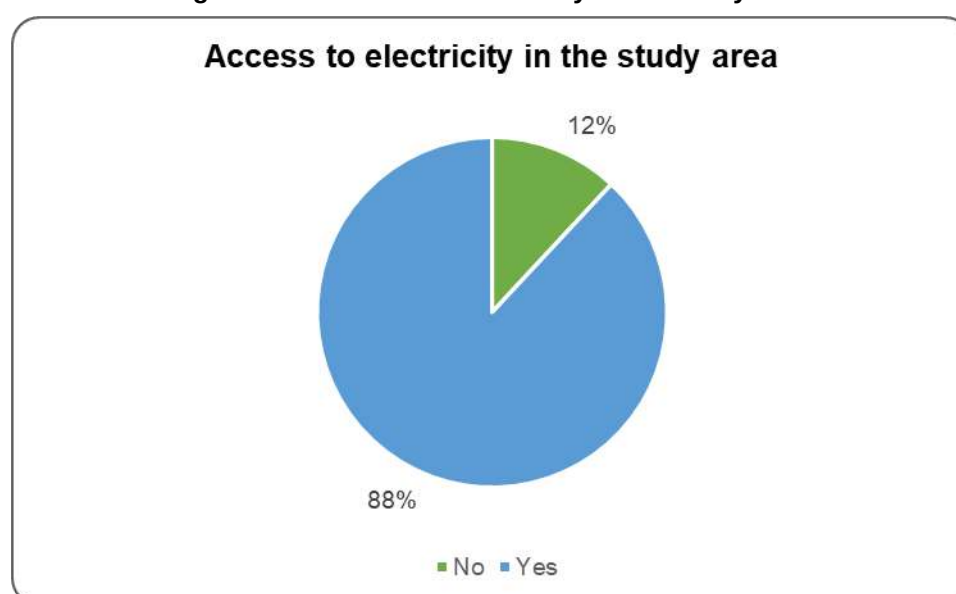
At present, according to the primary survey, about 64% of the houses in the core area are tin sheds, 23.6% of the houses are semi-pucca and 12 % of the houses are buildings. Less than 1 % of the households are reported to be Jhupri/kacha. The quality of housing and infrastructures are shown in Figure 3-94.

Figure 3-94: Type of Housing Structure Among Survey Households

Source: Household Survey conducted by EQMS 2023

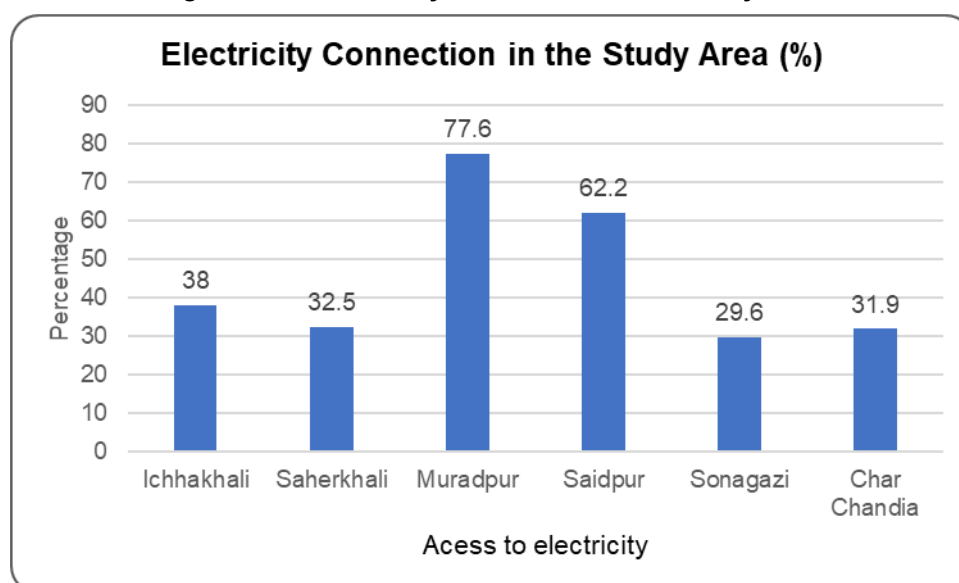
3.12 Access to utilities and services

Electricity is an important indicator for measuring the quality of life in the study area. In the NSEZ area, most of the surveyed households (88%) have grid electricity connections (Figure 3-95).

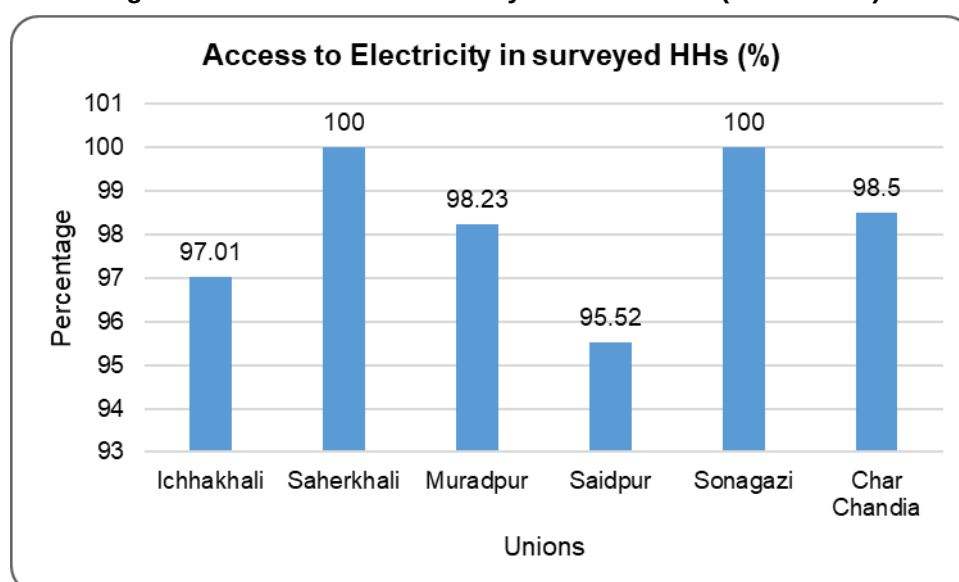
Figure 3-95: Access to Electricity in the Study Area

Source: Household Survey conducted by EQMS 2023

Union-wise data shows variation in access to electricity. Figure 3-96 and Figure 3-97 show the secondary and primary data regarding access to electricity in the households by union. Primary survey findings show majority of households in all unions, except Muradpur, have access to electricity.

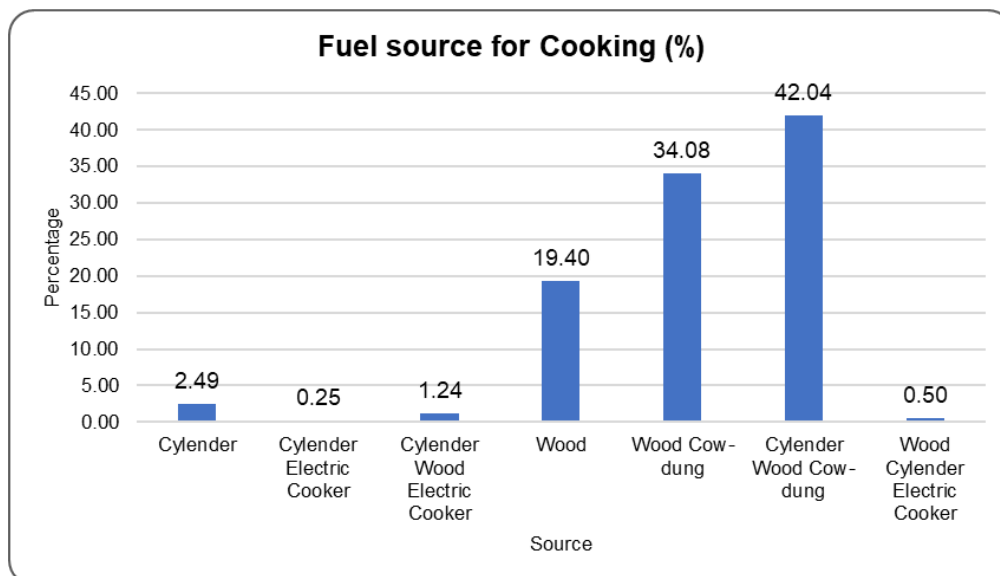
Figure 3-96: Electricity Connection in the Study Area

Source: Population and Housing Census, BBS, 2011

Figure 3-97: Access to Electricity in Households (Union-wise)

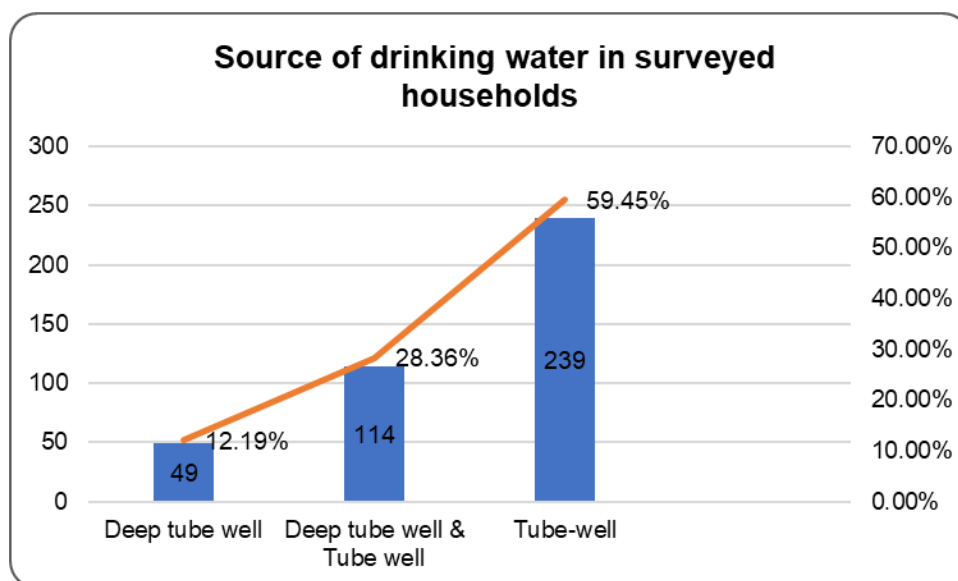
Source: Household Survey conducted by EQMS 2023

The study shows that around half of households use wood (19.40%) and a mix of wood/cow dung (35%) as cooking fuel sources and 42% use a mix of wood, cow dung, and Liquefied Petroleum Gas (LPG). About 2.5% of households are using LPG for their cooking. The rest of the households use mixed electric, cylinder, and other energy sources for cooking (Figure 3-98).

Figure 3-98: Fuel Source for Cooking in the Survey Area

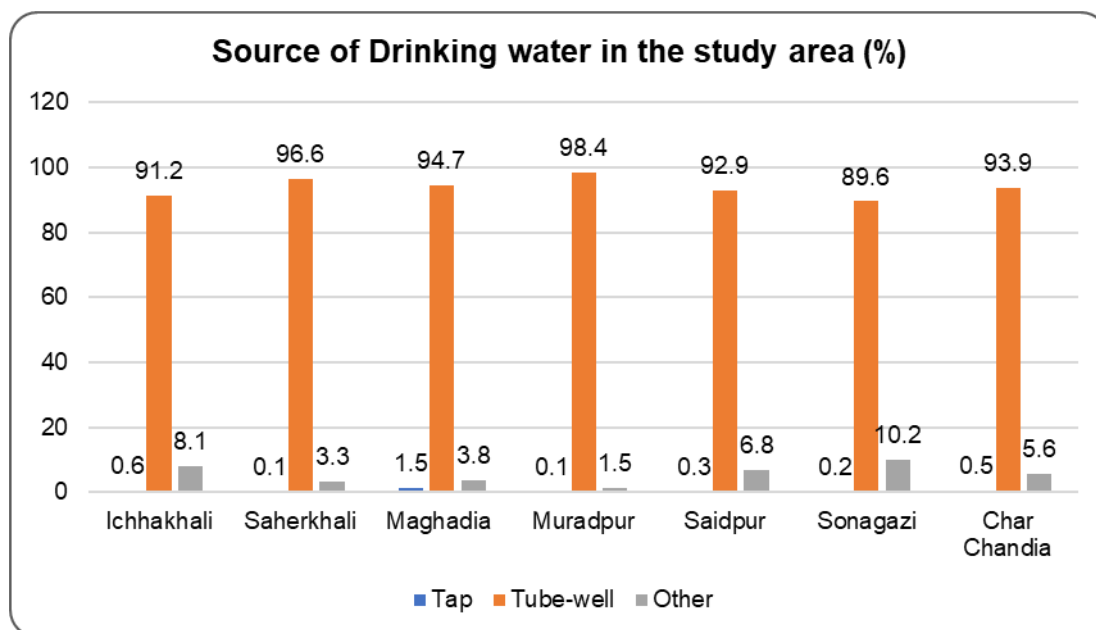
Source: Household Survey conducted by EQMS 2023

In the NSEZ area, the major source of drinking water is tube-well where about 59.45% of the population uses tube-well water. About 28.36% of people collect water from both tubewell and deep tubewell. Another 12.19% of people have access to deep tube wells. An overview is depicted in Figure 3-99.

Figure 3-99: Source of Drinking Water in Surveyed Households

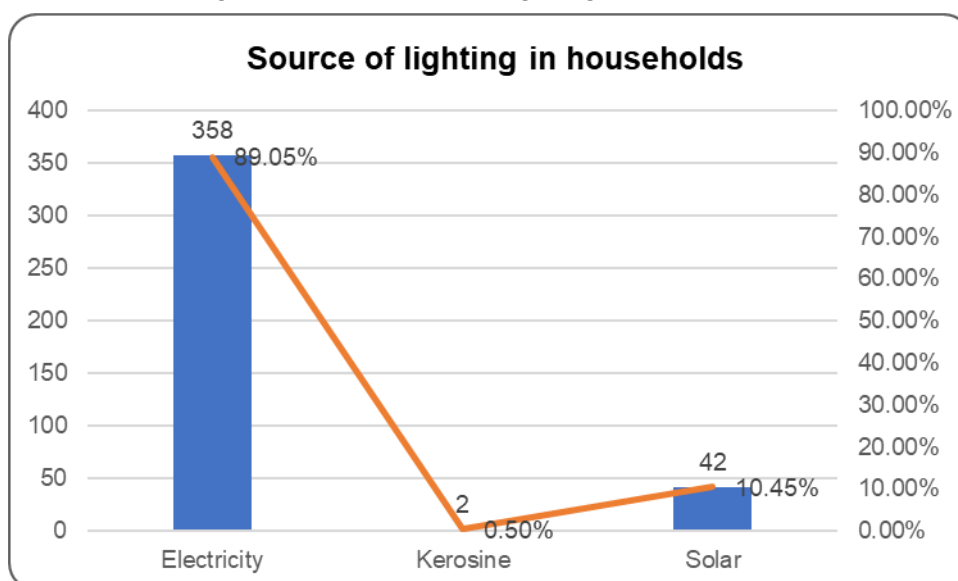
Source: Household Survey conducted by EQMS 2023

Figure 3-100 shows the secondary data obtained from the Population and Housing Census (2011). Primary findings indicate an increase in the number of households that collect water from deep tube wells. The number of other sources of drinking water in the survey area reduced significantly.

Figure 3-100: Source of Drinking Water in the Study Area

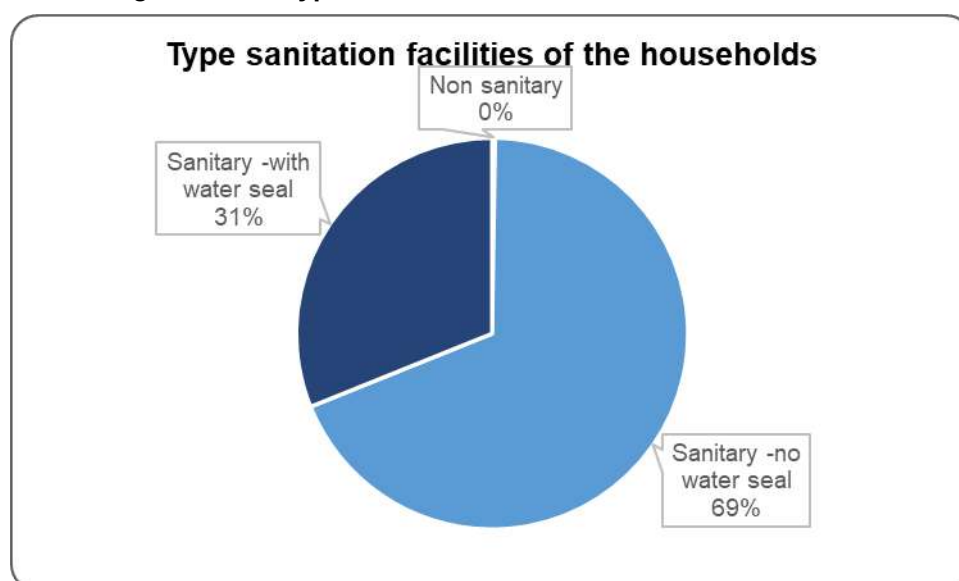
Source: Population and Housing Census, BBS, 2011

In the study area, survey results (Figure 3-101) find that nearly 90% of the households have access to electricity for lighting and fanning purposes. Around 10.45% of households utilize solar panels for lighting. Less than 1% of households use kerosine lamps as a source of light in day-to-day activities.

Figure 3-101: Source of Lighting in Households

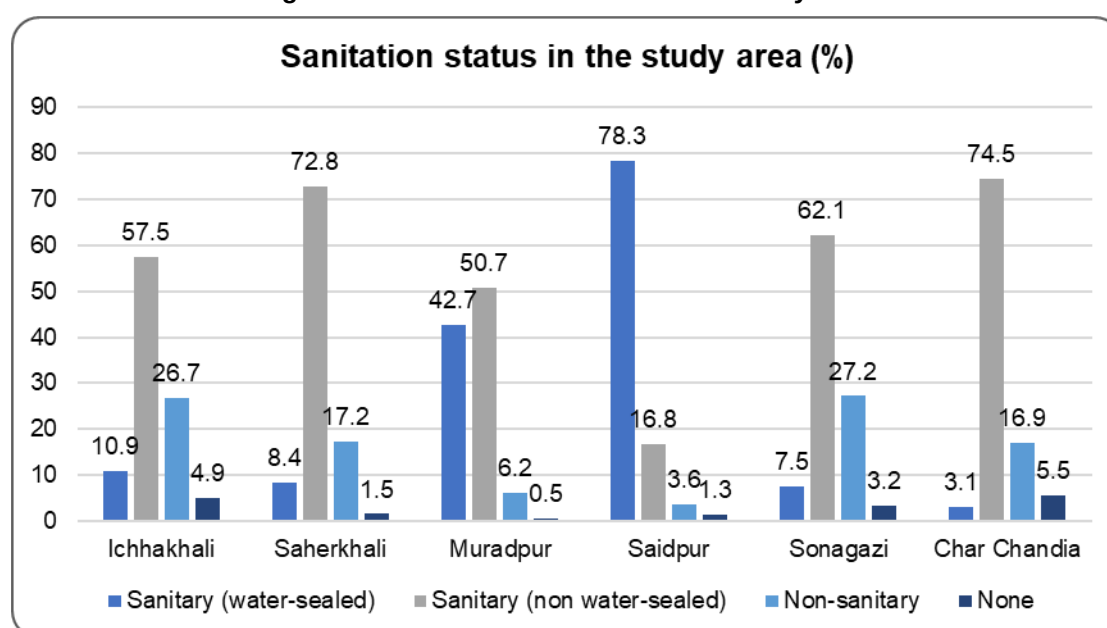
Source: Household Survey conducted by EQMS 2023

In the study area, households that use water-sealed sanitary latrines and non-water-sealed sanitary latrines facilities are 31% and 69% respectively which indicates almost the entire survey population has access to sanitary latrines. Figure 3-102 shows the sanitation facilities of the households among the surveyed population.

Figure 3-102: Type of Sanitation Facilities of the Households

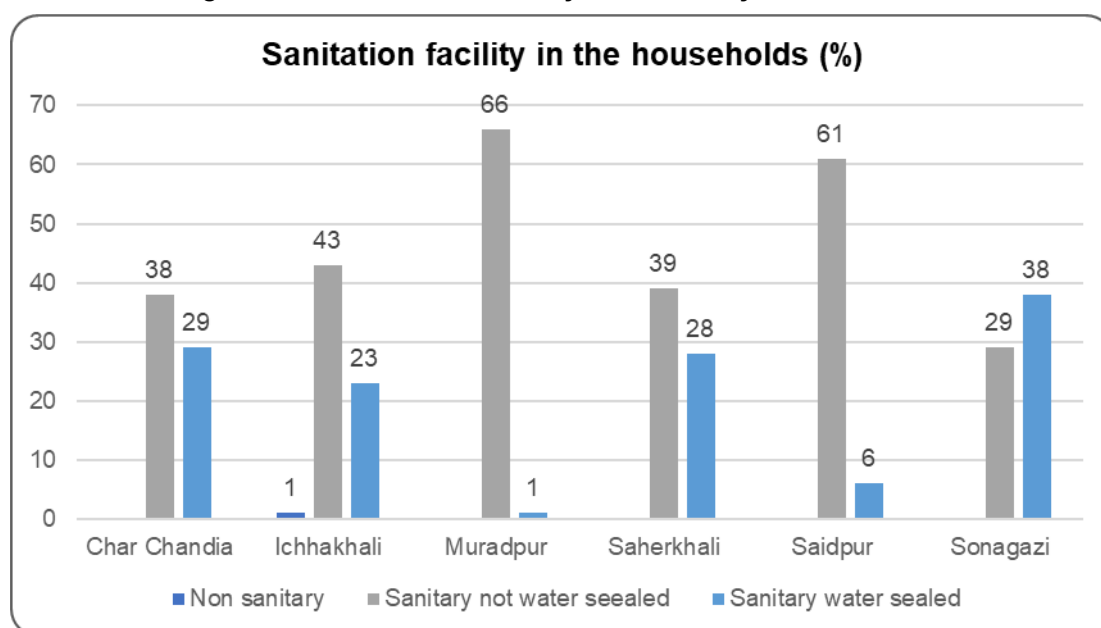
Source: Household Survey conducted by EQMS 2023

Figure 3-103 and Figure 3-104 show a comparison between secondary data obtained from the Population and Housing Census 2011 and data obtained from the primary survey.

Figure 3-103: Sanitation Status in the Study Area

Source: Population and Housing Census, BBS, 2011

The sanitation situation improved as the number of households with no sanitary latrine reduced to nearly zero percent shown in Figure 3-104.

Figure 3-104: Sanitation Facility in the Surveyed Households

Source: Household Survey conducted by EQMS 2023

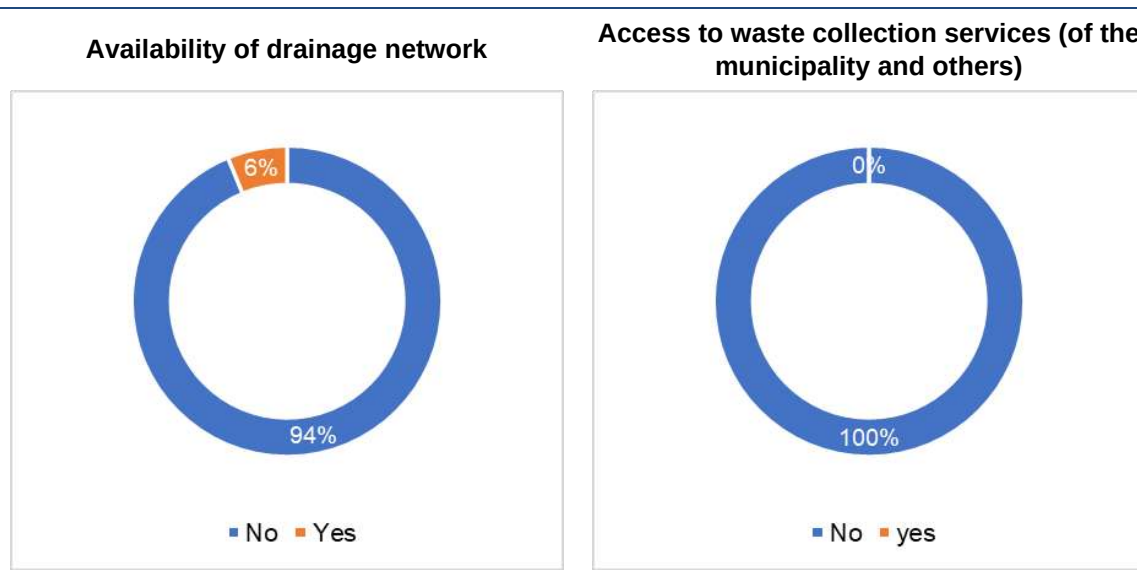
During the survey, it was found that around 12.44% of the total households have healthcare facilities within 1 km of their houses, while 32% have healthcare services between 1 to 3 km distance. However, a significant number of HHs (55.47%) have to travel more than 3 km to get healthcare facilities. More than half of the survey population have a market (60.20%) and primary school (65.42%) within 1 km of their household. Table 3-61 shows the distance to the local hospitals, local markets, and primary schools from households.

Table 3-61: Distance to school, market, and hospital

Distance	Distance of Local Market		Distance of Primary School		Distance of Nearest Hospital	
1-3 km	116	28.86%	139	34.58%	129	32.09%
Less than 1 km	242	60.20%	263	65.42%	50	12.44%
More than 3 km	44	10.95%	0	0.00%	223	55.47%
Total	402	100%	402	100%	402	100%

Source: Household Survey conducted by EQMS 2023

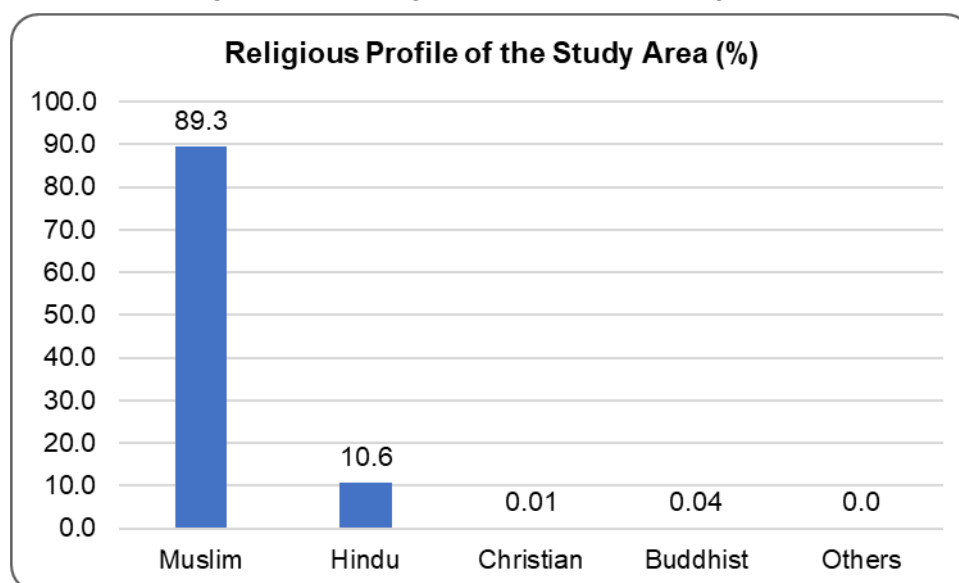
The primary survey reveals that waste collection services and drainage networks are not available to the households in the NSEZ area according to most (100% and 94% respectively) of the respondents. Figure 3-105 shows the availability of the drainage network system and waste collection system in the study area.

Figure 3-105: Availability of Drainage Network and Waste Collection in the Surveyed Area

Source: Household Survey conducted by EQMS 2023

3.13 Religious Profile

According to the Population and Housing Census (2011), the population of the study area is dominated by the Muslim community constituting almost 89.3% of the total population. The remaining 10.6% is Hindu, 0.04% is Buddhist and the remaining population is Christian. Figure 3-106 displays the various religious profiles of the NSEZ areas.

Figure 3-106: Religious Profile of the Study Area

Source: Population and Housing Census, BBS 2011

Additionally, Upazila and Union-wise census data on population by religion is provided in Table 3-62 and Table 3-63.

Table 3-62: Population by Religion - Upazila Data

Upazila	Total	Muslim	Hindu	Christian	Buddhist	Others
Mirsharai	398,716	343,374	49,266	70	4,852	1,154

Upazila	Total	Muslim	Hindu	Christian	Buddhist	Others
Sitakunda	387,832	334,053	51,797	229	1,345	408
Sonagazi	262,547	246,209	16,208	8	97	25
Total	1,049,095	923,636	117,271	307	6,284	1,587

Source: Population and Housing Census, BBS, 2011

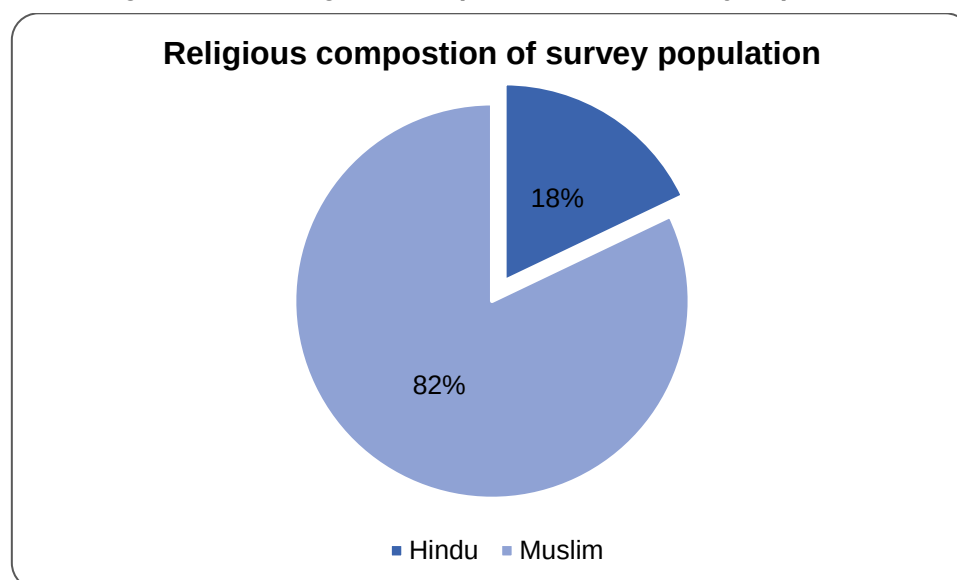
Table 3-63: Population by Religion in the Study Area

Union	Total	Muslim	Hindu	Christian	Buddhist	Others
Ichhakhali	27,980	24,594	3,326	2	51	7
Saherkhali	16,912	15,405	1,506	0	1	0
Muradpur	29,602	27,106	2,486	0	10	0
Saidpur	30,655	26,076	4,566	13	0	0
Sonagazi	22,164	20,913	1,250	0	1	0
Char Chandia	40,592	37,889	2,702	0	1	0
Total	167,905	151,983	15,836	15	64	7

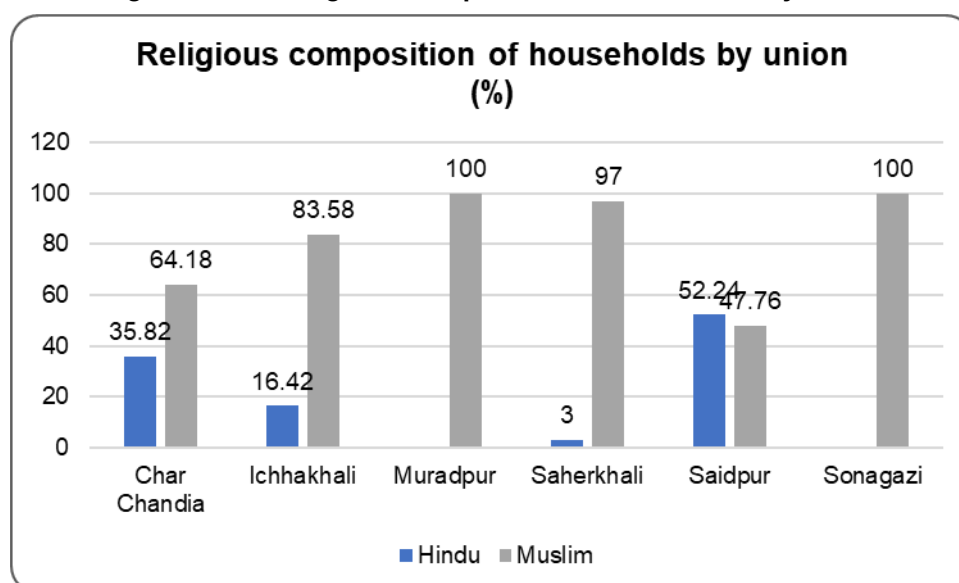
Source: Population and Housing Census, BBS 2011

According to the findings of the socio-economic survey, about 88% of the population are Muslim while 12% are Hindu by faith. No indigenous community or household was found during the socioeconomic survey. Figure 3-107 and Figure 3-108 show the present religious profile of the people in the NSEZ area. The findings of the primary survey are consistent with the secondary findings.

Figure 3-107: Religious Composition of the Survey Population



Source: Household Survey conducted by EQMS 2023

Figure 3-108: Religious Composition of Households by Union

Source: Household Survey conducted by EQMS 2023

3.14 Income and Expenditure

According to a socio-economic survey conducted in the area (Table 3-64), the monthly income of the community people living in the studied areas ranges between BDT 10,000 to BDT 60,000 with one exception where monthly income is reported to be BDT 1500,000.

Table 3-64: Income and Expenditure

Income/Expenditure	Minimum	Maximum	Mean
Monthly Income	3,000	1,500,000	27,043.5323
Monthly Expenditure	9,000	55,000	20,757.4627

Source: Household Survey conducted by EQMS 2023

Table 3-65 presents, 50% of the family have a monthly average income between 10,000-20,000 BDT, and 38% of the households have a monthly income between BDT 20,000 to BDT 30,000.

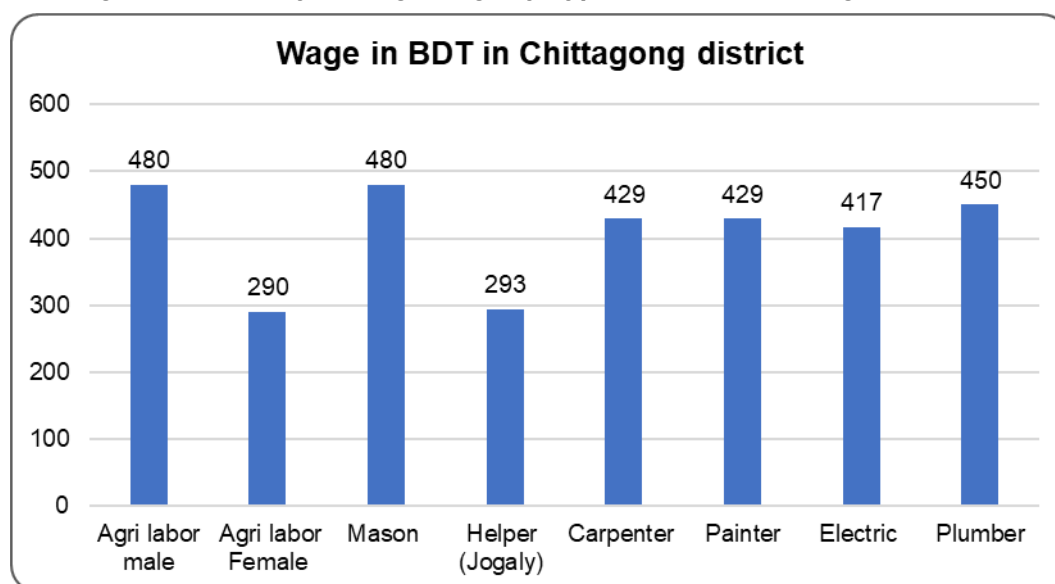
Table 3-65: Monthly Income of Households in the Study Area of NSEZ-Upazila

Income Ranges	Mirsharai	Sitakunda	Sonagazi	Average
Below BDT 10,000	1.5%			0.5%
BDT 10,001 to BDT 20,000	48.5%	59.0%	41.0%	49.5%
BDT 20,001 to BDT 30,000	38.8%	32.8%	42.5%	38.1%
BDT 30,001 to BDT 40,000	9.0%	3.0%	9.0%	7.0%
BDT 40,001 to BDT 50,000	1.5%	0.7%	3.7%	2.0%
BDT 50,001 to BDT 60,000	0.7%	1.5%	3.0%	1.7%
Above BDT 60,000	-	3.0%	0.7%	1.2%
Total	100.0%	100.0%	100.0%	100.0%

Source: Household Survey conducted by EQMS 2023

The monthly nominal income in the Chittagong division is BDT 16,073 (and expenditure is BDT 18,974). Estimated rural income is expected to be lower than these figures (HIES 2016). Figure 3-109 shows wage data by type of work in the Chattogram district.

Figure 3-109: Daily Average Wage by Type of Work in Chattogram District



Source: Population and Housing Census, BBS, 2011 2022

A substantial portion of the HHs spend less than BDT 20,000 on average per month. Around 33% of the households reported a monthly expenditure between BDT 20,000 to BDT 30,000. Households in the Sonagazi union have a higher average income and expenditure compared to the rest of the unions. However, proximity to Sonagazi municipality may have an effect on the income and expenditure of the households. Some 20% of the households reported a monthly expenditure of more than BDT 30,000 in the Sonagazi union as per data in Table 3-66.

Table 3-66: Monthly Expenditure Range of Households in the Adjacent Area of NSEZ

Expenditure Range	Char Chandia	Ichhakali	Muradpur	Saherkhali	Saidpur	Sonagazi	Average
Below BDT 10,000	-	-	6.0	-	1.5	-	1.2
BDT 10,001 to BDT 20,000	68.7	74.6	64.2	64.2	68.7	23.9	60.7
BDT 20,001 to BDT 30,000	26.9	23.9	29.9	34.3	26.9	55.2	32.8
BDT 30,001 to BDT 40,000	4.5	1.5	-	1.5	1.5	19.4	4.7
BDT 40,001 to BDT 50,000	-	-	-	-	1.5	-	0.2
BDT 50,001 to BDT 60,000	-	-	-	-	-	1.5	0.2
Total	100	100	100	100	100	100	100

Source: Household Survey conducted by EQMS 2023

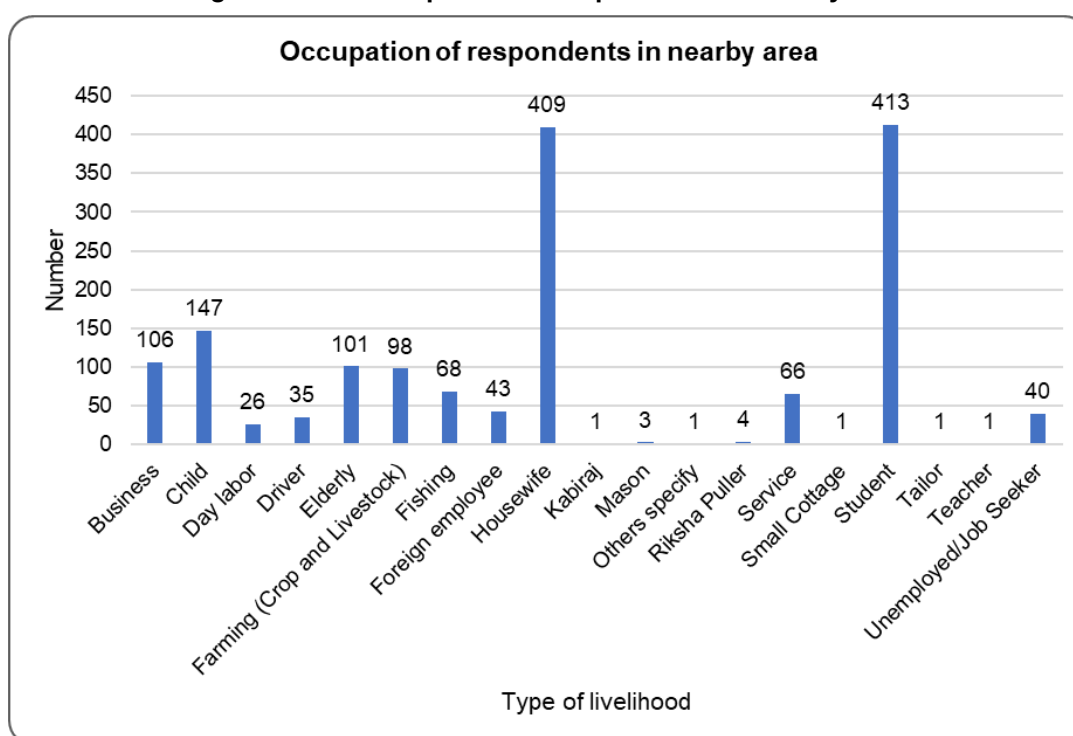
According to the Household Income and Expenditure Survey, around 19.4% of the households in the rural area of the Chittagong division are under the poverty line using the Headcount rate- HCR by the cost of basic living. (HIES 2016).

3.15 Livelihoods

To assess the livelihood and occupation categories in the studied areas, the consultant team followed both secondary and primary data sources. According to the primary socio-economic survey data, the main source of livelihood is mostly related to agriculture, comprising crop cultivation, fisheries, direct farming, sharecropping, agricultural laborers, etc. A mentionable number of fishermen were found in Mirsharai, Sitakunda, and Sonagazi upazila during the stakeholder consultation. In addition to crop farming, the number of poultry farms is 44 and 397, the number of dairy farms is 9 and 43, the number of nurseries is 30 and 14, number of decorative services is 90 and 67 respectively in Mirsharai and Sitakunda upazila. Moreover, thirty-four brick kilns were also found in these two upazilas. On the other hand, eighty-nine poultry farms, 79 dairy farms, 3 nurseries, and 42 decorative services were found in Sonagazi (BBS 2011).

According to the household survey (Figure 3-110), primary sources of livelihood are farming, fishing, business, service, day labor, driving, etc.

Figure 3-110: Occupation of Respondents in Nearby Area



Source: Household Survey conducted by EQMS 2023

Qualitative data provides an outline of potential employment opportunities for the nearby communities as well as for the eligible/skilled workers from all over the country. NSEZ is expected to create thousands of employment opportunities in various sectors such as business, service, production, residence/housing, market and commodities, transportation and tourism, etc.

Buffalo Grazing, Fishing, and Fisheries Landing Site: The vast areas of Saherkhali, Ichhakhali, Sonagazi, Char Chandia, and Muradpur Union are used for buffalo, cow, and sheep grazing. Typically, an individual farmer owns up to one hundred buffaloes or 150 sheep on average. Buffalo and cow provide both milk and meat while sheep are for meat only. There is an established dairy value chain in the area.

There are five major fisheries landing sites/Ghat in the area: 1) Saherkhali Ghat, 2) Domkhali Ghat, 3) Bamonsundor Ghat, 4) Muhuri project Mukh Ghat, and 5) Mithachora Ghat.

3.15.1 Common Property Resources

Common Property Resources have been largely described in the community structure part. The number of specific CPRs in the NSEZ area has been identified through site visits and consultation. The list of CPR identified through consultations is mentioned in Table 3-67.

Table 3-67: Common Property Resources

S/N	Common Property Resources	Resources extracted by community/utility
1	Low & wetland, canal & Rivers	Buffalo grazing, Fishing & crab hunting
2	Government khas land	Cow and sheep grazing
3	Mangroves and coastal forests	Fuel wood, fish, crabs
4	Sea beaches and Sandwip channel	Fish, fish drying space, tourism

3.16 Community Health and Safety Health Care Facilities

According to the District Statistics (BBS 2011), there are 60 Private Hospitals in these three Upazilas with 45 MBBS/FCPS doctors in the study area. Sitakunda upazila has a large concentration of private hospitals with fifty-five private hospitals in the upazila, there are 5 private hospitals in Mirsharai. However, several private hospitals reported in Sonagazi are zero. Additionally, there are eighteen diagnostic centers in the Mirsharai, Sitakunda, and Sonagazi Upazila of the proposed study area. The lists of upazila and union-level government hospital/health centers are provided in Table 3-68 and Table 3-69.

Table 3-68: List of Upazila Health Complex

Upazila	Mirsharai	Sitakunda	Sonagazi
Name of Upazila Health Complex	Mirsharai Upazila Health Complex	Sitakunda Upazila health complex	Sonagazi Upazila Health Complex

Source: Population and Housing Census, BBS, 2011

Table 3-69: List of Union-level health centers

S/N	Mirsharai	Sitakunda	Sonagazi
1	Zorawarganj, Sadar Clinic	Sitakunda, Sadar Clinic	Dagonbhuiyan, Sadar Clinic
2	Khaliyachhara, UH&FWC	Banshbaria, UH&FWC	Dagonbhuiyan, UH&FWC
3	Hinguli, UH&FWC	Bariadyala, UH&FWC	Jailashkara, UH&FWC
4	Ichhakhal, UH&FWC	Muradpur, UH&FWC	Purba Chandrapur, UH&FWC
5	Karerhat, UH&FWC	Saidpur, UH&FWC	Matubhuiyan, UH&FWC
6	Katachhara, UH&FWC	Salimpur, UH&FWC	Rajapur, UH&FWC
7	Durapur, UH&FWC	Sonaichhari, UH&FWC	Ramnagar, UH&FWC
8	Maghadia, UH&FWC	Barakunda, UH&FWC	Sindurpur, UH&FWC
9	Mayani, UH&FWC	Kumira, Rural Dispensary (RD)	Yakubpur, UH&FWC
10	Mirsharai, UH&FWC	Bhatiari, Others	Fazilerghat, UH&FWC

S/N	Mirsharai	Sitakunda	Sonagazi
11	Mithanala, UH&FWC		
12	Saherkhali, UH&FWC		
13	Osmanpur, UH&FWC		
14	Dhum, UH&FWC		
15	Wahedpur RD		
16	Joralgoanj, MCH-FP Unit		
17	Kumarlihat MCWC		
18	Mirsharai MCWC		

*RD=Rural Dispensary, MCWC= Mother & Child Welfare Centre, UH&FWC= Union Health & Family Welfare Centre

Source: https://www.dgfpmis.org/ss/others8/facility_name.php

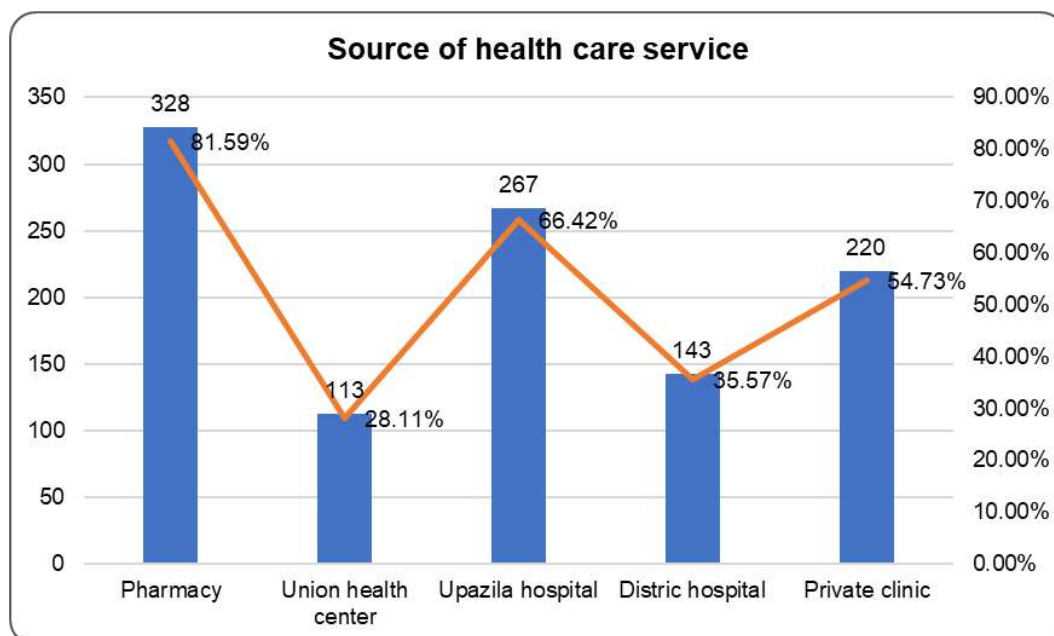
Table 3-70 shows the number of available beds in the three above-mentioned upazila. In total, there are 112 beds in the government hospital for a population of 0.9 million. Considering the number of medical practitioners and total population of the areas, the capacity of the health facilities seems inadequate. For any major medical support and healthcare need, people seek treatment from Chittagong Medical College Hospital which is located in Chattogram City.

Table 3-70: Number of Government Health Complex and Health Personnel

Upazila	Number of Beds	Number of Doctors	Number of Nurses	Number of Technicians	Number of Other Staff
Mirsharai	50	26	9	2	186
Sitakunda	31	23	7	4	54
Sonagazi	31	7	5	1	158
Total	112	56	21	7	398

Source: Population and Housing Census, BBS, 2011

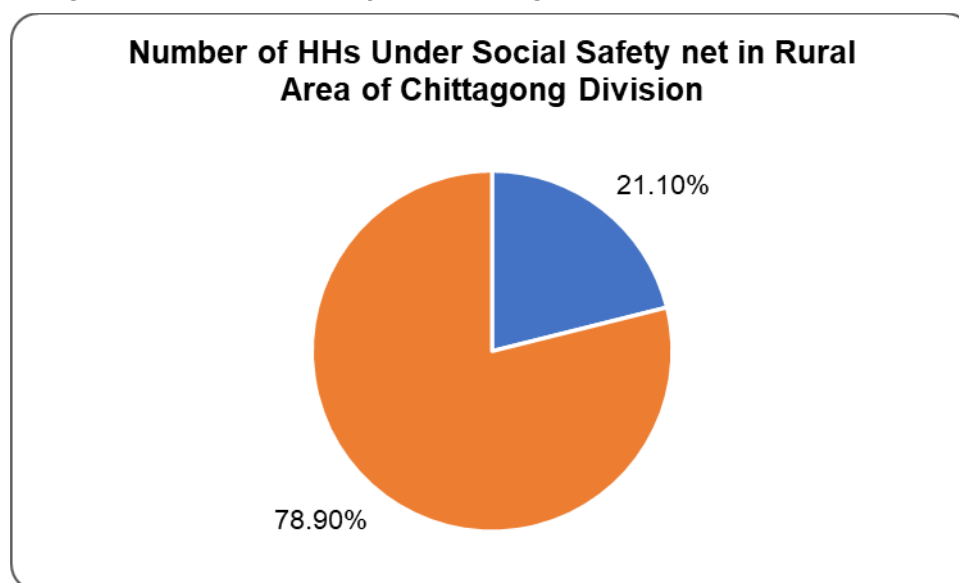
Consultation findings and secondary review indicate that the generation of emissions, effluents, waste, and increased vehicular movements may have an overall adverse impact on the health of the people in the area. Moreover, the future influx of population, the number of beds, necessary logistics, and resources in the Upazila level hospitals need to meet the future demands. According to the findings of the consultation, it has been recommended to increase additional healthcare facilities with well-trained medical practitioners and staff. Medical facilities need to increase gradually considering the rise of population size in the areas, particularly in Saherkhali, Ichhakali, Saidpur, Muradpur, and other NSEZ surrounding areas. Figure 3-111 supports the qualitative findings with 81.6 % of the survey population seeking treatment from the pharmacy as a first source of treatment, while 66% seek treatment from Upazila Hospital if the treatment from the pharmacy is not sufficient.

Figure 3-111: Source of Healthcare Service

Source: Household Survey conducted by EQMS 2023

3.17 Disadvantage and Vulnerable Groups

According to the Household Income and Expenditure Survey 2016 and Poverty Maps of Bangladesh 2016, around 18.43% of the total population of the Chattogram division live below the poverty line. Stakeholder consultation further revealed the existence of an artisanal fisherman Community called 'Jaldas' (translated as servant of water). They are from a minority Hindu community and are found vulnerable in terms of their level of income and living conditions. Those communities expressed a great concern assuming any potential risk of interruption in their access to traditional fishing. Additionally, people living near the shoreline are vulnerable to natural disasters like cyclones as the majority of the house structures are made of tin sheds (64%, Figure 3-112).

Figure 3-112: Social Safety Net Coverage of Households in Rural Areas

Source: Household Income and Expenditure Survey-HIES 2016

Allowances and Social Safety Net Program: According to the Household Income and Expenditure Survey 2016¹⁸, 21.1% of HHs are under the coverage of social safety net programs in the rural areas of the Chattogram division (Figure 3-112). Education and other stipends, old age allowance, widow deserted and destitute woman allowance, Freedom Fighter honorarium, VGF, VGD, GRA-General relief activities, etc. are the major categories of safety net coverage.

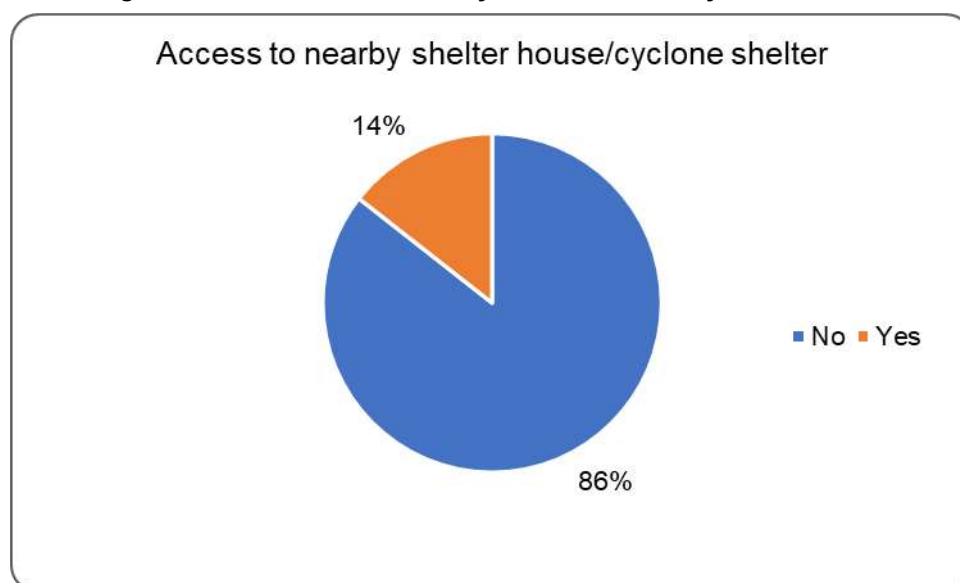
Department of Social Services and Disaster Management Directorate have multiple social safety nets including the above-mentioned VGF, VGD, GRA, and different allowances. Additionally, there are employment generation programs for the hard-core poor, and food/cash-for-work programs are implemented by different government departments. NGOs are also implementing IGA, microcredit, and other programs for vulnerable communities. BRAC has a Targeting Ultra Poor (TUP) program for poor households in the areas.

As per the socioeconomic survey, only 14% of the households reported that there are nearby cyclone shelters. Figure 3-113 shows there is no cyclone shelter near the majority (86%) of the households

Please incorporate specific suggestion and plan for following issues:

- Suggest specific area for housing
- Provide the list of roads needs to be upgradation
- provide the list of schools, collage , hospital, clinic, playground and rest of community structure needs to improve
- Suggest skills development center
- Suggest rest of CPRs name and location map including who will do What

Figure 3-113: Access to Nearby Shelter House/Cyclone Shelter

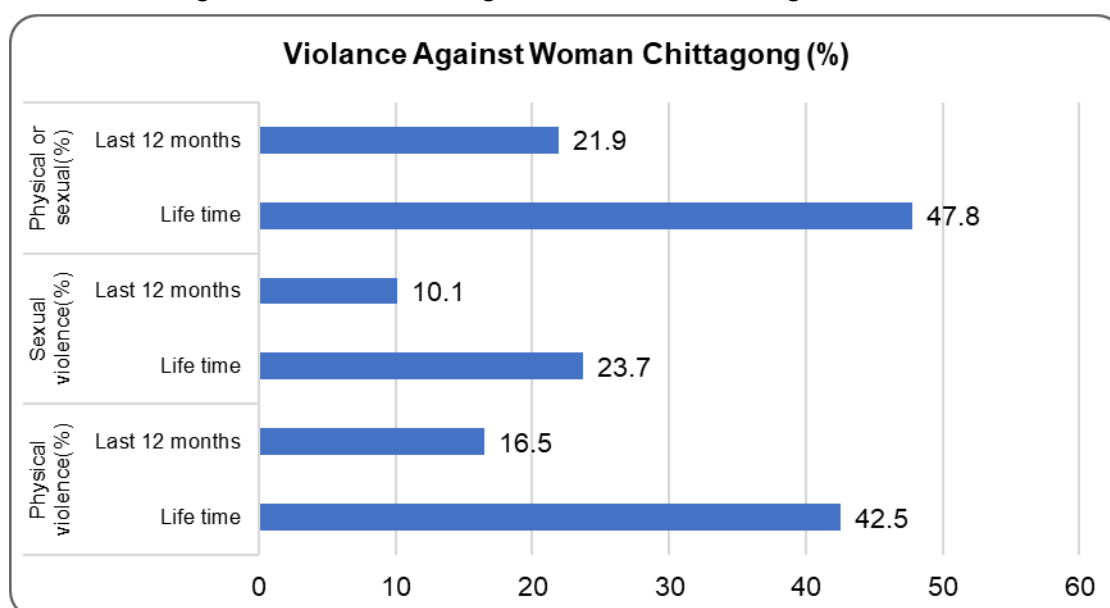


Source: Household Survey conducted by EQMS 2023

3.18 Status of Gender-Based Violence

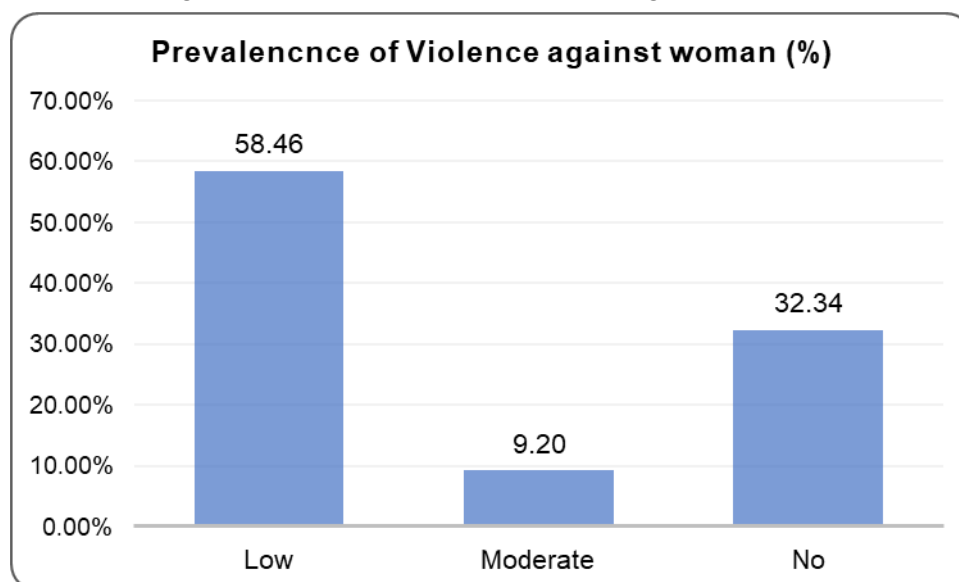
A survey named "Violence Against Women (VAW) Survey 2015" was conducted by the Bangladesh Bureau of Statistics. According to that survey violence against women in Chattogram Division is given in Figure 3-114.

¹⁸ Household Income and Expenditure Survey -HIES 2016, BBS

Figure 3-114: Violence Against Women in Chattogram Division

Source: Violence Against Women (VAW) Survey 2015

The primary survey conducted in the study area during the study period reveals that about 9.20% of the population moderately believes violence against women is a social issue. While 58.46% of the population perceived violence against women as a non-major social issue. Additionally, a total of 32.34% of the respondents do not consider the Prevalence of Violence against women as a social issue (Figure 3-115).

Figure 3-115: Prevalence of Violence Against Women

Source: Household Survey conducted by EQMS 2023

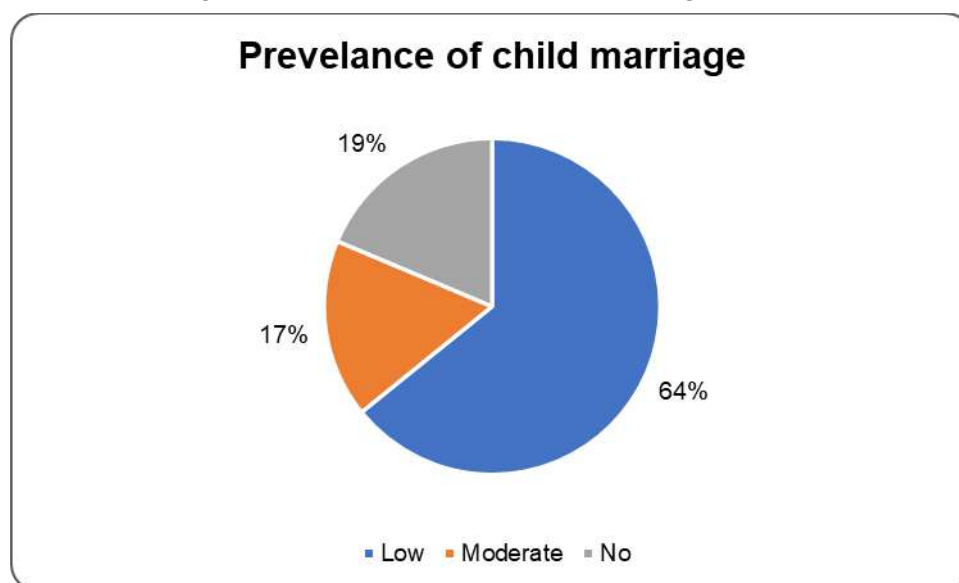
According to BDHS 2022, the prevalence of child marriage is 64.3% in the rural areas of the Chittagong division., 19.5% of females get married before reaching the age of sixteen, and 44.8% of females get married before 18 years of age¹⁹.

According to the primary socio-economic survey, about 64% of the respondents assert that the prevalence of child marriage is low in the area (Figure 3-116), while 17% of the respondents reported

¹⁹ Bangladesh Demographic and Health Survey-2022 (BDHS 2022)

perceiving the prevalence of child marriage as a social major issue. Around 19% percent of the respondents do not perceive child marriage as a social issue.

Figure 3-116: Prevalence of Child Marriage



Source: Household Survey conducted by EQMS 2023

3.18.1 Traffic and Transport

According to the District Statistics (2011), in Mirsharai, Sitakunda, and Sonagazi Upazila, the total length of the metalled road is 587 km and there are 310 km of semi-metalled road. In these upazilas, the total length of the unmetalled (kacha) road is 2126 km. There are three railway stations in Mirsharai upazila and six railway stations in Sitakunda upazila. There are 16 Bus stands in the study areas. Additionally, six steamer or launch stations were found in Sitakunda upazila. The waterway in the monsoon is 59 km and the waterway round the year is 53 km found in the area. Table 3-71 shows the traffic and transportation status of the study area.

Table 3-71: Traffic and Transportation of the Study Area

Upazila	Length of Metalled, Semi Metalled and Unmetalled road			Length of Railway and waterway			Stations		
	Metalled road	Semi metalled	Unmetalled Kacha Road	Total Railway	Waterway in monsoon	Waterway round the year	Railway Station	Steamer/ Launch Station	Bus Stand
Mirsharai	260	227	1,484	12	59	53	3	0	8
Sitakunda	157	74	301	45	0	0	6	6	6
Sonagazi	170	9	341	0	0	0	0	0	2
Total	587	310	2,126	57	59	53	9	6	16

Source: Population and Housing Census, BBS, 2011

3.18.2 Archaeological, Heritage, and Cultural Structure

Bangladesh possesses three world heritage sites namely the Historic Mosque City of Bagerhat, the Ruins of the Buddhist Vihara at Paharpur, and Sundarbans. Out of three, the first two have a cultural designation and the later one is designated for its natural entity. None of the existing world heritage sites are located within or around the study area.

3.18.3 Tourist Spots/Tourism

Rangamati, Khagrachari, Bandarban, and Cox's Bazar districts are the main tourist hubs of the country and are in the Chattogram division. Any future influx of population in the NSEZ area will create opportunities in the adjunct tourist hubs as well as for the local tourist spots. Primary and secondary data reveal the presence of multiple tourist spots in the three upazilas in which the NSEZ is located. A list of the tourist spots is provided in Table 3-72 and a map showing the tourist spots in the study region is presented in Figure 3-117.

Table 3-72: Tourist Spots in the Study Area

Upazila	Tourist spot	Sea Beaches	Historical places
Mirsharai	Mahamaya lake, Khoiyachara Waterfalls, Melkhum trail, Napittachora Waterfall, Bawachhora Lake ²⁰	Saherkhali sea beach, Mohanagor sea beach, Uttor bogar char beach	• Hinguli Court Parr (embankment) built by Arakani Moghs • Chhuti Khan Mosque (16th century) • Daulat Bibi Mosque (16th century) • Mahadia Mosque (1780) • Nai Duari Mosque (18th century) • Hamidullah Khan Mosque (19th century) • The tomb of Shah Zayed (R) (806 AH) • Tomb of Awal Kazi Moakkel (R) • The tomb of Hazrat Shah Badal (R) • tomb of Hazrat Chinki Montana (R) • Tomb of Hazrat Mia Noor Ali Shah (R) • Tomb of Sufi Noor Mohammad Nizampuri (R) • Tomb of Hazrat Mir Gaffar Khan • Jagannath Mandir (Abu Torab Bazar) • Kali Mandir (Karerhat) • Hazisharai Mandir • Newanpur Mandir.²¹

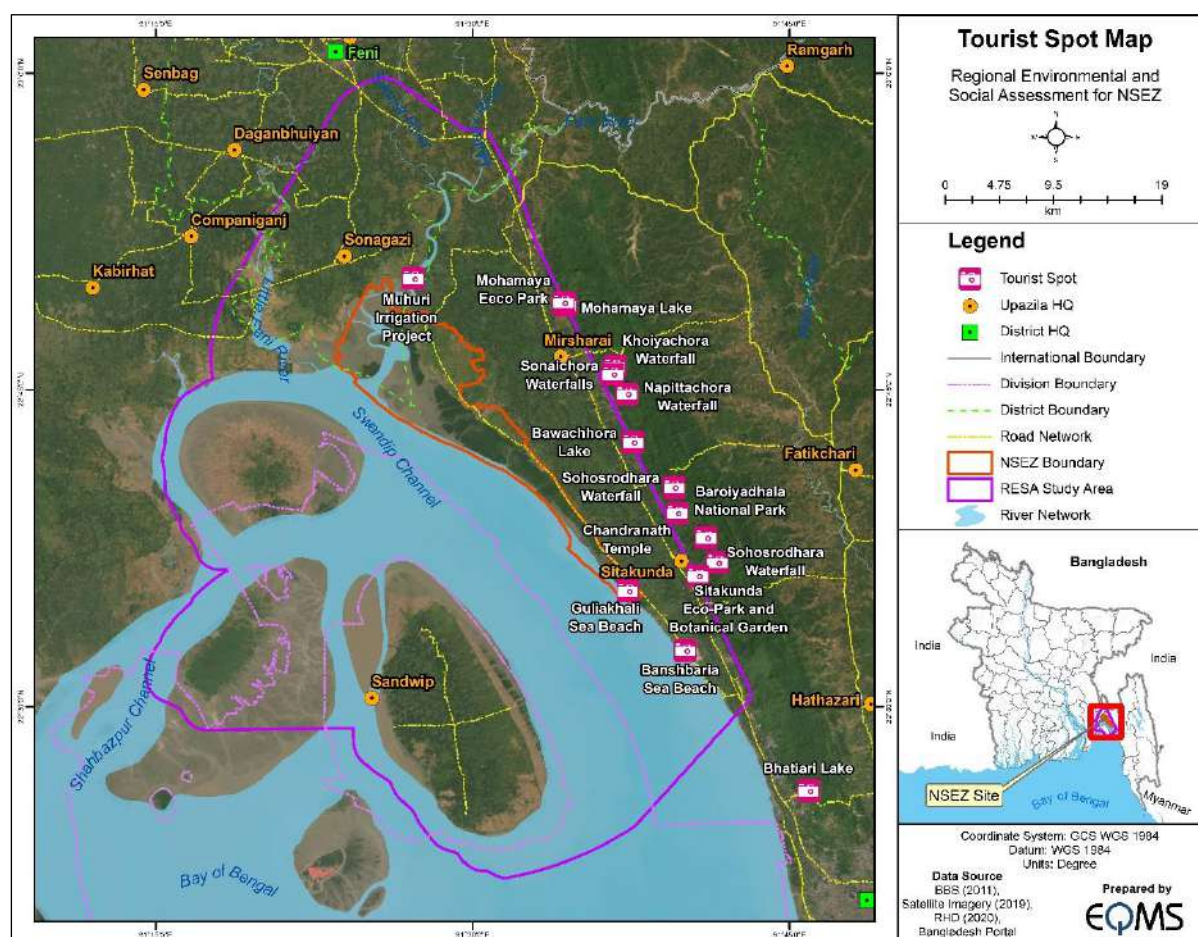
²⁰ <https://www.thedailystar.net/life-living/travel/news/top-5-places-visit-mirsharai-chattogram-3350356>

²¹ https://en.banglapedia.org/index.php/Mirsharai_Upazila

Upazila	Tourist spot	Sea Beaches	Historical places
Sitakunda	Eco Park, Botanical Garden, Sohosrodhara Waterfall, Jharjhari Waterfalls, Bhatiari Lake, Komoldoho Trail	Guliakhali Sea Beach, Banshbaria Sea Beach,	• Tomb of Bara Aulia • Kalu Shah Mazar • Fakir Hat Mazar • Pasthishala Buddhist Vihara • Sitakunda Shankar Math • Labanakhya Mandir • Chandranath Mandir and Hill
Sonagazi	Muhuri project	Sonagazi national forest	-

*One of the longest sea beaches in the world is the sea beach from Mirsharai to Teknaf.

Figure 3-117: Tourist Spots in the Study Region



Source: EQMS, December 2023

4 STAKEHOLDER MAPPING AND PUBLIC CONSULTATION

4.1 Background

Stakeholder engagement is a continuous process of sharing information, seeking to understand the concerns of community stakeholders, and building relationships based on collaboration. It is an inclusive and culturally appropriate process that provides stakeholders with opportunities to express their concerns, views, observations, and feedback. It begins as early as possible in a project preparation because early identification of and consultation with both the affected and interested parties allows stakeholders views and concerns to be considered in the project design, implementation, operation, and decommissioning.

In order to achieve effective engagement, the disclosure of NSEZ information is crucial. Disclosure refers to the provision of relevant and adequate NSEZ information/report/data to support stakeholders in understanding the impacts, risks, and opportunities of the NSEZ. Engagement seeks to develop effective means of communication with potentially affected groups in ways in which they are encouraged and feel most able to participate in the development of NSEZ and express their views. For truly effective engagement, it is fundamental that stakeholders feel that they can access NSEZ decision-makers and comment and feedback in an ongoing manner as a NSEZ develops.

4.2 Objectives

The main objectives of the stakeholder engagement are to:

- Adopt long-term relationships with the NSEZ stakeholders, establish a positive community existence, and manage expectations and possible misconceptions.
- Identify and prioritize stakeholders as well as vulnerable groups, within the NSEZ region.
- Generate a good understanding of the NSEZ amongst stakeholders, including NSEZ updates, environmental and social assessments, mitigation measures and management plans, and monitoring plans.
- Receive feedback from stakeholders regarding environmental and social risks and impacts associated with the NSEZ, along with proposed measures and actions to address them.
- Demonstrate the commitment to all stakeholders with respect to environmental and social issues.
- Prepare a list of corrective actions/procedures suggested by stakeholders and include them in the planning and implementation.
- Prevent conflict by addressing impacts and issues raised by stakeholders promptly, particularly with the communities that will not be served by the NSEZ.
- Demonstrate the ability to comply with standards and expectations that may arise in the future.
- Propose a guideline for the systems to be implemented at the NSEZ and how they achieve an effective environmental and social management system.
- Fulfill the World Bank's requirements concerning public access to information and public involvement in the decision-making process.

4.3 Regulatory Context

4.3.1 World Bank Requirements for Stakeholder Engagement and Public Consultation

World Bank's Environmental and Social Standards under the Environmental and Social Framework pertaining to stakeholder engagement activities are:

- WB ESS10: Stakeholder Engagement and Information Disclosure.

4.3.2 National Legislations Related to Community Engagement

Environmental Conservation Rules (ECR) 2023 provides a legal framework for public consultation and disclosure during Environmental Impact Assessment (EIA).

