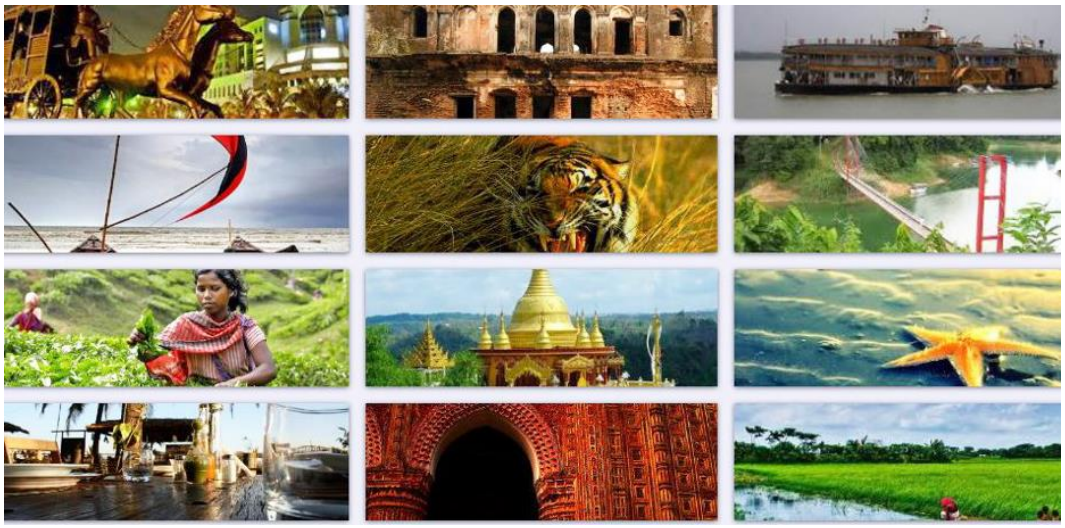
Final Report

Feasibility Study of Sonadia Eco-Tourism Park



Bangladesh Economic Zones Authority

November 2021

DevCon Leading Today for Tomorrow

Mahindra Consulting Engineers

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List of Abbreviation

Abbreviation	Full Form
AADT	Average Annual Daily Traffic
AC	Air Conditioner
ADB	Asian Development Bank
ATM	Automatic Teller Machines
AV	Audio-Video
B_2B	Business to Business
BBS	Bangladesh Bureau of Statistics
BCDA	Bases Conversion and Development Authority
BDT	Bangladeshi Taka
BEPZA	Bangladesh Export Processing Zone Authority (BEPZA)
BEZA	Bangladesh Economic Zones Authority
BHTPA	Bangladesh High-Tech Park Authority
BIDA	Bangladesh Investment Development Authority
BIFFL	Bangladesh Infrastructure Finance Fund Limited
BIWTA	Bangladesh Inland Water Transport Authority
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
BLPA	Bangladesh Land Port Authority
BOI	Board of Investment
BPC	Bangladesh Parjatan Corporation
BR	Bangladesh Railways
BWDB	Bangladesh Water Development Board
B_2B	Business to Business
BBS	Bangladesh Bureau of Statistics
BUA	Built-up area
CAAB	Civil Aviation Authority of Bangladesh
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CPA	Chittagong Port Authority
CPGCBL	Coal Power Generation Company Bangladesh
CV	Curriculum vitae
CCTV	Closed-circuit television
CDM	Clean Development Mechanism
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	Carbon Dioxide
CoxDA	Cox's Bazar Development Authority
CSP	Concentrating solar power
Cum/hr	Cubic Metre per Hour
DevCon	Dev Consultants Limited
DG	Diesel Generator
DI	Ductile Iron
DICT	Department of Communications and Technology
DNA	Deoxyribo Nucleic Acid
DoE	Department of Environment
DoF	Department of Forestry
DPHE	Department of Public Health Engineering
DSS	Decision Support System
DSCR	Debt Service Coverage Ratio
EIRF	Economic Impact Analysis Framework
EIRR	Economic Internal Rate of Return

Abbreviation	Full Form
EMP	Environmental Management Plan
EoDB	Ease of Doing Business
EOI	Expression of Interest
E&S	Environmental and Social
EA	Environmental Assessment
EAN	Enriched Air Nitrox
ECA	Ecologically Critical Area
EDWHC	Employment, Decent Work and Human Capacity
EIA	Environmental Impact Assessment
EIP	Eco-Industrial Park
ELISA	Enzyme-Linked Immunosorbent Assay
ELSR	Elevated Level Storage Reservoir
EMP	Environmental Management Plan
EPC	Engineering, Procurement and Construction
EPIC	Economic Performance, Investment and Competitiveness
ESIA	Environment and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ETA	Environmental Technical Assistance
EPZ	Export Processing Zones
ERR	Economic Rate of Return
EXIM	Export Import
EZs	Economic Zones
FDI	Foreign Direct Investment
ft.	feet
FY	Financial Year
FTIR	Fourier-Transform Infrared
GDP	Gross Domestic Product
GIS	Geographical Information System
GLSR	Ground Level Storage Reservoir
gm	gram
GoB	Government of Bangladesh
GoT	Government of Tourism
GSTC	Global Sustainable Tourism Council
GTKES	Global Tourism & Knowledge-based Economy Summit
GW	Giga Watt
HDPE	High-Density Polyethylene
hr.	hour
HVAC	Heating, Ventilation, and Air Conditioning
ICT	Information and Communications Technology
IDCOL	Infrastructure Development Company Limited
IFC	International Finance Corporation
IIFC	Infrastructure Investment Facilitation Company
IMF	International Monetary Fund
IRR	Internal Rate of Return
IoL	Inventory of Losses
IRC-CoE&IDC	Innovation Research Centre-Centres of Excellence & International Design Centre
IRD	Influence Region Development
ISO	International Standard Organisation
ISPS	Integrated Safeguard Policy Statement
ITDC	Indonesia Tourism Development Corporation
IT	Information Technology

Abbreviation	Full Form
JICA	Japan International Co-operation Agency
kg	Kilogram
Km	Kilometre
KPIs	Key Performance Indicators
kV	kilo-Volt
kVA	kilo Volts Ampere
kW	Kilowatt
LDC	Least Developed Countries
LGED	Local Government Engineering Department
LNG	Liquefied Natural Gas
LST	Local Services Tax
LED	Light Emitting Diode
LEED	Leadership in Effective Energy Design
LPCD	Litres Per Capita per Day
m	metre
M&E	Monitoring & Evaluation
m/s	metre per second
MACE	Mahindra Consulting Engineers Limited
MEP	Mechanical Electrical Plumbing
MFIs	Micro Finance Institutions
MFL	Maximum Flood Level
mg /l	milligram per litre
MICE	Meetings, Incentives, Conferences and Exhibitions
MLD	Millions of Litres Per Day
mm	millimetre
MoUs	Memorandum of Understandings
MP&DP	Master Plan & Development Plan
MSL	Mean Sea Level
mVA	mega-Volt Ampere
MW	Megawatt
NGOs	Non-Governmental Organisations
NBP	National Broadband Pilot Project
NH	National Highway
NHTTI	National Hotel and Tourism Training Institute
NIBT	Net Income Before Tax
NMT	Non-Motorised Transport
O&M	Operation and Maintenance
^{o}C	Degree Celsius
OHT	Overhead Tank
OSs	Operational Safeguards
OPEX	Operational Expenditure
PAPs	Project Affected Persons
PCB	Pollution Control Board
PCU	Passenger Car Units
PGCB	Power Grid Corporation of Bangladesh
PIRR	Project Internal Rate of Return
PPP	Purchasing Power Parity
PRC	People's Republic of China
PwC	PricewaterhouseCoopers
PESTEL	Political, Economic, Social, Technological, Environmental and Legal
PIU	Project Implementation Unit
PPP	Public-Private Partnership

Abbreviation	Full Form
PV	Photovoltaic
R&D	Research & Development
REB	Rural Electrification Board
RHD	Roads and Highways Department
RMG	Readymade Garments
RSMF	Resettlement and Social Management Framework
SASEC	South Asia Sub regional Economic Corridor
SERF	Shadow Exchange Rate Factor
SFB	Standard Factory Building
SPVs	Special Purpose Vehicles
sq.km	Square kilometre
STP	Sewage Treatment Plant
SWM	Solid waste management
SWOT	Strength, Weakness, Opportunities and Threat
SWRF	Shadow Wage Rate Factor
SWRO	Seawater Reverse Osmosis Plants
TAF	Tourist Attraction Facilities
TGS	Tourism Governance and Structure
TIEZA	Tourism Infrastructure and Enterprises Zone Authority
TKZC	Tourism and Knowledge Zone Component
TOAC	Tour Operators Association of Cox's Bazar
TOR	Terms of Reference
TPD	Tonnes Per Day
TS	Transportation Sector
UN	United Nations
UN SDGs	United Nations Sustainable Development Goals
UNIDO	United Nations Industrial Development Organisation
UNWTO	United Nations World Tourism Organisation
USPs	Unique Selling Propositions
USA	United States of America
UNO	Upazila Nirbahi Office
USD	United States Dollar
UV – VIS	Ultraviolet–Visible spectrophotometry
VAT	Value-added Tax
VGF	Viability Gap Funding
W	Watt
WB	World Bank
WHO	World Health Organisation
WTP	Water Treatment Plant
WTTC	World Travel and Tourism Council

1. Executive Summary

Tourism sector has witnessed an innovative model presenting a new perception with development of qualitative trends which include the development of the concept of sustainable tourism, increased market segmentation, development of new forms of tourism, especially those related to nature, ocean wealth, wildlife, rural areas, culture, arts & crafts, heritage, sustainable tourism, eliminating poverty etc. Bangladesh has a vast geographical spread and great historical and cultural heritage, which are excellent conditions for growth in the tourism sector. The Government of Bangladesh (GoB) have placed tourism on a priority platform, making efforts to sustainably explore and utilise the tourism resources and potential offered by the country. The development of the tourism sector and the overall development of tourism destination is Bangladesh's key priority and a strategic objective for the diversification of the Bangladesh economy. The GoB's objective is to maximise the potential direct and indirect impacts through a more modern regime of Economic Zones (EZs) including Tourism SEZ.

GoB set up Bangladesh Economic Zones Authority (BEZA) as the nodal agency and regulator of EZ development within the country. BEZA has set forth an ambitious target of developing 100 EZs in the coming 15 years spread across various locations of Bangladesh. As part of this endeavour, BEZA intend to undertake pre-feasibility studies of two economic zone at Barisal and Moheshkhali. BEZA engaged a consortium of Dev Consultants Limited (DevCon), Bangladesh and Mahindra Consulting Engineers Limited (MACE), belonging to US$ 21 billion Mahindra Group, India as consultants through a transparent bidding process.

This report captures pre-feasibility assessment of economic zone located at Sonadia in Moheshkhali. Since the area surrounding the proposed EZ in Sonadia falls under ecologically sensitive area, manufacturing based development is not a good fit for this proposed EZ and this proposed EZ is fit for an eco-tourism-based development.

The proposed EZ is spread over an area of 8,967 acres and it is located in Moheshkhali Upazila, Cox's Bazar district. Proposed EZ is located at the northwestern part of the Cox's Bazar district and is surrounded by Chakaria and Kutubdia upazila in the north.

Economy of Cox's Bazar district is primarily dependent on tourism. Besides involvement in the primary sectors, local populace is also involved in tourism related activities. Cox's Bazar is famous for accommodating the longest continuous sea beach in the world admeasuring 111 km in length. This area is also the home of many tourist destinations including the much-visited St. Martin's Island. Tourism in Cox's Bazar has become a significant part of the local economy. This district is known as the tourist capital of the country. Millions of foreigners and natives visit this coastal city every year. Therefore, a number of hotels, guesthouses and motels have been built to accommodate the influx of tourists.

Multi-modal connectivity of site in light of existing and propose infrastructure is explained below:

Road connectivity: The proposed EZ has an approach road of width ~10 feet, which runs along the Kutubjom Union and connects with Janatabaza - Gorakhghata road (Z1004) in Moheshkhali upazila. The proposed EZ is further connected to Chittagong via Dhaka Chittagong National Highway (N1), zila road Z1004 connects the site with the Chakaria Badarkhali Road R172 which further connects to N1 and the travel time is 5 hours covering an estimated distance of approximately 127 km.

Rail connectivity: There is no prevailing rail network in Cox's Bazar District. The nearest existing railway station is Chittagong railway station, which can be accessed by Patiya-Anowara-Banshkhali-Toitong-Pekua-Badarkhali-Chokoria (Eidmoni) highway (R170) or Dhaka –Chittagong - Teknaf highway (N1). Travel time from the proposed EZ to Chittagong rail station (by road) is around 4.5 hours and distance is approximately 120 km.

However, a railway network is proposed in Cox's Bazar, which is 8 km via waterway & 10 km via roadway from the site. The railway line originates from Dohazari in North of Chittagong division, and runs towards south to reach Cox's Bazar district.

Air Connectivity: The proposed EZ is located at a distance of approximately 110 km from Cox's Bazar airport and can be accessed via Janatabaza – Gorakhghata road (Z1004) and Dhaka – Chittagong highway (N1). It can be also accessed through the waterway which cuts down the distance to 9 km from the site.

River Port: Moheshkhali - Cox's Bazar boat line connects the Moheshkhali-Gorokghata ghat with Kastura ghat. This Island is located at a distance of 7.5 km from Kastura ghat and 8 km from Moheshkhali- Gorokghata ghat. Jetty facilities are available at these Ghats.

Sea Port Connectivity: Chittagong Sea port is the nearest port to the project EZ at a distance of 124 km.

Site assessment indicates that proposed EZ has access to power from the Kiranthuli sub-station but during summers the demand surges above capacity resulting in frequent power cuts which will be prevented in the future with advent of the Matarbari power plant and a proposed wind power station at Kurushkul.

The site has over 43% of its land under mangrove vegetation cover and is home to various endangered species of animals such as olive ridley turtles, migratory birds, rare crabs etc. Apart from these, it has an exquisite collection of flora and fauna which imparts a unique and ecologically sensitive nature to the area.

Based on the above assessment and the fact that the presence of rich biodiversity features and the proximity to Cox's Bazar and other notable places of attractions in the region, the proposed EZ is found to be more appropriate for the development of an Eco-Tourism zone rather than a manufacturing based economic zone.

In order to compare the proposed EZ with similar developments across similar economies and geographies in Asia, the site has been benchmarked against tourism based economic zones from Indonesia, Phillipines and Bangladesh. Benchmarking exercise brings out the fact that the tourism based EZ at Sonadia is competitive with respect to factors such as Hospitality and food service, availability of manpower at low cost in Bangladesh. This will help attracting tourists from countries with a burgeoning middle class. Low cost of air travel from countries such as India and China will help in attracting greater number of price sensitive tourists (especially from the neighboring countries). Apart from these, already in place economic zone policy which offer incentive to investors will bring in capital to develop facilities for tourism based economic zone development. Offering resident visa and citizenship at lower investment value as compared to its competitors will attract a greater number of foreign investors.

In order to identify the key interventions that needs to be addressed in terms of tourism related developments, a market assessment exercise was also performed. The market assessment exercise

was primarily performed in two approaches i.e., top down and bottom up. The top-down approach took into consideration a holistic assessment of the travel and tourism sector in the country context and brings out the key actions agendas for Government and key stakeholders. Trends of travel and tourism sector have been analyzed to understand the key interventions required to boost up this sector in Bangladesh. Further, this assessment converged to site and region specific attributes and analyze the key improvements solicited. The bottom-up approach comprised of primary survey among domestic and foreign tourists and other key stakeholders (such as Govt. officials, hotels and hospitality sector professionals) to understand the market impression of Sonadia as a prospective location for tourism-based development.

The market assessment exercise helped to identify some key areas which should attract the policy maker's attention; areas such as impetus on robust policy frame working for tourism, aggressive PR and promotional strategy, addressing of security issues, stress on improving transport and utility infrastructure, focus on skill development and including automation in tourism industry. The bottom-up approach which included the primary survey of 45 Bangladeshi nationals and 10 foreign nationals also provided some insights on what the domestic and international tourists want to witness in the proposed tourism-based EZ. According to the survey results, respondents were interested in visiting places with wildlife, sanctuaries, and natural resources (flora and fauna) and recreational facilities in the sea beach (such as water sports, eateries). The respondents showed inclination towards having good quality resorts and eco-huts (upscale), four/ five-star hotels, as well as affordable segment hotels in terms of accommodation in tourist destinations and showed concerns regarding security and support infrastructure in the existing tourism destinations in the country. The market assessment exercise also highlighted where the proposed EZ stands in terms of the 5 A's of tourism i.e. Accessibility, Attraction, Amenities, Accommodation and Activities.

Based on the above exercise and the competition benchmarking, the following tourism product mix was ascertained for the site. It includes seven zones with micro components for each explained in the chapter concerning the same:

Entrance Zone

Adventure Zone

Adventure Zone

Eco-science Zone

Heritage Zone

Family & Entertainment Zone

Hospitality Zone

It was understood that important aspects of commercial and economic feasibility of the eco-tourism zone are dependent upon land allocation assessment and tourist footfall forecasting exercise wherein the allocation of land to be used for developing accommodation facilities and tourism related facilities and projections of tourist footfall in the area are to be ascertained in order to validate the business case of the proposed eco-tourism zone. This provided a comparative scenario of tourist footfall v/s land allocated for the tourism product mix ascertained for the zone and aid in decision making for the feasibility of the proposed eco-tourism zone.

The methodology adopted for forecasting tourist footfall at the proposed eco-tourism zone includes an associative forecasting method. Tourist footfalls both domestic and international in the influence region have been forecasted to arrive at future anticipated footfall in the region based on available data and informed assumptions. In absence of any precedence of development of similar kinds in Bangladesh context, the land allocation patterns for the identified product mix has been ascertained through benchmarking the subject components planned for the EZ with similar tourism components across the continent and the country. The impact of COVID 19 and ensuing lockdown protocols all over the world has had an adverse effect on tourism. The effect of the same has been assessed in case of footfall projection.

Conservative case assumes economic conditions of Bangladesh and the region are not showing steady trend and behaving lower than expected; because of the same, macro-economic indicators are not showing good prospect which is leading to slower increase in disposable income for the domestic population. Base case assumes economic conditions of Bangladesh and the region are showing steady trend and behaving as expected; because of the same, macro-economic indicators are showing good prospect which is leading to an increase in disposable income for the domestic population. Optimistic case assumes economic conditions of Bangladesh and the region are showing an increasing trend and behaving in better than expected; because of the same, macro-economic indicators are showing steadier prospect which is leading to a considerable increase in disposable income for the domestic population; and potential infrastructure projects planned for the subject region are commencing before schedule resulting in faster and easier access to the region which in turn is leading to a further increase in domestic and international traffic in the region.

Demand projection outlines that in Base case 0.50 million tourists would be visiting the proposed EZ annually in the 10th year mark from its operational commencement year and 3.27 million would be visiting in 2050, which is the 30th year mark. The CAGR for the same scenario is 10.00% between 2020 and 2050

For purpose of demand forecasting, it has been assumed that since Sonadia is in close proximity to Cox's Bazar which is one of the most popular tourist destinations in Bangladesh, it will be spin-off tourist destination and would mostly be visited by tourist staying over in Cox's Bazar as a day time destination. Moreover, this also makes it obvious that few would be availing accommodation facilities at the site.

Keeping the above in mind and in order to preserve the ecological aspect of the Sonadia Island, most of the available space in the site is kept open and only a portion of it is considered for developing the tourism product mix identified for the site. The land allocation for the same has been determined by benchmarking the determined tourism components in similar zones Vis a Vis the site. Since it is difficult to ascertain land space for some of the components identified for the site such as the Eco-science Zone (which will be dependent on the behaviour of the different species that are available in the island), Water Sports area (which will be mostly water-based activities and land allocation for the same will be lesser) and similar areas, we have allocated land usage area for the following components:

Water based Amusement park: 10 – 30 acres (for Base scenario - 20 acres)

Premium Resort with Spa and Conference Room: 45 - 50 acres (for Base scenario – 47.5 acres)

Budget Hotels (4 in no.): 0.5 - 1 acre (for Base scenario – 0.75 acres)

Residential villas: 5 - 10 acres (for Base scenario – 7.5 acres)

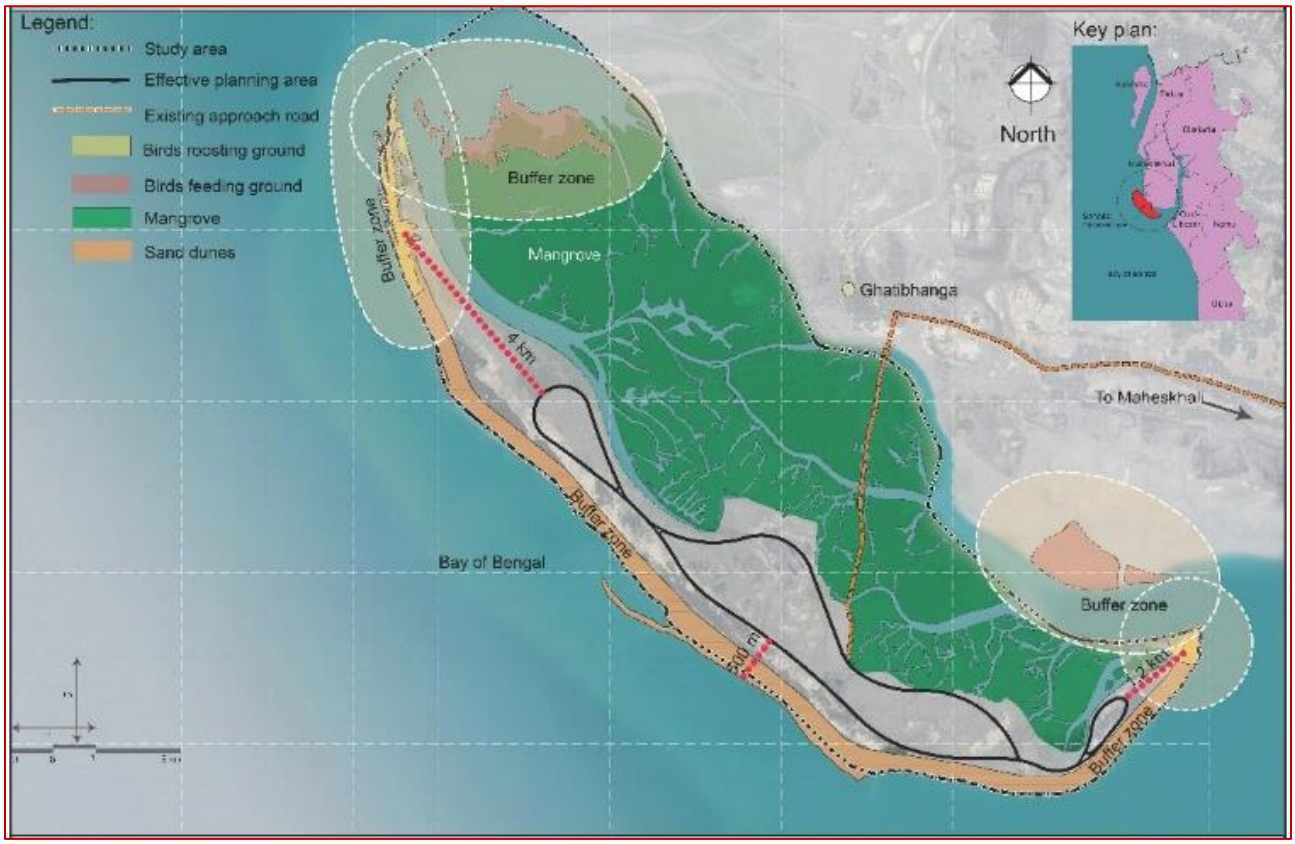
Convention Center: 12 – 15 acres (for Base scenario – 13.5 acres)

Heritage Zone: 45 – 50 acres (for Base scenario – 47.5 acres)

Sustainable eco-tourism, through Sonadia Eco-Tourism Park (SE-TP) initiative, is a vehicle to foster economic and social growth of Bangladesh, through the achievement of the development imperatives, while minimising negative social, cultural and environmental impacts. The SE-TP is a self-contained region with a salubrious surrounding and will eventually emerge as a "Sustainable-holistic-smart-intelligent-Eco-Tourism zone". The study provides the structure of SE-TP master plan, objectives of the master plan and planning framework, planning considerations, zones spotting, land use pattern and space allocation, development plan, phased development etc. The existing eco-sensitive areas such as birds roosting and feeding ground, turtle's hatcheries & nesting area, red crabs crawling area along seashore, mangroves and water channels have been retained, and these areas are excluded from the overall development plan. Adequate buffer is provided from the shoreline along the coast for protecting turtles & red crabs and also for birds roosting and feeding ground.