The Constitution of the People's Republic of Bangladesh guarantees freedom of thought and conscience, and freedom of expression and speech, subject to any reasonable restrictions imposed by law. The Right to Information Act 2009 makes provisions for ensuring the free flow of information and people's right to information. Freedom of thought, conscience, and speech is recognized in the Constitution as a fundamental right and the right to information is an alienable part of it.

The Department of Environment (DOE), Bangladesh shall not reach a decision on any application for an environmental permit until such time that the proponent has demonstrated to the satisfaction of DOE that informed the public that the document is being made available for public review by advertising the document displaying a copy of it for inspection, and convened and recorded the proceedings of a public hearing specifically for a RED category project. After reviewing the application for a permit, DOE reaches a decision, informs the public of that decision, and makes available any relevant documentation or information for public review.

4.4 Stakeholder Identification

The first step in the process of stakeholder engagement is stakeholder identification; that is, determining who the stakeholders are and what they should be grouped under. According to the World Bank's ESSs, a stakeholder refers to "individuals or groups who: (a) are affected or likely to be affected by the NSEZ (project-affected parties), and (b) may have an interest in the NSEZ (other interested parties)". Therefore, aiming to understand the surrounding social context of the proposed NSEZ region, the RESA team conducted site investigation visits for the proposed NSEZ activities. Once stakeholder groups were identified, it was then possible to suitably understand the social context and map out all the relevant stakeholders. Aligning with the requirement of WB ESS10, the stakeholders have been categorized into the following groups:

- **Project Affected Parties:** those who are or are likely to be affected by the NSEZ activities.
- **Other Interested Parties:** those who have an interest in the NSEZ.

In addition to the above two main categories, the following group has also been identified as stakeholders for this NSEZ considering different socioeconomic vulnerabilities and disadvantages:

- **Disadvantaged/Vulnerable Individuals or Groups:** Persons who may be disproportionately impacted or further disadvantaged by the project(s) as compared with any other groups due to their vulnerable status, and that may require special engagement efforts to ensure their equal representation in the consultation. These groups may include the following:
 - The elderly, especially those living alone
 - Individuals with chronic diseases and pre-existing medical conditions
 - Ethnic minority groups
 - Female-headed households
 - Disaster-affected populations
 - Poor households including homeless and landless families.
 - Persons with disabilities.

Subsequently, a primary analysis is applied to distinguish each stakeholder's impact on NSEZ development so as to plan their respective level of engagement in the future. This stakeholder mapping and analysis exercise is used to group stakeholders according to their roles and influence pertaining to the NSEZ. Accordingly, Table 4-1 lists the identified stakeholders and states their effect on the NSEZ.

Table 4-1: Stakeholder Identification

Categories of Stakeholders	Stakeholder Groups
Project Affected Parties	• Affected Persons who are living in or beside the planned IMD land. • Communities in the vicinity of the NSEZ's planned activities. • The local population and local communities including ethnic communities. • The vulnerable group (that includes the elderly, physically and mentally disabled persons, single mothers, adolescent girls, minority transgender community, and the children). • Local health, education, and like services would have to provide basic support to the EZ staff, workers, and their families including school-going children like basic healthcare, schooling, etc. • Residence, business entities, and individual entrepreneurs in the area of the NSEZ who are adversely affected owing to the NSEZ activities. • Local laborers are to be engaged in the NSEZ work. • Suppliers and service providers. • Contractors, subcontractors. • Transport owners & workers.
Other Interested Parties (International Level: Investors)	• Environmental and societal NGOs (including those working on Labor, Human rights, environment, Gender, and GBV matters) • Foreign investors & companies, Development Partners (at National and International levels), Indian Economic Zone, etc. • Multinational or foreign companies • Donor agency
Other Interested Parties (National Level: Government, investors, political groups)	• Bangladesh Garment Manufacturers and Exporters Association (BGMEA) • Bangladesh Export Processing Zones Authority (BEPZA), Bangladesh Economic Zone, SBG EZ • Local investors • Chittagong Port Authority • Business and workers' organizations • Academic institutions (e.g. universities, think tanks, schools) • Training service providers • Urban Development Directorate (UDD) • Roads and Highway Department (RHD), Chattogram Water and Sewerage Authority (CWASA), Bangladesh Railway (BR), Urban Development Directorate (UDD), Bangladesh Telecommunication Company Limited (BTCL), Bangladesh Industrial Technical Assistance Center (BITAC), Karnaphuli Gas Distribution Company Limited (KGDCL), Gas Transmission Company Limited (GTCL), Cyclone Preparedness Programme (CPP), Ministry of Social Welfare (MOSW), Export Competitiveness for Jobs (EC4J) Project. • Civil Society Organization (CSO)/Community Based Organization (CBO)/Non-Government Organization (NGO)/Other NGOs (HR, Gender, Labor Issues). • GOB officials (Deputy Commissioner, Upazila Nirbahi Officer), permitting and regulatory agencies at the national and regional levels, including environmental, technical, social protection, and labor authorities. • GOB officials at the district level and below including the Department of Environment (DOE), Upazila Health and Family Planning Officers

Categories of Stakeholders	Stakeholder Groups
	(UHFPO)/Upazila Health Complex (UHC), Bangladesh Rural Electrification Board (BREB), Fire Service and Civil Defense, Department of Youth Development, Department of Public Health Engineering (DPHE), Department of Narcotics Control, Forest Department (FD), Department of Agriculture (DA), Department of Fisheries (DOF), Bangladesh Water Development Board (BWDB), Bangladesh Inland Water Transport Authority (BIWTA), Power Grid Company of Bangladesh (PGCB), Power Division (PD), Bangladesh Meteorological Department (BMD), Upazila Education Office (UEO). - Local Government including Union Parishad, Upazila Parishad in the NSEZ area, village administrations; elected representatives such as Member of Parliament (MP) and Major Political Representatives - Business owners and providers of services, goods, and materials that will be involved in the NSEZ's wider supply chain & transportation business. - Feni and Chattogram Chamber of Commerce and Industry. - Mass media and associated interested groups including District and local Press Clubs, local, regional, and national print and broadcasting media, digital/web-based entities, and their associations.

4.5 Stakeholder Engagement Process

The engagement of stakeholders is an evolving process that commences from the inception phase and continues throughout the RESA report preparation. Each stage and phase have its specific objectives of engagement and results in specific outputs to be integrated into the RESA. Special attention was given to vulnerable groups including women groups, elderly people, landless and economically vulnerable, and other vulnerable community members. A summary of the stakeholder engagement process for the RESA has been given in Figure 4-1.

Figure 4-1: Stakeholder Engagement Process during the RESA



Source: EQMS, April 2024

4.6 Stakeholder Engagement Methods

Various techniques were employed through stakeholder engagement exercises under the RESA which included different participatory methods such as key informant interviews, focus group discussions, household questionnaire surveys, and validation workshops.

The information on each consultation and meeting summary along with the photographs were included in the report and raw forms in Appendix C (Vol-III) with the attendance sheet.

- **Key Informant Interviews (KIIs):** KIIs were carried out with stakeholders based on pre-set questionnaires to focus on the NSEZ objectives. Stakeholders include government departments 'representatives, local government institutes, staff, investors, community leaders, local and regional stakeholders, nongovernmental organizations, business community, news media representatives, and other stakeholders. Their opinion, issues, concerns, and suggestions were recorded considering the study objectives.
- **Focus Group Discussions (FGDs):** FGDs were carried out with local communities, fishermen, farmers, buffalo owners/grazers, workers, disadvantaged/vulnerable communities, women groups, youth, students, and other stakeholders. In FGDs, discussions were held on the issues set out by the key expert of the team. The issues were related to environmental and social components. In order to carry out the discussion more effectively and efficiently, the team was involved from 6 to 12 participants at a time during the discussion. FGDs were carried out throughout the RESA as per the requirement to know the issues, concerns, and suggestions of the local communities and other stakeholders.
- **Validation Workshops:** a total of eight validation workshops (Union, Upazila, District, Regional, and National level) were carried out to disclose the first draft RESA report among the public and stakeholders as per the TOR requirement. The RESA team prepared a PowerPoint presentation on the first draft RESA report to present the initial findings in these workshops. Prior to validation workshops, an invitation letter was issued by BEZA and sent to the targeted stakeholders for their participation. RESA team assisted the BEZA in drafting the invitation letter for inviting the stakeholders. The invitation letter was delivered in person to respective stakeholders and sent via email. The minutes of the validation workshops were prepared by the RESA team. The minutes along with feedback and suggestions received from the workshops were incorporated in the first draft RESA report.

4.7 Conducted Activities during the Baseline Data Collection

4.7.1 Summary of Stakeholder Consultation

A total of 98 consultations were conducted with various stakeholders including BEZA, NSEZ officials, investors, utility providers, permitting and regulatory government authorities, government departments, community leaders, non-governmental organizations, business community, students, journalists, teachers, religious leaders, raw materials supplier, women, disadvantage/vulnerable groups, and local communities that include different occupational groups i.e., farmers, buffalo grazers, fishermen, workers, drivers, etc. Photographs of the stakeholder consultation are given in Figure 4-2.

Figure 4-2: Photographs of the Stakeholder ConsultationConsultation with Upazila Nirbahi Officer,
Mirsharai Upazila, ChattogramConsultation with Upazila Nirbahi Officer,
Sitakunda Upazila, ChattogramConsultation with Jaldash Community (Female
Participants) at Domkhali, Mirsharai UpazilaConsultation with Fishermen at Saidpur,
Sitakunda Upazila

Source: EQMS, 2024

Stakeholder consultation covers several issues including the stakeholders' knowledge and perception of the NSEZ, anticipated impacts, opinions, major concerns, and suggested mitigations from their end. The key findings of the stakeholder consultations are given in Table 4-2.

Table 4-2: Key Findings of the Stakeholder Consultations

Themes/Aspects/ Issues Raised	Response/Findings/Observations
Knowledge and perception of the NSEZ	- Most of the stakeholders have mentioned that they know about the NSEZ in Mirsharai, Sitakunda, and Sonagazi Upazila. The local community shared that they are witnessing the development works in NSEZ, which include roads, industry building, etc. - A mentionable extent of consulted stakeholders perceived that the NSEZ would be a significant intervention for the development of the region for various reasons such as increased access to communication, information, and utility services. - Institutional-level stakeholders like GOB officials, LGIs, and CSO representatives opined that the NSEZ would be a 'game changer' not only for local development but also for the country's economic development. - In the Mirsharai area, local people have already witnessed infrastructural development in the areas, they described it as a very positive impact of the

Themes/Aspects/ Issues Raised	Response/Findings/Observations
	NSEZ and a potential contributor to the overall socio-economic development of the area. They opined that if new roads, bridges, educational institutes, welfare services, etc. are increased, it would bring a noticeable change in the local environment.
Land acquisition/Compensation/Resettlement	• Most of the NSEZ's lands were reclaimed from the sea. • Land acquisition was done by the Deputy Commissionaire (DC) office and affected people opined that they were receiving their compensation. • Compensation for squatters has been provided. A group of squatters have already been relocated to the "Gucchha Gram" NSEZ area developed by the Government of Bangladesh. • Stakeholders also strongly suggested that compensation and rehabilitation must be ensured prior to the starting of construction work as per applicable national legislation for any further development in the region.
Ambient Air Quality	• Dust generation from the movement of vehicles on the access roads has increased. It may impact the local community health if dust control measures are not followed. • RESA should consider assessing ambient air quality in the NSEZ region and surrounding area. • The government should assess the pollution load resulting from any industrial facilities that will be established because there are agricultural lands and vegetation surrounding NSEZ.
Water Resources	• Stakeholders emphasized the water issue, specifically the groundwater availability. Groundwater, especially shallow tubewells, is the main water supply source for local people in the surrounding communities of the NSEZ. • Currently, there is a groundwater crisis for domestic uses as well as irrigation during the dry season. The extraction of groundwater for NSEZ (construction and operation activities) may cause a groundwater crisis and conflict with the surrounding community. Requested to reduce or stop the use of groundwater specifically for the operation purpose and find out alternative sources of water i.e., surface water from Meghna River. • In case of unavailability of water in NSEZ, investors may not be interested in investing. • RESA study should consider future impacts on water resources, water quality, and groundwater issues in the region. • Requested to consider rainwater harvesting systems in individual industries.
Ambient Noise Level	• Ambient noise levels in the NSEZ area increased due to the movement of vehicles. • Construction activities associated with the NSEZ generate noise that is also likely to affect wildlife. • Proper mitigation should be followed to avoid noise pollution during construction works otherwise it would harm community health. • BEZA needs to encourage its investors to adopt environmentally friendly equipment and technology to avoid noise pollution.

Themes/Aspects/ Issues Raised	Response/Findings/Observations
Livelihoods	• Most of the people's livelihoods in the NSEZ adjacent areas depend on agricultural farming, fishing, livestock, small businesses, etc. Participants of the consultations opined that the NSEZ would bring both positive and negative impacts on their existing livelihood patterns. Potential impacts would include the scope of new works, occupational shifting, increase of wages, migration, increased access to the service facilities, etc. while negative impacts are assumed to be made for some particular type of occupations such as fishing, agriculture, buffalo grazing, etc. • The development of access roads will reduce travel time to reach Chattogram and Feni towns. People from Saherkhali, Ichakhali, and adjacent areas have already started migration to those towns to sell their labor, temporary businesses, or selling their locally produced agricultural products. It is also assumed that once the NSEZ is fully developed, the in-migration would take place greatly instead of out-migration. • Fishermen communities and buffalo owners/grazers are identified to be one of the most impacted groups as they assume to lose their access to the fishing ground and grazing land respectively. • Fishermen have raised their concerns as they are encountering interruptions for fishing in the Sandwip Channel due to the increased navigation of ships and vessels. They are often getting their net harmed by the bulk carriers and other cargo ships, which requires additional time and money to repair the nets. Such nets are costly with prices reaching up to 50,000 BDT per net. Fishermen also mentioned that such interruption and damage are gradually increasing their costs for fishing in the Sandwip Channel. • Buffalo grazers have already experienced a reduction in grazing areas due to the intervention under the NSEZ. • Day laborers expressed their hope to get more work opportunities with increased wages at different activities like development works. At the same time, they have raised a concern about not being able to utilize the opportunities if require any particular skill that they do not have currently. • Proper mitigation measures such as alternative livelihoods/employment opportunities, skill-development training, increased communication and business opportunities, and other facilities could contribute to reducing the impacts on the livelihoods of different occupational groups.
Employment Generation	• The local people are expecting that the NSEZ will create a lot of work opportunities for them. Young people are hoping to be directly employed in different activities during the construction and operation phases. • Local people with educational qualifications are expecting to be employed in different official and managerial positions. • In addition to the anticipated scope of direct employment in the development activities, the NSEZ has also been considered to contribute indirectly to employment generation in the adjacent areas. Surrounding the NSEZ areas, for instance, many types of economic activities are taking place/planned to take place such as small businesses, shopkeeping, service providers (e.g., legal services for land, engineering services for housing development, etc.), etc.

Themes/Aspects/ Issues Raised	Response/Findings/Observations
	• Department of Youth Development opined that the NSEZ would be a great contributor to the local labor market. Although they have not yet introduced any activities to prepare local youth for the future skilled labor demand in NSEZ. They are in the process of enhancing their capacities by providing skill development training on time-demanding trades. They hope that their capacities and future large-scale training programs will contribute to preparing the local youth as a potential labor force for NSEZ. • Skills development and capacity-building training/initiatives will improve opportunities for future employment in local communities.
Land and Other Resources	• Land value has been increased in the adjacent areas of NSEZ. Landowners expressed satisfaction as they are getting increased value. On the other hand, the affected landowners received compensation for their land. Landowners are also receiving offers from various investors and developers who are interested in coming to their areas to invest in different sectors such as opening businesses, developing housing, developing markets/ shops, etc. • For the fishermen and fish traders, fishing nets and fishing boats are the common assets. There are different types of fishing nets used by the Jaldas community to catch fish. “Ton”, “Binti”, and ‘Chandi” are the most common type of fishing nets used by the fishermen in Saherkhali. Boats are typically light-fiber boats with diesel engines. A boat costs between BDT 200,000 to BDT 400,000 depending on the size and condition of the boat.
Fish Production/ Fish Landing Stations/Ghats	• Currently, both capture and culture fishery are there. Culture fish yield rate 6 tons/acre in Mirsharai Upazila. The number of registered fishermen in the Upazila is around 2,557. Fisherman mostly catches fish in the Sandwip channel using light fiber boats with diesel engines. Few fishermen in the NSEZ areas catch fish in the deep sea. • There are four main fisheries ghat/landing stations according to the local fisherman community. These are Domkhali, Mithachora, Saherkhali, Ichakhali, and Bamansundor Ghat. • Usually, fishermen from three villages use one fishery landing ghat. They collect necessary items like string bought from Chaktai, Chattogram, and diesel acquired from local shops. • Fish yield varies by season and depends on other factors like rainfall, salinity, marine traffic, etc. In recent times, fish have become scarce. On average 15-20 kg of fish is caught by every boat per day. As their current practice, they usually sell the fish immediately after landing at the ghat and do not preserve it. Usually, the “Bepari” (vendor) or the middleman buys those fish from the fisherman and supply them to the market. • Consultation with the Jaldash community/traditional fishermen and fishery office found that fishing could be impacted in some ways such as fish catching rate could be reduced if fishermen face difficulties netting in the seas due to the navigation; if fishermen encounter difficulties accessing boats due to relocation of Ghats or boat parking station, etc. • No facilities (resting, drinking water, sewage, etc.) at the shifted ghats and no berthing facility during cyclone emergencies.

Themes/Aspects/ Issues Raised	Response/Findings/Observations
Community Health and Safety	- Currently, local people access their healthcare services from Upazila hospitals, private clinics, and Chattogram Medical College, which is both time-consuming and expensive for the general community people. Mostly dependent on private clinics. - Local people are looking forward to enjoying their access to increased health services and safety as a positive result of the NSEZ in their areas. The establishment and operation of health centers in NSEZ will contribute to community health greatly. - Many opined that they will require more community clinics, specialized hospitals, and medical colleges in their areas. - Local health practitioners including UHFPO emphasized enhancing their resources and capacities proportionately with the increased population and service demand in the areas. They also gave importance to increasing ambulance services, medical practitioners, support staff, infrastructure, and training on handling occupational diseases and health hazards.
Flora and Fauna	- Participants emphasized the importance of studying the animals and plants in the study region. - Stakeholders emphasized plantation, protection of wildlife, and biodiversity to keep the ecosystem balanced. Some opined that biodiversity and natural resources such as wildlife and forest areas are the unique features of the areas, which should not be harmed. - Wildlife residing in the NSEZ area is suggested to be rehabilitated in alternative forest areas. If there is any endangered species, it requires to take steps to save them.
Law Enforcement and Security	- Currently, there are three police stations surrounding the NSEZ namely Mirsharai, Sitakunda, and Sonagazi Police Station. The common crimes are theft, kidnapping, sexual harassment/gender-based violence, robbery, drug dealing, fraud, etc. Crimes like murder and rape are also reported occasionally in these areas. The crime scenario slightly varies among the areas. - Despite all the dedication and effort from the police department, it is also claimed that there is a scope for improvement in terms of equipment and logistics of police stations. - Due to rapid urbanization and industrialization, incidents related to crime may increase as it is a general trend in society. - Rapid influx of workers may decrease social cohesion which may lead to an increased number of crimes in society as outsiders have less integration in the local community and lack empathy for the community and surroundings. - The prevalence of GBV including false marriage, women and child trafficking, sexual harassment, etc. may increase with the influx of workers, industrialization, and urbanization. - There is a scope for engaging industrial police and tourist police in the areas. - Since the industries are starting their operation and labor influx is being observed gradually, local people emphasized establishing a dedicated

Themes/Aspects/ Issues Raised	Response/Findings/Observations
	police station. Local police also suggested increasing security personnel in and around the NSEZ area.
Local Culture	• People of different sociocultural backgrounds are living in the NSEZ adjacent areas with community harmony and their traditional norms and values. Residents are mostly Muslim and Hindu in terms of religious background. There are a mentionable number of artisanal fishermen who have practiced fishing over the generations as their hereditary occupation.
Tourist Spots and Tourism Development	• There are many tourist spots and natural resources surrounding the NSEZ, particularly in Sitakunda and Mirsharai such as Chandranath Hill and Temple, Sohosrodhara waterfalls, Shuptodhara waterfalls, Sitakunda Botanical Garden and Eco-Park, Guliakhali Sea Beach, Mohamaya lake, etc. There is a great scope for developing and promoting these potential tourist places. It is also suggested that the government can develop tourist zones in the area. • There would be a demand for recreational facilities and tourism if a city developed at NSEZ. The existing tourist spots would be the main source of such facilities. Some other tourist spots outside the Paurashava could also have potential for tourism development. • Stakeholders also raised concerns that a negative impact on the environment of tourist spots may be made if there is no development plan targeting the attractive spots of the areas. • Proper management plans are required to manage waste generated in tourist spots and ensure accommodation for tourists and their security. • Local law enforcement agencies suggested that tourist police could play important roles in ensuring the security of the tourist in the future.
Social Infrastructure/Cap acity and preparation of regional/local service providers	• In terms of the capacity and preparation of local service providers, they would require additional support to enhance the services. The capacity of the local government offices needs to be enhanced to handle the potential population influx in the future. • Accommodation and Housing: stakeholders highlighted the future demand for housing facilities in NSEZ's surrounding areas, particularly in the Mirsharai areas. They opined that the Upazilas are not yet ready to provide housing facilities for the large number of newcomers. They suggested some potential places for developing the residential and market facilities for the upcoming population i.e., UP no. 6, 7, 8 of Sonagazi Upazila; Dakshin Edilpur and Shibpur areas of Sitakunda Paurashava; and Mahasimpur and hillside fallow lands of Mirsharai Upazila. • The National Housing Authority is also searching for a potential location near Ichakhali Union and Muhuri Reservoir for future housing development. • Stakeholders also raised concerns regarding the increase in house rent in the future. • A separate township could be developed to manage the population influx considering the provision of schools, hospitals, markets, graveyards, mosques, playgrounds, sports complexes, recreational facilities, etc. Separate accommodation facilities for the workers and investors should be developed.

Themes/Aspects/ Issues Raised	Response/Findings/Observations
	• A dedicated development authority such as RAJUK can be established to regulate the unplanned building construction and ensure a planned development in the region. • Currently, houses, shops, and markets are being constructed beside the existing roads. Further expansion of existing roads will be required in the region. In that case, such types of structures will be a problem during land acquisition for road improvement. • Educational Institutes: schools and other educational institutes are able to provide services with their current resources. Capacity enhancement including academic building, teachers, supporting staff, etc. of the existing educational infrastructure will be required to meet the future demand. A demand for the establishment of additional educational institutes such as colleges, universities, and engineering institutes in the region was raised by the stakeholders. The quota for local students in the NSEZ's educational facilities is expected by the local people. • Healthcare Facilities: additional healthcare facilities with well-trained medical practitioners and staff are required. According to the consultation, medical facilities need to be increased gradually considering the rise of population in the NSEZ surrounding area including Saherkhali, Ichakhali, Saidpur, Muradpur, and other areas. A demand for a Medical Institute/Medical College establishment in the Sonagazi area arises from the stakeholder consultation. • Electricity Supply: increased demand for electricity in the future is being anticipated. Considering the existing demand, one power station has already been established in the NSEZ by an independent power producer. It is anticipated that the community-level demand will also increase in the future considering the township development in the region. Therefore, the sourcing and distribution of electricity need to be considered in the development planning. • Roads and Communication: The current roads and transportation system in the NSEZ surrounding area is inadequate to meet future demand. RHD has already prepared a DPP for the development of infrastructure targeting the increasing demand. On the other hand, LGED has not yet taken any initiative in the NSEZ region. The improved road network in the Sonagazi area will reduce the travel time from Dhaka to NSEZ and facilitate the movement to the nearby districts. Mirsharai Upazila Development Plan prepared by the Urban Development Directorate, suggested considering regional roads such as Sitakunda to Sonaimuri (Noakhali) via Domkhali to facilitate the movement in this direction. Stakeholders also suggested developing road networks from Sonagazi to the NSEZ to facilitate communication from NSEZ to the different locations of the region. The roads such as Muhuri Project to NSEZ (7.8 km); Jorarganj to Sonapur Road; Badamtali - Raghunathpur (this road will connect NSEZ to Dhaka - Chattogram Highway (via Koshka). • Considering the need for workers' movement from different locations of the region (Baroirhat and Sitakunda) to NSEZ, Bangladesh Road Transport Corporation (BRTC) has introduced a bus service. Stakeholders

Themes/Aspects/ Issues Raised	Response/Findings/Observations
	recommended increasing the number of trips considering the demand of workers. - According to the Department of Fire Service and Civil Defense, currently, it is not practically possible to timely respond to any emergency in the EZ region due to narrow and undeveloped roads. - The station is equipped with a large and small fire truck, motorbikes, ambulances, and various tools and water pumps. It also has oxygen cylinders and the capability to conduct water rescue operations. - Considering the future plan the EZ will require 2.5-inch hose connections facilities for fire service, dedicated fire hydrants, wider roads, and six new fire stations. Developers must get NOCs and follow safety codes. The station needs more capacity, manpower, and specialized vehicles. A master fire safety plan is essential. Embankment and Super Dyke: Bangladesh Water Development Board has constructed a Super Dyke that spans 22.5 km at the Mirsharai portion, with plans to extend it by an additional 12.5 km towards Sitakunda. Within the existing 22.5 km, the BWDB-financed Bangladesh Forest Department for the plantation of 100 acres of vegetation along the seaside. Jetty and Others: BIWTA has planned to establish a permanent jetty in the Sandwip Channel. Raw materials suppliers demanded access to the Jetty facilities so that they could timely deliver their goods and materials to facilitate the construction activities in the NSEZ.
Waste Management	- Generation and management of waste in NSEZ will be a critical task. Currently, there is no mentionable waste management system in the region. Even the local municipal authority has a lack of ability to handle waste in the region. - UDD suggested a waste treatment plant in the Domkhali for the community. Paurashava authority demanded for establishment of waste management systems in their areas to meet future demand. - The establishment and function of WTP, CSTPs, and CETPs need to be ensured to protect the environment in the region. Proper solid waste management facilities should also be ensured in the NSEZ. - The cost and technology of CETPs and CSTPs must be investment friendly. If the cost of CETPs and CSTPs is higher, then the investor may not be interested in establishing and using them. Modern and cost-effective treatment systems for individual industries should be ensured.
Emergency Response	Fire Services and Civil Defense provide emergency response to any fire outbreak or accident in the region. Although there are three fire service stations in Mirsharai, Sitakunda, and Sonagazi. However, stakeholders are emphasized in establishing a dedicated fire service for the NSEZ.
Drainage	- The rainwater naturally drains out through the khals. Stakeholders suggested considering drainage facilities parallel to the road network and keeping existing khals functional at any cost. - Currently, the local community in the NSEZ surrounding area is constructing their housing without considering adequate provision for

Themes/Aspects/ Issues Raised	Response/Findings/Observations
	stormwater drainage, therefore it can accelerate the waterlogging/flooding in the region in the future.
Foreseen Risk	Various foreseen risks and concerns have been mentioned by different stakeholders following: • Social risks such as theft, divorce, false marriage, increase of living cost, competition over common property/resources, integration of migrants/outsiders due to language and culture, decrease of social cohesion, and social conflict among the insiders and outsiders. • The risk of fire outbreaks/accidents such as community-level incidents may increase due to the increased population in the areas. If roads and communication channels do not improve proportionately with the population, it will be a high risk in the future. • Environmental risks such as increasing population will produce an increased extent of waste and pollution, it will contribute to environmental hazards in the future. Drainage facilities should also be developed to avoid future drainage congestion/water logging. • The NSEZ site is vulnerable to different natural disasters, therefore adequate mitigation and management plans need to be considered.

4.8 Validation Workshops

According to the RESA study TOR, six validation workshops were carried out (one for each Upazila - Mirsharai, Sitakunda, and Sonagazi, one District level at Feni, one regional level at Chattogram, and one national level at Dhaka). In addition, as per request from BEZA, two additional validation workshops were carried out in two Union Parishad namely Sonagazi and Maghadia. The summary outcome of the validation workshops is given in subsequent sections.

4.8.1 Key Recommendations from Workshop

Table 4-3 presents a summary of the main outputs of the validation workshop conducted for the EZ Development.

Table 4-3: Outputs of the validation workshop

Themes/ Aspects/ Issues	Comments/Concerns/Expectations/Recommendation
Water Resources	• Measures should be undertaken to prevent groundwater extraction in Mirsharai and Sitakunda to address the existing crisis. • Utilize rainfall runoff by reserving it in internal khals for construction activities • Focus on surface water collection from the Meghna River and establish a 150 km pipeline to supply water, considering competition for PPP service providers for effective management. • Introduce rainwater harvesting, recycling, and artificial recharge of groundwater aquifers.
Agricultural Land and Productivity	• Ensure no agricultural land is acquired in the future to protect national food security • Address the lack of water availability to prevent hampered agricultural production in Mirsharai and Sitakunda

Themes/ Aspects/ Issues	Comments/Concerns/Expectations/Recommendation
	Agriculture-based entrepreneurship should be created and encouraged.
Land Acquisition and Involuntary Resettlement	- Ensure fair market value or replacement cost compensation and timely disbursement. - Set compensation rates for land, structures, crops, and lost livelihoods, ensuring they meet national legislations and international standards
Livelihood Restoration	- Develop and implement a comprehensive livelihood restoration plan for communities dependent on fishing and livestock affected by the NSEZ. - Some local investors and entrepreneurs were affected and they should also be covered by livelihood restoration.
Employment Opportunities	- Provide training for local residents to enhance their job readiness for industries in EZ - Ensure job opportunities are available for affected individuals and maintain quotas for residents of Mirsharai, Sonagazi and Sitakunda. - Take initiative for skill development of local affected communities.
Social Infrastructure	- Current educational, health, and recreational facilities are inadequate for the growing population. Road infrastructure is also insufficient to support increased traffic from EZ operations. - Invest in the development of educational and healthcare facilities, including schools, playground, clinics, and hospitals, in the EZ area - Develop bridges, roads and railways for the smooth communication and transportation of goods. - Technical institute or vocational training center should be developed to enhance the number of skilled workers for local industries. - Growth centers should be more developed with improved communication facilities. - Housing and accommodation for workers and followers should be created. - Unplanned housing should not be allowed. It will create hurdles in the future specifically for road and drainage improvement. - Need step to increase security and protection of the boats and resources in the relocated fish landing stations. Boats are being vulnerable during cyclones or storms in the newly shifted boat parking area.
Transportation and Communication	- Increase transportation facilities to support labor movement for the industries and locals. There is a gap between the need and existing facilities in terms of transportation services. - BRTC has already launched a service, but it is insufficient in terms of frequency of services, number of buses, etc. - Transport cost for labor is also high. Steps need to be taken to reduce it otherwise it will demotivate the workers to work in NSEZ. - Alternative roads to NSEZ could be developed to reduce pressure on NSEZ Sarani.

Themes/ Aspects/ Issues	Comments/Concerns/Expectations/Recommendation
	Foot overbridge at relevant spots (e.g. near Nurul Absar school) need to be considered to reduce the accident risk for students and villagers.
Flora and Fauna/Wildlife/Biodiversity	- The implementation of EZ is likely to disrupt local wildlife habitats. Rehabilitation efforts and conservation measures are needed to protect biodiversity. - Establish wildlife rehabilitation initiatives to relocate affected species to suitable habitats. - Consider declaring a wildlife sanctuary in nearby hilly areas to protect local flora and fauna. - Encourage the development of wildlife parks and ecotourism ventures in the EZ area to foster conservation and community engagement. - Implement reforestation programs, including roadside plantations, to restore local vegetation.
Environmental and Social Impacts and Risks	- Significant changes in land use and cover will occur due to EZ development, impacting air, water, soil, and local wildlife. Increased traffic could lead to congestion and pollution. - Provision of the environmental and social impacts of EZ development to mitigate negative effects on local resources should be ensured. - Green industry should be introduced in the NSEZ to reduce environmental pollution.
Natural Disasters/Hazards	- The EZ region is prone to cyclones and tidal surges, necessitating effective disaster management strategies and infrastructure improvements to safeguard the area. - Complete the construction of the Super Dyke and develop additional green belts to protect coastal areas from cyclones and tidal surges. - Assess and incorporate existing local khals into flood management strategies.
Storm Water Drainage	- Existing drainage systems are insufficient, leading to flooding risks in the surrounding areas. - Enhance Drainage System by maintaining existing khal of the EZ area. - Design and implement comprehensive drainage systems to manage stormwater effectively and reduce flooding. - Consider provisions of drainage system along with road development.
Waste Management	- Effective waste management practices are crucial to avoid pollution and environmental degradation. CETPs must function properly to treat industrial waste. - Implementation of CETPs to treat industrial wastewater, ensuring no hazardous materials enter the environment. - Zero Discharge Plan (ZDP) should be considered to reduce pressure on water resources. Promote and adopt practices based on Reduce, Reuse, and Recycle to minimize waste generation and encourage sustainable waste management. - Shipbreaking waste management could be integrated with the NSEZ master plan, it will save agricultural land. A project regarding

Themes/ Aspects/ Issues	Comments/Concerns/Expectations/Recommendation
	shipbreaking waste management facilities establishment in Sitakunda Pourashava is in process.
Tourist Spots and Tourism Development	- Existing tourist attractions, such as Guliakhali Sea Beach, need to be preserved and enhanced to promote tourism while avoiding disruption during land acquisition. - Develop plans for enhancing tourist facilities and promoting ecotourism in the region while ensuring the preservation of sensitive areas - Ensure that land acquisition processes avoid disrupting existing tourist attractions and sensitive environments
Law Enforcement and Security	- Security measures need to be established to maintain law and order in the EZ area, particularly as labor influx increases. - Create an industrial police unit to ensure security in EZ and a separate Thana Police unit for law enforcement in the surrounding area - Improve the capacity of the Bangladesh Coast Guard to ensure effective patrolling and response in coastal areas.
Coordination and Cooperation among Various Entities	Effective coordination among governmental entities is essential for the successful implementation of the NSEZ and to address local community concerns.
Miscellaneous	- Issues such as unauthorized sand extraction and land grabbing pose significant challenges to local communities. - Adequate facilities for workers and transportation need to be provided to ensure smooth operations. - Implement measures to stop unauthorized sand extraction and land grabbing, safeguarding local resources and community rights. - Ensure that adequate accommodations, transportation, and other facilities are available for workers to support the EZ development. - Currently, there is no gas supply in the Sonagazi area. Therefore, the gas supply should be ensured not only for the NSEZ but also for the local community.

4.8.2 Participation of Women and Vulnerable People

RESA team conducted focus group discussions and group interviews with women groups, elderly people, landless and economically vulnerable, and other vulnerable community members in different areas of the NSEZ adjacent community to obtain their opinions and suggestions. Key findings from the consultation with women and vulnerable people are as follows:

- Local women welcomed the NSEZ and considered the NSEZ as a very positive intervention to contribute to their local economy.
- Local women expressed their willingness to get employed in different industries in NSEZ. They also demanded training for women's development and empowerment.
- Women from the fishermen's community raised concerns regarding the impact on fishing. They demanded livelihood training and support for alternative occupations.
- Elderly people emphasize increasing service facilities regarding law enforcement, healthcare services, etc.
- Elderly people who are covered by government allowance or safety net programs demand increasing amounts and scope of allowance considering the potential price hike in the area due to the future population influx to their communities.

- Parents of disabled children suggested creating education and healthcare opportunities for person with disability. Currently, there are no mentionable educational facilities for special children in the Mirsharai, Sitakunda, and Sonagazi areas.
- Economically vulnerable people lacking any skills for industry work demanded cash support to start businesses.

5 POTENTIAL ES RISKS AND IMPACTS

This chapter presents the identification and appraisal of various potential environmental and social risks and impacts from the implementation of the economic zone in the surrounding environment. It is to be noted that the total required land for the economic zone has not yet been acquired and some lands have been allocated to investors, it is more complicated to accurately phase the site according to best practices. Considering the above facts, the master plan area has been divided into three phases. Development activities of different components and subcomponents of the economic zone are expected to continue in the region up to 2040 parallel to the operation of established industries inside the economic zone. Therefore, the consultant has divided the impacts considering the development of the economic zone and operation phase activities.

The potential environmental and social risks and impacts in the region are identified based on both the secondary and primary baseline information as well as extensive stakeholder consultations. Environmental issues are not isolated since they have social implications as well. On the contrary, social issues too, have environmental implications and are listed together below:

5.1 Methods of Impacts Significance

The following criteria (Table 5-1Error! Reference source not found.) were used to evaluate Significance.

Table 5-1: Ranking criteria

Nature	Geographical Extent	Duration	Intensity/Severity	Irreplaceable Loss	Probability
Direct Impacts will be generated directly from the NSEZ activities, which are directly linked with the NSEZ. (e.g., discharge of untreated wastewater from construction camps into a nearby water body may lead to a decline in water quality).	5 – Trans-boundary Impact is considered not only within the national level but also within the neighboring country. Impact is considered at a global level.	5 – Permanent (no mitigation) Impact will remain after the operational life of the NSEZ. No mitigation measures will reduce the impact after implementation.	5 – Very high Natural, cultural, and social functions and processes permanently cease, and valued, important, sensitive, or vulnerable systems or communities are substantially affected. Negative impacts cannot be reversed.	5 – High Impact replaces a particular/vulnerable resource.	5 – Definite Impact will occur regardless of any prevention measures.
Indirect Impacts will be generated from secondary sources which are induced by the NSEZ activities.	4 – National Impacts area considered at a national level.	4 – Permanent (mitigated) Impact will remain after the operational life of the NSEZ, but appropriate mitigation measures reduce the impact.	4 – High Cultural and social functions and processes distorted/disturbed/impacted. Potentially ceasing to Environmental function temporarily. Negative impacts cannot be fully reversed.	3 – Medium Irreplaceable/unique resources can be replaced with mitigation measures/efforts and will be replaced after a certain period of time.	4 – High Most likely that the impact will occur.
Induced Impacts will be generated (which are not part of the NSEZ) due to the effect/	3 – Regional Impacts' area extends to the immediate surrounding areas	3 – Long term Impact duration will continue for more than 10 years or the entire	3 – Medium Environment remarkably distorted/disturbed/impacted, still	1 – Low No irreplaceable/unique resources will be impacted.	3 – Medium Distinct probability of the impact occurring.

Nature	Geographical Extent	Duration	Intensity/Severity	Irreplaceable Loss	Probability
consequence/outcome of the NSEZ.	along with adjacent areas.	operational life of the NSEZ.	functions, if in a modified way. Negative impacts cannot be fully reversed.		
	2 – Local Impacts' area is not only limited to the NSEZ site but also its immediate surrounding areas/receptors.	2 – Medium term Impact duration will continue after the construction period but stop/discontinue/cease within a tenure of 10 years.	2 – Low Natural functioning of the environment is minimally affected. Natural, cultural, and social functions and processes can be reversed to their original state if mitigation measure is taken.		2 – Low Probability of the impact to occur is low due to its design or historic experience.
	1 – NSEZ site Impacts' area only at or within the NSEZ site/ boundary.	1 – Short term Impact duration is a very limited time or length of construction/ decommissioning period.	1 – Insignificant Changes due to potential/possible impact are minor, not visible/noticeable, natural functioning of the environment not affected.		1 – Unlikely Under normal conditions, no potential/possible Impact expected.

Magnitude

The magnitude was calculated as extent + duration + intensity + potential impact on irreplaceable resources.

Magnitude essentially describes the intensity of the change that has the potential to occur in the resource/receptor as a result of the potential impact. The magnitude designations themselves are universally consistent, but the definitions for these designations vary depending on the resource/receptor.

In the case of a potential positive impact, no magnitude designation (aside from 'positive') was assigned. It was considered sufficient for RESA to indicate that the NSEZ has the potential to result in a potential positive impact, without characterizing the exact degree of positive change that may occur.

Significance

The significance was rated by multiplying the consequence of the impact and the probability of occurrence (i.e., Magnitude × Probability = Significance).

Table 5-2: Significance of Issues (based on environmental and social parameters)

Significance	Description
Positive Impact	Potential/possible impacts that have a beneficial impact on affected media/stakeholders
Very Low (4-14)	- No action is required. - Potential/possible impacts that are practically indistinguishable from the ES baseline, with little to no potential impacts to or concerns from affected external stakeholders. - No impact on the public.
Low (15-29)	- Impacts are within the acceptable range. - Potential/possible impacts such as localized or short-term effects on habitat, species, or environmental media. - Potential/possible impacts that are short-term nuisance or inconvenience; potentially affected external stakeholders concerned but likely able to adapt with relative ease. - Potential/possible illness or adverse effect with limited or no impacts on the ability to function and medical treatment is limited or not necessary.
Medium-Low (30-44)	- Impacts are within the acceptable range but should be mitigated to lower significance levels wherever possible. - Potential/possible impacts such as localized, long-term degradation of sensitive habitat or widespread, short-term impacts on habitat, species, or environmental media. - Potential/possible impacts such as localized or short-term effects; potentially affected stakeholders concerned but likely able to adapt with relative ease. - Potential/possible illness or adverse effects with mild to moderate functional impairment requiring medical treatment or management.
Medium-High (45-59)	- Potential/possible impacts are significant and require attention. - Mitigation is required to reduce the negative impacts to acceptable levels. - Potential/possible impacts such as localized but irreversible habitat loss or widespread, long-term effects on habitat, species, or environmental media. - Potential/possible impacts such as local-to-regional or medium-term effects; potentially affected stakeholders concerned and raised the issue

Significance	Description
	as a high priority but may be able to adapt with some targeted support or assistance. • Potential/possible serious illness or severe adverse health effects requiring a high level of medical treatment or management.
High (60-80)	• Impacts are of great importance, and mitigation is crucial. • Potential impacts such as significant, widespread, and persistent changes in habitat, species, or environmental media. • Potential impacts such as persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species. • Potential/possible impacts such as local-to-national or long-term effects; potentially affected stakeholders concerned and raised as a high priority; may not be able to adapt without targeted support or assistance to maintain a preimpact livelihood. • Potential/possible serious illness or chronic exposure of a few resulting in life-shortening effects.
Very High (81-100)	• Impacts are unacceptable. • Potential impacts such as loss of a significant portion of a valued species or loss of effective ecosystem function on a landscape scale. • Potential/possible impacts such as local-to-global or irreversible long-term effects; potentially affected stakeholders concerned raise the issue as a high priority and are likely not able to adapt without targeted support or assistance. • Potential/possible serious illness or chronic exposure of many resulting in life-shortening effects.

The potential environmental and social risks and impacts in the region are identified based on both the secondary and primary baseline information as well as extensive stakeholder consultations. Environmental issues are not isolated since they have social implications as well. On the contrary, social issues too, have environmental implications and are listed together below:

5.2 Potential Positive Impacts

5.2.1 Employment Opportunities

The implementation of the economic zone master plan is expected to provide a large number of employment opportunities in the short and long term during both the development of the economic zone and operation phases. According to the master plan, it is expected that approximately 1.4 million job opportunities will be created in the economic zone. The NSEZ is envisaged to provide direct employment in different industries in the economic zone as well as indirect employment opportunities in different sectors including logistics, manufacturing, healthcare, education, retail, transportation, entertainment, financial services, etc. of the study region. Priority will be given to workers from the local communities wherever casual work will also be needed. The majority of this number will be low-skilled labor, which will be hired from local communities. This will present a positive but short-term economic benefit for the local youths. As of now, approximately 10,000 workers are engaged in different industrial development/construction and operational activities in the economic zone. Moreover, it is common for the largest proportion if not all of this labor to comprise male workers only but for the equitable benefit and gender equity, able women should also be hired wherever they meet job requirements.

5.2.2 Increased Value of Land

The implementation of the master plan will lead to an increase in demand for residential housing in the region. This will in turn lead to an increase in land and property values in the region benefiting residents

owning land and residential properties. During the stakeholder consultations, this issue was also raised by the participants and confirmed that the land value already increased in the region.

The price of land and property including rental houses along the access roads will be raised after road network improvement. This will provide monetary benefits to the owners of the property. This impact will be post-construction and will be long-term. However, it will only benefit the property owners while tenants and buyers will pay higher prices.

5.2.3 Capacity Building

The economic zone will provide increased capacity building and training during the implementation of the economic zone ensuring that the locals, project-affected people, and their communities are prioritized. During the development stage, locals and project-affected people will be taught, skills enhanced and impacted which will be utilized even after the economic zone life cycle.

5.2.4 Skill Transfer

The economic zone seeks to attract both national and foreign experts, investors, workers, and consultants for the development, design, construction, and operation of the industries in the economic zone. During these interactions and processes, the locals will have significant benefits through the transfer of relevant technical skills and tools.

5.2.5 Growth of Foreign Exchange Reserves

The economic zone is anticipated to boost national foreign exchange reserves and bring in foreign currency through two major streams. These are a) increased export earnings - growth of the industrial base will help Bangladesh reduce its dependence on foreign imports to meet manufactured product needs, and b) foreign direct investments into the manufacturing industrial sector.

5.2.6 Increase Public Revenue

The economic zone will help restore confidence in foreign investors and promote a good business climate. Economic zones seek to attract foreign and national investment that helps strengthen and decentralize the economy, increase the national treasury through tax payments, and encourage rural and community development.

5.2.7 Economy

The economic zone will promote production and value-added goods and services for the local and foreign markets thus stimulating industrial and commercial growth. It will eventually increase the revenue and profitability of the sector thereby encouraging mindset change in youth towards the business sector. Banks and financial services will be improved, including automated teller machines (ATMs).

5.2.8 Local Infrastructure Development

The economic zone will be a stimulus towards the development of local infrastructure, notably the transport infrastructure, to support the transport connectivity needs of industries and workers. The economic zone will stimulate the establishment of major infrastructures for both local and foreign needs considering the region's infrastructure gaps and needs. These infrastructural developments will improve the physical and aesthetic outlook of the region. The economic zone envisages accelerating the infrastructure development in the region (Noakhali, Feni, and Chattogram Districts) and making it the third largest city in Bangladesh.

5.2.9 Improved Social Amenities

An increase in population attributed to workers in the economic zone will inform the provision of more and better social amenities including education facilities, health facilities, recreational facilities, and markets among others. This will ensure improved living conditions for the community members.

5.2.10 Improved Security in the Area

Under the proposed development activities, police stations will be established in the economic zone to ensure public security. The roadside lights along the proposed access roads will increase visibility on the road at night hence reducing crime in the area. This impact will be long-term and will benefit all road users, roadside businesses, and residents.

5.2.11 Increased Number of Tourist Visiting the Area

The surrounding of the proposed economic zone master plan area has numerous tourist attraction sites that include Mahamaya Lake, Khoiyachara Waterfalls, Napittachora Waterfall, Sitakunda Eco Park, Botanical Garden, Sohosrodhara Waterfall, Jharjhari Waterfalls, Bhatiari Lake, Komoldoho Trail, Muhuri project among others. An increase in population as attributed to the number of workers to be engaged in the economic zone will translate to more visitors to these tourist attraction sites. This will, in turn, translate to an increased demand for existing hospitality facilities. In addition, parks and recreational facilities for visitors are also proposed in the economic zone.

5.2.12 Benefit to Local Retail Businesses

The economic zone will have development/construction works ongoing up to 2040 parallel to the operation of industries. The local communities will gain through the sale of items like foodstuffs, drinks, and other consumable products. They will also benefit indirectly from the increased spending of the workforce. The increase in demand for products will lead to increased supply and the creation of a market for products thereby improving the incomes and general welfare of the local communities and their families. This will positively impact women (and their households) who would be involved in such businesses.

5.2.13 Increased Market for Local Agricultural Products

An increase in population as a result of economic zone implementation will inform an increase in demand for agricultural products from the region. As such, livestock products from the local community as well as other agricultural products from the region. During the stakeholder consultation, this issue was raised by the participants, and they also mentioned that currently excess agricultural products are exported to other parts of the country.

5.2.14 Vibrancy of Area Commercial/Urban Nodes

Notable commercial and urban nodes in the surrounding of the economic zone include Noakhali, Sonagazi, Feni, Mirsharai, Sitakunda, and Chattogram. These urban areas are key commercial nodes that will significantly benefit from the implementation of the master plan due to an increase in the population of workers in different industries in the economic zone. This will be attained through the establishment of various operations in these nodes to support the economic zone operations.

5.2.15 Improved Public Transportation

Public transportation in the economic zone surrounding area is currently limited to CNGs, motorcycles, and bicycles. This can mainly be attributed to the fact that most local roads are in a poor state. The implementation of the master plan will facilitate the provision of more access roads. This will encourage the establishment of public transportation and enhance mobility in the area. During the stakeholder consultation, participants raised the importance of the establishment of a public transportation system in the economic zone surrounding area for the frequent movement of workers. This will mainly benefit residents of Sonagazi, Mirsharai, and Sitakunda among others in the vicinity.

5.2.16 Improved Quality of Life

The proposed master plan implementation will improve the livelihoods of the region's residents through the creation of employment opportunities and improved levels of social infrastructure and social

provision. This will benefit the host community as well as residents of the economic zone surrounding upazilas and districts.

5.2.17 Income to Material/Equipment Suppliers and Contractors

Construction activities in the economic zone and related facilities will require the supply of various materials and/or equipment. For example, construction of a road will require gravel and aggregate, etc. some of which can be sourced locally. Other materials are lime, bitumen, water, cement, stones, and steel. Some of these materials required for the NSEZ will be sourced nationally and internationally to ensure that the desired quality is achieved. Procurement of these resources connotes income to suppliers and owners of the land where borrow pits and quarry sites will be located.

Besides the employment of workers, another important type of employment has been observed for some particular groups such as local contractors, vendors, and raw materials suppliers for construction works. Nearly 30-40 contractors, vendors, and suppliers are involved in the works related to the construction of different industries in the economic zone. These parties also created employment for local people in several positions like managerial positions, supervisory positions, and labor.

5.3 Potential Negative Impacts

5.3.1 Impacts During Development Phase

5.3.1.1 Impacts on Air Quality

It is important to note that the development of the economic zone takes place in rural areas and on the coastline of the Bay of Bengal where air quality is usually good and natural. During the development of the EZ, the main pollutant will be the particulate matter, which will be generated during earthwork activities including vegetation clearing, excavation works, dredging and reclamation, and transportation of constructional materials to and from the economic zone sites especially where trucks will travel on unpaved portions of tracks and roadways. Particulate matter will also be generated from site development activities such as levelling on land, cutting and filling activities to the NSEZ site from various sources, rock breaking, crushing, etc. The particulate matter will thus generate blows along the wind direction. Generally, these particles will settle down within 100m to 200m from the construction site. However, during strong wind conditions, they will blow further. At the economic zone site, the wind direction is mostly from the southwest to the northeast direction. Since there are habitations in the downwind direction. The impact is likely to be felt during the development of EZ and would be generally confined locally to the construction site itself. However, when the construction activity is near habitation, it might be a cause of concern. In addition, dust will get deposited on the leaves of plants and trees causing a lessening of photosynthetic activities leading to loss of pollination and even mortality.

The local ambient air quality around the economic zone will be temporarily impacted during the development of EZ as a result of air emissions generated by construction activities. In addition, pollutant emissions will occur due to the operation of diesel fuel generators, and exhaust emissions from transport vehicles such as material transport trucks and administrative vehicles. Therefore, the potential impacts of the NSEZ activities on air quality are associated with dust emissions and an increase in the following combustion pollutant concentration (CO, NO_x, SO₂, PM, etc.). This has the potential to cause temporary impacts on the ambient air quality. As most of the construction equipment will be mobile, the emissions are likely to be fugitive and not concentrated at a single place or source. As the impacts will be localized in nature, the areas outside the economic zone boundary are not likely to face any significant adverse impact with respect to ambient air quality.

Air Quality Modelling Result

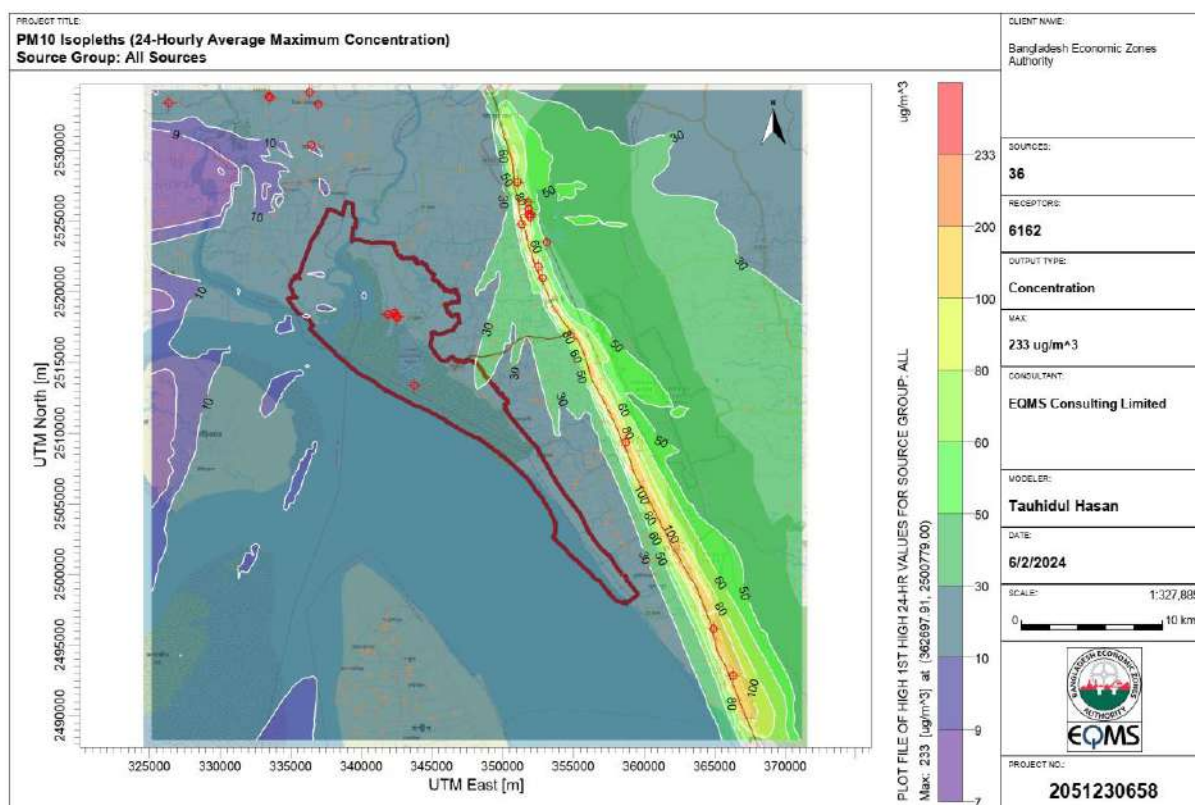
Air dispersion has been modelled using the AERMOD dispersion model (Version 12.0.0) which has been developed by the United States Environmental Protection Agency (USEPA). The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources. The model has been designated the regulatory model by the USEPA for modelling emissions

from industrial sources in both flat and complex terrain. Resulting Ground Level Concentrations (GLCs) were determined specifically for NO_2 -24 hr. and Annual average, and PM_{10} -24 hr. and Annual average. Details of the ambient air quality model output have been given in Appendix G (Vol-III).

Concentration of Particulate Matter

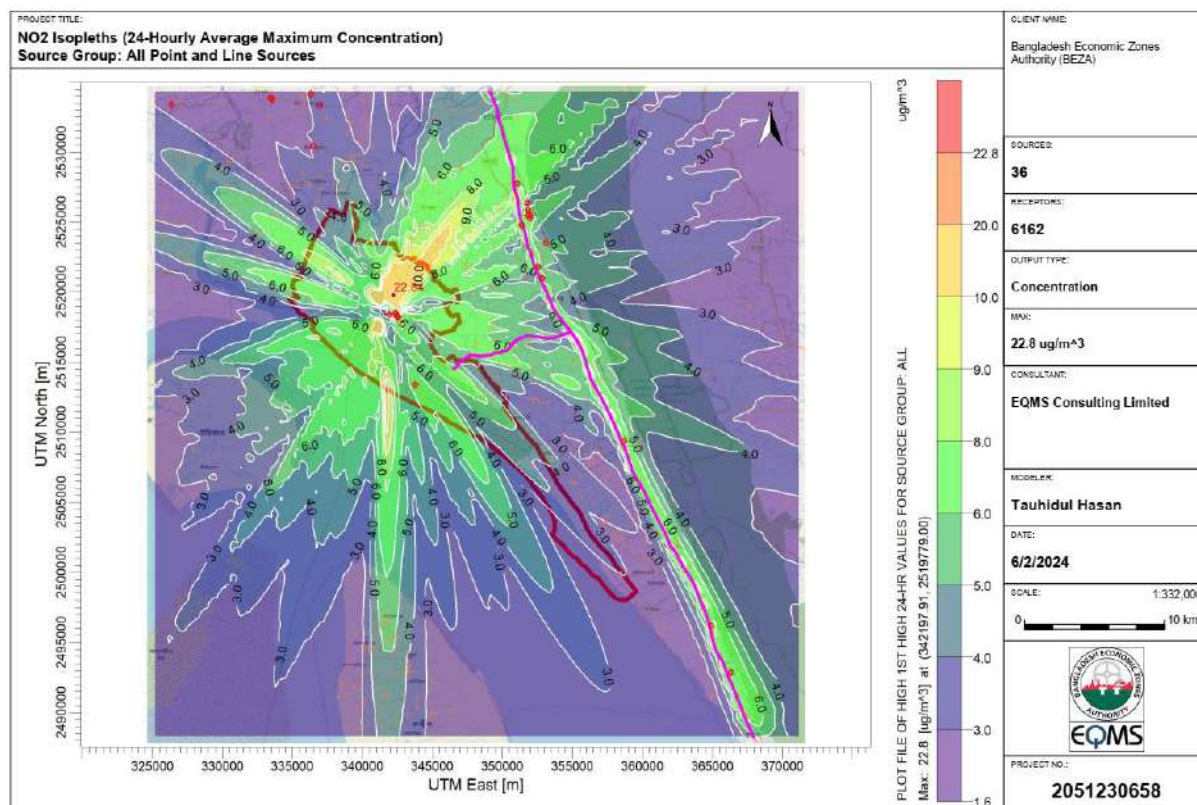
The contribution of PM_{10} from existing industries including power plants, chemicals, paint, steel, brick, and glass has been predicted through modelling study. The modelling result reveals that brick kiln and road dust will cumulatively result in increased PM_{10} concentrations in the study area. The model reveals that major PM_{10} contributors in the study area are road dust and brick kilns. However, the brick kiln only contributes to air pollution during the dry period only. The model shows that the contribution of PM_{10} from the existing industries in the economic zone on air quality monitoring locations is insignificant. Hence, the contribution of PM_{10} from existing industries within the economic zone towards PM_{10} concentrations in the air shed is assessed to be low. The isopleths representing 24-hourly maximum PM_{10} GLCs is presented in Figure 5-1. Details of the ambient air quality model output have been given in Appendix G (Vol-III).

Figure 5-1: Isopleths of 24-Hourly Maximum PM_{10} GLC- All Sources



Concentration of NO_2

The past and present industrial activity will cumulatively impact the condition of the economic zone and the surrounding area airshed. The model shows that the contribution of NO_2 from the power plant inside the economic zone contributes maximum followed by other industries in the economic zone, road traffic, brick kiln, and industries outside the economic zone. It can be stated that the existing industries in the economic zone will contribute NO_2 significantly to the airshed. The isopleths representing 24 hourly maximum NO_2 GLCs are presented in Figure 5-2. Details of the ambient air quality model output have been given in Appendix G (Vol-III).

Figure 5-2: Isopleths of 24-Hourly Maximum NO₂ GLC- All Sources

Considering the above issues, the impact of the development of the EZ on ambient air quality is evaluated to be **Medium Low**.

5.3.1.2 Impacts from Noise

The major sources of noise during the development of the EZ will be vehicular traffic and the operation of heavy construction equipment like dozers, scrapers, concrete mixers, cranes, compressors, generators, pumps, rock drills, pneumatic tools, saws, vibrators, etc. The operation of this equipment will generate noise ranging between 70-85 dB(A). The noise produced during the construction will have a significant impact on the existing ambient noise levels. The construction equipment may have high noise levels, which can affect the personnel operating the machines. However, these impacts will be short-term and intermittent in nature. Additionally, noise will be generated from transportation activities during the construction period. The increased noise level can impact worker's health and safety and reduce performance. Heavy vehicle operators, nearby communities, and residents close to access roads are at higher risk of noise nuisance.

Dredging activities in the Sandwip Channel/Bay of Bengal will generate noise from a variety of sources, the primary sources of equipment noise would include the dredger itself, with its associated pumps and generators, and the tugboats used to position the dredger. Other equipment such as the crew boats and survey boats would not contribute substantially to the noise associated with the dredging activities. Additionally, noise will be generated by the onshore plant used to spread the dredged materials and to assemble and periodically relocate pipelines. Generally, a weighted noise intensity from working engines at the noise source shall not exceed a continuous level above approximately 120 dB(A).

Seawater is an efficient medium for sound propagation, particularly low-frequency sound, and therefore marine life over a wide area could be potentially affected. Underwater noise during the jetty construction will result from the equipment that is used for underwater activities, such as dredging, reclamation, or the construction of the bund wall, piling, and ship movements. The noise generated by underwater activities can potentially be transmitted to considerable distances through the water and hence cause negative impacts on marine mammals and fish resources.

Construction Method and Equipment

There is limited information available on construction methods, plant, and equipment before the works contract is awarded, but based on the anticipated scope of works it can be assumed that standard construction methods and equipment would be used for the civil works for the construction of industries and other facilities in the economic zone.

The construction equipment expected to be employed for construction has been identified and Table 5-3 lists the likely construction equipment usage at each of the major work sites.

Table 5-3: Equipment Likely to be Used During Major Construction Activities and Location

Activity	Equipment	Work Site Location
Demolition/ Breaking Up Concrete	Hydraulic hammers, Wheeled Loader, Trucks, Excavators, Breaker	Existing structures (bridges and culverts) and houses to be demolished
Site Clearance	Milling machine, Wheeled Loader, Trucks, Excavators, Dozer	Across the work site
Earthworks	Excavators, Loaders, Dump trucks, Graders, Dozers, Vibrating rollers, Compactors	Across the work site
Structure Works	Excavators, Drilling Rigs, Concrete Mixer Trucks, Concrete pumps, Trucks, Cranes, Poker Vibrators, Diesel Generator	At all construction locations
Road Construction Works	Water Tanker, Graders, Road Sweeper, Bitumen Sprayer, Paver, Multi-tyred Rollers	Across the NSEZ site

Ideally, noise data in calculations should be for the specific equipment to be used on site. However, at the assessment stage, the equipment has not been selected, and data is not available. Therefore, for initial predictions reference noise data from BS 5228-1:2009 has been used.

BS 5228-1:2009 includes reference noise level data for typical construction equipment. These data have been obtained from measurements at construction sites in the United Kingdom on similar types of equipment to those used internationally. These data are used as a guide to establish the construction noise emissions.

Table 5-4 presents the A-weighted sound pressure level at 10 m for the anticipated generic construction equipment together with an estimate on the length of time the construction equipment has been used.

Table 5-4: Major Noise Generated Sources During Construction of Industries in the EZ

Source	Noise Level dB(A)
Generators	68
Excavator	77
Backhoe	68
Wheeled loader	80
Dump Truck	79
Lorry	80
Roller	73
Hydraulic Hammar Rig	89
Impact Pile Driver	68
Vibratory Piling Rig	88

Source	Noise Level dB(A)
Large Rotary Bored Piling Rig	83
Crawler Mounted Rig	80
Concrete Pump	78
Wheeled Mobile Crane	67
Tracked Mobile Crane	70
Wheeled Loader	71
Wheeled Mobile Telescope Crane	78
Tower Crane	77
Cement Mixer Truck	75
Asphalt Paver	75
Breaker (Pneumatic)	87
Grader	83
Milling Machine	82
Multi-tired Roller (asphalt)	82
Poker Vibrator	69
Road Sweeper	76
Water Pump	68
Road Planer	82
Wheeled Loader	76

Source: BS 5228-1:2009

Calculated Noise Emissions

Table 5-5, Table 5-6, Table 5-7, Table 5-8, and Table 5-9 contain summary noise emission levels for major construction activities to be undertaken in the EZ site. To calculate the combined noise level for a construction activity the following equation has been used to combine the noise levels from the individual construction equipment:

$$\text{Combined Noise Level} = 10 \times \text{Log}_{10} (10^{(L_1/10)} + 10^{(L_2/10)} + \dots + 10^{(L_n/10)})$$

where: L = individual noise events

Table 5-5: Noise Emission for Demolition/Breaking up Concrete Works

Equipment Type	Noise level at 10 m	Duration of Activity	Correction to	Activity Noise Level
	L _{Aeq} (dB)	as percentage of 10 h	L _{Aeq} (dB)	L _{Aeq(10)} (dB)
Hydraulic Hammer	93	50	-3.0	90.0
Breaker	87	50	-3.0	84.0
Excavator	80	80	-1.0	79.0
Wheeled Loader	76	80	-1.0	75.0
Truck	79	60	-2.2	76.8

Equipment Type	Noise level at 10 m	Duration of Activity	Correction to	Activity Noise Level
Total Activity				91.5

Table 5-6: Noise Emission for Site Clearance Works

Equipment Type	Noise level at 10 m	Duration of Activity	Correction to	Activity Noise Level
	L _{Aeq} (dB)	as percentage of 10 h	L _{Aeq} (dB)	L _{Aeq(10)} (dB)
Milling Machine	82	80	-1.0	81.0
Dozer	75	80	-1.0	74.0
Excavator	80	80	-1.0	79.0
Wheeled Loader	76	80	-1.0	75.0
Truck	79	60	-2.2	76.8
Total Activity				84.9

Table 5-7: Noise Emission for Earthworks

Equipment Type	Noise level at 10 m	Duration of Activity	Correction to	Activity Noise Level
	L _{Aeq} (dB)	as percentage of 10 h	L _{Aeq} (dB)	L _{Aeq(10)} (dB)
Excavator	80	80	-1.0	79.0
Wheeled Loader	76	80	-1.0	75.0
Excavator	80	80	-1.0	79.0
Truck	79	60	-2.2	76.8
Grader	83	80	-1.0	82.0
Dozer	75	80	-1.0	74.0
Vibrating Roller	77	60	-2.2	74.8
Compactor	80	80	-1.0	79.0
Total Activity				87.3

Table 5-8: Noise Emission for Bridge/Structure Works

Equipment Type	Noise level at 10 m	Duration of Activity	Correction to	Activity Noise Level
	L _{Aeq} (dB)	as percentage of 10 h	L _{Aeq} (dB)	L _{Aeq(10)} (dB)
Excavator	80	80	-1.0	79.0
Drilling Rig	83	80	-1.0	82.0
Concrete Mixer Truck	79	80	-1.0	78.0
Concrete Pump	80	80	-1.0	79.0

Equipment Type	Noise level at 10 m	Duration of Activity	Correction to	Activity Noise Level
Truck	79	60	-2.2	76.8
Crane	76	60	-2.2	73.8
Poker Vibrator	69	80	-1.0	68.0
Diesel Generator	66	100	0.0	66.0
Total Activity				86.7

Table 5-9: Road Pavement Works

Equipment Type	Noise level at 10 m	Duration of Activity	Correction to	Activity Noise Level
	L _{Aeq} (dB)	as percentage of 10h	L _{Aeq} (dB)	L _{Aeq(10)} (dB)
Water Tanker	79	50	-3.0	76.0
Graders	83	80	-1.0	82.0
Road Sweeper	76	20	-7.0	69.0
Bitumen Sprayer	79	50	-3.0	76.0
Asphalt Paver	75	60	-2.2	72.8
Total Activity				84.2

All noise predictions are for a circumstance where specific or general noise mitigation has not been implemented on-site. Therefore, noise levels from the activity would generally be lower than shown in Table 5-10. The predicted noise levels in Table 5-11 represent the highest noise level likely to be received from the construction site without any mitigation. It should be noted that noise emissions would vary as construction progresses and the inherent variability in construction noise makes it very difficult to predict.

Table 5-10: Activity Noise Levels Depended on Distance

Activity	Activity Noise Level				
	at 10 m (dB)	at 20 m (dB)	at 50 m (dB)	at 100 m (dB)	at 200 m (dB)
Demolition	91.5	85.5	77.5	71.5	65.5
Site Clearance	84.9	78.9	70.9	64.9	58.9
Earthworks	87.3	81.3	73.3	67.3	61.3
Bridge/Structure Works	86.7	80.7	72.7	66.7	60.7
Road Pavement Works	84.2	78.2	70.2	64.2	58.2

Noise Modelling Result

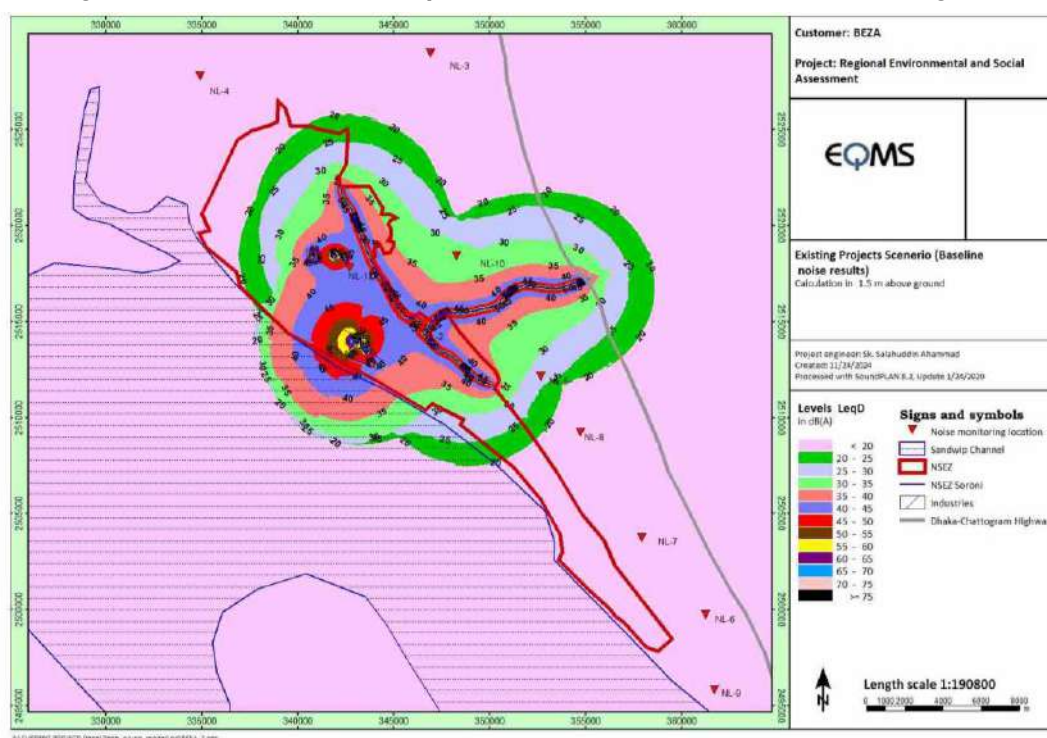
The environmental noise prediction model Sound PLAN 8.2 has been used for modeling noise emissions from the existing construction and operation of industries in the economic zone and noise from other sources in the surrounding area. Based on the noise propagation from the existing projects at the economic zone, a noise contour map has been prepared using the modeling tool. The predicted noise level at different receptor points is shown in Table 5-11 and the noise contour map is shown in Figure 5-3. Details of the ambient noise model have been given in Appendix G (Vol-III).

Table 5-11: Predicted Noise Levels at Receptors for the Existing Condition

Receptor	Category of Area/ Receptor	Baseline Sound Pressure Levels at Receptors, Leq (dBA) ²²		Predicted Sound Pressure Levels at Receptors, Leq (dBA)		Total Sound Pressure Level (Baseline + Predicted), Leq (dBA)		Applicable National Standard ²³ , dB(A) as per Land use		IFC Guidelines	
		Leqd	Leqn	Leqd	Leqn	Leqd	Leqn	Leqd	Leqn	Leqd	Leqn
ANL-1	Industrial	48.0	44.0	47.5	47.5	50.8	49.1	75	70	70	70
ANL-2	Mixed	62.2	53.5	57.5	57.5	63.5	59.0	60	50	55	45
ANL-3	Silent	60.6	48.4	<20.0	<20.0	60.6	48.4	50	40	55	45
ANL-4	Commercial	69.6	58.4	<20.0	<20.0	69.6	58.4	70	60	70	70
ANL-5	Commercial	60.2	39.4	27.5	27.5	60.2	39.7	70	60	70	70
ANL-6	Commercial	65.0	51.6	<20.0	<20.0	65.0	51.6	70	60	70	70
ANL-7	Commercial	61.0	51.9	<20.0	<20.0	61.0	51.9	70	60	70	70
ANL-8	Commercial	61.1	57.9	<20.0	<20.0	61.1	57.9	70	60	70	70
ANL-9	Industrial	60.7	46.4	<20.0	<20.0	60.7	46.4	75	70	70	70
ANL-10	Commercial	56.5	47.0	32.5	32.5	56.5	47.2	70	60	70	70

Source: EQMS, June 2024

It has been observed that the predicted noise level in all the receptors is within the permissible limit set in the Noise Pollution (Control) Rules 2006, except the ANL-2 which already exceeds the standard due to industrial activities and vehicular movement around the receptors. However, the incremental noise level at ANL-2 is very low.