From the overall study area of 8967 acres, effective planning area of 909.4 acres has been delineated based on outcomes from analysis of existing features, identified issues and constraints. Exhibit No. 6 depicts delineated effective planning area.

Exhibit No. 1: The delineated effective planning area for SE-TP



Source: MACE analysis

Based on the demand assessment, benchmarking analysis of international comparisons, primary survey etc. a detailed master plan is prepared to have an optimum mix of tourist attraction facilities (TAF) and other tourism-related facilities while ensuring the principles of sustainable eco-tourism. The planning of installations of allocated Tourism and Knowledge Zone Component (TKZC) shall be the responsibility of the respective private companies/ occupant units. However, such planning shall adhere to overall regulations and stipulations laid by SE-TP development authority. A structured process is adopted for evaluating the themes and attractions based on adherence to a set of compliance criteria and its responsiveness, as it is pertinent that the themes and attractions fulfil the tenets of sustainable eco-tourism and promotion of knowledge-based green economy. Sustainability and eco-restoration occupy the centre stage of the entire development and operation cycle.

The proposed zones include Entrance zone, Heritage & hospitality zone, Knowledge centre zone, Family entertainment zone, Adventure zone, and Eco-science zone. The proposed zones have been spatially distributed within the proposed SE-TP based on various considerations, as depicted in Exhibit No. 7.

Exhibit No. 2: Zoning plan of SE-TP

Source: MACE analysis

Various sustainable eco-tourism elements, sustainability initiatives, biomimicry and circular economy principles have also been incorporated into the planning process to position the development on a sustainable path.

Provision of infrastructure and facilities is crucial for the sustained development and operation of SE-TP. The study dwells on SE-TP common infrastructure facilities:

General infrastructure covering boundary wall and fencing; roads; non-motorised transport (NMT); bicycle movement; and pedestrian walkways; non-vehicle streets; smart parking; security and surveillance; robust IT connectivity and digitalisation; specific features for differently-abled;

Social infrastructure covering training centre, incubation centre; commercial infrastructure zone; utility and support infrastructure zone; innovative use of open space and visible improvement;

Environmental and green infrastructure covering water treatment; adequate water supply including wastewater recycling and stormwater reuse; drainage; rainwater harvesting; sewerage network; sewage treatment and wastewater recycling infrastructure; sanitation including solid waste management (SWM); composting and environment/pollution abatement structures; assured electricity supply; renewable energy; waste to energy; site energy utilisation; energy-efficient street lighting; and

Specialised tourism infrastructure.

These infrastructure facilities are grouped under major heads like general infrastructure, multi-facility complex, entertainment and social facilities, health areas, parks and sports zone, transportation system, signage's, green infrastructure, specific and specialised infrastructure etc. For the sustained business operation of SE-TP, it is pertinent that off-site infrastructure and SE-TP connectivity are adequately addressed.

The total investment in SE-TP, works out to Taka 16948.61 million and out of which Taka 10230.04 million (60%) will be from the private sector through PPP mode or other variants. Table No. 1 depicts a summary of SE-TP total investment and mode of development.

Table No. 1: Summary of SE-TP total investment and mode of development

Sl No.	Component	Mode of development (Taka in million)		
		SE-TP:PIU	Third-party - Government	TKZC:SPV
1	Sonadia Island tourism facilitation development	4440.52		
2	Entrance zone	163.17		
3	Heritage and hospitality zone	58.48		1963.81
4	Knowledge centre zone			862.77
5	Family entertainment zone	3.68		202.54
6	Adventure zone			353.82
7	Eco-science zone	103.71		6847.11

8	Amenity buildings	263.11		
9	Utility structures	1138.07		
10	Connectivity & external infrastructure		547.82	
	Total	6170.74 funding through GoB /BEZA and implemented through SE-TP:PIU	547.82 funded through GoB and implemented by third-party respective Government agencies	10230.04 investment by PPP or private sector
	Total project cost	16948.61		

Source: MACE analysis

In the SE-TP context, a suitable balance must be established between the three dimensions of sustainability to guarantee its long-term sustenance of SE-TP. The poverty reduction, social inclusion and creation of large-scale local employment aspect should include measures to prevent or minimise the potential negative social impacts of SE-TP. The study provides the environmental and social (E&S) assessment, the methodology of E&S review, an overview of environmental, legal, regulatory and policy requirements, baseline data, conservative measures, impact assessment, mitigation measures based on the studies and inferences drawn at feasibility level of investigation. Considering the sensitivity of the proposed site, it can be said that overall the impacts from pre-construction, construction and operation phase will have quite detrimental impacts to the surrounding environment. Many of the impacts are possibly irremediable in nature and can't be replenished, and the proposed site is quite rich from an ecological point of view. Hence, a thorough Environment and Social Impact Assessment (ESIA) and Environment and Social Management Plan (ESMP) study needs to be conducted. The study also gives a brief of the requirements for conducting the ESIA and ESMP. The objective of the ESMP is to develop procedures and plans to ensure that the mitigation measures for identified impacts are implemented throughout the project phases. Also, ESMP needs to ensure the effective long-term protection of the area and other biotic and abiotic components of the environment. The study also provides the generalised guidelines for E&S safeguard activities for SE-TP development and operations.

Taking into consideration the cost of developing the EZ and expected revenue that would be generated from the proposed EZ a financial model has been developed in order to assess the feasibility of developing this EZ. In order to do so, two cases were analyzed, Case 1 where BEZA plays the role of developer of the project and Case 2 where BEZA assigns a PPP developer to develop the project.

Analysis of Case 1 indicates that the project generates healthy returns for BEZA in the Base scenario, with Project IRR of ~15.0% when BEZA is assisted by multilaterals and respective government nodal agencies to develop off-site and on-site infrastructure for the project. This indicates the financial criticality of the project. However, with BEZA objective of socio-economic upliftment of the southern parts of Bangladesh, which has not witnessed significant development compared to more developed

regions of the country, BEZA could opt for developing the project with assistance through concessional borrowings.

Case 2, which analyses the returns for the PPP developer assigned by BEZA, depicts similar results. When the PPP developer is refrained from making pay-outs to BEZA, the project accrues attractive returns with a Project IRR of ~16.0% and an Equity IRR of ~16.5%. This however deteriorates when we analyze the various pay-out options. The most viable pay-out option of upfront fees (BDT 300 million), annual land lease of BDT 9 per sq. ft. per annum together with a revenue share of 3% also generates an attractive project IRR of ~12.0% for the developer. But a combination of financial support mechanisms of VGF and annuity, the returns could further improve the project returns.

Thus, if BEZA decides to embark on the project as a developer, it would realize healthy returns from it when off-site and onsite infrastructure related cost is borne with assistance from multilaterals such as the World Bank and concerned nodal agencies of Bangladesh. The returns will improve further if BEZA avails concessional borrowing (in higher proportion than commercial borrowing) for funding the project. In case of a PPP developer, an exception of pay-outs to BEZA by the private player presents the best-case scenario for the project.

In addition to the financial modelling, an economic modelling exercise has also been undertaken to evaluate the economic benefits accrued from this project. Financial analysis (or Financial IRR) estimates the return accruing to the project operating entity (EZ developer), whereas Economic Internal Rate of Return (EIRR) estimates the return on the investment to the national economy. Economic analysis is essential to develop a rationale for Government of Bangladesh to support the development of the proposed EZ and illustrates the measure of the accrued economic benefits. A good EIRR would also assist the private developer in making a good case to be able to avail concessional loans and financial support.

Three scenarios have been considered for the purpose of EIRR calculation viz. conservative, base, and aggressive. Details of these scenarios are outlined in the demand forecasting exercise. Base case Economic Internal Rate of Return (EIRR) has been calculated as 29.1%, which indicates that the project is attractive and would provide good returns. In conservative case, the project generates 24.0% economic return which is good. Aggressive scenario indicates that the economic return of the project is 33.9%, which is highly attractive in nature.

Based on the area, location attributes, stage of development, macroeconomic parameters, and subscription tariffs a bench-marking exercise has been undertaken with the intention of assessing the competitiveness of the proposed economic zone vis-a-vis other similar developments in the region or emerging economies.

The benchmarking exercise has assessed various parameters such as commercial terms, infrastructure availability, labour cost, accessibility, etc. for similar developments. This analysis not only provides the relative competitiveness of the proposed economic zone but also synthesises the key learnings from each of these zones. For the purpose of benchmarking of the proposed EZ with other competitors at the same development stage, a total of 6 economic zones/ tourism parks have been shortlisted at local, regional, and global levels. These 6 economic zones/ tourism parks are spread across countries such as Indonesia, Philippines, Thailand and Malaysia. Out of these 6, 4 are economic zones as per designation and they are compared with our subject EZ.

Benchmarking exercise highlights the fact that the proposed EZ at Sonadia, Cox's Bazaar is competitive with respect to the benchmarked zones in terms of land lease rental, power tariff, and labour cost. Moreover, provision of facilities such as Water Treatment Plant and Sewage Treatment Plant within the stipulated area of the proposed zone also keeps it at par with the competing zones as most of these zones entail such facilities. Incentives offered by the GoB for investors in Bangladesh are also competitive as compared to most of the competing zones which may again prove to be advantageous for the proposed EZ. On the other hand, higher land lease premiums and utility tariff as compared to the competing zones may act as a catalyst in augmenting the project profitability as some of the benchmarked zones show such trend compared to the proposed EZ, which calls for re-evaluation. Moreover, lack of ready-made social infrastructure in proximity to EZ could act as a hindrance to attract skilled human resources especially the expatriates. However, as stated in the Master Planning section, a land parcel has been earmarked for developing support amenities which can be used to establish vocational training centre, retail outlets and creche facility within the proposed EZ.

2. Introduction

The objective of this chapter is to establish the background and the necessity of the economic zone regime in Bangladesh. Further, the chapter delves deeper to lay out the project timelines, team deployed and a brief description of the proposed EZ location and the existing transport and utility infrastructure prevalent at the site.

2.1. Emergence of Economic Zones in Bangladesh Context

Over the last few decades, Asian economies have been witnessing robust growth and gradually shaping up as the engines of economic activity. South Asian nations such as Vietnam, Thailand, Indonesia and Malaysia have been creating their place in the global map by various proponents of economic proliferation such as easing up FDI rules, increased ease of doing business, and creating specialized industrial corridors and manufacturing parks. Bangladesh has also demonstrated steady growth in the past. With constant price Gross Domestic Product (GDP) growth rate ranging over 6% in the last decade, the country has graduated from Least Developed Country (LDC) status. Bangladesh is gradually progressing to achieve middle-income economy status by 2021 and developed nation status by 2041. With the vison of improving the economy of the country and generating livelihood for the burgeoning populace, Government of Bangladesh (GoB) has also ushered in the era of organized industrialization by following the footsteps of other South Asian economies.

GoB has laid down an aggressive plan to boost the competitiveness of the nation with respect to other economies in the region through organized industrialization. The journey of this reform commenced with the regime of export processing zones (EPZs) – an institutional change in the approach to organized manufacturing. Advent of EPZ regime coupled with the cost-friendly pool of human resources positioned Bangladesh in the global map as the hub of readymade garments (RMG). EPZ regime also fostered foreign investment in the country especially in textile and RMG sector.

With time, the government decided to move from the typical EPZ regime and envisioned setting up economic zones (EZ) instead. The motive behind this shift was the inclusive nature of EZs that would promote inclusion of local supply chains and domestic manufacturers, thus enabling a deeper rooted and inclusive growth for the economy in general.

GoB set up Bangladesh Economic Zones Authority (BEZA) as the nodal agency and regulator of EZ development within the country. BEZA has set forth an ambitious target of developing 100 EZs in the coming 15 years spread across various locations of Bangladesh.

2.2. Background of the Project

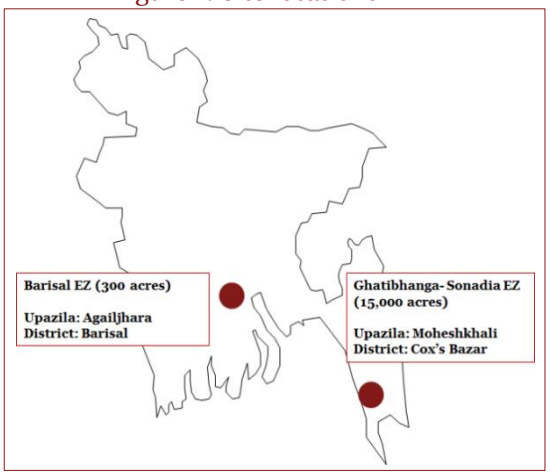
In line with this aspiring growth agenda, BEZA has envisaged development of two prospective locations as economic zones.

- Barisal (Agailjhara) spread over 328.51 acres
- Moheshkhali SEZ (Ghatibanga – Sonadia) spread over 15,000 acres

BEZA has engaged the Joint Venture (JV) of DevConsultants Limited, Bangladesh (DevCon) and Mahindra Consulting Engineers Limited, India (MACE) in association with PricewaterhouseCoopers Private Limited (PwC) to undertake feasibility study of these proposed EZs.

In the inception meeting dated 25th April, it was concluded that since the exact demarcation of Ghatibanga EZ is not available the consultants shall undertake feasibility study of Sonadia Eco-Tourism Park instead. Further, BEZA shall explore the possibility for feasibility study of Ghatibanga EZ as an enhancement to the existing contract.

Figure 1: Site locations



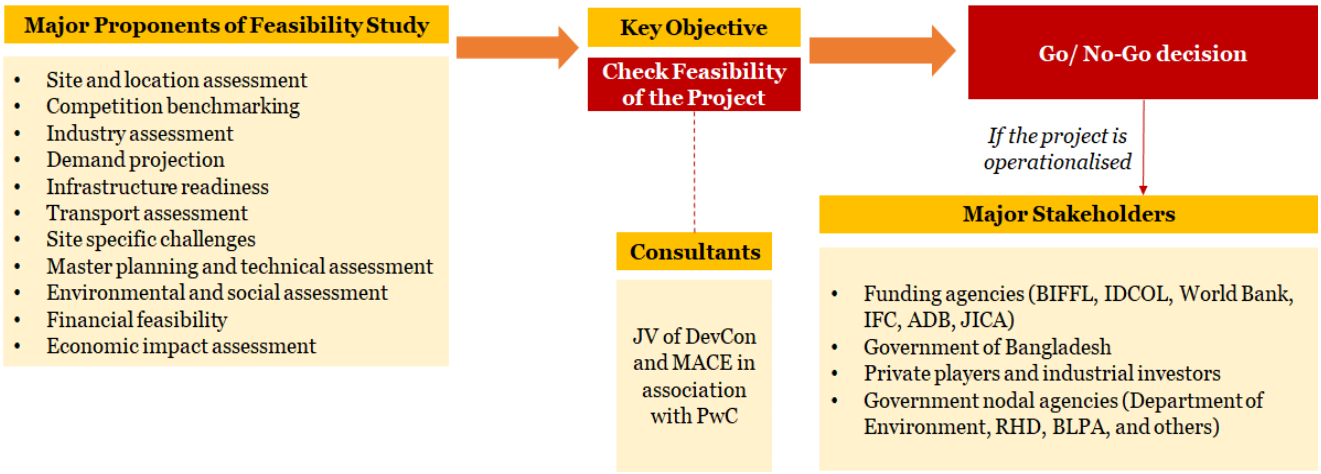
Source: PwC Analysis

This report captures the feasibility assessment of proposed EZ at Moheshkhali (Sonadia Eco-Tourism Park)

2.3. Objectives of the Project

BEZA has identified the proposed EZ at Sonadia for setting up of tourism based economic zone. There is a need of critically examining this site on various techno-commercial parameters to assess the feasibility of establishing tourism based economic zones. The plan of setting up the infrastructure for tourism support involves considerable amount of capex and interplay of various stakeholders from the private and public domains.

Figure 2: Key objective of the project



Source: PwC Methodology

Feasibility analysis of the proposed project would essentially encompass a holistic assessment of this proposed EZ from a tourism attractiveness perspective, commercial diligence, infrastructure readiness, site intrinsic challenges, master planning, environmental and social review aspects, cost implications, and the financial/ economic impact assessment. This analysis would help BEZA to take a go/no-go decision on operationalizing these two proposed EZs. Findings from this study shall also help BEZA in coordinating with the funding agencies, private players and various nodal agencies (such as but not limited to the transport and utility departments) in Bangladesh while operationalizing this proposed EZ.

2.4. Overview of the Team of Experts

In consideration of the deliverables required during the course of this engagement, the JV of DevCon and MACE in association with PwC has formed a team of experts with ***significant experience in the required areas of focus***. Through cross-sectoral experience in handling projects of various types, our experts are well versed in the areas where expertise is required for this engagement: ***Feasibility Studies, Industry/ Market Assessment, Demand Forecasting, Competition Benchmarking, Master Planning, Infrastructure Planning, Project Costing, Financial & Economic modelling, and Environment and Social Review***.

Our team of experts are duly supported by a large team of non-key experts (i.e. support staffs) spread across different locations in India and in Bangladesh. Some of the non-key experts are placed on-ground to ensure smooth project coordination.

The multi-disciplinary team has been formulated comprising of professionals drawn from various disciplines as listed below.

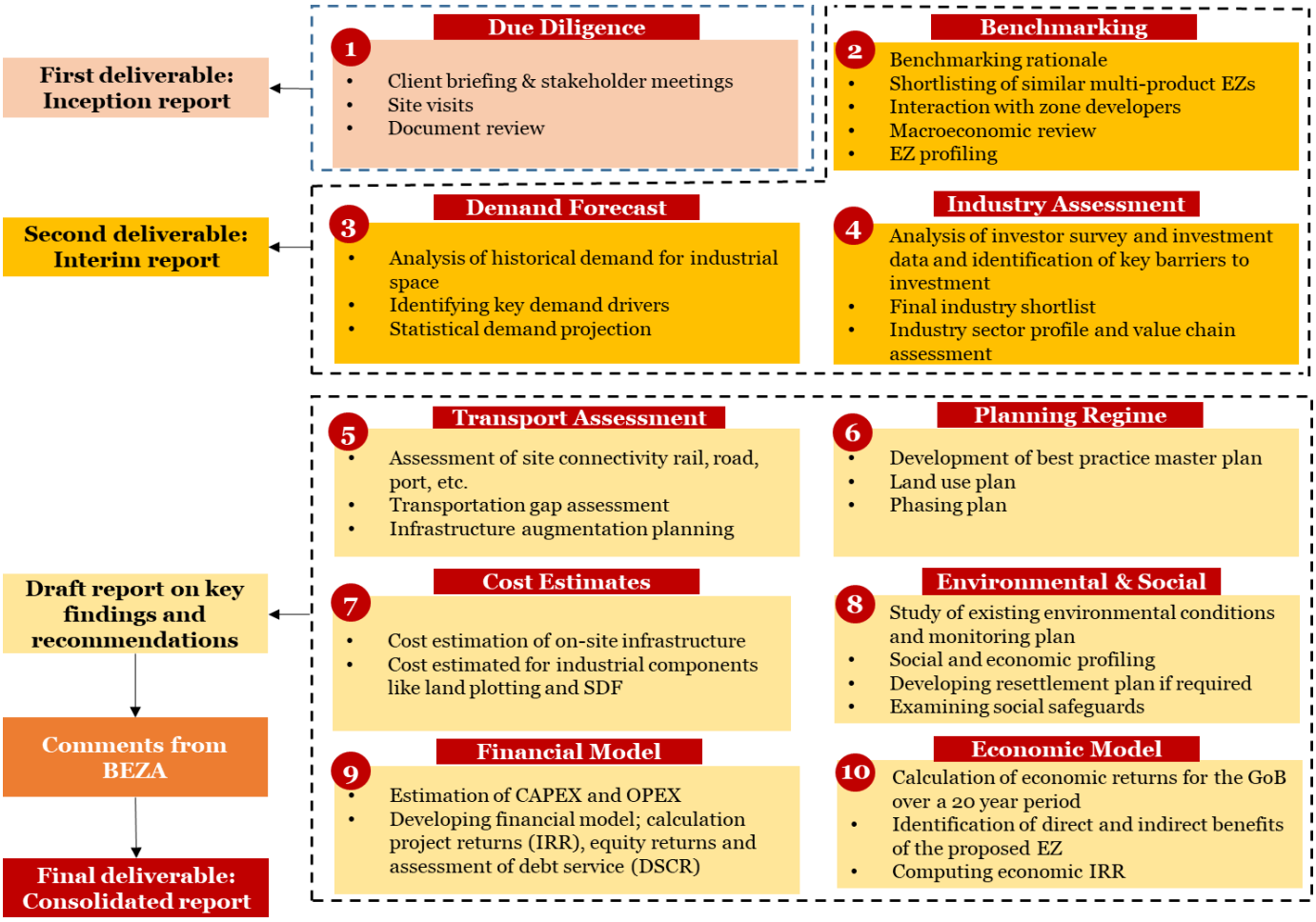
- Team leader
- Ecotourism expert
- Infrastructure expert (Civil)
- Infrastructure expert (Mechanical)
- Infrastructure expert (Electrical)

- Infrastructure expert (Structural)
- Architect
- Civil Engineer
- Mechanical Engineer
- Electrical Engineer
- GIS experts
- 3D model maker
- Tourism facility planner (Urban planner)
- Transport planner
- Social expert
- Environmental expert
- Economist

2.5. Outline of the ToR for this Project

Following figure captures the brief outline of the ToR for this project in line with the contract agreement executed between DevCon and BEZA dated 27 February 2019

Figure 3: Brief outline of the ToR



Source: Contract agreement executed between DevCon and BEZA dated 27 February 2019

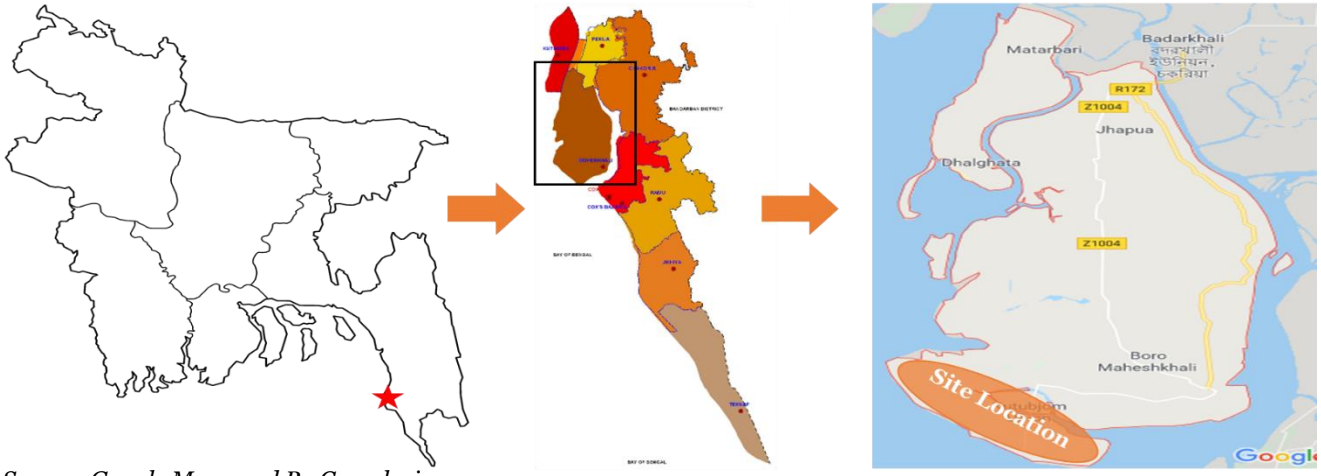
2.7. Description of the Site Location

The proposed ecotourism zone in Sonadia spreads over 8,967 acres is located in the Moheshkhali upazila of Cox's Bazar District in Chittagong Division. Cox's Bazar is district is located at the southeastern part of Bangladesh in the coast of Bay of Bengal and the longest sea beach of the world belongs to Cox's Bazar (111km).[1] Cox's Bazar district has eight upazila and the proposed EZ is located at the Sonadia Island of Moheshkhali upazila, which spreads in the north-west region of Cox's Bazar District. Other districts bordering Cox's Bazar are:

- North: Chittagong District
- South: Bay of Bengal
- East: Bandarban district and Myanmar
- West: Bay of Bengal

As per census data, Cox's Bazar district has a population of 2.289 million (in 2011). Linear projection techniques indicate that in 201 9, population of Cox's Bazar district would be 2.565 million (as per the trend since 1981). Population of Moheshkhali upazila was 321,218 (in 2011) and linear projection technique indicates that this population figure could reach 360,000 (as per the trend since 1981) by 2019.[2] Cox's Bazar is the major city in this district and the heart of all administrative and commercial activities. Proposed EZ is located at a distance of 22 km from Cox's Bazar district.

Figure 4: (Map) Site location (Cox's Bazar division) > Cox's Bazar District > Moheshkhali Upazila



Source: Google Maps and PwC analysis

The region experiences a moderate climate throughout the year with temperature ranging from 39.5°C in summer and 11.8°C during winter.[3] The moderate and pleasant temperature attract tourist from different parts of the world to enjoy the beauty of its sea beaches.

2.7.1. Cox's Bazar District: Tourism Potential Assessment

Cox's Bazar is famous for accommodating the longest continuous sea beach in the world admeasuring 111 km in length. This area is also the home of many tourist destinations including the much-visited St. Martin's Island. Tourism in Cox's Bazar has become a significant part of the local economy.

This district is known as the tourist capital of the country. Millions of foreigners and natives visit this coastal city every year. Therefore, a number of hotels, guesthouses and motels have been built to accommodate the influx of tourists.

[1] *Cox's Bazar district website*
[2] *Cox's Bazar district statistics 2011 & PwC analysis*
[3] *Cox's Bazar district website*

This rapid expansion of hotels and restaurants generates employment directly through various kinds of vendors, tourist guides, souvenir sales, entertaining activities and indirectly through supply of goods and services related to the tourism-based businesses.

Apart from being associated with tourism related occupations, other primary means of livelihood for the local people is mainly fishing and agriculture. Local populace is also involved in seafood and sea product businesses. According to Cox's Bazar District Statistics 2011, 23% of the total land area in this district is used for cultivation.

Major populace of the district is concentrated around the upazila of Chakaria, Cox's Bazar Sadar, Moheshkhali, Ramu and Teknaf. The upazila of Moheshkhali has a population of 321,218 (as of 2011) and contributed to about 14% of the total population in the district. The district has an overall literacy rate of 39.3% (as of 2011 census).[4] This point to the fact there is a dearth of skilled human resources in the district for skill based employment opportunities. Among the upazilas with a higher literacy rate than the district's average are Chakaria and Cox's Bazar Sadar. Most of the educated youth migrate to the cities of Chittagong and Dhaka for employment which may be somewhat curbed with the development of the proposed Tourism based EZ at Sonadia.

Major tourist attractions within the district include:

(i) Cox's Bazar beach: within the Cox's Bazar

(ii) Saint Martin island: 95 km from Cox's Bazar

(iii) Inani beach: 22 km from Cox's Bazar

(iv) Himachori beach and waterfall: 12 km from Cox's Bazar

(v) Moheshkhali island: 82 km from Cox's Bazar

Apart from these, there are numerous Buddhist monasteries, Temples and other places of interest, which attract tourists in the district. According to the government website of the district, this district has 59 private and 9 government operated accommodation facilities and there are about 20 tourist bus services (AC & Non-AC) that operate within the district.[5]

Being adjacent to the coast, Sonadia Island offers tourists access to some of the most serene beaches of Bangladesh. The island also offers the scenic beauty of raw nature with mangrove forest. The mangroves present a natural aesthetic value to the area and availability of small water channels makes navigation through the mangrove vegetation convenient and provide a scenic perspective to the area. Apart from that, the island is home to a large variety of migratory birds and it is a breeding ground for turtles, which make more attractive from the tourism perspective. Thus, it provides an opportunity to be developed into an attractive ecotourism destination by leveraging the already robust tourism potential of Cox's Bazar. Apart from tourism, fishing is the main livelihood in the island. Many people are also involved in salt production. Despite having an incredible mixture of forest and sea, the island does not count among the most popular tourist spots in the country. Hence, an eco-tourism park will not only contribute in providing a safe, secure and enjoyable environment for the tourists (currently due to connectivity issues from Cox's Bazar, tourists visiting Sonadia generally make it a same day trip returning to Cox's Bazar the same night), but also in the overall socio-economic upliftment of Sonadia area.

2.7.2. Site Surrounding Features

The proposed Eco-tourism Park is located in the northwestern part of Cox's Bazar district and almost 6 km far from Moheshkhali Township by waterways. Proposed EZ earmarked for ecotourism Park spans an area of 8,967 acres in Sonadia Island.

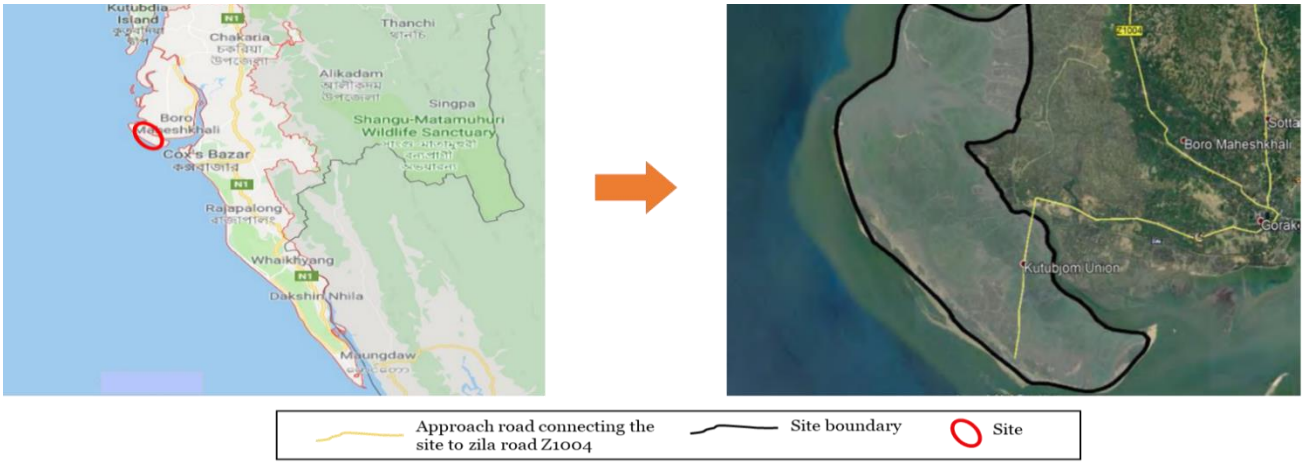
The following Upazilas are surrounded by the proposed EZ.

- Northeast: Chakaria Upazila
- Southeast: Cox's Bazar Sadar Upazila

[4] *Cox's Bazar district statistics 2011*
[5] *Cox's Bazar district website*

- Southwest: Bay of Bengal
- Northwest: Kutubdia Upazila

Figure 5: (Map) Cox's Bazar district > Site boundary and surrounding features



Source: Google Maps and PwC analysis

One of the key features of the site in terms of tourism is its proximity to the beach of Cox's Bazar and the Moheshkhali Island. It takes about 40 minutes from Cox's Bazar city to reach Sonadia Island via 6 no. fishing ghat. Cox's Bazar beach is approximately 10 km (aerial distance) away from Sonadia Island. However, there is no direct mode of transport from the beach to Sonadia due to the absence of a jetty service in the beach. Sonadia Island covers an area of 10,300 hectares including coastal and mangrove plantation, salt production fields, shrimps culture firms, and plain, agriculture land, human settlement etc. This Island is separated from the mainland by the Moheshkhali channel and a Bara canal separates it from the Moheshkhali Island. This entire island is characterized by mild temperature and high humidity. The soil of the area is the mixture of sand and clay. Multiple canals crisscross this island; these canals are the primary sources of aquaculture for the local fisherman community.

2.7.3. Reconfirmation of Site Location

Basis site visit, site location and site demarcation details have been reconfirmed.

Table 1: Site description and reconfirmation of site location

Parameters	Details
Site co-ordinates	2374924.377 N- 2386338.522 N & 380091.306 E – 389270.197 E
Site boundaries on East	Settlement – Ghatibhanga village
Site boundaries on West	Sea
Site boundaries on North	Water channel
Site boundaries on South	Water channel connecting to the Sea
Total area of the site	8,967 Acres
Land ownership details	Government owned
Government land	8,967 acres
Private land	Nil (as per details obtained from UNO Office)
Others	Nil (as per details obtained from UNO Office)
Expansion potential	Discussion with local inhabitants and Upazila Nirbahi Officer (UNO) indicates that there is no chance of expanding the proposed EZ because the site is surrounded by private land and settlements on all four sides
Existing land use	Mangroves, Water bodies, Char land, Mixed vegetation, and Aquaculture

Source: Information collected during site visit

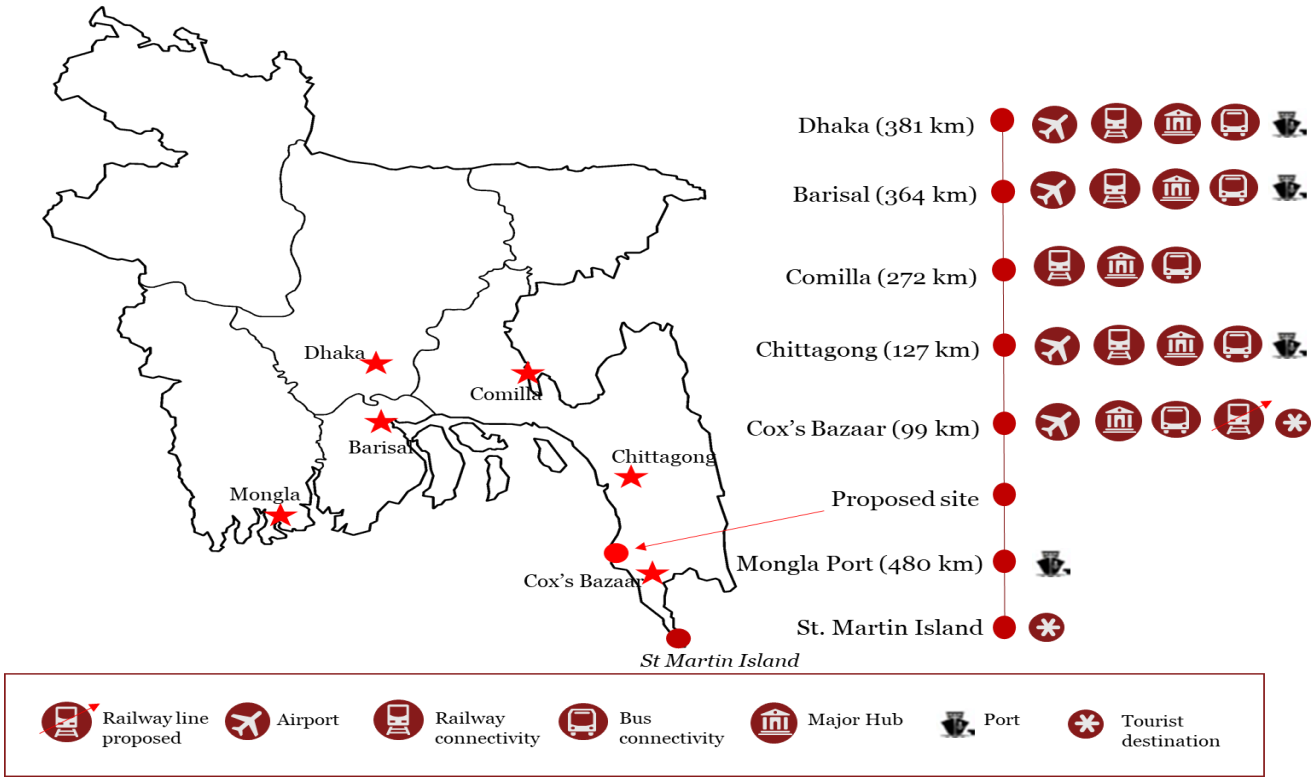
The preliminary analysis of the site and its surroundings reveals the fact that there exists a potential of development of an eco-tourism park in this location. With mangrove vegetation occupying most of the land, it

must be an area with a great variety of flora and fauna, which is yet to be discovered. Additionally, the site is also in close proximity to the most visited tourist spot of Bangladesh in Cox's Bazar, which are approachable by road and waterway. This makes it pertinent to assume that the site could be used for cross selling of tourism offerings by connecting and integrating it with the other attractive tourism locations of Cox's Bazar district.

2.7.4. Transport Infrastructure for the Proposed EZ

Any location to shape up as a potential tourism zone requires access to multimodal connectivity with the major hubs of the country. To enable seamless movement of travelers, access to multimodal connectivity is crucial. Figure in the next page depicts the site location in light of the major hubs, important nodes and transport infrastructure of the country.

Figure 6: (Map) Major hubs and Transport connectivity in proximity of the proposed site



Source: Information obtained from the site visit, google map and PwC analysis

Table 2: Assessment of multi-modal connectivity to the proposed EZ

	Highway connectivity	• Nearest highway connectivity is Dhaka-Chittagong Highway (N1) (~52 km). It is connected via Janatabaza - Gorakhghata road and Chakaria Badarkhali Road (R172). • N1 connects the proposed EZ with Cox's Bazar (!99 km), Chittagong (~127 km) and Dhaka (~381 km).
	Last mile connectivity with nearest highway	• Currently, an approach road of width ~10 feet runs within the island which is connected to Zila road (Z1004). • There is an existing bridge connecting this approach road, which helps to cross the water channels running within the Island. The site is facilitated by a single approach, which restricts the people movement from Moheshkhali upazila.

		• Preliminary assessment indicates that to propose roads around the site and upgrade existing road with standard size for ease and comfort for movement of tourists. • Adequacy of this road to cater to the increased traffic movement and the possibility of widening (once this EZ is operational) has been evaluated in the transport assessment section.
	**Rail connectivity**	• There is no prevailing rail network in Cox's Bazar District. The nearest existing railway station is Chittagong railway station, which can be accessed by Patiya-Anowara-Banshkhali-Toitong-Pekua-Badarkhali-Chokoria (Eidmoni) highway (R170) or Dhaka –Chittagong - Teknaf highway (N1). • Travel time from the proposed EZ to Chittagong rail station (by road) is around 4.5 hours and distance is approximately 120 km. • However, a railway network is proposed in Cox's Bazar, which is 8 km via waterway & 10 km via roadway from the site. The railway line originates from Dohazari in North of Chittagong division, and runs towards south to reach Cox's Bazar district.
	**Air connectivity**	• The proposed EZ is located at a road distance of approximately 110 km from Cox's Bazar domestic airport and can be accessed via the approach and the Zila road Z1004. It can also be accessed through waterway, which cuts down the distance to 9 km • Travel time from Cox's Bazar airport to proposed EZ is around 2 hours by waterway and 3.5 hours by road via Z1004 and N1. • The nearest international airport is in Chittagong (~127 km). Proximity to airport will supplement international and domestic transfers for tourists and staff from the proposed EZ.
	**Sea Port and IWT connectivity**	• Moheshkhali - Cox's Bazar boat line connects the Moheshkhali-Gorokghata ghat with Kastura ghat. This Island is located at a distance of 7.5 km from Kastura ghat and 8 km from Moheshkhali- Gorokghata ghat. Jetty facilities are available at these Ghats. This can be integrated with the proposed jetty facility at Sonadia Island • Currently, jetty services are the most used mode of transport to the proposed EZ from Cox's Bazar. However, the service is slow. The nearest major port from the site is the Chittagong port, which is at a distance of 124 km.

Source: PwC Research

2.7.5. Utility linkage at the Proposed EZ

Utilities play an important role in the successful operation of tourism establishments. The existence of a functioning power, water and gas linkage in the vicinity helps in reducing setup costs for developers. Thus, it is imperative to understand the existing utility linkages at the site for gauging potential challenges upfront.

Table 3: Assessment of utility linkages

Power availability	• The nearest substation to the proposed EZ is at a distance of ~4 km and has a capacity of 10 MVA. This substation is the 33/11 KV Kiranthuli substation and it has a surplus peak demand of 4 -6 MVA. • During summers, the demand surges to above the capacity that results in load shedding in the region. The government has also planned a wind power plant with a capacity of 60 MW at Kurushkul, in Moheshkhali upazila.[6] • In addition to that, Coal Power Generation Company Bangladesh (CPGCBL), a state-owned enterprise of the People's Republic of Bangladesh, is developing the 1.2GW project with an estimated investment of $4.5bn. • The Matarbari power plant was proposed in September 2011 and granted environmental approval in October 2013. Ground-breaking ceremony for the project took place in January 2018, while operations are expected to begin by 2024. The plant is expected to account for 10% of the total generation capacity of Bangladesh.[7]
Water availability	• Since the proposed study area falls adjacent to Bay of Bengal and Moheshkhali water channel having tidal influence from sea, the surface water will be saline and shall not be relied as a source of water for the proposed EZ. There is no freshwater source near the proposed study area • The inhabitants rely mostly on ground water for which there are three boreholes within the proposed EZ area; the maximum depth is about 1,000 ft. There are about 12 deep tube wells within Sonadia Island, which forms the main source of drinking water for the inhabitants. • The ground water is saline in nature and the officials of Department of Public Health and Engineering (DPHE) suggested relying on desalination plant for Sonadia Ecotourism Park. However, setting up of a desalination plant is cost intensive as compared to extracting water from ground water sources.
Solid Waste Management	• There is a proposed solid waste dumping site area by Cox's Development Authority near the Sonadia Island.[8]
Telecom Availability	• Moheshkhali Island has been chosen by Korea Telecom, a Korean telecommunications company to transform it into a digital island along with support from Government of Bangladesh. The proposed EZ would benefit immensely once this initiative becomes a reality. • At present, Grameenphone, Banglalink, Robi are the most prominent telecom service providers in Cox's Bazar district.