Figure 5-3: Noise Contour Map of the Economic Zone and Surrounding Area

Source: EQMS, June 2024

²² Ambient noise levels as monitored during the regional baseline survey²³ Noise Pollution (Control) Rules, 2006

Considering the above issues, the impact of the development of the EZ on ambient noise level is evaluated to be **Medium Low**.

5.3.1.3 Impacts on Surface Water

During the development of the EZ, water will be required for the construction of structures, sprinkling on roads for dust suppression, and domestic and non-domestic uses of the construction workers. All the water required during the construction phase will be arranged from groundwater sources.

Sources of pollutants that may impact surface water quality during the construction period include domestic wastewater from workers and sediment from runoff, particularly in land development activities where vegetation clearing is needed. The present surface water (internal khals and Sandwip Channel) may be impacted due to non-point discharges of solids from soil loss and sewage generated by the construction workforce stationed at the site. Sewage discharge and runoff during the construction phase may lead to contamination of surface water if not managed properly. Septic tanks should be provided to treat the sewage from temporary toilets at the construction site and workers accommodation. The septic tanks will need to be adequately designed so that untreated sewage due to leakage or overflows does not have the potential to enter surface water.

Raw sewage can impact surface water quality by promoting the growth of algae and delivering pathogens that may be harmful to human and ecological receptors. Sewage is generally characterized as having a high concentration of suspended solids and dissolved solids, biochemical oxygen demand, chemical oxygen demand, nutrients (nitrogen, ammonia), and fecal coliform counts. Organic substances are decomposed in water and the decomposition of organic matter will reduce the oxygen content dissolved in water.

During construction activity in the rainy season (April-September), the surface water quality is likely to be affected due to the construction work and loosening of topsoil. This is likely to increase the sediments as a result of increased soil erosion due to earthworks can enter surface waters causing increased turbidity and hence impacting aquatic fauna and flora by altering the aquatic environment. Improper handling of lubricants, hazardous substances, and hydrocarbons (fuels, gasoline, etc.) may also cause water pollution of surface water. Surface water could be affected during the construction of individual industries in the economic zone.

During dredging, oxygen-demanding compounds, nutrients, and sediments from the seabed will enter into the marine water column. Since concentrations of oxygen-demanding compounds are normally much higher in pore water than in the water column it will cause a depletion in oxygen concentration. Nutrients may stimulate primary production when light and temperatures are sufficient and may cause eutrophication problems when released in favorable conditions. DO levels in bottom sediments, which are usually low, would increase during the dredging period.

Considering the above issues, the impact of the development of the EZ on surface water quality is evaluated to be **Medium Low**.

5.3.1.4 Impacts on Groundwater

During the development of the EZ, water will be required for the construction of structures, sprinkling on roads for dust suppression, and domestic and non-domestic uses of the construction workers. According to the discussion with BEZA, all the water required during the construction phase is arranged from groundwater sources, and to date about 25 nos. of tubewell has been established considering the demand of construction phase water requirement. About 40 MLD of water is produced to supply in different construction sites. Withdrawing groundwater in excess of the rate of recharge may result in the lowering of the water table, land subsidence, and decreased water quality. Therefore, sustainable use of groundwater will require proper utilization and groundwater recharging techniques.

Groundwater, especially shallow tubewells, is the main water supply source for local people in the surrounding communities of the economic zone. From the stakeholder consultation, it was observed that currently there is a groundwater crisis in the region for domestic uses as well as irrigation during

the dry season. The water will be produced from groundwater sources at the site camp and for construction purposes which may cause a groundwater supply crisis and conflict with the surrounding community.

The Hydro-Geological Survey under Mirsharai Upazila Development Plan (MUDP) 2018, recommends that the aquifer condition in the EZ area is not suitable for heavy groundwater withdrawal required for the NSEZ. The shallow groundwater in this part of the Upazila is brackish while the deep groundwater is fresh and occurs in a thin confined aquifer below a thick and soft clay layer. Heavy pumping from that aquifer would cause the compression of the aquitard and result in land subsidence. Besides, there is a high risk of later intrusion of sea water (salinity intrusion) into groundwater from the adjacent sea.

The groundwater quality of observed locations showed that most parameters are in standard of groundwater for drinking. Groundwater can get worse in quality because proper treatment of generated wastewater is neglected in the economic zone. At this phase, there is a likelihood of having an adverse impact on groundwater quality through sewage disposal from temporary workers facilities, debris, and solid waste deposits in case of lack of proper management. Treating toilets and lavatories in labor camps and the other wastewater from various activities of workers by proper treatment units shall prevent groundwater contamination.

Improper handling of lubricants, hazardous substances, and hydrocarbons (fuels, gasoline, etc.) may also cause groundwater pollution. Hydrocarbon pollutants in the events of leakage of petroleum hydrocarbons from heavy vehicles operating in the economic zone site could lead to the local aquifer systems potentially being contaminated. Potential chemicals and improper handling of lubricating slurry, and other toxic substances during construction may cause groundwater pollution thus through gradual seepage.

Considering the above issues, the impact of the development of the EZ on groundwater quantity and quality is evaluated to be **Medium High**.

5.3.1.5 Impacts on Topography and Soil

The topography during the development of EZ will change due to the activities such as soil excavation, land development, embankment/super dyke, internal roads, stormwater drainage, construction of access roads, pipelines, etc. These changes are accounted for as being the adverse impacts of the NSEZ, as these kinds of activities usually cause changes to the natural status of the land. This negative impact is limited to the length of the construction period, which occurs with great intensity, however, is accounted as an irreversible effect.

Construction of the individual industries in the economic zone will involve a large amount of earth movement. Most of the materials obtained from the excavation and dredging in the Sandwip Channel will be used for backfilling of the low areas of the NSEZ. The NSEZ area is in the coastal region of Bangladesh. The land elevation on the site varies from the site's lowest point at -3.33m MSL to the highest point at +8.71m MSL²⁴. According to the consultation with BEZA, the NSEZ site has partially filled with an elevation of 6.5 m, and the rest of the site will be filled with an elevation of 6.5 m.

The construction of the desalination facility, water reservoir, water transportation pipeline, and pump stations may cause physical damage to the destruction of soil crust and horizons,

The main impacts on soil will occur due to increased erosion potential as a result of vegetation clearing and earth-moving activities. Construction activities in the EZ will involve leveling, excavation, and removal of existing vegetation would invariably disturb the soil of the area. The impacts on soil during the construction phase shall be mainly due to loss of topsoil in the construction areas and contamination of the soils of the surrounding area due to solid waste generation from site activities, as well as liquid waste such as lubricants, slurry, and accidental spills, and leaks occurring from storage and work areas. The rainfall and surface runoff can cause soil erosion. The disturbances would be more pronounced

²⁴ https://NSEZ.gov.bd/?page_id=639

during the summer and monsoon seasons with strong rains as the NSEZ site is located near the sea. Accidental spillage of oil from construction vehicles might cause soil contamination.

During the development of EZ, there will be imported materials from outside especially construction materials like bricks, cement, HDPE pipes, backfill material, sand, clay, etc. These materials will be stored at the site which is likely to change the characteristics of the soil in the construction area. In addition to that, municipal waste due to construction workers, domestic sewage, and sullage from the construction labor facilities and office at the NSEZ site, etc. will contribute to changing the soil characteristics.

Considering the above issues, the impact of the development of the EZ on topography and soil quality is evaluated to be **Medium Low**.

5.3.1.6 Impacts on Sediment

Construction activities i.e., piling of building, excavation, concreting work, construction of a jetty at the vicinity of the internal khals, Rivers, and Sandwip Channel, accidental spillage of hazardous chemicals like oil and lubricant from the construction vehicles, improper storage and disposal of construction waste, solid and liquid waste from the worker's facilities may mix with rainfall water and it can accumulate on the adjacent khals, Rivers, and Sandwip Channel through runoff. Besides the above-mentioned sources of impact, there are some additional sources i.e., runoff and erosion of exposed bare soil, slopes, earth, and stockpiles, the release of cement materials with rain, and washing water of dust suppression sprays and vehicle wheels. The extra sediment loads in the khals, rivers, and marine water also lead to an impact on the aquatic environment.

Sediment quality in the Sandwip Channel was sampled at eight different locations in December 2023. Note that there are no standards for sediment quality in Bangladesh, therefore the result was compared with the USEPA standard. From the results, nickel concentration was found in the range of moderate polluted (20-50 ppm), and chromium concentration was found in the range of moderate polluted (25-75 ppm). It is recommended to confirm the sediment quality/contamination level of the dredge materials prior to dredging that will be used for landfill in the economic zone.

Dredging disturbance of sediments can release contaminants into the water column, which has the potential to change the chemical properties of the sediment and reduce water quality at both extraction and dumping sites for some time after dredging has ceased. These pollutants can have a negative impact on water quality, posing risks to both aquatic marine life and human health.

Considering the above issues, the impact of the development of the EZ on sediment quality is evaluated to be **Medium Low**.

5.3.1.7 Impact due to Changes in Land Use

The economic zone has a total land area of 33,805 acres or 136.86 square kilometers (mostly reclaimed land) with a 25 km coastline along the Sandwip Channel in the Bay of Bengal. Land use and land cover of the region will be changed due to the implementation of the EZ master plan. Before the development of the economic zone, the site was comprised of barren lands (27.6%), mangroves/forest/vegetation (31.65%), water bodies (8.71%), and underdevelopment (6.53%)²⁵. The existing vegetation and trees will be cleared for the development of the NSEZ and its allied facilities; therefore, the land use of the existing area will be changed to an industrial area which results in loss of existing vegetation. Also, it will have an impact on the existing drainage pattern in the EZ as well as in the adjoining area if the development is not properly planned.

During the development of the EZ, there will be a large number of personnel moving into the economic zone and the surrounding area. The majority will be construction crews with low wages. They will likely depend in part on the locals to provide certain low-cost basic services, such as food, cleaning, transportation, and entertainment or relaxation. Naturally, there will be temporary structures set up to

²⁵ https://NSEZ.gov.bd/?page_id=639

provide such services at the place most convenient to the workers, predictably near the access roads and the entrance to the site. These squatted temporary settlements will over time take more permanent forms but not necessarily are tidy, safe, or sanitary. It is recommended to provide a designated township for the workers considering the convenient distance between the accommodation and work/construction sites. In terms of land use, such temporary service activities and structures set up for workers' needs must be planned out and monitored regularly. Relocation may be needed in intervals as appropriate so that eventually most or all services for NSEZ personnel will not be allowed to scatter outside the designated township zone.

Considering the above issues, the impact of the development of the EZ on land use changes is evaluated to be **Medium High**.

5.3.1.8 Impact due to Solid Waste Generation

Solid waste is likely to be generated in significant amounts during the development of the economic zone. Construction activities will generate different categories of solid waste. Solid materials such as domestic/canteen waste, food packet wrappers, paper, plastic drums, paints, oil containers, packaging from construction materials, generation from earthwork, debris, excess construction materials, site establishment activities, removal of vegetation/bush/trees, and others will be generated. This may cause environmental degradation at the EZ site as well as its immediate surroundings if adequate measures are not taken.

Hazardous waste, i.e., oil, chemicals, lubricants, paints, compressed gases, varnishes, etc. generated during the development of EZ should be dealt with separately from non-hazardous waste. The dripping of oil from construction vehicles might cause soil contamination. Medical waste will be generated from the first aid facilities in the construction sites.

In order to avoid any solid waste disposal problems, an effective solid waste management system by means of collection of wastes in different types of dustbins and transporting the same to the central waste treatment facility. Though EZ will have an integrated waste storage, treatment, and disposal facility, the investors should also develop a waste management plan in tune with the overall waste management system for EZ. Strict adherence to the established solid waste collection and disposal system will ensure a clean environment during the development phase.

Considering the above issues, the impact of solid waste generation and disposal due to the development of the EZ is evaluated to be **Low**.

5.3.1.9 Impacts from Liquid Waste Generation

During the development of EZ, the primary wastewater issues relate to stormwater events and sanitary wastewater generated by construction activities on site. Storm water has the potential to run off into areas containing hazardous materials and either leach into the soil or carry these off the site, potentially contaminating other areas, groundwater, or marine waters. Storm events can potentially have adverse impacts on water resources resulting in large amounts of silt-laden run-off.

Sewage will be generated from the construction worker's facilities and the NSEZ site. Wastewater generation at construction sites includes surface runoff also which may contain pollutants and traces of solvents, paints, metal compounds, etc. which may impact the nearby surface water resources if not managed properly. The impact is until the construction phase is completed as infrastructure for wastewater conveying network and treatment plants will be available.

Considering the above issues, the impact of solid waste generation and disposal due to the development of the EZ is evaluated to be **Low**.

5.3.1.10 Impacts on Drainage

The implementation of the EZ masterplan has the potential to change the topography of the land, which may also disrupt the natural drainage of the region. This is because the construction will involve cutting

and filling earthworks. The cut-and-fill works will normally change the natural topography of the land which will result in a disruption of the natural drainage of the land and the surrounding area.

The township, access roads, and other utility services will be developed while undertaking minimum cutting for making traces for construction of buildings while making minimum modifications in the terrain conditions, and implementing appropriate environmental measures.

EZ site is sloping from north-east to south-west. Storm runoff generated from the entire area of the economic zone, and its surroundings gets drained to the sea through a number of natural drainage channels passing through the EZ viz. Ichakhali, Daborkhali, Bamansundar, Hoania, Saherkhali, Domkhali, etc. Altogether there are 13 number of drainage channels, all getting discharged to the sea, apart from Feni River, which passes through EZ before conferencing to the sea (Master Plan, 2020). All these rivers and khals are influenced by the tidal effect. In the case of NSEZ development, rivers, and khals may be affected by the NSEZ construction activities. Excavation, earthwork, and levelling activities are possible to obstruct the water drainage. The effects might include an increase in sediments or a change in river/khals velocity or direction.

Stormwater from villages upstream is drained through different khals and finally falls to the Sandwip Channel. These khals will not be impacted due to the development of economic zones and will be retained in existing conditions. However, sluice gates are proposed to be developed at different khals at the point of entry of the khal in the EZ site from the seaside to control the flow of water. These sluice gates will control the level of water entering the khals and will be closed only during high tide and high flow times and allowing the water movement in the rest of the time.

EZ site has a good amount of rainfall during the rainy season. Hence, suitable measures for conserving rainwater through rainwater harvesting mechanism should be adopted. The proposed storm water drainage network has been designed in such a way that there will be no disturbance to the natural drainage system. Hence no major adverse impact is envisaged on the drainage and hydrology during the development of the EZ.

Considering the above issues, the impact of the development of the EZ on drainage is evaluated to be **Medium Low**.

5.3.1.11 Impacts of Traffic

The development of EZ will generate a significant increase in traffic volume on the local road networks on a long-term basis as the construction activities will be done in different phases and will continue up to 2040. Construction traffic will include vehicles transporting equipment, materials, and personnel. The main transportation route corridor from the Chattogram Sea Port is the Dhaka-Chattogram Highway. Currently, NSEZ Sarani is the main route to access the EZ from Dhaka-Chattogram Highway (N1) is already improved to bitumen standard. The length of the road is approximately 10 km. Improving this road is not only beneficial for the EZ but for the inhabitants of different villages located along the roads. Thousands of vehicles per day are moving from the beginning of the development of the EZ.

During the development of the EZ, there will be an increase in the traffic volumes on the local road networks in the region day by day. The increased traffic volumes will place an additional burden on the existing roads within the study region. Traffic congestion may occur by vehicles of the construction site and vehicles of entry and exit to the industrial zone. The volume of vehicles involved in transporting raw materials has a lot of potential for traffic accidents and potential injuries to public road users, especially residents staying close to the access roads. Therefore, it is essential to regulatory check vehicles and shipping volumes to minimize road accidents on roads. To reduce the risk of accidents, EZ should install signboards along the roads that are most frequently used by the NSEZ's vehicles. Investors/contractors should regularly propagate and enhance workers' awareness of obeying traffic laws to minimize risks and accidents when driving vehicles. In addition to the risk of accidents, increased traffic will lead to inconvenience to the public and increase the potential for nuisance in the EZ area.

Since the transport and communication routes will be improved during the development phase, all advantages and disadvantages usually relate to that phase. However, as a long-term impact, its benefits remain. The improvement and development of the local road conditions will enhance various socio-economic activities.

Considering the above issues, the impact of the development of the EZ on traffic is evaluated to be **Medium Low**.

5.3.1.12 Loss of Ecosystem Services

Currently, the local community benefits from a wide range of provisioning, regulating, and supporting ecosystem services in the EZ site and its surrounding area. These services include fishing, abstraction of groundwater for various purposes, medicinal plants, fuel wood, livestock grazing, protection against natural hazards and extreme events, aesthetics value, etc. Some of these services, which are key sources of income, may be eliminated or reduced with the implementation of the EZ.

Increased construction and infrastructure development may lead to groundwater depletion, affecting the availability of water for various purposes such as drinking, irrigation, and domestic use. This disrupts the provisioning service of freshwater. Changes in water body dynamics due to construction activities can impact fish populations, affecting the livelihoods of local communities who rely on fishing for income. This impacts the provisioning service of the ecosystem.

Habitat destruction and land conversion for the industrial city may lead to the loss of medicinal plant species. This reduces access to traditional healthcare resources, impacting cultural services and potentially increasing reliance on external healthcare systems. Deforestation and land clearing for development purposes may lead to a reduction in the availability of fuelwood, affecting households dependent on it for cooking and heating. Conversion of land for industrial purposes may reduce grazing areas for livestock, thereby impacting the livelihoods of pastoral communities. All of these activities affect the provisioning services of the ecosystems.

The alteration of natural landscapes and habitats may diminish their ability to protect against natural hazards and extreme events, increasing vulnerability to disasters like floods and cyclones, and affecting the regulating services of the ecosystem. Changes in the landscape due to industrial development may reduce the aesthetic value of the area. The reduction or elimination of these ecosystem services could result in a loss of income for the local community, particularly for those dependent on natural resource-based livelihoods.

Considering these issues, the impact of the development of the EZ on ecosystem services is evaluated to be **Medium-low**.

5.3.1.13 Impacts on Terrestrial Flora

The initial construction works in the EZ involve land clearance, cutting, filling, and leveling. As the construction activities involve vegetation clearance, terrain shaping, and soil excavation, several plant species will be lost, as well as mangrove species i.e., Keora (*Sonneratia apetala*), Sada Bain (*Avicennia alba*), and Gewa (*Excoecaria agallocha*). Major visible trees are Akashmoni (*Acacia auriculiformis*), Jhao Ghas (*Tamarix indica*), and Karoi (*Albizia procera*), among others, will also be affected, leading to a reduction in vegetation cover in the area. All the species are very common, their destruction will reduce the vegetation cover in the area. Water from the sea enters the EZ site and nearby Mangroves Forest during high tides. This area serves as intertidal mud flats and thus provides a habitat for mud crabs, water birds, fishes, and shrimps. All these species will be impacted during the removal of trees as well as the land development, dyke construction, and other construction activities. The basic significant impact of construction on terrestrial ecology will be due to the loss of vegetation. According to the BEZA, the NSEZ site, spanning 33,805 acres (mostly reclaimed land), comprises 31.65% mangroves/forest/vegetation.

Soils play a fundamental role in biodiversity conservation thus changes to the structure and chemical composition can have subsequent effects on vegetation structure and composition as well as altering

water courses. Clearing of vegetation may lead to changes in surface runoff flow direction and quantity in the area. This will potentially cause wind and water erosion.

Destruction of ecosystems can also be caused indirectly if emissions from EZ development activities reduce the productivity of vegetation. Dust for instance will affect plant growth by interrupting physiological processes like transpiration when lodged on leaf surfaces thereby blocking their stomata. Stack emissions such as Sulphur dioxide, nitrogen oxides, carbon monoxide, and heavy metals (such as mercury) may contribute to acid rain, which in turn pollutes and affects plant growth by corrosion of their surfaces and causes acidification of aquatic ecosystems.

Human activities are responsible for most of the loss in biodiversity throughout the world and with the proposed development in the study region, activities such as the construction of access roads and an upwelling of the human population are expected in the area as NSEZ staff, suppliers, opportunistic jobseekers, and new settlements due to opening up of the area. This may impact negatively on the biodiversity of the study region due to increased pressure on ecosystem services.

With the expected habitat disturbance during the implementation of the EZ master plan, invasive species may take advantage of the situation and increase in the region. Clearing of natural vegetation opens up gaps that are immediately occupied by opportunist invasive and weedy species when conditions become favorable. Movement of trucks and soil from one point to another might spread seeds of these species along the communication and travel paths that are under persistent disturbances. Exotic species might also be introduced in the region either passively as people dispose of fruit seeds in the environment or by design during landscaping activities.

Considering these issues, the impact of the development of the EZ on terrestrial flora is evaluated to be **Low**.

5.3.1.14 Impacts on Terrestrial Mammals

Clearing of vegetation, soil excavation, and construction of facilities may alter the habitat for mammals in the area. The population of trees and other plant species will also be reduced through the clearing of vegetation for the NSEZ structures. It is expected that the removal of vegetation will alter the ecological function of the area. As a result, wildlife ranging, foraging and roosting areas will be adversely affected.

From the primary baseline survey and secondary literature review, 11 species of terrestrial mammals were observed in the EZ site. Among the identified species in the EZ site, the Rhesus Macaque (*Macaca mulatta*) is categorized as Vulnerable (VU), and Jungle Cat (*Felis chaus*) is categorized as Near Threatened (NT) in the IUCN Red List of Threatened Species of Bangladesh 2015. In the study region, all the documented species of the EZ site and an additional 7 species were exclusively found. Among the study region species, the Fishing Cat (*Prionailurus viverrinus*) is listed as Endangered (EN) in the IUCN Red List of Threatened Species of Bangladesh 2015. Therefore, considering the presence of these species there will be some obvious impacts on mammalian species during the development of EZ.

Vegetation removal will diminish food resources available for herbivorous mammals like spotted deer (*Axis axis*), impacting their foraging success and potentially leading to population decline. Loss of habitat complexity due to clearing can also negatively affect prey availability for carnivorous mammals like the Jungle Cat (*Felis chaus*) and Fishing Cat (*Prionailurus viverrinus*).

Spatial occupation of the area by NSEZ facilities and people will displace mammals that currently forage in the EZ site and study region and could create a barrier effect, which may alter their dispersal patterns. Displacement of mammals due to habitat loss and construction activity could increase human-wildlife conflict as animals may seek food and shelter in nearby human settlements.

Mammal species are sensitive to human occupation. Disturbances include flood lights, vehicle lights, and noise from machinery and vehicles. Road kills of nocturnal animals are expected due to the movement of vehicles through the approach roads for the transport of construction material during dawn and dusk periods. Occupation of the area by NSEZ facilities will render the site inaccessible to

mammals. This will reduce faunal foraging options by barring the site as a foraging ground. Noise and vibrations from the heavy machinery may interfere with the foraging, ranging, breeding, and nesting behavior of mammals in the ecosystem within the NSEZ site and those in the larger ecosystem.

Considering the above issues, the impact of the development of the EZ on terrestrial mammals is evaluated to be **Medium Low**.

5.3.1.15 Impacts on Birds/Avifauna

Birds serve as important indicators of ecosystem health, reflecting the conditions of their habitats. While birds are highly mobile and may relocate once an area is developed, the presence of species of conservation concern, including those listed on the IUCN Red List and migratory species, highlights the cumulative impact on conservation obligations.

During the survey, two Important Bird and Biodiversity Areas have been identified: Ganges-Brahmaputra-Meghna delta and Muhuri Dam. The EZ site is situated along the Sandwip Channel of the Bay of Bengal, encompassing several islands. The mudflats in this area are crucial for migratory birds, as they lie along migratory routes of numerous species. From the primary baseline survey and secondary literature review, 89 species were recorded from the EZ site. Among the recorded birds of the EZ site, the Black-headed Ibis (*Threskiornis melanocephalus*) is categorized as Vulnerable (VU), while all other species are categorized as Least Concern (LC) as per the IUCN Red List of Threatened Species. In the study region, all the documented species of the EZ site and an additional 96 species were exclusively found. Among the recorded birds of the study region, Grey-headed Fish Eagle (*Ichthyophaga ichthyaetus*) is categorized as Near Threatened (NT). The baseline survey in the study region recorded a total of 65 migratory bird species. Among the recorded species 21 species were found in the EZ site and 30 species were exclusively identified within the study region except the species found in the EZ site.

During the development of the EZ, noise and vibration may be an issue due to the vehicle's movement, construction machinery and equipment operation, movement of workers, etc. Access roads will be built, and traffic to the site will increase. It is apparent that when the site is cleared of forest, the birds have a tendency to migrate to a more suitable habitat for relocation. There will be a significant loss of species diversity due to the clearing of the site. Opportunistic species, e.g., scavenging birds will replace them. The increase in human population and associated activities e.g., waste disposal is likely to attract and increase populations of scavenging and invasive bird species e.g., Indian House Crows. This will have a direct effect on populations of indigenous species through mainly predation as well as risk to public health. One more ecological impact that is envisaged during construction is related to lighting in the construction area. Light generally affects birds, especially the nocturnal ones.

Considering the above issues, the impact of the development of the EZ on avifauna species is evaluated to be **Medium Low**.

5.3.1.16 Impacts on Herpetofauna

Herpetofauna refers to the collective group of reptiles and amphibians found in a particular region or habitat. From the primary baseline survey and literature review, a total of 28 species of reptilian fauna were documented in the study region. Out of the documented species, 12 species were observed in the EZ site. As per the IUCN Red List of Threatened Species of Bangladesh 2015, the EZ site doesn't hold any species of Conservation significance. In addition, in the study region, 16 species are exclusively found. Among the recorded species, the Asian water monitor (*Varanus salvator*) is categorized as Vulnerable (VU), while the Bengal Monitor (*Varanus bengalensis*), Yellow Monitor (*Varanus flavescens*), Monocled Cobra (*Naja kaouthia*), Red-necked Keelback (*Rhabdophis subminiatus*), and Spectacled Cobra (*Naja naja*) are classified as Near Threatened (NT) according to the IUCN Red List of Threatened Species of Bangladesh 2015.

From the primary baseline survey and literature review, 9 amphibian species were documented in the study region. Out of the documented species, 5 species are observed in the EZ site. All the recorded

species of the EZ site are regarded as Least Concern (LC) as per the IUCN Red List of Threatened Species of Bangladesh 2015. In addition, in the study region, 4 species were exclusively found within the study region. Among these species, the Cascade Frog (*Amolops marmoratus*) is categorized as Vulnerable (VU) according to the IUCN Red List of Threatened Species of Bangladesh 2015. It is noteworthy that all reptilian and amphibia species receive legal protection under the Bangladesh Wildlife (Conservation and Security) Act, 2012, safeguarding them from hunting, killing, and capturing.

Herpetofauna loss is likely to occur during the site preparation. The habitat loss will happen during the initial clearing or removal of vegetation. The construction phase will involve landscaping which will involve excavation, compacting flattening of some areas. This will clear all the herpetofauna habitats on the ground like trees, dead tree trunks, and grasses which are home to amphibians and reptiles. It will also remove the source of food which are insects that are eaten by lizards who are in turn eaten by snakes thereby interfering with the food chain.

Cleared vegetation will expose herpetofauna to their predators when closing the roads and in open spaces. The animals will be prone to being crushed on the road by vehicles. This is especially during the wet season when the animals have more movement in search of mates for breeding.

During the clearing of the EZ site, animals such as snakes and lizards will move to other areas. However, due to the sudden change of environment, there is likely aggression from animals such as agitated snakes trying to escape. Further, snakes will move to other sites that are near the area. The concentration of snakes and lizards may rise thus leading to competition for available resources near homes and feeding on domesticated animals. Increased snake bites and snake encounters may occur to workers and the surrounding people. Waste and new habitats formed will attract lizards and rodents which in turn attract snakes, this might cause human-wildlife conflicts as well as wildlife-wildlife conflicts.

Oils and fuels from machines, generators, and vehicles plus other chemicals used during construction may accidentally spill on the site. This spillage, if collected by rainwater will eventually accumulate and if not well disposed of on the land will end up in the khals, sea, or other habitats. This will contaminate water and soil and affect especially amphibians more because they rely on their skin for respiration. This will lead to death and low reproduction due to the eggs and larval stages not getting enough air thus leading to population changes.

During the development of EZ, there will be exhaust emissions from vehicles and also dust during excavation which may affect the breathing systems of herpetofauna. Amphibians who breathe through their skin and need to keep their skin moist for this purpose will be mostly affected. The removal of vegetation/current habitat will impact herpetofauna which depends on the flora. The impact will be limited as most of the faunal species will be able to relocate to other areas where the vegetation is significant.

Considering the above issues, the impact of the development of the EZ on herpetofauna is evaluated to be **Low**.

5.3.1.17 Impacts on Aquatic Mammals

The baseline survey reveals the presence of two aquatic mammalian species in the Sandwip Channel of the Bay of Bengal, along the coast of the Sonagazi, Mirsharai, and Sitakunda regions within the study region. The most frequently observed aquatic mammal is the Irrawaddy dolphin (*Orcaella brevirostris*), which is classified as globally Endangered (EN) on the IUCN Red List of Threatened Species. Another dolphin species expected to occur in the Sandwip Channel near EZ is the Indo-Pacific Humpback Dolphin (*Sousa chinensis*), listed as Vulnerable (VU) on the IUCN Red List of Threatened Species.

The development of the EZ, specifically the construction of jetty and dredging activities will pose several threats to dolphin populations in the Sandwip Channel, particularly the Irrawaddy Dolphin and Indo-Pacific Humpback Dolphin. Pile driving for jetties, breakwaters, and other structures, along with dredging activities for port development, can generate intense underwater noise. This can disrupt communication, echolocation (used for navigation and feeding), and cause hearing damage in dolphins.

Increased vessel traffic associated with construction activities can elevate background noise levels, further impacting dolphin communication and the ability to detect prey.

Construction of new marine intake and outfall pipelines for desalination plant, and blasting may directly affect surf-zone and nearshore species.

Capital dredging and construction of approach channels, breakwaters, and cargo berths will result in disturbance to marine ecology. Dredging activities in the marine environment can also have a negative effect on the natural flow patterns of water bodies. These changes can influence the distribution of nutrients, oxygen levels, and temperature, impacting the overall health of aquatic ecosystems. Dredging activities can alter the seabed composition and destroy foraging grounds for prey species dolphins rely on. Landfilling can also lead to habitat loss in critical areas. The construction of physical structures like jetties and other structures can fragment migration corridors and hinder movement between feeding and breeding grounds.

Accidental spills of oil, lubricants, or other contaminants can pollute the water and harm dolphins directly through exposure or indirectly through bioaccumulation in their prey. Construction activities can stir up sediments, increasing water turbidity and reducing prey visibility for dolphins. Noise pollution and habitat disturbance can alter dolphin behavior, making it more difficult to find food and mates, and increasing stress levels. Habitat alteration and pollution can harm fish populations that dolphins rely on for food. Exposure to intense underwater noise can cause physical injuries and permanent hearing damage in dolphins.

The dolphin is a unique charismatic megafauna and an indicator species for its respective ecosystem. The presence of dolphins indicates a high-quality aquatic habitat where various aquatic organisms can thrive without facing any threats. Dolphins tend to avoid noisy or polluted areas, resulting in shifts in their distribution patterns and potential displacement from crucial habitats.

Considering the above issues, the impact of the development of the EZ on aquatic mammals is evaluated to be **Low**.

5.3.1.18 Impacts on Ichthyofauna (Fish)

The baseline survey reveals a significant number of fisheries resources, encompassing both captured and cultured fish species, within the study region. Pond-based aquaculture practices are not very common, but fishing activities based on rivers are noted. Furthermore, the EZ is situated on the eastern side of the Sandwip Channel, where substantial fishing activities have been observed, with marine and estuarine fish being caught. A baseline fisheries survey in the Sonagazi, Mirsharai, and Sitakunda upazilas revealed a total of 30 species, comprising 22 species of finfish, 2 species of crab, and 6 species of shrimp. Additionally, fish farmers in the study region mostly culture fourteen species of fish and two species of crustaceans.

The development of EZ is likely to have several negative impacts on the ichthyofauna (fish populations) of the surrounding water bodies, including the Sandwip Channel. Land reclamation and infrastructure development will result in the loss and alteration of aquatic habitats, including estuaries, rivers, and coastal areas, where many fish species reside and breed. Construction of jetties and other marine structures can fragment existing aquatic habitats, disrupting fish migration routes and spawning grounds. Habitat loss, degradation, and pollution can lead to a decline in fish species diversity in the affected water bodies.

Clearing of riparian vegetation can result in the loss of habitat and food sources for fish, reducing biodiversity and impacting the overall health of aquatic ecosystems. Development activities can disrupt fish spawning and recruitment, leading to a decline in fish stocks that are important for local fisheries. Dredging activities for jetty development and potential landfilling can directly destroy fish habitat by removing or smothering aquatic vegetation and altering the seabed composition.

Development activities can lead to increased erosion and runoff, resulting in sedimentation in waterways. This can suffocate fish eggs and clog gills, hindering fish respiration and development.

Leakage or spills of oil, lubricants, concrete, or other construction materials can contaminate waterways, making them toxic to fish and other aquatic life. Construction activities can stir up sediments, increasing water turbidity and reducing light penetration. This can disrupt fish feeding behavior and reduce photosynthesis by aquatic plants, impacting the overall food web. Pollutants released during construction can bioaccumulate in fish tissues, posing a health risk to humans who consume these fish.

Pile driving, dredging, and other activities generate underwater noise that can disrupt fish communication, breeding behavior, and the ability to detect predators. Increased vessel traffic associated with construction activities can disturb fish behavior and increase the risk of collisions with vessels. Construction activities may facilitate the introduction and spread of invasive species into water bodies, which can outcompete native fish species for resources and disrupt the balance of the aquatic ecosystem.

Dredging activities often disturb sediments, thereby reducing visibility and increasing the turbidity of water to the point where the amount of photosynthesis that can occur in the water is curtailed with the result that there will be an overall impairment of the function of the ecosystem. Consequently, the growth of fish and other organisms will be affected since the food supply will be reduced in turbid conditions. Other adverse effects of turbidity include a decrease in disease resistance, suffocation, and death.

Considering the above issues, the impact of the development of the EZ on ichthyofauna is evaluated to be **Low**.

5.3.1.19 Impacts on Hilsa Fisheries

Hilsa (*Tenualosa ilisha*) comprises the largest and most valuable single fishery in Bangladesh. Hilsa is largely anadromous and fast swimming, being a euryhaline pelagic fish that thrives in brackish water and marine environments of the Bay of Bengal. The baseline study reveals the presence of hilsa fish, along with its spawning and breeding grounds, in the Sandwip Channel. The hilsa spawning ground boundary point is located within the study region, namely Mayani Point at Mirsharai, Chattogram. The peak spawning period occurs three days before and seven days after the full moon, including the day of the full moon, totaling eleven days of the moon, which first appears in the Bengali month of Ashwin each year.

The development of the EZ poses several threats to Hilsa fish, particularly in the vicinity of the identified spawning ground near Mayani Point. Activities such as land reclamation, infrastructure development, and dredging can lead to the loss and alteration of aquatic habitats, including the hilsa's spawning and breeding grounds in the Sandwip Channel. This loss of habitat may disrupt hilsa migration routes and access to critical spawning areas.

Increased sedimentation from construction-related activities can adversely affect water quality in the Sandwip Channel, potentially impacting the survival of hilsa eggs and larvae. Sedimentation can also smother aquatic vegetation, which serves as an important spawning and nursery habitat for hilsa.

Discharge of untreated or inadequately treated construction-related pollutants such as heavy metals, organic compounds, and toxins into the water bodies can harm hilsa health and reproduction. Additionally, spills of oil, lubricants, and other materials during construction activities can contaminate the water and adversely affect hilsa populations. Activities such as dredging, pile driving, and vessel traffic can create underwater noise and disturbances that may disrupt hilsa spawning behavior and communication, particularly during their peak spawning period around the full moon.

The establishment of infrastructure, ports, and industrial areas may encroach upon or disrupt hilsa spawning and breeding grounds, including critical areas like the Mayani Point in Mirsharai, Chattogram. This loss of spawning grounds could have significant implications for hilsa reproduction and population dynamics. The development of ports and improved access to waterways within EZ may attract more fishing vessels, leading to increased fishing pressure on hilsa populations. Overexploitation of hilsa stocks, especially during their peak spawning season, could further threaten their sustainability.

Considering the above issues, the impact of the development of the EZ on hilsa fisheries is evaluated to be **Low**.

5.3.1.20 Impacts on Plankton and Benthos

Plankton and benthos are two crucial components of aquatic ecosystems. Planktonic organisms form the base of the food chain for many aquatic animals and play a crucial role in the global carbon cycle by absorbing and releasing carbon dioxide. Meanwhile, benthic organisms play a vital role in nutrient cycling and sediment transport, serving as an important food source for many larger aquatic animals. Both plankton and benthos serve as important indicators of the health of aquatic ecosystems.

During the baseline study, sample analysis from predefined collection locations in the Sandwip Channel, downstream of the Feni River and its confluences, adjacent to the EZ, identified a total of nineteen species of phytoplankton, fourteen species of zooplankton, and sixteen species of benthos.

Several impacts on planktonic and benthic organisms in the Sandwip Channel can be anticipated during the development of EZ. Activities such as dredging, land reclamation, and infrastructure development can directly disturb the habitats of planktonic and benthic organisms in the Sandwip Channel. These disturbances can disrupt their natural environment, affecting their ability to thrive and reproduce. Construction activities may lead to increased sedimentation and runoff, which can degrade water quality in the Sandwip Channel. Sedimentation can smother benthic organisms and reduce light penetration, affecting photosynthesis in important phytoplankton. Pollutants from EZ sites can also negatively impact planktonic and benthic communities.

Construction activities often generate noise and vibrations, which can disturb planktonic and benthic organisms sensitive to sound and movement. These disturbances may alter their behavior, distribution, and reproductive patterns. Construction projects may introduce chemicals such as cement, oil, and lubricants into the water, posing a threat to planktonic and benthic organisms. Chemical spills or leaks can have acute and chronic effects on their health and survival. Infrastructure development, such as the construction of ports and embankments, can create physical barriers that impede the movement of planktonic and benthic organisms, disrupting their natural migration patterns and dispersal.

Changes in water flow and circulation patterns due to construction activities can impact planktonic and benthic communities. Alterations in hydrology may disrupt nutrient cycling, oxygen levels, and food availability, affecting the overall health of aquatic ecosystems. Combined disturbances from different NSEZ activities may lead to population declines, shifts in species composition, and ecological imbalances.

Considering the above issues, the impact of the development of the EZ on plankton and benthos is evaluated to be **Low**.

5.3.1.21 Ecologically Critical Areas

An Ecologically Critical Area (ECA) is an environmental protection zone in Bangladesh. In 1995, specific areas in Bangladesh could be deemed ECAs as a result of the Environmental Conservation Act, 1995. As per the legal mandate, the Ministry of Environment, Forest, and Climate Change (MOEFCC) till now declared thirteen ECA areas in Bangladesh. According to the literature review, there is no ECA area located inside the EZ master plan area. Therefore, no impacts on ECAs are anticipated due to the development of EZ.

5.3.1.22 Protected Areas

The protected area refers to an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity and natural and associated cultural resources and managed through legal or other effective means i.e., a protected area is predominantly a natural area established and managed in perpetuity, through legal or customary regimes, primarily to conserve their natural resources. According to the Wildlife (Conservation and Security) Act 2012, types of protected areas are national parks, sanctuaries, eco-park, botanical gardens, community conservation areas, safari parks,

Kunjaban, etc. According to the Bangladesh Forest Department list of protected areas, there is no protected area located within the EZ area. Therefore, no impacts on protected areas are anticipated due to the development of EZ.

5.3.1.23 Critical Habitat Assessment

A critical habitat assessment (CHA) was undertaken as part of the ecological impact assessment to determine areas of high biodiversity value within the EZ site and surrounding region. Based on an evaluation of the CHA within and around the EZ site coupled with the NSEZ activities, the potential environmental effects on terrestrial and marine populations of species at risk that are present will be mitigated with standard construction practices and scheduling of NSEZ components (e.g., clearing only those areas of the NSEZ footprint that are required for construction purposes). Mangroves that will be cut for the EZ and its related facilities offset measures will be taken by planting trees in the EZ area.

From the baseline biodiversity survey, fifteen (15) species were reported in the study region as potential trigger species for Critical Habitat (CH), including four (4) Critically Endangered (CR) and eleven (11) Endangered (EN) species according to global IUCN status. Conversely, only nine (9) species trigger the CH criterion based on their national IUCN status. The remaining six (6) species do not meet the CH criterion as their national IUCN status is Vulnerable, Near Threatened, or Least Concern. According to the assessment conducted following the ESS6 of the World Bank Environmental and Social Framework (ESF) and its Guidance Note (2018), none of the species in the study area meet the threshold limit for Criterion (a). Moreover, the species found in the study region do not qualify for CH Criteria (b) to (e) and do not fully or partially overlap with any internationally or nationally designated area.

Thus, it has been concluded that the proposed NSEZ site and study region is not a Critical Habitat for any of the identified species, because the study area does not meet any of the ESS6 of ESF, 2017 and its Guidance Note (2018) criteria during the critical habitat screening study. Hence, the NSEZ area and study region do not qualify for critical habitat areas. Details of the critical habitat screening have been provided in Appendix E (Vol-III).

5.3.1.24 Impacts due to Land Acquisition, Resettlement and Rehabilitation

The total land area of the EZ is 33,800 acres. To date, BEZA has received approximately 17, 000 acres of land from the Deputy Commissioner offices of Feni and Chattogram districts. The concerned DC offices are responsible for providing the land needed to develop the EZ. According to the discussion with the BEZA and review of secondary documents, most of the land was reclaimed from the sea through dredging in the Sandwip Channel. As of now, the land has been acquired emphasizing the development of Zone 2A and Zone 2B in the Mirsharai area. The land acquisition for the development of accommodation facilities and heavy industrial zone respectively at Sonagazi and Sitakunda area is yet to be completed.

Both physical and economic displacement occurred because of land acquisition. It is anticipated that the future development of the proposed NSEZ will lead to a significant increase in physical and economic displacement. To date, approximately 76 households (135 persons) have been displaced due to land acquisition for the development of the access road and they were mostly poor fishermen who were living on the government-owned land²⁶. Among them, 10 households have been resettled.

In terms of economic displacement, a significant number of buffalo owners, gazers, and fishermen are displaced due to the intervention of the EZ.

Land acquisition and the provision of resettlement will be required for the new construction, expansion, and improvement of associated facilities including roads, railway, and accommodation facilities. The anticipated sources of future land acquisition and resettlement for the EZ include the following:

- **Railway:** for the development of railways, around 89 acres of land, 990 residential and commercial structures, 1209 households, and some other assets are likely to be impacted.

²⁶ <https://www.beza.gov.bd/wp-content/uploads/2020/08/Publication-of-BSMSN-14-August-2020.pdf>

- **Roads Development:** the development of access roads will require land acquisition and resettlement in some respects. The following structures are the potential subjects to be considered under resettlement:
 - *Feni-Sonagazi Roads: a total of 61 residential structures, 60 commercial structures, and 16 other structures (Schools/Madrasah, Mosque, Hospital).*
 - *Sonagazi-Muhuri Road: a total of 95 residential structures, and 550 commercial structures.*
 - *Muhuri Road: a total of 35 residential structures, 180 commercial structures, and 17 other structures (Schools/Madrasah, Mosque, Mondir, Graveyard, Small Mill).*
 - *Bamonsundar Road: a total of 26 HHs comprising 60 residential structures, 120 commercial structures, and 5 other structures (Schools/Madrasah, Mosque).*
 - *Barodarogarhat-Mohanagar Road: a total of 80 residential structures, 500 commercial structures, and 16 other structures (Schools/Madrasah, Mosque, Hospital).*
 - *North to NSEZ Saroni: A total of 117 HHs comprising 225 residential structures, and 2 other structures (Schools/Madrasah, Mazar).*
 - *South to NSEZ Saroni: a total of 84 HHs comprising 177 residential structures, and 3 other structures (Schools/Madrasah, Mandir).*
 - *NSEZ Avenue: 69 HHs were affected by the intervention of the NSEZ.*
- **Housing and Accommodation Facilities Development:** development of accommodation facilities for incoming workers and followers, services providers, etc. would further require land acquisition and resettlement. For example, the National Housing Authority (NHA) is planning for township development near EZ boundaries, and they have initially identified around 200-300 acres of open lands which is adjacent to the EZ's boundary (opposite side of the BEPZA main gate). This land is owned by the community people and will require acquisition if it is finally considered by NHA for any development.

A Resettlement Policy Framework (RPF) has been prepared by BEZA under the Private Investment and Digital Entrepreneurship Project (PRIDE) to guide the Resettlement Action Plans (RAP) preparation in case of land acquisition and resettlement in the EZ. It is strongly recommended to prepare a Resettlement Action Plan and Land Acquisition Plan (where required) and ensure proper compensation prior to starting construction activities. Also, proper consultation with the Project Affected Persons (PAPs) should be ensured in order to share information about entitlement, eligibility, type of compensation, and the Grievance Mechanism (GM).

To address the resettlement issue, four resettlement sites namely RS1, RS2, RS3, and RS4 have been provided in EZ. RS1 is located in Precinct A in Char Khondakar Mouza in Sonagazi Upazila of Feni District with an approximate area of 13.19 acres of land. Whereas, both RS2 and RS3 are located in Precinct D and Precinct F in Purba Ichakhali Mouza of Mirsharai Upazila with an approximate area of 21.71 acres and 21.39 acres of land respectively. RS4 is located in precinct B. Moreover, during the site visit, it was identified that 36 HHs had been relocated to the Bangla Bazar area of Ichakhali Union.

Considering the above issues, the impact of the development of the EZ on land acquisition, resettlement, and rehabilitation is evaluated to be 'Direct' in nature with 'High' intensity/severity and the duration of the impact will be 'permanent-mitigated'. Thus, the significance of the impact during development phase will be **'Medium-high'**.

5.3.1.25 Community Health, Safety, and Security

The development of EZ will have certain impacts beyond the EZ boundaries. The local communities around EZ may be affected by various health and safety issues. Due to the construction and transportation activities, local communities will be exposed to excessive dust and noise that can lead to an increase in respiratory diseases and nuisances. From the mobility of workers, sexually transmitted diseases, such as HIV/AIDS, will be the most concerned communicable diseases. The impact of increased risk of HIV includes pressure on local health systems, impact on community livelihood, and social cohesion. Diseases such as malaria, dengue, pneumonia, dysentery, hepatitis, and tuberculosis can increase due to poor sanitation.

The migrated workers may bring emerging diseases to the EZ surrounding area. If this happens, local villagers will likely be exposed to new strains of diseases. Common cold and flu as well as respiratory tract infections caused by probably new strains are also possible. An increase in alcoholic drinking, smoking, and substance abuse and increasing of migrated labors, violence, and social disturbance are expected as well.

With the influx of people in an area as a result of construction works and the introduction of equipment and various materials comes associated impacts that affect the health and safety of the communities in the EZ area. Machinery and equipment such as vibrators, graders, trucks, rollers/compactors, excavators, concrete mixers, vehicles, etc. increase traffic on the roads and increase the risks of accidents, especially in institutions such as schools near the EZ access roads.

Unsafe vehicle transport with existing road conditions can trigger vehicle accidents and injuries, particularly among young adults. Accidents may occur while transporting materials and supplies including chemicals such as gasoline, solvents, or lubricants. These accidents will lead to the release of hazardous materials that may result in fire, explosion, and/or toxic chemical leaks into the environment.

The influx of workers and service providers into communities may increase the rate of crimes in the region and/or a perception of insecurity by the local community. Such illicit behavior or crimes can include theft, hijacking, physical assaults, substance abuse, prostitution, and human trafficking.

To ensure security in the EZ, BEZA has deployed different security forces including Police and Ansar. Currently, 25 nos. of police have been deployed at the site. In addition, BEZA has a plan to deploy a full-scale industrial police unit where 500 active servicemen will be on duty. An accommodation facility for 300 members of the police has already been constructed. Further, the entire industrial city will be surrounded by a boundary wall to ensure more security²⁷.

Considering the above issues, the impact of the development of the EZ on Community Health, Safety, and Security is evaluated to be 'Direct' in nature with 'High' intensity/severity and the duration of the impact will be 'permanent-mitigated'. Thus, the significance of the impact during development phase will be '**Medium-high**'.

5.3.1.26 Occupational Health, Safety, and Security

During the development of EZ, accidents and injuries will be notable for workers, especially among untrained ones. A wide range of injuries may be found from minor or medical aid required only to serious cases, disabling injuries, and/or death. Faulty electrical devices, blunt injuries, cut wounds, falling, as well as eye irritation and burns are common, however, broken limbs, trauma, and or serious injuries can also occur. Besides, an increased number of traffic accidents can be expected. The risks and impacts on health and safety are increased if contractors and employees do not adhere to the administration of the Personal Protection Equipment (PPEs) relative to their respective scope of work and are not equipped with relevant training in occupational health and safety procedures.

Potential respiratory diseases may be aggravated, due to pollutants exposure in the workplace, such as dust, exhaust gas, chemicals, or solvents. Underlying chronic diseases such as asthma, allergy, peptic ulcer, or mental disorder, can be exacerbated by the exposure of hazardous/chemical wastes. Moreover, noise, vibration, and workplace temperature are likely to be expected. Workers will experience new jobs, hard work, and an unfamiliar environment. Hence, they may encounter stress, anxiety, and hypertension. Being away from home, workers easily turn to drinking more, alcoholic beverages, smoking, and/or substance abuse.

Moreover, unhygienic habits, poor personal hygiene, and environmental sanitation may increase diarrhea, hepatitis, and communicable diseases. Malaria and dengue fever and local diseases from the

²⁷ beza.gov.bd/wp-content/uploads/2020/08/Publication-of-BSMSN-14-August-2020.pdf

affected area, can be easily spread. Sexually transmitted diseases and HIV/AIDS are also expected and need to be seriously concerned to designate prevention and control measures.

Fire may occur from ignition of flammable materials or other reactive chemicals which can lead to accidents and injuries as well as loss of properties. The project owners should always provide a first-aid unit in the working area. Qualified first-aid units should also be established to ensure that can properly handle serious or trauma cases. Patients should be taken care of and transferred to appropriate medical facilities in time.

Considering the above issues, the impact of the development of the EZ on Occupational Health, and Safety is evaluated to be 'Direct' in nature with 'High' intensity/severity and the duration of the impact will be 'permanent-mitigated'. Thus, the significance of the impact during development phase will be **'Medium-high'**.

5.3.1.27 Labor Influx

Labor influx will be triggered due to the EZ development attracting various categories of workers from local, regional, national, and international markets. There are, within the local population, high expectations of getting employed by the EZ. During the public consultation, the issues raised were related to employment opportunities.

The development stage will involve the labor of unskilled, semi-skilled, skilled, and highly skilled types. Considering the dynamics of the development in both on and offsite infrastructure, several types of construction workers will be housed near the EZ such as buildings construction, road construction, embankment construction, railway construction, gas pipeline installation, electric line installation, dredging and khal re-excavation, transportation workers, etc. From the stakeholder consultation, it was revealed that approximately 10,000 to 12,000 laborers have already been engaged in different construction works. Construction activities could continue even after the EZ enters its operation phase. Moreover, according to the phasing in the EZ's masterplan, different construction works will be required at different phases while many industries will be in operation at the same time.

As per the consultation findings, currently, a majority of the workers are residing in the EZ surrounding communities like Abu Torab Bazar, Boro Takia, Mirsharai, and other nearby areas. While the construction works offer employment opportunities for local skilled and unskilled laborers along with outsider workers, the influx of outsiders is likely to have some negative impacts such as conflicts between construction workers and local communities due to differences in lifestyle, habits, customs, culture, employment, and income.

Considering the above issues, the impact of the development of the EZ on Labor Influx is evaluated to be 'Direct' in nature with 'High' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be **'Medium-high'**.

5.3.1.28 Child Labor and Forced Labor

The development of the EZ will necessitate the recruitment of the local population as well as outsiders. Among the recruited personnel may be identified those that are under the age of employment as per the labor act in Bangladesh (Labor Act 2006 prohibits employment of children under 14 years old, as well as hazardous forms of child labor for persons under 18). Others recruited may be exposed to forced labor and discrimination. It will be useful for the BEZA, investors, contractor(s), and subcontractor(s) management to protect the NSEZ from such incidents by ensuring that recruitment complies with national laws and that continuous monitoring is done within the phase to ensure the nonoccurrence of such incidents. Investors through their appointed contractors shall confirm that workers under the age of 18 will not be hired to work on the project in the EZ. To confirm that workers under the age of 18 years are not hired to work, workers shall need to provide legally recognized documents such as a Citizenship Card or Birth Certificate. Further, awareness-raising sessions shall be conducted regularly in the communities to sensitize on prohibition and negative impacts of child and forced Labor. However, in practice in some sectors of work, there might be the risk of non-compliance.

Considering the above issues, the impact of the development of the EZ on Child Labor and Forced Labor is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'Permanent-mitigated'. Thus, the significance of the impact during development phase will be **'Medium-high'**.

5.3.1.29 Gender Based Violence, Sexual Harassment and Abuse/Sexual Harassment

Construction workers will predominantly be younger males. Those who are away from home on the construction job are typically separated from their family and act outside their normal sphere of social control. This can lead to inappropriate and criminal behavior, such as sexual harassment of women and girls, exploitative sexual relations, and illicit sexual relations with minors from the local community. A large influx of male labor may also lead to an increase in exploitative sexual relationships and human trafficking whereby women and girls are forced into sex work. In addition, they may be infectious to communicable diseases, and social diseases such as HIV/AIDS, syphilis, etc.

The construction activities will be continued for a long term and phase by phase up to 2040. During the development of the EZ, the vulnerable residents of the host communities, such as youth, girls, and women, may be subjected and exploitative to the social interaction between community members, casual laborers, and some skilled workforces who are coming from different places during the construction phase, which may result in gender-based violence (GBV), sexual exploitation and abuse (SEA) as well as attitude and behavior changes among local people.

Considering the above issues, the impact of the development of the EZ on Gender Based Violence and Sexual Exploitation and Abuse/Sexual Harassment is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be **'Medium-low'**.

5.3.1.30 Violence Against Children

Violence against children is defined as physical, sexual, emotional, and/or psychological harm, neglect, or negligent treatment of minor children (i.e., under the age of 18), including exposure to such harm that results in actual or potential harm to the child's health, survival, development, or dignity in the context of a relationship of responsibility, trust, or power. This includes using children for profit, labor, sexual gratification, or some other personal or financial advantage. This also includes other activities such as using computers, mobile phones, video, digital cameras, or any other medium to exploit or harass children or to access child pornography.

To reduce construction costs, child labor can be used for some jobs that do not require high qualifications. Due to limited knowledge, children can suffer from labor abuse that will affect their psychological, health, and ability to learn.

Considering the above issues, the impact of the development of the EZ on Violence Against Children is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be **'Medium-low'**.

5.3.1.31 Impact on Social Infrastructures

The presence of construction workers, and their followers will generate additional demand for the provision of public services such as healthcare/medical services, education, transport, housing and sanitation, waste management, and social services. This demand for services will require a significant number of service providers. The local people in the host community will face more or less changes and inconveniences in various aspects of their life, for example, the increase of users for the existing social infrastructures/services such as schools, health care centers, roads, etc. Therefore, it needs to be considered and planned the expansion of capacity and the improvement of specification in advance. In this case, EZ will consider planning the arrangement of necessary public facilities according to the expected demand of future users.

According to the stakeholder consultation, the existing social infrastructures/services in the EZ surrounding area are absolutely insufficient and barely up to the mark while the social infrastructure that EZ is expected to develop through other government departments will benefit the local citizens a great deal. Roads and public transport exist, but they need a lot of improvement.

Healthcare/Medical Services

From the recent information, it was identified that there are a few basic health units and hospitals functional in the area. Besides, there are no emergency hospitals in Mirsharai, Sitakunda and Sonagazi Upazila. As per the Population and Housing Census, 2011, the existing available healthcare facilities including health personnel in the EZ region have been given in Table 5-12.

Table 5-12: Number of Government Health Complex and Health Personnel

Upazila	Number of Beds	Number of Doctors	Number of Nurses	Number of Technicians	Number of Other Staff
Mirsharai	50	26	9	2	186
Sitakunda	31	23	7	4	54
Sonagazi	31	7	5	1	158
Total	112	56	21	7	398

Source: Population and Housing Census, 2011

A list of union-level health centers²⁸ in the EZ region has been given below:

Mirsharai Upazila: there are 18 centers in Mirsharai Upazila as follows.

- Zorawarganj Sadar Clinic
- Khaiyachhara Union Health & Family Welfare Centre
- Hinguli Union Health & Family Welfare Centre
- Ichhakhali Union Health & Family Welfare Centre
- Karerhat Union Health & Family Welfare Centre
- Katachhara Union Health & Family Welfare Centre
- Durapur Union Health & Family Welfare Centre
- Maghadia Union Health & Family Welfare Centre
- Mayani Union Health & Family Welfare Centre
- Mirsharai Union Health & Family Welfare Centre
- Mithanala Union Health & Family Welfare Centre
- Saherkhali Union Health & Family Welfare Centre
- Osmanpur Union Health & Family Welfare Centre
- Dhum Union Health & Family Welfare Centre
- Wahedpur Rural Dispensary
- Joralgoanj maternal and child health - family planning Unit
- Kumarlihat Mother & Child Welfare Centre
- Mirsharai Mother & Child Welfare Centre

Sitakunda Upazila: there are 9 centers in Sitakunda upazila as follows.

- Sitakunda Sadar Clinic
- Banshbaria Union Health & Family Welfare Centre
- Bariadyala Union Health & Family Welfare Centre
- Muradpur Union Health & Family Welfare Centre
- Saidpur Union Health & Family Welfare Centre

²⁸ https://www.dgfpms.org/ss/others8/facility_name.php

- Salimpur Union Health & Family Welfare Centre
- Sonaichhari Union Health & Family Welfare Centre
- Barakunda Union Health & Family Welfare Centre
- Kumira Rural Dispensary, and Bhatiari Others

Sonagazi Upazila: there are 10 centers in Sonagazi upazila.

- Dagonbhuiyan Sadar Clinic
- Dagonbhuiyan Union Health & Family Welfare Centre
- Jailashkara Union Health & Family Welfare Centre
- Purba Chandrapur Union Health & Family Welfare Centre
- Matubhuiyan Union Health & Family Welfare Centre
- Rajapur Union Health & Family Welfare Centre
- Ramnagar Union Health & Family Welfare Centre
- Sindurpur Union Health & Family Welfare Centre
- Yakubpur Union Health & Family Welfare Centre
- Fazilerghat Union Health & Family Welfare Centre

Local healthcare services and healthcare personnel, in quantitative and potentiality dimensions, are quite limited at present. However, the injuries and illness will be increased in the future in terms of quantity and complexity. The wide range of injuries and disabilities will create an excessive burden on the existing health services. Death and serious injuries from accidents will be increased in the region. Moreover, the complexity of illness from long-term and multiple exposures to health hazards is expected. Consequently, an effective health surveillance system needs to be established inside of the EZ.

During the stakeholder consultation, the following health institutions' establishment proposals have been raised by the participants.

Type of Medical Institution Proposed	Proposed Location
Medical College Hospital	Mirsharai
	Sitakunda
	Sonagazi
Hospital/Medical Center/Facility	Mirsharai
	Sitakunda
	Sonagazi
Upgradation of Existing Facilities (e.g., Community Clinics, Upazila Health Complex, Clinics)	Mirsharai
	Sitakunda
	Sonagazi

Regarding the significant number of workers in the EZ, a hospital/healthcare facility located in the project township should be established. This newly established healthcare facility should be a comprehensive one, in terms of adequacy, capability, and accessibility since at present public health facilities and services provided by local authorities are quite limited.

Education

Existing available educational institutes in the EZ region have been given in Table 5-13.

Table 5-13: List of Educational Institutes

Type of Educational Institutions	Mirsharai	Sitakunda	Sonagazi	Total
Government primary school	145	73	76	294
Registered primary school	38	22	24	84
Private (non-registered) primary school	2	3	1	6
Kindergarten school	12	54	20	86
NGO Schools	16	5	0	21
Madrasa (under madrasah board)	16	14	14	44
Kawmi madrasah	20	3	6	29
Ebtedayee madrasah	12	15	3	30
Government secondary school	0	1	0	1
Non-government secondary school	46	27	17	90
School and college operating jointly	0	2	0	2
Government College	0	1	1	2
Non-government College	6	5	1	12
Technical and vocational institution	0	0	0	0

Source: Population and Housing Census, 2011

There are three vocational educational institutes and courses have been found in the concerned upazilas are listed in Table 5-14.

Table 5-14: List of Schools with Vocational Courses

Upazila	Name of School	Vocational Courses
Mirsharai	Maghadia N.A.C. High School	Refrigeration and Air-conditioning
Sitakunda	Zafar Nagar Aparna Charan High School	General Electrical Works
Sonagazi	Amirabad B.C Laha High School	Refrigeration and Air-conditioning

Source: sesip.gov.bd²⁹

There are many nearby educational institutes (primary and high schools) in the surroundings of the EZ. These are:

- **High Schools:** Maghadia Orphanage Nurul Absar Chow. High School, Shaher Khali High School, Mirsharai Girls High School, Mirsharai Pilot High School, Zhulon Pol Beni Madhab High School, Zorwargonj Model High School, Abutorab High School, Mithanala Ramdayal High School, Mithachara High School, Aburhat High School, and Bamon Sundor Fakir Ahmed High School.
- **Primary Schools:** Mithachara Government Primary School, Mithanala Government Primary School, Mithanala Sufia Government Primary School, Abu Torab Government Primary School, Shaherkhali Jamal Shafi Government Primary School, Magadia Anzumer Government Primary School, Ichakhali Government Primary School, Ichakhali Sufia Government Primary School, Char Shorot Government Primary School, and Aburhat Government Primary School.

²⁹ https://sesip.gov.bd/wp-content/uploads/2020/08/Vocational-Database-for-Student-Data-for-BTEB_23_07_2020.pdf

In addition, two textile engineering colleges namely Textile Engineering College at Zorargonj (CTEC) and Professor Kamal Uddin Chowdhury College, have been found in Mirsharai Upazila.

During the stakeholder consultation, the following educational institution's establishment proposals were raised by the participants.

Type of Educational Institution Proposed	Proposed Location
Primary School and Kindergarten	Mirsharai
	Sitakunda
	Sonagazi
High School	Mirsharai
	Sitakunda
	Sonagazi
Degree College	Mirsharai
	Sitakunda
	Sonagazi
University	Mirsharai
	Sitakunda
	Sonagazi
Technical Institute/Engineering College	Mirsharai
	Sitakunda
	Sonagazi
Upgradation of Existing Institutes	Mirsharai
	Sitakunda
	Sonagazi

The supply and quality of human resources in the EZ region are not commensurate with what is required in EZ by and large, human resources in the project region are not trained and capable enough to operate modern technological machinery. This is one of the major challenges that the GOB and BEZA need to address to benefit from the employment opportunities presented by EZ. The establishment of new technical and vocational training institutes and upgrade/upscaling of existing institutes is a critical pre-requisite to meet the requirements of technically trained human resources for industries being set up in EZ as well as associated businesses in the region.

EZ has the potential to transform positively the lives of women in the region. A significant portion of the local population comprises women who are currently unable to contribute to the national economy because of cultural constraints and lack of income-generating opportunities. The GOB via BEZA can categorically focus on the engagement of women in businesses that are directly and indirectly generated by EZ. Tax reliefs for industries that employ women, schools for children of employees working EZ, housing facilities in the vicinity, and healthcare insurance are facilities that would encourage native women to engage in income-generating activities. In addition, the GOB could also consider the allocation of reserved seats and incentives such as fully funded scholarships for women in technical and vocational institutes.

Transportation/Roads

During the construction phase, the transportation of huge quantities of construction material (quarry material, gravel, stone, aggregate, sand, bricks, cement, steel, bitumen, paint bricks, etc.) for the EZ development results in the use of public infrastructure like roads, which in turn results in extra burden on the existing infrastructure. The current road condition in the EZ region is not adequate to support additional traffic volume due to the implementation of the EZ.

According to the master plan of the EZ, the anticipated movement pattern of passenger and freight, Dhaka - Chattogram Highway (N1) and Feni - Sonagazi Road are likely to assume greater importance, especially for predominant north-south movement. The connecting roads are proposed mainly from Dhaka-Chattogram Road and can be listed as the following:

- Muhuri Project Road (Zorarganj - Muhuri Project)
- Bamonsundar Road
- NSEZ Sarani
- Mohan Nagar Barodarogarhat Road

These roads will be developed in different phases of EZ. In addition, EZ is quite likely to be connected with the Dhaka-Chattogram Highway via internal road networks however passenger transportation in the whole region needs to be improved on a priority basis. From the stakeholder consultation, the road development proposals that have been raised by the participants are provided in Appendix I (Vol. III).

Housing and Sanitation

Currently, there is a lack of adequate accommodation for the construction workforce in the EZ. Due to the increasing number of workers and also the growth of other supporting industries and surrounding areas, numerous accommodations are being constructed outside the EZ. This is creating pressure on public health services, public health facilities, and sanitation. Currently, the public health services provided by local authorities are rather limited. Improper management of sewage, wastewater, and solid waste may generate sources of diseases. Therefore, township development for the workers is very crucial to facilitate the workers living close to the EZ.

Due to the increasing demand for accommodations, local people are developing infrastructures in an unplanned way without considering drainage and road networks. It will create long-term flooding/waterlogging and traffic congestion impact in the region.

Considering the above issues, the impact of the development of the EZ on Social Infrastructures is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be '**Medium-low**'.

5.3.1.32 Impacts on Fisherman and Fishery Activity

The livelihoods of the people in Mirsharai, Sitakunda, and Sonagazi Upazilas are mainly farming, fishing, livestock grazing, small business, day laboring, service, etc. During the development of the EZ, the impact on the living and livelihoods of the fisherman and land-dependent community will arise due to the construction activities. According to the consultation with stakeholders, there are 2,557 and 800 registered fishermen respectively in Mirsharai and Sonagazi Upazila. In addition, there are unregistered/seasonal fishing activities in the study region and a mentionable number of fishermen are engaged. Three types of fishing are practiced within the study region which are freshwater aquaculture (extensive, semi-intensive), fishing in rivers, estuaries, and adjacent khals, and fishing in the Bay of Bengal/Sandwip Channel.

Disruption and loss of livelihoods related to the fishing industry are a concern expressed by the local community during stakeholder consultation meetings. The fish industry-related livelihoods including fishing boat owners, fish vendors, day laborers of fish landing stations, mechanics, fuel suppliers, boat building and repair, net and fish trap manufacture and repair, marketing and transportation, etc. will also be impacted. The extent of the impact associated with the disruption of livelihoods already observed in the Jaladash community who are the artisanal fishermen communities of the area of Domkhali, Saherkhali, Joynagar, Mirzanagar, Mogadia (Bodulla Para Mozumdar Hat), 6 No. Ichakhali (Boro

Darogar Hat Jaladash Para, Char Khandoker). The fishing community has also experienced a reduction in fish catching due to the dredging activities in the Sandwip Channel for EZ land development and increasing marine traffic. Previously one fishing boat could catch fish from 40 kg to 100 kg per visit and this rate started reducing since 2018 from 5 kg to 40 kg per visit. The increasing marine traffic in the Sandwip Channel is damaging the fishing net which is creating extra economic pressure on the fisherman community. The community's perception is that the EZ will adversely impact fish through hazardous discharges into the sea. The majority of the fishermen in the region employ traditional techniques which have limited their capacity to fish in deep seas. An expressed concern was that project activities will destroy the current fishing area in Sandwip Channel, and result in migration of fish to the deep sea. Therefore, the impacts on livelihood and income generation are expected to be permanent in duration for the fishing community.

The fish landing stations/ghats/boat parking areas i.e., Saherkhali, Domkhali, Muhuri, Bamonsundor, and Ichakhali Ghat already impacted. All these fish landing stations are being relocated to places that are 2-3 km distance from the Jaladash/fishermen community. Now, they are facing difficulties in accessing the fish landing site/boat parking site due to relocation. In addition, the khals i.e., Ichakhali, Bamon Sundar, Saherkhali, Domkhali, Daborkhali, Khutakhali, Hoania, Donakhali, etc. were previously used by the fisherman to access the Sandwip Channel as well as used as a shelter during Cyclones. However, the construction of super-dyke and sluice gates along the Sandwip Channel has restricted the free movement of fishermen to access the fishing sites as well as lose the shelters for Cyclones. The fishermen have parked their fishing boats outside of the Super Dyke and boats were damaged by the Cyclone associated severe wave action.

Due to the restriction in the EZ site and Sandwip Channel will lose fisherman employment, as they are not skilled laborers to relocate them to other jobs. Fishermen mostly lack an institutional education background, so they cannot get high-rank jobs in EZ, they can work only as casual laborers. The situation will lead to the worsening of their socioeconomic condition. Therefore, in addition to suitable financial compensation, the impacted fisherman and allied workers should be given preference in employment by the EZ or in the business units in the EZ. There should be a provision for their subsequent absorption in employment in different industries in the EZ.

Considering the above issues, the impact of the development of the EZ on Fisherman and Fishery Activity is evaluated to be 'Direct' in nature with 'High' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be **'Medium-high'**.

5.3.1.33 Impacts on Livestock Population and Dependent Community

The communities in the study region are dependent on livestock for income and livelihood. Livestock production contributes considerably to improving the economic status of the rural poor in the EZ surrounding area. The common livestock resources in the area are buffaloes, sheep, cows, and goats. There are two types of Buffalo. Firstly, buffaloes totally depend on grazing land and stay there in the natural environment all the time. Secondly, the types that are grazed for a certain time of the day and stay at owners' homes in a domesticated environment like other cattle. This type is mostly dependent on stall feeding. The char areas and khals inside of EZ were the source of grazing for herds of buffaloes, sheep, cows, and goats in a natural environment.

From the start of the development of the EZ, it impacted the livestock resources by reducing the grazing land, and the grazing area became restricted for them. As a result, many buffalo owners have already decided to find other businesses and started selling their buffaloes. A few of them are now shifting to other areas for grazing although they reported to face restriction from the forest department for their random grazing in the forest department's areas. According to the consultation findings, the grazed buffalo and sheep have been reduced to around 8,000 currently which was more than double previously. Concern was also raised by them for the negative impact on the dairy value chain of the areas and other cattle-related business activities.

Buffalo grazers, on the other hand, have started experiencing a reduction in grazing areas due to the construction and development works in EZ. Some portion of land within the boundary of the EZ was a major area for buffalo, sheep, and cow grazing. During the development of the EZ, the grazers started shifting towards the seaside/char area for a temporary period. Experiencing the reduction of grazing lands during the construction period, many of the grazers/owners decided to sell their buffalo which impacted the livelihoods of the categories including buffalo boys (*Batainna/Rakhal*), owners of buffalo, sheep, and cows, buffalo vendors, and people involved dairy business, and other involved parties.

According to the consultation with buffalo owners and grazing boys, there were around 20,000 buffalos and sheep of 700 owners and 400 grazing boys (*Rakhal*) before NSEZ started, which have been reduced to 8,000 buffalos and sheep of 300 owners and 150 grazing boys currently.

Considering the above issues, the impact of the development of the EZ on Livestock Population and Dependent Community is evaluated to be 'Direct' in nature with 'High' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be 'Medium-high'.

5.3.1.34 Tourism

There are many tourist spots in the EZ surrounding area i.e., Mahamaya Lake, Khoiyachara Waterfalls, Napittachora Waterfall, Sitakunda Eco Park, Botanical Garden, Sohosrodhara Waterfall, Jharjhari Waterfalls, Bhatiari Lake, Komoldoho Trail, Muhuri project among others. However, one tourist spot, namely Guliakhali Sea Beach is located inside of the proposed EZ boundary. The implementation of the EZ master plan will add both positive and negative impacts on the tourism activity in the region. During the development of the EZ, a large number of workers will be influx in the region to be engaged in the EZ will translate to more visitors to these tourist spots. Negative impacts from tourism may occur when the level of visitors' use is greater than the environment's ability to cope with their use within acceptable limits of change. Uncontrolled conventional tourism may pose potential threats to many natural areas around the EZ.

The development of tourism facilities in the region by the Bangladesh Parjatan Corporation under the Ministry of Civil Aviation & Tourism such as accommodation, water supplies, restaurants, and recreation facilities can put enormous pressure on an area and lead to impacts such as soil erosion, sand mining, increased pollution, discharges into the sea, natural habitat loss, increased pressure on wildlife. It will put a strain on water resources, and it can force local populations to compete for the use of critical resources. In addition, road construction can lead to land degradation and loss of wildlife habitats, and deterioration of scenery.

Considering the above issues, the impact of the development of the EZ on Tourism is evaluated to be 'indirect' in nature with 'Low' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be 'Low'.

5.3.1.35 Cultural Heritage

Cultural heritage encompasses tangible and intangible heritage. Tangible cultural heritage includes movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. In addition, intangible cultural heritage includes practices, representations, expressions, knowledge, skills as well as the instruments, objects, artifacts, and cultural spaces associated therewith that communities and groups recognize as part of their cultural heritage, as transmitted from generation to generation and constantly recreated by them in response to their environment, their interaction with nature and their history.

According to the literature review, baseline data collection, and stakeholder consultation, there are no known cultural heritage sites located within the EZ master plan area. However, unknown cultural heritage sites, which may exist beneath the surface or as undiscovered surface scatters may be impacted due to the construction activities including civil works and excavation activities. Therefore, a

“Chance Find Procedure (CFP)” has been recommended to be prepared in accordance with national legislation and WB ESS8 and followed by the EZ authority to mitigate potential impact if previously unknown cultural heritage is encountered during master plan implementation. This should also be considered in the screening procedure of the environmental and social risks and impacts identification process.

However, considering the above issues, the impact of the development of the EZ on Cultural Heritage is evaluated to be ‘Direct’ in nature with ‘Low’ intensity/severity and the duration of the impact will be ‘Long-term’. Thus, the significance of the impact during development phase will be ‘Low’.

5.3.1.36 UNESCO World Heritage Sites

As per the UNESCO cultural heritage listing, there are two cultural heritage sites in Bangladesh i.e., Historic Mosque City of Bagerhat and Ruins of the Buddhist Vihara at Paharpur, and one natural heritage site i.e., the Sundarbans. No heritage sites available in the EZ master plan area as well as the study region. Therefore, no impacts on UNESCO heritage sites are anticipated by the development of the EZ.

5.3.1.37 Impacts on Community Dynamics

Men and women from different parts of the country will come over to the EZ area for jobs and they are likely to assimilate into local culture. Depending on the number of incoming workers and their engagement with the host communities in the project region, the composition of the local community, and with it the community dynamics, may change significantly.

Considering the above issues, the impact of the development of the EZ on Community Dynamics is evaluated to be ‘Direct’ in nature with ‘Low’ intensity/severity and the duration of the impact will be ‘Long-term’. Thus, the significance of the impact during development phase will be ‘Low’.

5.3.1.38 Changes of Landscape - Visual Impact

Impacts on the physical environment will consist of landscape transformation causing visual impacts. The construction of the industries in EZ and related facilities for EZ will alter the total landscape of the EZ site. These impacts will remain during the operational phase.

According to the land use in the EZ site, the main land use was mangroves/ forest/ vegetation (31.65%) which is followed by barren lands (27.6%), water bodies (8.71%), and underdevelopment (6.53%) area before implementing the NSEZ master plan. The existing landscape has been already changed from time to time because of the construction work for Mirsharai EZ 2A and 2B. Approximately 900 acres of land have been already cleared and altered as the industrial zone among the entire area of EZ, and then several industries have already moved into and partly started their operation so far. Moreover, 500 acres of land have been cleared and altered into industrial areas as part of Zone 2B development. Therefore, the existing landscape is in the process of urbanization due to EZ 2A and 2B development and it will push the urbanization more and more due to the project.

According to the Bangladesh Economic Zones (Construction of Building) Rules 2017, the owner of the individual industry shall be responsible for landscaping the plot and maintaining the same in a well-kept condition including, but not limited to, trimming, watering, and fertilization. According to the rules, about 5% of the total land area shall be reserved as green space along the road network, green strips used along the roads may not be less than 1.5 m, green strips less than 3 m may not be used for any kind of utility service line, and central green median, roadside green strips, channel, water body are part of these requirements. In addition, the plantation will be done outside of the EZ by the Forest Department, Bangladesh Water Development Board, and other organizations. Therefore, as long as the industry follows the rules, the project proponent will make an effort to maintain a green area which enables it to secure the environmental friendliness for users and residents around the EZ. Hence, it is judged that the impact of landscape in and around the project area would be controlled well by the Project.

Considering the above issues, the impact of the development of the EZ on visual impact is evaluated to be **Medium Low**.

5.3.1.39 Impacts due to Natural Disasters

Natural hazards anticipated at the EZ site are cyclones, earthquakes, tsunamis, and floods/flash floods. As per the seismic zone map of Bangladesh, the country is divided into four seismic zones i.e., Zone-I, II, III, and IV. Zone 1 is the low-hazard zone and zone-IV is the most hazardous zone. As per the seismic zone map, the EZ site and study region fall in a severe seismic intensity zone (zone 3) with coefficients of 0.28. Thus, it is essential to take this into consideration while designing the structure of the proposed intervention so that the site can withstand earthquakes of severe and very severe intensity.

Bangladesh has experienced several earthquakes in the past and there is a possibility that earthquakes will occur in and around the EZ. If an earthquake occurs during the construction phase, the damage would be extended to some extent such as the collapse of buildings and injury by falling objects. To minimize the damage by earthquakes, working conditions, and disaster prevention activities should be managed by the contractor based on occupational health and safety training.

Another natural hazard associated with the EZ site is cyclones. The site is located in the high-risk zone for cyclones and its associated disasters like storm surges. Thus, safety and prevention measures should be included in the NSEZ design to minimize the damage due to these events.

Tsunamis are a series of waves produced by the displacement of a large volume of water generally generated by earthquakes or volcanic eruptions. Considering the state of tsunami vulnerability and potential seismic sources, the coastal belt is classified into three tsunamigenic zones.

As per the tsunamigenic zones map of Bangladesh, the coast is divided into three tsunamigenic zones i.e., zones I, II, and III. Zone-I is the most vulnerable and zone-III is the lowest vulnerability zone. According to this classification, the EZ site falls within zone-I, which is reportedly the most vulnerable belt. Though the Indian subcontinent is in a seismically active region, tsunamis along the coastline of India and Bangladesh have been rare, but not unprecedented.

All the interventions will be developed along the shoreline of the Bay of Bengal thus are highly vulnerable to coastal floods caused by tidal surges. According to the Upazila Disaster Management Plan of Mirsharai and Sitakunda, both upazilas are flood-prone areas specifically vulnerable to flash floods. According to the consultation with BEZA, the whole EZ site will be filled with an elevation of 6.5 m. The finished level of both the off-shore and on-shore structures should be above the high flood level of the sea and rivers/khals to prevent flood hazards. At the Mirsharai site, an embankment/super dyke having approximately 22.5 km length is already developed along the Sandwip Channel thus the site is not prone to flooding. Further, a 12.5 km embankment will be constructed along the coastline from Domkhali in Mirsharai to Guliyakhali in Sitakunda.

Considering the above issues, the impact on the EZ due to national disaster is evaluated to be **Medium High**.

5.3.1.40 Climate Change and Greenhouse Gas Emissions

Climate change differs fundamentally from other potential environmental considerations in that it has global impacts that cannot be directly linked to one specific source. Climate change is a cumulative effect caused by the combined impact of past, present, and future human and natural processes. Impacts on climate change can be measured in terms of the amount of Greenhouse Gas (GHG) emissions from a project or activity as well as through its emissions intensity (emissions per output).

GHGs are a range of gases that have the ability to trap radiation in the upper atmosphere, contributing to global warming. GHGs include the following:

- Carbon dioxide (CO₂) - by far the most abundant, primarily released during fuel combustion.
- Methane (CH₄) - is released through biomass decomposition, solid waste landfills, and wastewater treatment.

- Nitrous Oxide (N₂O) - from industrial activity, fertilizer use, and production.
- Hydrofluorocarbons (HFCs) - are commonly used as refrigerant gases in cooling systems.
- Perfluorocarbons (PFCs) - are used in a range of applications including solvents, medical treatments, and insulators.
- Sulphur hexafluoride (SF₆) - is used as a cover gas in magnesium smelting and as an insulator in heavy-duty switchgear.
- Nitrogen trifluoride (NF₃).

Each of the above gases has a global warming potential (GWP), which is a measure of the degree to which a greenhouse gas mass can contribute to global warming as compared with the same mass of CO₂. Global Greenhouse gases are usually expressed as carbon equivalents (Ce) or carbon dioxide equivalents (CO₂e).

Table 5-15: Global Warming Potential

Gas	Global Warming Potential for Given Time Horizon (100 years)
Carbon Dioxide (CO ₂)	1
Methane (CH ₄)	25
Nitrous Oxide (N ₂ O)	298

Source: IPCC, Fourth Assessment Report (AR4), 2007³⁰

Development activities will lead to emissions emanating from fuel-powered equipment i.e., vehicle engines, vessels, construction equipment, etc. The exhaust will contain pollutants notably Carbon Dioxide (CO₂), Nitrogen Oxides (NO_x), Sulphur Dioxides (SO₂), Carbon Monoxide (CO), Hydrocarbons, and Particulate Matter (PM). These greenhouse gases (GHGs) are known to interfere with temperature regimes and cause climate change effects. CO₂ is the main GHG gas that contributes maximum to the warming of the atmosphere and increased CO₂ concentration is one of the major drivers of climate change. It is noteworthy to mention that the quantity of emissions during the development phase will depend on the vehicles/vessels/equipment type, amount, and condition (e.g., level of maintenance).

To minimize GHG emissions during the development of the EZ, mitigation measures shall be taken by the investors and contractors, such as management of operation time of construction machinery, avoidance of excessive loading operation, and education of construction workers/drivers about the idling stop practice for construction machinery and vehicles.

Considering the above issues, the impact of the development of the EZ on climate change and greenhouse gas emissions is evaluated to be **Medium Low**.

A summary of environmental and social impact significance during the development of the EZ has been provided in Table 5-16.

³⁰ https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf

Table 5-16: Summary of Environmental and Social Risks and Impacts During Development of the EZ

Aspects/Issues/Impacts	Nature	Extent & Location	Duration	Intensity/Severity	Irreplaceable	Probability	Significance
Impacts on Air Quality	Direct	Local	Medium	High	Low	High	Medium Low
Impacts from Noise	Direct	Local	Medium	Medium	Low	High	Medium Low
Impacts on Surface Water	Direct	Local	Medium	High	Low	High	Medium Low
Impacts on Groundwater	Direct	Regional	Long Term	High	Medium	High	Medium High
Impacts on Topography and Soil	Direct	EZ Site	Permanent-no mitigation	Medium	Low	Medium	Medium Low
Impacts on Sediment	Direct	Local	Long Term	Medium	Medium	High	Medium Low
Impact due to Changes in Land Use	Direct	EZ Site	Permanent-no mitigation	High	Medium	High	Medium High
Impact due to Solid Waste Generation	Direct	EZ Site	Medium	Medium	Low	Medium	Low
Impacts of Liquid Waste Generation	Direct	Local	Medium	High	Low	Medium	Low
Impacts on Drainage	Direct	Local	Permanent mitigated	Medium	Low	Medium	Medium Low
Impacts of Traffic	Direct	Local	Long Term	Medium	Low	High	Medium Low
Loss of Ecosystem Services	Direct	Local	Medium	Medium	Medium	Medium	Medium Low
Impacts on Terrestrial Flora	Direct	EZ Site	Medium	Low	Medium	Medium	Low
Impacts on Terrestrial Mammals	Direct	Local	Medium	Low	High	High	Medium Low
Impacts on Birds/Avifauna	Direct	Local	Medium	Low	High	High	Medium Low
Impacts on Herpetofauna	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Aquatic Mammals	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Ichthyofauna (Fish)	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Hilsa Fisheries	Direct	Local	Medium	Low	Medium	Medium	Low

Aspects/Issues/Impacts	Nature	Extent & Location	Duration	Intensity/Severity	Irreplaceable	Probability	Significance
Impacts on Plankton and Benthos	Direct	Local	Medium	Low	Medium	Medium	Low
Ecologically Critical Areas	No impacts are anticipated as there are no ECAs in the EZ area						
Protected Areas	No impacts are anticipated as there are no protected areas in the EZ area.						
Critical Habitat Assessment	EZ area and study region do not qualify for critical habitat areas.						
Impacts due to Land Acquisition, Resettlement and Rehabilitation	Direct	Regional	Permanent-mitigated	High	Medium	High	Medium-high
Community Health, Safety, and Security	Direct	Regional	Permanent-mitigated	High	Medium	High	Medium-high
Occupational Health, and Safety	Direct	Project site	Permanent-mitigated	High	Medium	High	Medium-high
Labor Influx	Direct	Regional	Long-term	High	Medium	High	Medium-high
Child Labor and Forced Labor	Direct	Regional	Permanent-mitigated	Medium	Medium	High	Medium-high
Gender Based Violence and Sexual Exploitation and Abuse/Sexual Harassment		Direct	Regional	Long-term	Medium	Medium	Medium
Violence Against Children	Direct	Regional	Long-term	Medium	Medium	Medium	Medium-Low
Impact on Social Infrastructures	Direct	Regional	Long-term	Medium	Medium	Medium	Medium-low
Impacts on Fisherman and Fishery Activity	Direct	Local	Long-term	High	High	High	Medium-high
Impacts on Livestock Population and Dependent Community	Direct	Local	Long-term	High	High	High	Medium-high
Tourism	Indirect	Regional	Long-term	Low	Low	Low	Low
Cultural Heritage	Direct	Regional	Long-term	Low	Low	Low	Low
UNESCO World Heritage Sites	No impacts are anticipated as there is no UNESCO heritage site in the EZ area.						
Impacts on Community Dynamics	Direct	Regional	Long-term	Low	Low	Low	Low

Aspects/Issues/Impacts	Nature	Extent & Location	Duration	Intensity/ Severity	Irreplaceable	Probability	Significance
Changes of Landscape - Visual Impact	Direct	EZ Site	Permanent Mitigated	Low	Medium	Medium	Medium Low
Impacts due to Natural Disasters	Induced	Regional	Permanent Mitigated	High	Medium	High	Medium High
Climate Change and Greenhouse Gas Emissions	Induced	National	Permanent Mitigated	Low	Medium	Medium	Medium Low

5.3.2 Impacts During Operation Phase

5.3.2.1 Impacts on Air Quality

During the operation of the EZ, there will be an increase in the movement of traffic, and hence, emissions from the moving vehicles will also increase. The exhaust from the DG set in different industries, diesel-operated small boats, vessels, dredgers, etc. will enhance a pollution load during operation.

Increased traffic on the access road has the potential to cause an impact on the air quality experienced by the residents along the access roads, specifically an increase in pollutants such as NO_x and particulate matter. Concentrations of primary pollutants generated by road traffic decrease exponentially with increasing distance from the road. This means that 50m to 100m from the road center the concentrations of carbon monoxide, oxides of nitrogen, particulates, and non-methane hydrocarbons (benzene and related compounds) are considerably less than half the levels at the central median.

With the increase in the number of ships and boats, their operation and movement of cargo to and from will also increase. These activities will increase the pollution load in the atmosphere. The sources of air pollutants from jetty operations will include combustion emissions from ships propulsion and auxiliary engines and boilers, mainly consisting of SO₂, NO_x, greenhouse gases (e.g., CO₂ and CO), fine particulate matter, and VOC, followed by combustion source emissions from vehicles, port equipment and land-based engines and boilers contributing similar pollutants. VOC may also be emitted for fuel storage and transfer.

Furthermore, another air pollutant that needs to be considered for the economic zone is dioxin which will be generated from waste incinerators. Dioxin is known as a persistent environmental pollutant and accumulates in the food chain mainly in the fatty tissue of animals. Dioxin is known as a highly toxic substance and can cause reproductive and developmental problems, damage the immune system, interfere with hormones, and cause cancer. It is obvious that dioxin formation occurred at temperatures above 450°C and was reduced significantly at temperatures above 850°C. The reaction occurring in an incinerator is extremely complex, and there are many factors in addition to combustion temperature influencing dioxin formation. Selection of manufacturing processes and incinerators with low dioxin emissions are recommended to reduce the formation of dioxin. In addition, stack emissions standards for municipal solid waste incinerator has been provided in Air Pollution (Control) Rules 2022 and this should be followed during the operation of the incinerator plant.

Methane gas, one of the greenhouse gas groups, generated from landfill sites and leachate treatment by anaerobic process is also concerned. Gas flaring must be provided to cope with this methane gas for the reduction of emitted greenhouse gas quantity.

During the operation, air pollution is generated from various sources, in the production process, and from the stacks. Air pollutants of concern and their major sources from the activities expected to take place in the economic zone include:

- Particulate matter (PM₁₀) will be generated from combustion processing, which includes fuel combustion in manufacturing, and vehicle exhaust.
- Sulfur dioxide (SO₂) will be generated from the combustion of fossil fuels, which contain sulfur, in boilers and power plants.
- Nitrogen oxide (NO_x) is a result of the reaction between oxygen and nitrogen in the air in the combustion process.
- Volatile Organic Compounds (VOCs) will be generated from electronic manufacturing industries.
- Dioxin will be generated from waste incinerators.

Potential impacts from the above air pollutants are mostly focused on human health, particularly to those living in the vicinity of the sources, in this case around the economic zone.

Considering the above issues, the impact of the operation of the EZ on ambient air quality is evaluated to be **Medium High**.

5.3.2.2 Impacts from Noise

During the operation, vehicle movements in the access roads for staff mobilization, materials/product transportation in and out of the economic zone, and the operation of industries will be the major sources of noise pollution from the economic zone. Noise will be generated due to industrial activities (operation of heavy-duty machinery like boilers, compressors, pumps, hydraulic systems, various industrial operations, etc.) involved in raw material/product handling and transportation and the same will be felt upon work personnel and nearby settlements.

Noise will also be generated from the jetty and terminal operational activities such as vessel loading/unloading, container handling, and access road/rail traffic that will result from container traffic arriving and departing through the jetty business day. Water is an efficient medium for sound propagation, particularly low-frequency sound, and therefore marine life over a wide area could be potentially affected. The day-to-day terminal activities such as vessel loading/unloading, container handling, etc. will cause additional underwater noise emissions. These are however not expected to be significant.

Noise sources in the operation phase will vary depending on the production processes of each facility/industry in the economic zone. Control of noise at the source will be the most effective approach to control the impact on the receptors outside the boundary of the facility/industry. Equipment that generates a high level of noise is usually installed in enclosed buildings. The noise level in the fence line of each facility/industry needs to be routinely monitored so that the ambient noise level does not exceed the standards applicable for industrial areas stipulated in Noise Pollution (Control) Rules, 2006. Effects from noise on the receptors outside the initial phase of the industrial estate area are negligible. Nevertheless, it is necessary for each factory to provide earplugs and/or earmuffs for employees or workers who work in places that have noise levels exceeding 80 dB(A).

Considering the above issues, the impact of the operation of the EZ on noise level is evaluated to be **Medium Low**.

5.3.2.3 Impacts on Surface Water

5.3.2.3.1 Water Quality Model

The water quality modeling has been done under this RESA study considering the future industrial entities. The assessment of water quality encompasses the prediction of water quality in the future Sandwip channel and rivers after the implementation of the NSEZ master plan and how the water quality is expected to evolve over time with the operation of the NSEZ. To understand the present water quality status in the study region both primary and secondary water quality data were collected, reviewed, and reviewed and incorporated in the prediction model. Using MIKE-21 FM and ECO Lab FM Modules a suitable water quality model has been developed for the study region and assessed the impact of various pollutants that will come from industrial and heavy hydrologic runoff from the upper catchment. All the pollution dispersion has been presented as the effect of STP and CETP combined failure scenario, and the effect of climate change and CETP failure on the water quality of NSEZ inside canals and Sandwip channel as well. The model data presented in the current model primarily reflects the worst-case scenario, assuming the failure of both the STP and CETP. This approach was taken to evaluate the potential maximum impact on water quality under extreme conditions. However, if CETP and STP systems function properly, the resulting water quality dispersion is also represented in the report (Appendix F).

The predicted water quality dispersion models have been evaluated for the water quality parameters like pH, Nitrate, Dissolved Oxygen, Chemical Oxygen Demand, Ammonia, Phosphate, Total Suspended Solids, Total Chromium, Total Coliform, Biochemical Oxygen Demand, Mercury, and Lead.

A summary of the water quality model output has been given in Table 5-17. Details of the water quality models have been presented in Appendix F (Vol-III).

The timeline for the water quality model is considered here for the operation phase of the project. The model was run continuously for a period of three months during the dry season as this period typically represents the worst-case scenario for water quality especially considering the failure of both the STP and CETP. By focusing on the dry period, we were able to assess the potential impacts on water quality under conditions where natural dilution is minimal and effluent concentrations are highest.

The key pollutants mentioned in the Environmental Conservation Rules (ECR, 2023) have been presented below. The detailed water pollution dispersion model has been shown in the Appendix F.

5.3.2.3.1.1 Combined Effect of STP and CETP Failure Condition

Biochemical Oxygen Demand (BOD)

Figure 5-4 and Figure 5-5 show the BOD variation in the study area. It's observed that BOD affects the Ichakhali, Bamansundar khal (canal) and Sandwip channel's water and crosses the allowable limit of all purposes of water uses. BOD disperses up to 2.14 km in low tide time and 0.51 km in the high tide time from Ichakhali regulator gate due to failure of STP and CETP mixing water.

Figure 5-4: BOD dispersion in the study area during High Tide



Figure 5-5: BOD dispersion in the study area during Low Tide

Ammonia

Figure 5-6 and Figure 5-7 show that changes of Ammonia concentration are significant in Ichakhali and Bamansundar canals due to CETP and STP failure. During the low tide time, it propagates 3.6 km in the Sandwip channel from the Ichakhali regulator gate. Ammonia dispersion ranges 1.0 – 15 mg/L in high and low tide time.

Figure 5-6: Ammonia dispersion in the study area during High Tide**Figure 5-7: Ammonia dispersion in the study area during Low Tide****Total Chromium**

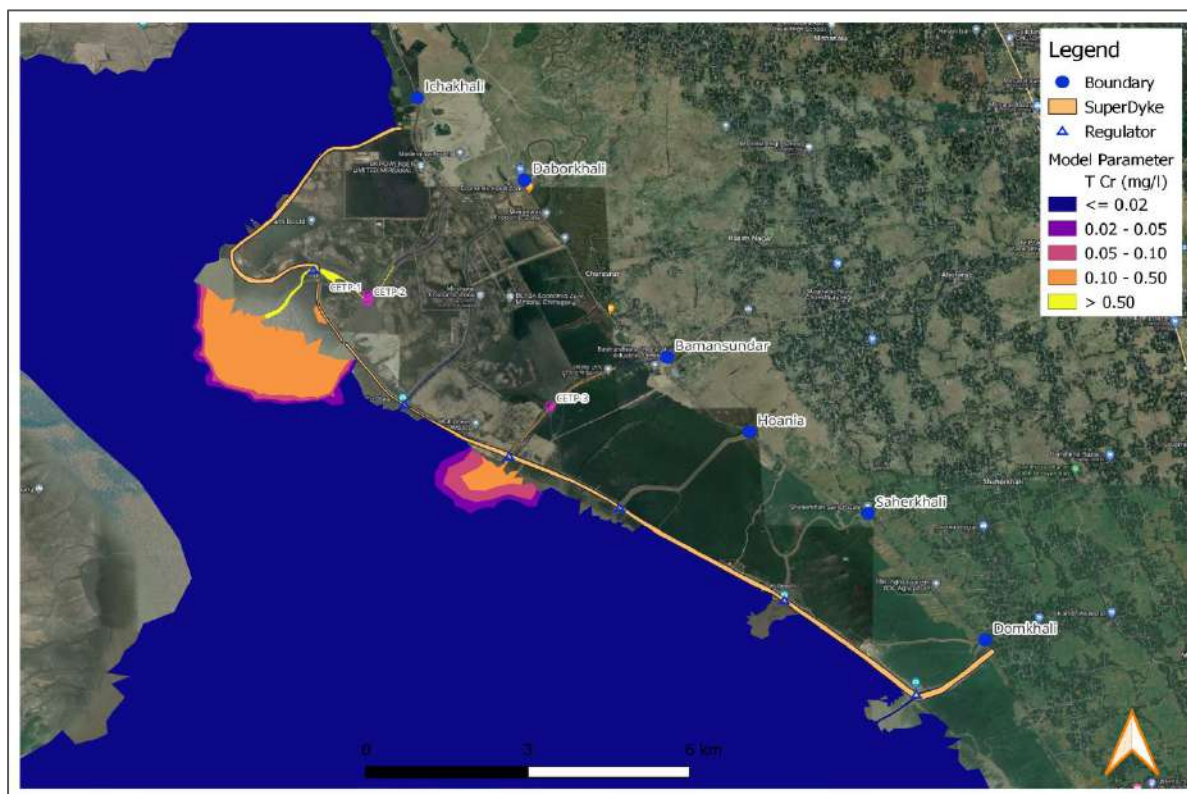
Chromium is dispersed up to 0.8 km from super dyke area with maximum intensity 0.50 mg/L from Ichakhali and Bamansundar Khals (canals) during the low tide time, which value is little bit high for

fisheries due to the STP and CETP failure condition as per the model output. **Error! Reference source not found.** Figure 5-8 and Figure 5-9**Error! Reference source not found.** show the Chromium dispersion during high and low tide respectively.

Figure 5-8: Chromium dispersion in the study area during High Tide



Figure 5-9: Chromium dispersion in the study area during Low Tide

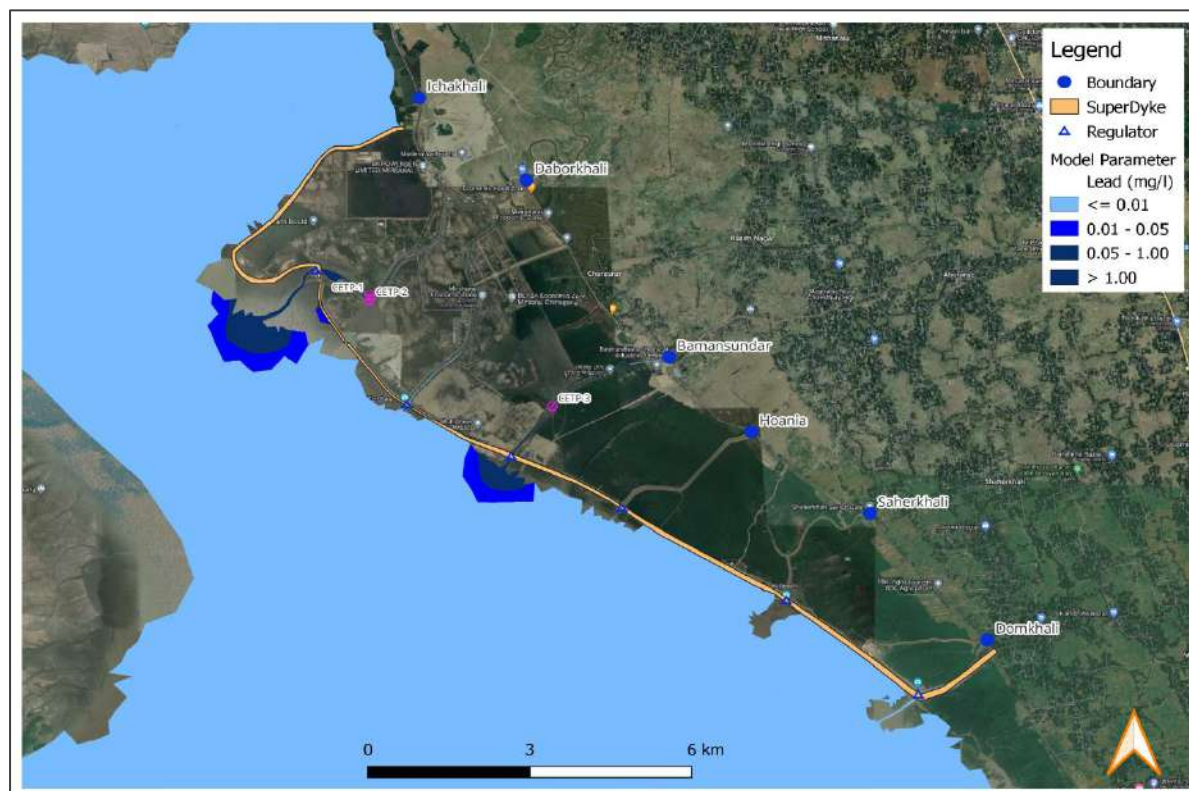


Lead

Due to STP and CETP failure, lead concentration crosses the allowable limit of all water quality parameters in Ichakhali Khal, Bamansundar khal (canals) and Sandwip channel (1.89 km from Ichakhali regulator). STP and CETP mixing failure condition have shown in Figure 5-10 and Figure 5-11. Reference source not found., where both figures showing the variation of Lead concentration, and high concentration dispersion spread over up to 2.55 km in the Sandwip channel from the super dyke area due to the high concentration of lead.

Figure 5-10: Lead dispersion in the study area during High Tide



Figure 5-11: Lead dispersion in the study area during Low Tide**Mercury**

Over the model domain, Mercury concentration was found within the limit except Ichakhali Khal and Bamansundar khal, and Sandwip channel also has same conditions. Figure 5-12 and Figure 5-13 show the Mercury dispersion during high and low tide time, respectively.

Figure 5-12: Mercury dispersion in the study area during High Tide



Figure 5-13: Mercury dispersion in the study area during Low Tide



5.3.2.3.1.2 Climate Change Effect on the Key Pollutant Dispersion

Biochemical Oxygen Demand (BOD)

Figure 5-14 and Figure 5-15 show the BOD variation in the study area. It's observed that the BOD affects the Ichakhali, Bamansundar and Sandwip channel's water and crosses the allowable limit of all purposes of water uses as per the ECR (2023) of Bangladesh. Biochemical Oxygen Demand (BOD) spreading more than normal conditions due to high flow push the CETP water into the Sandwip channel.

Figure 5-14: BOD dispersion in the study area during High Tide



Figure 5-15: BOD dispersion in the study area during low Tide**Ammonia**

Figure 5-16 and Figure 5-17 show that dispersion of Ammonia concentration is significant in Ichakhali and Bamansundar canals due to CETP water mixing and sea level rises and extreme hydrological conditions due to climate change. Ammonia dispersion ranges 1.0 – 5 mg/L in high and low tide time as per the figures from the modelling and it disperse up to 4.1 km into the Sandwip channel from super dyke area.

Figure 5-16: Ammonia concentration dispersion in the study area during High Tide**Figure 5-17: Ammonia concentration dispersion in the study area during Low Tide****Chromium**

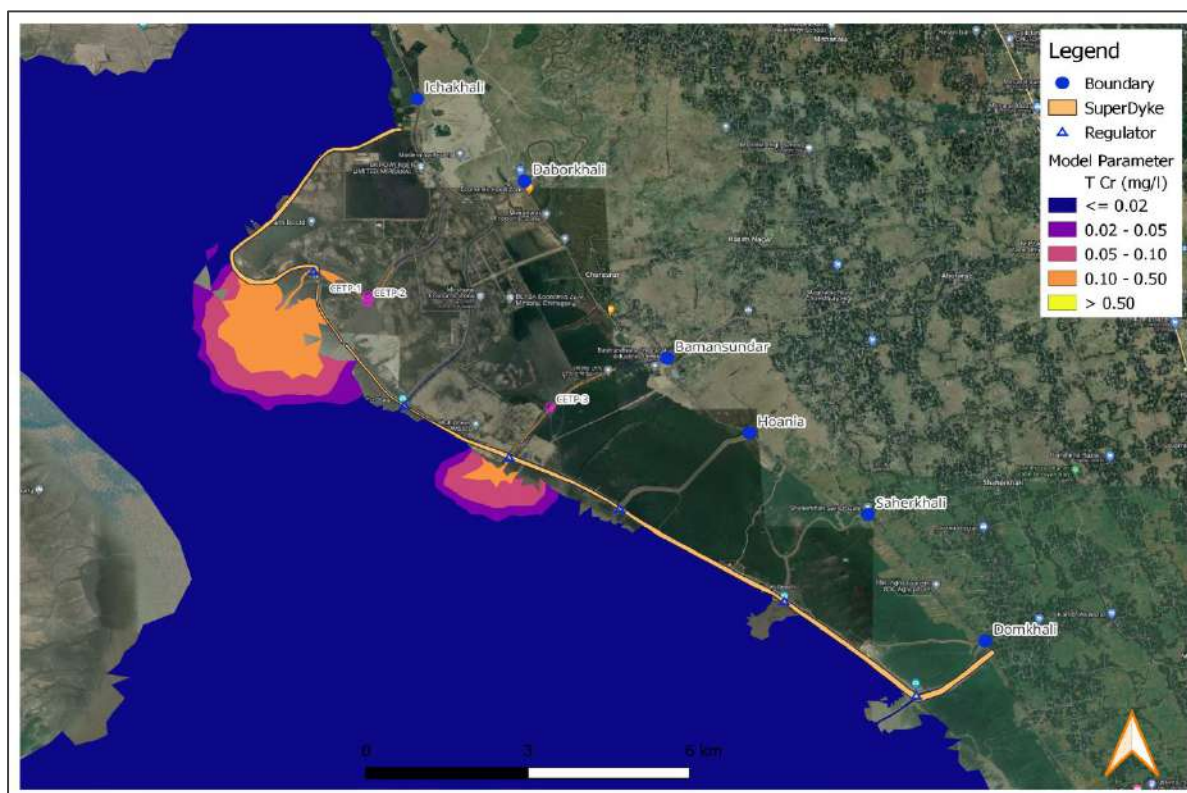
Total chromium ranges from 0.02 mg/L to more than 0.5 mg/L during low and high tide time as per the model output. Total chromium will disperse up to 4.33km from the super dyke area with maximum

intensity 0.02 mg/L, which is allowable for fisheries purposes. Total chromium spreads up to 0.6m more due to the high flow from upstream catchment under the climate change scenarios. Figure 5-18 and Figure 5-19 show the Total Chromium dispersion during low and high tide, respectively.

Figure 5-18: Total Chromium dispersion in the study area during High Tide



Figure 5-19: Total Chromium dispersion in the study area during Low Tide



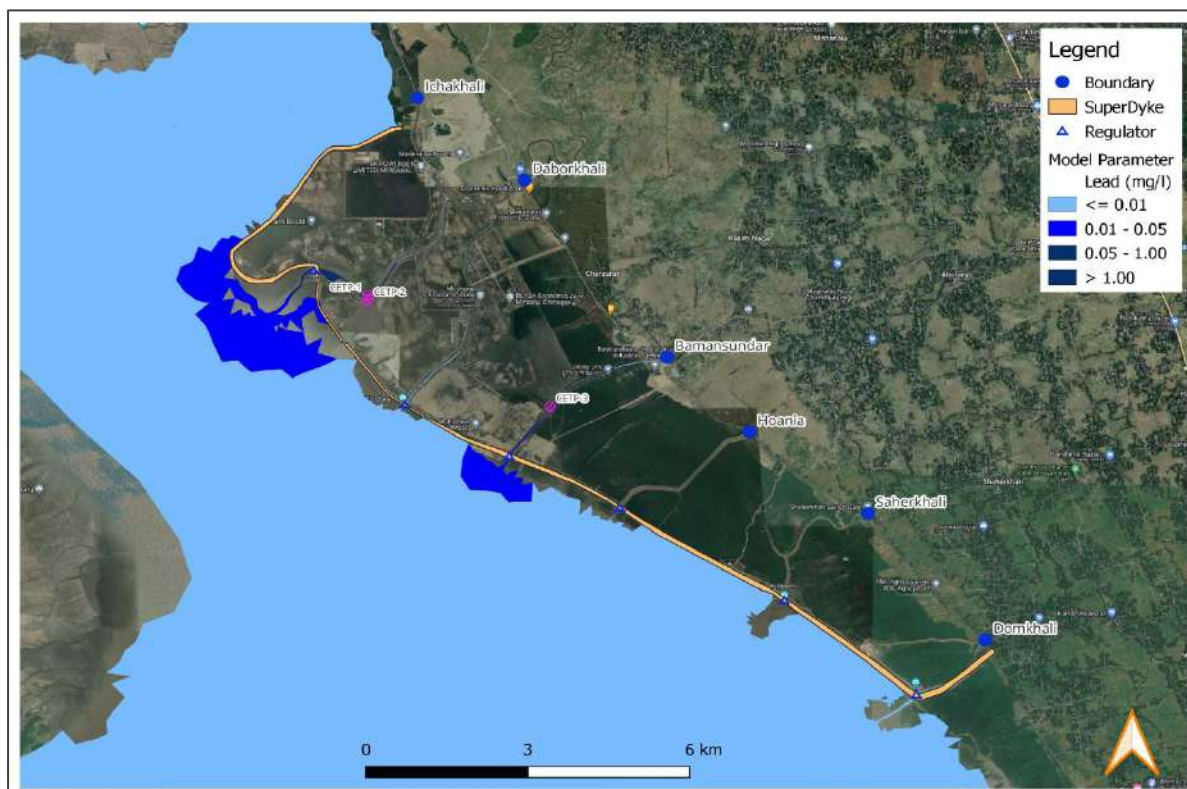
Lead

Figure 5-20 and Figure 5-21 are showing the variation of Lead concentration, and high concentration is dispersed up to 3.85 km into the Sandwip channel from the super dyke area due to climate changes.

Figure 5-20: Lead dispersion in the study area during High Tide



Figure 5-21: Lead dispersion in the study area during Low Tide

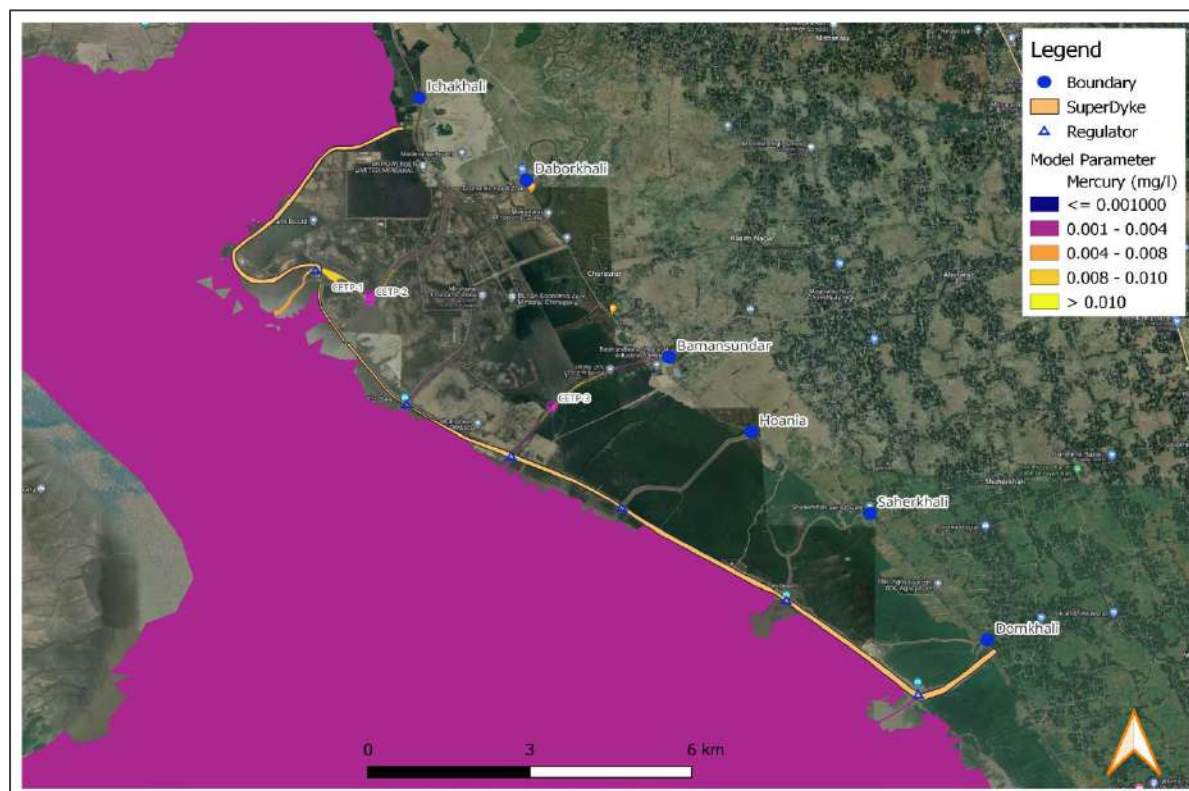


Mercury

Over the model domain, Mercury concentration found within the limit except Ichakhali Khal, Bamansundar khal and Sandwip channel's just near to Ichakhali and Bamansundar regulator gate. The dispersion area is higher than the normal condition. Figure 5-22 and Figure 5-23 show the Mercury dispersion during low and high tide time, respectively.

Figure 5-22: Mercury dispersion in the study area during High Tide



Figure 5-23: Mercury dispersion in the study area during Low Tide**Table 5-17: Summary of the Model Results Under the CETP and STP Failure Condition**

Parameters	Model Result	High Tide	Low Tide	Remarks
pH	>8.0	Due to the combined failure value of 8.0-9.0 pH increases in the Ichakhali canal	Low dispersion in any canals or Sandwip channel	Exceeds during high tide, thus impact in high tide
Nitrate (mg/L)	1-6.375	No dispersion	Ichakhali, Daborkhali, and Bamansundar canals exceed 7.0 mg/L spreads up to 1.23 km	Impact in Sandwip channel during low tide
DO (mg/L)	1.0-10.0	Found critical in Ichakhali and Bamansundar canals. No disperse in the Sandwip Channel	Disperse up to 1.67km from Ichakhali and 1.53km from Bamansundar canal.	Impact during low tide
COD (mg/L)	50 - >100	Less than 50.0 mg/L, within limits	Spreads up to 2.86km in the Sandwip channel	Impact during low tide
Ammonia (mg/L)	1.0-15.0	Ichakhali and Bamansundar canals possess 0.3-3.0	1-15.0 mg/L from Ichakhali and Bamansundar canals up to 3.6 km	Impact during low tide

Parameters	Model Result	High Tide	Low Tide	Remarks
		mg/L during dispersion		
Phosphate (mg/L)	2.0 - >10.0	Ichakhali and Bamansundar canals crossed 10.0 mg/L limit spreads up to 1.7 km	Ichakhali canal dispersion up to 10.0 mg/L	All khals exceeded the limit and affected the Sandwip channel as well
TSS (mg/L)	50-200	Low dispersion	High dispersion up to 1.83 km with 131 mg/L from Ichakhali and Bamansundar canals	Impact during low tide
Cr (mg/L)	0.02-0.5	>0.5 mg/L in Ichakhali canal. Other canals have low dispersion	High dispersion with >0.5 mg/L spreads up to 0.8 km	dispersed up to 0.8 km, impact in low tide
TC (CFU/100 mL)	50	<50.0 mg/L in Sandwip channel, low dispersion	Not exceeding 50.0 CFU, spreads up to 2.6 km in the Sandwip channel	does not exceed 50.0 CFU, with no impact
BOD (mg/L)	1.5- >20.0	Ichakhali, Daborkhali, and Bamansundar canals with 5-10 mg/L spreads up to 0.51 km	Ichakhali, Daborkhali, and Bamansundar canals with 5-12 mg/L spreads up to 2.14 km	Impact during low tide
Mercury (mg/L)	0.001-0.010	High dispersion in Ichakhali and Bamansundar canals	Low dispersion	Impact during high tide
Lead (mg/L)	0.01- >1.0	Exceeds the limit in Ichakhali and Bamansundar canals, spreads up to 1.89 km	Exceeds the limit, spreads up to 2.55 km	Impact during high and low tide

In the water quality model, climate change scenarios are considered based on the projections provided by the Bangladesh Delta Plan 2100, which includes variations in rainfall, temperature, and sea level rise. Specifically, we accounted for a 20% increase in rainfall and a 15% increase in river inflows under extreme (stagnation) scenarios by 2050. Additionally, a sea level rise of 38 cm was incorporated to simulate its effect on salinity and water quality, particularly for downstream boundaries influenced by tidal flows. These projections were used to assess future water quality changes under potential climate impacts.

Climate change scenarios

The Bangladesh Delta Plan 2100 has developed various climate scenarios based on Representative Concentration Pathways (RCPs) to provide indicative projections for key variables like rainfall, temperature, and mean sea level rise. Table 5-18Error! Reference source not found. details these different climate scenarios, which help predict future environmental changes in Bangladesh.

Table 5-18: Climate change scenarios and projections across different time frames

Climate change		2015 (reference)	2030	2040	2050		2100
Sea level rise Mean Sea level rise in cm	Productive	7100	10-20	15-25	20-30		40-60
	Resilient	7100	15-30	30-40	40-60		80-125
	Congestion	7100	10-20	15-25	20-30		40-60
	Stagnation	7100	15-30	30-40	40-60		80-125
Longest dry day period Increase of mean number of consecutive dry days	Productive		0	0	0		+5
	Resilient		+5	+8	+10		+20
	Congestion		0	0	0		+5
	Stagnation		+5	+8	+10		+20
Rainfall intensity % change of mean total precipitation	Productive		10		10	10	20
	Resilient		20		20	20	50
	Congestion		10		10	10	20
	Stagnation		20		20	20	50
Cyclone intensity % change	Productive	?	25		45		90
	Resilient	?	70		90		100
	Congestion	?	25		45		90
	Stagnation	?	70		90		100

Table 5-18 Depicts projected climate variables (such as temperature, precipitation, or sea-level rise) under various Representative Concentration Pathways (RCP2.6, RCP4.5, RCP6, and RCP8.5) for different future horizons (e.g., 2030, 2040, 2050, 2100).

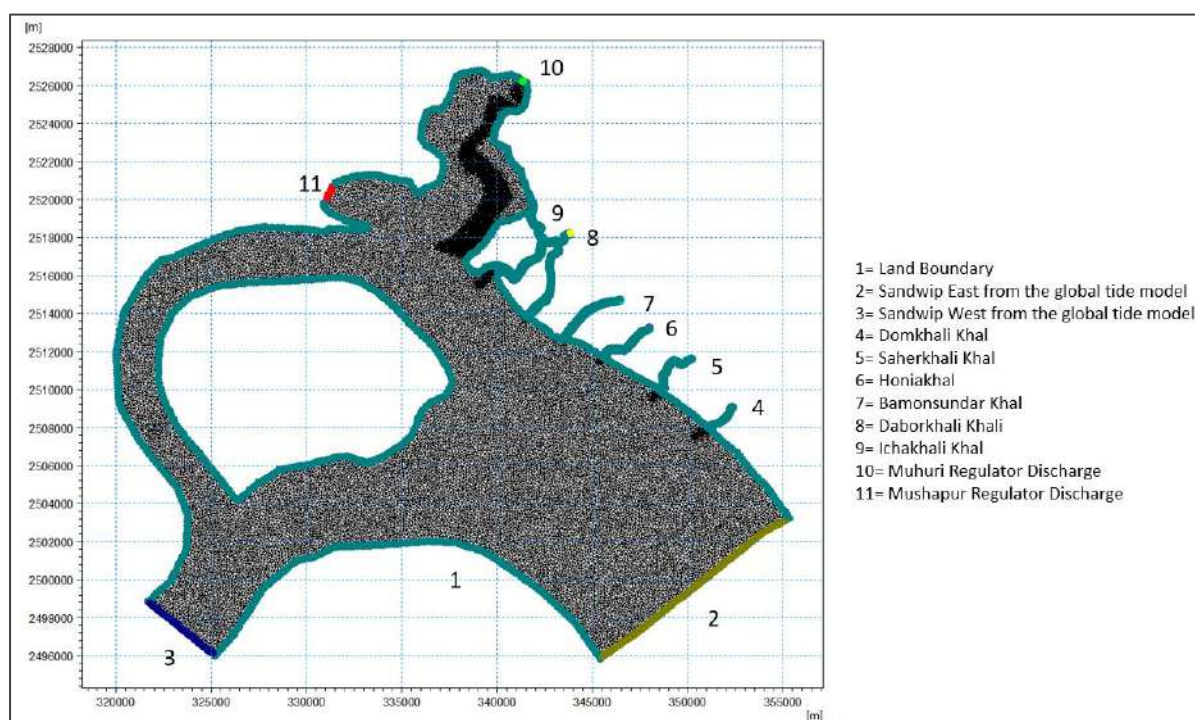
In this study, we focus on the most extreme climate scenario, the stagnation scenario, for predicting the inflow boundary conditions and local runoff contributions for the Water Quality Model in different canals. Specifically, a projected 20% increase in rainfall by the 2050s under this scenario has been factored into the model. To account for these changes, the rainfall data was reanalyzed using the Delta Plan's stagnation scenario projection, and boundary conditions were recalculated accordingly to reflect future climate impacts on water quality in the canal systems as shown in Table 5-19. Error! Reference source not found..

Table 5-19: Inflow boundary condition based on climate scenario of Delta Plan 2100

Canal/Khal	Maximum Runoff (m3/s)	Minimum Runoff (m3/s)	Average Runoff (m3/s)
Ichakhali Canal	6.798	0	1.064
Daborkhali Khal	70.882	0.01	12.528
Bamansundarkhal	87.108	0.2	6.743
Honiakhali	9.269	0	0.864
Saherkhali Khal	45.123	1.1	3.839
Domkhali Khal	70.444	0	5.614
NSEZ Catchment	131.692	1.1	5.446

The other two major boundaries (Muhuri of Feni and Mushapur regulator of Little Feni) of water quality model shown in Figure 5-24Error! Reference source not found., have been increased 15% of average flow in climate and STP scenarios. The downstream boundaries (as shown in Figure 5-24Error! Reference source not found., lines 2 and 3) represent the influence of tidal effects in the water quality model. To assess the impact of sea level rise on future water quality, the model incorporates an average sea level increase of 38 cm. This adjustment allows for the simulation of all water quality parameters considering the potential changes due to rising sea levels, which could affect tidal dynamics and overall water quality in the region.

Figure 5-24: Boundary location of this study model area in NSEZ, Feni and Sandwip



Additionally, two key boundary conditions, the Muhuri regulator on Feni and the Mushapur regulator on Little Feni (as shown in Figure 5-24) have been adjusted. Their average flow rates increased by 15% to account for climate change impacts from average historical value, following projections for both climate and STP failure scenarios. These adjustments help to simulate the potential impact of climate change on water flow and water quality in the region more accurately. This approach ensures that the model reflects realistic future climate conditions, allowing for better management and planning for water quality management due to changing rainfall patterns, river flows and sea level rising.

The time frame for the model is set during the operational phase, and the simulation was run continuously for three months during the dry season to capture the worst-case scenarios. This includes the scenario of potential failure of pollution control measures, such as the Sewage Treatment Plant (STP) and Common Effluent Treatment Plant (CETP), to analyze water quality without functional pollution control systems.

Table 5-20: Summary of the Model Results Under the Climate Change Conditions

Parameters	Model Result	High Tide	Low Tide	Remarks
pH	>8.0	Ichakhali canal downstream will be affected with >8.0 value	Low dispersion except for the Ichakhali canal	No effect on the Sandwip channel

Parameters	Model Result	High Tide	Low Tide	Remarks
Nitrate (mg/L)	1-6.375	Low dispersion, within limit	Low dispersion, within limit	No impact on the Sandwip channel
DO (mg/L)	1.0-10.0	1-5 mg/L, no dispersion in Sandwip	1-5 mg/L in Ichakhali and Bamansundar canals, spreads up to 0.5-1 km	No high impact on the Sandwip channel
COD (mg/L)	50 - >100	Always prevails >50.0 mg/L in the Ichakhali and Bamansundar canals	Spreads up to 1-1.5 km	Low impact in Sandwip
Ammonia (mg/L)	1.0-15.0	Dispersion ranges 1.0 – 5 mg/L, spreads in Sandwip channel	Low dispersion in the Sandwip channel	High impact during high tide
Phosphate (mg/L)	2.0 - >10.0	Crosses the limits in Ichakhali canal	Disperse up to 1.78 km	High impact during low tide
TSS (mg/L)	50-200	All canals TSS ranges 130 mg/L	Low dispersion	No impact on the Sandwip channel
Cr (mg/L)	0.02-0.5	Dispersed up to 0.02-0.5 mg/L, low spreading	>0.5 mg/L in Sandwip channel, spreads up to 4.33 km	Impact during low tide in Sandwip channel
TC (CFU/100 mL)	50	50 CFU, low dispersion in Sandwip	Spreads up to 3.06 km, with >7000 CFU	Impact during low tide in Sandwip channel
BOD (mg/L)	1.5- >20.0	10-20 mg/L in Ichakhali, Bamansundar canals, low dispersion	High dispersion with 10-20 mg/L in Sandwip channel	Impact during low tide in Sandwip channel
Mercury (mg/L)	0.001-0.010	0.004-0.008 mg/L high dispersion in Ichakhali and Bamansundar canals	0.004-0.008 mg/L dispersion in Sandwip channel	Impact during low tide time
Lead (mg/L)	0.01- >1.0	0.05-1.0 mg/L in Ichakhali and Bamansundar canal, low dispersion in Sandwip channel	Disperse up to 3.85 km from Ichakhali and Bamansundar canals	Impact during low tide time

5.3.2.4 Impacts on Groundwater

During the operation, the economic zone will extract groundwater as well as surface water for industrial operation. Accidental spillage or leaks of chemicals, hydrocarbons (oil, fuel, or other substances), and leachate from the landfill site could percolate into the subsurface and potentially contaminate the groundwater. Any leachate in the groundwater would have adverse impacts on the hydrology.

It is unlikely that the surface infrastructure associated with the desalination facility, pump stations, water reservoirs, and water pipelines will pose a significant risk to the groundwater resources in the EZ.

According to the master plan of the EZ, four central wastewater treatment plants have been considered and operated to treat wastewater from industries. It is planned that initial treatment will be done by

individual industries and sent to the CETPs for further treatment. Wastewater effluent shall be well within the standard, and discharged to the river, no untreated wastewater is allowed to seep into the groundwater source.

The project activity that might impact groundwater quality is the waste management facilities where sanitary landfills and secure landfill sites will be located. A groundwater monitoring program will be required particularly for the waste management facilities.

Good design and construction practices of industries and manufacturing facilities can prevent contamination of groundwater by using impervious material for drainage systems and tanks. However, it is recommended that a systematic groundwater monitoring program should be established to monitor overall contaminants that may be released into groundwater due to project activities. A conceptual hydro-geologic setting of the area should be formulated in order to propose a monitoring program in the long-term program. This will be one of the feasible tools for preventing future groundwater contamination from the developed industrial zones. Possible groundwater pollution sources and pollutants in the economic zone and its surrounding area during the operation are given in Table 5-21.

Table 5-21: Groundwater Pollution Sources and Pollutants

Pollution Sources	Potential Pollutants
Domestic activities (leakage from sewage systems, sewage water drains, septic tanks)	Nitrate, ammonia, phosphate, heavy metals, organic micro compounds, bacteria, etc.
Agricultural activities (excessive use of fertilizers and pesticides, irrigation with wastewater)	Nitrate, phosphate, pesticides, bacteria (from wastewater irrigation), etc.
Industrial activities - chemical industry	Aromatic hydrocarbons, chlorinated hydrocarbons, Heavy metals (Zn, Cd, Cu, etc.)
Industrial activities - textile industry	Aromatic hydrocarbons, Heavy metals (Zn, Cd, Cu, etc.), Acids, Mineral oils
Industrial activities - metal and machinery	Aromatic hydrocarbons, Heavy metals (Zn, Cd, Cu, etc.), Acids, Mineral oils
Industrial activities - food production	Ammonia, vegetable oil products, Nonchemical hydrocarbons
Industrial activities - construction industry	Mineral oils
Industrial activities - small-scale service (gas stations and garage)	Aromatic hydrocarbons, Mineral oils

Considering the above issues, the impact of the operation of the EZ on groundwater is evaluated to be **Medium Low**.

5.3.2.5 Impacts on Topography and Soil

During the operation, impacts on topographic conditions are expected to be very small, limited to each plot of the land where individual industries or factories may adjust the elevation and level of their land plot. Potential impacts on the soil environment are envisaged due to hazardous and non-hazardous wastes generated due to the operation of various industries in the economic zone. Process waste including sludge and residues, chemical waste including toxic waste, used/waste oil, oil slurry, spent solvents, CETPs & WTPs sludge, etc., are the sources of hazardous waste. Poor management of such waste from the operations is a potential risk of soil contamination. The waste management facility is another area where potential soil contamination may occur.

The operation activities will require that individual manufacturers and factories have appropriate chemical storage areas with secondary containment on impervious ground. Industries with a higher risk of chemical release, such as garment and textiles, and electronics industries, will need to conduct

specific environmental assessments that will include identifying the risk of spill and preventive measures. The individual industry and factory should develop a spill and emergency response plan. Potential contamination of soil can be limited through these measures.

Considering the above issues, the impact of the operation of the EZ on topography and soil is evaluated to be **Medium Low**.

5.3.2.6 Impacts on Sediment

The operation of industries in the economic zone will produce various types of waste. If not properly handled, the waste can contaminate water and sediment quality in internal khals and Sandwip Channel. All industrial wastewater from each industry will be treated by their wastewater treatment plants. Wastewater from the industrial industry will be collected and transferred to the central treatment plant, designed with appropriate treatment techniques.

The wastewater from industries will be pretreated to meet the requirements according to the national regulatory requirements (Schedule-3 and Schedule-4 of ECR 2023). The pretreated wastewater will then be combined and transferred to the central effluent treatment plants of the economic zone. The treated wastewater is then transferred through a drainage system and discharged into the Sandwip Channel.

Solid waste that will be generated at the jetty facility should be collected and managed properly. Waste disposal from ships/vessels may impact sediment quality if proper management is not done.

Considering the above issues, the impact of the operation of the EZ on sediment quality is evaluated to be **Medium Low**.

5.3.2.7 Impact due to Changes in Land Use

Potential negative impacts on land use are predicted to affect the surrounding area of the economic zone. One of the major concerns is the unplanned land use in EZ's surrounding areas as a result of the increasing demand for social infrastructures by the influx of a large number of workers. As the industries in EZ will start operation, there will be a need for services other than those day-to-day services that can be provided within the township zone. Naturally, it can be predicted that the EZ surrounding area, with a certain level of infrastructure and social services, will rapidly grow to accommodate the requirements of project personnel such as residences for the supervisors or higher officials who prefer not to stay within the industrial estate, business clients, and guests who visit the economic zone shortly for specific purposes, or other workers who perform services to the project personnel but are not allowed to stay in the township zone.

The major negative impact due to land use changes around the EZ is the problem of uncontrollable use. Currently, the locals are facilitating workers by providing food, services, and even temporary shelters for additional income. Therefore, they are developing their houses and markets haphazardly and in an unplanned way. Without proper control, at the time of the EZ operation, the surrounding area will become permanent communities over time at the location unfitted and even endangering both efficient and safe operations of the project and also the residents themselves. Urban Development Directorate (UDD) under the Ministry of Housing and Public Works is the only physical planning agency of the GOB to advise the government on matters of policy relating to urbanization, land use, and land development and to prepare and co-ordinate regional plans, master plans and detailed layout and site plans for the existing as well as the new urban centers excluding the areas covered by the present town development authorities of Dhaka, Chittagong, and Khulna. Their vision is to augment the quality of life of the people by improving the environment through planned development activities for adequate infrastructure, service, and utility provisions, to make optimum utilization of resources, especially land, and to ensure geographically balanced urbanization. UDD already prepared the Mirsharai Upazila Development Plan (MUDP) in 2020 which will help to reduce unemployment and poverty problems and

socio-economic development by creating employment opportunities by protecting agricultural land and building an industrial and tourism-based city³¹.

The National Housing Authority (NHA) is also working in the area to select a suitable site and develop a township for the workers and officials. At present, there is no specific authority to exercise the land use planning practice in the whole total EZ area, therefore, participants during the stakeholder consultation raised their concerns and proposed to establish a “Development Authority” for the EZ surrounding area.

Considering the above issues, the impact of the operation of the EZ on land use changes is evaluated to be **Medium High**.

5.3.2.8 Impact due to Solid Waste Generation

During the operation, it is likely to generate a substantial volume of solid waste which can be broadly categorized as municipal waste, hazardous waste, and non-hazardous waste. Further, the generated solid waste generated may include biodegradable, recyclable, reusable, and inert compounds from municipal and nonindustrial occupants and industrial occupants. Solid waste will be generated from the canteen, office, workers facilities, medical, maintenance workshop, etc.

According to the master plan, the total amount of industrial solid waste to be generated from the EZ in the year 2040 will be 288,925 tons out of which 250,751 tons (86.78%) will be non-hazardous industrial solid waste and 38,174 tons (13.22) will be hazardous in nature.

Apart from those listed, e-waste from both domestic and industrial segments is also expected to be generated in the EZ. If the solid waste generated is not properly managed and disposed of in an unauthorized manner, it will impact the air quality, soil quality, and groundwater quality.

Wastes originating at the jetty may include inert solid waste from administrative offices, as well as hazardous or potentially hazardous waste associated with vehicle and equipment maintenance operations (e.g. used lubricating oils and engine degreasing solvents). Wastes originating from ships may include oily sludge, inert materials such as food packaging, and food waste. These wastes will generate odor and health impacts and ground and surface water contamination, if not managed properly.

Considering the above issues, the impact due to solid waste generation and disposal from the operation of the EZ is evaluated to be **Medium High**.

5.3.2.9 Impacts of Liquid Waste Generation

The EZ is anticipated to generate various forms of wastewater. According to the master plan, an estimated volume of 118.32 MLD of sewage wastewater is projected by the year 2040. Therefore, two STPs have been proposed having a total capacity of 125 MLD (45+80 MLD) and 48 acres of land area have been allocated. In addition, an estimated volume of 560.39 MLD of industrial wastewater is projected by the year 2040. Therefore, four CETPs have been proposed having a total capacity of 568 MLD (16+32+150+370 MLD) and 158 acres of land area have been allocated. This is bearing in mind that there is no existing wastewater treatment plant in the EZ area. As such this high volume of wastewater might be a major health hazard if proper measures are not put in place.

The source of wastewater generation from EZ operational activities is industrial process wastewater/effluent, domestic wastewater/sewage, equipment cleaning, floor washings, etc. The facilities in the industrial sectors proposed in the EZ can be considered a series of unit processes such as:

The types of industries are apparel and textile involving de-sizing, scouring, mercerizing, bleaching, neutralizing, dyeing, printing, and finishing. The automobile and electronics industry involves melting, die casting, cutting, shearing, forming, welding and soldering, heat treatment, forging, dressing/grinding, machining, non-destructive testing, surface preparation, surface coating, etc. Industries non-metallic

³¹ <https://www.mudp.gov.bd/about.php>

minerals involve crushing/grinding, classifying/separating, wet/dry product mixing/blending, firing/curing/cooling, melted products manufacture, resin-coated sand & foundry cores, stone, and monument working processes.

Food and agro-processing grinding, sieving, mixture, fluidization, sedimentation, flotation, filtration, rectification, absorption, extraction, adsorption, heat exchange, evaporation, drying, fermentation, sterilization, pasteurization, enzymatic peeling, refining, chemical peeling, aquaculture. Also, sewage will be generated from the sanitary and domestic blocks at the industrial units of the clusters, mixed-use & residential, and common facilities such as amenities and utilities. The untreated wastewater, if discharged into nearby surface waters may affect the surface water and/or if disposed of on land without treatment may pollute the ground and surface water.

Considering the above issues, the impact due to solid waste generation and disposal from the operation of the EZ is evaluated to be **Medium High**.

5.3.2.10 Impacts on Drainage

During the operation, surface water flow would be the same as the flow at the end of the development phase because the drainage system and structures on the surface during this phase would undergo no change since they will be completed in the previous phase. According to the EZ master plan, storm water drains shall be provided on either side of the proposed road network of the area to collect the storm runoff generated from the catchment and get it discharged to the drainage channel for ultimate disposal to the Sandwip Channel. Indicative command area (catchment area) for each of the existing drainage channels passing through EZ with locations of the pumping stations, proposed at the location close to its outfall to the sea.

From the stakeholder consultation, it was revealed that currently, the local community is constructing their structures haphazardly and without keeping adequate drainage facilities in the EZ surrounding area. Heavy and continuous rainfall during the monsoon and cyclones may expose the risk of rapid flooding locally including cumulative flooding in regional areas. The flood control infrastructures, if not well maintained, will be subject to negative impacts such as local flooding, due to inadequate maintenance of the drainage system.

Different road networks are developing in the EZ and its surrounding area without considering proper drainage or water-passing provisions. In such cases, there is a possibility of drainage congestion or flooding in the surrounding area of EZ. Moreover, erratic rainfall will make more worsen conditions in the drainage system in the whole area mainly during the rainy season (April-September). The prolonged local flooding may affect directly and indirectly the living conditions of people and workers, cause poor environmental sanitation, and pose potential sources of communicable diseases.

For the area immediately outside of the EZ, not only land use should be controlled, but also other infrastructure that will enable setting up structures and services, such as local roads, electricity, gas, water supply, telephone, internet line, and drainage should be well planned and controlled. The strategic locating or prohibiting of these basic infrastructures will induce and encourage early settlers and services outside the designated township zone into the area planned by the organization to provide temporary services in the early stage of development.

The EZ site is currently dominated by natural vegetation. The implementation of the EZ master plan will hence lead to a reduced rate of water infiltration rate due to increased concrete coverage in the area. In view of this, the volume of runoff will accumulate from the current volumes leading to a strain on the existing drainage channels. This will lead to flooding downstream if proper measures are not put in place. This will in turn lead to an increase in soil erosion in the area.

In the EZ, when the floodwater comes from the river/khals upstream and meets the strong sea tides, the water level will rise, the water will drain slowly, and flood time will be prolonged. In such cases, the risks of flooding can be minimized by popular technical mitigation measures such as pumping.

Considering the above issues, the impact of the operation of the EZ on drainage is evaluated to be **Medium High**.

5.3.2.11 Impacts of Traffic

Traffic volume on the improved roads is predicted to increase significantly during the operation of EZ, specifically during the morning and afternoon peaks. According to the EZ master plan, it is assumed that the maximum one-way passenger traffic by 2040 towards Dhaka-Chattogram Road and Sonagazi will be around 9,000 passenger car units/hour and 3,200 passenger car units/hour respectively. Improvement of regional road networks may prompt high-speed driving, which is likely to cause accidents for pedestrians unless adequate road safety measures are adopted. In addition to the risk of accidents, increased traffic will lead to inconvenience to the local public, and road users, and increase the potential for nuisance in the region.

During the operation, a huge number of workers will be moved on the access road at a time, therefore, there will be a risk of traffic congestion on access roads as well as the Dhaka-Chattogram Highway. Traffic congestion will not only waste precious time and fuel of commuters but also cause air and noise pollution along with causing stress and anxiety leading to impatience and accidents.

The increased traffic volumes will increase the potential of incidents on the internal road as well as access roads within the study region, specifically at intersections and passing through busy (market, schools, etc.) areas, resulting in serious injuries or even fatalities.

Existing road networks in the region are not adequate to support additional traffic volume due to the operation of industries in the EZ. There is an urgent demand for up-gradation and expansion of the provision of additional transport systems with the increase in the capacity of roads to scoop up the upcoming requirements of transportation and communication. The existing secondary roads in the region that are linked between EZ and Dhaka-Chattogram Highway need to be constructed/strengthened the roads for the workers and public to use. A service lane should be introduced for walking and slow vehicle movement along the main road network. In addition, adequate drainage provision for rainfall water should need to be considered in road design.

Considering the above issues, the impact of the operation of the EZ on traffic is evaluated to be **Medium High**.

5.3.2.12 Loss of Ecosystem Services

The operation of the EZ brings potential benefits alongside significant environmental concerns. Increased industrial activities can lead to a cascade of effects on vital ecosystem services. Deterioration of water quality is a major concern. Discharge of pollutants from industrial effluents and runoff from paved surfaces can contaminate groundwater and surface water resources used for drinking, irrigation, and other purposes. This can disrupt aquatic ecosystems and negatively impact fisheries, a key provisioning service.

Continued habitat degradation and fragmentation due to ongoing operations can further reduce biodiversity. Urban sprawl and industrial infrastructure expansion may encroach on remaining natural habitats, limiting space for wildlife. This disrupts regulating services such as natural water purification and pollination and reduces cultural services like recreation and aesthetic enjoyment.

Industrial emissions and traffic associated with EZ can lead to air pollution, affecting human health in surrounding areas. Pollutants like particulate matter, nitrogen oxides, and volatile organic compounds can contribute to respiratory problems.

Increased industrial activities and urbanization may result in elevated noise and light pollution. Noise from machinery and transportation disrupts wildlife habitats, interfering with communication and breeding. Light pollution can disrupt natural light cycles, impacting nocturnal wildlife. Both noise and light disrupt supporting services crucial for healthy ecosystems.

Accidental spills, leaks, and improper waste disposal can contaminate soil, affecting fertility and ecosystem health. Accumulation of heavy metals, chemicals, and other pollutants can pose risks to human health, wildlife, and agricultural productivity, impacting provisioning services like food production.

Continued urbanization and industrial expansion can exacerbate pressure on natural resources like land, water, and energy, leading to further depletion and degradation. This reduces the overall capacity of ecosystems to provide services.

Exposure to pollutants and environmental stressors can impact community health, leading to increased respiratory illnesses, allergies, and other health problems. Disruption of ecosystem services and loss of access to natural environments may also affect community resilience and economic stability.

Considering the above issues, the impact on ecosystem services during the operation of EZ is evaluated to be **Low**.

5.3.2.13 Impacts on Terrestrial Flora

The operation of the EZ will likely have several impacts on terrestrial flora in the study region. The conversion of large swathes of land for various purposes such as residential, industrial, and commercial areas will lead to fragmentation of natural habitats. This fragmentation will disrupt natural habitat connectivity, leading to the isolation of plant populations and potentially reducing genetic diversity. The conversion of land for infrastructure development will inevitably result in the loss of native vegetation and biodiversity. Terrestrial flora adapted to specific ecological niches may not be able to survive in altered environments, leading to a decline in plant species richness and abundance.

Ongoing construction activities, urbanization, and industrial operations can result in habitat degradation through soil compaction, pollution, and alteration of hydrological regimes. These factors can directly affect the health and vitality of terrestrial flora, leading to reduced growth rates, reproductive success, and overall fitness. The introduction of new infrastructure and increased human activity associated with the operation phase may facilitate the introduction and spread of invasive plant species. These invasive species can outcompete native flora, disrupt ecosystem processes, and reduce habitat quality for native plants.

Industrial activities within the EZ may result in air and water pollution, which can have indirect impacts on terrestrial flora. Pollution can lead to soil acidification, nutrient imbalances, and toxic accumulation, all of which can adversely affect plant health and growth. The operation of infrastructure can alter natural ecological processes such as nutrient cycling, water flow patterns, and disturbance regimes. These alterations can have cascading effects on terrestrial flora, potentially favoring certain species over others and leading to shifts in plant community composition.

Continued human activity and trade associated with the operation phase may facilitate the spread of invasive plant species, which can outcompete native vegetation and disrupt ecosystem balance. The operation phase may contribute to climate change through greenhouse gas emissions and land-use changes, leading to shifts in temperature and precipitation patterns that can impact plant distribution and ecosystem dynamics. Once ecosystems are disturbed or destroyed during the operation phase, restoring them to their original state can be challenging and may not fully recover the original biodiversity and ecological functions. Restoration efforts may require significant time, resources, and expertise to be successful.

Considering the above issues, the impact of the operation of the EZ on terrestrial flora is evaluated to be **Low**.

5.3.2.14 Impacts on Terrestrial Mammals

The operation of the EZ can have long-term impacts on terrestrial mammals. A fully developed industrial zone, buildings and infrastructure, and the creation of new transportation networks can further fragment

existing mammal habitats. This can disrupt breeding, foraging, and dispersal patterns, hindering mammal movement and potentially leading to population decline in the long run.

Modified and converted habitats for industrial purposes can lead to a permanent reduction in the availability of food resources for herbivores. This can have cascading effects on carnivore populations that rely on herbivores for prey. Roads, railways, and other transportation infrastructure can act as barriers, restricting mammal movement and isolating populations. This can disrupt gene flow and hinder adaptation to changing environmental conditions.

Operational activities such as traffic, maintenance work, and industrial processes can cause ongoing disturbance to mammals in the surrounding areas. This can lead to chronic stress, disrupt breeding behavior, and reduce the overall fitness of mammal populations.

Artificial lighting from industrial facilities, streetlights, and other operational activities can disrupt the behavior of nocturnal mammals. This can affect their foraging efficiency, predator-prey interactions, and navigation patterns. As human activity and infrastructure expand with the operational EZ, the likelihood of encounters between humans and mammals increases. This can lead to conflicts, injuries, and even fatalities for both humans and wildlife.