[6] *Rural Electrification Board*
[7] *NS Energy*
[8] *Asian Development Bank*

- As part of Digital Bangladesh initiative, optical fiber based telecom access has been established up to the Upazilla Nirbhahi Officer (UNO) office.

Source: Data collected during site visit and secondary research

2.7.6. Access to Social Infrastructure

Social infrastructure is one of the basic proponents that is required by the people for a sustainable living. Quality educational institutions churn out educated and qualified professionals who can be employed in hospitality, amusement parks and other tourism related industries. Apart from education, the other facet of social infrastructure is the medical facilities available. The populace living in any region expects to be near modern day medical institutions, which can take care of any physical emergencies. In line with the importance of these social establishments, the following sections aim to assess the site from the perspective of healthcare and educational standards.

The social infrastructure facility available in Moheshkhali upazila of Cox's Bazar district are given below:

Educational Facilities: This District has an overall 39.3% literacy; while the upazilas of Moheshkhali has an overall literacy rate of 30.8%.[9] The literacy rate in the upazila is lower than the district's average indicating a dearth supply of skilled individuals for the proposed Tourism zone. Various educational facilities in Moheshkhali upazila are:

- 4 colleges,
- 21 secondary schools,
- 51 primary schools,
- 13 kindergarten schools,
- 10 NGO schools,
- 49 madrasa and
- 1 technical and vocational institutions

However, there are no world-class schools/ educational institutions present in the vicinity. Some of the educational institutions (general colleges) in Moheshkhali upazila are:

- Bongobondhu Women's College
- Moheshkhali University College
- Hoanak College

Presence of educational institutions serves a twofold purpose – one is they make available skilled workforce for service sector consumption, and second is they provide opportunity for the white-collar employees to send their children for basic and high level education.

This upazila lacks on both aspects that need to be addressed by the proposed development via incorporation of a decent social infrastructure. Moving ahead of the upazilas, nearest urban center is the Cox's Bazar town in terms of social infrastructure.

Cox's Bazar town is located 99 km from the proposed EZ and there are various vocational institutions/ technical training centers in Cox's Bazar, the prominent ones being:

- Cox's Bazar Polytechnic Institute
- Cox's Bazar Model Polytechnic Institute

[9] *Cox's Bazar district statistics*

- Cox's Bazar Technical School & College

Due to the proximity of Cox's Bazar town, sourcing of qualified/ skilled manpower may be ascertained. However, there are very few technical training centers located near Moheshkhali upazila.

Healthcare Facility: There is no international standard hospital in this upazila. Moheshkhali upazila health complex is located at around 11 km from the proposed EZ.

Available healthcare facilities in Moheshkhali upazila are captured in the following table.

Table 4: Medical facilities in this upazila

Facility Type(s)	Total (No.)	No. of Beds	No. of Healthcare personnel
No. of Upazila Health Complex	01	50	74
No. of Diagnostic Centers	02	N/A	10
No. of Union Health Centers	06	N/A	N/A
No. of Community Clinic	27	N/A	87

Source: Cox's Bazar District Statistics 2011

Unskilled and semi-skilled human resources employed within the proposed Tourism zone can avail the above stated medical facilities, whereas quality healthcare facilities could be developed within the proposed EZ to cater to the need of the skilled work force, executives, and expatriates employed in the proposed Tourism zone.

Residential Facilities: Basic residential facilities are available in Moheshkhali upazila. Basis primary site visit and discussion with the local residents, it was informed that residential requirements of unskilled and semi-skilled workforce employed in the proposed Tourism zone are available in the surrounding region. For accommodation of skilled manpower and executives, necessary infrastructure needs to be set up within the proposed EZ.

Commercial Facilities: A number of clubs, cinema halls, institutional accommodation facilities, police stations, post office and banks also adorns Moheshkhali upazila. Various facilities in Moheshkhali upazila are:[10]

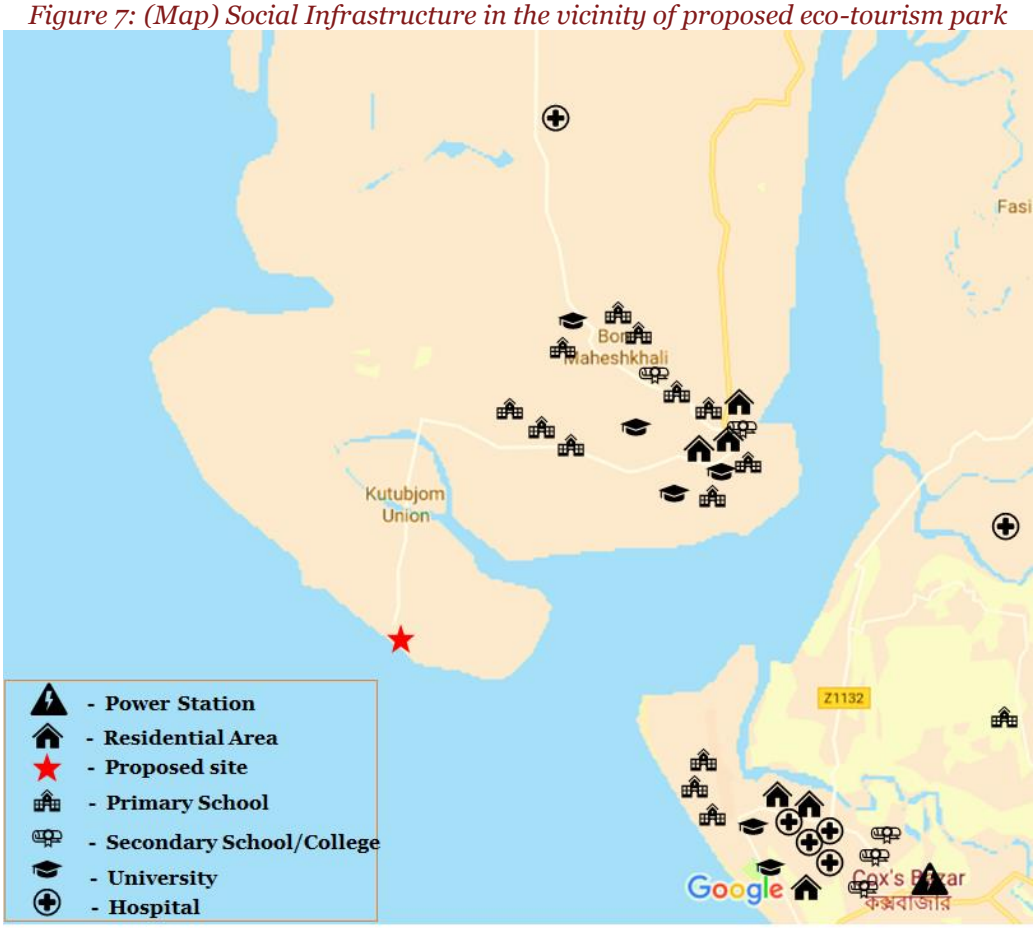
- 1 nationalized commercial bank,
- 1 private commercial bank,
- 1 filling station,
- 3 police stations,
- 6 stadiums,
- 200 cooperative societies
- 1 post office
- 1 NGO
- 1 rest house
- 240 registered clubs
- 20 libraries
- 70 orphanages

[10] *Cox's Bazar district statistics*

- 40 restaurants and
- 12 hotels

Apart from these, the upazila is also home to a number of growth centers, markets, warehouses etc.

Figure 7: (Map) Social Infrastructure in the vicinity of proposed eco-tourism park



Source: Google maps and site visits

2.8. Key Takeaways: How the Proposed EZ Can Shape Up as a Hub for Eco-tourism

Transport and Social infrastructure – intervention required to increase the commercial and tourism potential of this region

Proposed Tourism zone at Sonadia is connected with Dhaka and other parts of the country through road network. Proposed EZ is connected to the existing zila road Z1004 through an approach road, which needs to be carpeted once the construction activity starts. Preliminary assessment suggests that the road needs an overhaul to support the magnitude of movements of passenger as well as goods once the developmental works begin. In addition, improvement is also solicited in maintenance of the existing zila road (Z1004) which is strategically important from the aspect of connectivity to Dhaka Chittagong highway (N1) and Chakaria Badarkhali road (R172). The nearest airport to the site is the Cox's Bazar airport, which will provide domestic as well as international access to the proposed eco-tourism zone and thus holds immense importance, but in order to cater to increased traffic and demanding passengers it needs to be upgraded and modernized. There are plans to transform this airport into an international one, which shall improve the connectivity of the area with other strategic locations both in and outside Bangladesh. The area has access to telecommunication facility, but limited sources of power and scope for development of water supply. The area also has good connectivity with the Cox's Bazar town through waterway, which can be further improved with the use of sophisticated boats and

well-maintained ferries services. The proposed rail connectivity of Cox's Bazar with Chittagong will boost tourism activity in the area.

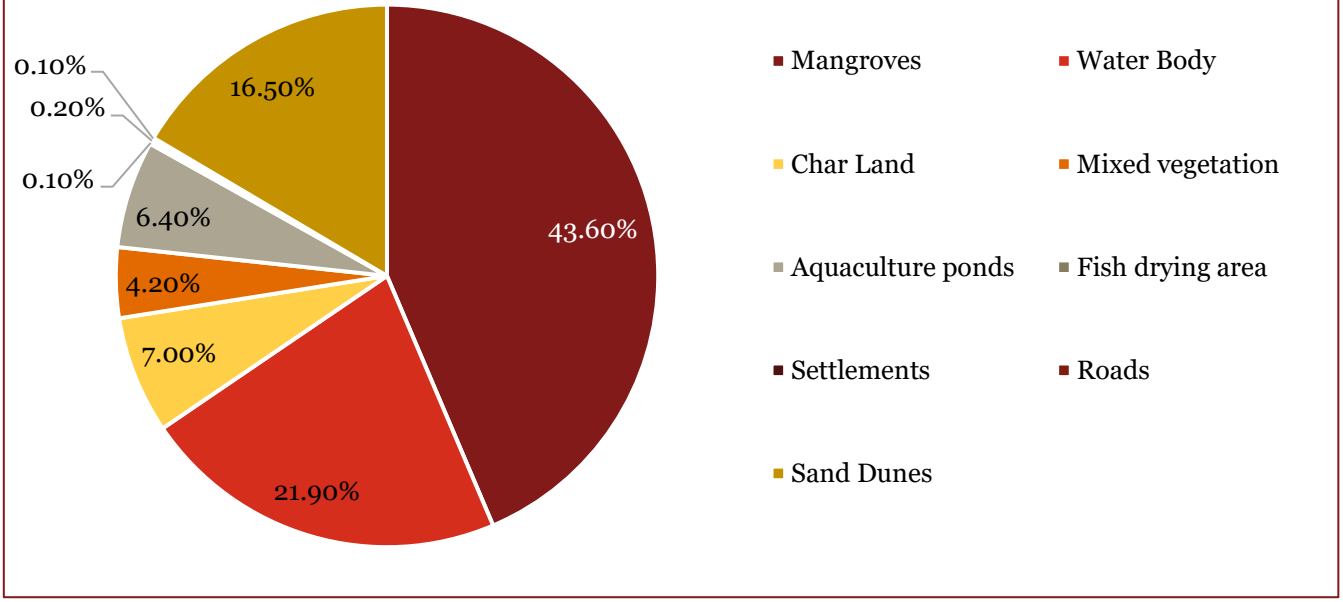
Moheshkhali has inadequate social infrastructure (for expatriates and executives) in the form of commercial and residential facilities and needs improvement in terms of medical facilities since the proposed tourism zone will see a huge influx of domestic as well as international tourists who will need better medical infrastructure for sustenance.

Mangroves providing a natural aesthetic value to the area

From the study of satellite image and site visit, it is observed that the Sonadia Island is covered with major land use such as Mangrove forests, water bodies, settlements, Agriculture, Open space and Sand dunes/cover. Majority of the land is occupied with mangroves (43.6%). Sonadia Island supports the last remaining mangrove forest in southeast Bangladesh. The distribution of mangroves within the site is at the sheltered inland part of Sonadia Island and a very narrow intertidal area on the edge of the estuary. The distribution of mangroves is largely on the inland part of the site with a very narrow distribution in the intertidal areas on the edge of the estuary. This vegetation provides great natural aesthetic value to the area and thus will be an added advantage in attracting tourists in the proposed zone.

Sonadia is an ecologically sensitive area and thus not suited for manufacturing and industrial activities. In cognizance of the same, development of an eco-tourism park is the best alternative by restoring the natural habitat and flora/ fauna in this area

Figure 8: Existing land use pattern for the proposed EZ



Source: Site assessment & PwC analysis

Presence of water channels – an aesthetic way to navigate throughout the island

Water channels occupies a major part of the Sonadia Island and is about 21.9% of total study area (8,967 acres) having branches, spreads and connects the Sea, thus providing a better water route to roam around the Island. This may provide an opportunity to overview the island in single water trip. Water channels with mangrove forests on either side creates a scenic perspective, attention and attraction to the tourists. From the environmental and sustainable aspect, the water channels should be conserved, maintained and retained in the Island for future development of the site. The Ecotourism Park must be planned to go and synchronize with the water channels scattered throughout the site.

Exquisite collection of Flora and Fauna – a key to attracting tourists

Sonadia Island is also known as sea turtles breeding ground. Various species of turtles are available, among which Olive Ridley is the most common species. Turtle breeding hatcheries are developed in and around the shoreline of Sonadia. A very rare species of crab namely "Horse shoe crab is a species with high immune system, its blood can be used to treat cancer, and their existence can be seen along the coastal area.

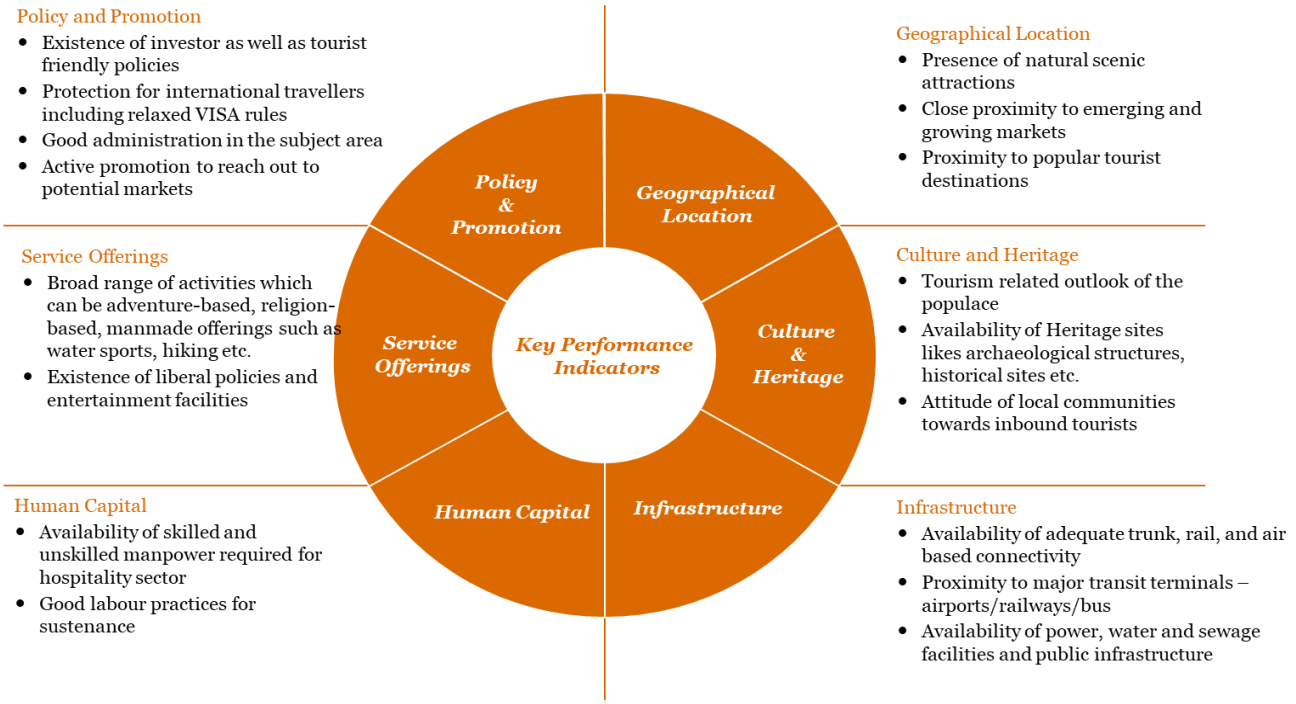
The region is also blessed with a majestic collection of flora and fauna and attracts many migratory birds throughout the year. Apart from that, there are a number of aquaculture ponds, which serve as one of the main sources of income for the local people. The development of an Ecotourism Park in the area will not only help in the upliftment of the area but also help preserve the ecological importance of the Sonadia Island.

Understanding the Key Performance Indicators for successful Tourism zones – an important aspect to assess the potential of the subject zone

Realizing that the success of an economic zone often hinges upon the competition experienced by it from similar developments either within the country or within the region and with the perspective that at a planning stage a developer should be well abreast of various best practices and the quality of similar economic zones that are being developed across the world, we have also studied other tourism based economic zones, which incorporates the best prevalent practices of the world.

The case studies prepared on these tourism economic zones gives us the premise for identifying the Key Performance Indicators (KPIs) responsible for the success of such developments, taking inspiration from similar developments in Thailand, Singapore and Myanmar. The case studies are attached with this report as part of Annexure.

The KPIs, which emerged out of the exercise of studying the above-mentioned tourism based zones, are as follows:

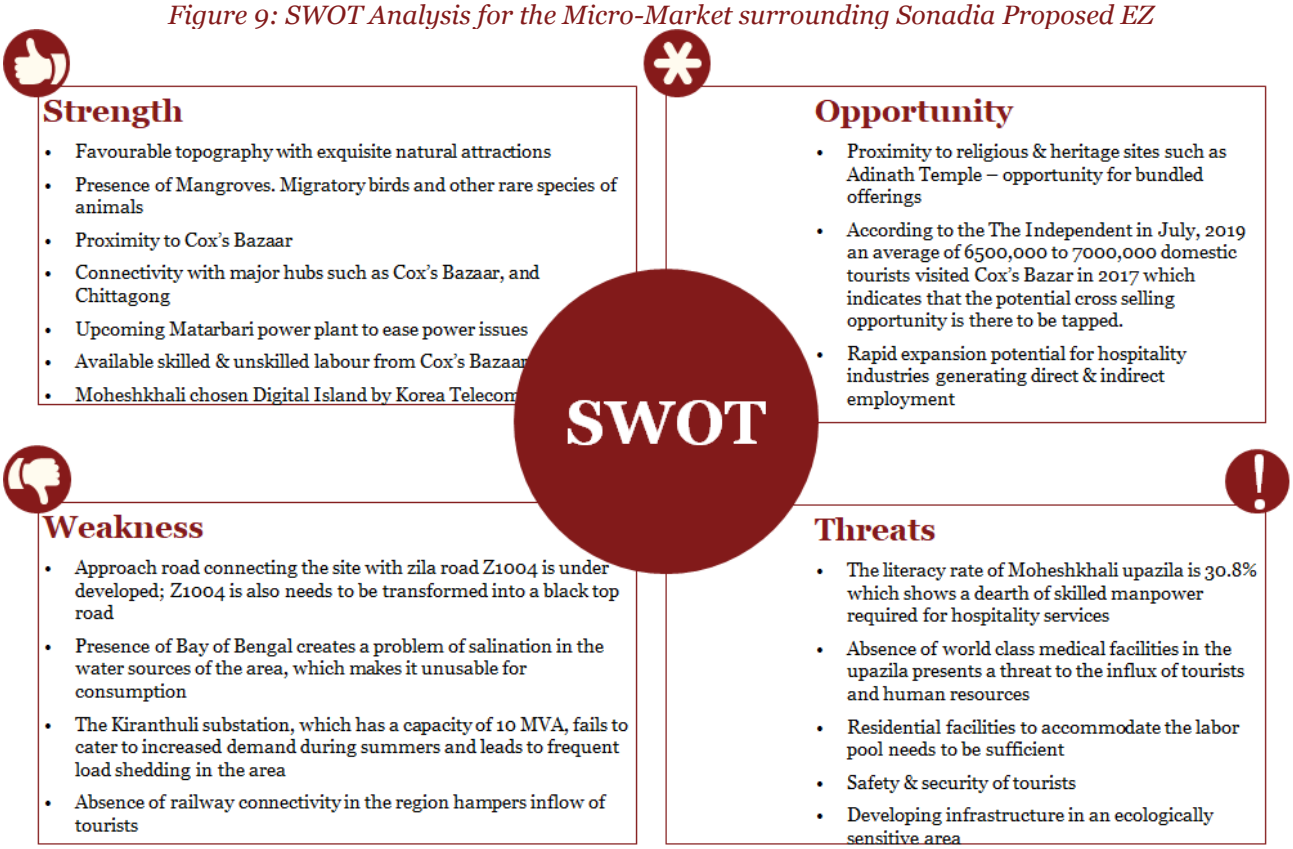


Based on the above-identified KPIs, we have mapped the strengths and weakness of the proposed EZ to justify the rationale behind development of the ecotourism zone.

2.8.1. SWOT Analysis of the Proposed EZ

Above discussion about the micro-market surrounding the proposed EZ at Sonadia culminates into following SWOT analysis. The site has inherent advantages and it is represented in the form SWOT Analysis in the figure below.

Figure 9: SWOT Analysis for the Micro-Market surrounding Sonadia Proposed EZ



Source: PwC Analysis

Based on the above assessment and the fact that the presence of rich biodiversity features together with the possibility of employment generation for the inhabitants and the proximity to Cox's Bazar and other notable places of attractions in the region, it is quite evident that the proposed EZ is more appropriate for the development of an Eco-Tourism zone rather than a manufacturing based economic zone.