Accidental spills of oil, lubricants, or other hazardous materials can contaminate the environment and harm mammals. Industrial activities may also generate air and water pollution, impacting mammal health and reproduction success.

Considering the above issues, the impact of the operation of the EZ on terrestrial mammals is evaluated to be **Low**.

5.3.2.15 Impacts on Birds/Avifauna

The operation of the EZ can also have long-term impacts on avifauna species. The conversion of large areas of land for various purposes such as residential, commercial, and industrial zones will result in habitat loss and fragmentation. This can disrupt breeding, foraging, and migratory patterns, affecting bird populations in the long run. Birds may collide with buildings, power lines, and other structures within the industrial zone, leading to injuries and fatalities. This is a particular concern for migratory birds unfamiliar with the area.

As human development encroaches on natural habitats, there is an increased likelihood of human-avifauna conflict. This can occur when avifauna species are attracted to urban areas in search of food and shelter, leading to encounters with humans and potential conflicts. The establishment of new infrastructure and increased human activity can facilitate the introduction and spread of invasive species. These invasive species may outcompete native fauna for resources, disrupt ecosystem dynamics, and threaten the survival of native species.

Operational activities within EZ will generate air and noise pollution. Air pollutants can affect respiratory health in birds, while noise pollution can disrupt communication and breeding behavior. Artificial lighting from industrial facilities, streetlights, and other operational activities can disrupt the nocturnal behavior of birds, impacting their feeding, breeding, and navigation patterns. Excessive artificial lighting can also affect the behavior, reproduction, and migration patterns of migratory birds.

Habitat modification and conversion for industrial purposes can reduce the availability of prey species for insectivorous and carnivorous birds. Species that are unable to adapt to urban environments or survive in fragmented habitats may face local extinctions, leading to a reduction in overall biodiversity. Accidental leakage of oil, lubricants, and fuel introduces toxic substances into the soil, disrupting the natural ecosystem balance and causing soil contamination, which may affect bird health. Operational activities such as traffic, maintenance work, and industrial processes can cause ongoing disturbance to bird populations in the surrounding areas.

Considering the above issues, the impact of the operation of the EZ on avifauna is evaluated to be **Low**.

5.3.2.16 Impacts on Herpetofauna

The EZ operation phase may create various challenges for terrestrial fauna, including reptiles and amphibians (herpetofauna). Land conversion for residential, commercial, and industrial zones will fragment and reduce available habitat for herpetofauna. This can disrupt breeding, foraging, and migration patterns, isolating populations and hindering their survival.

Ongoing urbanization can lead to displacement and habitat degradation for reptiles and amphibians. Noise pollution, habitat destruction, and increased human activity can disrupt their natural behaviors, leading to stress, reduced breeding success, and potential population decline. As human development encroaches on natural areas, there's a higher chance of human-wildlife conflict. Herpetofauna, especially snakes, might be attracted to urban areas in search of food or shelter, leading to encounters and potential conflicts with humans.

The establishment of new infrastructure and increased human activity can facilitate the introduction and spread of invasive species. These invaders may compete with native herpetofauna for resources, disrupt ecosystem dynamics, and threaten the survival of native species.

Industrial activities within EZ may result in air, water, and soil pollution. Pollutants can contaminate food sources, degrade habitats, and compromise the health of herpetofauna populations. Some amphibians, with their permeable skin, are particularly vulnerable to pollutants. The operation of EZ infrastructure can alter natural ecological processes like nutrient cycling, water flow patterns, and disturbance regimes. These alterations can disrupt the balance of ecosystems and negatively impact the abundance and distribution of herpetofauna species.

Habitat conversion can lead to a loss of biodiversity among terrestrial fauna, including reptiles and amphibians. Species unable to adapt to urban environments or survive in fragmented habitats may face local extinction, reducing overall biodiversity. Excessive artificial lighting can disrupt the movement patterns of nocturnal herpetofauna species, potentially affecting their foraging, reproduction, and migration behaviors. Accidental leakage of oil, lubricants, and fuel can introduce toxic substances into the soil, disrupting the natural ecosystem balance and causing soil contamination, further impacting herpetofauna.

Considering the above issues, the impact of the operation of the EZ on herpetofauna is evaluated to be **Low**.

5.3.2.17 Impacts on Aquatic Mammals

The operation of the EZ could potentially have adverse effects on dolphin populations in the Sandwip Channel, particularly impacting species such as the Irrawaddy Dolphin and the Indo-Pacific Humpback Dolphin.

The operation of the port and increased shipping activity may result in heightened vessel traffic within the Sandwip Channel, thereby increasing the risk of collisions with dolphins. Additionally, the continuous noise generated by vessels and port activities has the potential to disrupt dolphin communication, and echolocation, and even cause hearing damage.

The discharge of untreated or inadequately treated industrial wastewater can introduce pollutants such as heavy metals, organic compounds, and toxins into the water, directly harming dolphins or indirectly through the bioaccumulation of these contaminants in their prey. Furthermore, spills of oil, lubricants, or other pollutants during operational activities can lead to water pollution, posing a threat to dolphins. Maintenance dredging activities carried out within the jetty or for channel expansion purposes may alter the seabed, thereby reducing the availability of prey for dolphins.

During operations, discharge brine effluent from the desalination facility may lead to elevated levels of salinity in the direct vicinity of the discharge. Effluent may also contain biocides, chlorine, and lower levels of dissolved oxygen, which will influence water chemistry and quality. Furthermore, the desalination process removes particulate matter from the water column where it is a food source for various marine biota.

The pollution and habitat alteration resulting from operational activities can also negatively impact fish populations, upon which dolphins rely for sustenance. Exposure to vessel noise and collisions can cause physical injuries and permanent hearing damage in dolphins. Consequently, dolphins may avoid noisy or polluted areas, potentially leading to shifts in their distribution patterns and displacement from crucial habitats. Moreover, the increase in tourism activities within the Sandwip channel could exacerbate these issues. Chronic stress induced by noise pollution and habitat disturbance may further impact dolphin reproductive success and calf survival rates.

Considering the above issues, the impact of the operation of the EZ on aquatic mammal populations is evaluated to be **Low**.

5.3.2.18 Impacts on Ichthyofauna (Fish)

The operation of the EZ will pose a significant challenge to the aquatic ichthyofauna (fish populations) of the surrounding water bodies. Discharge of untreated or inadequately treated industrial wastewater can introduce pollutants such as heavy metals, organic compounds, and toxins into the water bodies, adversely affecting fish health and reproduction. Furthermore, increased stormwater runoff from urban areas may carry pollutants like fertilizers, pesticides, and oil residues into waterways, leading to the degradation of water quality. Spills of oil, lubricants, and other materials during jetty operations can also contaminate the water, posing risks to fish populations.

The operation of infrastructure, including jetty, industrial areas, and residential zones, will result in habitat loss, fragmentation of aquatic habitats, and alteration of aquatic ecosystems where fish species reside and breed. This can hinder fish migration routes and access to spawning grounds. Moreover, improved access to waterways through ports may attract more fishing vessels, potentially leading to the overexploitation of fish stocks if not managed sustainably.

Habitat loss, degradation, and pollution from operational activities may contribute to a decline in fish species diversity in affected water bodies. Leakage or spills of construction materials, such as oil, lubricants, and concrete, can contaminate waterways, posing toxicity risks to fish and other aquatic life. Increased sedimentation from surface runoff can suffocate fish eggs, impede fish respiration, and disrupt fish development. Furthermore, pollutants from industrial activities and urban runoff may bioaccumulate in fish tissues, posing health risks to humans who consume these fish.

Impacts on fish populations can have cascading effects on aquatic food webs, affecting other aquatic organisms like birds and mammals that rely on fish for food. Additionally, increased vessel traffic associated with operational activities may disturb fish behavior and heighten the risk of collisions with vessels. Operational activities may also facilitate the introduction and spread of invasive species into water bodies, further disturbing the balance of the aquatic ecosystem.

Improper disposal of industrial waste, food waste, cardboard, paper, packaging, plastic, etc., in the waterbody not only degrades the aesthetic value of the Sandwip channel but may also potentially cause health hazards to fish ichthyofauna in the form of water and soil sediment contamination. Therefore, stringent measures for waste management and pollution control are imperative to safeguard the health and sustainability of aquatic ecosystems in the EZ operational phase.

Considering the above issues, the impact of the operation of the EZ on Ichthyofauna (fish) is evaluated to be **Low**.

5.3.2.19 Impacts on Hilsa Fisheries

While the construction phase presents significant threats, the operation of the EZ can also negatively impact the Hilsa fish of the Sandwip channel and their spawning grounds near Mayani Point.

Untreated or inadequately treated industrial wastewater discharge can introduce pollutants like heavy metals, organic compounds, and toxins into the water bodies, harming Hilsa health and reproduction. Spills of oil, lubricants, and other materials during port operations can contaminate the water and harm fish populations, including Hilsa.

Increased stormwater runoff from urban areas within EZ can carry pollutants like fertilizers, pesticides, and oil residues into waterways, degrading water quality. Clearing vegetation along riverbanks for development purposes can reduce shade and food sources for Hilsa, impacting their growth and survival. The continued presence of jetties and other structures can fragment migration routes and hinder access to spawning grounds.

The development of the port might attract more fishing vessels, leading to overexploitation of Hilsa stocks if not managed sustainably. Increased fishing activity can result in unintentional catching of Hilsa during the targeting of other fish species.

Underwater noise from vessel traffic and operations, along with artificial light from the port and surrounding areas, can disrupt Hilsa communication and spawning behavior.

Degradation of water quality, habitat alteration, and disruption of spawning activities can significantly reduce the spawning success of Hilsa in the affected area. Reduced spawning success can lead to a decline in the number of Hilsa juveniles recruited into the population, impacting future fish stocks. Pollutants from industrial activities and urban runoff can bioaccumulate in Hilsa tissues, posing a health risk to humans who consume these fish.

Increased human activity associated with the operation of the EZ may facilitate the introduction and spread of invasive species into the water bodies. These invasive species could compete with hilsa fish for resources, further threatening their population.

Considering the above issues, the impact of the operation of the EZ on hilsa fish is evaluated to be **Low**.

5.3.2.20 Impacts on Plankton and Benthos

The operation of the EZ may also pose some threats to the plankton and benthos population of the Sandwip channel. Continued operation of infrastructure within EZ, such as ports and industrial facilities, may lead to ongoing habitat alteration in the Sandwip Channel. Dredging for port maintenance and industrial activities could disrupt benthic habitats and alter sediment dynamics, affecting benthic organisms. Operational activities within EZ, including industrial processes, shipping, and urban runoff, may contribute to ongoing pollution and contamination of the Sandwip Channel. Chemical pollutants, such as heavy metals and industrial effluents, could adversely affect planktonic and benthic communities, leading to reduced biodiversity and compromised ecosystem health.

Effluent discharge from industrial facilities and urban areas within EZ could continue to degrade water quality in the Sandwip Channel. Elevated nutrient levels and organic matter from wastewater discharge may promote algal blooms, altering planktonic communities and potentially leading to hypoxic conditions harmful to benthic organisms.

Ongoing maritime traffic associated with the port and logistics hub within EZ could continue to pose physical disturbance to planktonic and benthic organisms in the Sandwip Channel. Ship traffic, including dredging operations and vessel movements, may cause habitat disturbance, sediment resuspension, and noise pollution, impacting both planktonic and benthic communities. The cumulative effects of ongoing operational activities within EZ, combined with other anthropogenic stressors in the Sandwip Channel, may exacerbate impacts on planktonic and benthic organisms over time. Continued pressure from multiple sources of disturbance could lead to further declines in species diversity and ecosystem resilience.

The operation of industrial facilities within EZ may contribute to greenhouse gas emissions and exacerbate climate change impacts on the Sandwip Channel ecosystem. Changes in temperature, precipitation patterns, and ocean acidification associated with climate change could further stress planktonic and benthic organisms, compounding existing threats to their survival and reproductive success.

Considering the above issues, the impact of the operation of the EZ on plankton and benthos is evaluated to be **Low**.

5.3.2.21 Community Health, Safety, and Security

Industrial and gas emissions from industries may cause direct impacts: increasing pollution levels of SO₂, NO₂, PM₁₀, and VOC in the surrounding environment. Disposal of waste, hazardous waste, and effluent discharge will cause certain impacts on the local environment, including soil and water, resulting in deterioration of the community's health status. Materials, machinery, and associated infrastructure items are required therefore volume of transportation may escalate significantly and may lead to an increase of road accidents and injuries.

The increase of accommodation and growth of supporting industries in the surrounding areas will create pressure on the adequacy of infrastructure amenities, public health services, public health facilities as well as sanitation, especially around the EZ area. Improper management of sewage, wastewater, and solid waste may lead to poor sanitation and environmental health stresses. Currently, public health services of the local authorities are limited therefore the EZ should closely collaborate with the local authorities to create mitigation measures to prevent the consequences that may occur.

The increase of foreign labor may lead to the emerging various diseases possibly spreading to the residents, especially in areas with poor hygiene practices. Sexual transmission diseases, HIV/AIDs, and communicable diseases are associated with the mobility of workers.

Considering the above issues, the impact of the development of the EZ on Community Health, Safety, and Security is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'permanent-mitigated'. Thus, the significance of the impact during development phase will be '**Medium-Low**'.

5.3.2.22 Occupational Health and Safety

During the operation of EZ, reckless work and accidents may become significant causes of injuries and fatalities of workers, particularly among unskilled workers. Depending on the type of industry, accidents may be caused by various activities, for example, electrical machines/devices, rotating and moving equipment, working at height, high temperature working conditions, confined space, and traffic at the site. A wide range of injuries may be found from minor and medical aid only to disabling injuries and/or death.

There will be diversified industries in the EZ. Each type of industry will have different environmental, health, and safety risks. Working environment and safety including accidents may become significant causes of injuries and fatalities for workers. Pollution due to emissions from industries to the environment may affect the health of workers, especially long-term effects. Industries will use chemicals that pose flammable, reactive, or toxic properties. Releasing of these chemicals may cause significant adverse impacts including fire, explosion, and toxic gases. Major hazards, fire explosions, and toxic chemical leaks may occur in crucial industries particularly steel mills, power plants, and petrochemicals plants resulting in a large scale of adverse effects including loss of properties, injuries, disabilities, and death.

Chemical, biological, and physical hazards may cause illness or injury. Acute and chronic diseases, e.g., allergies, respiratory symptoms, nervous system, systemic disorders, and cancer, may be a result of exposure to chemicals or hazardous wastes in the working environment. Noise, Vibration, and Workplace Temperature including repetitive work and improper ergonomics are likely to be expected. Psycho-social disorders may increase among workers with hard work, unfamiliar environments, and being away from home. Among others, stress, anxiety, insomnia, substance abuse, violence, smoking, alcohol drinking, and mental illnesses will be found more often.

Sexual transmission diseases and vector-borne infections are mostly related to poor personal hygiene and poor sanitation. Foreign or migrated workers are possibly exposed to local diseases, malaria, and dengue fever.

Considering the above issues, the impact of the development of the EZ on Occupational Health, and Safety is evaluated to be 'Direct' in nature with 'High' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be '**Low**'.

5.3.2.23 Labor Influx

Considering the EZ footprint and longer timeframe, people can migrate to the EZ region in addition to the labor force. These can be people who expect to get a job with the project, family members of workers, as well as traders, suppliers, and other service providers, particularly in areas where the local capacity to provide goods and services is limited. A significant increase in demand for goods and services due to labor influx may lead to local price hikes and/or crowding out of community consumers.

Labor influx can cause social disorders and pose social problems such as gambling, drugs, prostitution, etc. Labor influx could also increase the risk of gender-based violence and sexual exploitation and abuse. Regarding the impact on public security, the deterioration of public order such as crime is expected because of the influx of laborers and people who are eager to have opportunities to gain profit by dealing with businesses such as small restaurants or tea shops, selling fuel for the project vehicle, food for the workers, etc. Therefore, the occurrence of incidents and disputes among local people and migrated workers may occur more or less. The living environment of local people is expected to be disturbed and lose their comfort by migrated workers in case they stay in and around the local community and dispose of garbage around their living place without paying any attention to the local community.

To reduce the impacts due to the labor influx, it is necessary to township development for the workers and officers separately by ensuring adequate facilities. In addition, industrial police and thana police unit establishment and capacity improvement of highway police unit is very important to ensure proper law and order situation in the region.

Considering the above issues, the impact of the development of the EZ on Labor Influx is evaluated to be 'Direct' in nature with 'High' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be '**Medium-high**'.

5.3.2.24 Child Labor and Forced Labor

The operation of the EZ will require a significant labor force, expected to generate approximately 1.4 million employment opportunities by 2040. The majority of the workers who will be recruited locally and regionally will be unskilled and semi-skilled laborers. Considering the number of employment opportunities and involvement of many investors in the EZ, the child and forced labor risk cannot be rolled out. In the case of absence of policy and procedures regarding labor and working conditions, they can potentially be the cause of issues related to the risk of child labor and forced labor. Child labor and forced labor is a problem in Bangladesh. A combination of poor living standards in urban settings and an influx of cheap labor from children perpetuate both poverty and the use of child labor. Oftentimes, families rely on the extra income produced by their children to sustain their livelihood. Many children are forced to work to help support the family. In other cases, children are forced to work for a living for themselves because their families are abandoned or cannot take care of them.

In order to protect children from jeopardy to their health, safety, or morals, it should be ensured that children under the age of 18 are not employed for work under the projects in EZ. As per the Labor Act 2006, no one below the age of 14 (minimum age) will be employed as a labor. A child over the minimum age (14) and under the age of 18 may be employed or engaged in connection with the project only if the work is not likely to be hazardous or interfere with the child's education or be harmful to the child's health or physical, mental, spiritual, moral or social development. During the operation period, there is a risk of engaging child labor in different tasks. Investors should be prohibited from employing anyone under 18 years for employment. Forced employment of laborers, especially of local laborers, is a serious offense and must be prohibited. Sudden and random inspection by BEZA needs to be done on a regular basis to ensure compliance.

Considering the above issues, the impact of the development of the EZ on Child Labor and Forced Labor is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'Permanent-mitigated'. Thus, the significance of the impact during development phase will be **'Medium-high'**.

5.3.2.25 Gender Based Violence and Sexual Exploitation and Abuse/Sexual Harassment

The term Gender Based Violence is used to underscore systemic inequality between males and females and acts as a unifying and foundational characteristic of most forms of violence perpetrated against women and girls. The nine core types of GBV are rape, sexual assault, sexual harassment, sexual exploitation and abuse, sexual favors, physical assault, forced marriage, denial of resources, opportunities or services, and psychological/emotional abuse.

Gender-based violence involves power imbalances where, most often, men are the perpetrators and women the victims. While women are usually the immediate victims of gender violence, the consequences of gender violence extend beyond the victim of society. Experience from other projects indicates that among the most serious and invisible risks is the increase in GBV in the populations in which a project is carried out.

Considering the above issues, the impact of the development of the EZ on Gender Based Violence and Sexual Exploitation and Abuse/Sexual Harassment is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be **'Medium-low'**.

5.3.2.26 Violence Against Children

During the operation of the EZ, children may become involved in operation activities by running errands or doing simple tasks. These activities could keep the children away from school in addition to the risk of being exposed to accidental and other injuries. In addition, increased opportunities for the host community to sell goods and services to the incoming workers can lead to child labor to produce and deliver these goods and services, which in turn can lead to enhanced school dropout.

Considering the above issues, the impact of the development of the EZ on Violence Against Children is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be **'Medium-low'**.

5.3.2.27 Impact on Social Infrastructures

The population influx will increase during the operation phase of the NSEZ. Workers, service providers and other followers will create pressure on existing social infrastructure and generate extra demand to a great extent. The following social infrastructure will be impacted during operation phase:

As detailed in the discussion under development phase above, the existing social infrastructures/services in the EZ surrounding area are absolutely insufficient and barely up to the mark while the social infrastructure that EZ is expected to develop through other government departments will benefit the local citizens a great deal. Roads and public transport exist, but they need a lot of improvement. During the consultation, it has also been mentioned by different stakeholders that the impact on social infrastructure will be mentionable once the NSEZ starts operation.

Different stakeholders specifically highlighted the future demand for housing facilities in NSEZ's surrounding areas, particularly in the Mirsharai areas. Some stakeholders opined that the Upazilas are not yet ready to provide housing facilities for any large number of newcomers. Therefore, a great impact is anticipated in this regard.

The impact has also been anticipated on the management of social infrastructure including housing, market, service providers, etc.

Educational Institutes: Local schools and other educational institutes are able to provide services with their current resources in response to the current demand. They require enhanced capacities to meet future demands such as academic buildings, the number of teachers and supporting staff, students' counselors, etc. Stakeholders emphasized a great demand for establishing educational institutes such as colleges, universities, and engineering institutes NSEZ surrounding areas.

The increased population will create pressure on healthcare facilities too. Stakeholder demanded to establish required healthcare facilities with well-trained medical practitioners and staff to meet the future demand and impact. Impacts are also anticipated on the other social infrastructure such as transportation services and system, sanitation and waste management, social services/religious institutes and services, local market/hat-bazar.

Considering the above issues, the impact of the development of the EZ on Social Infrastructures is evaluated to be 'Direct' in nature with 'High' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be **'Medium-High'**.

5.3.2.28 Impacts on Fisherman and Fishery Activity

Increased shipping activities during the operation phase may impede fishermen's livelihood activities and increase safety hazards. Firstly, it may be considerably more difficult to observe the activities of artisanal fishermen from the decks of larger vessels. Secondly, while these vessels may travel more slowly than high-powered motorboats, large ships also have large bow waves and large washes that may affect the safety of fishermen. Thirdly, where there are established shipping channels, the increased number of vessels may impede local communities' ability to cross the channel safely. Finally, where construction, production, and general operational schedules involve lengthy waiting periods, the vessels may anchor outside the project's designated footprint, thereby considerably increasing the actual affected area. During this period, the project footprint and potential impact on fisheries may be expanded. In addition, associated fishing activities, such as boat building and repair, net and fish trap manufacture and repair, marketing and transportation, employment, and business and trade will also be impacted.

Operation of the EZ may entail modifying coastlines, development of infrastructure such as jetties, ensuring operational access for shipping (e.g., establishment and maintenance of access khals, turning basins, breakwaters, and safe mooring), development of offshore facilities, and the enforcement of exclusion zones, all of which may reduce the area of fisheries and/or people's access to and use of these resources. An exclusion zone will be designated to ensure the safety of local people, avoid accidental damage to or loss of fishing equipment, ensure the protection of the project infrastructure against damage or sabotage by local people, and meet national security requirements covering jetty facilities, waterways, and particular types of vessels while loading or unloading.

In addition to posing threats to the habitats and fish resources in the region, the presence of project activities can also cause direct, increased risks to people and equipment involved in the fishing sector. Without an understanding of local fishing practices, the transit of speedboats and larger ships through common access channels and across fishing grounds is often associated with accidental damage to equipment, most commonly damage to lines, fish traps, and nets. Considering the above situation, the EZ will provide job opportunities and a community support program in order to improve the situation on the living and livelihood of the fisherman.

Besides, there are no good facilities for resting, sanitation, drinking water, etc. for the fishermen in the newly shifted locations as well as no safe boat parking area. The project proponent may develop a resting facility for the fishermen and a safe boat parking area considering the Cyclone disaster in the region.

Considering the above issues, the impact of the development of the EZ on Fisherman and Fishery Activity is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be **'Medium-Low'**.

5.3.2.29 Impacts on Livestock Population and Dependent Community

Currently, livestock (buffalo) is playing a crucial role in food and nutrition security in the EZ region. Livestock also serves as an income source which the local community sells to meet their needs. The EZ currently serves as grazing land for the local community livestock. The EZ will contribute to a reduction in livestock grazing lands. The EZ master plan may consider setting aside some sections as grazing lands for the community livestock.

During the operation phase of the EZ, all the industry will go for operation and the area will be restricted by constructing a boundary fence to ensure security. Therefore, existing livestock feeding grounds will completely be lost. In addition, economic losses will be incurred from the loss of open-access grazing land. Considering the above situation, the EZ will provide job opportunities and a community support program in order to improve the situation on the living and livelihood of the livestock dependent community.

Considering the above issues, the impact of the development of the EZ on Livestock Population and Dependent Community is evaluated to be 'Direct' in nature with 'Low' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be 'Low'.

5.3.2.30 Tourism

During the operation of the EZ, the increase in population as attributed to the number of workers to be engaged in the EZ will translate to more visitors to the EZ surrounding tourist spots. This will create extra pressure on the existing infrastructures and local resources i.e., energy, food, fuel, road, accommodation, water resources, health facilities, waste management, etc. Tourist activity can cause the same forms of pollution as any other industry, i.e., air emissions, noise, solid waste and littering, releases of sewage, oil and chemicals, and even architectural/visual pollution. Water, specifically groundwater, is one of the most critical natural resources in the region. The use of water for hotels, swimming pools, and personal use of water by tourists can result in water shortages and degradation of water supplies, as well as generate a greater volume of wastewater. More solid waste will be generated from the tourist facilities and there will be a possibility of impact on the environment if adequate measures are not taken. In addition, tourist activity can put enormous stress on local land use and can lead to soil erosion, increased pollution, natural habitat loss, and more pressure on wildlife.

Considering the above issues, the impact of the development of the EZ on Tourism is evaluated to be 'indirect' in nature with 'Low' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be 'Low'.

5.3.2.31 Impacts on Community Dynamics

During the operation phase, rapid and continuous influx of outside population may lead to an assimilation of social and cultural practices and belief. Outsiders and locals will represent their own community dynamics in terms of festivals, social practices, etc. With the possibilities of assimilation, negative impact is also anticipated as there is a chance of decreasing social cohesion. It may lead to competition over common resources, community conflict or disharmony. It may also contribute to an increased number of crimes in society as outsiders have less integration in the local community and lack empathy for the community and surroundings.

Considering the above issues, the impact of the development of the EZ on Community Dynamics is evaluated to be 'Direct' in nature with 'Medium' intensity/severity and the duration of the impact will be 'Long-term'. Thus, the significance of the impact during development phase will be 'Medium-low'.

5.3.2.32 Impacts due to Natural Disasters

If an earthquake occurs during the operation phase, the damage would be extended in the NSEZ including industries/buildings of individual industries and infrastructure such as roads, railways, jetties, gas pipelines, electricity transmission lines, water treatment plants, central sewage treatment plant,

central effluent treatment plant, etc. which will be constructed. To minimize the damage, the project proponent and investors should design and construct their structures properly to meet the required standards such as the Bangladesh National Building Code (BNBC) 2020. An emergency response plan for earthquakes should be established by individual industries, and emergency drills should be implemented by the investors to minimize the negative impact of earthquakes.

For cyclones and its associated disasters like storm surges. Thus, safety and prevention measures should be included in the EZ design to minimize the damage due to these events.

Tsunamis are a series of waves produced by the displacement of a large volume of water generally generated by earthquakes or volcanic eruptions. Considering the state of tsunami vulnerability and potential seismic sources, the coastal belt is classified into three tsunamigenic zones.

As per the tsunamigenic zones map of Bangladesh, the coast is divided into three tsunamigenic zones i.e., zones I, II, and III. Zone-I is the most vulnerable and zone-III is the lowest vulnerability zone. According to this classification, the EZ site falls within zone-I, which is reportedly the most vulnerable belt. Though the Indian subcontinent is in a seismically active region, tsunamis along the coastline of India and Bangladesh have been rare, but not unprecedented.

All the interventions will be developed along the shoreline of the Bay of Bengal thus are highly vulnerable to coastal floods caused by tidal surges. According to the Upazila Disaster Management Plan of Mirsharai and Sitakunda, both upazilas are flood-prone areas specifically vulnerable to flash floods. According to the consultation with BEZA, the whole EZ site will be filled with an elevation of 6.5 m. The finished level of both the off-shore and on-shore structures should be above the high flood level of the sea and rivers/khals to prevent flood hazards. At the Mirsharai site, an embankment/super dyke having approximately 22.5 km length is already developed along the Sandwip Channel thus the site is not prone to flooding. Further, a 12.5 km embankment will be constructed along the coastline from Domkhali in Mirsharai to Guliyakhali in Sitakunda.

Considering the above issues, the impact on the EZ due to national disaster is evaluated to be **Medium High**.

5.3.2.33 Climate Change and Greenhouse Gas Emissions

Increasing greenhouse gases (GHGs) due to the implementation of the industries in the EZ will result in global warming and climate change. Its consequences are devastation for the environment such as the rising temperature, sea level change, impacts on the ecosystem, etc. The activities and sectors associated with the EZ are transportation, industry, commercial, and residential will emit greenhouse gases into the atmosphere. One of the most significant of these gases is carbon dioxide (CO₂), which will be generated when fossil fuels, such as oil and natural gas are burned (e.g., in industry, electricity generation, and automobiles) and changes in land use (i.e., deforestation). In the long run, the accumulation of CO₂ and other GHGs in the atmosphere can cause global climate change.

Transportation will be one of the major sources of GHGs in the region. GHGs from transportation will be carbon dioxide (CO₂), Carbon monoxide (CO), Non-Methane (CH₄), Organic compounds (VOCs), Oxides of nitrate (NO_x), Sulphur dioxide (SO₂), and Hydrocarbons. The total amount of GHGs will depend on the number of population and transportation activities, types of vehicles/vessels, choices of fuel, and condition of vehicles (e.g., level of maintenance). The operation of equipment and machinery will lead to GHG emissions.

The operation of heavy industry inside of the EZ including cement, iron/steel, chemicals, fertilizer, minerals, paints, or similar will emit GHGs. The type of energy input or fuels used in the industries is an important factor that will contribute to the amount of GHG emission. It is recommended to keep a record of resource utilization to analyze greenhouse gas emissions in each industry and report to the EZ authority.

Greenhouse Gases (GHGs) Estimation

The total amount of GHG emission potential is calculated following the scenario where the EZ is implemented in full operation in the year 2041. For calculation, all factories are considered running 16 hours daily throughout 300 days in a year.

The total electrical energy to be consumed is estimated keeping the maximum demand in mind, whereas for natural gas consumption total gas demand per day (m³/day) values are used. The GHG estimation is demonstrated in Table 5-22.

Table 5-22: GHG Estimation for EZ Operation

Consumption Type	Demand**	Operation Time Considered	Yearly Demand	Emission Factor	GHG Emission (million tons CO ₂ e)
Electricity	3248.17 MW	300 days, 16 hours/day	15591216 MW-h	0.648 tons CO ₂ eq/ MW-h	10.103
Natural Gas	4675467.96 m ³ /day		1402640388 m ³	1.885 kg CO ₂ eq/ m3	2.643
Total GHG Emission Estimated for 2041					12.746

** Electricity and Natural Gas demand values are taken from EZ Master Plan

Note: Emission Factors used in GHG Calculation

1. Natural Gas: EF = 1.885 kg- CO₂ eq /m³ [GHG Protocol]
2. Bangladesh Grid Electricity: EF = 0.648 kg CO₂ eq /kWh [GEF of Bangladesh (SREDA)]

To minimize GHG emissions, mitigation measures shall be taken by the investors and contractors, such as management of operation time of construction machinery, avoidance of excessive loading operation, and education of construction workers/drivers about the idling stop practice for machinery and vehicles. In order to reduce GHG emissions, the usage of solar light and the usage of LED in the EZ area is planned. In addition, energy-saving equipment and fuels that emit less GHG will be recommended to be installed in all industries for their operations as much as possible.

Besides, the utilization of commuter buses and/or industrial electric vehicles for workers to reduce traffic GHG emissions shall be initiated by the industries. Gases-based fuels tend to emit lower amounts of GHGs than liquid fuels and solid fuels. Thus, clean fuel alternatives or low-emission GHG fuels and technologies that will be established in the EZ shall be promoted. In order to reduce GHG as part of the carbon footprint incentive program, energy conservation, recovery of heat, or power efficient consumption shall be implemented. Therefore, this issue is recommended in GHG mitigation measures or as an alternative option for future development of the EZ.

The operation of industrial facilities within EZ may contribute to greenhouse gas emissions and exacerbate climate change impacts on the Sandwip Channel ecosystem. Changes in temperature, precipitation patterns, and ocean acidification associated with climate change could further stress planktonic and benthic organisms, compounding existing threats to their survival and reproductive success.

The NSEZ itself may be vulnerable to changes in the environment due to climate change. The EZ is located on the coastline of Bangladesh which is highly vulnerable to Cyclones disaster and its associated tidal surges. The frequency of Cyclones has already increased in the Bay of Bengal. To meet the water demand EZ is planning to take saline water from the Sandwip Channel/Sea and establish a desalination plant. The seawater intake of the desalination plant would need to be designed to account for changes in sea state that may become worse because of higher-intensity storm

(Cyclones) events. The location of the desalination plant should consider sea-level rise and its possible implications. Any change in ocean temperatures and circulation patterns may also change the frequency of tide events that may impact the water intake of operations of the desalination plant.

Considering the above issues, the impact of the operation of the EZ on climate change and greenhouse gas emissions is evaluated to be **Medium High**.

A summary of environmental and social impact significance during the operation of the EZ has been provided in Table 5-23.

Table 5-23: Summary of Environmental and Social Risks and Impacts During Operation Phase

Aspects/Issues/Impacts	Nature	Extent & Location	Duration	Intensity/Severity	Irreplaceable	Probability	Significance
Impacts on Air Quality	Direct	Regional	Permanent Mitigated	Medium	Medium	High	Medium High
Impacts from Noise	Direct	Regional	Permanent Mitigated	Medium	Low	High	Medium Low
Impacts on Surface Water	Direct	Local	Permanent Mitigated	Medium	Medium	Medium	Medium Low
Impacts on Groundwater	Direct	Regional	Permanent Mitigated	High	Medium	Medium	Medium Low
Impacts on Topography and Soil	Direct	EZ Site	Long Term	Medium	Medium	Medium	Medium Low
Impacts on Sediment	Direct	Local	Long Term	Medium	Medium	Medium	Medium Low
Impact due to Changes in Land Use	Indirect	Regional	Permanent Mitigated	High	Medium	High	Medium High
Impact due to Solid Waste Generation	Direct	Local	Permanent Mitigated	High	Medium	High	Medium High
Impacts of Liquid Waste Generation	Direct	Local	Permanent Mitigated	High	Medium	High	Medium High
Impacts on Drainage	Induced	Regional	Permanent Mitigated	High	Medium	High	Medium High
Impacts of Traffic	Induced	Regional	Permanent Mitigated	High	Medium	High	Medium High
Loss of Ecosystem Services	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Terrestrial Flora	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Terrestrial Mammals	Direct	Local	Medium	Low	Medium	Medium	Low

Aspects/Issues/Impacts	Nature	Extent & Location	Duration	Intensity/ Severity	Irreplaceable	Probability	Significance
Impacts on Birds/Avifauna	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Herpetofauna	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Aquatic Mammals	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Ichthyofauna (Fish)	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Hilsa Fisheries	Direct	Local	Medium	Low	Medium	Medium	Low
Impacts on Plankton and Benthos	Direct	Local	Medium	Low	Medium	Medium	Low
Community Health, Safety, and Security	Direct	Regional	Permanent-mitigated	Medium	Medium	Medium	Medium-Low
Occupational Health and Safety	Direct	Project site	Long-term	High	Low	Medium	Low
Labor Influx	Direct	Regional	Long-term	High	Medium	High	Medium-high
Child Labor and Forced Labor	Direct	Regional	Permanent-mitigated	Medium	Medium	High	Medium-high
Gender Based Violence and Sexual Exploitation and Abuse/Sexual Harassment		Direct	Regional	Long-term	Medium	Medium	Medium
Violence Against Children	Direct	Regional	Long-term	Medium	Medium	Medium	Medium-Low
Impact on Social Infrastructures	Direct	Regional	Long-term	High	Medium	High	Medium-High
Impacts on Fisherman and Fishery Activity	Direct	Local	Long-term	Medium	Medium	Medium	Medium-Low
Impacts on Livestock Population and Dependent Community	Direct	Local	Long-term	Low	Low	Low	Low
Tourism	Indirect	Regional	Long-term	Low	Low	Low	Low
Cultural Heritage	Direct	Regional	Long-term	Low	Low	Low	Low

Aspects/Issues/Impacts	Nature	Extent & Location	Duration	Intensity/ Severity	Irreplaceable	Probability	Significance
UNESCO World Heritage Sites	No impacts are anticipated as there is no UNESCO heritage site in the EZ area						
Impacts on Community Dynamics	Direct	Regional	Long-term	Medium	Medium	Medium	Medium-low
Impacts due to Natural Disasters	Induced	Regional	Permanent Mitigated	High	Medium	High	Medium High
Climate Change and Greenhouse Gas Emissions	Induced	National	Permanent Mitigated	High	Medium	High	Medium High

6 SCENARIO DEVELOPMENT

This chapter describes three alternative growth scenarios (high, medium, and low) for the NSEZ area as well as the region over the next 20 years – as influenced by a range of interacting driving forces and recognizing several uncertainties, e.g., climate and water availability, commodity prices, and the nature of governance:

- High growth scenario represents the growth path that will be required - through added stimulus (investment, innovation, etc.) to achieve high-income country status by 2041.
- Medium growth scenario is equivalent to the country's current growth path aimed at achieving upper middle-income country status by 2031.
- Low growth scenario postulates a reduction of economic growth that could be triggered mostly by external factors - over which Bangladesh has little or no control.

Each scenario incorporates indicators and projections of the developments that will be likely to arise over the next 20 years including, for example, new/upgraded infrastructure, new industrial facilities, changed environmental and social management regimes, changes to agricultural and fisheries activities, etc.

6.1 Scenario Development

The future will be shaped by the interacting effect of many environmental and social factors or drivers of change and uncertainties (Table 6-1) - particularly factors that are external to the country and beyond its direct control. Some of these are discussed in Table 6-1.

Table 6-1: Potential Drivers of Change and Uncertainties

Types of Drivers	Description
Environmental Drivers	• Increasing pollution of air, noise, water, soil, and sediment - leads to declining human health, impeded ecosystem functioning, and reduced ecological services. • Availability of water resources including groundwater. • Increasing solid, liquid, and hazardous waste from domestic and industrial sources - leading to environmental pollution and impacting human health and ecosystem and biodiversity. • Climate Change: – Sea level rise - leading to migration away from coastal areas – Saltwater intrusion in the coastal belt – Increase in temperature and rainfall • Natural disasters (earthquakes, tsunamis, cyclones, tidal surges, etc.) – Coastal erosion due to wave action – Influencing the use of building materials and designs – Creating more demand for building materials (e.g., dredged material (i.e., sand, wood, bamboo, etc.), imported from other countries. • Increasing soil salinity (mainly due to reduced freshwater flows in rivers and sea level rise) - reducing land productivity.
Social Drivers	• COVID-19 and future pandemics outbreak. • Changes in people's lifestyles and social mobility. • Out-migration in different countries - for employment and work. • In-migration to urban areas (i.e., Dhaka, Chattogram, etc.) from rural areas.

Types of Drivers	Description
	• Cultural factors: – Women employment – Influence of globalization – External influences on culture (i.e., television, internet, movies, drama, etc.) – Intercultural exchange • Gender factors: – Domestic violence – Women's participation in socio-economic activities – Women's participation in paid work • Health and sanitation • Access to education • Employment opportunities and skill development • Social infrastructures i.e., playground, cemetery, graveyard, etc.
Governance and Legal Instrument Drivers	• National legislation, policies, and guidelines • National, regional, and municipal policies • International legally binding instruments ratified by the GOB (i.e., treaties, conventions, agreements, etc.) • Institutional factors (coordination and integration of government agencies) • Inadequate skills and capacity • Politics
Economic Drivers	• Domestic demand (i.e., locally produced goods and services and imports) • Global and regional markets (i.e., exports) • Prices of energy-related raw materials (coal, oil, LNG, LPG, etc.) • Lack of access to capital for domestic investors • Opportunity for foreign direct investment • Global financial crisis • Tourism facilities • Remittances • Government policy to achieve transformation of Bangladesh into an upper middle-income country by 2031 and higher income country by 2041.
Other Drivers	• Donors (multilateral, bilateral, UN agencies, etc.). • Technology: – New technologies available for power generation (providing advanced low-carbon or zero-carbon energy) and higher efficiency of conversion. – Renewable energy (wind and solar). – New technologies are available in the industry (enabling higher energy efficiency, lower emissions, less waste, and improved recycling/zero discharge plan). – Availability of more energy-efficient appliances. – Phones and laptops. – White goods (fridges, televisions, air conditioners, etc.) - making life easier/more comfortable (but increasing energy demand).

Types of Drivers	Description
	• Access to information and portals: – Enabling increased freedom of speech. – Affecting accountability and transparency - citizens can keep leaders and others accountable. – Allowing people to be more vocal about issues. • Infrastructures: – Feni-Noakhali National Highway to 4-Lanes at Begumgonj to Sonapur – Chattogram - Cox's Bazar Rail Link project – Dhaka-Chattogram Highway - providing easier access to the Chattogram region including a better connection with the Chattogram Sea Port. – Bangabandhu Tunnel – Bay Terminal project – Matarbari Port Development – Power hub in Matarbari area – Flyover in Chattogram City – Chattogram Elevated Expressway – Chattogram Airport Development Project – Bayezid-Faujdarhat Link Road • Sonadia Ecotourism, Sabrang and Naf Tourism Park • S Alam Banshkhali EZ. • 900 MLD Water Pipeline from the estuary of Padma Meghna Dakatia Estuary – Economic zones are in the Chattogram and Cox's Bazar region (Anowara (Gohira) Economic Zone, Anowara-2 Economic Zone, Cox's Bazar Free Trade Zone, Moheshkhali/Dhalghata Economic Zone, etc.). – Hazardous waste Treatment Storage and Disposal Facility at Sitakunda area for waste from the ship-breaking industry. – Construction of Jetty in Sandwip and Teknaf (Sabrang and Jaliar Island). – Bangladesh Regional Waterway Transport Project 1 (Dredging of the river routes on the Chattogram-Dhaka-Ashuganj corridor).

The use of scenarios in this report is to help explore systematically what the future might look like over the next 20 years under three growth scenarios (high, medium, and low) and to ensure that the analysis and projections made for the three scenarios are as realistic and robust as possible.

6.1.1 Scenario Assumptions and Uncertainties that Might Influence the Future

In developing the scenarios elaborated in subsequent sections, a number of assumptions have been made:

- Population growth rate will be highest in the low growth scenario but is likely to decline under high growth.
- Climate change and groundwater availability in the region are major uncertainties.
- Industrial and manufacturing expansion will play a major role in Gross domestic product (GDP) growth.

- Increasing power demand will be covered by newly built power plants as well as upcoming and planned projects.
- There is a strong emphasis on ensuring a smooth transition from an agrarian economy to an industrial economy.
- The government will pursue decentralized urban development through political, legal, institutional, and financial reforms and incentives.
- Rural-urban migration will be discouraged through the 'My Village-My Town' programme and other measures including the implementation of economic zones all over Bangladesh.
- Small and medium-sized entrepreneurship will be encouraged and supported.
- Government will seek to eliminate gender discrimination and increase female literacy and employment.
- Bangladesh will continue to enjoy internal and external peace and security under the dynamics of international and regional geopolitics.
- Government will implement all existing policies and associated environmental and socioeconomic measures.
- Global and regional economies will recover post-COVID-19 (particularly for the high growth scenario).
- Other countries will also invest in infrastructural development including economic zones in Bangladesh.

6.2 Scenario Narratives

Key features of the different growth scenarios are given in Table 6-2.

Table 6-2: Key features of the scenario

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
Environmental Factors	Groundwater Availability and Salinity Intrusion	- Currently, there is a groundwater crisis in the region (i.e., Mirsharai and Sitakunda Upazila of Chattogram District) for domestic and industrial uses as well as irrigation during the dry season. The extraction of groundwater for different increasing industrial activities in the region may cause an extreme groundwater crisis and conflict with the community. - Withdrawing groundwater in excess of the rate of recharge may result in the lowering of the water table, land subsidence, salinity intrusion into the groundwater aquifer, and decreased water quality.	Groundwater availability and salinity intrusion - currently the local community is facing a groundwater crisis in the region specifically in Mirsharai and Sitakunda areas.	- Pressure on groundwater resources in the region was started by establishing different heavy industries in the Sitakunda area. - Salinity intrusion in freshwater was less and mainly due to the effect of tidal surges during the cyclones.
	Ecosystem Services	- With rapid industrialization and urban expansion, water scarcity could become more pronounced. - Overfishing, pollution, and habitat loss could severely diminish fish stocks. - Traditional medicinal resources could be replaced by modern pharmaceuticals, and households might shift to alternative energy sources like	- With controlled industrialization and urban expansion, water scarcity might not be as severe as in a high-growth scenario. - Fish stocks face pressure due to moderate industrial and population growth but overfishing and pollution are less intense than in a high-growth scenario. - Livestock farming declined slightly but could coexist with	- Limited industrial expansion and urbanization due to low economic growth result in less habitat destruction and fragmentation, potentially preserving more natural areas and biodiversity in the region. - With decreased industrial activities, there would likely be lower emissions of pollutants into the air, water, and soil. This could maintain or improve the

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		gas and electricity for cooking and heating. - Fishing activities and dependent livelihoods community may be impacted in the region. - Livestock farming may decline in the region potentially reducing pastoral lifestyles. - Increased vulnerability to natural disasters might be countered. - Biodiversity may decline unless significant conservation efforts are implemented.	more intensive agricultural practices and urban occupations. Cultural shifts towards modern healthcare systems reduce dependence on traditional practices.	quality of ecosystem services such as clean water and air. - Reduced economic growth led to fewer financial resources allocated for environmental protection and conservation efforts, potentially resulting in inadequate management of natural resources and neglected conservation projects. - Economic struggle driven local communities to over-exploit natural resources (e.g., fishing, logging, agriculture) as a means of subsistence, leading to the gradual degradation of ecosystem services such as soil fertility, water regulation, and biodiversity. - Without the pressures of rapid industrialization, ecosystems have better resilience and recovery potential, allowing them to maintain their ecological functions and services despite economic stagnation. However, this heavily depends on effective local management and sustainable practices.
	Wildlife Habitat and Biodiversity Conservation	Implementation of stringent environmental regulations will control pollution and manage resource use effectively. The	Sufficient resources to establish and enforce protected areas, although not as extensively as in a high-growth scenario. This	With constrained economic resources, the establishment of new protected areas and the enforcement of existing ones

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		adoption of sustainable industrial practices and green technologies will become commonplace. • Marine Protected Areas (MPAs) will conserve marine biodiversity, safeguarding coral reefs, mangroves, and seagrass beds. Fishing regulations will be strictly enforced within MPAs, promoting sustainable fishing practices. • Scientific research on marine biodiversity will receive increased funding. Monitoring programs will continuously assess the health and biodiversity of marine ecosystems. • Habitat of the Irrawaddy Dolphin (<i>Orcaella brevirostris</i>) and Indo-Pacific Humpback Dolphin (<i>Sousa chinensis</i>) may be impacted due to the increasing activities (i.e., port/jetty developments, vessel movement, dredging) in the sea. • Migratory shorebirds in the coastline i.e., Sandwip Channel, Bay terminal, Maheskhali, and Matarbari area may be impacted.	balanced approach helps conserve critical habitats, while initiatives to restore degraded habitats and reforestation efforts still play a significant role in habitat recovery. • Implementation of environmental regulations is feasible and effective. While stringent regulations could control pollution and manage resource use, the adoption of sustainable industrial practices and green technologies may become more widespread, albeit at a slower pace compared to a high-growth scenario. • Adequate funding and enforcement capabilities for the management of MPAs. This supports the conservation of marine biodiversity, including coral reefs, mangroves, and seagrass beds. Strict enforcement of fishing regulations within MPAs promotes sustainable fishing practices. • Funding for scientific research on marine biodiversity and continuous monitoring programs could be steady, though not as high as in a high-growth	were limited. This led to insufficient conservation of critical habitats, leaving them vulnerable to degradation and exploitation. • Stringent environmental regulations and the adoption of sustainable industrial practices are not prioritized. As a result, pollution levels are not adequately controlled, and unsustainable resource use persists, negatively impacting wildlife habitats and biodiversity.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
			scenario. This allows for ongoing assessment of marine ecosystem health and biodiversity, enabling informed conservation efforts. - Irrawaddy Dolphin and Indo-Pacific Humpback Dolphin may be affected due to the intervention in the marine environment. - Migratory shorebirds on the coastline of the Bay of Bengal will be impacted.	
	Invasive Alien Species	- High economic growth and development can lead to increased trade, industrial activity, and human movement, all of which can exacerbate the spread of Invasive alien species. - Infrastructure improvements and urban expansion could disrupt local ecosystems, making them more vulnerable to invasion. - Additionally, climate change, potentially exacerbated by industrial growth, could further stress native species and habitats, providing more opportunities for IAS to establish and spread.	- With a medium rate of economic growth, there will still be an increase in trade, industrial activity, and human movement, but at a more controlled pace. This reduces the number of pathways for IAS introduction and spread compared to a high-growth scenario. - Infrastructure improvements and urban expansion occur but on a smaller scale. This likely leads to fewer disruptions of local ecosystems, making them somewhat less vulnerable to IAS invasions compared to rapid and extensive development. - Native species and habitats experience less stress,	- Lower economic growth and limited development result in decreased trade, industrial activity, and human movement. This reduces the pathways and opportunities for IAS to spread into new areas, potentially slowing their introduction and establishment. - With less infrastructure development and urban expansion, local ecosystems experience fewer disturbances. This helps maintain the integrity of native habitats, making them less susceptible to invasion by IAS.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
			potentially reducing the opportunities for IAS to establish and spread.	
	Land Use/Cover Change	• Increase in the extent of land converted to industrial area, transportation infrastructures, township development, urban area expansion, etc.	• A moderate increase in the extent of land converted to industrial and urban development.	• No significant change in land use/cover.
	Waste	• Big improvement in implementation of waste collection mechanisms and waste treatment facilities. • Large increase in capacity to convert waste to usable resources through recycling. • Significant improvement in waste collection and processing. Advanced recycling systems and waste-to-energy projects are established, reducing landfill dependency and maximizing resource recovery. • Strict regulations ensure proper disposal. Modernized medical waste treatment facilities are set up, and new technologies reduce infection risks and environmental contamination. • Dedicated treatment and disposal facilities are constructed, and regulations are enforced, particularly for	• Moderate increase in capacity to convert waste to usable resources, with about half of the municipalities and pourashavas equipped with waste recycling plants. • Steady improvement in urban waste collection and recycling, but growth is slower due to limited resources. New facilities are introduced but may struggle to keep up with increasing waste generation. • Some upgrades to medical waste handling, but gaps remain in collection and treatment capacity. Manual handling increases risks to workers and the environment • Expansion of hazardous waste treatment facilities is modest. Although basic management systems are enforced, they may not be sufficient for new	• Poor waste collection mechanisms and adoption of waste treatment facilities. • Limited or no capacity to convert waste to usable resources. • Waste collection remains basic, and recycling is minimal. Poor infrastructure leads to overfilled landfills and illegal dumping, creating public health hazards. • Limited resources result in inadequate collection and treatment. Improper disposal methods pose risks to workers and local communities. • Little improvement in handling hazardous waste, leading to growing contamination risks due to poorly managed facilities and insufficient monitoring.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		industrial zones. Advanced methods are employed for handling and recycling hazardous materials, minimizing environmental impacts.	industrial activities, leading to risks of spills and soil contamination.	
	Pollution	- Increased air pollution by transport, power generation, and industrialization, considerably compensated by emission reduction measures (use of LPG/LNG, improved vehicle fleet and traffic management, abatement techniques in power plants and industries, etc.). - Moderate to high increase in noise in highly populated areas with the introduction of technology (including vehicles) compensating for increased traffic and industrial intensity. - Large increase in greenhouse gas emissions, partially compensated for by energy efficiency measures and increased use of renewables. - Pollution is fully and effectively managed through: - Implementation of pollution reduction measures and regulations. - Establishment of effluent treatment plants in all	- Increased air pollution by transport and industrialization is partially compensated for by emission reduction measures (switching to LPG/LNG, emission abatement techniques, etc.). - Moderate increase in greenhouse gas emissions from industrial activities and the transportation sector. - Moderate to high increase in ambient noise level in highly populated areas due to increased traffic intensity and industrial activity. - Pollution management is improved through: - Partial implementation of pollution reduction measures and regulations. - Establishment of effluent treatment plants in most of the industries. - Increased sewage treatment capacity.	- No significant change in ambient air quality and noise level. There was more green area in the region. - Limited increase in greenhouse gas emissions from the burning of fossil fuels. - Noise increases in highly populated areas due to the traffic. - Pollution management is poor due to: - Ineffective implementation of pollution reduction measures and regulations. - Establishment of effluent treatment plants in only a limited number of industries. - Limited sewage treatment capacity.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		industries and economic zones. – Sufficient sewage treatment capacity to deal with volume generated. – Adoption of modern and upgraded technology and stringent air quality mitigation measures including clean fuel.		
	Vulnerability to Climate Change and Natural Disasters	• Reduction in the extent of land inundated (due to the improvement of embankments/super dyke) in the coastal belt, with a reduction in the number of households affected. • Substantial improvement of natural disaster early warning system and increased number of shelters and rescue teams. • Adequate adaptation and mitigation measures implemented (embankments/super dyke strengthened, coastal afforestation, etc.).	• Little initial change to the extent of land inundated but with moderate improvement in later years (due to the strengthening of embankments/super dyke). • Improved early warning system, rescue teams, rescue equipment, and increased number of shelters. • Adaptation and mitigation measures implemented (embankments strengthened, coastal afforestation, etc.).	• A moderate increase in the extent of land inundated (due to poor maintenance and deterioration of embankments/super dyke) - with a large increase in the number of households affected. • Inadequate early warning system and dissemination mechanism (specifically for Cyclones and associated tidal surges) and inadequate number of shelters, rescue teams, and equipment for the increasing population. • Inadequate adaptation and mitigation measures implemented (embankments/super dyke strengthened, coastal afforestation, etc.).

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
	Drainage, Waterlogging, and Flooding	- Development of improved drainage systems, super-dykes, and embankments to mitigate the risk of waterlogging and flooding. The scenario envisions large-scale drainage projects, especially in the coastal areas and flood-prone zones. - Implementation of modern drainage networks in rapidly urbanizing areas, aimed at preventing urban flooding during heavy rainfall. - Emphasis on flood-resilient design of roads, industrial facilities, and residential areas, helping reduce the impact of heavy rainfall and riverine flooding.	- Implementation of drainage systems at a municipal level, focusing on flood-prone urban centers. Rural areas receive incremental improvements. - Upgrades in embankments are gradual, covering key industrial and residential areas but not comprehensive across all vulnerable regions.	- Minimal investment in drainage and flood protection infrastructure, resulting in high vulnerability to waterlogging and flooding in both urban and rural areas. - The low-priority drainage upgrades result in frequent urban waterlogging and hinder mobility in cities like Dhaka and Chattogram.
	Natural/Manmade Hazards and Accidents	- Improved disaster management measures like early warning systems, evacuation plans, and increased investments in disaster shelters. - Infrastructure developments incorporate earthquake-resistant features in construction codes due to Bangladesh's vulnerability to seismic activities. - Establishment of stricter environmental controls to mitigate risks from hazardous	- Investment in disaster preparedness measures is moderate, covering priority zones and industries prone to risks like chemical hazards or oil spills. - Seismic-resistant construction is promoted but not mandated across all sectors, focusing primarily on essential facilities.	- Lack of substantial investment in emergency response systems leads to greater exposure to natural hazards, manmade industrial risks, and accidents. - Weak enforcement of safety regulations and building codes, increasing the risks from industrial accidents and natural hazards like earthquakes.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		chemicals in industrial zones. Enhanced monitoring systems and emergency response units stationed near critical industrial hubs.		
	Green Belt, Forest Cover, and Vegetation	- Implementation of extensive coastal afforestation programs to counteract sea-level rise and provide natural protection against tidal surges. - Nationwide campaigns to enhance forest cover and introduce more green zones in urban developments. This includes promoting urban parks, roadside plantations, and dedicated green belts near industrial areas. - Protection and expansion of existing mangrove forests and conservation areas to safeguard biodiversity and stabilize coastal ecosystems against erosion and storm impacts.	- Some afforestation and reforestation efforts continue, mainly focusing on maintaining existing green belts and minimizing deforestation. - Introduction of urban green spaces is driven by local initiatives but lacks comprehensive national planning.	- Limited or no focus on afforestation programs, leading to increased vulnerability of coastal areas to erosion and tidal surges. - Weak conservation efforts and growing urbanization cause significant declines in forest cover and vegetation, affecting local biodiversity and ecosystems.
Social Factors	Population	Population growth rate likely to be reduced due to a lower total fertility rate as a consequence of improved education and employment of women - thus delaying the age of marriage and prohibition of early marriage.	- Total population is marginally higher than the baseline and higher than for the high-growth scenario. - Population growth rate reduces due to a lower total fertility rate as a consequence of a higher	High population growth due to a higher total fertility rate.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		In migration from other areas will increase due to industrial development and employment opportunities.	- number of women being in employment. - Considerable reduction in migration from rural to urban areas.	
	Land Administration	- Land administration system will be upgraded by curbing corruption and implementing land digitization projects. - Good governance will be promoted in the land management and administration system. - Substantial decrease in the number of land disputes/conflicts as more cases are resolved by formal and informal processes and improved governance for their management is in place.	- Small and marginal landholders tend to sell their land to enable an increase in industrial enterprises. - Agricultural land, particularly single-cropped areas, is increasingly converted for urbanization and industrialization, especially in urban and semi-urban areas. - Moderate increase in the number of land disputes/conflicts due to increased land acquisition and land grabbing but improved governance for their management.	- An increase in unplanned development and poor land administration. - Voluntary and involuntary land transfers will transform smallholders into marginal and landless people. - A small increase in the number of land disputes/conflicts due to increased land acquisition and land grabbing and poor or inadequate governance of land-related disputes.
	Education	Considerably improved educational system and delivery with an emphasis on quality. Well-educated and trained labor force. The private sector will play a dominant role in delivering tertiary education and skill training, while the public sector remains dominant in delivering primary and secondary education.	Moderately improved educational system and delivery, with increased investment in the education sector, particularly in secondary education.	No change to the education system, quality, and delivery (particularly at the primary level) and job-based training. Public sector education remains dominant with usual investment in the education sector.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		Technical and vocational education will increase.		
	Health and Sanitation	- Considerably improved health care with a large increase in the number of physicians and well-equipped health care services affordable for most of the population. - Moderate increase in life expectancy. - Large improvement in the percentage of the population connected to water supply and sanitation services.	- Moderately improved health care with a moderate increase in the number of physicians. - Modest increase in life expectancy. - Moderate improvement in the percentage of the population connected to water supply and sanitation services. - A moderate increase in the number of women employed in the productive sectors of the economy, participating in decision-making, and participating in formal education and skills development. - High population growth due to a higher total fertility rate (which declines after 2026).	- No mentionable change to health care with little increase in the number of physicians. - Small increase in life expectancy. - No mentionable change initially in the percentage of the population connected to water and sanitation services, with a moderate improvement in later years.
	Women Empowerment	A notable increase in the number of women employed in the productive sectors of the economy, participating in decision-making and participating in formal education and skills development.	-	- A limited or no major changes in the number of women employed in the productive sectors of the economy, participating in decision-making, and participating in formal education and skills development. - Low level of participation of women in the job market compared to their male

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
				counterparts; and no changes in numbers of women participating in formal education and skills development.
	Poverty and Equality	• Large reduction in poverty and inequality due to a major increase in productive employment. • An increase in alternative forms of income generation. • Moderate engagement of landless and marginal people in development activities.	• Moderately reduced poverty and inequality. • Modest improvement in the engagement of landless and marginal people in development activities.	• No reduction in levels of poverty and inequality with people having few alternative income-generating opportunities. • A dependency on the sea and local resources like grazing land remains unchanged.
	Cultural and Natural Heritage Sites	• Improved management, maintenance, and preservation of existing Cultural and Heritage Sites and development of new sites.	• Modest improvement in management, maintenance, and preservation of cultural and heritage sites.	• Typical management, maintenance, and preservation of cultural and heritage sites.
Economic Factors	Economic growth	• Rapid economic growth driven by innovation, ICT, an increased skills base and trained manpower, and considerably improved labor productivity. • GDP grows much faster than the population - at 2.1% between 2031 and 2041, with GNI per capita reaching US\$ 12,536+ (2019) by the year 2041, and a continuing trend of a positive balance of payments.	• Moderate economic growth with some improvement in efficiency, an increase in innovation, improved ICT, and a moderate increase in the skills base and availability of trained manpower. • GDP grows slightly faster than the population at 1.6% per annum between 2031 and 2041, with GNI per capita reaching 4,046 to 12,535 USD (upper middle-income) by the year 2031.	• Low economic growth with no improvement in efficiency, limited or no innovation, minor improvement in ICT, and no increase in the skills base or availability of trained manpower. • GDP and GNI per capita grow only at the rate of population increase. • Limited increase in the share of GDP of industry, transport, and services but a small increase in the share of agriculture.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		- Major increase in the share of GDP of industry, agriculture, transport, and services. - NSEZ is partially operational, and others economic zones are in the planning and developing stage.	Moderate increase in the share of GDP of industry, agriculture, transport, and services, though the scope for improvement.	
	Industry and Exports	- A high rate of industrialization with an emphasis on export-oriented manufacturing, and transformation of the rural agrarian economy to a primarily industrial and digital economy. - A considerable increase in the volume of exports via NSEZ Jetties, Chattogram seaport, Bay terminal, and Matarbari Ports where the facilities will be well maintained and regularly upgraded to increase capacity. - Capital and maintenance dredging will be undertaken to increase the draught limit in these routes. - A large increase in freight transported by inland waterways.	- A moderate rate of industrialization with some increase in export-oriented manufacturing, and a start to transforming the rural agrarian economy to a primarily industrial and digital economy. - A moderate increase in the volume of exports via Chattogram seaport. - Maintenance dredging is done periodically to maintain navigability in the Karnaphuli River channel. - Freight is transported by a mix of road, rail, and inland waterways.	- A low rate of industrialization with a minor increase in export-oriented manufacturing, and no immediate transformation of the rural agrarian economy to a primarily industrial and digital economy. - The volume of exports via Chattogram seaport remains static. - Maintenance dredging is sporadic in the Karnaphuli Channel. - Roads and railways are preferred over inland waterways for freight transportation.
	Employment	- Decline in people employed in agriculture in the region. - Moderate to high increase in job opportunities in service and industrial sectors.	- Decline in people employed in agriculture. - Modest to moderate increase in job opportunities in the service and industrial sectors.	Small increase in people employed in the service and industrial sectors.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
			- Moderate investment, intensification, and diversification of agricultural production (HYV and use of organic and bio-fertilizers), expansion in mechanization, and increase in agro-based small industries and manufacturing. - A moderate to high level of food security with increased nutritional values and affordability.	
	Agriculture	- A reduction in the extent of agricultural land but adoption of advanced agro-technology will take place. - Considerable investment, intensification, and diversification of agricultural production and coastal aquaculture, with expanded mechanization, a major shift from the use of inorganic to organic and biofertilizers, and increased use of SMART technologies. - Increase in agro-based small industries and manufacturing, with producers emphasizing high-value products such as vegetables, fruits, pulses edible oils, and also meat, fish, egg and	-	- No or limited further investment, intensification, and diversification of agricultural production. - A moderate level of food security, although with a reduced level of nutritional value and affordability.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		milk, especially for the urban people.		
	Power and Energy	- Focus on low-cost and low-carbon/zero-carbon power generation (for Bangladesh as a whole) (renewables, natural gas, clean coal, and LPG). - Increased efficiency in the use of the installed capacity of power plants. - Extensive governmental support for fuel switches to LPG and LNG in cooking and transportation. - Expansion of energy trade. - Strengthening and enhancement of the power grid network. - Conversion to renewable energy, as per the Renewable Energy Policy of Bangladesh, 2008.	- A moderate increase in demand for energy to support increased industrialization, urban expansion, and to meet the growing demands of an increasing population and improved transport, will be addressed through: - A continuing reliance on coal-fired power generation, but only a moderate increase in the use of renewable energy, LNG, and LPG). - Moderate governmental support for fuel switch to LNG and LPG in cooking. - Started expansion of power grid network for power transmission and distribution. - Expansion of renewable energy i.e., wind and solar.	- A continuing reliance on coal-fired power generation, but a low increase in the use of renewable energy, a modest increase in the use of natural gas and LPG but no phasing out of high-cost rental power plants. - Limited increase in the efficiency of use of the installed capacity of power plants. - No change in the expansion of the power grid network for power transmission and distribution. - Limited use of renewable energy i.e., wind and solar power.
	Infrastructure, Transport, Connectivity and Communication	Major expansion of infrastructure development, e.g. expansion of pipelines for transportation of petroleum; power transmission and distribution; small further increase in the density of roads, and more emphasis on inland water transport and railways with	Moderate expansion of infrastructure development, e.g., expansion of Dhaka-Chattogram Highway, installation of LNG floating storage and re-gasification units in Maheskhali area, power transmission and distribution from Matarbari power	- Limited expansion of infrastructure development. - A considerable increase in non-motorized vehicles. - Deterioration in management of urban traffic.

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		rapid extension in the railway network of Chattogram-Cox's Bazar region due to high passenger count and growth in income. • High growth in motorized traffic, with non-motorized traffic on highways. • Substantial improvement in the management of urban traffic (e.g. fitness certificates, illegal or unfit vehicles not permitted on roads, proper application of restrictions on sounding car horns and noisy engines, more efficient traffic management measures). • Strong inter-district and inter-regional connectivity with neighboring countries for passengers, goods and services. • A large increase in the usage of mobile phones and internet.	hub, development of Matarbari seaport, a moderate increase in the density of roads and an emphasis on creating inter-district connectivity and upgrading national highways. • Moderate growth in motorized traffic. • Moderate improvement in the management of urban traffic (e.g., fitness certificates, illegal or unfit vehicles not permitted on roads, proper application of restrictions on sounding car horns and noisy engines). • Moderate improvement in inter-district and inter-regional connectivity for passengers, goods and services. • A moderate to high increase in the usage of mobile phones. • A moderate increase in the usage of internet.	• Limited improvement in inter-district and inter-regional connectivity for passengers, goods and services. • A small increase in the usage of mobile phones.
	Urbanization	• An urban physical environment where there is a balance between environmental requirements and the needs of the urban population. • Effective drainage, modern sewerage, and a fully functioning waste management system.	• An urban physical environment where there are growing initiatives to achieve a balance between environmental requirements and the needs of the urban people. There is a mix of traditional and modern sewerage systems and partial	• No transition of an agrarian economy to an urban-based industrial economy along with the poor harmonization in urban ecosystem management, sewerage treatment, and solid waste management. • Initiatives to achieve a balance between environmental

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		Majority of the rural population will enjoy facilities similar to those available in urban areas.	development in waste management.	requirements and the needs of the urban people stagnate or cease, with no improvement of sewerage and waste management systems and poor maintenance of existing systems. No change in the proportion of the rural population enjoying facilities similar to those available in urban areas.
	Housing, Residence, and Public Amenities	- Rapid urbanization and industrial growth lead to a boom in housing projects. The government and private developers invest heavily in modern residential complexes to cater to the growing population and workforce. New townships are planned, emphasizing sustainable urban design with efficient land use and integration of green spaces. - Policies promoting affordable housing are prioritized to support low and middle-income families. Residential areas include amenities like parks, educational institutions, healthcare centers, and recreational facilities, ensuring a high quality of life. - Large-scale investment is made in developing public services	- Steady but not overly rapid development of housing infrastructure, with a focus on affordable and mixed-income housing. Urban and semi-urban zones will develop with moderate density, providing essential services such as clean water, electricity, and waste management facilities. - The focus will be on essential public services such as parks, playgrounds, community centers, and healthcare facilities. Public amenities will be built alongside residential expansions to ensure an integrated urban environment. Moderate investments in green spaces and public facilities will aim to foster social cohesion and well-being.	- Due to economic constraints, housing development will be slower, with limited availability of new affordable housing units. Expansion of residential areas may lag behind demand, potentially leading to the growth of informal settlements and slums. Urban sprawl could occur without adequate planning, resulting in poorly connected residential areas. - Investment in public amenities such as parks, recreational areas, and community centers will be limited. Existing public infrastructure might face pressure due to increasing population density without corresponding improvements in public services like waste

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		and amenities such as reliable public transport, healthcare facilities, schools, and marketplaces. The scenario envisions a well-planned urban fabric with sufficient public utilities, including clean water supply, efficient sewage systems, and electricity. Advanced technology is integrated into urban planning, focusing on smart city initiatives like e-governance, digital infrastructure, and automated traffic management systems to ensure efficient and safe living conditions.	Public infrastructure improvements will be gradual, emphasizing sustainable city planning with improved connectivity, roads, transport facilities, and walkable urban spaces. However, resource constraints could limit the scale of improvements, leading to gradual but steady progress in enhancing livability.	management, healthcare, and education facilities. Limited resources and slow growth in infrastructure investments may lead to inadequate road networks, public transport, and services in newly developing residential areas. Water supply and sanitation facilities in semi-urban and rural regions might see only modest improvements.
	Safety and Security	- Increased emphasis on implementing security measures like enhanced surveillance systems, safe public transport, and improved lighting in streets and public spaces. Community policing initiatives are expanded to strengthen law enforcement at local levels. - A robust disaster management plan includes modernized early warning systems for natural hazards such as floods, cyclones, and earthquakes. New regulations ensure buildings are	- There will be a moderate focus on building a more efficient and responsive emergency service network, including police, fire departments, and medical emergency teams. Enhanced law enforcement will gradually expand to areas experiencing significant growth in population or industries. - The emphasis will be on improving community awareness and preparedness for natural and manmade hazards. The gradual establishment of local disaster management units and	- Security infrastructure will be under-resourced, with fewer investments in emergency services and law enforcement. A lack of trained personnel and limited resources could delay response times, reducing the effectiveness of public safety measures. - Disaster preparedness efforts may struggle with underfunding, leading to insufficient early warning systems, shelters, and rescue teams. Low investment in disaster response mechanisms could leave communities

Factors	Aspects	High Growth Scenario	Medium Growth Scenario	Low Growth Scenario
		constructed using disaster-resilient designs and materials. - Health and safety standards are strictly enforced in industrial zones to minimize workplace accidents. Community awareness programs on emergency response and first aid are launched in collaboration with local governments and NGOs. - The construction of emergency shelters and upgraded fire safety systems within densely populated urban areas to mitigate risks from fire hazards and accidents.	a moderate increase in shelters and first responder capacity will help manage risks. Standards for workplace safety will slowly be enhanced in new and existing industries, with compliance being moderately enforced. Industrial zones and economic hubs will experience gradual improvements in safety protocols, reducing risks to workers and nearby communities.	vulnerable to both natural and manmade hazards. With economic constraints, workplace safety improvements might be deprioritized. Compliance with safety standards could be inconsistently enforced, particularly in smaller industries and informal workplaces, increasing risks for workers and local communities.
	Tourism	A moderate to high rate of growth in the number of tourists visiting the different tourist spots in the region. Extra pressure on infrastructure and services and utilization of resources, generation of wastes, etc.	Moderate growth in the number of tourists visiting different tourist spots in the region.	Low growth in the number of tourists visiting different tourist spots in the region.

6.2.1 Comparison of Different Growth Scenarios

The comparison of different growth scenarios is given in Table 6-3.

Table 6-3: Comparison of Different Growth Scenarios

Growth Factors	Growth Scenario		
	Low	Medium	High
Environment			
Groundwater availability	Available	Crisis	Severe crisis
Salinity intrusion	Increase	Decrease	Substantially decrease
Wildlife Habitat and Biodiversity Conservation			
Management and efficient use and conservation of natural resources	Poor	Good	Very good
Forest and tree cover	Small reduction	Moderate	Significant reduction
Illegal activities in protected areas	Increase	Moderate reduction	Major reduction
Fish resources	Increase	Moderate reduction	Major reduction
Pollution			
Water pollution	Good	Moderate	High
Air quality	No significant change	Increase	Significantly increase
Pollution management	Existing pollution reduction measures and regulations are not effectively implemented. Limited adoption of modern and upgraded technology and stringent air pollution mitigation measures including clean fuel. Effluent treatment plants in a limited number of industries. Limited sewage treatment capacity.	Pollution reduction measures and regulations partially implemented. Moderate adoption of modern and upgraded technology and stringent air pollution mitigation measures including clean fuel. Effluent treatment plants in an increased number of industries. Increased sewage treatment capacity.	Pollution reduction measures and regulations are fully and effectively implemented. Widespread adoption of modern and upgraded technology and stringent air pollution mitigation measures including clean fuel. Effluent treatment plants in all industries & economic zones. Sufficient sewage treatment capacity to deal with volume generated.
Noise in highly populated areas	High increase in noise in highly populated due to an increase in traffic without technological	High to very high increase in noise in highly populated areas due to increased traffic	Moderate to high increase in noise in highly populated areas with the introduction of

Growth Factors	Growth Scenario		
	Low	Medium	High
	improvements and a high incidence of old vehicles in use	intensity and industrial activity	technology compensating for increased traffic and industrial intensity
Greenhouse gas emission	Moderate increase	Moderate increase, partially mitigated by energy efficiency measures and increased use of renewables.	Major increase, largely mitigated by energy efficiency measures and increased use of renewables.
Invasive Alien Species			
Land use change	No change	Minor loss of agricultural land to urban/industrial use	Moderate loss of agricultural land to urban/industrial use, transportation, township, etc.
Land Degradation			
Riverbank erosion	Lack of adequate river protection measures	Moderate level of riverbank protection and increased application of sustainable land management practices	Extensive riverbank protection and widespread implementation of sustainable land management
Soil salinity	Increase	Moderate reduction due to the introduction of some sustainable land management practices	Greatly reduced due to sustainable land management practices
Waste			
Waste (collection & treatment)	Poor management of waste. Traditional dumping/landfill continues with very limited recycling options	Moderate improvement - city corporations and municipalities are equipped with waste recycling plants	Major improvement. All city corporations and municipalities will be equipped with waste recycling plants
Capacity to convert waste to usable resources	Limited	Moderate increase	Large increase
Vulnerability to Climate Change and Natural Disasters			
Extent of land liable to inundation	Moderate increase. Inadequate early warning system, response team, equipment, and shelters. Inadequate adaptation and	Moderate improvement. Improved early warning system, response team, equipment, and shelters. Adaptation	Moderate reduction due to improvement to embankments. Improved early warning system, response team, equipment, and

Growth Factors	Growth Scenario		
	Low	Medium	High
	mitigation measures were implemented.	and mitigation measures implemented.	shelters. Adequate adaptation and mitigation measures were implemented.
Social			
Population			
Total population	High population growth due to a higher total fertility rate	Marginally higher than the baseline	Marginally increased over baseline, but lower than the medium growth scenario
Population growth rate	High	Reduced (due to lower total fertility rate)	Reduced (due to lower total fertility rate)
Total fertility rate	High	Lower	Declines after 2026
Land			
Land acquisition/grabbing	Increase in unplanned development. Small increase in land acquisition due to limited urbanization, industrialization, and infrastructure development.	Small and marginal landholders tend to sell their land to enable an increase in industrial enterprises. Moderate increase in land acquisition due to medium urbanization, industrialization, and infrastructure development.	A large increase in land acquisition due to the high rate of urbanization, industrialization, and infrastructure development.
Land disputes	A small increase in the number of disputes. High number of incidents of land grabbing due to poor land administration and inadequate governance.	Moderate increase in a number of disputes. A moderate number of incidents of land grabbing due to improved land administration and governance.	Considerable decrease in number of disputes. Minimal incidents of land grabbing due to good land administration governance.
Large landowners	Remain same	Slightly increase	Increase
Medium-sized landholders	Remain same	Become smallholders	Some made small and marginal holders
Landless and marginal people engaged in development activities	Modest improvement	Moderate improvement	Moderate improvement
Land use change			

Growth Factors	Growth Scenario		
	Low	Medium	High
Poverty & inequality	No reduction	Moderately reduced	Considerably reduced
Education system	No change (possible a deterioration)	Moderate improvement	Major improvement
Health and sanitation	No change	Moderate improvement	Major improvement
Health care	No change with little increase in the number of physicians	Moderately improved with a moderate increase in the number of physicians	Considerably improved (e.g. big increase in the number of physicians and well-equipped health care services affordable for most of the population)
Life expectancy	Small increase	Modest increase	Moderate increase
Connection to water supply and sanitation services	No change	Moderate improvement	Major improvement
Migration	Large reduction	Increasing for employment	Increased due to employment opportunity in economic zones
Women's Empowerment			
Women in employment	Low level	Increase	Moderate increase
Women participating in decision-making	Poor level	Good level	Very good level
Participation of women in formal education & skill development	Good level	Very good level	Extremely good level
Cultural and Heritage Sites			
Management of cultural and heritage sites	Poor	Moderate improvement	Improved
Economic			
Economic Growth			
GDP growth rate	Low or stagnant	Moderate. GDP grows slightly faster than population (1.6% 2031-2041)	Rapid. GDP grows considerably faster than population (2.1% 2031-2041)
GDP per capita	GDP per capita grows only at the rate of population increase but could decline	4,046 to 12,535 USD by 2031	12,536 USD or more by 2041

Growth Factors	Growth Scenario		
	Low	Medium	High
Increase of share of GDP in main sectors (e.g., agriculture, industries and services)	No or limited increase	Moderate	Considerable
Development of economic zones	No economic zones	Partial operation of NSEZ	New economic zones - (Anowara (Gohira), Anowara-2, Cox's Bazar, Moheshkhali/Dhalghata EZ, etc.
Employment in industry	Low	Moderate	High
Industry & Exports			
Rate of industrialization	Low	Moderate	High
Volume of exports	A minor increase in export-oriented manufacturing.	A moderate increase in export-oriented manufacturing.	Large increase in export-oriented manufacturing.
Rural economy	No immediate transformation of the rural agrarian economy	Start to transform the rural agrarian economy into an industrial and digital economy	Transformed rural agrarian economy to an industrial and digital economy
Dredging for ports/jetty	Sporadic maintenance dredging	Regular maintenance dredging	Regular maintenance dredging
Port facilities	Not well maintained and developed. Full capacity not utilized. Less ships using port/jetty.	Well-maintained and regularly upgraded (up to 2031). Full capacity utilized. More ships using the port/jetty.	Well-maintained and developed. Full capacity utilized. A high number of ships will use port/jetty facility.
Freight/cargo traffic	Roads and railways are preferred over inland waterways. Volume below available capacity.	By a mix of road, rail, and inland waterways.	Large as well as by roads and railways increase by inland waterways.
Agriculture and Aquaculture			
Intensification/diversification of production	No or limited diversification of agricultural production. Limited expansion of mechanization. Wasteful of fertilizers. More than two-thirds of crop production is based on groundwater.	Moderate diversification of agricultural production. Some expansion in mechanization. Moderate use of organic/bio-fertilizers. 50% reduction in groundwater use.	Considerable diversification of agricultural production. Expanded mechanization. Major shift to organic/bio-fertilizers. Groundwater dependency will be

Growth Factors	Growth Scenario		
	Low	Medium	High
	Limited increase in agro-based industries.	Moderate increase in agro-based industries. HYV is used in >50% of agricultural land.	reduced by at least 70%. Extensive increase in agro-based Industries. Emphasis on high-value products.
Food security	Moderate, with reduced nutritional value and affordability	Moderate – high, with increased nutritional value and affordability	High, with better quality of food and nutritional value
Power and Energy			
Increase in demand for energy	Moderate	Moderate	Large
Power use and production	Continuing reliance on coal-fired power generation. A low increase in the use of energy from renewables, and a modest increase in the use of LNG and LPG. No phasing out of high-cost rental power plants.	Continuing reliance on coal-fired power generation. A moderate increase in the use of energy from renewables, LNG and LPG.	Reduced reliance on coal-fired power generation. High increase in the use of energy from renewables, LNG, and LPG. Focus on low-cost energy generation.
Efficiency in the use of installed capacity of power plants	Limited increase	Limited increase	Increased
Energy trade	Limited expansion	Limited expansion	Completion of expansion as per government target
Renewable energy	1%	5%	10%
Power grid network	Limited expansion	Started expansion	Strengthening and enhancing
Mitigation measures for air pollution	Insufficient to change the current situation	Moderate	Full mitigation measures, adoption of modern technology, and stringent ambient air quality standards and emission limit values
Infrastructure, transport, connectivity and communication			
Infrastructure development	Limited expansion of railway network, pipelines for the transportation of petroleum,	Moderate expansion of railway network, pipelines for transportation of petroleum,	Major expansion of railway network, pipelines for transportation of petroleum,

Growth Factors	Growth Scenario		
	Low	Medium	High
	installation of LNG floating storage and re-gasification units, power transmission, and distribution.	installation of LNG floating storage and re-gasification units, power transmission, and distribution.	installation of LNG floating storage and re-gasification units, power transmission, and distribution.
Road density	Small increase	Moderate increase	Widened and upgraded roads
Mass rapid transport, flyover, expressway, metro rail networks	Start of development (only Dhaka city)	Start of development in Chattogram city	In all major cities
Motorized traffic	Low increase	Moderate increase	High increase
Non-motorized traffic	Large increase	Moderate reduction	Discourage the major roads/highways
Management of urban traffic	Poor management	Moderate improvement	Considerable improvement
Rail network (management/ maintenance)	Poor management and maintenance of the existing rail network	Moderate improvement	More emphasis on railways
Inland waterways (management/ transport maintenance)	Limited use and maintenance	Moderate use and maintenance	More emphasis on inland water transport
Inter-district, inter-regional, and national connectivity	Limited improvement	Moderate improvement and emphasis on upgrading national highways	Major improvement and upgraded national and regional highways
Mobile phone and internet use	Small increase	Moderate increase	Large increase
Urbanization			
Urbanization	No transition of an agrarian economy to an urban-based industrial economy along with poor harmonization in urban ecosystem management, sewerage treatment, and solid waste management.	Growing initiatives to achieve a balance between environmental requirements and the needs of the urban people (i.e., in only some cities and municipalities). Modern sewerage systems and partial development in waste management. A third of the rural population enjoys facilities similar to	A balance between environmental requirements and the needs of the urban population. All cities are flood-free with effective drainage, modern sewerage, and fully functioning waste management. A majority of the rural population will enjoy facilities similar to

Growth Factors	Growth Scenario		
	Low	Medium	High
		those available in urban areas.	those available in urban areas.
Rural population enjoying facilities	No change	One-third of the rural population	Majority (approximately 80%)
Growth of tourism	Low	Moderate	Moderate to high

7 ALTERNATIVE ANALYSIS

This chapter presents the analysis of NSEZ alternatives and compares between potential impacts and risks of these alternatives from environmental and social aspects. It also analyses the advantages and disadvantages of each of these alternatives in order to help decision-makers to identify the environmental and social dimensions of potential alternatives for implementing the NSEZ and to compare the advantages and disadvantages of these options among other technical and economic factors.

7.1 No Go Alternatives

Bangladesh has an impressive track record of growth and development. It has been among the fastest-growing economies in the world over the past decade, supported by a demographic dividend, strong ready-made garment exports, remittances, and stable macroeconomic conditions. Bangladesh sets a target to reach a middle-income country by 2031.

National Special Economic Zone (NSEZ) is a successful initiative of BEZA to fulfill the dream of regeneration of that congregational tradition in modern Bangladesh. NSEZ with multi-dimensional features is a great junction of domestic and foreign investment, industrialization, and economy at the entrance of the southeastern part of the country. One of the largest economic and industrial zones in South Asia, NSEZ will be a state-of-the-art industrial city. It is one of the priority projects of the government for industrialization and job creation to achieve the vision of attaining upper middle-income status by 2031.

In addition, if the NSEZ is not implemented by BEZA, the country and community people will be deprived of the following positive impacts that might result from implementing the project:

- Increase the employment rates in the region by providing about 1.4 million job opportunities during the project lifecycle. Accordingly, promotes economic gains and social benefits arising from construction and operation jobs.
- Job opportunities will be provided for skilled, semiskilled, and unskilled laborers and workers as well as for professionals. Accordingly, quality of life will be improved, and health and social risks will be reduced.
- It is expected that NSEZ is going to be the first planned industrial city in the country, and it will pave the way for establishing a truly world-class business and industrial center.
- BEZA aims to build strong partnerships with the private sector and local entrepreneurs.
- NSEZ would contain a seaport, rail connectivity, marine drive, residential area, hospital, school, university, etc. which will improve the transportation and communication network in the region.
- BEZA aims to improve the quality and increase the export quantity of local products by establishing industries including garments & garments supporting industries, agro-products and agro-processing products, integrated textiles, leather and leather products, shipbuilding, motorbike assembly, food & beverage, paint & chemical, paper & products, plastics light engineering (including auto-parts and bicycles), pharmaceutical products, etc. Accordingly, this will reduce the import of the products.

7.2 Location Alternatives

With regard to the project site location alternatives, it is always recommended by the World Bank that private lands should be avoided. Alternatively, if private lands cannot be avoided, at least the lands with the minimum socioeconomic impacts should be selected. Additionally, the location of the land and the proximity to infrastructure are two key factors that support decision-making regarding the land to be acquired. As well as the impacts on the surrounding direct area of influence should be carefully considered.

NSEZ location is selected on the coastal area of Bangladesh considering the accessibility by road and waterways. The selected site is mostly reclaimed land from the sea and a very small amount of private

land. Sensitive areas/protected areas such as national parks, wildlife sanctuaries, marine protected areas, marine reserves, archaeological sites, cultural heritage sites, ancient monument sites, key biodiversity areas, etc. in the project site were not observed.

Additional advantages expected from this location could be summarized as follows:

- Ease and low cost of transportation of inputs/raw materials needed in industries.
- Reduce GHGs from transportation by burning less fuel in short distance traveling.
- Continuous availability of inputs/raw materials.

Basically, in Bangladesh, there is a scarcity of suitable alternative land for establishing such a huge industrial city.

7.3 Access Road

According to the TOR, the NSEZ site is about 10 km from the Mirsharai-Chattogram highway and 67 km from the Chattogram port city. As reported in the Master Plan, the connecting roads are mainly from Dhaka Chattogram Road and can be listed as Muhuri Project Road (Zorarganj - Muhuri), Bamonsundar Road, NSEZ Sarani, and Mohan Nagar Barodarogarhat Road. At present, the capacity of the local access roads adjacent to NSEZ is quite limited and the number of existing links to NSEZ are inadequate to cater to the new volume of traffic likely to be generated by NSEZ. Hence, the road network will need to be upgraded and improved.

- The following improvements to the transport system have been prioritized to support NSEZ:
- Access to the northern side of NSEZ will be from NSEZ North Road (Bhangi Road). A 6-lane bypass for Sonagazi has been suggested from Precinct A.
- The traffic volumes from the access roads connecting the Dhaka-Chattogram Highway will be inadequate by 2025. For proposed freight/cargo traffic, a separate access-controlled link from the Dhaka-Chattogram Highway connecting to the port and logistic area in NSEZ (Precinct G) will be required.
- The proposed Dhaka Chattogram Expressway will be located approximately 80m west of the present highway (N1). Though some amount of regional traffic will be shared by the expressway, the present 4-lane highway is required to be widened to 6-lanes.
- In order to have direct connectivity to Chattogram from NSEZ, a new link is proposed. This road will start near the Port (Precinct G) and follow the coast down to Chattogram. This will reduce pressure on the Dhaka-Chattogram Highway and create a special link for a future mass transit solution.

The selected alternative of access road is not expected to cause significant impacts and will be acceptable from the social aspect.

7.4 Source of Construction Materials

Possible sources of construction materials for the development of the EZ can be divided into categories such as national (Bangladesh) and international (other countries). Major construction materials such as cement, aluminum, bricks, rocks, roofing sheets, timber, paving blocks tiles, sanitary, plumbing and electrical appliances, steel, and other miscellaneous materials required for construction can be sourced locally e.g., Chattogram city or other parts of Bangladesh, depending on the type of materials required. This will increase the quantity of materials to be procured from the various local suppliers and hence it will enhance the income generation capacity of local suppliers. The use of locally available materials for the EZ development will contribute to the economy's growth by contributing to the gross domestic product. The consumption of these materials and others will attract taxes, including VAT which will be payable to the government hence increasing government revenue, while the cost of these raw materials will be payable directly to the producers. In addition, atmospheric emissions during the transport of construction materials from abroad will be reduced.

7.5 Water Supply

Water is one of the fundamental aspects that the surrounding communities utilize for domestic, industrial, fisheries, and irrigation water use. The alternative sources of water should consider the adverse impacts on the surrounding communities.

As reported in the “*Detail Study on Total Water Demand & Water Availability Assessment for NSEZ*”, based on the assumption the water required production capacity will be 343 million liters in 2025, 482 million liters in 2030, 683 million liters in 2035, and 965 million liters in 2040.

7.5.1 Sources of Water Resources

Surface Water Resource

- **Feni River:** existing surface water reservoir in the Feni River is a potential source of water supply for the NSEZ. Presently the available active storage of the Feni reservoir is about 17.4 mm³. Under average rainfall and stream flow conditions use of 100 MLD water from the reservoir to meet the industrial requirement of NSEZ after meeting crop water requirements would be a problem. However, the withdrawal of 100 MLD for industrial requirements during dry conditions in February and March would reduce a bit the minimum reservoir storage for use in the later part.
- **Water Supply to NSEZ from the Meghna River:** In order to meet the water demand, CWASA sent a concept note to the local government department mentioning a source of water supply to NSEZ through a transmission line after extracting and purifying water from the Meghna River. A review of the said concept notes shows that after extraction and purification of 95 crores liters (950 MLD) of water from the Meghna River in Chandpur is possible to supply water to NSEZ through 132 km long transmission lines.
- **Other Khals and Reservoir:** water available in Ichakhali and Bamon Sundor Khal and water available in Mohamaya, Bawa Chhara, Boroomoldoho, and Sahasradhara reservoir is not sufficient for NSEZ, therefore not considered as potential sources of surface water.
- **Sea Water:** rest of the water could be taken from the Sandwip Channel/Bay of Bengal and treated to the desalination plant before industrial use.

Desalination of Sea Water

- Sea water can be used from the Sandwip Channel/Bay of Bengal. Desalination RO plant is required in future to fulfill the water requirement of the economic zone. As an alternative source of raw water sea water from the Sandwip channel can be taken at the outfall of Bamon Sundor, Hoania, Saherkhali and Domkhali canals in the NSEZ development area.
- IWM suggested keeping a provision of 11 Nos. desalination units to supply 50 MLD water among the total water demand of the NSEZ development area.
- With current technological trends a sea water reverse osmosis (SWRO) plant would be suitable for NSEZ area as it is relatively less energy intensive technology as per recommendations of IWM. The performance of SWRO depends heavily on the quality of the seawater at the intake location.
- Different types of treatment schemes can be adopted like Sea Water Reverse Osmosis (SWRO), Ultra Filtrations (UF), Nutrient Removal Filter, Brackish Water Reverse Osmosis (BWRO), Product Water Collection and Transfer System, Intake & Outfall System, Intake Basin & Intake Pumps etc.
- A 50MLD desalination plant may require \$50 million as capital cost. Approximately 15 acres of land may be required for the plant. The approximate power requirement for a 50 MLD plant can be 200 MWh/day.

Environmental Implications of desalination plan in NSEZ

- Desalination is a critical technology for producing potable water from seawater or brackish sources, especially valuable for regions where fresh water is scarce.

- Desalination plants produce a highly concentrated brine byproduct, which contains elevated levels of salt and potentially residual chemicals used in the desalination process. Discharging this brine into the marine environment through the existing drainage canals in NSEZ can increase local salinity, especially in areas with limited water circulation, causing adverse effects on marine ecosystems. Species that are sensitive to salinity changes may be endangered in such conditions, leading to a reduction in biodiversity.
- Various chemicals, including chlorine, antiscalants, and coagulants, are used in desalination to treat incoming seawater. When these chemicals are discharged from the brine, they can contribute to marine pollution.
- Desalination processes, particularly those involving reverse osmosis (RO), are energy-intensive and often rely on fossil fuels. This dependency results in significant greenhouse gas emissions, which increase the facility's carbon footprint and contribute to global climate change. In large-scale desalination facilities, energy use remains a critical concern.
- Desalination plant intake systems can impact marine organisms through impingement and entrainment. Impingement occurs when organisms are trapped against intake screens, while entrainment draws small marine life directly into the plant. This can reduce local biodiversity, impacting juvenile fish, plankton, and other small organisms essential to the marine food web.

Mitigation Measures for desalination plant establishment

- Diffuser systems can be installed at the brine discharge point to disperse the concentrated brine more effectively, reducing local salinity spikes and minimizing harm to marine life.
- When possible, mixing brine with cooling water before discharge can help to dilute its salinity and temperature, making it less harmful to the surrounding environment.
- Environmentally friendly options, such as deep-well injection, deeper ocean discharge points, or evaporation ponds, can be used to manage brine disposal more sustainably.
- Switching to safer treatment options like UV or ozone instead of chlorine reduces toxic byproducts.
- Switching to safer treatment options like UV or ozone instead of chlorine reduces toxic byproducts.
- Treating and neutralizing chemicals used in pretreatment and cleaning before discharge reduces their toxicity and potential harm to the environment.
- Advanced energy recovery devices, such as pressure exchangers used in RO systems, can capture and reuse energy, significantly lowering energy consumption.
- Utilizing renewable energy sources, like solar or wind, can reduce reliance on fossil fuels and help to lower greenhouse gas emissions, making desalination operations more sustainable.
- Subsurface intake structures, such as beach wells or infiltration galleries, help to filter water naturally, reducing impingement and entrainment impacts on marine.
- Fine screens and velocity caps at intake points can limit the intake velocity and prevent larger organisms from being trapped, protecting local biodiversity.
- Ongoing monitoring of water quality, salinity, and marine biodiversity near discharge areas allows for early detection of any adverse impacts and enables timely adjustments to operations.
- Regular environmental monitoring programs and adherence to environmental regulations ensure that mitigation measures are effective and help protect the surrounding ecosystem.

Groundwater Resource

- The drainable storage volume estimated is about 205 MLD that can be obstructed from the deep aquifer and a total of 100 nos. of 1 cusec pumps (28.414 liter/sec), operating for 20 hours per day will be required for its development. According to the discussion with BEZA, to date, about 40 nos. of tubewell has been established considering the demand of construction phase water requirement.

Rainwater Harvesting

- Rainwater harvesting is considered a very potential source of water supply in NSEZ. If 50% of the area is considered a catchment area for rainwater harvesting and 60% of rainfall from May to October can be utilized, then about 65,487 million liters volume rainwater will be available from the potential area annually, which is equivalent to about 179 MLD. This huge amount of harvested rainwater can be utilized as non-potable usage.

7.5.2 Use of Available Resources and Phasing

About 100 MLD of water can be supplied from the Feni River reservoir and the plant has been proposed to be constructed in two phases. In the 1st phase, 50 MLD treatment plants with 25 nos. DTW will be constructed for supplying water in priority zones 2A, 2B, 3, 4, & 5.

In the 2nd phase, another surface water treatment plant from Feni River will be constructed for the next priority zones. The location for the 50 MLD water treatment plant (phase II) has been selected adjacent to phase I.

Little Feni River is another source of surface water that can provide 40 MLD water to meet the water demand of NSEZ. A surface water treatment plant will be required in this regard. About 6 km of a raw water transmission line will be required to carry the river water to the treatment plant in NSEZ. The raw water transmission main of 800 mm diameter Ductile Iron pipe or steel pipe will be required.

Detailed groundwater investigation in the NSEZ area reveals that the average thickness of deeper aquifer in this area varies between 120m to 205m. The available water that can be extracted from groundwater is a maximum of 205 MLD.

The total amount of water that will be available from surface water and groundwater sources is about 430 MLD. The additional water that will be required to fulfill the water demand of the whole NSEZ will be about 535 MLD. This amount of water will need to be managed by using the treatment of seawater and other sources.

7.5.3 Phase Wise Water Sourcing including Alternative Options and Distribution/Matrix

Phase wise water source has been presented in Table 7-1.

Table 7-1: Future Sources of Supply under different phases of NSEZ up to 2040

Planning horizon	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2035	2040
Water Demand	30	60	100	150	250	344	380	400	450	450	482	682	965
Feni Reservoir – Phase I				50	50	50	50	50	50	50	50	50	50
Feni Reservoir – Phase II						50	50	50	50	50	50	50	50
Total Feni Reservoir	0	0	0	50	50	100	100	100	100	100	100	100	100
Groundwater Phase I	30	50	50	50	50	50	50	50	50	50	50	50	50
Groundwater Phase II		10	50	50	50	50	50	50	50	50	50	50	50
Groundwater Phase III					10	10	40	60	70	70	100	100	100
Total Groundwater	30	60	100	100	110	110	140	160	170	170	200	200	200
Mohra Treatment Plant					90	90	90	90	90	90	90	90	90
Little Feni Treatment Plant									40	40	40	40	40
Off stream Reservoirs	0	0	0	0	0	0	0	0	0	0	0	0	0
Mahamaya Reservoir	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Reservoirs	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-total (SW+GW)	30	60	100	150	250	300	330	350	400	400	430	430	430
Gap	0	0	0	0	0	44	50	50	50	50	52	252	535
Desalination Plant (sea water) & other sources				0	0	50	50	50	50	50	50	250	535
Required Production Capacity	30	60	100	150	250	350	380	400	450	450	480	680	965

7.6 Gas Supply

7.6.1 Sources of Gas

The required gas can be sourced in the following two ways:

Sources	Advantages	Disadvantages
Trucking through tankers	- Land acquisition and displacement will not be required. - Population employees the land for income-earning activities (e.g., agriculture) will not be impacted.	- Transportation and traffic impact - Safety and environmental consequences leading to exploration, fire, emission, and pollution of the environment - Challenges of gas supply reliability - Impact on production and a possible increase in the cost of produced items.
Pipeline	- Low-cost feed solution for the EZ. - Reduction of greenhouse gas emissions. - Cleaner feed matrix in the country. - Potential to spur industrial development, employment opportunities, and foreign investments. - The pipeline will consider multiple uses of the pipeline Right of Way (ROW).	- The land would be acquired for the pipeline ROW and therefore the likelihood of people being displaced increased. - Loss of income-generating activities on land developed for the pipeline. - Socioeconomic effects (diseases, inflation, pollution) associated with construction workers. - Potential for water quality, ecology, and fisheries impacts, in particular (habitat disruption, contamination, construction in sensitive habitats and ecosystems, and potential safety/security hazards associated with pipeline).

Preferred Option:

The need for the EZ is based on the following:

- Potential demand for the gas as feed in the industries in EZ
- Technical feasibility to implement the EZ
- No legal nor commercial aspects have been identified that could obstruct EZ implementation.
- Feasibility to implement the project in a cost-effective, efficient, and timely manner.

BEZA will meet the EZ objective to commence production early enough providing a more reliable supply of energy and feedstock for a variety of industrial processes while stimulating foreign investment. At the same time, natural gas will help to reduce greenhouse gas emissions and reduce environmental pollution.

Size of the pipeline:

The selection of pipe size will consider the delivery of the required volume of gas to the EZ. Several factors including project cost, environmental and social impacts, disruption of existing services, etc. shall be considered.

Pipeline Route Alternatives:

The main objective of the route selection process should be to identify the lowest cost option that meets the safety requirements of both the general public and pipeline workers while minimizing impacts on the environment and surrounding communities.

7.7 Electricity Supply

Economic zones cannot rely solely on the national grid for power. To be successful, a zone requires clean, consistent, and stable access to power and backup power in cases of emergency. For the residents in NSEZ, power will be obtained from a variety of sources. As such, a percentage of total demand may be met by on-site generation facilities. In the present scenario, NSEZ may take 2,000 MW (without contingency) from the grid network against the demand of 3,248 MW through an existing, dedicated 400 kV transmission linked with the grid system.

Power plants within NSEZ are perfect for the use of liquefied petroleum gas (LPG), natural gas, and/or liquefied natural gas (LNG). Besides that, aiming to reduce the industry sector's increasing demand for fossil fuels and the related CO₂ emissions, a provision of renewable also be planned installed in the form of floating, rooftops, and panels along the inner slope of the super dike. There might be some potential for offshore wind turbines too.

Renewable energy sources will be the best option for minimizing pollution and increasing the economy, and energy security. Clean energy development is a fundamental requirement for addressing climate change and mankind's sustainable development as well as maintaining the environmental sanctity of NSEZ. Renewable energy sources could be considered as additional energy supply sources besides the installed electrical power source. The most recommended sources are solar and wind. A comparison of recommended power sources is given in Table 7-2.

Table 7-2: Comparison of Recommended Power Sources

Items of Comparison	Wind Power Plant	Solar Power Plant
Potential for conventional and renewable energy power plants in Bangladesh	The potential for wind energy is still under study. Wind data are being collected from 13 different locations in Bangladesh which is measured by SREDA. A wind resource study was conducted in Sonagazi Upazila of Feni under the initiative of EGCB. LIDAR is used as a wind measurement instrument. The data collection period was from June 2017 to September 2018. Mean Wind Speed - 5.38 m/s at 100 m height.	Among the different forms of RE potentials, at present solar energy seems to have the greatest potential with biomass and biogas having some limited applications. Bangladesh receives an average daily solar radiation in the range of 4.5 kWh/m ² /day.
Capital cost	Capital cost per MW for onshore wind projects was generally in the range of \$1 million to \$2.5 million.	Capital cost per MW for utility-scale solar photovoltaic (PV) projects was typically in the range of \$1 million to \$3 million.
Average generation cost	Onshore wind power generation costs were generally in the range of \$30 to \$60 per megawatt-hour (MWh), while offshore wind costs were typically higher, ranging from \$60 to \$120 per MWh.	The average generation cost for solar power plants, specifically utility-scale solar photovoltaic (PV) projects is generally in the range of \$20 to \$60 per megawatt-hour (MWh).
Water needed	Negligible	Surface or groundwater may be required

Table 7-3 shows the on-site generation source for the economic zone. The rest of the electricity will be sources from the national grid.

Table 7-3: Expected On-site Generation

Plants and Utilities	Phase 1 (MW)	Phase 2 (MW)	Phase 3 (MW)	Total (MW)
Power Hub A, Precinct F (Zone 5)				
IPP or others	250	300	250	800
Renewable Energy	100		50	150
Power Hub B, Precinct I (Zone 25)				
IPP or others		250	500	550
Renewable Energy		50	50	100
Total	350	600	650	1600

Source: Master Plan, 2020

7.8 Hazardous/Non-hazardous Waste Management and Disposal

Significant quantities of wastes including organic, solid, and hazardous will be generated during the NSEZ life cycle (construction, operation, and maintenance phases). However, the development and implementation of a waste management system will limit the quantities of the generated waste.

The hierarchy of the waste management system in the NSEZ should consider the 3R/4R/5R strategy including prevention, reduction, reuse, recovery, recycling, removal, and finally disposal of waste.

The waste management system should identify the following:

- Waste sources and prevention methods.
- Waste categorization by identifying waste streams by type, quantities, and potential use/nature.
- Waste segregation system.
- Definition of opportunities for source reduction, as well as reuse and recycling.
- Necessary treatment and storage.

According to the NSEZ Master Plan, two types of waste will be generated from both industrial as well as non-industrial areas – solid waste and liquid waste. Municipal Solid Waste (MSW) will be generated from household activities, commercial activities, institutions, healthcare units, etc. Industrial Solid Waste (ISW) will be generated from different industries/establishments in the NSEZ. Both municipal and industrial solid waste may be hazardous and non-hazardous in nature.

Municipal solid waste will comprise a number of solid waste streams that are:

- **Residential Solid Waste** - waste will be generated from residences. Recyclables prevalent in the residential waste stream will include paper, plastics, metals, food scraps, textiles, personal electronics, etc.
- **Commercial Solid Waste** - waste will be generated from businesses, offices, stores, markets, institutions, government, other commercial establishments, etc. Recyclables common in the commercial waste stream include paper, plastic, metals, food, textiles, electronic devices, etc.

Other solid waste streams that may also be a part of municipal solid waste include:

- **Bio-Medical Waste** - treated waste, where allowed, will be generated from hospitals/health complexes, other acute care facilities, and homes that result from the use and administration of medications, surgery, or other medical procedures.
- **Bio-solids** - typically waste will be generated from the de-watering of municipally generated wastewater.

- **Construction and Demolition Debris** - materials resulting from the construction and demolition of buildings and other structures, including materials such as metals, wood, gypsum, asphalt shingles, roofing, concrete, rocks, rubble, soil, paper, plastics, glass wastes, etc. Construction and demolition components can be a significant portion of the municipal solid waste stream with a high potential for recycling. Non-recyclable construction and demolition wastes may be disposed of in solid waste landfills, or if cleaned of unacceptable debris, used for land reclamation.
- **Others** - there are a host of other separately managed solid wastes that may be a part of municipal solid waste such as tires, street sweepings, carpets, furniture, mattresses, etc.

According to the NSEZ Master Plan, it has been estimated that food and vegetable waste will dominate (69%) the municipal solid waste followed by paper products (9.3%) and plastic (4.5%). Out of total waste generation, 25% of the material will be recycled, 10% of the material will be composted, 13% of the material will be used for combustion for energy generation or as fuel in other industries and 52% of the material will be sent to landfill site for disposal. It has been estimated that total waste generation in 20 Years (in 2040) will be 11.27×10^6 tons considering a population of 4.41 million in 2040 and waste generation of 0.350 kg/capita/day. It has also been estimated that the area required only for the Municipal solid waste landfill is 185 acres and the total land requirement considering other facilities like a composting plant, different infrastructure, an area for biomedical waste and a separate area for hazardous waste storage and management is about 274 acres. If the NSEZ adopts the 3R/4R/5R strategy and global trend in developed countries as reported by EPA the land demand for landfills will be reduced to 52% i.e., 142.5 acres. A specific site in Precinct H (Transitional Area) is selected as the landfill site, land for storage and primary processing of industrial solid waste, and land for storage and transfer station. Also, there will be thirty secondary transfer stations in the whole NSEZ area.

Management of Medical Waste

Medical waste, which is also referred to as clinical waste, has to be handled and disposed of in a proper manner to eliminate the possibility of injury or infection and safeguard the environment as a whole. The impacts associated with improper municipal waste management can damage the environment and affect public health directly and indirectly in the NSEZ and its surrounding areas.

According to the NSEZ Master Plan, medical wastes will contain both general wastes (approximately 75-80%) and infectious wastes (approximately 20-25%). Medical waste will constitute a public health hazard if not managed properly. According to the Ministry of Health and Family Welfare (MOHFW), Bangladesh - "Government (through Department of Environment) has adopted Medical Waste (Management and Processing) Rule 2008, which serves as the main code to be followed by all concerned agencies for proper management and disposal of medical waste and thus safeguard the environment".

Management of Plastic Waste

Bangladesh Environment Conservation Act was formulated in 1995 and the law of Section 1 under this act was revised in 2002. According to Rule 6 (ka) of Clause-5 under Section-9, a restriction has been imposed on the production and use of polythene shopping bags. According to the rule, there is a restriction on the production and sale of environmentally harmful products. If it is proven that any kind of plastic bag or product made of polyethylene or polypropylene is detrimental to the environment, then the government could control/ban the use of these products in any selected area or all over the country. Under rule 6(ka) the penalty and punishment provisions have been introduced for violation of the act.

BEZA may declare the NSEZ as a "Plastic Free City" and all types of polythene bags should be banned in the industrial city. No polythene bags should be collected during waste collection and the target should be fixed so as not to send any plastic bags to the disposal site. At present, there are no guidelines or rules available for the management of plastic waste in Bangladesh. Plastic products other than polythene bags should be recycled (100%) as per the national 3R policy of the Government of

Bangladesh. The national 3R goal for waste management is to achieve higher levels of waste reduction, reuse, and recycling and minimize waste disposal on open dumps, rivers, flood plains, and landfills.

Management of Industrial Solid Waste

In Bangladesh, the management of industrial solid waste is not the responsibility of local authorities (city corporations/municipalities/union parishad). Industries generating solid waste must manage such waste by themselves and are required to seek approval from the Department of Environment (DOE) under relevant rules and if it is within an economic zone then from DOE as well as from economic zone authority. As per the master plan of the NSEZ, the collected solid waste of each industry will be taken in a compact truck to its landfill.

Industrial Organic Waste

Instead of disposing of the industrial organic waste in landfill, industrial organic waste such as off-specs organic raw materials, organic by-products, and off-specs products, as well as organic waste from different industries should be collected by a licensed organic waste contractor and to be treated for reuse.

As per the NSEZ master plan, industrial organic waste will be sent to a composting plant for treatment and to be reused in NSEZ. A composting plant has been proposed in Precinct H (Transitional Area) inside of NSEZ having the required land area (10 acres).

In addition, the following alternatives could be considered and recommended to be further studied by the study team.

- Alternative 1: industrial organic waste to be sent to a composting plant for treatment and to be reused.
- Alternative 2: industrial organic waste to be sent to a fermentation plant for treatment and to be reused.

Alternatives 1 and 2 are recommended to be established near the landfill of the NSEZ.

A comparison between different recommended industrial organic waste treatment methods (anaerobic digestion, aerobic digestion, and solid-state fermentation) is presented in Table 7-4.

Table 7-4: Comparison Between Different Industrial Organic Waste Treatment Methods

Items of comparison	Anaerobic Digestion	Aerobic Digestion	Solid State Fermentation
Definition and treatment process	Anaerobic digestion is the decomposition of organic waste in the absence of oxygen using sealed and well-controlled tanks.	Composting is the aerobic (in the presence of air) decomposition of organic waste.	A biotechnological process in which organisms grow on non-soluble material or solid substrates in the absence or near absence of free water. It is the process of transformation of food waste into animal feed by using a variety of microorganisms such as fungi, yeasts, and bacteria.
End products	Biogas and sludge	Soil conditioner	Animal feed
Requirements	Large area and controlled sealed tanks	Huge area and constantly re-pile	Availability of feedstock and microorganisms such

Items of comparison	Anaerobic Digestion	Aerobic Digestion	Solid State Fermentation
		(manpower or machine)	as fungi, yeasts, and bacteria
Advantages	A net energy-producing process which produces renewable energy in the form of biogas. Reduces the amount of waste sent to landfills and accordingly, methane emissions are significantly reduced.	Could be mixed with the dewatered sludge generated from the STPs and CETPs to produce compost. Reduces and in some cases eliminates the need for chemical fertilizers. Heat produced during the decomposition process is great enough that kill harmful bacteria and pathogens within the pile. Reduces the amount of waste sent to landfills and accordingly, methane emissions are significantly reduced. Less cost compared to anaerobic digestion.	Food and vegetable waste may possess bioactive compounds and nutrients that may favor the transformation into animal feed. Requires a low amount of water or the absence of water in the solid-state fermentation process. This offers several advantages such as easy product recovery, low cost of the complete production process, smaller fermenter size, and reduction of energy requirements for stirring and sterilization. Save money by reducing waste discharges, cutting waste-management costs, and preventing environmental pollution.
Disadvantages	High construction and maintenance costs. Large area required for facilities. Bad smell if in case of inefficient treatment. More technical complex compared to composting as it requires delicate control to ensure desired output. Overloading of feedstock can cause process failure. Does not convert as large a proportion of the carbon in the biomass to biogas as	A huge area is needed. Bad smell. Process duration. The required hot temperature must be held constant for a stated minimum time. Requires a large amount of energy to operate.	Food waste may exhibit variations in nutrient composition and potential hazards if not treated appropriately. Bacteria and yeasts, which require comparatively higher moisture content for efficient fermentation, can be used for solid state fermentation, but with a lower yield.

Items of comparison	Anaerobic Digestion	Aerobic Digestion	Solid State Fermentation
	can be achieved using gasification. It takes longer to start up the process due to the slow growth rate of the methane-producing organisms as compared to aerobic systems.		

By comparing different industrial organic waste treatment methods alternatives to landfills, they were found to be better than landfills from the environmental perspective as they will reduce the amount of waste disposed of to landfills. Reducing the pressure on landfills will reduce the methane emissions and accordingly, reduce the Greenhouse gases (also known as GHGs). In addition, more employment opportunities might be created in the NSEZ.

Recyclables

Recyclable materials such as packing materials, plastics, bottles, and metals should be collected and sent to recycling units for further treatment and reuse. A centralized recycling plant instead of recycling units has been recommended to be constructed in the NSEZ transfer station.

The advantages of waste recycling include but are not limited to the following:

- Reduces the amount of solid waste sent to landfills and/or incinerators and allows these materials to re-enter the manufacturing process.
- Recycling reduces the need for extracting, refining, and processing raw materials.
- Saves energy and accordingly, it reduces Greenhouse gas emissions, which helps to tackle climate change.
- More employment opportunities might be created in waste recycling and trading in recyclables.

Others

Solid waste that cannot be treated, reused, and/or recycled, should be disposed of through a licensed waste contractor to the NSEZ landfill which will be established inside of the NSEZ.

Hazardous Waste

In case sludge is of hazardous content (heavy metals or hazardous elements), it should be disposed of in a lined hazardous waste cell that is recommended to be constructed inside the NSEZ landfill to receive all hazardous waste from NSEZ industries including hazardous sludge.

7.9 Wastewater Pre-Treatment, Discharge, Treatment and Reuse

As discussed in the NSEZ Master Plan, about 80% of the water consumption that will be supplied to NSEZ industries will be generated as wastewater, where domestic wastewater from workers and labors daily activities will be discharged to the Sewage Treatment Plants (STPs) and the industrial wastewater will be discharged to the Common Effluent Treatment Plants (CETPs). However, developing and implementing a water and wastewater management system as well as the implementation of regular inspections to monitor for spills/leakage will limit the amount of the generated wastewater as well as identify possible methods for wastewater treatment, and reuse.

This could be developed and implemented at low/medium cost, where the following should be considered at the minimum:

- Install water flow meters to measure and control the water consumption in all the industries/establishments inside of the NSEZ and accordingly, reduce the amount of wastewater generated.
- Execute regular inspections to monitor for leakage/spill.
- Raise awareness on water conservation and management among the workers/employees by giving them different sessions.
- Prohibit the mixing of solid waste and hazardous waste with the generated effluent.
- Split between the wastewater streams as follows:
 - Domestic wastewater should be collected in holding tank(s) and directed to STPs.
 - Industrial wastewater should be directed first to a pre-treatment unit consisting of settling, equalization, and oil & grease removal tanks and installed for each industry/establishment then it should be directed to the CETPs to reduce the load of treatment.
 - Stormwater should be separated from the industrial wastewater streams in order not to place an unnecessary burden on the CETPs as stormwater is typically "clean" water/ uncontaminated water.

According to the NSEZ Master Plan, domestic wastewater will be collected in holding tanks and directed to NSEZ STP-1 and STP-2 with a proposed capacity of 45 MLD and 80 MLD respectively, while industrial wastewater will be collected and directed to NSEZ CETP-1, CETP-2, CETP-3, and CETP-4 with a proposed capacity of 16 MLD, 32 MLD, 150 MLD, and 370 MLD respectively via the installed wastewater network system.

A) Treatment

Generally, there are three levels of wastewater (domestic and industrial) treatment i.e., primary, secondary, and tertiary. However, it is recommended that each industry applies preliminary treatment (pre-treatment) for its industrial wastewater before discharging it to NSEZ CETPs.

- **Preliminary treatment:** will include the removal of coarse suspended and grits by screening, and grit chambers respectively.
- **Primary treatment:** will include the removal of settleable organic and inorganic solids by sedimentation and floating materials by skimming. At this stage, up to 50% of BOD₅, 70% of suspended solids, and 65% of oil and grease will be removed. In addition, some organic nitrogen, organic phosphorus, and heavy metals will also be removed. However, at this stage of treatment, colloidal and dissolved constituents will not be removed.
- **Secondary treatment:** will include the removal of the residual organics and suspended solids from the primary treatment. In addition, it will include the removal of the biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes.
- **Tertiary treatment or advanced treatment:** will include the removal of significant amounts of nitrogen, phosphorus, heavy metals, biodegradable organics, bacteria, and viruses. At this stage, in order to make the water meet the national standards for industrial re-use as well as other usages to meet non-domestic demand including gardening, cleaning, car washing, etc., the treated effluent has to be disinfected by the injection of chlorine, ozone, and ultraviolet radiation.

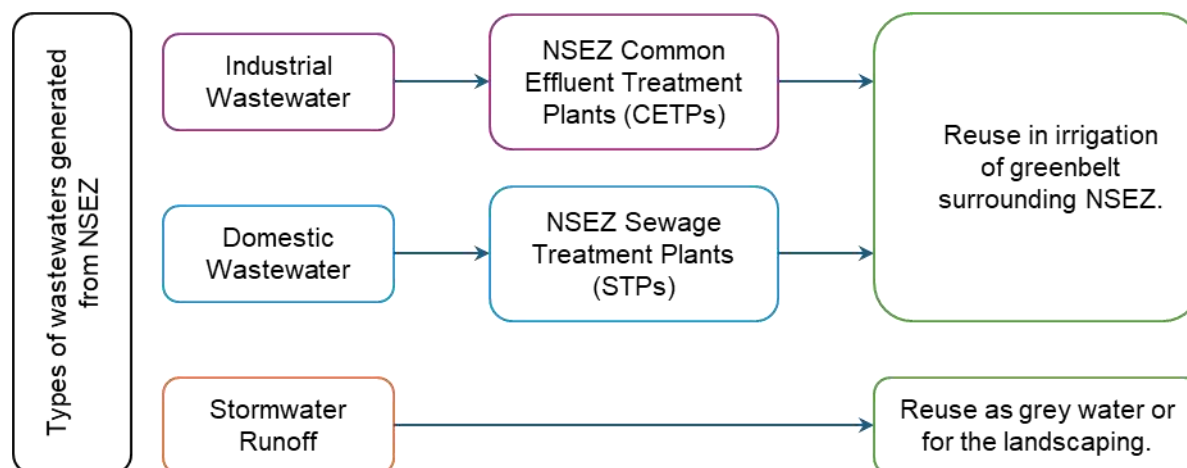
B) Discharge and Reuse

Efforts shall be made to recycle about 70% of the wastewater after treatment to meet various industrial usage. This in turn will substantially reduce the quantum of water to be drawn from various sources to meet the water demand of NSEZ. The treated effluent from the STPs and CETPs could be reused in irrigation of the greenbelt surrounding NSEZ, reuse for industrial purposes such as cooling, floor washing, etc. The stormwater runoff could be reused as greywater or for the purpose of landscaping.

In case of discharging the surplus of the treated industrial or domestic effluent to the Bay of Bengal/Sandwip Channel, the effluent quality from the STPs should comply with the national standards as mentioned in Schedule-3 of Environment Conservation Rules 2023 while the effluent quality from

the CETPs should comply with the national standards as mentioned in Schedule-4 of Environment Conservation Rules 2023. These standards need to be monitored on a regular basis to ensure the appropriate function of the wastewater treatment systems. Figure 7-1 summarizes the options for potential reuse of all types of treated effluents generated from NSEZ.

Figure 7-1: Types of Wastewaters Generated and Potential Reuse After Treatment



7.10 Sludge Handling and Disposal

As a result of the sewage and industrial wastewater treatment processes, a large volume of sludge is expected to be generated in the NSEZ. This sludge should be removed, treated, and reused or finally disposed of.

Different sludge treatment methods are presented below:

- Thickening should be applied to the sludge generated from the wastewater treatment process, where sludge solids will be concentrated either by settling due to gravity or by floating due to the introduction of air. Thickening treatment will increase solids content from 5-6%.
- Then dewatering should be applied to the sludge generated from the thickening treatment. Sludge dewatering could be implemented using one of the following processes: centrifugation, belt press (filtration), centrifuge, air drying on sand beds, etc. The choice of the suitable dewatering process will depend on many factors: land area, amount of sludge produced, moisture content of the dried sludge, etc.
- Dewatering will increase solid content from 25-30%.
- Sludge should be tested periodically for containing heavy metals or other hazardous elements.

A) Sludge with high content of organic matter treatment and reuse

The widely used common methods for treating and stabilizing sludge are presented in Table 7-5.

Table 7-5: Common Methods for Treating and Stabilizing Sludge

Method of Treatment	Description	Effects on Sludge
Anaerobic Digestion	One of the most widely used methods for sludge treatment. Sludge is stored in the absence of air for 15 to 60 days at temperatures of 20°C to 55°C. Anaerobic bacteria feed on the sludge, producing methane (CH ₄) and carbon dioxide (CO ₂). CH ₄ could be collected in some treatment plants and burned to	Increase solids content, reduce odors, decrease volatile solids, decrease viable pathogens, conserve nutrients, etc.

Method of Treatment	Description	Effects on Sludge
	maintain the treatment temperature.	
Aerobic Digestion	Sludge is agitated with air or oxygen for 40 to 60 days at temperatures of 15°C to 20°C. Aerobic bacteria feed on the sludge producing carbon dioxide (CO ²)	Increase solids content, reduce odors, decrease volatile solids, reduce viable pathogens, some loss of nitrogen usually occurs, etc.
Alkaline Stabilization for Sludge from STP	Sufficient alkaline material, most commonly lime, known as quick lime, is added to the sludge to increase its pH to at least 12 for 2 hours. The pH must remain above 11.5 for an additional 22 hours.	Decrease volatile solids, reduces viable pathogens, loss of ammonia, phosphorus may be converted to forms not readily available to plants, etc.
Composting	Sludge is dewatered to increase the solids content to around 20%, then mixed with a high-carbon organic material such as the organic waste that will be produced from NSEZ industries/ establishments. The mix is composted under aerobic conditions at temperatures of at least 55°C for several days during the composting process.	Volume reduction of sludge and organic waste reduces odors, eliminates most pathogens, decreases nutrient value, etc.

The above-mentioned treatment processes are highly technical and have very specific requirements for variables such as holding time, temperature, pH, and solids content.

B) Sludge Residue Disposal

The sludge residue from the above-mentioned sludge treatment methods should be disposed of at the NSEZ landfill site. Non-hazardous industrial waste may be disposed of along with municipal solid waste in the landfill.

C) Hazardous Sludge Disposal

In case sludge is of hazardous content (heavy metals or hazardous elements/medical waste), it should be storage and disposed of in a lined hazardous waste cell that is recommended to be constructed inside the landfill of NSEZ to receive all hazardous waste from NSEZ industries including hazardous sludge. This alternative will depend on land availability in the landfill. According to the NSEZ master plan, only the MSW landfill is about 185 acres, and the total land requirement considering other facilities like a composting plant, different infrastructure, an area for biomedical waste and a separate area for hazardous waste storage and management about 274 acres has been considered. In addition, this alternative requires high capital costs.

In case this alternative is not feasible, the Department of Environment has specific National Waste Management Policies and Procedures to handle any hazardous waste and dispose of it in landfills. Different non-government organizations are working with DOE to manage medical waste. However, the discussion with relevant authorities will commence after the Environmental Impact Assessment is approved by DOE for any hazardous waste disposal.

7.11 Types of Industries

According to the Environmental Conservation Rules 2023, considering the extent of industrial establishment or Project activities and generated possible impacts periphery, dimension, and possible negative environmental and community health impact, all industrial units or projects are classified into the following four categories viz: Green, Yellow, Orange, and Red. In Schedule-9 of the ECR, it is mentioned that the buffer distance between different categories of industries should be considered.

It is recommended that, during the establishment of an industry in the NSEZ site, BEZA must confirm the buffer distance between the two industries to avoid environmental and social risks and impacts and comply with the national regulatory requirements. The buffer distance between different industries and sensitive areas is shown in Table 7-6.

Table 7-6: Buffer Distance Between Different Industries and Sensitive Areas

Category of Industry	Industry Type	Buffer Distance
Red	High-risk industry, establishment, or activities that have the following characteristics: • Significant risk characteristics considering fire, radiation, and very hazardous chemicals. • Raw materials that are used in the production process, few of them are very hazardous. • Significant level air pollution emission. • Significant amounts of hazardous waste are generated, and few are very difficult to treat.	• Minimum 500 meters or • Actual buffer distance should be determined based on modelling study considering the types and level of risks of the relevant industry or activity, if applicable.
Orange or Red	Heavy industry or activities that have the following characteristics: • The possibility of high pollution and fire, radiation, and risks for very dangerous chemicals. • High-level air pollution emission. • Excessive noise pollution or generated vibration. • A large volume of raw material is used which generates significant dust during transfer, storage, etc. • Significant amounts of hazardous waste are generated, and few are very difficult to treat.	• Minimum 300 meters or • Actual buffer distance can be determined based on modelling study considering the types and level of risks of the relevant industry or activity, if applicable.
Orange or Red	Medium industries or activities that have the following characteristics: • Possibility of medium pollution and fire, radiation, and risks for very dangerous chemicals. • Medium-level air pollution emission.	• Minimum 100 meters. • Actual buffer distance can be determined based on modelling study, if applicable.

Category of Industry	Industry Type	Buffer Distance
	• Medium-level noise pollution or generated vibration. • Hazardous waste is generated that is treated in the industrial boundary.	
Green or Yellow	Light industry or activities that have the following characteristics: • Very low or no possibility of air pollution, noise, vibration, odor, fire, and explosion. • Hazardous substances are not used as raw materials or not produced in the production process. • No hazardous solid waste is generated.	• Minimum 50 meters. • Actual buffer distance can be determined based on modelling study, if applicable.
Green or Yellow	Small industries or activities that have the following characteristics: • Very low or no possibility of air pollution, noise, vibration, odor, fire, and explosion. • Except for land, investment capital is not more than BDT 40 lakhs any time in a year and annual turnover is not more than BDT 60 lakhs. • Dry types of the production process. Liquid waste can be generated from washing, wiping, and cleaning, however, there is less possibility of water pollution due to discharge. • No hazardous solid waste is generated.	• Buffer distance can be considered as a minimum of 10 meters if temperature and noise are generated.

7.12 Phasing of Development

Phasing alternatives relates to the timing of developing the NSEZ and the time constraints for establishing it. According to the master plan of the NSEZ, all the land within NSEZ has not yet been acquired and some lands have been allocated to investors, it is more complicated to accurately phase the site according to best practices. Considering the above facts, the master plan area has been divided into three phases. The execution period of the project is divided into the following three phases:

- Phase I: years 0-5
- Phase II: years 6-10
- Phase III: years 11-20

However, to maximize the land values and minimize capital costs within the urban/industrial city/zone, the following phasing rules should be followed in NSEZ.

- Develop land that has been already acquired and where investors want to construct their industries.

- Develop core infrastructure and utility networks incrementally within NSEZ so that only the required networks/systems are built to support each phase of development.
- Infrastructure/utility networks should never be constructed without demand as they will erode and will need to be replaced, at a later date. This will substantially increase the infrastructure/utility costs within NSEZ.
- All public infrastructure such as access roads and utility networks must be constructed within precincts before investment projects are implemented by investors.
- All public roads and associated utilities (power, water, drainage, sewerage, telecom, etc.) should be constructed in an integrated manner with sufficient rights-of-way in order to support maintenance.
- Try to cluster development so one or a few adjacent precincts are constructed in parallel. Only construct main public roads between existing precincts and investment projects. Main roads should be expanded only when new precincts are to be implemented.
- Larger investment projects within a precinct should be divided into smaller, phased components, where possible. i.e., new phases within investor projects should not begin until 70% of the first or previous phase of a project is sold out/leased.

7.13 Drainage Management

The National Special Economic Zone (NSEZ) and its surrounding communities have been experiencing frequent flooding and waterlogging, primarily due to poor drainage canal systems during heavy rainfall, high tides, and storm surges. Current drainage systems suffer from sediment accumulation, structural deterioration, and limited capacity, leading to drainage congestion and waterlogging. Local consultations highlight the need for both immediate and long-term interventions, particularly in upper catchment canals like Ichakhali, Daborkhali, Bamon Sundor and Hoania canals. To manage these risks effectively key improvements including excavation and re-excavation, as well as necessary upgrades to structural component of the drainage system to enhance the overall resilience and functionality of the NSEZ.

As per the public consultations meeting, local people suggested improving the existing drainage canals. The canals' drainage capacity is poor during the heavy monsoon and high tide time, sometime causes drainage congestion and inside water logging in the local community area outside of the NSEZ development zones. Some of the existing the regulatory and sluice gates located at the upstream or downstream of the canals are in poor conditions, some gates area constructed at the super dyke area. As per the local consultation and environmental point of view, the bed slope, side wall, free-board of the drainage canals can be upgraded thus improving the drainage system of the NSEZ development area.

Considering the deteriorated condition of existing drainage canals, it is essential to implement a comprehensive drainage management strategy that includes both structural and non-structural measures. Addressing these challenges will help mitigate flooding risks, safeguard community safety, and support sustainable development within the NSEZ.

The following measures can be taken for the improvement of the drainage condition of the National Special Economic Zone (NSEZ):

- Management responsibility: Initiation should be taken by the NSEZ incorporation with the Bangladesh Water Development Board (BWDB) and local government administrations if applicable for the drainage improvement of the NSEZ development area in Mirsharai. Due to diminishing condition of the existing drainage canals which might cause during heavy rainfall and cyclonic storm surge in the Sandwip channel. Considering the safety of the local community and NSEZ, the improvement and maintenance of the natural canals should be considered by the NSEZ and BWDB as well.
- Excavation and Re-Excavation of Drainage Canals: Regular excavation of drainage canals to restore the optimal bed level, ensuring smooth water flow and reducing sediment build-up.

- Structural Upgrades for Regulatory Gates: Replacing or repairing deteriorated sluice gates and regulatory structures to allow more effective water level management and prevent backflow.
- Reinforcement of Canal Sidewalls: Strengthening sidewalls and embankments to prevent erosion, especially in areas with high water pressure, to increase canal durability and stability.
- Alternative Analysis of Interventions: Conducting an assessment to explore both structural options (e.g., canal lining, gate improvements) and non-structural measures (e.g., community education and emergency planning) for a holistic drainage management plan.
- Upper Catchment Canal Interventions: Improving drainage in upper catchment areas to enhance downstream capacity and reduce the likelihood of waterlogging in the NSEZ and surrounding community areas.

7.14 Dredging and Land Filling Alternatives

7.14.1 Selection of Dredging Site

The locations of dredging sites should be selected considering the following issues:

- Availability of required materials for landfilling activities in the EZ site.
- Location is not included in any sensitive locations like wildlife/birds/mammals/fish sanctuaries, marine protected areas, marine reserves, or any other sensitive locations.
- Avoid fish/mammal breeding season, migratory season, etc.
- Geotechnical site investigations for dredging projects typically involve the taking of soil borings or vibrocores to obtain samples for material classification.
- Perform sediment quality testing before the selection of the dredging sites and avoid contaminated sediment.

7.14.2 Dredging Methods and Techniques

The selection of dredging equipment and method used to perform the dredging will depend on the factors including physical characteristics of the material to be dredged, quantities of material to be dredged, dredging depth, distance to disposal area, physical environment of and between the dredging and disposal areas, contamination level of sediments, method of disposal, production required, and type of dredges available.

Selection of dredgers is important as selection of dredger has many environmental implications such as the effect of production rate on the project duration, levels of turbidity and suspended sediment concentrations generated relative to background levels, proportion of total sediment lost to the environment, and degree of contamination in the sediment.

There are two primary types of dredging equipment presently being used for dredging. These are the mechanical dredgers (grab dredger, backhoe dredger, and bucket ladder dredger), and hydraulic dredgers (cutter suction dredger, trailing suction hopper dredger, and plain suction dredger). The difference between these types of operations is the mechanisms and methods by which the sediments are excavated, collected, and conveyed.

The dredging activities are achieved by only two mechanisms as given in Table 7-7.

Table 7-7: Dredging Mechanism

Mechanism	Description	Types of Dredgers
Hydraulic Dredging	Removal of loosely compacted materials by cutter heads, dustpans, hoppers, hydraulic pipeline plain suction, and side casters.	• Plain Suction Dredger • Cutter Suction Dredger • Trailer Suction Hopper Dredger
Mechanical Dredging	Removal of loose or hard, compacted materials by clamshell, dipper, or ladder dredges.	• Grab Dredger • Backhoe Dredger

7.14.2.1 Hydraulic Dredges

Hydraulic dredges remove and transport sediment in liquid slurry form. They are either barge mounted where the slurry is transported by pipeline to a disposal area or hopper dredges where the dredged material is simply pumped into the self-contained hopper on the dredge. The advantage of hopper dredges is that it can transport dredged material over long distances and have a relatively high rate of production. However, it has an inability to dredge strong materials and dilution of dredged materials during the loading process.

7.14.2.2 Mechanical Dredger

Mechanical dredges remove bottom sediments through digging or gathering from the bottom surface of a sea, typically through the use of a bucket. It can excavate the material at almost in situ densities. Backhoe, Grab, and dipper dredgers are some types of mechanical dredges. Sediment excavated with a mechanical dredge is generally placed into a barge and transported to the disposal site. The primary advantage of a Backhoe dredger is its ability to dredge a wide range of materials including stiff clays and soft rock. Smaller BHD can work in narrow, confined spaces close to shore. A backhoe is not suggested if the disposal site is located far from the dredging location as it uses a barge for transporting the dredged sediments and also, has a low rate of production.

The selection of dredging equipment and method used to perform the dredging will depend on the following factors:

- Physical characteristics of material to be dredged
- Quantities of material to be dredged
- Dredging depth
- Distance to disposal area
- Physical environment of the dredging disposal areas
- Contamination level of sediments
- Method of disposal
- Production required

Preferred option

The dredged sediment will be used for landfilling/site development of the EZ area. Hence considering the required production rate and disposal site location (far from the dredging area), a Trailer Suction Hopper Dredger (TSHD) can be preferred for dredging. However, a Cutter Suction Dredger (CSD) is preferred over TSHD at locations where the depth is shallow.

7.14.3 Disposal Techniques

The latest techniques for the disposal of dredged material generally consist of fill materials, open-water disposal, etc.

7.14.3.1 Fill Material

Dredged sediment can be used as fill material for construction works after dewatering e.g., EZ land development/landfill, road construction, port area land development, erosion-prone sites, etc. This will help to reduce overall project costs by not having to purchase off-site material for landfilling/development purposes. This will allow large volumes of dewatered dredged sediment in holding areas to be used up which will make available more space at disposal sites for subsequent disposal of material. This option, however, requires large holding areas and depending on dredge volumes will be required for storage of these materials until they are used.

7.14.3.2 Open Water Disposal

Discharge into the sea is one of several alternative options for dealing with the dredged material. Depositing large amounts of sediment may lead to physical and chemical changes in the water column as well as changes in bottom morphology. This may disrupt the balance inside and around the selected

dumping site. Dumping sediments into water columns has the potential to adversely impact the environment. Dumping may influence food chain structures for inhabiting aquatic species.

Preferred Option

A preferred option would be the use of the dredge material as fill material. Dewatering will reduce volumes of the sludge available for disposal and allow recovery of the sand for reuse. The sand can be used to reclaim the economic zone land area.

7.15 Conclusion of Alternatives

Without the project implementation, which is expected to provide about 1.4 million job opportunities during the different phases of the project, increased price of land and property, infrastructure development, improved transportation network, increased revenue by attracting national and foreign investors and promote a good business climate will not be achieved.

Consideration of site alternative, the NSEZ site is selected on the coastal area of Bangladesh considering the accessibility by road and waterways. The selected site is mostly reclaimed land from the sea and a very small amount of private land. Sensitive areas/protected areas such as national parks, wildlife sanctuaries, marine protected areas, marine reserves, archaeological sites, cultural heritage sites, ancient monument sites, key biodiversity areas, etc. in the project site were not observed. Basically, in Bangladesh, there is a scarcity of suitable alternative land for establishing such a huge industrial city.

Access Road(s): without proper link access roads that provide sufficient space to handle the movement of traffic to and from NSEZ, its daily operational activities will be highly delayed and potential traffic accidents will become a threat to community safety in the neighborhood. The following improvements to the transport system have been prioritized to support NSEZ:

- A 6-lane bypass has been suggested to access the northern side (Sonagazi) of the NSEZ.
- A separate access-controlled link road connecting to the port and logistic area in NSEZ.
- The present 4-lane highway is required to be widened to 6 lanes.
- In order to have direct connectivity to Chattogram from NSEZ, a new link is proposed. This road will start near the Port and follow the coast down to Chattogram.

Water Resources: it is estimated that the total annual water usage of the water project is 343 million liters in 2025, 482 million liters in 2030, 683 million liters in 2035, and 965 million liters in 2040. Water will be obtained from both the surface and groundwater sources.

Electricity Supply: For the residents in NSEZ, power will be obtained from a variety of sources. As such, a percentage of total demand may be met by on-site generation facilities. In the present scenario, NSEZ may take 2,000 MW (without contingency) from the grid network against the demand of 3,248 MW through an existing, dedicated 400 kV transmission linked with the grid system.

Power plants within NSEZ are perfect for the use of LPG, natural gas, and/or LNG. However, renewable energy sources such as solar and wind could be considered as additional energy supply sources besides the installed electrical power source.

Hazardous/non-hazardous waste management and disposal: waste should be collected at the source in colored bins with appropriate capacities. Bins should be labeled and placed at appropriate places so that dropping, and collection of waste is convenient. Waste should be collected daily to maintain a hygienic environmental system. Collected waste of each industry will be taken in compact trucks to its destination; where:

- According to the NSEZ Master Plan, food and vegetable waste (69%) will dominate municipal solid waste followed by paper products (9.3%) and plastic (4.5%). Organic wastes or residues will be treated at the compost plant in NSEZ. Additionally, other treatment methodologies could be considered. These treatment methodologies include Anaerobic Digestion, Aerobic

Digestion, and Solid-State Fermentation to be reused as a source of energy, and/or animal feed, respectively.

- Recyclables such as packing materials will be sent to recycling units for treatment and reuse.
- A lined hazardous waste cell to be constructed in the landfill, which will be located inside the NSEZ, is recommended as a final hazardous waste disposal site. Waste collection and transportation to the landfill could be managed by a private sector/company through a contractual agreement between the private sector/company and NSEZ/BEZA. However, the landfill site's overall management and control will be the NSEZ's responsibility.

Domestic wastewater will be collected in holding tanks and directed to NSEZ STP-1 and STP-2 with a proposed capacity of 45 MLD and 80 MLD respectively, while industrial wastewater will be collected and directed to NSEZ CETP-1, CETP-2, CETP-3, and CETP-4 with a proposed capacity of 16 MLD, 32 MLD, 150 MLD, and 370 MLD respectively via the installed wastewater network system.

Stormwater is to be separated from the industrial wastewater streams in order not to place an unnecessary burden on the CETPs as stormwater is typically "clean" water/uncontaminated water. This could be reused as greywater or for the purpose of landscaping.

A wastewater pre-treatment unit consisting of settling, equalization, and oil & grease removal tanks is recommended to be installed for each industry/establishment then wastewater will be directed to the CETPs via the NSEZ wastewater network system to reduce the load.

The pre-treatment unit is the responsibility of the industries/establishments and NSEZ management should monitor the quality of the effluent that will be directed to the CETPs of NSEZ against its design parameters before receiving it.

The treated effluent from the STPs and CETPs could be reused in irrigation of the greenbelt surrounding NSEZ and the surplus or in case the reuse is not an option, the treated effluent from the STPs and CETPs could be discharged to the Bay of Bengal/Sandwip Channel.

- In the case of reusing the treated wastewater effluents in irrigation of the greenbelt surrounding NSEZ, it should be monitored against national standards (Schedule-3 and Schedule-4 of ECR 2023).
- In case of discharging the treated wastewater effluent into the Bay of Bengal/Sandwip Channel, it should also be monitored against the national standards (Schedule-3 and Schedule-4 of ECR 2023).

The effluent from the STPs and the CETPs should be tested periodically to ensure that both STPs and CETPs are operating in an efficient way.

Sludge should be tested periodically for containing heavy metals or other hazardous elements. Sludge with a high content of organic matter is to be treated and reused as a soil conditioner or a source of energy. Hazardous sludge with heavy metals or hazardous elements is to be disposed of in a lined hazardous waste cell to be constructed in the NSEZ landfill site. In case this alternative is not feasible, the Department of Environment has specific National Waste Management Policies and Procedures to handle any hazardous waste and dispose of it in landfills. Different non-government organizations are working with DOE to manage medical waste. However, the discussion with relevant authorities will commence after the Environmental Impact Assessment is approved by DOE for any hazardous waste disposal.

According to the ECR 2023, all industrial units or projects are classified into the following four categories viz: Green, Yellow, Orange, and Red. It is recommended that, during the establishment of an industry in the NSEZ, BEZA must confirm the buffer distance as mentioned in Schedule-9 of the ECR 2023 between the two industries to avoid environmental and social risks and impacts and comply with the national regulatory requirements.

Phasing alternatives relates to the timing of developing the NSEZ and the time constraints for establishing it. The execution period of the project will be completed in three phases i.e., Phase I: years

0-5, Phase II: years 6-10, and Phase III: years 11-20. For the phase-wise development, BEZA should consider the following issues:

- Develop land that has been already acquired and where investors want to construct their industries.
- Develop core infrastructure and utility networks so that only the required networks/systems are built to support each phase of development.
- Infrastructure/utility networks should never be constructed without demand.
- All public infrastructure such as access roads and utility networks must be constructed before investment projects are implemented by investors.
- All public roads and associated utilities (power, water, drainage, sewerage, telecom, etc.) should be constructed in an integrated manner with sufficient rights-of-way to support maintenance.
- Try to cluster development so one or a few adjacent precincts are constructed in parallel.

It is recommended that the implementation of NSEZ should follow phase-wise development and the new phase should not begin until 90% of the previous phase of a project is completed and sold out/leased to the investors.

Dredging and Land Filling Alternatives: Dredging sites should be chosen based on material availability, avoiding sensitive locations like wildlife sanctuaries, and considering seasonal breeding and migration. Geotechnical investigations and sediment quality tests are essential to ensure environmental safety.

Dredging methods depend on material characteristics, dredging depth, sediment contamination, and distance to disposal sites. Hydraulic dredges, like Trailer Suction Hopper Dredgers (TSHD), are suitable for transporting large volumes over long distances, while Cutter Suction Dredgers (CSD) are effective in shallower waters. Mechanical dredgers, such as backhoe and grab dredgers, are best for excavating dense materials but have lower production rates.

Dredged material can be dewatered and reused as fill for land development, reducing costs and conserving disposal space. Open-water disposal, though an option, poses environmental risks like disrupting aquatic ecosystems. The preferred approach is to dewater and reuse dredged material for economic zone development.

8 ES MANAGEMENT PROCEDURE

This chapter outlines the framework for assessing and managing environmental and social issues in different projects in the NSEZ as well as surrounding regions. It also provides necessary procedures and tools for screening and assessing environmental and social impacts. The environmental and social assessment of the projects in the region needs to be carried out based on the provisions of the Environment Conservation Act 1995 and its subsequent amendments and Environment Conservation Rules 2023 of the Government of Bangladesh as well as relevant World Bank's Environmental and Social Standards (ESSs).

8.1 General Principle

Due to the nature of some of the proposed activities in the region during the development and operation of the NSEZ and their potential environmental and social impacts, the different activities/projects will fall into different project categories (red, orange, yellow, green) according to Environment Conservation Rules 2023 and World Bank environmental and social risk classification (high, substantial, moderate, and low), which will require initial ES screening, EMP/ESMP, IEE, and in some cases detail EIA/ESIA. Therefore, the ES management plan is prepared based on the following principles that can lead to the development and implementation of the activities/projects in the region.

- BEZA HQ at the national level and the Project Director of NSEZ at the project level are responsible for compliance with national policies, regulations, and WB ESSs and guidelines.
- PD of NSEZ in coordination with the other institutions including RHD, LGED, BWDB, BIWTA, PGCB, BR, KHDCL, etc. as well as investors/industries in the NSEZ is responsible for obtaining environmental clearance from DOE, local government agencies, and WB as required.
- IEE, EIA/ESIA, and EMP/ESMP need to be prepared for activities upon screening. In case, the requirements of DOE's EIA guidelines differ from those of WB ESF, the more stringent standards and requirements will apply.
- If any activities/projects with impacts are identified in ESIA which may categorize the project as High risk (according to ESF) will not be eligible for WB's financing.
- Activities requiring Free, Prior, Informed Consent (FPIC) from small ethnic communities will not be eligible for implementation in the region under WB financing.
- Activities with significant environmental impacts, including those that significantly increase greenhouse gas emissions and impact on natural habitats and biodiversity will not be eligible for implementation in the region under WB financing.
- Planning and design of any additional activities should ensure minimal assessment of cumulative impacts.
- Environmentally sensitive areas, cultural heritage sites, and restricted or disputed lands (if identified during project implementation) should be handled with appropriate mitigation or compensation measures during implementation following the chance find procedure.
- Participation of stakeholders (especially local communities) should be ensured by the HSE team of NSEZ in the planning, implementation, and monitoring of project activities.
- NSEZ management will ensure appropriate institutional set up for implementing E&S management plans and inter-agency coordination. They will also ensure that bidding/agreement/contract documents for construction contractors, and PPP operators have specific clauses to ensure implementation of E&S management plans, as required.
- Contractors to be engaged in construction/renovation/expansion/repair and maintenance/operation workers under the NSEZ should be conversant with OHS standards, labor laws, SEA/SH issues, incidence response, and reporting mechanisms.
- NSEZ management will inform project stakeholders about project interventions and their potential impacts on the surrounding ES elements.

8.2 Environmental and Social Management System

The objective of this aspect of the framework is to establish an effective framework for the implementation and management of the measures for a better E&S performance of the NSEZ in the region. In essence, its focus is on institutional practices for implementing the measures as well as monitoring the implementation process. The goal is to ensure that the right policies and procedures, as well as capacity, exist to effectively execute the implementation and monitoring exercises.