3. Competition Benchmarking

3.1. Key Objectives

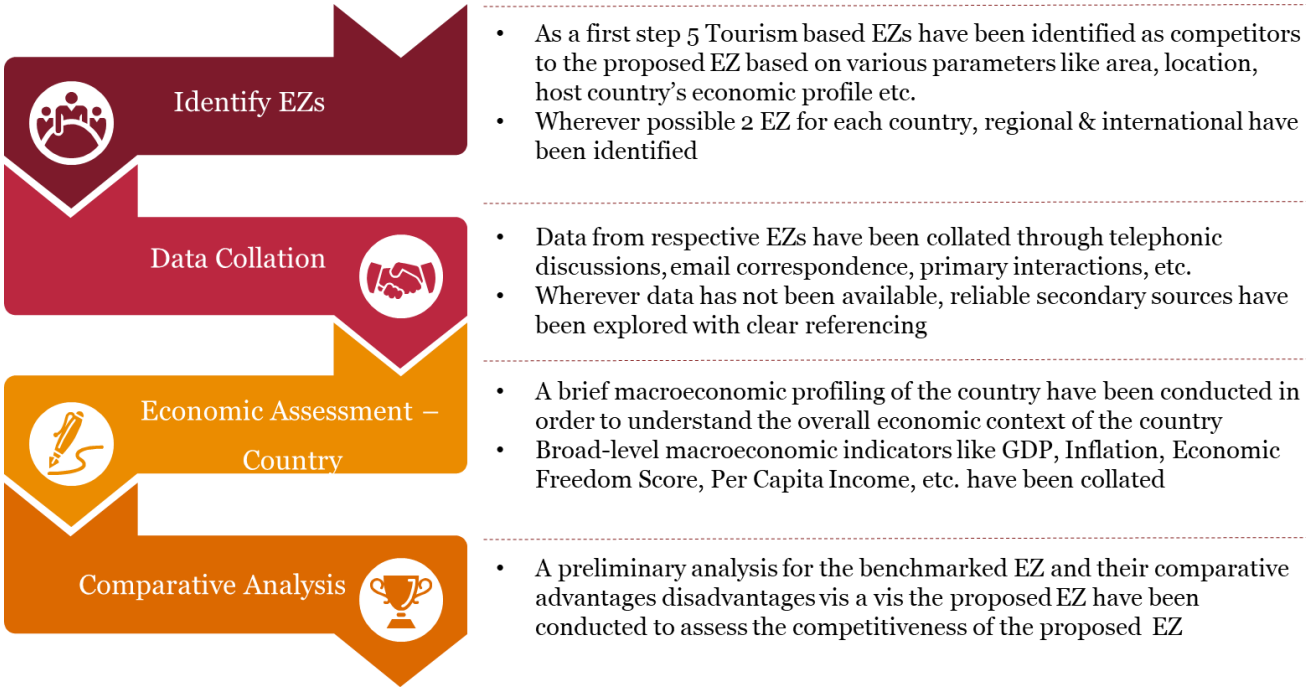
The success of an economic zone often hinges upon the competition experienced by it from similar developments either within the country or globally. Additionally, at a planning stage a developer should be well abreast of various best practices and the quality of similar economic zones that are being developed across the world. Hence, studying of other economic zones and their development strategies are vital information for a developer to construct a state of the art tourism based economic zones, which incorporates the best prevalent practices of the world.

Based on this premise, this chapter attempts to provide a profiling of various tourism based economic zones, which share similar physical and economic attributes as the proposed zone.

3.2. Methodology of Benchmarking

The benchmarking exercise has been conducted through extensive research that entailed telephonic discussions, email correspondence, primary interactions, with developers of economic zones, etc. An illustration for the flow of the benchmarking exercise has been depicted below:

Figure 10: Methodology of benchmarking



Source: PwC Analysis

3.3. Competitor identification

Tourism based economic zone is being planned in Sonadia area in Cox's Bazar District. It is envisaged that this tourism zone will be equipped with all required facilities and will attract visitors from both domestic and international population.

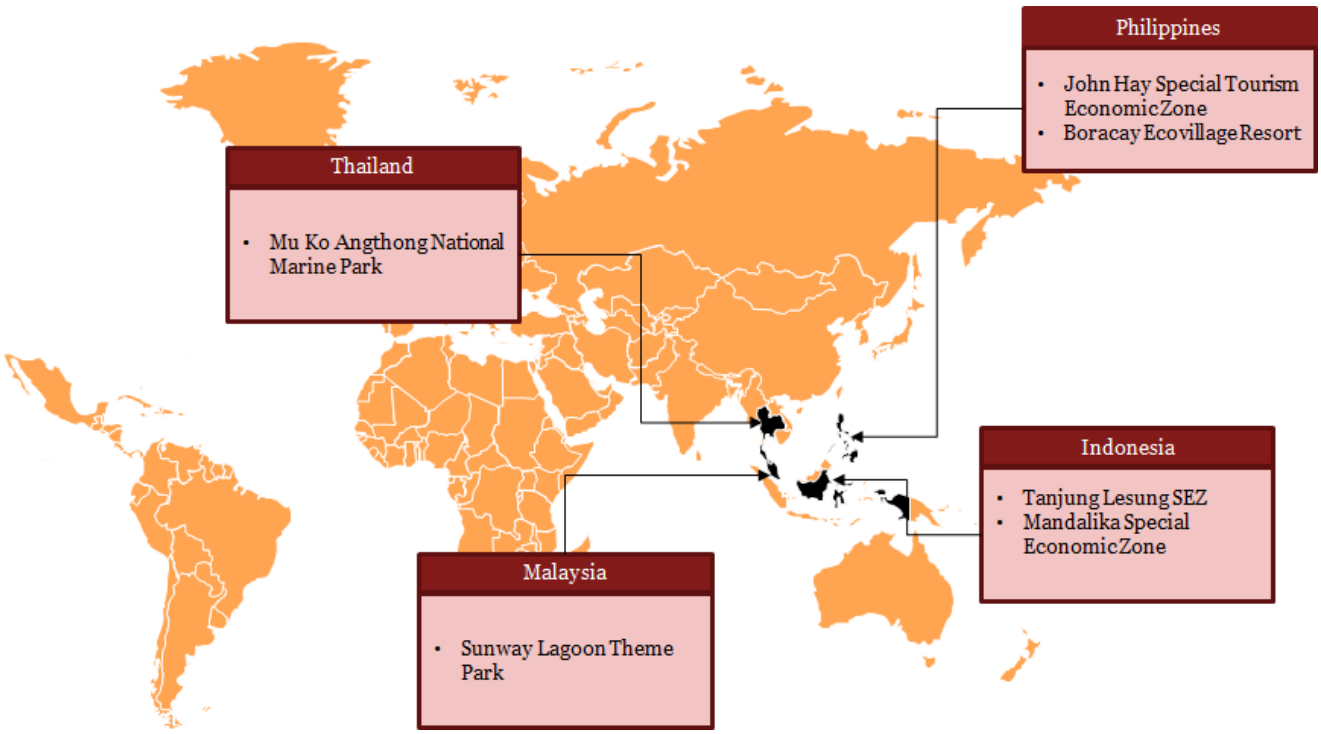
Bangladesh has recently witnessed development of a number of EZs by both private developers and Government agency (BEZA). Although, most of them are still at planning stages, some of them are at active stages of marketing as well.

Tourism zones from Philippines and Indonesia have been selected for benchmarking because of the similar socioeconomic conditions and objectives of developing tourism zones. The EZ's considered in Indonesia and Philippines are SEZs dedicated to tourism.

The other tourist attractions are taken from countries such as India, Sri Lanka, Malaysia and Thailand, and are tourist spots, but they are not SEZs dedicated to tourism. These examples highlight and showcase the Accessibility, Attractions, Accommodation, Amenities and Activities in these places so that the same can be replicated in case of Sonadia Eco-tourism zone. Therefore, the comparative analysis has been done with respect to the EZs from Indonesia and Phillipines and not the others.

While identifying the competitors it has been considered that these tourisms based EZs are similar in size and are at similar stage of development.

Figure 11: (Map) Locations of the tourism based economic zones



Source: PwC Research

A brief overview and rationale for selection for each of these economic zones have been provided below:

Table 5: Details of competing economic zones

Name of Zone	Country	Offerings	Land Area	Selection Rationale
Tanjung Lesung SEZ	Indonesia	▪ 3 to 5 Star Rated Classified Hotel ▪ Tourism Resort ▪ Convention & Exhibition Center ▪ Bar, Café, Singing Room ▪ Golf Course & Driving Range ▪ Culture and Nature Tourism	3,706 acres (Phase-I)	Tanjung Lesung SEZ occupies a natural peninsula on the west coast of the western Java and bordering the Sunda Strait. This tourism zone harbors activities, which could also be developed in the proposed zone. Being in south east Asia it can be aimed to attract tourists with similar expectations. Hence, this zone is considered as a suitable comparable for the proposed EZ.

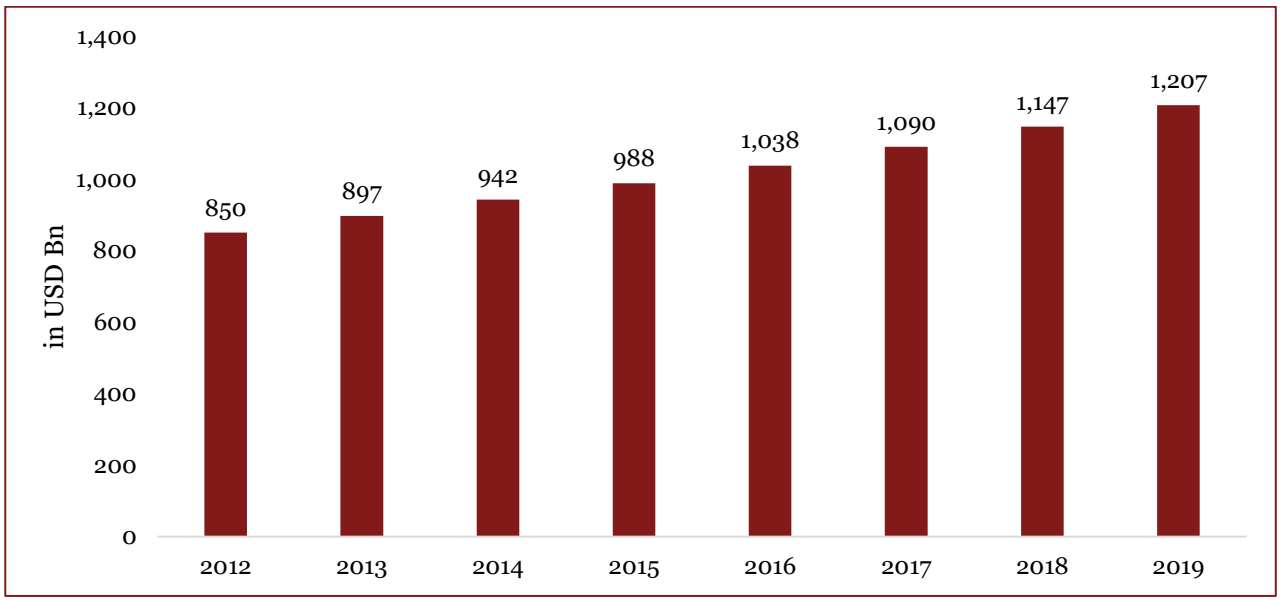
Name of Zone	Country	Offerings	Land Area	Selection Rationale
Mandalika Special Economic Zone	Indonesia	▪ Beaches ▪ Water Sports ▪ Leisure activities ▪ Shopping ▪ Golf course ▪ Cruise service ▪ Underwater Tourism ▪ Water Park ▪ Theme Parks	3,125 acres	Mandalika has excellent tourist attraction on the island of Lombok: 7.5 Km white sand beach of the Indian Ocean, and various local attractions nearby to the Mandalika. With the total area of 1,255.40 ha, it offers natural beauty, panoramic view, and many other attractions. Having similar geography makes this SEZ suitable for comparison.
John Hay Special Tourism Economic Zone	Philippines	▪ Premier hotel groups ▪ Golf Course ▪ Recreational and eco-cultural tourism ▪ Wellness and medical tourism ▪ Tree to adventure Zip line ▪ Horseback riding and eco-walks	610 acres	Commonly known as Camp John Hay, is a major tourism and recreation attraction located in Baguio City, on Luzon island, the Philippines. Being an ecotourism zone and situated in a developing country having similar economy as Bangladesh this tourism zone is suitable reference point for current project.
Boracay Ecovillage Resort	Philippines	▪ Para sailing ▪ Trekking ▪ Freediving ▪ Scuba diving ▪ Nature tour ▪ Kite surf ▪ Zipline ▪ Zorb riding	195 acres	Boracay can be found on the northwestern tip of Panay in Aklan, a province on the Visayas island known for its colorful Ati-Atihan festival. Boracay's thousand-hectares boast of all the elements of a tropical heaven - crystal blue waters, powder white sand, liberal doses of tropical palms and flowering plants, and a healthy and diverse marine life. Having similar offerings as being envisaged in the proposed tourism zone this can help in identification of interests of tourists.
Mu Ko Angthong National Marine Park	Thailand	▪ Snorkeling ▪ Kayaking ▪ Diving ▪ Beach activities ▪ Viewpoints ▪ Emerald Lake ▪ Sam Sao Island ▪ Nature trails ▪ Geological touring ▪ Rock climbing ▪ Over-night camping	102 km^2	Mu Ko Ang Thong is a marine national park in the Gulf of Thailand in Surat Thani Province. The marine park covers a total of 42 islands. Having similar offerings as being envisaged in the proposed tourism zone this can help in identification of interests of tourists.
Sunway Lagoon Theme Park	Malaysia	▪ Water parks ▪ Scream parks ▪ Amusement park ▪ Extreme park ▪ Wild life park ▪ Beach Soccer ▪ Aqua Valley	88 acres	Sunway Lagoon is a theme park in Bandar Sunway, Subang Jaya, Selangor, Malaysia owned by Sunway group. Having similar offerings as being envisaged in the proposed tourism zone this can help in identification of interests of tourists.

Source: PwC Research

3.3.1. Indonesia

Indonesia, the world's largest island country is located Southeast Asia between Indian and Pacific oceans. The largest economy in Southeast Asia is classified as a newly industrialized country and has mixed economy, where state-owned enterprises (SOEs) and large private business groups (conglomerates) play a significant role. The Indonesian economy is traditionally a commodity export-oriented economy with palm oil and coal briquettes being the main exports followed by petroleum gas, crude petroleum, rubber and cars. Lately the central government has been providing strong support to increase the role of manufacturing industry in the country, thus reducing the dependence on exports. Resilient economic growth, low government debt and prudent fiscal management play a key role in attracting financial inflows into Indonesia. Over the last decade, economic clusters in Indonesia have increased manifold given the country's locational advantage, rich natural resources and climate conducive to agriculture. The GDP growth of Indonesia has been depicted below. **Data used for the analysis is the latest data point available in the respective database.**

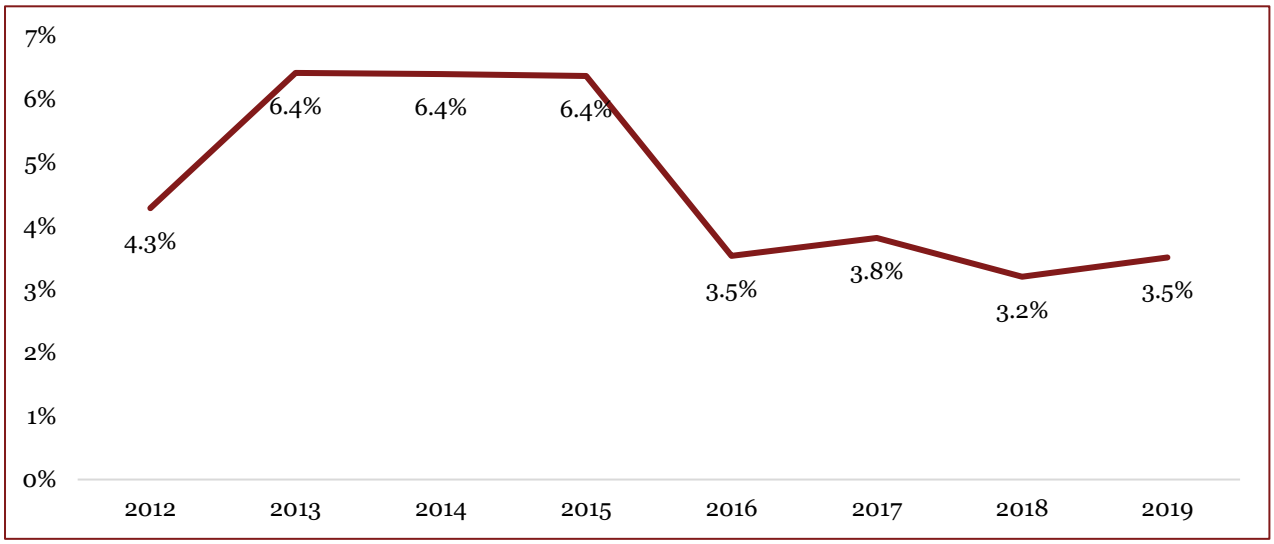
Figure 12: GDP of Indonesia



Source: The World Bank

The inflation rate in Indonesia has been higher than its peer nations. During the period 2005-2014, average annual inflation in Indonesia has been 8.5%. The high volatility in inflation has been mainly due to significant energy subsidies. However, the current government has diverted such funds subsidies to infrastructure development, getting inflation under control. The same is depicted below. **Data used for the analysis is the latest data point available in the respective database.**

Figure 13: Inflation Trend of Indonesia



Source: World Bank

The other broad level economic parameters of the country have been depicted below –

Table 6: Macro-economic Parameter of Indonesia

Macroeconomic Indicator	Description	Data Source
Unemployment	4.3%	The Heritage Foundation
FDI Inflow	USD 19.7 Billion	The World Bank
Exports	USD 183.5 Million	ITC Trade Map
Imports	USD 156.3 Million	ITC Trade Map
Heritage Foundation's Index of Economic Freedom Rankings	54	The Heritage Foundation
Cato Institute's Human Freedom ranking	81	Human Freedom Index | Cato Institute
World Economic Freedom's Global Competitive Index Rating	50	Global Competitiveness Index 2019 rankings
WB Doing Business ranking	73	Doing Business 2020

Source: PwC Research

Indonesia, the 16th largest economy in the world and one of the emerging economies, has been recently termed as a newly industrialized economy. The country predominantly depends on domestic market and state-owned enterprises. The country faced a financial crisis until 2012, post which, the government took strict measures as regulations to promote FDI. This in turn improved the economy. However, the country is still facing problems such as weakening currency, declining exports and stagnating consumer spending.

Post analysis of the broad macro-economy of Indonesia, an analysis of the selected zone has been provided below:

3.3.1.1. Special Economic Zone (KEK) of Tanjung Lesung National Tourism Strategic Location (KSPN), Banten

Tanjung Lesung has the status of Special Economic Zone (SEZ) in tourism sector and was launched by the Government of Indonesia in 2012. It has benefits for investors in terms of fiscal and non-fiscal incentives. SEZ Tanjung Lesung is also one of the 50 National Tourism Destinations stipulated by the Ministry of Tourism and Creative Economy of the Republic of Indonesia.

SEZ Tanjung Lesung is managed by PT Banten West Java, a subsidiary of PT. JABABEKA, Tbk that has more than 20-year experience in township and real estate development.

Tanjung Lesung is nestled in the west coast area of Java in the Banten Province. Beaches on the coast known to be some of the best as they offer good surf, calm swimming spots, considerably healthy reefs and white sands.

Figure 14: Tanjung Lesung in Indonesia

Source: Google images

The detailed profiling of this tourism zone is provided below.