8.2.1 Objective of Environmental and Social Management System

The primary objective of this Environmental and Social Management System (ESMS) is to guide the NSEZ in screening and selecting projects and assessing and managing environmental and social impacts. NSEZ will ensure that:

- All projects are screened against the negative/exclusion list of activities.
- All projects with potentially significant environmental impact are categorized as per DOE and WB.
- All projects are reviewed and evaluated against all other national laws, regulations, and standards on environment, health, safety, involuntary resettlement and land acquisition, indigenous peoples, and physical cultural resources.
- All applicable existing policy frameworks are adequate for the implementation, monitoring, and reporting of the measures defined in the E&S safeguard documents/instruments.
- Capacity exists for the implementation, monitoring, and reporting of the measures defined in the E&S safeguard documents/instruments.
- Stakeholder engagement strategy is adequate to ensure all relevant affected and interested parties participate in the implementation of the E&S safeguard documents/instruments.

8.2.2 Environmental and Social Management Procedures

8.2.2.1 Screening Criteria for Selection of Investment in NSEZ

The following types of projects or activities could be preferred during the initial section of investment in NSEZ but are not limited to:

- Low pollution generating industries.
- Prefer low-carbon emission industries.
- Low water-consuming industries.
- Low impact on ecology and biodiversity.
- Higher engagement opportunities, however, would be aligned with the actual requirements of the upcoming industries.
- Green energy generation-related industries.
- Exports-oriented or pure-play domestic market industry or a combination of both.
- Contribution to national/regional economic development.
- Contribution to social development - contribution to job creation.
- Environment impact - no critical or protected areas are impacted.
- Social impact - no structure affected, no resettlement, archaeological sites are impacted, etc.
- Legal compliance to national environmental and social legislation.

8.2.2.2 Description of Negative/Exclusion List of Activities

The activities that are likely to pose high risks and severe negative impacts on the environment, society, health, and safety will not be established in the NSEZ. A list of such activities has been compiled as the “negative/exclusion list of activities” and presented below:

- Any activity that violates the provisions of applicable national laws and regulations as well as international treaties, agreements, and conventions where Bangladesh is a signatory.

- Any activity that has a high probability of serious adverse effects on human health and/or the environment.
- Any activity that impacts productive land and tourist spots due to the land acquisition under the Acquisition and Requisition of Immovable Property Act 2017.
- Involuntary land taking, irrespective of ownership, leads to loss of shelters, livelihood, or sources of livelihood, and loss of access to private and/or community property.
- Any project or activity within protected areas (e.g., wildlife sanctuary).
- Any activity that leads to the conversion of natural or critical habitats, legally protected areas of high biodiversity, and designated forest areas.
- Construction/works involving use/installation of Asbestos Containing Materials (ACM)/Items.
- Activities involved harmful or exploitative forms of forced labor or child labor.
- Production of trade of any product or activity deemed illegal under the law of Bangladesh or subject to international phaseouts or bans (e.g., ozone-depleting substances, wildlife or wildlife products, waste products, etc.).
- Production or trade in weapons and munitions, including paramilitary materials.
- Production or trade of alcoholic beverages, excluding beer and wine.
- Production or trade of tobacco.
- Gambling, casinos, and equivalent enterprises.
- Pornography (goods/stores/web-based).
- Production or trade-in, or use of unbounded asbestos fibers.
- Marine and coastal fishing practices, such as large-scale pelagic drift net fishing and fine mesh net fishing, are harmful to vulnerable and protected species in large numbers and damaging to marine biodiversity and habitats.

All projects in the EZ will be checked to confirm that it does not include any activity listed on the negative/exclusion list of activities. This applies to all projects including civil construction works in the EZ as well as related activities in the region. The contract documents between EZ and the project authority will include necessary clauses to exclude support for any activities in the negative/exclusion list of activities.

The responsibility for checking and ensuring that none of the activities listed in the 'negative/exclusion list of activities' lies with the HSE team of NSEZ. The HSE manager/ESG manager of the NSEZ will check:

- All detailed project reports and contract documents of the project.
- All activities to ensure that they do not contain any activities on the negative/exclusion list of activities.

8.2.2.3 Environmental and Social Screening

A screening procedure will be prepared and implemented in order to identify any environmental risks and impacts associated with the proposed project. Environmental and social screening would be undertaken for each project/activity.

If the proposed project does not involve any activities in the negative/exclusion list of activities, then the environmental and social screening would be carried out to determine whether there are any potential environmental and social risks and impacts, involuntary resettlement impacts and risks, impacts on ecosystem and biodiversity, Indigenous people living in the area, etc. Screening would be carried out comprising proposed project information, locations, proposed interventions and activities, utility requirements and consumption (water, fuel, manpower, raw materials, gas, etc.), production process, generation of emission and effluent, solid waste generation, requirements proximity from settlements, forest, environmentally sensitive areas, national parks, wildlife statuary, marine protected areas, important birds and biodiversity area, wetlands, waterbodies, etc.; applicability of laws, regulations and clearances and permits to be required; identification of potential E&S risks and impacts (physical, biological, social and cultural); and to classify the project based on risk level and finally, presenting

conclusion on risk category, need for the detailed environmental assessment, land acquisition and recommendations for preparation of environmental and social safeguard documents (e.g., IEE/EIA/ESIA/ EMP/ESMP and RPF/RAP).

The Environmental and Social Screening for all projects and activities in the EZ would be undertaken using project E&S screening templates prepared under the “Environmental and Social Management Framework (ESMF) for Private Investment and Digital Entrepreneurship (PRIDE) Project³²” to identify the nature and extent of E&S risks and impacts for different types of proposed activities. Environmental and Social screening shall be carried out before the preparation of detailed project reports by the environmental & social experts of the project authority through physical site visits/transect walks and will be made after a thorough understanding of environmental settings at and around the project sites. Dully Environmental and Social screening checklists will be checked and verified by environmental and social experts of NSEZ’s HSE team. The World Bank will review a selection of projects, through desk review /site visits and provide suggestions and guidance for improvements, if required. In the case of substantial risk categories of projects, the Bank will review and approve all E&S checklists.

Environmental and Social screening will be carried out for all projects by Environmental and Social Experts of the project authority. They will identify major project activities and carry out a preliminary assessment of the impacts of these activities on the ecological, physio-chemical, and socio-economic environment of the project’s surrounding areas. The HSE team of NSEZ will review the E&S screening checklists and will be sent to the World Bank through BEZA HQ for reviewing its completeness, correctness, compliance, and approval.

8.2.2.4 Project Categorization as per DOE

The legislations relevant to environmental assessment in Bangladesh for all projects are the Environmental Conservation Act (ECA) 1995 and its subsequent amendments, and the Environmental Conservation Rules (ECR) 2023. Department of Environment (DOE), under the Ministry of Environment, Forest, and Climate Change (MOEFCC), is the regulatory body responsible for enforcing both ECA 1995 and ECR 2023.

According to the Environment Conservation Rules 2023, considering impacts on the environment and human health, locations and extension of impacts, etc. all the projects have been categorized into four categories i.e., Green, Yellow, Orange, and Red. A list of projects or activities for each category has been provided in Schedule 1 of the ECR 2023. In case of projects or activities that are not mentioned in Schedule 1 then the project or activities will be categorized as per the instruction provided in Schedule 14 of the ECR 2023. Based on the category of projects or activities, further, the level of the environmental assessment will be determined by whether a detailed IEE, site-specific EMP, or EIA is required or not.

8.2.2.5 Project Categorization as per WB ESF

As part of the review of environmental and social risks and impacts, the World Bank categorizes projects into four categories (low, moderate, substantial, and high) considering type, location, sensitivity, and scale of the project; nature and magnitude of the potential E&S risks and impacts; and capacity and commitment of the Borrower to manage the E&S risks and impacts in a manner consistent with the WB ESSs. The categories have been provided in Table 8-1.

Table 8-1: World Bank Project Categorization

Categories	Definition
High Risk	A project is classified as High Risk if the project is likely to generate a wide range of significant adverse risks and impacts on human populations or the environment because of the complex nature of the project, the scale (large to

³² <https://documents1.worldbank.org/curated/zh/599071580345036563/pdf/Revised-Environmental-and-Social-Management-Framework-ESMF-Bangladesh-Private-Investment-and-Digital-Entrepreneurship-Project-P170688.pdf>

Categories	Definition
	very large), or the sensitivity of the location(s) (sensitive and valuable ecosystems and habitats like Protected Areas, National Parks, World Heritage Sites, Important Bird Areas, etc., lands or rights of Indigenous Peoples or other vulnerable minorities, intensive or complex involuntary resettlement or land acquisition, impacts on cultural heritage or densely populated urban areas, etc.) of the project. The potential risks and impacts have the majority or all of the following characteristics: • Long-term, permanent, and/or irreversible (e.g., loss of major natural habitat), and impossible to avoid entirely due to the nature of the project. • High in magnitude and/or in spatial extent (the geographical area or size of the population likely to be affected is large to very large). • Cumulative and/or transboundary in nature. • High probability of serious adverse effects on human health and/or the environment (e.g., due to accidents, toxic waste disposal, etc.). • Some of the significant adverse E&S risks and impacts of the project cannot be mitigated or specific mitigation measures require complex and/or unproven mitigation or compensatory measures or technology, or sophisticated social analysis and implementation. • Significant social conflict or harm or significant risks to human security. • History of unrest in the area of the project or the sector. • Significant uncertainty or conflict as to the jurisdiction of competing agencies, or legislation or regulations do not adequately address the risks and impacts of complex projects, or changes to applicable legislation are being made, or enforcement is weak. • Stakeholder engagement is weak.
Substantial Risk	A project is classified as Substantial Risk if the Project may not be as complex as High-Risk Projects, its E&S scale and impact are smaller (large to medium), and the location is not in a highly sensitive area. The potential risks and impacts have the majority or all of the following characteristics: • Mostly temporary, predictable, and/or reversible, and the nature of the project does not preclude the possibility of avoiding or reversing them. • Few of the significant adverse E&S risks and impacts of the project cannot be mitigated or specific mitigation measures require complex and/or unproven mitigation or compensatory measures or technology, or sophisticated social analysis and implementation. • Adverse social impacts of the project, and the associated mitigation measures, may give rise to significant social conflict or harm or significant risks to human security. • Medium in magnitude and/or in spatial extent (the geographical area and size of the population likely to be affected are medium to large). • Cumulative and/or transboundary impacts may exist, but they are less severe and more readily avoided or mitigated than for High-Risk projects. • Medium to low probability of serious adverse effects on human health and/or the environment. • Effects of the project on areas of high value or sensitivity will be lower than High-Risk projects. • Mitigatory and/or compensatory measures may be designed more readily and be more reliable than those of High-Risk projects.
Moderate Risk	A project is classified as Moderate Risk if risks and impacts on human populations and/or the environment are not likely to be significant. The Project is not complex and/or large, does not involve activities that have a high potential for harming people or the environment and is located away from environmentally or

Categories	Definition
	socially sensitive areas. The Project's risks and impacts can be easily mitigated predictably. The potential risks and impacts and issues are likely to have the following characteristics: • Predictable and expected to be temporary and/or reversible. • Low in magnitude. • Site-specific, without the likelihood of impacts beyond the actual footprint of the Project. • Low probability of serious adverse effects on human health and/or the environment.
Low Risk	A project is classified as Low Risk if its potential adverse risks to and impacts on human populations and/or the environment are likely to be minimal or negligible. These Projects, with few or no adverse risks and impacts and issues, do not require further E&S assessment following the initial screening.

8.2.2.6 Preparation of the Safeguard Documents/Instruments

National Regulatory Requirements

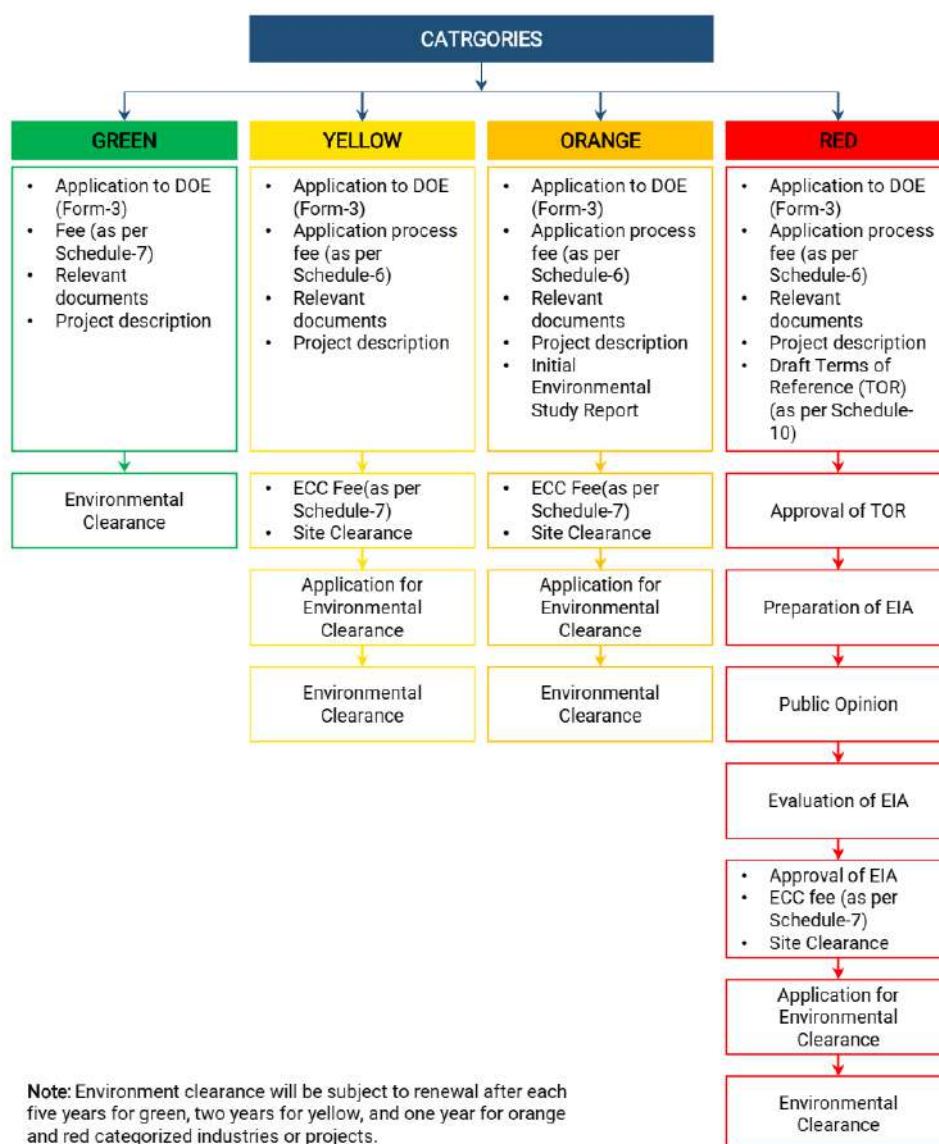
- Red category projects will require a detailed Environmental Impact Assessment (EIA) including an Environmental Management Plan (EMP). Terms of Reference (TOR) for EIA approval from the DOE will be required.
- Orange category projects will require an Initial Environmental Examination (IEE) and application to DOE (form-3), fees, project descriptions, etc.
- Yellow category projects will require to submit an application to DOE (form-3), fees, project descriptions, etc.
- Green category projects will require to submit an application to DOE (form-3), fees, project descriptions, etc.

World Bank Requirements

- High and Substantial Risk Category projects will require a detailed Environmental and Social Impact Assessment (ESIA) including an Environmental and Social Management Plan (ESMP). These should include site-specific information (e.g., environmentally sensitive areas, or need to better define and understand potential issues, a brief description of impacts specifying well-defined mitigating measures, and adopting accepted operating practices and monitoring).
- Moderate Risk Category projects will require an Initial Environmental Examination (IEE) with a site-based Environmental and Social Management Plan (ESMP). The IEE is a review of the reasonably foreseeable effects of a proposed development intervention/activity on the environment. Participation and consultation with local communities are important in identifying the potential impacts and suitable mitigation measures.
- Low Risk Category projects will require a site-specific Environmental and Social Management Plan (ESMP) will be required to ensure enhancements such as greening measures are implemented. The ESMP should clearly lay out: (a) the measures to be taken during both the construction and operation phases of a project to eliminate or offset adverse environmental and social impacts or reduce them to acceptable levels; (b) the actions needed to implement these measures; and (c) a monitoring plan to assess the effectiveness of the mitigation measures employed.

8.2.2.7 National Environmental Clearance Requirements of the Proposed Projects

Steps to be followed for environmental clearance for different categories from the DOE are shown in Figure 8-1.

Figure 8-1: DoE Environmental Clearance Steps

Source: ECR, 2023

Exceptions for the Projects or Activities inside of the EZ's

According to Clause 6 for the ECR 2023, site clearance will be not required for any type of industries or projects located inside of the Economic Zones, Public and Private Export Processing Zones, and Bangladesh Small and Cottage Industries Corporation area. Only the environmental clearance needs to be taken from the DOE.

8.2.2.8 Review and Approval of the E&S Safeguard Document and Dissemination

The Environmental and Social Experts of the project authority will submit the E&S safeguard documents (i.e., IEE/EMP/EIA/ESIA) to DOE and WB through NSEZ and or One Stop Service at BEZA HQ. The report will be reviewed by a national regulatory authority (DOE) and the World Bank and provide technical advice on the conduct of assessments and related studies on undertakings and the reports submitted on them. Additionally, they will make recommendations on the adequacy of the assessment and any observed gap and advice on the seriousness of such gaps and the risks or otherwise to decisions required to be made recommend whether the undertakings as proposed must be accepted and under what conditions, or not to be accepted and the reasons, as well provide guidance on how any outstanding issue/areas may be satisfactorily addressed.

Copies of all the final and approved versions of E&S safeguard documents will be shared with NSEZ, BEZA HQ, DOE District Offices, DOE division office, DOE HQ as well as World Bank.

8.2.2.9 Implementation, Supervision, Monitoring, and Reporting

Detailed institutional or stakeholder arrangements, capacity assessment, and strengthening are provided in Chapter 4.

Day-to-day implementation and monitoring of the E&S plan will be done by the individual industries and their appointed contractors following the approved environmental and social management plan as well as any subsequent corrective measures prescribed by the HSE team of NSEZ and WB. In addition, they will maintain close communication with the HSE team of NSEZ and relevant stakeholders as necessary. The HSE team of NSEZ will regularly supervise works through site visits, review of documentation, and other available means. The HSE team of NSEZ will prepare regular semiannual monitoring reports on the environmental, social, health, and safety performance of the NSEZ, including but not limited to stakeholder engagement activities and grievance logs, and submit to the World Bank and DOE through BEZA HQ. It will help to assess the progress made in the implementation of E&S safeguards and the measures required for its improvement. It will provide the necessary feedback for the NSEZ management for timely decision-making and achieving the objectives. If appropriate, DOE and other local authorities may also monitor the implementation of the E&S measure during the implementation and operation of the EZ.

The HSE team of NSEZ will notify WB within 48 hours of any incident or accident related to the EZ or that has an impact on it, and that has or could have a significant adverse effect on the environment, the affected communities, the public, or the workers included, for example, occupational accidents that could result in serious injury, minors, injuries, falls, vehicle accidents, larger spills of chemicals, oils, fuels, etc.

8.2.3 Environmental, Health, and Safety Standards for the Industrial City

Environment, health, and safety (EHS) standards will play a key role in overall environment, health, and safety management in the NSEZ. NSEZ should comply with both national as well as World Bank environmental, health, and safety standards. The more stringent of these two, as required to meet lenders' requirements, will be adopted. BEZA shall adopt ISO 14001:2015 - Environmental Management Systems, ISO 45001:2018 - Occupational Health and Safety Management Systems Standards, and ISO 9001:2015 - Quality Management Systems in their management system as a good practice. It will ensure that BEZA's environment management system remains globally oriented and best in class. ISO certification will promote safe practices to reduce the chances of accidents and injuries in the workplace. ISO 14001:2015 will help to achieve the intended outcomes of its environmental management system, which provide value for the environment, the organization itself, and interested parties. In addition, ISO 45001:2018 will enable organizations to provide safe and healthy workplaces by preventing work-related injury and ill health, as well as by proactively improving their OH&S performance.

World Bank Group/International Finance Corporation has developed General as well as sector-specific Environmental, Health, and Safety Guidelines that can be used. In addition, other international guidelines i.e., WHO guidelines, ILO labor standards, etc. should be used. In case of the absence of standards in national legislation in those cases, international standards should be used. For example: there are no national standards for soil and sediment quality analysis, therefore USEPA, Dutch or any other international standards should be adhered to in NSEZ.

8.2.4 Guideline for Long-term Environmental and Social Monitoring

To ensure effective implementation of the NSEZ, long-term monitoring will need to be done throughout the NSEZ life cycle. Monitoring will verify if predicted impacts have actually occurred and check that mitigation actions recommended in the RESA are implemented and their effectiveness. Monitoring will

also identify any unforeseen impacts that might arise from the development and operation of NSEZ, and appropriate new actions shall be undertaken to mitigate any upcoming negative effects.

For the long-term environmental and social monitoring in the region, close collaboration will be required regarding environmental and social issues monitoring in the region with other government departments/agencies. In addition, different online-based monitoring systems i.e., Continuous Air Quality Monitoring (CAQM) for ambient air quality, and Online Continuous Emission Monitoring System (CEMS) to monitor the effluent quality at the CETPs outlets should be introduced in the NSEZ. A weather monitoring station should be installed to monitor long-term changes in the region.

An ESG data management tool that can be developed by BEZA, which will enable them to accurately, efficiently, and transparently track and report on their environmental, social, and governance performance in different economic zones as well as NSEZ. Digitalization can significantly improve operational efficiency, leading to a reduced environmental footprint. This digital tool will allow to generation of reports based on specific parameters. These tools will make it easy to visualize and share data with their employees, customers, other stakeholders, and the general public. Graphs, charts, and dashboards can be easily generated using data visualization tools, which can then be shared with stakeholders. Analysis of ESG data over time, trends that point to areas for improvement, and use this information to make continuous improvements in ESG performance.

8.3 Environmental and Social Management Plans

8.3.1 Air Quality Management Plan

Purpose

This plan is prepared to identify and present means of management of air emission sources. The overall aim is to keep the air quality impacts below the accepted limits in accordance with Air Pollution (Control) Rules 2022 and WHO standards.

Reference

- Air Pollution (Control) Rules, 2022
- Solid Waste Management Rules, 2021
- World Bank Environmental and Social Standards¹ and 3
- WBG Environmental, Health, and Safety General Guidelines
- World Health Organization (WHO) Ambient Air Quality Guidelines
- Bangladesh Climate Change Strategy and Action Plan, 2009
- National Adaptation Programme of Action, 2009
- Bangladesh Climate Change Trust Act, 2010
- Bangladesh Delta Plan, 2100.

Mitigation Measures for Impacts on Air Quality

The following measures could mitigate the anticipated negative impacts on the ambient air quality as well as climate change and greenhouse gases in the region :

- Sprinkling water to suppress the dust at the EZ specifically on the dust-generating sites.
- Maintain the speed of a vehicle to 20 km per hour at the EZ site and internal road to reduce dust emissions to a large extent.
- Develop a green belt in the NSEZ site, empty land, outside of the super dike, and surrounding access roads to increase green area.
- Use of electric cars inside the EZ for all transport requirements should be encouraged.
- Consider cleaner technology for alternative production processes and power sources from solar and wind resources.
- Methane gas produced from landfill sites and other treatment units must be flared.

- Arranging transportation for factory workers (or) encouraging them to use bicycles or walk to work.
- Design the offices and worker's township using appropriate "green building" methods.
- Weather monitoring stations should be installed at one location in the EZ site to gather real-time weather-related data.

Monitoring of Ambient Air Quality Management

The proposed scope of the air quality monitoring activities in the region is as follows:

- Presence and validity of environmental permits for individual industries must be checked.
- Establishment and operation of continuous ambient air quality monitoring stations at five (5) different locations (number may be changed considering the spatial extent of the EZ as well as other activities) in the NSEZ site and surrounding region to gather real-time air quality data. The monitoring parameters will be PM₁₀, PM_{2.5}, NO₂, SO₂, CO, Pb, O₃, NH₃, VOC, etc.
- Weather conditions in the EZ region including the parameters of air temperature, atmospheric pressure, humidity, precipitation, solar radiation, wind, etc.
- Continuous emission monitoring system for power plants and waste incinerators.
- Conduct an annual energy audit in each industry and prepare an annual report for the NSEZ.
- Conduct an annual greenhouse gas inventory in each industry and prepare an annual report for the NSEZ.

The availability of environmental permits for individual industries must be checked and confirmed by the HSE team of NSEZ. The Department of Environment (DOE) will establish and monitor the ambient air quality of the region following the provision of Air Pollution (Control) Rules 2022. NSEZ will establish and confirm the continuous emission monitoring system for power plants and waste incinerators in the EZ. NSEZ management will establish a weather station and the HSE team will maintain the station and keep a record of historical data for further reporting. The individual industry/investor will conduct annual energy audits and greenhouse gas inventory for their facilities and share a copy with the NSEZ management. The HSE team of NSEZ will compile all the data/reports and prepare an annual report and a copy of the annual report will be shared with the DOE.

8.3.2 Noise Management Plan

Purpose

The noise management plan is developed to manage significant sources of noise and its impacts on the receiving environment, as well as monitoring the noise levels generated by the development and operational activities of the NSEZ. The overall aim is to keep the noise impacts below the accepted limits in accordance with Noise Pollution (Control) Rules 2006 and WHO standards.

Reference

- Noise Pollution (Control) Rules, 2006
- World Bank Environmental and Social Standards¹ and 3
- WBG Environmental, Health, and Safety General Guidelines
- World Health Organization (WHO) Ambient Noise Level Guidelines.

Mitigation Measures for Impacts of Noise

The following measures could mitigate the anticipated negative impacts on the ambient noise level in the region:

- Activities that will take place near residential or sensitive receptors should be carefully planned (restricted to daytime, taking into account weather conditions, etc.).
- Preferably battery-operated very low noise-generating vehicles should be used in the EZ.
- Use of personal protective equipment such as earmuffs, ear plugs, etc. should be strictly enforced for the workers engaged in high-noise areas.

- Optimize dredging activity and duration. Underwater noise generation should be restricted with modified equipment. The measures include modifying propellers and/or hulls and performing regular maintenance, vibrationally isolating machinery, implementing vessels/ships speed restrictions, and incentivizing the use of fewer, larger vessels, etc.
- Timing and programming outside sensitive seasons (e.g., avoiding the migration seasons of marine mammals, birds, fishes, etc.), especially concerning underwater noise.
- Ensuring that the noise level of operation of all facilities and structures is within the acceptable limit stipulated in Noise Pollution (Control) Rules 2006 and WHO/WBG standards.

Monitoring of Noise Management

The proposed scope of the noise level monitoring activities is as follows:

- Ambient noise level monitoring should be carried out on a half-yearly basis at selected 10 locations in the EZ and surrounding regions specifically near the sensitive receptors i.e., schools, settlements, mosques, bazar, etc. the monitoring parameters include leq_{day} , leq_{night} , L_{max} , L_{min} , L_{90} , and L_{10} , etc. should be measured.
- Grievances received on impacts related to noise generation will be monitored and evaluated to develop corrective actions, as required throughout the lifecycle of the EZ.

The HSE team of NSEZ will conduct the monitoring in the region and results to be compared with the Noise Pollution (Control) Rules 2006 as well as WHO/WBG Standards. NSEZ may engage DOE or any third-party consultant to carry out the monitoring work in the region. Finally, the NSEZ's HSE team will be responsible for submitting a copy of the report to the DOE.

8.3.3 Surface Water Management Plan

Purpose

This plan is developed to provide proper management of the surface water quality in the region. The overall aim is to keep the surface water quality below the accepted limits in accordance with national and international regulations and standards.

References

- Environmental Conservation Rules, 2023
- Bangladesh Water Act, 2013 and Bangladesh Water Rules, 2018
- National River Protection Commission Act, 2013
- Natural Water Reservoir Conservation Act, 2000
- National Water Policy, 1999
- World Bank Environmental and Social Standards 1 and 3
- WBG Environmental, Health, and Safety General Guidelines.

Mitigation Measures for Impacts on Water Quality

The following measures could mitigate the anticipated negative impacts on the surface water quality in the region:

- No sewage should be discharged without treatment to any water body.
- Directly draining raw wastewater and/or used chemicals/oils/lubricants to surface water courses are banned.
- Cleaner technology for production processes, especially water-saving machines/equipment must be the first alternative for investors.
- In order to conserve water resources and rainwater, efforts will be made to utilize the rainwater by constructing appropriate rainwater harvesting structures within each building's premises.
- Discharged treated wastewater to surface water must meet effluent standards mentioned in Schedule-3 and Schedule-4 of the ECR 2023.

- Installation of a surveillance system with industrial grade internet protocol (IP) cameras having Pan Tilt Zoom (PTZ) with leased line real-time connection for data streaming and transmission of the same.

Monitoring of Surface Water Quality Management

The proposed scope of the surface water quality monitoring activities is as follows:

- Records on water extraction and distribution in the EZ from surface water sources and ensure no objection certificate (NOC) from the Water Resources Planning Organization (WARPO) for surface water extraction.
- Water quality monitoring on a half-yearly basis (before and after the rainy season) (through sampling and analyses to be done by NZES laboratory) at selected 10 locations (inside khals and surrounding waterbodies including Sandwip River and Feni River).

Record of water extraction will be maintained by the Department of Public Health Engineering (DPHE) and the NOC from the Water Resources Planning Organization (WARPO) under the Ministry of Water Resources (MOWR) will be ensured following the requirements of the Bangladesh Water Act 2013 and Bangladesh Water Rules 2018. In addition, surface water quality monitoring on a half-yearly basis from the inside and surrounding water bodies will be carried out by the NSEZ laboratory, and a copy of the report will be shared with DOE.

8.3.4 Groundwater Management Plan

Purpose

This plan is developed to provide proper management of the groundwater quality in the region. The overall aim is to keep the groundwater quality below the accepted limits in accordance with national and international regulations and standards.

References

- Environmental Conservation Rules, 2023
- Bangladesh Water Act, 2013
- Bangladesh Water Rules, 2018
- National River Protection Commission Act, 2013
- Natural Water Reservoir Conservation Act, 2000
- National Water Policy, 1999
- World Bank Environmental and Social Standards 1 and 3
- WBG Environmental, Health, and Safety General Guidelines.

Mitigation Measures for Impact on Groundwater

The following measures could mitigate the anticipated negative impacts on the groundwater quality in the region:

- Cleaner technology for production processes, especially water-saving machines/equipment must be the first alternative for investors.
- NSEZ should focus on the extraction of surface water and stop the extraction of groundwater during the operation of EZ.
- Instruct the investors, utility providers, contractors, subcontractors, and workers regarding water saving considering the groundwater crisis in the EZ surrounding region.
- Directly draining raw wastewater and/or used chemicals/oils/lubricants to the ground is forbidden.
- Construction of the landfill shall include the construction of properly designed leachate treatment ponds, which shall treat the collected leachate on site.

Monitoring of Groundwater Quality Management

The proposed scope of the groundwater quality monitoring activities is as follows:

- Records on water extraction and distribution in the EZ from groundwater sources and ensure no objection certificate (NOC) from the Water Resources Planning Organization (WARPO) for groundwater extraction.
- Annual groundwater depletion/replenishment rates in the NSEZ region.
- Groundwater quality monitoring at the landfill site and nearby village on a half-yearly basis (through sampling and analyses to be done by accredited laboratories). Monitoring parameters including pH, dissolved oxygen, temperature, conductivity, turbidity, and metals (cadmium, copper, lead, manganese, nickel, arsenic, selenium, and mercury).

Record of water extraction will be maintained by the Department of Public Health Engineering (DPHE) and the NOC from the Water Resources Planning Organization (WARPO) under the Ministry of Water Resources (MOWR) will be ensured following the requirements of the Bangladesh Water Act 2013 and Bangladesh Water Rules 2018. The groundwater level of the region will be monitored by the DPHE or BWDB and share a copy of the monitoring result with the NSEZ management. In addition, groundwater quality monitoring on a half-yearly basis near the landfill site and nearest village will be carried out by the DPHE, and a copy of the monitoring report will be shared with NSEZ management.

8.3.5 Topography and Soil Management Plan

Purpose

This plan is prepared to prevent soil pollution within the EZ site and surrounding areas in compliance with national and international regulations/standards.

References

- United States Environmental Protection Agency (USEPA) Soil Quality Standards.

Mitigation Measures for Impact on Topography and Soil

The following measures could mitigate the anticipated negative impacts on the topography and soil quality in the region:

- Ensure to rehabilitate areas with topsoil and revegetate after completion of activities.
- Good housekeeping and best practices of waste handling should be adopted to eliminate/minimize the risks of soil contamination.
- Individual manufacturers and factories should have appropriate chemical storage areas with secondary containment on impervious ground.
- Municipal waste should be disposed of in an integrated solid waste management facility proposed within the EZ.
- Industrial waste to nearby treatment, storage, and disposal facilities and to approved/authorized vendors of DOE and local municipalities. However, waste minimization techniques should be adopted to minimize the generation of waste.

Monitoring of Topography and Soil Quality Management

The proposed scope of the topography and soil quality monitoring activities is as follows, which may be revised within the course of the NSEZ development and operation as required:

- Availability of spill kits at each hazardous and chemical storage area.
- Number of spills or incidents.

Individual industries/investors will inform the HSE team of NSEZ. Regulatory authority i.e., the Department of Environment (DOE) under the Ministry of Environment, Forest, and Climate Change (MOEFCC), other departments/ministries, and local administration may inspect the activities.

8.3.6 Sediment Management Plan

Purpose

This plan is prepared to prevent sediment pollution within the EZ site and surrounding water bodies in compliance with national and international regulations/standards.

References

NA

Mitigation Measures for Impact on Sediment

The following measures could mitigate the anticipated negative impacts on the sediment quality in the region during the development and operation of the NSEZ:

- Sediment quality analysis and analysis of contamination levels in the dredging area before dredging.
- A Dredging Management Plan (DMP) should be prepared before starting dredging activities in the Sandwip Channel.
- Individual industries should develop an appropriate chemical storage area with secondary containment on impervious ground.
- Municipal waste should be disposed of in an integrated solid waste management facility proposed within the EZ.

Monitoring of Sediment Quality Management

The proposed scope of the sediment quality monitoring activities is as follows:

- Sediment quality monitoring report in the dredging site.
- Annual sediment quality testing at the CETPs discharge point and jetty site.

The appointed dredging contractor will confirm the quality of dredge sediments before starting dredging and a copy of the sediment testing report will be shared with the HSE team of NSEZ. In addition, NSEZ will collect sediment samples and test them in their laboratory, or they may engage other laboratories to perform the activities.

8.3.7 Solid Waste Management Plan

Purpose

This plan is prepared for setting the basic principles for solid waste management and disposal rules taking into account national and international regulations and standards. The EZ will result in solid waste generation during the development and operation phases.

References

- Solid Waste Management Rules, 2021
- Medical Waste (Management and Handling) Rules, 2008
- Hazardous Wastes and Ship Breaking Waste Management Rules, 2011 & amendment in 2012
- Hazardous Waste (E-waste) Management Rules, 2021
- World Bank Environmental and Social Standards 1 and 3
- WBG Environmental, Health, and Safety General Guidelines.

Mitigation Measures for Impacts of Solid Waste

The following measures could mitigate the anticipated negative impacts due to the solid waste generation in the region during the development and operation of the NSEZ:

- A waste management facility for the NSEZ should be established at an early date so that onsite disposal can be avoided.

- No solid waste generated shall be thrown, burned, or buried on streets, or open public spaces outside the premises or in the drains or water bodies.
- Institutional strengthening of local government organizations for effective solid waste management in the region.
- Design and construction of the landfill shall be in accordance with the Solid Waste Disposal Facility Criteria – Technical Manual published by US EPA (1993) or other applicable standards.
- The concept of the 3Rs (Reduce, Reuse, Recycle) must be promoted and awarded.
- In accordance with the requirements of MARPOL 73/78 and its annexes IV and V, appropriate facilities shall be provided for the reception of all wastes (oil mixed water, fuel residues, sludge, garbage from crew and passengers, maintenance of the ship, cargo activities) arising from ships.

Monitoring of Solid Waste Management

The proposed scope of the solid waste monitoring activities is as follows:

- Volume and types of wastes generated per month per every industry.
- Quantity per classification, treatment, storage, and final disposal of solid wastes.

Individual industry/investors will keep their records and share a copy of the generated and disposal volume monthly record will be shared with the HSE Team of NSEZ. In addition, NSEZ's HSE team will conduct a physical inspection of the waste storage and disposal site to ensure that the waste collection, storage, and disposal are carried out in an acceptable manner and following the applicable national legislations as well as Good International Industry Practices. Regulatory authority i.e., the DOE under the MOEFCC, other departments/ministries, and local administration may inspect the activities. The timing and frequency of these inspections would be determined by the relevant authority.

8.3.8 Liquid Waste Management Plan

Purpose

This plan is prepared for setting the basic principles for liquid waste management and disposal rules taking into account national and international regulations and standards. The EZ will result in liquid waste generation during the development and operation phases.

References

- Environmental Conservation Rules, 2023
- National 3R Strategy for Waste Management, 2010
- World Bank Environmental and Social Standards 1 and 3
- WBG Environmental, Health, and Safety General Guidelines.

Mitigation Measures for Impacts of Liquid Waste

The following measures could mitigate the anticipated negative impacts due to the liquid waste generation in the region during the development and operation of the NSEZ:

- All industries and activities would have to follow the guidelines and standards set by the DOE under the MOEFCC and other respective ministries.
- Recycling of wastewater should be promoted.
- Directly draining raw wastewater and/or used chemicals/oils/lubricants to surface water course and ground are banned.
- Regularly check and maintain wastewater treatment plant to control the treated wastewater quality, at least as required effluent from EZ Wastewater Treatment System especially BOD must be less than mentioned values for minimizing the impact to surface water and sediment qualities.
- A digital water flow meter should be installed to measure the discharge volume.

Monitoring of Liquid Waste Management

The proposed scope of the liquid waste monitoring activities is as follows:

- Continuous monitoring of effluent quality at the outlet of the CETPs by installation of an Online Continuous Emission Monitoring System (CEMS).

DOE will establish and operate the Online Continuous Emission Monitoring System at the CETPs outlet incorporation with NSEZ. Installation of a surveillance system with industrial-grade internet protocol (IP) cameras having Pan Tilt Zoom (PTZ) with leased line real-time connection for data streaming and transmission of the same will be ensured by the DOE. The HSE team of NSEZ will keep records of all data and prepare an annual report. If non-compliance is found as a result of the monitoring, all the work that is required to eliminate the non-compliance will be carried out by the individual industries/investors based on the instruction from NSEZ management.

8.3.9 Drainage Management Plan

Purpose

This plan is prepared to ensure proper drainage management and eliminate the risk of waterlogging and flooding in the region that NSEZ and personnel may be exposed to.

References

- Bangladesh Water Act, 2013 and Bangladesh Water Rules, 2018
- National River Protection Commission Act, 2013
- Embankment and Drainage Act, 1952.

Mitigation Measures for Impact on Existing Drainage

The following measures could mitigate the anticipated negative impacts on the existing drainage pattern in the region during the development and operation of the NSEZ:

- EZ site needs to be levelled as per the development requirements and shall be limited to the project site. An adequate stormwater drainage system along with rainwater harvesting structures shall be provided to ensure that the drainage pattern of the region is maintained.
- A detailed hydrological and morphological study of the NSEZ region (in drainage and other related structures) should be carried out.
- Excavation of khals in the region and ensuring the provision of sufficient sizes of drains/khals/canals to take design flows.
- Construction of the roads interferes with the natural surface and groundwater flow regimes.
- Inspect that the drainage system and sediment controls are functional during the rainy season.
- Ensure the sluice gates are functional and ensure regular maintenance when required.

Monitoring of Drainage Management

The proposed scope of the drainage monitoring activities is as follows:

- Presence and functionality of the drainage system specifically before the monsoon.
- Records, reports, or complaints on flood/waterlogging cases in the region.
- Record of excavation and maintenance activities.

Bangladesh Water Development Board (BWDB) under the Ministry of Water Resources (MOWR) will inspect the functionality of the drainage system at regular intervals and a special check before the monsoon season as well as keep and share the record of excavation and maintenance activities in the region with the NSEZ management. In addition, the excavation of khals, the function of sluice gates, maintenance of the super dike, etc. shall be ensured. Records, reports, or complaints on flood and waterlogging will be maintained by the HSE team of NSEZ.

8.3.10 Traffic Management Plan

Purpose

This plan is developed to prevent, minimize, and control risks and adverse impacts on community health and safety, natural environment, work and workers' safety from traffic accidents, and traffic jams, which may occur due to the behavior of the driver or the quality of the vehicle and/or to the road design or construction and maintenance issues.

References

- Penal Code
- Road Transport Act, 2023
- Traffic Rules, 2022.

Mitigation Measures for Impact on Traffic

The following measures could mitigate the anticipated negative impacts on the traffic in the region during the development and operation of the NSEZ:

- Adoption of best transport safety practices across all aspects of project operations to prevent traffic accidents and minimize injuries suffered by project personnel and the public.
- Safety measures should be incorporated in the engineering designs to include for example details of signboards to notify the public about the potential dangers, markings, intersection layouts, access restrictions, bus stops, crossings, footpaths, etc.
- Establishment of a traffic police unit to make necessary arrangements not to worsen the existing traffic condition in the region.
- A Traffic Management Plan should be prepared and implemented considering all industries in the region, the demand of local communities, and other projects located in the region.
- Speed limitations should be enforced for instance, onsite 20 km/h, through towns and villages 35 km/h, and on the highway 80 km/h.
- Establish an overbridge at the crossing point and educational institutions such as Nurul Absar Choudhury High School.
- Engage school administrators to sensitize pupils/students about the risks associated with road construction and operation and the necessary precautions they need to undertake.

Monitoring of Traffic Management

The proposed scope of the traffic monitoring activities is as follows:

- Implementation of Traffic Management Plan including the presence of traffic signage/warning signage and speed limits for vehicles.
- Accidents and fatal incidents reporting (number, type, location, and causes, etc.).

NSEZ management should request law enforcement agencies i.e., Bangladesh Police to establish traffic units in the local police stations to manage future increasing traffic-related issues in the region. In addition, they will maintain records of accidents and fatal incidents including number, type, location, and causes, etc., and share the annual report with the NSEZ management.

8.3.11 Ecosystem and Biodiversity Management Plan

Purpose

This plan is developed to manage the development and operation of NSEZ activities that are causing habitat alteration and fragmentation in a way that the impact on both terrestrial and aquatic ecosystems and biodiversity, habitats, and species are minimized in line with national and international regulations/standards/requirements and establish NSEZ as an eco-friendly and world-class business hub.

References

- Ecologically Critical Areas Management Rules, 2016
- Biodiversity Act, 2017
- Wildlife (Conservation and Security) Act, 2012
- Protected Area Management Rules, 2017
- Marine Fisheries Act, 2020
- Protection and Conservation of Fish Act, 1950 and its amendment in 1982 and Rules, 1985
- Forests Act, 1927 and its amendment in 1982, 1989, 2000, and 2018
- Bangladesh Dolphin Action Plan 2020-2030
- National Fisheries Policy, 1999
- Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973
- Conservation of Migratory Species of Wild Animals, 1979
- World Bank Environmental and Social Standards 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.

Mitigation Measures for Impacts on Ecosystems and Biodiversity

General mitigation measures will be implemented during the development and operation of NSEZ to protect ecological receptors, as follows:

- Forest/vegetation areas should be clearly marked before vegetation clearance and clearance could occur gradually to allow fauna to relocate from the EZ sites.
- Establish protected areas, buffer zones, and green belts to conserve native vegetation and promote biodiversity.
- Wildlife crossings, such as underpasses and overpasses, should be incorporated into road and railway infrastructure to facilitate safe wildlife movement in the region.
- Translocation of existing wildlife that is available in the NSEZ boundary to the nearest forest area as well as Wildlife Sanctuary i.e., Hazarikhil Wildlife Sanctuary.
- Bird diverters shall be installed on power lines and other structures to prevent collisions and electrocutions.
- Important fish and dolphin habitats, including feeding and breeding grounds, shall be designated and protected through protected areas or other conservation measures.
- Penalties for non-compliance will be implemented to deter activities that could harm wildlife species or their habitats.

Monitoring of Ecosystems and Biodiversity

The proposed scope of the ecosystem and biodiversity monitoring activities is as follows:

- All identified sensitive fauna species including dolphins should be monitored twice a year.
- The mudflats of the Sandwip Channel, which serve as a foraging ground for migratory winter and residential shorebird species, will be monitored once a year during the winter season.
- Progress of tree plantation, green belt development, and sapling survival rate will be monitored twice a year.
- An expert ichthyologist will monitor all critical fish species detected in and around the study region, twice a year.

The Forest Department (FD) (Chattogram south forest division) under the Ministry of Environment, Forest, and Climate Change (MOEFCC) will be responsible for floral and faunal monitoring work in the region. In addition, the Fisheries Department of the region will be responsible for fish resource monitoring. A copy of the monitoring report will be shared with the NSEZ management.

The HSE team of NSEZ will be responsible for keeping records of wildlife accidents or kills, human-wildlife conflicts, translocation of existing wildlife, and poaching. If non-compliance is found as a result

of the monitoring and inspection activities, all the work that is required to eliminate the non-compliance will be carried out by the individual industries/investors based on the instruction from NSEZ.

8.3.12 Land Acquisition, Resettlement, & Rehabilitation Management Plan

Purpose

This Plan has been developed to manage the land acquisition, resettlement, and livelihood restoration issues of the NSEZ. This plan includes the references, mitigation measures, and monitoring schedule following national and international standards and regulations.

References

- Acquisition and Requisition of Immovable Property Act, 2017.
- World Bank Environmental and Social Standards 5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement.
- World Bank Environmental and Social Standards 10: Stakeholder Engagement and Information Disclosure.

Mitigation Measures for Impact Due to Land Acquisition, Resettlement, and Rehabilitation

The following measures could mitigate the anticipated negative impacts due to the land acquisition, resettlement, and rehabilitation in the region during the development and operation of the NSEZ:

- Conduct early, meaningful consultations with affected communities, ensuring clear communication about the project, land acquisition process, and potential impacts.
- A transparent, fair, and legally compliant process for land acquisition, ensuring adequate notice, just compensation, and support services should be followed by NSEZ.
- Develop and adopt livelihood restoration programs to support income and employment for displaced individuals.
- Develop and implement RAP as per the RPF prepared for NSEZ to ensure assistance for relocating affected households, including housing, utilities, and community facilities.
- Identify and provide additional assistance to vulnerable groups, such as women, elderly, and disabled individuals, to mitigate resettlement impacts and support their needs.
- Offer skills training and income-generating opportunities to affected individuals to support their integration into new locations and improve long-term livelihood options.

Monitoring of Land Acquisition, Resettlement, and Rehabilitation Management

The proposed scope of the land acquisition, resettlement, and rehabilitation monitoring activities is as follows,

- Number of Physical and economically displaced persons.
- Number and Percentage receiving compensation on time.
- Number and Percentage of households relocated with adequate housing.
- Percentage of individuals restoring or improving income.
- Number of vulnerable individuals receiving support.
- Number and Percentage of grievances resolved on time.
- Number of scheduled monitoring visits/audits.
- Percentage of feedback addressed or implemented.

The Land Department of BEZA HQ, in collaboration with the NSEZ, will implement land acquisition activities through the respective Deputy Commissioner (DC) offices. BEZA or an appointed Third-Party Consultant will be responsible for executing the land acquisition and resettlement process, ensuring compliance with all regulatory requirements. For the development of related facilities, such as roads and social infrastructure, the respective government departments, agencies, or ministries will handle the acquisition process. BEZA HQ will maintain and document all compensation-related activities, including compensation receipts and signed agreements, to ensure transparency. NSEZ, or the

designated Third-Party Consultant, will monitor and supervise the land acquisition, resettlement, and livelihood restoration activities.

8.3.13 Community Health, Safety, and Security Management Plan

Purpose

This Plan has been developed to manage the Community Health, Safety, and Security of NSEZ in the region. This plan includes the references, mitigation measures, and monitoring schedule following national and international standards and regulations.

References

- National Health Policy, 2011
- National Policy for Safe Water Supply and Sanitation, 1998
- Bangladesh Penal Code
- WBG Environmental, Health, and Safety General Guidelines
- World Bank Environmental and Social Standards 4: Community Health and Safety.

Mitigation Measures for Impact on Community Health, Safety, and Security

The following measures could mitigate the anticipated negative impacts on the community health, safety, and security in the region during the development and operation of the NSEZ

- To mitigate the additional pressure over existing community services from labor influx during the development and operational phases of NSEZ, social infrastructure in health and education should be strengthened through collaborative initiatives with relevant ministries.
- Establishment of new police stations to ensure the security of the region considering the future influx.
- SEP and GM should be adopted during the development and operation phase of NSEZ.
- Adopt Waste and Hazardous Material Management Plan accordingly.
- In terms of Emergency Preparedness and Response adopt an Emergency Response Plan accordingly.
- Raise HIV/AIDS awareness; regulate worker-community interactions.
- Enforce Traffic and Community Health & Safety Plans during the developing and operation phase of NSEZ.

Monitoring of Community Health, Safety, and Security Management

Monitoring parameters for assessing the effectiveness of mitigation measures on community health, safety, and security for the NSEZ development and operation could include:

- Health and education facilities established/strengthened, and new police stations set up.
- Frequency of SEP activities, grievance resolution, and crime rate trends.
- Hazardous waste managed, compliance with protocols and emergency response drills conducted.
- Participation in HIV/AIDS awareness programs and worker-community interaction regulations.
- Traffic incidents reported, compliance with traffic safety plans, and safety audits conducted.
- Community satisfaction with health, safety measures, and grievance handling.

The HSE team will implement community health, safety, and security monitoring activities. NSEZ HQ will maintain, and document records related to the Grievance Redress Mechanism (GRM), community-related accidents, and infectious diseases, providing transparency and accountability. NSEZ will also be responsible for conducting worker training programs to enhance their understanding of health and safety measures. Monitoring the Traffic Management Plan to ensure safe road usage and implementing awareness campaigns for community health and safety are key elements of the plan. NSEZ Management will facilitate stakeholder engagement, ensuring continuous stakeholder consultations and

collaboration with the community and other relevant stakeholders throughout the implementation process.

8.3.14 Occupational Health, Safety, and Security Management Plan

Purpose

This Plan has been developed to manage the Occupational Health, Safety, and Security of NSEZ. This plan includes the references, mitigation measures, and monitoring schedule following national and international standards and regulations.

References

- National Occupational Health and Safety Policy, 2013
- Bangladesh Labor Act, 2006 and Labor Rules, 2015
- Fatal Accidents Act, 1855
- Factory Act, 1965 and Factory Rule, 1979
- Boiler Act, 1923
- Explosive Act 1884
- Explosive Substance Act 1998
- Public Procurement Rule (PPR), 2008
- National Child Labor Elimination Policy, 2010
- Bangladesh Industry Policy, 2016
- Bangladesh Fire Prevention and Fire Fighting Act, 2003
- ILO conventions
- WBG Environmental, Health, and Safety General Guidelines
- World Bank Environmental and Social Standards 2: Labor and Working Conditions.

Mitigation Measures for Impact on Occupational Health, Safety, and Security

The following measures could mitigate the anticipated negative impacts on occupational health, safety, and security in the region during the implementation of the NSEZ master plan:

- Establish a comprehensive Occupational Health and Safety Management System in line with national regulations and World Bank standards to address project-specific risks.
- Ensure mandatory training for all workers focusing on job-specific risks, use of safety equipment, and emergency response as a part of the capacity development.
- Provide and enforce the use of Personal Protective Equipment (PPE)
- Ensure safe and sanitary worker accommodation and mental health support.
- Conduct security risk assessments and train security personnel on minimal force use.
- Establish incident reporting and investigation procedures, with corrective actions.
- Perform routine safety inspections and share OHSS monitoring results with stakeholders.

Monitoring of Occupational Health, Safety, and Security Management

The proposed scope of the occupational health, safety, and security monitoring activities is as follows,

- Number of safety systems established and compliance with standards.
- Percentage of workers trained and using PPE.
- Number of accesses to safe accommodation and mental health support for workers.
- A number of security personnel were trained, and risk assessments were conducted.
- Incident reporting, investigation, and corrective actions taken.
- Routine safety inspections and sharing of OHSS monitoring results.

The HSE team of NSEZ will conduct monitoring activities within the framework of the NSEZ master plan under the oversight of the designated HSE team at BEZA HQ, in coordination with NSEZ Management. This team will maintain records of complaints, increased human accidents, and reports on occupational

diseases or accidents. NSEZ HSE team is responsible for promoting awareness among workers about the proper use of personal protective equipment (PPE) and for maintaining an accident incident register to log and monitor all incidents systematically.

Additionally, comprehensive training programs will be developed by the NSEZ HSE team, and training will be provided by the vocational or other training institute.

8.3.15 Labor Influx Management Plan

Purpose

This plan has been developed to manage the labor influx in the region. This plan includes the references, mitigation measures, and monitoring schedule following national and international standards and regulations.

References

- Bangladesh Labor Act, 2006 (amended in 2018)
- Bangladesh Labor Rules, 2015
- Factories Act, 1965
- National Occupational Health and Safety Policy, 2013
- Bangladesh National Building Code (BNBC), 2020
- Bangladesh Fire Prevention and Fire Fighting Act, 2003
- ESS2: Labor and Working Conditions.

Mitigation Measures for Impact Due to Labor Influx

The following measures could mitigate the anticipated negative impacts due to labor influx in the region during the implementation of the NSEZ master plan:

- Labor Management Procedure (LMP) developed for the NSEZ should be adopted during the development and operation phase of the NSEZ.
- Prioritize hiring from local communities to reduce the need for outside labor as well as labor influx.
- The establishment of a vocational training center should be strengthened through collaborative initiatives with relevant ministries.
- Implementation of GM for the community and workers should be ensured during the development and operation phase of the NSEZ.
- Regularly monitor labor influx impacts and adjust the plan as needed.
- Establish regular communication channels with community leaders to address concerns of Labor Influx as a part of SEP implementation.

Monitoring of Labor Influx Management

Monitoring parameters for assessing the effectiveness of mitigation measures on Labor Influx Management for the NSEZ development and operation could include:

- Number of workers accommodated and trained on labor influx management.
- Percentage of workers with access to adequate services and accommodation.
- Frequency of community engagement and grievance resolution.
- Number of health and safety incidents related to labor influx.
- Monitoring of social impacts on local communities (e.g., employment, services).
- Workforce integration effectiveness, including employment and services access.
- Compliance with labor influx mitigation measures.

The HSE team of NSEZ will oversee the implementation of the LMP to mitigate risks associated with labor influx during the development and operation phase of NSEZ. BEZA HQ will maintain comprehensive records related to the Labor and community Grievance Mechanism specifically tracking

grievances concerning recruitment fairness, social tensions, and cases of gender-based violence (GBV), ensuring transparent and timely resolutions.

The HSE team will facilitate regular orientation sessions for incoming workers, focusing on cultural sensitivity, anti-GBV protocols, and community cohesion to foster a positive relationship between the workforce and local communities. The training center for skill development within the region should be developed by the relevant authority.

8.3.16 Child Labor and Forced Labor Management Plan

Purpose

This plan has been developed to manage the child labor and forced labor of NSEZ. This plan includes the references, mitigation measures, and monitoring schedule following national and international standards and regulations.

References

- Bangladesh Labor Act, 2006 and Bangladesh Labor Rules, 2015
- National Child Labor Elimination Policy, 2010
- National Occupational Health and Safety Policy, 2013
- ILO conventions
- ESS2: Labor and Working Conditions.

Mitigation Measures for Impact due to Child Labor and Forced Labor

The following measures could mitigate the anticipated negative impacts of child labor and forced labor in the region during the development and operation of the NSEZ

- Establish and adopt a strict policy prohibiting child and forced labor.
- Verify the ages and employment conditions of all workers during hiring.
- Include clauses prohibiting child and forced labor in all contracts with subcontractors and suppliers.
- Develop a confidential reporting system for workers to report abuses or concerns.
- Engage with local communities to raise awareness about child and forced labor issues.

Monitoring of Child Labor and Forced Labor Management

Monitoring parameters for assessing the effectiveness of mitigation measures on child labor and forced labor for the NSEZ development and operation could include:

- Number of underage workers identified and removed.
- Percentage of workers compliant with legal age and forced labor regulations.
- Frequency of training on child and forced labor policies.
- Number of audits and inspections for child/forced labor detection.
- Grievance reports related to child or forced labor and resolution rates.
- Monitoring of recruitment practices for policy adherence.
- Percentage of contracts with suppliers meeting labor standards.

The HSE team of NSEZ will implement this plan to prevent child and forced labor throughout the development and operation phase of the NSEZ.

Monitoring activities will include regular audits of worker identity cards, signed contracts with clauses on child and forced labor, and age verification procedures and will be conducted by the HSE team of NSEZ. Stakeholder engagement with local groups, trade unions, and NGOs will ensure compliance, while feedback channels will be maintained for continuous oversight.

8.3.17 Gender-Based Violence and Sexual Harassment Management Plan

Purpose

This plan has been developed to manage Gender-Based Violence (GBV), Sexual Exploitation and Abuse, and Sexual Harassment (SEA/SH) during the development and operation of NSEZ. This plan includes the references, mitigation measures, and monitoring schedule following national and international standards and regulations.

References

- The Bangladesh Constitution
- Prevention of Violence Against Women and Children Act, 2000
- National Women's Policy, 2011
- ESS2: Labor and Working Conditions.

Mitigation Measures for Impact on due to GBV and SEA/SH

The following measures could mitigate the anticipated negative impacts regarding GBV and SEA/SH in the region during the development and operation of the NSEZ

- Implement a zero-tolerance policy against GBV and SEA/SH with clear consequences.
- Conduct regular training and awareness programs for workers and local communities on GBV and SEA/SH.
- Set up confidential reporting mechanisms and provide support services for survivors of GBV and SEA/SH.
- Ensure safe working conditions, including secure accommodation and transport for workers.
- Collaborate with local communities, NGOs, and government bodies to prevent GBV and SEA/SH.
- Monitor the effectiveness of mitigation measures and adjust strategies as needed.
- Establish a gender-sensitive grievance mechanism for confidential and timely handling of GBV and SEA/SH complaints.

Monitoring of GBV and SEA/SH

Monitoring parameters for assessing the effectiveness of mitigation measures on GBV and SEA/SH for the NSEZ development and operation could include:

- Number of GBV and SEA/SH incidents reported and resolved.
- Percentage of workers trained in GBV and SEA/SH prevention.
- Use of confidential reporting mechanisms for GBV and SEA/SH.
- Access to support services for survivors.
- Frequency of safety audits for secure working conditions.
- Community engagement activities to prevent GBV and SEA/SH.
- Effectiveness and resolution rate of the grievance mechanism.

The HSE team of NSEZ will implement this Plan, The BEZA HQ will oversee the Grievance Mechanism (GM), maintaining comprehensive records of reported incidents and responses to ensure transparency.

NSEZ HSE team would provide Training programs on gender sensitivity, anti-harassment policies, and respectful workplace conduct will be provided to all employees. Collaboration with local women's organizations will enable access to timely support and referrals for GBV survivors, enhancing community resources. BEZA HQ will monitor the implementation of these measures, regularly reviewing compliance and effectiveness. Additionally, NSEZ will conduct community outreach and maintain open communication channels to ensure ongoing stakeholder engagement and effective response to community concerns throughout the project lifecycle.

8.3.18 Infrastructure Management Plan

Purpose

This plan has been developed to manage the infrastructure to be developed during the development and operation phase of NSEZ. This plan includes the references, mitigation measures, and monitoring schedule following national and international standards and regulations.

References

- The Constitution of Bangladesh
- Bangladesh Urban Planning and Development Policy, 2001
- National Housing Policy, 2017
- National Health Policy, 2011
- National Water Policy, 1999
- National Education Policy, 2010
- Rural Development Policy, 2001
- National Environmental Policy, 1992
- Local Government (City Corporation) Act, 2009
- Bangladesh Road Transport Act, 2018
- National Social Security Strategy, 2015.

Mitigation Measures for Impact on Infrastructure

The following measures could mitigate the anticipated negative impacts regarding the additional pressure on social infrastructure in the region during the development and operation of the NSEZ.

- Collaboration with NHA, UDD, Ministry of Education, Ministry of Health, and local governments to address increased future housing demands, educational institutions, and health services from the project workforce.
- Promote the development of affordable housing options to prevent displacement and support local communities.
- Enhance existing educational facilities to accommodate potential increases in student population due to labor influx.
- Work with the Ministry of Education and local bodies to establish additional schools where existing capacity is inadequate.
- Strengthen local health facilities, including labs, to handle public health demands and potential emergencies.
- Coordinate with relevant authorities like LGED and BR to improve communication and transport infrastructure to support mobility and community access.
- Develop recreational centers, temples/mosques, and playgrounds for the well-being of workers and local communities.
- Ensure adequate provision of graveyards to address burial needs in the project area.

Monitoring of Social Infrastructure Management

- Number and quality of new or improved housing, health, education, recreational, and religious facilities.
- Utilization rates and satisfaction levels for health, education, and recreational services.
- Accessibility and availability of affordable housing, with community feedback on the adequacy of graveyards.
- Standards for maintenance and cleanliness of recreational areas and religious sites.
- Frequency of coordination meetings with relevant authorities

NSEZ Management, in coordination with BEZA HQ, will implement social infrastructure mitigation during the development and operation phase of the NSEZ. NSEZ will take the initiative to develop the social facilities and infrastructure in collaboration with different ministries.

8.3.19 Living and Livelihoods Management Plan

Purpose

This plan has been developed to manage the living and livelihood management during the development and operation phase of NSEZ. This plan includes the references, mitigation measures, and monitoring schedule following national and international standards and regulations.

References

- Acquisition and Requisition of Immovable Property Act, 2017
- ESS5: Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement.

Mitigation Measures for Impact on Living and Livelihoods

The following measures could mitigate the anticipated negative impacts regarding the living and livelihoods in the region during the development and operation of the NSEZ.

- Implement Resettlement and Livelihood Restoration Plans to ensure fair compensation and support.
- Prioritize local hiring, offering vocational training and skills development for community members.
- Support fishermen with access to alternative fishing areas and improved facilities at relocated landing sites.
- Consult buffalo grazers, buffalo boys and owners, dairy product producers, and other involved parties on alternative grazing options and encourage dairy farming for income generation.
- Provide training for new skills and alternative income activities to help affected individuals transition effectively.

Monitoring of Living and Livelihoods Management

The proposed scope of the living and livelihoods monitoring activities is as follows,

- Percentage of affected individuals compensated and resettled as per plan.
- Number of local hires and participants in training programs.
- Compliance rate of employment contracts with labor law standards.
- Availability and usage of alternative fishing areas and facilities at new landing sites.
- Number of buffalo grazers using alternative grazing areas and participating in dairy initiatives.
- Community feedback on livelihood restoration, training adequacy, and consultations with affected parties.

The HSE team of NSEZ will implement the Living and Livelihoods Management Plan. This plan will encompass the development of a Resettlement Action Plan (RAP) and Livelihood Restoration Plan (LRP) to ensure adequate compensation and support for affected individuals. For the livelihood management of fishermen, buffalo grazers, and livestock owners, the Grievance Mechanism (GM) and Stakeholder Engagement Plan (SEP) prepared for NSEZ will be documented and implemented by the NSEZ HSE team.

8.3.20 Natural Disasters Management Plan

Purpose

This plan is prepared to define strategies in accordance with national regulations/standards to prevent and control potential natural disasters that NSEZ and personnel may be exposed to.

References

- Disaster Management Act, 2012
- Fire Prevention and Extinction Act, 2003 and Fire Prevention and Extinction Rules, 2014
- Bangladesh National Building Code, 2020
- Standing Orders on Disaster, 2019
- National Disaster Management Policy, 2015.

Mitigation Measures for Impacts Due to Natural Disasters

The following measures could mitigate the anticipated negative impacts due to natural disasters in the region during the development and operation of the NSEZ:

- The structure design of the building should be prepared considering the seismicity of the area and the building should be designed for one higher seismic zone.
- Bangladesh National Building Code 2020 should be applied to ensure structures are designed and constructed following sound architectural and engineering practices, including aspects of fire prevention.
- All structures should be designed above the high flood level of the coastal flood for 100 years, river flood for 25 years, and to historical maximums of pluvial floods return period.
- Regular supervision and maintenance for adequacy and intactness of the flood control measures provided at the site.
- An emergency control center should be established in the NSEZ to take care of and handle the expected emergency.
- Display of emergency contact nos. should be made in the emergency control center and all other site locations. The emergency control center should be comprised of personnel well-trained in health and safety management at the EZ site.
- Tie-ups with the local hospitals of the area to handle various emergencies.

Monitoring of Natural Disaster Management

The proposed scope of the natural disaster monitoring activities is as follows:

- Tracking system for cyclone and flood forecasting and early warning systems.
- Trends of natural disasters, time of occurrence, etc.
- Record of casualties, loss, and damage.

NSEZ management will be responsible for monitoring and declaring an emergency in the EZ. During the emergency they will communicate with the Upazila and District administration, Bangladesh Meteorological Department (BMD), Flood Forecasting and Warning Center (FFWC), Bangladesh Fire Service and Civil Defense (BFSCD), Volunteers of Cyclone Preparedness Programme (CPP), District Disaster Management Committee (DDMC), Upazila Disaster Management Committee (UZDMC), Union Disaster Management Committee (UDMC), Local Police Station, Health Complex, and others to get assistance.

8.4 Recommendations to Strengthen Social Inclusion Aspects for the Future Investments

To strengthen social inclusion within the NSEZ, it is essential to implement socially responsive strategies across all project phases. Starting with planning, conducting culturally adapted needs assessments for local and marginalized communities, and ensuring the inclusion of women, households living below the poverty line, persons with disabilities, and Indigenous groups. Communication materials should be designed in local languages and accessible formats to promote broad-based participation in consultations. When engaging with Indigenous or minority communities, apply Free, Prior, and Informed Consent (FPIC) protocols to respect their preferences in project design. To enhance local capacity, targeted skills training linked to project jobs and set employment targets for local and underrepresented groups, including women and youth, with support measures like childcare and transportation subsidies

should be provided. For service accessibility, structure pricing models that offer affordable access to essential resources, such as water, sanitation, healthcare, and education, facilities accessible to low-income households should be ensured. Gender-sensitive facilities, such as separate restrooms, breastfeeding rooms, and well-lit public spaces, should be incorporated during the construction of labor accommodations. Additionally, all infrastructure is accessible to individuals with disabilities and should be ensured.

Resettlement action plans (RAPs) and Livelihood Restoration Plans (LRP) should be developed considering the fair compensation with full replacement cost, for those affected by physical and/or economic displacement. Targeted assistance programs can further support vulnerable groups, providing income support or transition grants where necessary. To ensure safe working conditions, establish robust health and safety protocols, equipment provision, and emergency response measures that meet national and international standards. Regular monitoring and evaluation are crucial; track inclusion metrics like local employment rates, access to services, and safety outcomes, with assessments to understand impacts on marginalized groups. Grievance mechanism (GM) should be accessible through multiple channels, such as in-person offices, online forms, and hotlines, with trained staff to handle sensitive issues. Publicize grievance resolutions to foster trust and adapt project activities based on feedback to continuously improve inclusion. These strategies will embed social inclusion and accountability across NSEZ operations, promoting equitable development and maximizing benefits for local communities, especially those that are vulnerable or marginalized.

8.5 Recommendation for the Integration of ES Policy/Principles in the Development Appraisal and Strategic Actions

Integrating environmental and social policies and principles into development appraisal and strategic actions is essential for ensuring sustainable and equitable outcomes. To integrate environmental and social policy principles effectively into the appraisal and strategic actions for NSEZ, the recommendations are as follows but not limited to:

- Define clear environmental and social objectives that emphasize sustainable growth, resilience, and social inclusion in alignment with national and international standards.
- Incorporate Comprehensive Environmental and Social Impact Assessments (ESIA) including cumulative impacts and develop Environmental and Social Management Plans (ESMPs) with mitigation measures and monitoring indicators.
- A risk classification system to guide due diligence and prioritize climate resilience to address environmental vulnerabilities should be implemented by NSEZ during development and operation of NSEZ.
- Build internal expertise on environmental and social standards, provide training on ESF principles to NSEZ staff and stakeholders, and clarify roles in implementing safeguards.
- Establish monitoring and reporting protocols with quantitative and qualitative indicators, facilitate public access to E&S performance data, and adopt adaptive management practices based on feedback and new data.
- Incorporate Environmental, Social, and Governance (ESG) criteria into strategic planning and investment decisions to enhance sustainable development and accountability.
- Engage with all relevant stakeholders, including local communities, government agencies, and non-governmental organizations, to gather diverse perspectives and ensure inclusive decision-making.
- Foster partnerships between public, private, and civil society sectors to leverage resources, expertise, and networks for achieving ES goals.

8.6 Recommendations for Preferred Alternatives Considering E&S Aspects to Reach Ultimate Development Goal with the Public-Private Partnership Projects

Public-Private Partnerships can play a crucial role in achieving sustainable development goals by balancing environmental, social, and economic aspects. Some of the recommendations for preferred alternatives to consider including:

- A feasibility study of the PPP Project should be carried out considering the issues including Environmental, Social, Technical, Commercial and financial considerations.
- Screening should be undertaken for the PPP projects and categorized following the procedure developed for the NSEZ and E&S instrument shall address the potential environmental difficulties associated with PPP development.
- All applicable national legislation, standards and E&S guidelines of BEZA, and World Bank should be followed in all PPP Projects.
- Prioritize private sector expertise in sustainable technologies and green infrastructure for minimal environmental impact in the development and operation phase of NSEZ.
- Establish governance frameworks with joint oversight, regular impact assessments, and third-party audits for accountability.
- Involve local communities in decision-making processes to align the development of NSEZ with local needs, fostering support and minimizing resistance.
- Build capacity within both public and private sectors for managing environmental and social risks, in alignment with international best practices and the World Bank's ESF.
- Investment in solar and wind power projects to reduce carbon footprints and promote clean energy.
- Implement recycling programs, waste-to-energy projects, and sustainable waste disposal methods to minimize environmental impact.

8.7 Identified Measures for Monitoring the Implementation of PPPs

Monitoring the implementation of Public-Private Partnerships is crucial to ensure that projects meet their objectives and deliver value for money. Identified measures for effective monitoring are as follows but not limited to:

- Establish clear and measurable KPIs to track the progress and performance of the project under provisions of PPP for NSEZ.
- Set up regular reporting and periodic performance reviews to track environmental, social, and financial milestones, allowing for adjustments or corrective actions as needed.
- Engage independent auditors to assess compliance with environmental, social, and governance standards and ensure transparency.
- Stakeholder Engagement Plan developed for NSEZ should be adopted by creating ongoing channels for stakeholder feedback, enabling communities, NGOs, and authorities to report concerns and ensuring prompt responses.
- Engage stakeholders, including local communities and civil society organizations, in the monitoring process to ensure transparency and accountability.
- Establishment of real-time monitoring digital tools enabling quick identification of issues and corrective actions should be ensured by NSEZ.
- Regularly check compliance with national regulations and international guidelines, ensuring adherence to environmental and social safeguards.
- Conduct periodic audits to assess long-term impacts and ensure the effectiveness of mitigation measures.

- Track and assess the effectiveness of environmental, social, and financial risk mitigation strategies, applying corrective measures as needed for NSEZ.
- Conduct periodic cost-benefit analyses to evaluate the financial viability and impact of the project.

8.8 Auditing Procedures/Monitoring Framework for Compliance with the Regional Environmental Management Plan

The effective implementation of a Regional Environmental Management Plan requires a robust auditing and monitoring framework to ensure compliance with environmental standards and regulations. This framework not only facilitates the assessment of ongoing environmental impacts but also ensures that mitigation measures are in place and functioning as intended. The auditing procedures are as follows but not limited to.

- Develop clear and comprehensive auditing procedures to ensure compliance with environmental standards and regulations throughout the lifecycle of NSEZ.
- Establish key performance indicators to monitor and evaluate environmental performance, focusing on critical areas such as air quality, water management, and biodiversity conservation.
- Conduct routine audits that assess both immediate and long-term environmental impacts, including on-site inspections to ensure ongoing compliance and effectiveness of mitigation strategies.
- Engage independent third-party auditors to ensure objectivity, transparency, and adherence to international environmental standards.
- Continuously track the implementation and effectiveness of mitigation measures and take prompt corrective actions when necessary to address any compliance gaps or environmental risks.
- Implement real-time environmental monitoring systems to quickly detect and resolve any compliance issues, ensuring swift responses to potential environmental concerns.
- Actively involve local communities and stakeholders in the auditing process to ensure the environmental management approach is aligned with local priorities and concerns.
- Ensure strict compliance with regional and national environmental laws and regulations throughout all stages of the NSEZ.
- Regularly publish audit results and environmental performance reports to ensure transparency, build public trust, and maintain accountability to stakeholders.
- Use audit findings to continuously improve the environmental management plan, adapting strategies as necessary to address emerging environmental challenges and ensure long-term sustainability.

9 EXISTING LEGAL AND REGULATORY FRAMEWORK

This chapter describes the legal and regulatory framework relevant to the NSEZ development and operation, covering national environmental, social, land, labor and working conditions, health and safety legislation, ecology and biodiversity, disasters, climate change, power and energy, tourism, etc.

9.1 Gap and Recommended Changes in Existing Legal and Regulatory Framework

A gap assessment of the existing legal and regulatory framework applicable to the management of environmental and social issues during the development and operation of the EZ and necessary recommended changes in the regulations is provided in Table 9-1.

Table 9-1: Gap and recommended changes in existing legal and regulatory framework

Aspects	Act/rules/law/ordinance/policy	Recommended Changes ³³
Environment	Bangladesh Environment Conservation Act, 1995, and its amendments in 2000, 2002, and 2010	-
	Environment Conservation Rules, 2023	-
	Environment Court Act, 2010	-
	National Environment Policy, 2018	-
Air Quality and Pollution Control	Air Pollution (Control) Rules, 2022	Provision of Continuous Air Quality Monitoring Stations specifically in the EZ and its adjoining areas. Incorporation of a representative from BEZA in the national committee related to air pollution control.
Noise and Vibration	Noise Pollution (Control) Rules, 2006	A national standard for vibration has not been formulated yet. Therefore, a vibration standard can be adopted following ISO 2631-1:1997, BS 6472: 1992, or any international standards/good practices.
Water Quality and Pollution Control	Bangladesh Water Act, 2013	-
	Bangladesh Water Rules, 2018	-
	National River Protection Commission Act, 2013	-
	Natural Water Reservoir Conservation Act, 2000	-
	National Water Policy, 1999	-
Soil and Sediment Quality and	-	A national standard for soil and sediment quality has not been formulated yet. Therefore, a soil and sediment quality

³³ Blank cells indicating no specific recommendations

Aspects	Act/rules/law/ordinance/policy	Recommended Changes ³³
Pollution Control		standard can be adopted following USEPA or any international standards/ good practices.
Ecology and Biodiversity	Biodiversity Act, 2017	-
	Wildlife (Conservation and Security) Act, 2012	Authorize all forest officers and designated personnel to enforce the Act. Include authority to arrest individuals suspected of wildlife crimes. Grant authority to the Coast Guard, BGB, Navy, and Fisheries officers to combat wildlife crimes.
	Protected Area Management Rules, 2017	-
	Ecologically Critical Areas Management Rules, 2016	-
	Marine Fisheries Act, 2020	-
	Protection and Conservation of Fish Act, 1950 and its amendment in 1982 and Rules, 1985	Clear definitions need to be developed for Maximum Sustainable Yield (MSY), fishing effort-MSY per type of 'Fishing Net'. Clear definitions need to be developed for Illegal Unreported and Unregulated (IUU) fishing.
	Forests Act, 1927 and its amendment in 1982, 1989, 2000, and 2018	Prioritize biodiversity and ecosystem conservation and promote the involvement of local communities. Introduce penalties for activities that threaten biodiversity, conservation of natural heritage, and ecosystems, such as noise pollution from tourism in the Sandwip Channel. Similarly, enforce strict punishments for illegal activities like unauthorized fishing in the Sandwip Channel and other harmful practices.
	Bangladesh Wildlife Conservation Master Plan 2015-2035	
Land Acquisition, Resettlement, and Compensation	Acquisition and Requisition of Immovable Property Act, 2017	The provision of compensation for the non-titled holders should be adopted.
Occupational Health and Safety	National Occupational Health and Safety Policy, 2013	-
	Bangladesh Labor Act, 2006 and amendment in 2013, Labor Rules, 2015	-
	Fatal Accidents Act, 1855	-

Aspects	Act/rules/law/ordinance/policy	Recommended Changes ³³
	Factory Act, 1965 and Factory Rule, 1979	-
	Boiler Act, 1923	-
	Explosive Act 1884	-
	Explosive Substance Act 1998	-
	Public Procurement Rule (PPR), 2008	-
	National Child Labor Elimination Policy, 2010	-
	Bangladesh Industry Policy, 2016	-
Community Health, Safety, and Security	National Health Policy, 2011	-
	National Policy for Safe Water Supply and Sanitation, 1998	-
	Bangladesh Penal Code	-
Waste Management	Solid Waste Management Rules, 2021	Incorporation of a representative from BEZA in the national committee related to solid waste management. Provision of an environmental assessment before selection and development of a solid waste management facility including landfill site.
	Medical Waste (Management and Handling) Rules, 2008	-
	Hazardous Wastes and Ship Breaking Waste Management Rules, 2011 & amendment in 2012	-
	Hazardous Waste (E-waste) Management Rules, 2021	-
	National 3R Strategy for Waste Management, 2010	-
Disaster Management	Disaster Management Act, 2012	-
	Fire Prevention and Extinction Act, 2003 and Fire Prevention and Extinction Rules, 2014	-
	Bangladesh National Building Code, 2020	-
	Standing Orders on Disaster, 2019	-
	National Disaster Management Policy, 2015	-

Aspects	Act/rules/law/ordinance/policy	Recommended Changes ³³
Climate Change and GHGs	Bangladesh Climate Change Trust Act, 2010	-
	Ozone Depleting Substance (Control) Rules 2004 and amendment in 2014	-
	National Adaptation Plan of Action, 2009	-
	Bangladesh Climate Change Strategy and Action Plan, 2009	Adopt restrictions on the introduction of exotic species (particularly invasive alien species) in plantation programs undertaken as a climate change/GHG mitigation measure (i.e., to store carbon).
	Bangladesh Delta Plan, 2100	Plan implementation should ensure the adoption of environmental measures to minimize air, water, and land pollution arising from infrastructural development.
Power and Energy	Renewable Energy Policy, 2008	Promote non-grid and small-scale facilities with substantial incentives and capacity building. Promote waste to energy production technologies, especially solid waste management in the EZ area in an environmentally friendly manner. Focus on solar power plants in the EZ area.
Tourism	National Tourism Policy, 2010	Address the extent of growth of mass tourism in the EZ surrounding area and restriction that might be required to addressing environmental degradation and pollution control. Tourism related infrastructure development in ecologically protected areas, protected areas, wildlife sanctuary, water stressed areas, etc. should be prohibited.

10 INSTITUTIONAL ARRANGEMENTS, ASSESSMENT, AND STRENGTHENING CAPACITY

10.1 BEZA's Institutional Arrangement

Bangladesh Economic Zone Authority (BEZA) was officially instituted by the government on 9 November 2010. BEZA aims to establish economic zones in all potential areas in Bangladesh including backward and underdeveloped regions to encourage rapid economic development through the increase and diversification of industry, employment, production, and export. They are mandated to establish, license, operate, manage, and control economic zones in Bangladesh.

BEZA is governed by a two-level management structure i.e., Governing Board and Executive Board. The governing board is the highest body that undertakes overall policy decisions. The executive board is responsible for overseeing day to day operation of BEZA. BEZA has an approved staff strength of 130 officers and staff³⁴. An existing and proposed organogram of BEZA has been given in Figure 10-1.

BEZA is representing the Government of Bangladesh as the executing agency of the National Specialized Economic Zone (NSEZ) in the Feni and Chattogram districts. BEZA is responsible for undertaking all studies, design, and construction of the EZ. It will also be responsible for the operation and maintenance of the EZ after its completion.

10.1.1 One Stop Service

Under the BEZA, the One Stop Service (OSS) Center was officially launched on 21st October 2019, as a single window for investors in the BEZA. By establishing OSS at BEZA HQ, investors have been relieved of visiting different ministries and departments to obtain required licenses and approvals. The officers from BEZA and concerned ministries/departments provide detailed consultation and information services to the investors from BEZA OSS and can organize required inspections for the investors before starting their business operation.

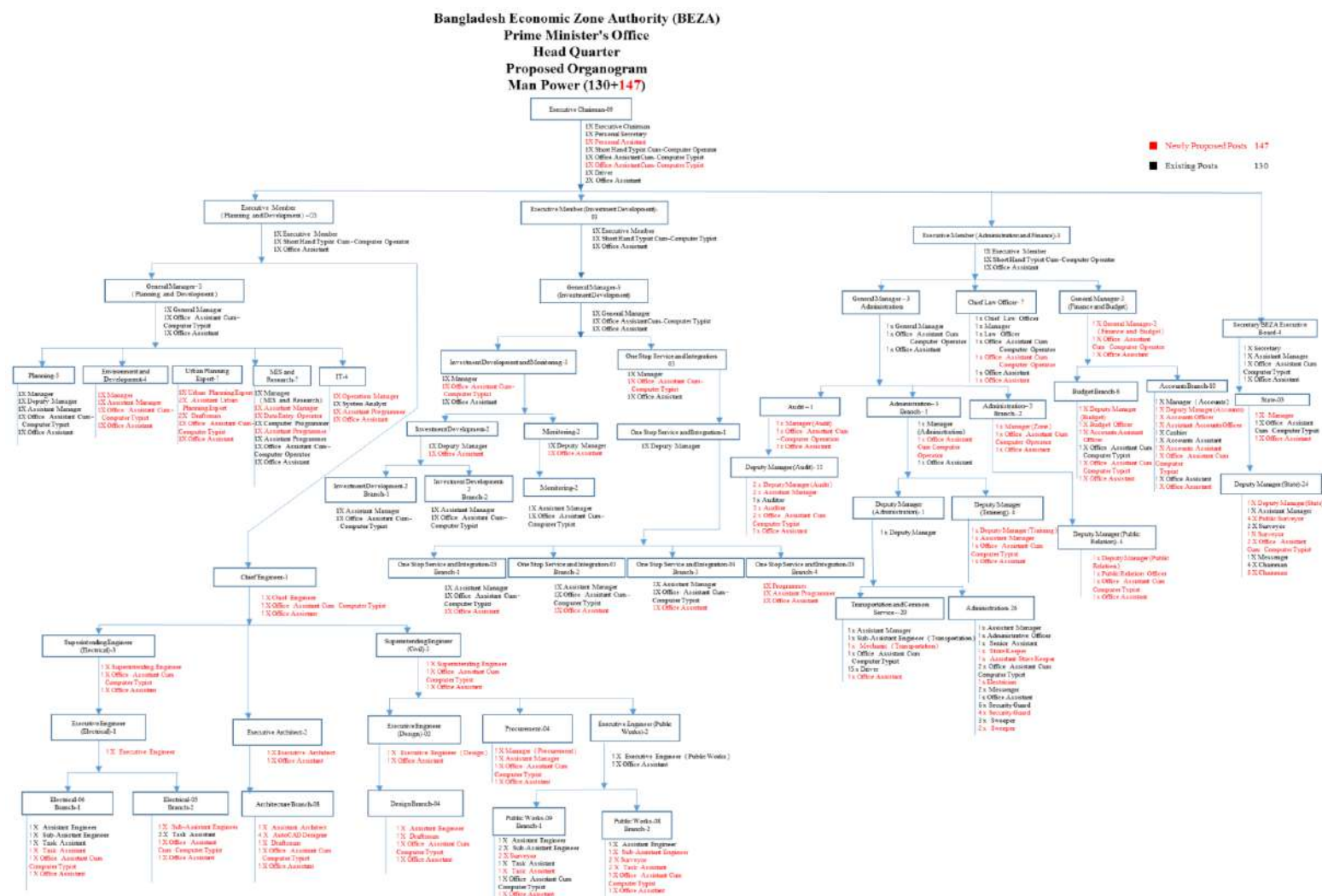
In partnership with 14 different ministries and departments, BEZA OSS offers a total number of 125 government services³⁵ including import permits, export permits, local sale and purchase permits, project clearance, NOC for bank loans, VISA recommendations, work permits, sale permits, manufacturing permits, building plan approval, utility connection, name clearance, certificate of incorporation/registration, TIN certificate, VAT registration, environment clearance, license for service providers, fire safety clearance, factory registration with DIFE, boiler registration, captive power plant (permission from DOE), customs clearance, sub-contract permit, NOC for an offshore banking license, permission for installation of WTP & ETP, permission for installation of generator, remittance clearance, request for utility connection, renewal of boiler registration, etc.

Representatives from the ministries/departments/agencies are working in the OSS including Department of Environment, Foreign Exchange Investment Department, Bangladesh Telecommunications Company Limited, Department of Explosives, Bakhraabad Gas Distribution Company Limited, Department of Inspection for Factories and Establishments, Bangladesh Standards and Testing Institution, Boiler Inspection Department, Ministry of Industries, Electricity Licensing Board, Dhaka Electric Supply Company Limited, Dhaka Power Distribution Company, Bangladesh Rural Electrification Board, Bangladesh Power Development Board, National Security Intelligence, Bangladesh Police, Bangladesh Fire Service & Civil Defense, Public Security Division, Ministry of Home Affairs, Security Services Division, Ministry of Home Affairs, Department of Immigration and Passport, National Board of Revenue, Federation of Bangladesh Chambers of Commerce & Industries, Export Promotion Bureau, Office of the Registrar of Joint Stock Companies and Firms, etc.

³⁴ <https://beza.gov.bd/about-beza/beza-management/>

³⁵ <https://beza.gov.bd/news/bangladesh-economic-zones-authority-beza-is-announce-the-official-inauguration-of-beza-one-stop-service-centre-oss/>

Figure 10-1: Existing and Proposed BEZA Organogram

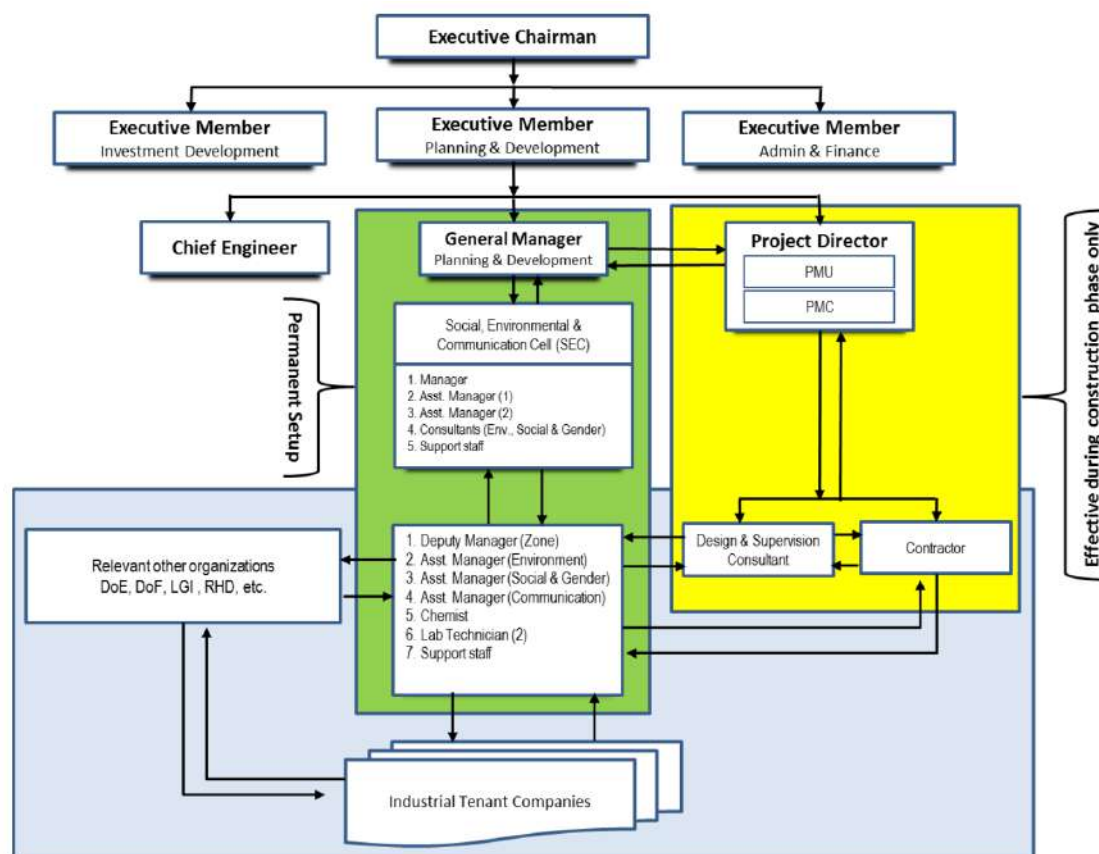


Source: Updated Environmental & Social Impact Assessment of BSEZ (Japanese Economic Zone)

10.1.2 Implementation Arrangement of BEZA

The institutional setting and implementation arrangement of BEZA for environmental and social issues is shown in Figure 10-2.

Figure 10-2: Implementation Arrangement of BEZA for Environmental and Social Issues



Source: Environmental and Social Assessment for Mirsharai Economic Zone-2A & 2B Under PRIDE Project, February 2020

10.1.3 National Special Economic Zone

In the Project Implementation Unit of the NSEZ, there are nine officers including the Project Director, Deputy Project Directors, Assistant Project Directors, Executive Engineers, and Accounts Officer. In addition, twenty-eight project consultants including legal, investment promotion, procurement, IT, monitoring & evaluation, social specialist, financial management specialists, environment specialist, administrative support, occupational health & safety, procurement, social counselors, environment counselors, audit officer, engineers, estimator, draftsman, etc. are working³⁶. Allotted manpower for Mirsharai 2A and 2B Economic Zone in NSEZ is shown in Table 10-1.

Table 10-1: Allotted Manpower for Mirsharai Economic Zone 2A & 2B in NSEZ

S/N	Designation	Number of Manpower	
		Mirsharai 2A EZ	Mirsharai 2B EZ
1.	General Manager	1	1
2.	Manager	1	1
3.	Deputy Manager	2	2

³⁶ https://NSEZ.gov.bd/?page_id=49

S/N	Designation	Number of Manpower	
		Mirsharai 2A EZ	Mirsharai 2B EZ
4.	Assistant Engineer	1	1
5.	Accountant	1	1
6.	Assistant Manager	3	3
7.	Sub Assistant Engineer	3	3
8.	Auditor	1	1
9.	Computer Operator	1	1
10.	Senior Assistant	1	1
11.	Assistant Accountant	1	1
12.	Office Assistant cum Computer Typist	2	2
13.	Task Assistant	2	2
14.	Office Assistant	3	3
Total		23	23

Source: BEZA, April 2024

10.2 Assessment of Capacity of BEZA

10.2.1 Environmental and Social Management System

An environmental and social management system is a set of processes and practices that enable an organization to manage the impacts of its organizational activities on the environment and social issues and also to increase its operating efficiency. It helps the organization to achieve its environmental and social goals through consistent control of its operations. The existing environmental and social management system of BEZA has been discussed below:

Environmental and Social Policy

Currently, BEZA's environmental and social compliances and obligations are guided by Chapter 10 (section 43) of Bangladesh Private Economic Zone Policy 2015 as well as Sections 33 and 34 of BEZA Act 2010. BEZA has also prepared a draft Green Zone Development Policy 2019 of BEZA. Based on the overarching policy and legal framework, EIA/ESIA studies are conducted as per national (Department of Environment) and development partners' requirements. Furthermore, staff/investors/contractors are made aware of their E&S due diligence through training.

Identification of Risks and Impacts

Identification of risks and impacts is done formally and informally by BEZA officials during project development as well as during execution. The formal process involves conducting EIA/ESIA studies as per GOB and development partner requirements.

Management Programs

BEZA currently has response procedures for E&S problems; action plans; and monitoring and review processes based on project-specific Environmental Management Plans (EMPs) to address E&S issues, for example, land acquisition and resettlement, occupational health and safety, resource efficiency, etc. The EMPs proposed under EZ are made part of the bidding document of the zone developer.

Organizational Capacity and Competency

BEZA has numerous staff and consultants who have day-to-day involvement in managing E&S risks and impacts. The main responsibility lies with the Project Directors, and they are supported by the Environment and Development Unit. Recently an Environment and Development Unit has been established by BEZA based on its HQ at Dhaka. The unit is under the planning and development wing and is responsible for environmental, social, health, and safety management. Presently, the unit consists of three officers i.e., Director, Deputy Director, and Assistant Director. To support the unit, seven environmental and social councilors are working in different economic zones in Bangladesh, and they are supporting the HQ team for environmental management, grievance, consultation with the community, implementation of CSR activities, etc.

Emergency Preparedness and Response

BEZA is in the process of developing a Business Continuity Plan for economic zone operation during disasters under the National Resilience Program of the Ministry of Planning. Similar programs are also planned under the NSEZ of the World Bank. For individual economic zone development projects, there are also emergency response plans as part of the project environmental and social management plan.

Stakeholder Engagement

BEZA has prepared a Stakeholder Engagement Plan under the Private Investment and Digital Entrepreneurship Project (PRIDE) Project and identified the stakeholders in terms of Project Affected People, Other Interested Parties, and vulnerable groups. BEZA also conducts stakeholder consultation meetings in different economic zones. A grievance mechanism has already been established to address complaints and grievances throughout the lifecycle of the project. The grievance mechanism is intended to address issues and complaints in an efficient, timely, and cost-effective manner.

Monitoring and Review

The E&S team of BEZA reviews the E&S monitoring/ reporting activities of Contractors and Consultants of each development project. The E&S team also provides feedback and takes follow-up measures when required. BEZA appointed environment and social counselors in different economic zones. These counselors are currently performing monitoring and review functions at the site level to ensure the smooth operation of the economic zone. BEZA conducts monthly coordination meetings where monitoring and review issues are raised.

10.3 Assessment of the Capacity of NSEZ

According to the review of the existing organogram of BEZA and NSEZ and discussion with the officials from the BEZA, it was realized that currently, NSEZ does not have permanent and dedicated staff responsible for environmental, social, health and safety, etc. One environment specialist, one social specialist, and one occupational health & safety specialist/consultant are working under the Project Implementation Unit (PIU) of NSEZ at the head office on a contractual basis. In addition, three environmental and social councilors are working in NSEZ on a project-based contract under the Private Investment and Digital Entrepreneurship (PRIDE) Project of BEZA.

10.4 Action Plan to Strengthen Staffing, Capacity, Systems, and Implementation

10.4.1 Establishment of an Environmental Laboratory

Considering the extent and diversity of the NSEZ, a full-fledged environmental laboratory equipped with ambient air, ambient noise, drinking/groundwater, wastewater, soil quality, and sediment quality monitoring system should be established to ensure the proper environmental management in the NSEZ and the surrounding region. The monitoring and testing service shall focus on the parameters that are mentioned in the Environment Conservation Rules, 2023 as well as international standards i.e., WHO, IFC EHS Guidelines, USEPA, etc. To ensure smooth operation, staffing, and maintenance of the proposed laboratory as well as to generate monitoring reports, at least two (2) lab technicians should

be recruited in NSEZ for the first phase. In addition, environmental safeguard specialists having a relevant educational background should be recruited in the NSEZ HSE team to ensure environmental monitoring and assist the laboratory team.

Basically, the NSEZ HSE team will supervise the monitoring of environmental pollution levels viz. ambient air quality, surface water quality, groundwater quality, wastewater quality, noise level, solid waste management, biodiversity, health safety, emergency/disasters, grievance, etc., either departmentally or by appointing external agencies wherever necessary. Monitoring will be done by individual industries, contractors, and subcontractors in line with regulatory compliance so as to ensure that the pollution is limited to allowable values and to take corrective action by either providing new equipment or improving the performance of the pollution control equipment.

In case the monitored results of environmental pollution are found to exceed the allowable values, the HSE team will suggest remedial action and get these suggestions implemented through the concerned industrial authority. The actual operation and maintenance of pollution control equipment of each industry is under the respective industry head. The HSE team will also coordinate all the related activities such as the collection of statistics on the health of workers and population of the region, afforestation and green belt development, etc.

10.4.2 Introduction of ESG Digital Tools in the Monitoring System

Environment, Social, and Governance (ESG) digital transformation is one of the most impactful concepts helping to shape modern business worldwide. Digital transformation refers to the integration of digital technology into all areas of business, resulting in profound changes to operations, culture, and customer value. It's not just about adopting new technologies but about fundamentally changing how businesses operate and deliver value. Adopting an ESG framework can have numerous benefits for businesses including improved reputation, lower risk, lower cost, etc. Investors, consumers, and regulators are increasingly advocating accountability and transparency on these aspects nowadays. Meeting these rising expectations necessitates robust ESG reporting, and digital transformation is emerging as a powerful ally in this endeavor.

An ESG data management software is a tool that can be developed by BEZA, which will enable them to accurately, efficiently, and transparently track and report on their environmental, social, and governance performance in different economic zones as well as NSEZ. Digitalization can significantly improve operational efficiency, leading to a reduced environmental footprint. This digital tool will allow to generation of reports based on specific parameters. These tools will make it easy to visualize and share data with their employees, customers, other stakeholders, and the general public. Graphs, charts, and dashboards can be easily generated using data visualization tools, which can then be shared with stakeholders. Analysis of ESG data over time, trends that point to areas for improvement, and use this information to make continuous improvements in ESG performance. These activities ultimately will have a positive impact on both society and the environment and lead to better changes for future generations.

10.4.3 Capacity Building/Strengthen Staffing

NSEZ will ultimately be responsible for the management and supervision of all activities during the development of the EZ and will have principal responsibility for implementing environmental and social management plans and mitigation measures. However, investors/plot owners will be responsible for each specific development and construction inside of the EZ.

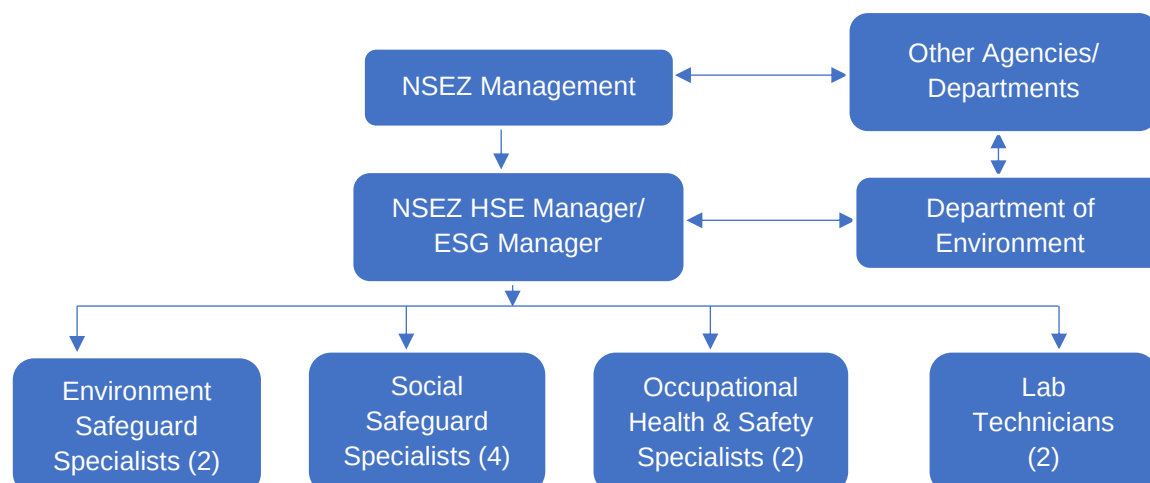
Environmental and social management of the NSEZ requires a multidisciplinary approach with consolidated and coordinated efforts from a number of agencies/departments/authorities. Various institutions/departments will be involved during the development and operation of the EZ. The investors and appointed contractors will also be responsible for the monitoring and implementation of the environmental and social management plan of individual projects/investments in the NSEZ during development activities in the EZ and also reporting the progress to the NSEZ through individual project owners/investors.

During operation, NSEZ will be responsible for ensuring all companies abide by operational-level environmental and social management and monitoring plans for NSEZ. However, the investors/plot owners must comply with the environmental and social management plan developed as part of the unit-specific environmental assessment and the guidelines set by NSEZ.

NSEZ is committed to providing resources and establishing the systems and components essential to the implementation and control of the environmental and social management and monitoring plan. These include appropriate human resources and specialized skills, training programmes, communication procedures, documentation control, and a procedure for the management of change. NSEZ will support the process and have an HSE team with competent staff on the basis of appropriate education, training, and experience. For the first phase, one HSE Manager/ESG Manager, two environment safeguard specialists, four social safeguard specialists, two occupational health and safety specialists, and two lab technicians are to be recruited for NSEZ to ensure the overall environmental, social, and health and safety risk management. They will be responsible for implementing environmental, social, gender, land acquisition, compensation, resettlement, grievance management, stakeholder engagement plans, etc. They will need to raise their capacity to perform their safeguards responsibility and for quality assurance, supervision, and monitoring.

An organogram of the proposed NSEZ HSE team has been given in Figure 10-3.

Figure 10-3: Proposed HSE Team for NSEZ



10.4.3.1 Roles and Responsibilities

The effective implementation of the environmental and social management and monitoring plan will be dependent on established and clear roles, responsibilities, and reporting lines within the NSEZ organizational structure. The organizational structure for environmental and social management for the NSEZ is defined below. The structure will be maintained throughout the development and operation phases, whilst being reviewed on a regular basis to adapt the structure as necessary. **Error! Reference source not found.** includes an organogram for NSEZ. The key roles and responsibilities of the HSE team are provided in Table 10-2.

Table 10-2: Roles and Responsibilities

Role	Overall Responsibilities
NSEZ Management	- Allocate necessary resources, time, and budget for the achievement of environmental and social management requirements. - Designate specific personnel on-site or at the administrative level, and clearly define their roles and responsibilities within the environmental and social management system. - Review of regular internal environment and social performance reports.

Role	Overall Responsibilities
	• Timely completion of mandatory training related to HSE issues. • Encourage and respond positively to observations related to environment and social management and suggestions for improvements from personnel. • Always engage with the local communities and relevant government authorities/departments/institutions professionally and positively. • Participate in internal and external audits. • Recognize and reward good behaviors by personnel at all levels.
NSEZ HSE Manager/ESG Manager and Other Specialists	• Ensuring that environmental and social management plans prepared are up to date. • Ensure compliance with all relevant legislation as well as adherence to all environmental and socio-economic mitigation measures specified in the individual industries ESMPs. • Undertake scheduled site supervision/audit to determine the state of environmental and social compliance in the NSEZ. • Review the project activities, methodologies, and plans in relation to the requirements of the mitigation and management measures of environmental and social management plans. • Collect, organize, and review monitoring data and performance monitoring reports provided by the contractor(s), investors, and provide summary results of such reports to NSEZ management, BEZA HQ, and stakeholders. • Monitor the environmental and social aspects, especially during the construction phase, to ensure that the environmental and social requirements of the contract and the mitigation measures proposed in the ESMPs are implemented. • Monitoring of operational activities of the industries/investors in the NSEZ.
Investors/Plot Owners	• Prepare and submit an environmental assessment report to DOE based on the category of the project, which includes the plan for environmental management, mitigation measures and monitoring to be conducted, for its business operation. • Obtain approval of the environmental clearance certificate from DOE before commencing the construction works at the project site. • Implement environmental mitigation measures and submit of monitoring report to the NSEZ management/HSE team in accordance with the submitted management plan.
Department of Environment (DOE)	• Review and provide approval or issuance of improvement comments on the project environmental assessment report. • Issue site clearance certificate and environmental clearance certificate and the associated conditions. • Monitor all environmental issues with a view to assessing any possible changes in the environment and their possible impacts. • Monitor the EZ operational activity to determine its immediate and long-term effects on the environment. • Routinely monitor the environmental and social management plan, certificate/license conditions compliance, and issuance of compliance notes or stoppage or improvement orders to the project. • Providing advice or taking direct action to prevent degradation of the environment.

Role	Overall Responsibilities
	• Pollution control, including the monitoring of effluent sources and ensuring mitigation of environmental pollution. • Renewal of environmental clearance certificate. • Carry out site inspection to ensure compliance with the environmental clearance certificate conditions of approval and monitor the effects on the environment of any activities carried out on the premises.
Contractor(s) and subcontractor(s)	• Preparation and implementation of the Construction Environmental and Social Management Plan. • Responsible for ensuring compliance with all relevant legislation as well as adherence to all environmental and socio-economic mitigation measures specified in the environmental and social management plan. • Ensuring that all environmental monitoring data is made available at regular intervals and that any divergences from performance standards will be fully explained, together with any necessary preventative measures. • Recruit qualified environmental, social, and health and safety specialists to develop and enforce environmental, social, safety, and health precautionary measures for both the workers and the community at large. • Appoint a Community Liaison Officer to bridge the gap between the contractor and the community, and coordinate grievance redress to ensure community concerns are addressed. • Day-to-day monitoring of environmental matters - this will include wider environmental and social aspects including matters not directly concerned with the actual construction. • Preparation of weekly and monthly environmental inspection and monitoring reports in a format acceptable to investors and NSEZ. • Undertake mainstreaming of gender issues into the entire project including but not limited to work placements, tools and fixtures, sanitary utilities, creating awareness on sexual harassment, and any other forms of discrimination based on gender, ethnic background, and race. • Ensure that all workers are provided with appropriate PPEs and further always enforce their use.
Other government agencies/departments (RHD, BR, BIWTA, PGCB, BREB, BTCL, CWASA, BWDB, LGED, NHA, KGDCL, FD, Police, Ansar, etc.)	• The relevant agency/departamental officers will be called upon where necessary during the development and operation of the EZ to provide the necessary permits/approval/license and advisory services to the NSEZ. • Coordination meetings with the NSEZ management as well as the HSE team regarding their activities. • Monitoring and period inspection of their implementation activities and plans/programs.

10.4.4 Capacity Building Training

To help build the institutional capabilities of NSEZ and different agencies or bodies that will be involved in the implementation of different environmental and social management plans, different areas of capacity enhancement have been recommended as part of the training program. A list of proposed capacity-building training programs that can be organized for different stakeholders based on their requirements:

- National legislation related to the environment, social, waste management, labor, occupational health and safety, land acquisition and resettlement, biodiversity management, cultural heritage, Indigenous community, and others.

- Introduction to WB ESS1-10 under WB ESF
- Labor and working conditions
- Occupational health and safety
- Community health and safety
- Stakeholder engagement plan and implementation
- Preparation of IEE, EMP, ESIA, RPF, LRP, RAP, etc.
- ESMP compliance monitoring and audit and reporting
- Efficient use of resources and prevention of pollution
- Emergency procedure and response
- Solid and liquid waste management
- Industrial waste management
- Wastewater treatment technology and reuse
- Terms and conditions of employment according to national working laws and regulations
- Contractor and sub-contractor Codes of Conduct
- Worker's organizations
- Workplace risk management
- Prevention of accidents at work sites
- Incidents causation, investigation, and reporting
- HSE induction/orientation course (site safety rules, PPE requirements, Emergency Preparedness and Response)
- Daily toolboxes talk for workers at the start of each day's job
- Refresher HSE courses as when required
- First aid training (for site first aiders)
- Safe driving techniques (for drivers)
- Grievance redress mechanism
- Raising awareness and measures to prevent and mitigate GBV risks
- Sensitization and awareness raising on HIV/AIDs, STIs harassment, sexual behavior, Gender Based Violence, etc.
- Laour influx management
- Child labor and minimum age employment rules
- Effective communication
- Conflict management
- Accident/incident reporting
- Community skill development training
- Other issues to be determined.

10.5 Communication

NSEZ will maintain a formal procedure for communications with the regulatory authorities i.e., DOE and communities. The HSE Manager/ESG Manager will be responsible for communication of EHS issues to and from regulatory authorities whenever required.

The following communication level can be distinguished regarding the NSEZ.

- Internal communication among various levels and functions of the NSEZ/BEZA.
- Internal communication among the various parties/investors is involved in EZ.
- Relevant communication from external interested parties related to ES issues.

Meetings should be held, as required, between NSEZ and the appropriate regulatory authority and community representatives to review EHS performance, areas of concern, and emerging issues. Dealing will be transparent, and stakeholders should have access to personal and information to address concerns raised.

10.6 Monitoring and Reporting Procedures

During the implementation of the NSEZ, management will designate an HSE team who will visually assess the contractor's practices. If high pollutant levels are observed, then they will instruct the individual industry/contractors/subcontractors to make necessary corrections immediately. Photographic records will be established to provide useful environmental monitoring tools. A full record will be kept as part of normal contract monitoring and shared with the NSEZ HSE team. All the records will be kept on the NSEZ site and will be backed up at several locations including secure cloud storage facilities. Records will be kept in both hardcopy and softcopy formats. The HSE manager/ESG manager of the NSEZ will be responsible for maintaining a master list of applicable EHS documents and making sure that this list is communicated to the appropriate parties. The HSE manager/ESG manager will be responsible for providing notice to the affected parties of changes or revisions to documents, issuing revised copies, and checking that the information is communicated within that party's organization appropriately.

All applicable regulations will be enforced by the NSEZ management and designated staff of the HSE team. Under environmental law, water quality discharge standards, air pollution emission standards, and noise standards have been established. It is a legal obligation of the individual industry/contractors/subcontractors that any discharges from the work sites meet these standards. The contractors/subcontractors will be required to develop a system for maintaining and controlling their own EHS documentation and describe these systems in their respective EHS plans.

10.7 Incident Reporting System

The purpose of the procedure will be to ensure all incidents and accidents involving contractor(s)/subcontractor(s), workers, visitors, local community, property, and activities are reported, investigated, and recorded.

The NSEZ HSE team will look after the overall incidents and accident records on the NSEZ site. The individual industry will have a Health and Safety Officer to facilitate and coordinate the reporting, recording, and investigation of all occupational health and safety incidents by:

- Receive all notifications of incidents/accidents and ensure proper response is being followed including reporting, investigations, and review.
- Once aware of an emergency, the actions should be taken i.e., contact or communicate with the Emergency Control Centre (ECC) of the NSEZ and site manager, coordinate activities of all personnel in the ECC and monitor its effectiveness, coordinate the activities of all personnel in the ECC and make further directions as required by the situation, etc.
- Maintain the NSEZ emergency response plans and associated processes.
- Display names and contacts of personnel to be reached out in case of emergencies.
- Keep a record of incident reports, and actions being taken to prevent reoccurrence.
- Coordinate training requirements for the emergency response team and all other site personnel.
- Ensure that adequate emergency response information and instructions are provided in training and inductions.
- Undertake planned inspections to ensure emergency response equipment and facilities are complete.

10.8 Auditing of Regional Environmental and Social Management Plan

Regular internal audits and environmental and social monitoring will be carried out by individual industries, contractors, and subcontractors in order to evaluate the performance of the environmental and social management plan. A copy of the audit report will be shared with the NSEZ HSE team.

NSEZ HSE team will prepare environmental and social monitoring reports twice a year regarding the management of environmental and social issues. In addition, they may conduct an annual audit on the regional environmental and social components. An external firm may engage to perform the audit.

10.9 Managing Changes to the NSEZ Activities

Changes in the NSEZ may occur due to unanticipated situations. Adaptive changes may also occur during the course of the EZ life cycle. The NSEZ will implement a formal procedure to manage changes in the EZ that will apply to all activities.

The objective of the procedure is to ensure that the impact of changes on the worker's labor and working conditions, the environment, and the communities' socio-economic conditions are identified and assessed prior to changes being implemented.

The management of the change procedure will ensure that:

- Proposed changes have sound technical, safety, environmental, and commercial justification.
- Changes are reviewed by competent personnel and the impact of changes is reflected in documentation, including operating procedures and drawings.
- Hazards resulting from changes that alter the conditions assessed in the RESA will be identified and assessed and the impact(s) of changes do not adversely affect the management of health, safety, or the environment.
- Changes are communicated to personnel who are provided with the necessary skills, via training, to effectively implement changes.
- The appropriate person accepts the responsibility for the change.

As information regarding the uncertainties becomes available, the NSEZ environmental and social management plan/procedure will be updated to include that information in subsequent revisions. Environmental and social, as well as engineering feasibility and cost considerations will be taken into account when choosing between possible alternatives.

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

The EZ proposed by the BEZA has strategic value on many fronts. As Bangladesh believes that the establishment of industrial zones throughout the country will contribute to the development of the national economy, it could also be said that the Project is strategic in the economic sense. The Project will contribute to the economic development of the Chattogram region as well as the economic development of the country.

The EZ will seek to develop the socio-economic conditions of the people living in the region. There is no denying that, once the Project is implemented, it will substantially enhance international trade. It also has the huge potential of attracting investors from inside and outside the country by establishing a favorable investment environment. At the micro-economic level, the EZ will promote entrepreneurship and create job opportunities.

In terms of the living environment, most of the impacts could be controlled and limited in and around the project area. Major negative impacts such as but not limited to air pollution, surface water, groundwater contamination, solid waste generation, and traffic flow are expected for EZ master plan implementation. However, the implementation of appropriate mitigation and management plans will minimize these impacts.

In terms of the natural environment, the major negative impact is the clearance of existing vegetation, though no protected areas are involved. However, the implementation of appropriate mitigation measures, such as creating green areas inside and outside of the EZ and keeping the existing environmental conditions as much as possible will minimize the impact on the ecosystem.

In terms of the social environment, the existing social infrastructures and services, living and livelihoods of the fisherman and livestock dependent community, risks for infectious diseases, occupational health and safety, and community health and safety are expected. However, the implementation of appropriate mitigation and management plans, such as managing working conditions during the construction work, providing security, and maintaining safety prevention measures during EZ master plan implementation will minimize these impacts.

On the other hand, some positive impacts of the EZ such as an increase in job opportunities and improvement of social infrastructure are also expected. There are no land issues for the project and the community living in nearby villages are pleased to see the project implementation as early as possible. They would like to get employment in the project.

The cumulative impacts could be expected on air quality, water quality, traffic, livelihoods, community health and safety, greenhouse gas emissions, and solid waste generation due to the different activities of EZ in the surrounding area. The cumulative impacts typically result from the actions of multiple stakeholders, it is necessary to engage with these stakeholders for effective collaboration and coordination.

Individual industries in the EZ will carry out environmental assessment and or environmental management plans including adequate mitigation measures and monitoring plans to reduce the negative impacts and consider necessary budget allocation for the industry. It should be confirmed that the environmental and social impacts of the industry are adequately assessed in the report, and the environmental management plan is formulated properly. In the process of environmental assessment, opportunity of public involvement should be ensured and comments from the public and DOE will be reflected in the report. Thus, the environmental assessment will be completed in accordance with the requirements of the environmental assessment procedure properly for the project proponent to follow the EMP accordingly.

Individual investors will be required to obtain a No Objection Certificate/approval/license/permission from relevant departments/authorities as per their nature of work. BEZA through their One Stop Service (OSS) may guide/support to obtain NOC/approval/license/permission.

It may be concluded that if proper mitigation measures are implemented, the EZ would cause the least effect on the area's existing environmental and social setting. On the other hand, it is expected that the EZ will generate a large number of employment opportunities for the residents of the region as well as other regions of the country and abroad.

11.2 Recommendations

Based on the RESA below are some of the recommendations that will ensure effective implementation of the EZ master plan. The following is a highlight of some of the key recommendations of this RESA report:

- ❖ **Air, Noise, Water, Soil, and Sediment Pollution:** pollution in the form of air, noise, water, soil, and sediment from various industries construction and operations inside of the EZ, as well as related facilities outside of the EZ boundary, is anticipated to increase if appropriate measures are not put in place. In view of this, all components of the EZ including infrastructure requirements and industries should be subjected to IEE/EIA/EMP as stipulated by ECR, 2023. IEE/EIA/EMP for respective components should detail comprehensive baseline ambient air quality, ambient noise level, water, soil, and sediment quality. In addition, the IEE/EIA/EMPs should detail a schedule for monitoring air, noise, water, soil, and sediment pollution by respective industries/investors. These pollutions should be controlled with the use of good engineering practices including land management, selection of pollution abatement devices, use of proactive measures, selection of proper sites, etc. The use of cleaner production practices will also be adopted by the investors/individual industry owners. It is also recommended to integrate continuous and online base monitoring systems in the EZ monitoring mechanism. In addition, BEZA can introduce ESG digitalization tools, which will enable them to accurately, efficiently, and transparently track and report on their environmental, social, and governance performance in different economic zones as well as EZ.
- ❖ **Liquid Waste Management:** waste generated for the EZ management can be detrimental to the environment if appropriate measures are not taken into consideration. In view of this, efficient waste management is recommended at EZ. Notably, fully functional and cost-effective central wastewater treatment plants are recommended. The treated water must meet the standards as mentioned in the ECR 2023 and ensure reuse to a maximum extent to reduce the volume of water consumption and wastewater. An online continuous emission monitoring system should be installed at the outlet of CETPs to monitor the effluent quality. In addition, the installation of a surveillance system with industrial-grade internet protocol cameras having pan tilt zoom with leased line real-time connection for data streaming and transmission of same is recommended.
- ❖ **Solid Waste Management:** due to the implementation of the EZ master plan a large quantity of solid waste will be generated in the EZ. Various waste that will be generated from individual industries can be used as raw materials in other industries. This will minimize the volumes of solid waste generated. Segregation of solid waste at sources is strongly recommended and all waste management should comply with the requirements of Solid Waste Management Rules 2021. The solid waste incinerator should be designed and operated following the operating standards mentioned in Solid Waste Management Rules 2021. A groundwater monitoring program should be established particularly for waste management facilities in the EZ.
- ❖ **Water Issues:** EZ is expected to obtain water from both the surface and groundwater sources. Now there is a groundwater crisis in the EZ region. Withdrawing groundwater in excess of the rate of recharge may result in the lowering of the water table, land subsidence, salinity intrusion, and decreased water quality. Therefore, it is recommended to source the surface water from a

sustainable source for industrial uses. In addition, rainwater harvesting, groundwater recharge, and 3R practices should be implemented in the EZ. For the extraction of both surface and groundwater for industrial uses, a no objection certificate (NOC) will be required from the Water Resources Planning Organization (WARPO) following the provisions of the Bangladesh Water Act 2013 and Bangladesh Water Rules 2018.

- ❖ **Climate Change:** Industrial development is anticipated to negatively contribute to climate change if appropriate measures are not taken into consideration. As such, climate change adaptation measures are recommended at the EZ. These measures include but are not limited to construction of green structures, use of climate-friendly construction materials, apply energy efficiency measures, cleaner production, use of renewable energy sources, use of electric vehicles, adoption of carbon trading for high-emission industries, and emission monitoring for the respective industries among others. A weather station is recommended to be established in the EZ region for monitoring climate trends.
- ❖ **Natural Disasters:** the EZ site is located on the coastline of Bangladesh. The region is vulnerable to various natural disasters including cyclones, tidal surges, earthquakes, floods, etc. Therefore, it is recommended to establish an emergency control center under a disaster management committee to monitor and manage natural disasters in the EZ and maintain coordination with other emergency response teams. A green belt development is strongly recommended outside of the existing super dike to protect the super dike as well as EZ from severe cyclones and associated tidal surges.
- ❖ **Drainage:** according to the upazila disaster management plan of Mirsharai, Sitakunda, and Sonagazi, the EZ region is vulnerable to floods. There can be heavy floods in the rainy season in the region, therefore advanced preparation should be taken for a better drainage system for EZ as well as the surrounding area. BWDB should monitor the function of drainage in the region specifically before the monsoon and take precautionary measures i.e., dredging of khals, if required. Currently, the development activities outside of the EZ are started in an unplanned way. This can exacerbate the waterlogging/flooding in the future. Therefore, adequate water passing provision should be considered during the design of infrastructure i.e., roads. In addition, a development authority could be established to develop the region in a planned way.
- ❖ **Biodiversity Conservation and Habitats:** The implementation of the EZ master plan has the potential to impact the biodiversity of the region, given its location within a biodiversity-rich area and along the coastline of the Sandwip Channel of the Bay of Bengal. To mitigate these negative impacts, particularly habitat loss, habitat fragmentation, increased human-wildlife conflicts, and wildlife accidents, a comprehensive strategy must be adopted. It is recommended to establish a partnership with the Forest Department to follow the biodiversity-inclusive ES management procedure developed for EZ and enforce effective biodiversity conservation measures. This collaboration should include shared responsibilities in monitoring and mitigating human-wildlife conflicts and wildlife accidents. It is also important to launch community awareness programs to educate local populations about the importance of biodiversity and how to coexist with wildlife. Finally, the EZ authority should also enhance the capacity of the EZ master plan implementation team and local stakeholders through training programs focused on biodiversity conservation, wildlife management, and conflict resolution techniques.
- ❖ **Land Acquisition, Compensation, and Resettlement:** For the development of the EZ a total of 33,800 acres of land will be required. Most of the land has already been reclaimed from the sea. However, due to the development of EZ-related facilities, housing and infrastructure development, a significant volume of land will be required to be acquired by EZ phase by phase. It is likely to be expected that a significant number of both physical and economic displacements will be required for the development of roads, railways, social infrastructures, etc. Compensation for the land, loss of income, and other investment loss for the affected household will be assessed and determined in the RAP as per the available laws of Bangladesh. To avoid

conflict between the communities of Mirsharai and Sonagazi area land prices should be determined accordingly. In case of any issues or discrepancies regarding land price, BEZA should take the initiative to provide the top-up amount to reduce the discrepancy in land price. To restore and enhance the livelihood of the affected populations specifically fishermen, and buffalo gazers a Livelihood Restoration Plan should be developed and adopted by the EZ. As a part of mitigation measures continuous stakeholders' consultations and the provision of grievance mechanisms should also be established accordingly. Training should be provided to the local people so that local workers can be easily recruited when the EZ is developed.

- ❖ **Labor Influx:** As per the master plan prepared for the EZ, a total of 1.4 million job opportunities will be created. Considering the phase-wise development approach, due to the creation of a huge number of employment opportunities it is expected that families, followers, and other service providers will create significant pressure on the existing community. Mitigation measures to reduce the impact of labor influx should be implemented accordingly. The labor management plan and community health and safety plan should be implemented and adopted accordingly by EZ. The provision of regular stakeholder consultations, grievance mechanisms, and coordination with the relevant agencies should be adapted by EZ accordingly. To minimize the risk of labor influx from large-scale projects like EZ following issues should be managed accordingly by EZ.

- Risk of social conflict
- Increased risk of illegal behavior, or behavior that violates social norms in the project area
- Influx of additional population ("followers")
- Increased burden on and competition for public service provision
- Increased risk of communicable diseases and burden on local health services
- Gender-based violence (GBV)
- Child labor and school dropout
- Local inflation of prices
- Increased pressure on accommodations and rents
- Increase in traffic and related accidents
- Inadequate waste disposal and illegal waste disposal sites
- Wastewater discharges
- Increased demand for potable water resources
- Camp-related land use, access roads, noise, and lights
- Increased deforestation, ecosystem degradation, and species loss
- Increased use of / demand for natural resources

- ❖ **Social Infrastructure:** As per the consultations and available secondary documents, it was identified that the available social infrastructure of the project region is not enough to meet the needs of existing communities. As EZ will contribute to a significant number of influxes including the workers, investors, employees, service providers, and followers it is expected that the existing social infrastructure will not be able to take this pressure of influx. Coordination among the service providers, relevant government agencies and ministries, and local government institutions should be conducted accordingly by EZ. Development of houses and settlements should be implemented consistent with the Township development of respective upazilas (e.g., Mirsharai Development plan).

From the consultations with the relevant government authorities, public representatives, local communities, and other stakeholders it was revealed that the sectors (citizen services from different government agencies, educational institutes, medical facilities, roads, housing and infrastructure, drainage and culverts, waste management facilities, graveyard, playground, community center, recreational facilities, etc.) should be developed considering the future influxes and interventions.

- ❖ **Community Health Safety and Security:** As per the master plan of EZ, communities of three upazilas will be considered for the development of EZ. The design and implementation of social infrastructures should be consistent with national and international guidelines. The EZ will avoid or minimize the potential for community exposure to hazardous materials and substances that may be released by the project. The EZ will implement measures and actions to control the safety of deliveries of hazardous materials, and of storage, transportation, and disposal of hazardous materials and wastes, and will implement measures to avoid or control community exposure to such hazardous material. Emergency Preparedness and Responses will be developed and adopted by the EZ to address the emergency event in a coordinated and expeditious manner; to prevent it from injuring the health and safety of the community; and to minimize, mitigate, and compensate for any impacts that may occur. EZ will be guided by the principles of proportionality and GIIP, and by applicable law in relation to hiring, rules of conduct, training, equipping, and monitoring of such security workers.

Investors, contractors, and subcontractors should take care of the local community and its sensitivity toward local customs and traditions. Environmental and social management measures proposed should be implemented in the true spirit. In order to address these issues formulation of laws and changes in future plans of the relevant district and upazila administration will be required. Therefore, it is suggested that BEZA as well as NSEZ management should coordinate with the relevant district and upazila administration of Feni and Chattogram Districts along with the departments/agencies/institutes/authorities related at all stages of the EZ master plan implementation. This will provide awareness of issues to be dealt with by relevant government departments and administration. This coordination will help relevant authorities develop their future strategies proactively to address the anticipated issues likely to arise in the EZ region.

12 REFERENCES

- Ahmed, K.M., Bhattacharya, P., Hasan, M.A., Akhter, S.H., Alam, S.M.M., Byuyian, M.A.H., Imam, M.B., Khan, A.A., and Sracek, O. (2004). Arsenic Enrichment in Groundwater of the Alluvial Aquifers in Bangladesh: An Overview. *Applied Geochemistry* 19:181-200.
- Akhtar, S.H. (2010). Earthquakes of Dhaka. In: Islam MA, editor. *Environment of Capital Dhaka—plants wildlife gardens parks air, water, and earthquake*. Dhaka, Bangladesh: Asiatic Society of Bangladesh, p. 401-426.
- Alam, E. (2019). Importance of long-term earthquake, tsunami, and tropical cyclone data for disaster risk reduction in Bangladesh. *Progr Disast.* 2:100019. doi:10.1016/j.pdisas.2019.100019.
- Alam, M.K., Hasan, A.K.M.S., Khan, M.R., and Whitney, J.W. (1990). Geological Map of Bangladesh. Geological Survey of Bangladesh (GSB) and United States Geological Survey (USGS).
- Aziz, M. A. (2019). Conservation Action Plan for Ganges River Dolphin and Irrawaddy Dolphin of Bangladesh. Expanding the Protected Area System to Incorporate Important Aquatic Ecosystems Project. Bangladesh Forest Department, Ministry of Environment, Forests and Climate Change, Dhaka, Bangladesh.
- Bangladesh Railway, 2018. Feasibility Study and Detail Design for Construction of Railway Link to Mirsharai-Feni Economic Zone. Final Feasibility Study Report. Prepared by: Infrastructure Investment Facilitation Company.
- Banu, Z., Chowdhury, M., Hossain, M., and Nakagami, K. (2013). Contamination and Ecological Risk Assessment of Heavy Metal in the Sediment of Turag River, Bangladesh: An Index Analysis Approach. *Journal of Water Resource and Protection*, Vol. 5 No. 2, 2013, pp. 239-248. doi: 10.4236/jwarp.2013.52024.
- Berninghausen, W. H. (1966). Tsunamis and Seismic Seiches reported from regions adjacent to the Indian Ocean, *Bull. Seism. Soc. Am.*, 56 (1), 69-74.
- BEZA. (2016a). Pre-Feasibility Report Mirsharai 2 Economic Zone. Bangladesh Economic Zones Authority, Dhaka, Bangladesh.
- BEZA. (2016b). Environmental Impact Assessment Report - Mirsarai Economic Zone-II. Bangladesh Economic Zones Authority, Prime Minister's Office, Government of the People's Republic of Bangladesh.
- BEZA. (2018). Environmental Assessment of Barotakia to Mirsharai EZ Approach Road, Bangladesh Economic Zones Authority, Prime Minister's Office, Government of the People's Republic of Bangladesh.
- BEZA. (2020a). National Special Economic Zone (NSEZ) Master Plan. Bangladesh Economic Zones Authority, Prime Minister's Office, Government of the People's Republic of Bangladesh.
- BEZA. (2020b). Detail Study on Total Water Demand and Water Availability Assessment for National Special Economic Zone (Volume II: Main Report). Bangladesh Economic Zones Authority, Dhaka, Bangladesh.
- BEZA. (2020c). Environmental and Social Assessment (ESA) for Private Investment and Digital Entrepreneurship (PRIDE) Project. Bangladesh Economic Zones Authority, Dhaka, Bangladesh.
- BEZA. (2022). Revised Environmental Impact Assessment (EIA) of Water Treatment Plant (Phase-1) at National Special Economic Zone (NSEZ). Bangladesh Economic Zones Authority, Dhaka, Bangladesh.
- BEZA. (Year Unknown). Addendum to Environmental Impact Assessment Report for Additional 96.56 Acres Landfilling Adjacent to the Existing Mirsharai EZ-2, Private Sector Development Support Project (PSDSP), Bangladesh Economic Zone Authority. Pp. 18-19.
- Bikos, D., Finch, J., and Case, J. L. (2015). The environment associated with the significant tornadoes in Bangladesh. *Atmospheric Research* 167 (2016) 183-195.

- BirdLife International. (2023a). Important Bird Area Factsheet: Ganges-Brahmaputra-Meghna delta. Downloaded from <http://datazone.birdlife.org/site/factsheet/ganges-brahmaputra-meghna-delta-iba-bangladesh> on 21/08/2023.
- BirdLife International. (2023b). Important Bird Area Factsheet: Muhuri Dam. Downloaded from <http://datazone.birdlife.org/site/factsheet/muhuri-dam-iba-bangladesh> on 21/08/2023.
- Biswas, S., Swanson, M. E., Shoaib, J.U.M., & Haque, S.M.S.S. (2010). Soil Chemical properties under modern and traditional farming systems at Khagrachari, Chittagong Hill Tracts, Bangladesh. *Journal of Forestry Research*, Vol. 21, (4), pp. 451-456.
- BIWTA (Bangladesh Inland Water Transport Authority). (2019). Feasibility Study and Detailed Design for Development of Jetties and Infrastructure at Mirsharai & Sandwip at Chittagong, Subrang and Jaliar Dwip at Teknaf and Sonadia Dwip at Cox's Bazar. Final Report, June 2019. Prepared by Bureau of Research, Testing and Consultation (BRTC), Bangladesh University of Engineering and Technology (BUET), Dhaka-1000.
- Brammer, H. (1996). *The Geography of the Soils of Bangladesh*. University Press Limited (UPL), Dhaka, Pp. 287.
- CDMP II (2013). Development of Four Decade Long Climate Scenario & Trend; Temperature, Rainfall, Sunshine & Humidity, Comprehensive Disaster Management Programme (CDMP II), Ministry of Disaster Management and Relief, Dhaka, Bangladesh.
- CEGIS (2015). Assessment of Sea Level Rise and Vulnerability in the Coastal Zone of Bangladesh through Trend Analysis. Center for Environmental and Geographic Information Services, Dhaka, October 2015.
- CEGIS (2018). EIA Report for Proposed Gas Transmission Pipeline for Mirsarai Economic Zone and KGDCL Gas Distribution Network upgradation Project. 290 pp.
- DANM (Department of Archaeology and National Museum) (2018). Bagan Disaster Risk Management Plan (DRMP). Ministry of Religious Affairs and Culture of the Government of the Union of Myanmar. With support from the Japan-World Bank Program for Mainstreaming Disaster Risk Management (DRM) and the Tokyo DRM Hub. Available in <https://documents1.worldbank.org/curated/en/671391544633861934/pdf/132874-WP-P162815-PUBLIC-Bagan-DRM-Eng.pdf>.
- DesInventar (2016). Disaster Information Management System. From <http://www.desinventar.net>
- eBird (2023). eBird Status and Trends, Data Version: 2022; Released: 2023. Cornell Lab of Ornithology, Ithaca, New York.
- ECAL (2018). Baseline Survey of Existing Flora and Fauna-Package-06 of "Preparation of Development Plan for Mirsharai Upazila, Chittagong District: Risk Sensitive Landuse Plan" Project under Urban Development Directorate (UDD).
- EGCB. (2018). Feasibility Study for Development of Utility Scale Solar PV & Wind Projects in Bangladesh. Power Cell, Power Division Ministry of Power, Energy and Mineral Resources, Government of the People's Republic of Bangladesh.
- Emran, A., Rob, M. A., & Kabir, M. H. (2019). Coastline Change and Erosion-Accretion Evolution of the Sandwip Island, Bangladesh. In I. Management Association (Ed.), *Oceanography and Coastal Informatics: Breakthroughs in Research and Practice* (pp. 434-447). IGI Global. <https://doi.org/10.4018/978-1-5225-7308-1.ch020>.
- Fukuyo, Y., Takano, H., & Chihara, M. (1994). *Red Tide Organisms in Japan: An Illustrated Taxonomic Guide*. Tokyo, Japan. 35 p.
- GOB (2020). National Plan for Disaster Management (2021-2025). Action for Disaster Risk Management Towards Resilient Nation. Ministry of Disaster Management and Relief. Government of the People's Republic of Bangladesh.
- GOB. (1994). *Bangladesh Towards 21st Century*. External Publicity Wing, Ministry of Information, Government of Peoples Republic of Bangladesh. Pp. 192.
- Goldar, R. N., Banerjee, S. K., and Debnath, G. C. (2001). Tornado in India and neighborhood and its predictability. *Sci. Rep.* 2 (21 pp., Indian Meteorol. Dep., Pune, India).

- Gomes, C., Kithil, R., and Ahmed, M. (2006). Developing a lightning awareness program model third world based on American experience, Proc. of the 28th Int. Conference on Lightning Protection (ICLP), Kanasawa, Japan.
- GSB. (1990). Geological Map of Bangladesh. Geological Survey of Bangladesh. Ministry of Energy and Mineral Resources, Government of the Peoples Republic of Bangladesh.
- GTCL. (2021). Environmental Impact Assessment (EIA) Report for Proposed Gas Transmission Pipeline for Mirsharai Economic Zone and KGDCL Gas Distribution Network upgradation Project.
- Halder, G. C., & Islam, M. R. (2008). Ilish Mach Sangrakhon Abang Unnoun Babashthapona Koushal (In Bengali) (Hilsa Fisheries Conservation, Development and Management Technique), Department of Fisheries, Dhaka, Bangladesh. Pp. 1-40.
- Haque, D.M.E., Khan, N.W., Selim, M., Kamal, A.S.M.M., and Chowdhury, S.H. (2020). Towards improved probabilistic seismic hazard assessment for Bangladesh. Pure Appl Geophys. 177(7):3089–3118. doi: 10.1007/s00024-019-02393-z.
- Hasan, M. K., Khan, M. M. H. and Feeroz, M. M. (2014). Amphibians and Reptiles of Bangladesh - A Field Guide. Arannayk Foundation, Dhaka, Bangladesh.
- Hibberd, T. (2009). Field identification guide to Heard Island and McDonald Islands benthic invertebrates. Deep-Sea Research Part I-Topical Studies in Oceanography, 53(8-10).
- Hibberd, T. and Moore, K. (2009). Field Identification Guide to Heard Island and McDonald Islands Benthic Invertebrates: a guide for scientific observers aboard fishing vessels. Kingston, Tas.: Australian Antarctic Division and Fisheries Research and Development Corporation (Australia), Pp. 159.
- Holle, R. L. (2010). Lightning Fatalities in Tropical and Subtropical Regions. Prepr 29th Conf Hurricanes Trop Meteorol. 2010; 1–10.
- Holthe, T. (1992). Identification of Annelida Polychaeta from Northern European and adjacent Arctic Waters. Gunneria 66: 1-30.
- Huq, S. I., & Shoaib, J. U. M. (2013). The Soils of Bangladesh. Netherlands: Springer Netherlands.
- IUCN (2002). Bio-ecological zones of Bangladesh. IUCN Bangladesh Country Office, Dhaka.
- IUCN (2015a). Red List of Bangladesh Volume 2: Mammals. IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, pp. xvi+232.
- IUCN (2015b). Red List of Bangladesh Volume 3: Birds. IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, pp. xvi+676.
- IUCN (2015c). Red List of Bangladesh Volume 4: Reptiles and Amphibians. IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, pp. xvi+320.
- IWM (2010). Updating of Hydrodynamic & Morphological Models to Investigate Land Accretion & Erosion in the Estuary Development Program (EDP) Area, Final Report.
- IWM and CEGIS (2007). Investigating the Impact of Relative Sea-Level Rise on Coastal Communities and their Livelihoods in Bangladesh, UK Department for Environment Food and Rural Affairs.
- Kabeer, N. (2011). Between Affiliation and Autonomy: Navigating Pathways of Women's Empowerment and Gender Justice in Rural Bangladesh.
- Kamal, A. S. M. M., Mitu, M., Hossain, M. S., Rahman, M. M., and Rahman, M. Z. (2021). Seismic hazard analysis for the south-central coastal region of Bangladesh considering the worst-case scenario. Pure Appl Geophys. 178(8):2821–2838. doi: 10.1007/s00024-021-02770-7.
- Karim, N. (1995). Disasters in Bangladesh. Natural Hazards. 1995; 11:247-258.
- Khan, A. A. (2007). Assessing earthquake and tsunami risk in Bangladesh, Environment, The Daily Star Vol.5 Num 972, February 23, 2007.
- Khan, M. M. H. (2018). Photographic Guide to the Wildlife of Bangladesh. Arannayk Foundation, Dhaka, Bangladesh. 488 pp

- Khan, M. M. H., & Rahman, T. (2013). Ganges River Dolphin (*Platanista gangetica* Rozburgh, 1801) survey in Pabna, Bangladesh. Final Report submitted to Flood Hazard Research Centre (FHRC), Dhaka Office, Middlesex University, UK.
- Miah, M. N. U., Shamsuzzaman, M. M., Ahmed Rashid A. H. I and Barman P. P. (2015). Present Status of Coastal Fisheries in Sitakunda Coast with Special Reference on Climate Change and Fish Catch. *Journal of Aquaculture Research and Development*, 6 (8): 362.
- Murty, T. S., Bapat, A., & Vinayak Prasad (1999). Tsunamis on the coastlines of India, *Science of Tsunami Hazards*, 17 (3), 167-172.
- Nishat, A., Huq, S. M., Imamul, Barua, Shuvashis, P., Reza, Ali A.H.M., Khan, & Moniruzzaman, A.S. (eds). (2002). *Bioecological Zones of Bangladesh*. IUCN Bangladesh Country Office, Dhaka, Bangladesh.
- PGCB. (2023). Revised Final Initial Environmental Examination on Construction of Internal Power Transmission Infrastructure at Bangabandhu Sheikh Mujib Industrial City. Power Grid Company Bangladesh Limited. Dhaka, Bangladesh.
- Pielou, E.C. (1966) The Measurement of Diversity in Different Types of Biological Collections. *Journal of Theoretical Biology*, 13, 131-144. [http://dx.doi.org/10.1016/0022-5193\(66\)90013-0](http://dx.doi.org/10.1016/0022-5193(66)90013-0).
- PwC (2018). Environmental Impact Assessment Report Mirsarai Economic Zone-II. Bangladesh Economic Zones Authority (BEZA). 425 pp.
- Rahman, M. M., Mustafiz, M. A. A., Islam, A. F. M. T., and Mohammad, N. (2014). The Effect of Rainfall, Temperature, and Humidity on Saline in the Southern area of Bangladesh; *Journal of Biology, Agriculture and Healthcare*. Available Online: <http://www.iiste.org/Journals/index.php/JBAH/article/viewFile/15747/16145>.
- Rahman, M.Z., Siddiqua, S., and Kamal, A.S.M.M. (2020). Seismic source modeling and probabilistic seismic hazard analysis for Bangladesh. *Nat Hazards*. 103(2):2489–2532. Doi: 10.1007/s11069-020-04094-6.
- Rashid, H. E. (1991). *Geography of Bangladesh*. University Press Limited, Dhaka, Bangladesh.
- Rashid, S.M.A., Akonda, A.W., & Ahmed, B. (2014). Ganges River Dolphin (*Platanista gangetica*) in the Padma, Jamuna and Hurasagar-Baral Rivers of Pabna District, Bangladesh. *International Journal of Current Science*, 14: E 107-124.
- Rastogi, B. K., and Jaiswal, R. K. (2006). A Catalog of Tsunamis in The Indian Ocean, *Science of Tsunami Hazards*, Vol. 25, No. 3, page 128, National Geophysical Research Institute, Hyderabad, India.
- Reimann, K.U. (1993). *Geology of Bangladesh*. Berlin: BeitrageZurRegionalenGeologie Der Erde.
- Reza, A., Islam, M.T., Akter, M.Y., Amanat, S., Alam, E., Sultana, M.L., Shahid, S., Das, A., Peu, S.D., and Mallick, J. (2023). Assessing seismicity in Bangladesh: an application of Guttenberg-Richter relationship and spectral analysis, *Geomatics, Natural Hazards and Risk*, 14:1, DOI: 10.1080/19475705.2023.2247138.
- Rizvi, S. N. H. (1975). *Bangladesh District Gazetteers: Chittagong*. Bangladesh Government Press, Dacca, Bangladesh, 542 pp.
- Royal HaskoningDHV, DEVCON, and IWM (2014), *Feasibility Study of the Urir Char Noakhali Cross Dam*, Final Report
- SDC, (2010). *Disaster Risk Reduction Programme for Bangladesh (2010-2012)*. Swiss Agency for Development and Cooperation, Directorate of Humanitarian Aid and SHA, CH-3003 Bern.
- Shannon, C. E., & Weaver, W. (1949). *The mathematical theory of communication*. University of Illinois Press.
- SRDI. (1997). *Physiography of Bangladesh*. GIS Unit, Soil Resource Development Institute (SRDI), Ministry of Agriculture, Dhaka, Bangladesh.
- Steckler, M.S., Mondal, D.R., Akhter, S.H., Seeber, L., Feng, L., Gale, J., Hill, E.M., and Howe, M. (2016). Locked and loading megathrust linked to active subduction beneath the Indo-Burman Ranges. *Nature Geosci*. 9(8):615–618. doi: 10.1038/ngeo2760.

- Sultana, T., Islam, M.T., Rahman, M.S., Siddique, A.B., Huda, ANMS, and Sarker, S. (2023). Evaluating the long-term geomorphic process in relation to hydrodynamics in the central coastal zone of Bangladesh, *Heliyon*, Volume 9, Issue 6.
- Tabassum, T. and Ansary, M.A. (2020). Strong ground motion in Bangladesh and north-east Indian region from 2005 to 2017 and its prediction of attenuation data during future earthquakes. *Geotech Geol Eng.* 38(6):6011–6029. doi: 10.1007/s10706-020-01410-6.
- Taylor, F.J.R. (1965). *Phytoplankton of the Southwestern Indian Ocean*. Nova Hedmigia, Beth. 12(314):433-476.
- Taylor, F.J.R. (1976). *Dinoflagellates from the International Indian Ocean Expedition*. Bibliotheca Botanica. Struttgart.
- UDD, (2019). Environmental Study of Mirsharai Upazila, Chattogram Sound, Air Pollution (Dust Particles) and Water Quality in Different Locations. Urban Development Directorate, Ministry of Housing and Public Works, Government of the People's Republic of Bangladesh.
- Uddin, A.M. K. (2005). Tsunami: A status paper reflecting Bangladesh coast's exposure and vulnerability, Program Development Office for Integrated Coastal Zone Management Plan. Bangladesh.
- UNDP and FAO. (1988). Land Resources Appraisal of Bangladesh for Agricultural Report No. 2. Agro-Ecological Region of Bangladesh. United Nations Development Program in Food and Agriculture Organization, Pp. 212-221.
- UNDP. (1982). Groundwater Survey: The Hydrogeological Conditions of Bangladesh. UNDP Technical Report DP/UN/BGD-74-009/1.
- Upazila Disaster Management Plan (UDMP). (2014a). Upazila: Mirsharai, District: Chattogram. Developed by Upazila Disaster Management Committee, Mirsharai, Chattogram. Sponsored by Comprehensive Disaster Management Programme (CDMP-II), Ministry of Disaster Management and Relief, Dhaka, Bangladesh.
- Upazila Disaster Management Plan (UDMP). (2014b). Upazila: Sitakunda, District: Chattogram. Developed by Upazila Disaster Management Committee, Sitakunda, Chattogram. Sponsored by Comprehensive Disaster Management Programme (CDMP-II), Ministry of Disaster Management and Relief, Dhaka, Bangladesh.
- USEPA, 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. U.S. Environmental Protection Agency, Washington, D.C. 20460.
- WARPO and BUET (2020). Research on Sediment Distribution and Management in South-West Region of Bangladesh. https://warpo.portal.gov.bd/sites/default/files/files/warpo.portal.gov.bd/page/9b4814df_f835_4b0d_8c60_f2b35e0343b9/2020-09-29-21-48-ec66f5fb5f9a3fccdad5521ec5bcd14.pdf
- World Bank (2010). Economics of adaptation to climate change: Bangladesh. Washington DC.
- Yamaji, I. (1969). Illustrations of the Marine Plankton of Japan. Pp. 337.



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