Table 7: Detailed profiling of Tanjung Lesung SEZ

Factors	Tanjung Lesung Special Economic Zone
Site	
Land Size (acres)	3,706 acres[11]
Number of Plots	Data Not available
No. of Development Phases	The complete zone will be developed in two phases(Phase 1 of 1,500 Ha and Phase 2 of 5,500 Ha)[12]
Land Lease (+length)	Land can be leased for up to 70 years[13] and no minimum price has been fixed for leases. Basis discussion with officials from this SEZ, the pricing is on negotiation basis
Pre-Built Facilities (PBF) (Y/N)	There are no PBF offered within the industrial park
Lease Rate for PBF	There are no PBF offered within the tourism zone; Hence no rentals for PBFs are applicable
Infrastructure/Utilities	
Electrical Power Supply(Y/N and Capacity)	Capacity to provide electricity up to 100 MVA[14]
Cost of Power (USD/ kWh)	Cost of power varies between 0.075 USD / kWh to 0.11 USD / kWh according to type of business[15]
Drinking Water	Capacity of 100 ltr/sec[16]
Industrial/ commercial Water	Capacity of 300 ltr/sec[17]
Cost of Water (Taka/USD)	Data not available

[11] *Source: http://www.pma-japan.or.id/bundles/bsibkpm/download/Tanjung%20Lesung_93.pdf*
[12] *Source: http://indonesiainvestmentforum.info/wp-content/uploads/2017/04/Tanjung-Lesung-Presentation.pdf*
[13] Source: *http://indonesiainvestmentforum.info/wp-content/uploads/2017/04/Tanjung-Lesung-Presentation.pdf*
[14] Source*: http://www.pma-japan.or.id/bundles/bsibkpm/download/Tanjung%20Lesung_93.pdf*
[15] *Source: https://www.pwc.com/id/en/energy-utilities-mining/assets/power/power-guide-2017.pdf*
[16] *Source:http://www.pma-japan.or.id/bundles/bsibkpm/download/Tanjung%20Lesung_93.pdf*
[17] *Source:http://www.pma-japan.or.id/bundles/bsibkpm/download/Tanjung%20Lesung_93.pdf*

Factors	Tanjung Lesung Special Economic Zone
Onsite Wastewater Treatment Plant (Y/N)	There is a waste water treatment plant to treat water from businesses[18]
ICT Communication	Wireless and fiber optic cables for high speed connectivity[19]
Accessibility	
Air	Nearest airport is Jakarta's Soekarno-Hatta International Airport (184 km). In the near future, government plans to build an airport in Banten Province (71 km).
Water	Nearest seaport is Port of Merak which is almost 100 km by road
Road	Tanjung Lesung is well connected by road to nearby towns. Government has planned a toll road that is located not far away from SEZ Tanjung Lesung. In addition, the government has planned to build the Selat Sunda Bridge, which will connect Sumatera Island and Java Island.
Rail	Presently not connected by rail
Airline Operators	Major international airlines like Singapore airlines, Emirates, Air Asia, Air China operate flights to different parts of the world
Cost of Travel (to Jakarta)	• Washington DC ~ USD 1260[20] • London ~ USD 1070 • Beijing ~ USD 724 • Canberra ~ USD 850 • Moscow ~ USD 580
Visa Rules	
Visa free entry	Tourists from 169 countries holding valid passports can enter Indonesia without any visa for 30 days[21]
Accommodation	
Type	Beach side hotels, villas and backpacker tents equipped with all modern amenities are available for accommodation
Cost (per room per night)	• Beach hotel ~ USD 85[22] • Villas ~ USD 177 • Backpacker tent ~ USD 35
Manpower	
Average salaries in Indonesia (per month)	• Manager ~ USD 2,247[23] • Skilled labor ~ USD 337[24] • Unskilled labor ~ USD 218[25]
Tourism Attractions	
Type of activities	Spa, Bar, Café, Karaoke, Golf course, Theme park, Water park, Marina, Culture and nature tourism, Ujung Kulon National park
Special Regime	
Yes/No	Yes, there's special regime for incentives
Fiscal Incentives[26]	

[18] *Source:http://www.pma-japan.or.id/bundles/bsibkpm/download/Tanjung%20Lesung_93.pdf*
[19] *Source:http://www.pma-japan.or.id/bundles/bsibkpm/download/Tanjung%20Lesung_93.pdf*
[20] *Source: https://www.emirates.com/english/destinations/iad/cgk/flights-from-washington-to-jakarta*
[21] *Source: https://www.indonesia.travel/gb/en/trip-ideas/visa-free-for-169-countries-to-travel-to-indonesia*
[22] *Source: https://www.tanjunglesung.com/accomodation/*
[23] *Trading economics database*
[24] *Trading economics database*
[25] *Source: https://tradingeconomics.com/indonesia/wages-low-skilled*
[26] *Source: https://www.pwc.com/id/en/taxflash/assets/english/2016/taxflash-2016-04.pdf*

Factors	Tanjung Lesung Special Economic Zone
Corporate Tax Reduction	• For an investment of greater than 1,000 Billion Rupiah CIT reduction to the tune of 20% to 100% will be provided for a period of 10 to 25 years • For an investment between 500 to 1,000 billion Rupiah CIT reduction of 20% to 100% will be provided for period of 5 to 15 years • For an investment of less than 500 Billion Rupiah CIT reduction for a period of 5-15 years will be provided and value will be decided by Ministry of Finance
Income Tax Allowance	Taxpayers that have been rejected for the CIT Reduction facility and taxpayers carrying out other activities in a Special Economic Zone (Kawasan Ekonomi Khusus/KEK) may apply for Income Tax Allowance that provides the following: • A reduction in net taxable income of up to 30% of the amount invested in the form of fixed assets (including land), prorated at 5% for six years of commercial production provided that the assets invested are not misused or transferred within a certain period • Acceleration of fiscal depreciation and amortization deductions • A reduction in the withholding tax rate on dividends paid to non-residents to 10% or the applicable reduced tax treaty rate • Extension of tax-loss carry forward for more than five years but not more than ten years
Other Tax Facilities	On top of the Income Tax facilities mentioned above taxpayers in a KEK are also entitled to the following tax facilities: • Non-collection of VAT and LST on the importation or domestic purchases of certain goods • Non-collection of VAT and LST on the delivery of certain goods between taxpayers in a KEK • Non-collection of Article 22 Income Tax on imports • Postponement of import duty on capital goods and equipment, and goods and materials for processing. Import duty is exempted on the import of capital goods to develop a KEK • Exemption of excise on goods to be used to produce non-excisable goods
Additional Tax Incentives for Tourism KEK	The following tax facilities are available in a KEK that focuses on tourism: • VAT refund for foreigners on the purchase of goods from participating stores • Exemption of LST and Article 22 Income Tax on the purchase of residences in a KEK area • Reduction/exemption of regional taxes and retribution
Non-Fiscal Incentives[27]	
Employment	• Permission to hire foreign workers who have position as directors or managers • Establishment of Wage council, Trade/Labor unions, Tripartite cooperation institution within SEZ
Immigration	Ease of entry for foreign business people
Licensing	• Administered in Integrated One Stop Service • Easiness for business licensing, industry and trade activity, port activity and other business activities
Land	• Ease in obtaining land rights and land acquisition • Granting land rights for those who already have land
Security	Security for SEZ will be high on priority for Indonesia Police

[27] *Source: http://www.pma-japan.or.id/bundles/bsibkpm/download/Tanjung%20Lesung_93.pdf*

Source: PwC Research

3.3.1.2. Mandalika Special Economic Zone – Indonesia

Mandalika has the status of Special Economic Zone (SEZ) for agro industry and ecotourism industry, which was launched by Government of Indonesia in 2014. It has benefits for investors in terms of fiscal and non-fiscal incentives. This area developed for Meetings, Incentives, Conventions and Exhibitions (MICE) purpose, leisure spot, luxury lodging, and unique products from some region in Central Lombok. It has excellent tourist attraction on the island of Lombok: 7.5 km white sand beach of the Indian Ocean, and various local attractions nearby to the Mandalika. With the total area of 1,255.40 ha, it offers natural beauty, panoramic view, and many other attractions. In addition to that, its proximity to the capital city of Jakarta makes this area a favorite destination among families. Its growing tourism potential along with Indonesia's remarkable economic development is still waiting to be developed and explored further.

Figure 15: Mandalika SEZ in Indonesia

Source: Google Images

The detailed profiling of this tourism zone is provided below.

Table 8: Detailed profiling of Mandalika SEZ

Factors	Mandalika Special Economic Zone
Site	
Land Size (acres)	3,125 acres[28]
Number of Plots	140 plots[29]
No. of Development Phases	The complete zone will be developed in two phases over a period of 30 years.

[28] *Source:http://indonesia-tourism-investment.com/index.php?page=regency&province=west-nusa-tenggara&regency=mandalika*
[29]*Source: https://www.aiib.org/en/projects/approved/2018/_download/indonesia-mandalika/mandalika-project.pdf*

Factors	Mandalika Special Economic Zone
Land Lease (+length)	Land can be leased for up to 70 years[30]
Land lease rate[31]	• Inland 2.93 USD/m² • Midland 3.25 USD/m² • Beach 5.00 USD/m² • Facilities 1.14 USD /m²
Pre-Built Facilities (PBF) (Y/N)	There are no PBF offered within the industrial park
Lease Rate for PBF	There are no PBF offered within the tourism zone; Hence no rentals for PBFs are applicable
Infrastructure/Utilities	
Electrical Power Supply(Y/N and Capacity)	Mandalika's projected power demand at full capacity will be 265 MVA. The State Electricity Utility (PLN) is responsible for supplying reliable electricity to the Project while Indonesia Tourism Development Corporation (ITDC) is responsible for the transmission and distribution of electricity within The Mandalika area
Cost of Power (USD/ kWh)	0.07 USD per Kwh[32]
Drinking Water	At full capacity, demand for potable water is estimated at 234 L/sec (20,210 m³/day). Clean water is supplied to The Mandalika SEZ by construction and operation of Seawater Reverse Osmosis plants (SWRO). Currently, one SWRO plant with a capacity of 34 L/sec (3,000 m³/day) has been constructed in the western part, but is not currently in operation[33]
Cost of Water	0.17 to 0.33 USD per cum[34]
Onsite Wastewater Treatment Plant (Y/N)	Wastewater Treatment Plants (WWTPs) in each of the western and eastern zones with a maximum total capacity of 20,000 m3 /day[35]
Communication	Wireless and fiber optic cables for high speed connectivity
Accessibility	
Air	Lombok International airport is 16 km (20 minutes' drive from the site). Closeness to Bali will make it beneficiary of spillover tourism business. Air travel to Bali takes 25 minutes from Lombok. Six airlines are currently offering domestic flights to Bali International Airport. Only two international connections to Kuala Lumpur and Singapore are operational but it is expected that airlines will establish additional connections once the supply of star-rated hotels on Lombok has increased.
Water	The sea transport options for Lombok are fast boat services, RoRo (Roll-on/Roll-off) ferries, and cruise ships. Foreign visitors typically take the frequent and direct 2-hour fast boats from Bali to the Gili Islands. Lembar Port located on the western coast is the most important harbor in Lombok, primarily used for inter-island freight and passenger transport.
Road	At full capacity, Mandalika will feature a 55.25 km road network, including 35.15 km of local roads (ROW8-30), 11.2 km of main collector roads (ROW45-50), a 6.03 km ROW60 east-west backbone, a 0.65 km ROW80 section and a 2.23 km ROW90 connecting to the future airport by-pass
Rail	Presently not connected by rail
Airline Operators	Major international airlines like Singapore airlines, Emirates, Air Asia, Air China operate flights to different parts of the world
Cost of Travel (to Jakarta)- round trip	• Washington DC ~ USD 1,260[36] • London ~ USD 1,070

[30] *Source:https://www.aiib.org/en/projects/approved/2018/_download/indonesia-mandalika/mandalika-project.pdf*
[31] *Source:https://www.aiib.org/en/projects/approved/2018/_download/indonesia-mandalika/mandalika-project.pdf*
[32] *Source: https://www.pln.co.id/search?q=statistik*
[33] *https://www.aiib.org/en/projects/approved/2018/_download/indonesia-mandalika/mandalika-project.pdf*
[34] *https://www.aiib.org/en/projects/approved/2018/_download/indonesia-mandalika/mandalika-project.pdf*
[35] *https://www.aiib.org/en/projects/approved/2018/_download/indonesia-mandalika/mandalika-project.pdf*
[36] *https://www.emirates.com/english/destinations/iad/cgk/flights-from-washington-to-jakarta*

Factors	Mandalika Special Economic Zone
	• Beijing ~ USD 724 • Canberra ~ USD 850 • Moscow ~ USD 580
Visa Rules	
Visa free entry	Tourists from 169 countries holding valid passports can enter Indonesia without any visa for 30 days
Accommodation	
Type	Hotels with different star ratings and all facilities are available
Cost (per room per night)	• For 5 star hotels, USD 140 / night[37] • For others, USD 30/ night
Manpower	
Average salaries in Indonesia (per month)	• Manager ~ USD 2,247[38] • Skilled labour ~ USD 337[39] • Unskilled labour ~ USD 218[40]
Tourism Attractions	
Type of activities	Beaches, Water Sports, Leisure activities, Shopping, MICE, Golf course, Cruise service, Underwater Tourism, Water Park, Theme Parks etc.
Special Regime	
Yes/No	Yes, there's special regime for incentives
Fiscal Incentives[41]	
Corporate Tax Reduction	• For an investment of greater than 1000 Billion Rupiah CIT reduction to the tune of 20% to 100% will be provided for a period of 10 to 25 years • For an investment between 500 to 1000 billion Rupiah CIT reduction of 20% to 100% will be provided for period of 5 to 15 years • For an investment of less than 500 Billion Rupiah CIT reduction for a period of 5-15 years will be provided and value will be decided by Ministry of Finance
Income Tax Allowance	Taxpayers that have been rejected for the CIT Reduction facility and taxpayers carrying out other activities in a Special Economic Zone (Kawasan Ekonomi Khusus/KEK) may apply for Income Tax Allowance that provides the following: • A reduction in net taxable income of up to 30% of the amount invested in the form of fixed assets (including land), prorated at 5% for six years of commercial production provided that the assets invested are not misused or transferred within a certain period • Acceleration of fiscal depreciation and amortization deductions • A reduction in the withholding tax rate on dividends paid to non-residents to 10% or the applicable reduced tax treaty rate • Extension of tax-loss carry forward for more than five years but not more than ten years
Other Tax Facilities	On top of the Income Tax facilities mentioned above taxpayers in a KEK are also entitled to the following tax facilities: • Non-collection of VAT and LST on the importation or domestic purchases of certain goods

[37] *https://www.booking.com/hotel/id/villa-sorgas.en-gb.html*
[38] *Source: https://www.averagesalarysurvey.com/indonesia*

[39] *Source:https://tradingeconomics.com/indonesia/wages-high-skilled*
[40] *Source: https://tradingeconomics.com/indonesia/wages-low-skilled*
[41] *Source: https://www.pwc.com/id/en/taxflash/assets/english/2016/taxflash-2016-04.pdf*

Factors	Mandalika Special Economic Zone
	• Non-collection of VAT and LST on the delivery of certain goods between taxpayers in a KEK • Non-collection of Article 22 Income Tax on imports • Postponement of import duty on capital goods and equipment, and goods and materials for processing. Import duty is exempted on the import of capital goods to develop a KEK • Exemption of excise on goods to be used to produce non-excisable goods
Additional Tax Incentives for Tourism KEK	The following tax facilities are available in a KEK that focuses on tourism: • VAT refund for foreigners on the purchase of goods from participating stores • Exemption of LST and Article 22 Income Tax on the purchase of residences in a KEK area • Reduction/exemption of regional taxes and retribution
Non-Fiscal Incentives[42]	
Employment	• Permission to hire foreign workers who have position as directors or managers • Establishment of Wage council, Trade/Labor unions, Tripartite cooperation institution within SEZ
Immigration	Ease of entry for foreign business people
Licensing	• Administered in Integrated One Stop Service • Easiness for business licensing, industry and trade activity, port activity and other business activities
Land	• Ease in obtaining land rights and land acquisition • Granting land rights for those who already have land
Security	Security for SEZ will be high on priority for Indonesia Police

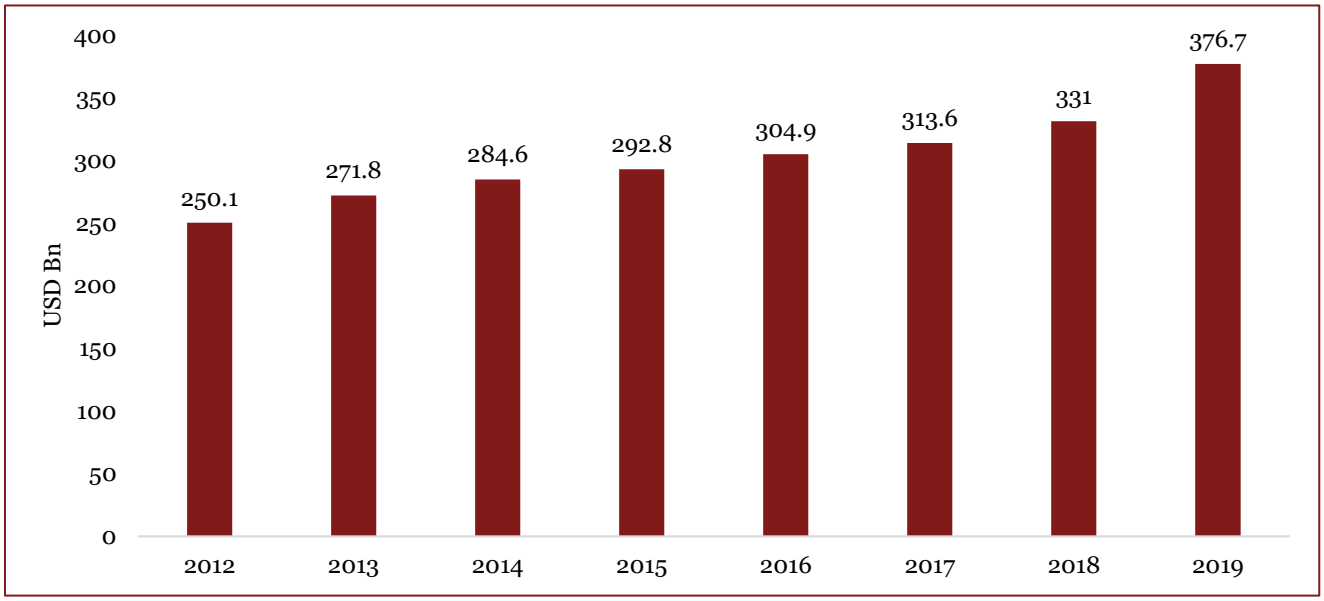
Source: PwC Research

[42] *Source:https://www.aiib.org/en/projects/approved/2018/_download/indonesia-mandalika/mandalika-project.pdf*

3.3.2. Philippines

The Philippines is one of the most dynamic economies in the East Asia Pacific region. With increasing urbanization, a growing middle class, and a large and young population, the Philippines' economic dynamism is rooted in strong consumer demand supported by a vibrant labor market and robust remittances. Post witnessing a slump in its economy in 2011 due to economic downturn, the economy of Philippines has revived, backed by strong domestic demand. Sound economic fundamentals and a globally recognized competitive workforce reinforced the growth momentum. Having sustained average annual growth of 6.4% between 2010-2019 from an average of 4.6% between 2001-2009, the country is on its way from a lower middle-income country with a gross national income per capita of US$3,830 in 2018 to an upper middle-income country (per capita income range of US$3,956–$12,235) in the near term.. The country also has a robust framework for promoting organized industrialization through the nodal agency PEZA which is similar in principle to the existent of BEZA in Bangladesh. The GDP trend of Philippines exhibit sustained growth levels as depicted below in the graph. **Data used for the analysis is the latest data point available in the respective database.**

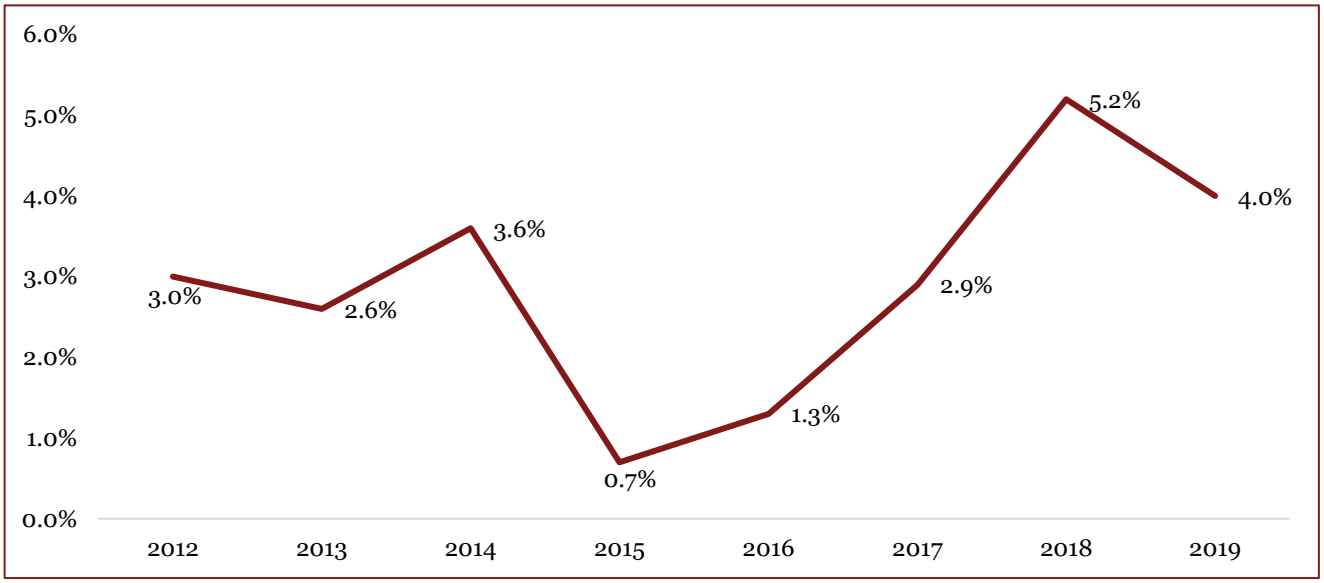
Figure 16: GDP Trend of Philippines



Source: World Bank

The following graph elucidates the inflation trend of Philippines. **Data used for the analysis is the latest data point available in the respective database.**

Figure 17: Inflation Trend of Philippines



Source: World Bank

Other macro-economic parameters of Philippines are presented below –

Table 9: Macro-economic Parameter of Philippines

Macroeconomic Indicator	Description	Data Source
Unemployment	2.5%	The Heritage Foundation
FDI Inflow	USD 9.8 billion	The World Bank
Exports	USD 70.3 billion in 2019	ITC Trade Map
Imports	USD 112.9 billion in 2019	ITC Trade Map
Heritage Foundation's Index of Economic Freedom Rankings	70[43]	The Heritage Foundation
Cato Institute's Human Freedom ranking	76	Human Freedom Index | Cato Institute
World Economic Freedom's Global Competitive Index Rating	64	Global Competitiveness Index 2018–2019 rankings
WB Doing Business ranking	95	Doing Business 2020

Source: PwC Research

Although real economic growth slowed in 2019 but was still strong with 6.0% year-on-year. Growth is now projected to significantly decelerate this year due to the impact of the COVID-19 outbreak, through the slowdown in trade, investment, tourism, remittances, and social distancing—including the associated community quarantine. Nevertheless, economic growth is expected to rebound gradually in 2021-2022 as global conditions improve, and with more robust domestic activity bolstered by the public investment momentum and a boost from 2022 election-related spending.

Post analysis of the broad macro-economy of Philippines, an analysis of the selected zones/park has been provided below –

[43] *Source: https://www.heritage.org/index/ranking*

3.3.2.1. Camp John Hay, Baguio City, Philippines

Established on 1903 Camp John Hay has been the epitome of what the definition of class, luxury, and fun is not only in Baguio but also for the rest of the country.

Camp John Hay was formally turned over to the Philippine Government by the Americans in 1991. The Philippine Government then designated Camp John Hay to what it is today a tourist area, human resource development hub, and forest watershed reservation.

Figure 18: Camp John Hay, Baguio City

Source: Google Images

The detailed profiling of this tourism zone is provided below.

Table 10: Detailed profiling of John Hay SEZ

Factors	John Hay Special Economic Zone (JHSEZ)
Site	
Land Size (acres)	610 acres[44]
Number of Plots	Data Not Available
No. of Development Phases	The complete zone will be developed in one phase
Land Lease (+length)	Lands and buildings can be leased to foreign investors for a period not exceeding fifty (50) years, renewable once for a period not more than twenty-five (25) years.[45] The rate was not communicated by the authority, according to them it is confidential and negotiable.
Pre-Built Facilities (PBF) (Y/N)	PBF can be leased to foreign investors for a period not exceeding fifty (50) years, renewable once for a period not more than twenty-five (25) years
Lease Rate for PBF	According to the authority, the rate is confidential and negotiable
Infrastructure/Utilities	
Electrical Power Supply(Y/N and Capacity)	Bases Conversion and Development Authority (BCDA) is constructing a mini hydroelectric power plant of 4 megawatt capacity
Cost of Power (USD/ kWh)	0.14 USD/kWh[46]

[44] *Source:http://campjohnhaybaguio.com/*
[45] *Source:https://www.pna.gov.ph/articles/1044792*
[46] *Source:https://meralcomain.s3.ap-southeast-1.amazonaws.com/images/ckeditor-documents/2018_IEC_Study_Updated.pdf?null*

Factors	John Hay Special Economic Zone (JHSEZ)
Water Supply	Water supply to JHSEZ is provided from two natural springs as sources. Four more natural springs are planned to be developed which will supply water to the city and will have annual revenue of PHP 18 million.
Onsite Wastewater Treatment Plant (Y/N)	There is a waste water treatment plant to treat water from businesses[47]
Communication	The Department of Communications and Technology (DICT), Transmission Corp. (Transco), and the Benguet Electric Cooperative (Beneco) have signed a memorandum of agreement (MOA) to implement the National Broadband Pilot Project (NBP) in Camp John Hay
Accessibility	
Air	Nearest international airport is Clark International Airport which is 165 kilometers from Camp John Hay
Water	San Fernando Seaport is the nearest to camp John Hay and is situated at a distance of 62 kilometers
Road	Baguio is well connected by road to all major cities including Manila (247 km). Both shared and private vehicle are available for going to camp John Hay.
Rail	Baguio is connected by rail to Manila (247 km) and San Fernando (186 km). A monorail is being planned for the city.
Airline Operators	Major international airlines like Philippine Airlines, Qatar airways, Emirates, Cebu pacific, China Eastern Airlines operate flights to different parts of the world
Cost of Travel (to Clark International Airport)[48]- round trip	• Washington DC ~ USD 1,100 • London ~ USD 1,240 • Beijing ~ USD 360 • Canberra ~ USD 890 • Moscow ~ USD 730
Visa Rules	
Visa free entry	Tourists from 157 countries holding valid passports can enter Philippines without any visa for 30 days[49]
Accommodation	
Type	Quality accommodation categorized as superior, deluxe and suite are available both within and outside Camp John Hay
Cost (per room per night)[50]	• Superior ~ USD 65 • Deluxe ~ USD 72 • Studio Suite ~ USD 87 • One Bedroom Suite ~ USD 105
Manpower	
Workforce	5,830 people employed in 113 businesses in JHSEZ[51]
Average salaries in Philippines (per month)	• Manager ~ USD 2,122[52] • Engineer ~ USD 713[53] • Labour ~ USD 112[54]
Tourism Attractions	
Type of activities	Golf Course, Recreational and eco-cultural tourism, Wellness and medical tourism, Tree to adventure Zip line, Horseback riding and eco-walks

[47] *Source:http://www.bongar.info/WWTPProjects.html*
[48] *Source:https://www.makemytrip.com/*
[49] *Source:http://immigration.gov.ph/faqs/travel-req*
[50] *Source:https://campjohnhay.ph/accommodations/*
[51] *Source:https://122.49.208.67/index.php/government-owned-and-or-controlled-corporation-goccs/category/7206-2017?download=35706:annual-financial-report-for-government-corporations-volume-i*
[52] *Source:https://www.averagesalarysurvey.com/philippines*
[53] *Source: https://www.averagesalarysurvey.com/philippines*
[54] *Source: https://tradingeconomics.com/philippines/wages*

Factors	John Hay Special Economic Zone (JHSEZ)
Special Regime	
Yes/No	Yes, there's special regime for incentives
Fiscal Incentives[55]	
Income Tax Holiday (ITH)	• New enterprises in Greenfield and Brownfield Tourism Zones shall be entitled to six (6) years ITH from start of business operations, which may be extended up to a maximum of six (6) years if the enterprise 18 Investment Incentives in the Philippines 2015 undertakes substantial expansion or upgrade prior to the expiration of its first six (6) years ITH. • An existing enterprise in a Brownfield Zone may avail of a maximum of six (6) years non-extendible ITH if it undertakes extensive expansion or upgrade of facilities. • Net operating losses for any taxable year immediately preceding the current taxable year which had not been previously offset as deduction from gross income, may be carried over as deduction from gross income for the next six (6) consecutive years immediately following the year of the loss.
Gross Income Taxation	Final tax of five percent (5%) on gross income earned in lieu of all other national and local taxes, license fees, imposts and assessments, except real estate taxes, and such fees as may be imposed by Tourism Infrastructure and Enterprises Zone Authority (TIEZA), after the ITH.
Other Tax Facilities	• Exemption of one hundred percent (100%) from all taxes and customs duties on importation of capital investment and equipment that will be used directly, actually, and exclusively by the enterprise in its registered activity • Exemption from customs duties and national taxes on importation of transportation equipment and accompanying spare parts that are reasonably needed and will be exclusively used by the accredited enterprise, provided they are not manufactured locally in sufficient quantity, of comparable quality, and at reasonable prices.
Goods and Services	• Exemption of one hundred percent (100%) from all taxes and customs duties on importation of goods actually consumed in the course of services actually rendered by or through the registered enterprise, excluding goods imported for the purpose of operating a wholesale or retail establishment in competition with the Duty Free Philippines Corporation. • Tax credit equivalent to all national internal revenue taxes paid on all locally sourced goods and services directly or indirectly used by the registered enterprise within the TEZ.
Social Responsibility Incentive	Tax deduction equivalent to a reasonable percentage, not exceeding fifty percent (50%), of the cost of environmental protection or cultural heritage preservation activities, sustainable livelihood programs for local communities, and other similar services.
Non-Fiscal Incentives[56]	
Employment	Employment of foreign nationals in executive, supervisory, technical, and advisory positions for reasonable periods and under such terms as approved by TIEZA.
Immigration	• A foreign national with a minimum investment of US$200,000 in a registered enterprise shall be entitled to a special investor's resident visa enabling the foreign national to reside in the Philippines while his or her investment subsists.

[55] *Source: https://www.pwc.com/ph/en/business-guides/assets/documents/pwc-investment-incentives-in-the-philippines-2015.pdf*
[56] *Source:https://www.pwc.com/ph/en/business-guides/assets/documents/pwc-investment-incentives-in-the-philippines-2015.pdf*

Factors	John Hay Special Economic Zone (JHSEZ)
	• Working visas renewable every two (2) years shall be issued to foreign personnel and other aliens possessing highly-technical skills, subject to certain conditions.
Foreign Currency Transactions	Subject to appropriate rules and regulations of the Bangko Sentral ng Pilipinas, registered enterprises are guaranteed the right to repatriate entire proceeds of the liquidation of the foreign investment or remit earnings from foreign investment, in the currency in which the investment was originally made and at the exchange rate prevailing at the time of repatriation; and in the case of foreign loans and foreign obligations arising from technological assistance contracts, the right to remit at the exchange rate prevailing at the time of remittance such sums as may be necessary to meet the payment of interest and principal.
Requisition of Investment	Protection from requisition of the property of the registered enterprise except in cases of war or national emergency, subject to payment of just compensation and repatriation of such compensation.
Lease and Ownership of Land	• Subject to conditions set forth under the Investor's Lease Act, lands and buildings in each TEZ may be leased to foreign investors for a period not exceeding fifty (50) years, renewable once for a period not more than twenty-five (25) years. • Leasehold right acquired under long-term contracts may generally be sold, transferred, or assigned.

Source: PwC Research

3.3.2.2. Boracay Ecovillage Resort

The tropical beauty of the island is compounded by the green hills and accommodation arrangements on either side of the hills and the beaches gives one a retreat from the crowded city life to a life of tranquility and peace. However, the development of so many resorts and the growing population is posing a serious threat to Eco Tourism in Boracay. The commercialization of the area has threatened the flora and fauna of this heavenly island.

Eco Tourism in Boracay plays an important role in maintaining and improving the beauty of the place that can give the tourist a place worth a visit for years to come.

Figure 19: Boracay Ecovillage Resort

Source: Google Images

The detailed profiling of this tourism zone is provided in the next page.

Table 11: Detailed profiling of Boracay Ecovillage

Factors	Boracay Ecovillage
Site	
Land Size (acres)	195 acres[57]
Number of Plots	Data Not available
No. of Development Phases	The complete zone has been developed in one phase
Land Lease (+length)	Lands and buildings can be leased to foreign investors for a period not exceeding fifty (50) years, renewable once for a period not more than twenty-five (25) years[58]
Pre-Built Facilities (PBF) (Y/N)	There are no PBF offered
Lease Rate for PBF	Not applicable
Infrastructure/Utilities	
Electrical Power Supply(Y/N and Capacity)	Power is supplied from Panay Island
Cost of Power (USD/ kWh)	0.23 USD/kWh[59]
Drinking Water	Water supply is provided by Boracay Island Water Company (Boracay Water)[60]

[57] *Source:http://www.peza.gov.ph/images/Operating_Tourism_Economic_Zones.xls*
[58] *Source:https://www.jica.go.jp/english/our_work/evaluation/oda_loan/post/2006/pdf/project16_full.pdf*
[59]*Source: https://panayelectric.com/index.php/home/monthly-rate*
[60]*Source: https://www.manilawater.com/corporate/boracay-water/agos*

Factors	Boracay Ecovillage
Onsite Wastewater Treatment Plant (Y/N)	Waste water treatment facility is provided by is provided by Boracay Island Water Company (Boracay Water)
Communication	High speed internet connectivity is available on the island through private players like Kalibo cable
Accessibility	
Air	Kalibo International Airport (80 km) is the nearest international airport
Water	Cagban Port (8 km) and Caticlan Port (10 km) serve passengers in Boracay
Road	Nautical highways which are combination of highways and roll-on, roll-off services connect Boracay to major cities
Rail	Presently not connected by rail
Airline Operators	Major international airlines like Air Seoul, Cebu Pacific, China Eastern airlines, Philippine Airlines fly from Kalibo International airport
Cost of Travel- round trip (to Kalibo)[61]	• Washington DC ~ USD 1,000 • London ~ USD 960 • Beijing ~ USD 500 • Canberra ~ USD 600 • Moscow ~ USD 640
Visa Rules	
Visa free entry	Tourists from 157 countries holding valid passports can enter Philippines without any visa for 30 days[62]
Accommodation	
Type	Rooms and dormitories with different facilities are available for accommodation. Function hall and plenary hall is also available for hosting events
Cost (per room per night)[63]	• 5 Star ~ USD 290 • 4 Star ~ USD 97 • 3 Star ~ USD 55
Manpower	
Employment	Employment in tourism characteristic industries was estimated at 5.4 million in 2018 which accounted for 13 percent of total employment in the country.
Average salaries in Philippines (per month)	• Manager ~ USD 2122[64] • Engineer ~ USD 713[65] • Unskilled labour ~ USD 112[66]
Tourism Attractions	
Type of activities	Para sailing, Trekking, Freediving, Scuba diving, Nature tour, Kite surf, Zipline, Zorb riding
Special Regime	
Yes/No	Yes, there's special regime for incentives
Fiscal Incentives[67]	

[61] *Source:https://www.makemytrip.com/*
[62] *Source:http://immigration.gov.ph/faqs/travel-req*
[63] *Source:https://www.boracay-philippineshotel.com/travel-guides/Adventure_And_Recreation_In_Boracay/Eco_Tourism_In_Boracay.htm*
[64] *Source:https://www.averagesalarysurvey.com/philippines*
[65] *Source:https://www.averagesalarysurvey.com/philippines*
[66] *Source:https://tradingeconomics.com/philippines/wages*
[67] *Source: https://www.pwc.com/ph/en/business-guides/assets/documents/pwc-investment-incentives-in-the-philippines-2015.pdf*

Factors	Boracay Ecovillage
Income Tax Holiday (ITH)	• New enterprises in Greenfield and Brownfield Tourism Zones shall be entitled to six (6) years ITH from start of business operations, which may be extended up to a maximum of six (6) years if the enterprise 18 Investment Incentives in the Philippines 2015 undertakes substantial expansion or upgrade prior to the expiration of its first six (6) years ITH. • An existing enterprise in a Brownfield Zone may avail of a maximum of six (6) years non-extendible ITH if it undertakes extensive expansion or upgrade of facilities. • Net operating losses for any taxable year immediately preceding the current taxable year which had not been previously offset as deduction from gross income, may be carried over as deduction from gross income for the next six (6) consecutive years immediately following the year of the loss.
Gross Income Taxation	Final tax of five percent (5%) on gross income earned in lieu of all other national and local taxes, license fees, imposts and assessments, except real estate taxes, and such fees as may be imposed by Tourism Infrastructure and Enterprises Zone Authority (TIEZA), after the ITH.
Other Tax Facilities	• Exemption of one hundred percent (100%) from all taxes and customs duties on importation of capital investment and equipment that will be used directly, actually, and exclusively by the enterprise in its registered activity • Exemption from customs duties and national taxes on importation of transportation equipment and accompanying spare parts that are reasonably needed and will be exclusively used by the accredited enterprise, provided they are not manufactured locally in sufficient quantity, of comparable quality, and at reasonable prices.
Goods and Services	• Exemption of one hundred percent (100%) from all taxes and customs duties on importation of goods actually consumed in the course of services actually rendered by or through the registered enterprise, excluding goods imported for the purpose of operating a wholesale or retail establishment in competition with the Duty Free Philippines Corporation. • Tax credit equivalent to all national internal revenue taxes paid on all locally sourced goods and services directly or indirectly used by the registered enterprise within the TEZ.
Social Responsibility Incentive	Tax deduction equivalent to a reasonable percentage, not exceeding fifty percent (50%), of the cost of environmental protection or cultural heritage preservation activities, sustainable livelihood programs for local communities, and other similar services.
Non-Fiscal Incentives[68]	
Employment	Employment of foreign nationals in executive, supervisory, technical, and advisory positions for reasonable periods and under such terms as approved by TIEZA.
Immigration	• A foreign national with a minimum investment of US$200,000 in a registered enterprise shall be entitled to a special investor's resident visa enabling the foreign national to reside in the Philippines while his or her investment subsists. Working visas renewable every two (2) years shall be issued to foreign personnel and other aliens possessing highly-technical skills, subject to certain conditions.
Foreign Currency Transactions	Subject to appropriate rules and regulations of the Bangko Sentral ng Pilipinas, registered enterprises are guaranteed the right to repatriate

[68] *Source: https://www.pwc.com/ph/en/business-guides/assets/documents/pwc-investment-incentives-in-the-philippines-2015.pdf*

Factors	Boracay Ecovillage
	entire proceeds of the liquidation of the foreign investment or remit earnings from foreign investment, in the currency in which the investment was originally made and at the exchange rate prevailing at the time of repatriation; and in the case of foreign loans and foreign obligations arising from technological assistance contracts, the right to remit at the exchange rate prevailing at the time of remittance such sums as may be necessary to meet the payment of interest and principal
Requisition of Investment	Protection from requisition of the property of the registered enterprise except in cases of war or national emergency, subject to payment of just compensation and repatriation of such compensation.
Lease and Ownership of Land	• Subject to conditions set forth under the Investor's Lease Act, lands and buildings in each TEZ may be leased to foreign investors for a period not exceeding fifty (50) years, renewable once for a period not more than twenty-five (25) years. • Leasehold right acquired under long-term contracts may generally be sold, transferred, or assigned.

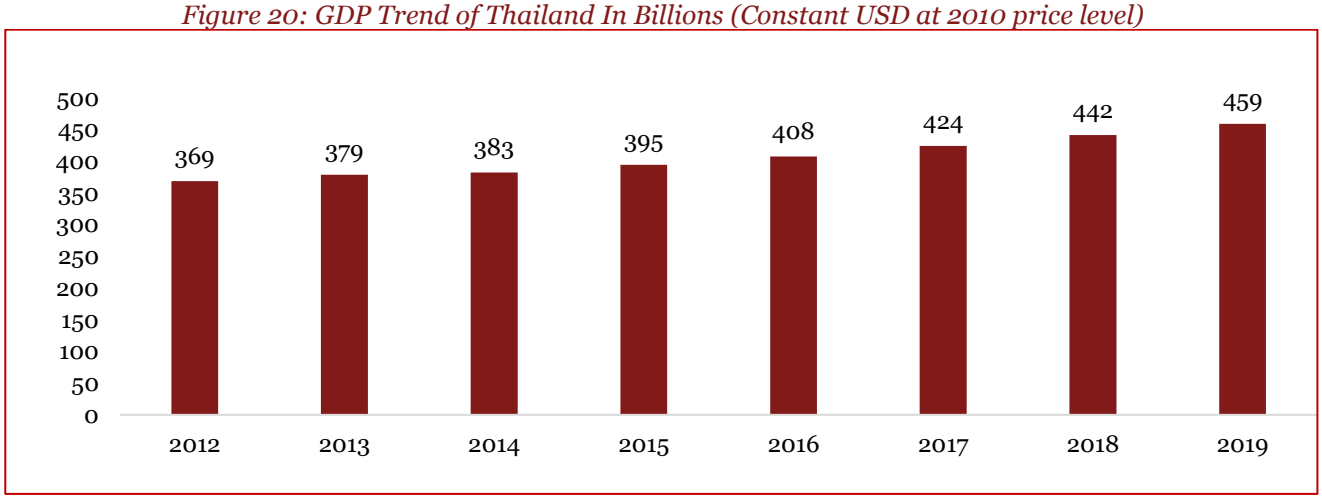
Source: PwC Research

3.3.3. Thailand

Over the last four decades, Thailand has made remarkable progress in social and economic development, moving from a low-income country to an upper-income country in less than a generation. As such, Thailand has been one of the widely cited development success stories, with sustained strong growth and impressive poverty reduction, particularly in the 1980s. Thailand introduced the policy of SEZ development in 2015, as an integral part of its expansive economic plan to promote trade and investment opportunities in border areas – connecting each zone with the respective bordering country in terms of trade, economy, and investment.

It has made a remarkable progress in terms of social and economic development and registered healthy GDP growth rates as depicted in the figure placed at next page. **Data used for the analysis is the latest data point available in the respective database.**

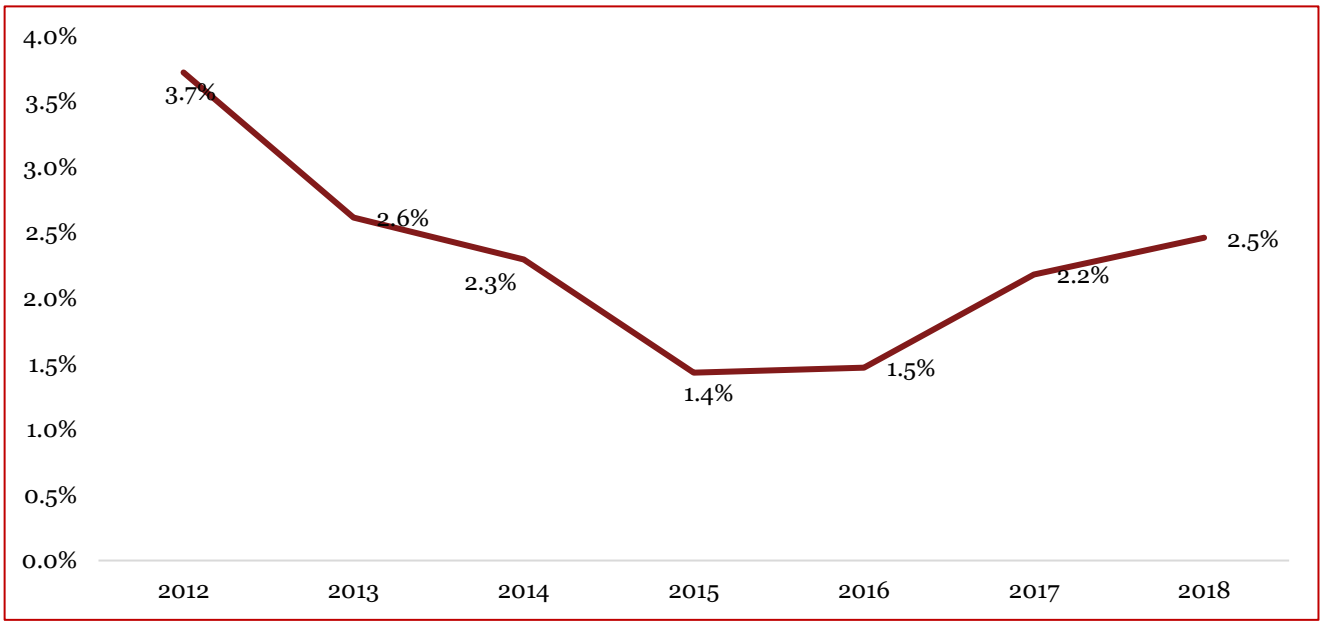
Figure 20: GDP Trend of Thailand In Billions (Constant USD at 2010 price level)



Source: World Bank (https://data.worldbank.org/country/thailand)

Inflation rates in Thailand have eased post a surge in the inflation rates owing to Core consumer prices in Thailand and the same is depicted below. **Data used for the analysis is the latest data point available in the respective database.**

Figure 21: Inflation Trend of Thailand



Source: World Bank (https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG)

The other macroeconomic indicators for the country have been summarized below:

Table 12: Macro-economic Parameter of Thailand

Macroeconomic Indicator	Description	Data Source
Unemployment	1%	Media articles
FDI Inflow	USD 6,316 million[69]	The World Bank
Exports	USD 245,380 million in 2019	ITC Trade Map
Imports	USD 240,139 million in 2019	ITC Trade Map
Heritage Foundation's Index of Economic Freedom Rankings	43 out of 180 in 2019	The Heritage Foundation
Cato Institute's Human Freedom ranking	98 out of 162 in 2019	Human Freedom Index | Cato Institute
World Economic Freedom's Global Competitive Index Rating	40 out of 141 in 2019	Global Competitiveness Index
WB Doing Business ranking	27 out of 190	World Bank Doing Business Rankings 2019

Source: Various trade and economic databases

Post identification of the various macro-economic parameters of Thailand, the subsequent section of the report intends to highlight the various attributes of each of the economic zones within the country.

3.3.3.1. Mu Ko Angthong National Marine Park

Mu Ko Ang Thong is a marine national park in the Gulf of Thailand in Surat Thani Province. The marine park covers a total of 42 islands. The park covers an area of 102 km^2, of which about 50 km^2 are land and the rest is water. The park was established on 12 November 1980. The name "Ang Thong" means bowl of gold and "Mu Ko" simply means "group of islands".

Figure 22: Mu Ko Angthong National Marine Park

Source: Google images

[69] *The amount represents Foreign direct investment, net inflows (Balance of Payments, current USD) for the year 2018*

The detailed profiling of this park is provided below.

Table 13: Detailed profiling of Mu Ko Ang Thong National Marine Park

Factors	Mu Ko Ang Thong Marine Park
Site	
Area	The park covers an area of 102 km², of which about 50 km² are land and the rest is water
Amenities	• Restaurant: Restaurant at the park main island is open daily 8 am till 10 P.M. • Electricity at the park is available only from 6 P.M. to 10 P.M. by diesel generator • Internet and mobile service: Free internet-WiFi signal is available on the main island near restaurant, also mobile signal is pretty good • Getting back from park: Transport back from the park to the Phangan or Samui island is charged 500 thb per person as company needs to keep a seat for you
Entrance fees	**Individuals Fees:** 300 Thai Baht/foreigner 150 Thai Baht/foreigner kid (under 12 years old) 50 Thai Baht/Thai person 25 Thai Baht/Thai kid (under 12 years old) **Boats parking and entrance fees:** 100 Thai Baht/1 outboard engine 300 Thai Baht/big slow boats **Next day pick up (overnighters)** 1000 Thai Baht per person as company needs to keep the seats for the person
Accessibility	
Air, Road and Water	Tourists can reach Koh Samui by air. After reaching the airport one can take cars or bus to the shore. From the shores, speed boats, safari boats and slow boats can be taken for day tours to explore 42 islands of the Angthong Marine Park. Speed boats are preferred as they are more safe, fast, comfortable and convenience than slow boats. Travel time by speed boat from Koh Phangan to Marine Park usually takes only 45 minutes. By slow boat it takes 2-3 hours, so with slow boats one is losing a lot of time to travel
Accommodation	
Bungalows	Most visitors arrive for a join-in day trip or by boat charter from Koh Samui or Koh Pha Ngan. For those who wish to stay overnight, there are six simple bungalows and camping tents available for rent at the Park Headquarters on Koh Wua Talab. The Park Headquarters has basic bungalow accommodation, visitor center, first aid tent and kayaks for rent.
Cost	600 Thai Baht per day for 2 bedroom cottage (Bungalows) Rent for tent for 2 persons is 250 Thai Baht per person per night
Attractions	
Ecology of the Park	Many marine creatures are adapted to the environment, and they live in forage, shelter and breed here. On land, the park supports several types of forest and wildlife such as, dry evergreen forest covers the large islands. An important plant in the park, Ang Thong Lady's Slipper Orchid, is an endemic species found only in Mu Ko Ang Thong. Limestone Mountain Forest consist of flora found in limestone crevices with little or no soil. They are often small, dry tolerant, and slow – growing species. Very little mangrove forest can also be seen. In general, the wildlife found consists of smaller animals, of which researchers have discovered 16 species of mammals, more than 50

Factors	Mu Ko Ang Thong Marine Park
	species of birds, 14 species of reptiles, and 5 species of amphibians. An interesting one to look out for is the Dusky Langur, which comes down to the park's headquarter allowing visitors to observe closely
Wildlife of the Park	Many species of animals are present on larger islands. The ones that are occasionally seen are: Spectacled langurs, Hairy-nosed otters, bats, Pacific reef-egret, Brahminy kite, White-bellied sea eagle, Common sandpiper, Edible nest Swiflet, Oriental pied hornbill, Southern pied hornbill, Ashy Drongo, Collared Kingfisher, Monitor lizards, Tortoises, Sea Turtles and Pythons. The coral development on the islands is not extensive and is restricted to a narrow band encircling each island close to the shore, especially on the southwestern and northeastern sides. Although the northwestern side of the islands is the area most influenced by the monsoon, in sheltered spots some good corals develop. Animals found inhabiting these reefs include; Butterflyfish, Angelfish, Parrotfish, Stingray, Black tip shark, Grouper and Cowrie shells.
Activities	
Type of activities	Snorkeling, Kayaking, Diving, Beach activities, Viewpoints, Emerald Lake, Sam Sao Island, Nature trails, Geological touring, Rock climbing, Over-night camping.
Kayaking	Sea kayaking in Angthong National Park is one of kayaking's most awe inspiring kayak destinations. With the mountains surrounding towering up to 400 meters above sea level, kayaking this part of Thailand is a must for any kayak-er looking for a beautiful, quiet, relaxing sea kayak adventure in one of the world's most stunning sea kayaking tour locations in Thailand
Diving	Scuba diving in the Park under good weather conditions is one of the best experiences for any diver visiting the marine park. Some recommended Dive Tour Sites are: Koh Yippon Lek, Koh Wao and Hin Yippon.
Hiking	Walking at Angthong Marine Park is probably one of the best hikes in Thailand. At park headquarters on Koh Wua Talab Island (Sleeping Cow) there is a path leading up the side of the rocks to take you as high as over then 500 meter above to sea level with spectacular view. This will take maybe 60 minutes to walk up but is well worth it. Please be warned this is not a hike for the faint-hearted. The climb is broken up by viewpoints every 100 meters.

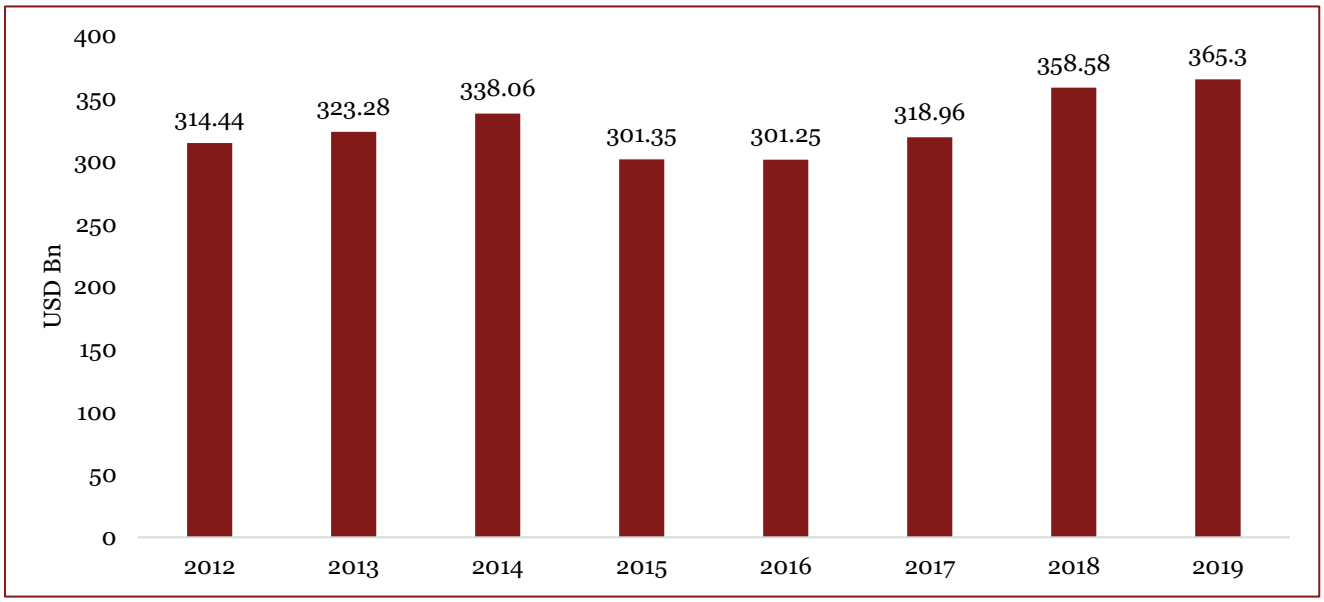
Source: https://www.angthongmarinepark.com

3.3.4. Malaysia

Since gaining independence in 1957, Malaysia has successfully diversified its economy from one that was initially agriculture and commodity-based, to one that now plays host to robust manufacturing and service sectors, which have propelled the country to become a leading exporter of electrical appliances, electronic parts and components. Malaysia is one of the most open economies in the world with a trade to GDP ratio averaging over 130% since 2010. Openness to trade and investment has been instrumental in employment creation and income growth, with about 40% of jobs in Malaysia linked to export activities. After the Asian financial crisis of 1997-1998, Malaysia's economy has been on an upward trajectory, averaging growth of 5.4% since 2010, and is expected to achieve its transition from an upper middle-income economy to a high-income economy by 2024.[70]
Data used for the analysis is the latest data point available in the respective database.

[70] *World Bank*

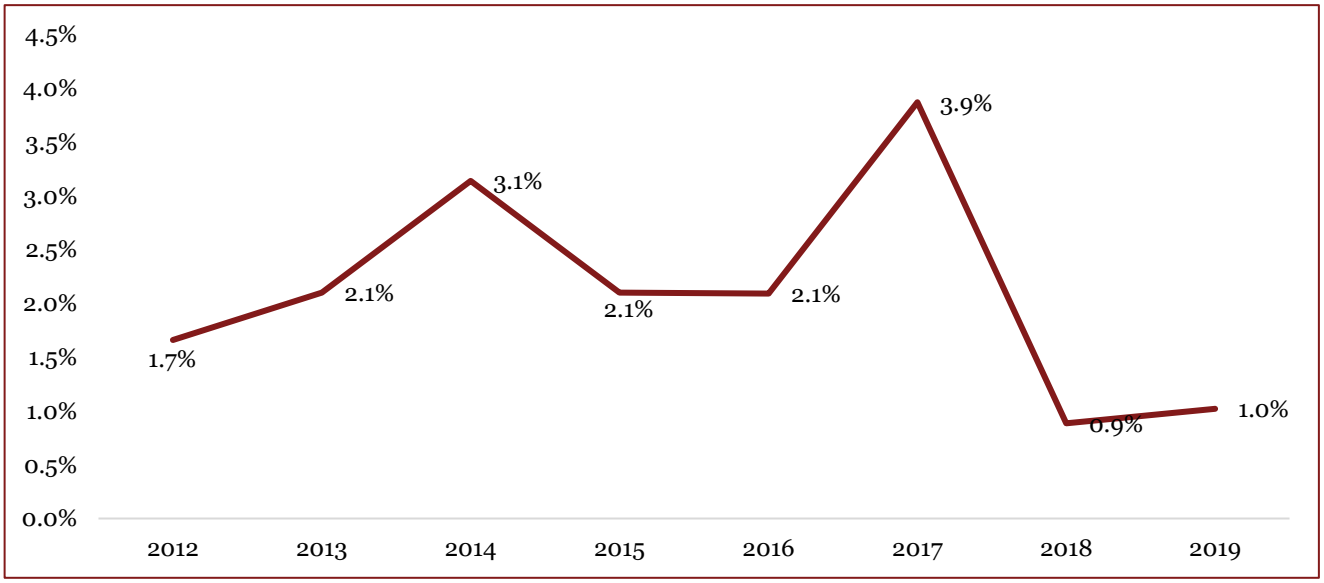
Figure 23: GDP Trend of Malaysia



Source: World Bank

The following graph elucidates the inflation trend of Malaysia. **Data used for the analysis is the latest data point available in the respective database.**

Figure 24: Inflation Trend of Malaysia



Source: World Bank

Other macro-economic parameters of Philippines are presented below –

Table 14: Macro-economic Parameter of Philippines

Macroeconomic Indicator	Description	Data Source
Unemployment	2.4%	The Heritage Foundation
FDI Inflow	USD 8.6 billion	The World Bank
Exports	USD 238.2 billion in 2019	ITC Trade Map

Macroeconomic Indicator	Description	Data Source
Imports	USD 205 billion in 2019	ITC Trade Map
Heritage Foundation's Index of Economic Freedom Rankings	24	The Heritage Foundation
Cato Institute's Human Freedom ranking	106	Human Freedom Index | Cato Institute
World Economic Freedom's Global Competitive Index Rating	27	Global Competitiveness Index 2018–2019 rankings
WB Doing Business ranking	12	Doing Business 2020

Source: PwC Research

Although the GDP of the country grew by 1.9% year on year, Growth is now projected to significantly decelerate this year due to the impact of the COVID-19 outbreak, through the slowdown in trade, investment, tourism, remittances, and social distancing—including the associated community quarantine. Malaysia's near-term economic outlook will be more dependent than usual on government measures to sustain private sector activity as the shock of COVID-19 reduces export-led growth, and as a depleted fiscal space limits public investment-led expansion. Over the longer term, as Malaysia converges with high-income economies, incremental growth will depend less on factor accumulation and more on raising productivity to sustain higher potential growth.

Post analysis of the broad macro-economy of Malaysia, an analysis of the shortlisted zone has been provided below –

3.3.4.1. Sunway Lagoon Theme Park

Sunway Lagoon is a theme park in Bandar Sunway, Subang Jaya, Selangor, Malaysia owned by Sunway group. The park began operations in 1992 and was officiated by the then Prime Minister of Malaysia. Since its opening it has made many changes and added newer rides and attractions to keep things interesting for the visitors.

Figure 25: Sunway Lagoon Theme Park

Source: Google images

The detailed profiling of this park is provided below.

Table 15: Detailed profiling of Sunway Lagoon Theme Park

Factors	Sunway Lagoon Theme Park
Site	
Area	The park is spread over an area of 88 acres and is built 150 feet below ground level
Amenities	Menara Sunway, Sunway Medical Center, Sunway University College, Sunway pyramid shopping mall, Sunway Resort and Spa are some of the facilities available at the park
Entrance fees	Adult (13 years old and above) : RM202 Child (12 years old and below) : RM170 Senior Citizen (60 years old and above) : RM170 (RM – Malaysian Ringgit)
Accessibility	
Road	Sunway Lagoon is located in the bustling township of Sunway City, within the district of Petaling Jaya in the state of Selangor. It is a mere 15-minutes' drive from Kuala Lumpur in smooth traffic conditions and is accessible via a network of expressways including the Federal Highway, Damansara-Puchong Expressway, New Pantai Expressway and KESAS Highway. Also, the park can be reached by the Sunway City Bus Rapid Transit System
Rail	• Via KTM Komuter Train: Take the train to the Subang Jaya Station then catch a feeder bus to the Sunway Pyramid stop • Via Putra LRT: Take the train to the Kelana Jaya Station then catch a feeder bus to the Sunway Pyramid stop.
Air	Subang Airport is the nearest airport to the park and it mainly serves domestic route. The remaining distance can be covered by rail or roadways. International tourists can arrive at Kuala Lumpur International airport and connect accordingly.
Accommodation	
Sunway Resort Hotel and Spa	If one needs a place to sleep, the Sunway Resort Hotel and Spa is just next door to the Sunway Lagoon Theme Park. There are dining options available here too.
Attractions	
Water Park	The first park to be introduced in the park and it features Waters of Africa with 13 attractions and Surf Beach with 9 attractions. The Waters of Africa has 2 water playground areas for young children. Other water rides includes Cameroon Climb, African Python, Congo Challenge, Vuvuzela and Waterplexx 5D.
Scream Park	The Scream Park designed strictly for ages above 7 years old, provides 4 interactive "scare" experience by using audio, visual effects and live actors
Amusement Park	The park are divided to 2 sides, Wild West with 4 rides and World of Adventure with 9 rides/ attractions.
Extreme Park	The Extreme Park features activities including paint ball, bungee trampoline, kayaking, paddle boat, swan ride, All-terrain vehicles (ATV), archery, flying fox, go kart, g-force and bungee jump.
Wildlife Park	The Wildlife Park is an interactive and educational zoo with exotic, small and friendly animals from a range of birds, reptiles and mammals. The Wildlife Park is home to more than 140 species
Nickelodeon Lost Lagoon	The first Nickelodeon-themed land in Asia, opens with 14 new rides that cater for all ages. Among the attractions are the SpongeBob Splash Adventure, Primeval, Jungle Fury and Monsoon 360
Activities and Shows	
Shows	Swashbuckling Pirates Show, SLIME Time, Wildlife Animal Show, Tale of Mount Berapi & Waves of Fun, Chill…Lah : Bring on the 60's Show

Factors	Sunway Lagoon Theme Park
Activities	Beach Soccer and Aqua Valley
Meet and Greet	Captain Quack & Lady Quack, Bani, Patches, Ara, Zola and Nickelodeon Meet & Greet: SpongeBob & Patrick
Concerts and Events	Sunway Lagoon has hosted some of the international lifestyle, music and sporting events including MTV World Stage and Quiksilver Revolution Tour. Other concert hosted are deadmau5, The Native Tour by OneRepublic, Pitbull and many more.

Source: https://sunwaylagoon.com

3.4. Comparative Analysis

This section gives a detailed comparison of macroeconomic indicators of countries and site specific parameters between proposed tourism zone site and its potential competitors in the region. Tables below provide an insight into macroeconomic performance indicators of the countries which are home to the tourism zones shortlisted as competitors to the proposed tourism zone. This comparison has been carried out to understand how Bangladesh fares with respect to these countries. This comparison is important as it helps investors in identifying opportunities based on top down approach.

Table 16: Macro-Economic indicators- Comparison of Competing Countries

Country	GDP (USD billion)	GDP annual growth rate (%)	GDP per capita (USD)	Inflation Rate (%)	Unemployment Rate (%)	Population (million)
Indonesia	1,206.6	4.8	3,870.6	3.5	4.3	264.2
Philippines	376.7	6.0	3,103.6	4.0	2.5	106.6
Thailand	520	1.3	7,187.2	2.5	0.7	68
Malaysia	365.3	1.9	10,941.7	2.4	3.4	32.4
Bangladesh	**317.5**	**7.8**	**1,744.5**	**5.6**	**4.3**	**164.9**

Source: World Bank

Table 17: FDI indicators

Country	FDI for 2018 (USD million)
Indonesia	1,206.6
Philippines	9,832.3
Thailand	6,316.4
Malaysia	8,570.0
Bangladesh	**2,940.2**

Source: World Bank

Table 18: Heritage Foundation Score (2019)

Country	Heritage Foundation Rating (global)	Individual country score	Freedom group ranking
Indonesia	54	67.2	Moderately free
Philippines	70	64.5	Moderately free
Thailand	43	68.3	Moderately free
Malaysia	24	74.7	Moderately free
Bangladesh	**122**	**56.4**	**Mostly unfree**

Source: The Heritage Foundation

Table 19: Global Competitiveness Ranking

Country	Global Competitiveness Ranking 2019	Country Score
Indonesia	50	64.6
Philippines	64	61.9
Thailand	38	67.5
Malaysia	27	74.6
Bangladesh	**105**	**52.1**

Source: World Economic Forum

Table 20: Global Financial Market Development Ranking (World Economic Forum 2019)

Country	Financial Market Development Ranking
Indonesia	58
Philippines	43
Thailand	16
Malaysia	15
Bangladesh	**106**

Table 21: World Bank Doing Business Ranking

Country	Ease of Doing Business Ranking 2019	Ease of Doing Business Ranking 2018	Rank Change
Indonesia	73	72	1 (Downwards)
Philippines	124	113	11 (Downwards)
Thailand	27	26	1 (Downwards)
Malaysia	15	15	(No change)
Bangladesh	**176**	**177**	1 (Upwards)

Source: World Bank

Table 22: World Bank Doing Business Components (Score)

Parameters	Indonesia	Philippines	Thailand	Malaysia	Bangladesh
Starting Business	81.22	71.97	92.72	82.78	**80.82**
Dealing with Construction Permits	66.57	68.58	71.86	86.96	**60.82**
Getting Electricity	88.38	87.45	98.57	99.27	**30.81**
Registering Property	61.67	57.56	69.47	80.38	**28.91**
Getting Credit	70	5	70.00	75.00	**25.00**
Protecting Minority Investors	63.33	43.33	75.00	81.67	**55.00**
Trading Across Borders	67.27	69.90	84.65	88.47	**31.76**
Enforcing Contracts	47.23	45.96	67.91	67.17	**22.21**

Source: World Bank

Table 23: World Economic Forum Travel and Tourism Competitiveness Components (Score)

Parameters	Indonesia	Philippines	Thailand	Malaysia	Bangladesh
Overall Score	4.16	3.60	4.5	4.5	**3.1**
Business Environment	4.54	4.32	4.9	5.5	**4.2**

Parameters	Indonesia	Philippines	Thailand	Malaysia	Bangladesh
Safety and Security	5.06	3.56	4.8	5.9	**4.9**
Health and Hygiene	4.30	4.79	5.0	5.3	**4.5**
Human Resources and Labour Market	4.64	4.78	5.1	5.4	**3.8**
ICT Readiness	3.81	3.96	5.2	5.4	**3.4**
Prioritization of Travel and Tourism	5.58	4.76	5.2	4.8	**3.6**
International Openness	4.27	3.37	3.9	4.5	**2.5**
Price Competitiveness	6.00	5.51	5.8	6.3	**5.3**
Environmental Sustainability	3.25	3.61	3.6	4.0	**3.8**
Air Transport Infrastructure	3.77	2.73	4.6	4.6	**2.0**
Ground and Port Infrastructure	3.20	2.47	3.3	4.5	**3.5**
Tourist Service Infrastructure	3.12	3.43	5.9	4.4	**1.9**
Natural Resources	4.75	3.95	4.8	3.8	**2.3**
Cultural Resources and Business Travel	3.28	1.92	2.6	2.6	**1.6**

Source: World Bank

Figure 26: Comparison of the subject economic zone with the competing zones worldwide

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
Land Size (acres)	8,967 acres (Developable area ~900 acres)	3,706 acres	3,125 acres	610 acres	195 acres
Number of Plots and operational units	The zone is divided into sub-zones details of which are furnished in the Master Plan chapter of this report	Data not available	A maximum of 140 plots to be leased over the life of the project[2]	Data not available	Data not available
No. of Development Phases	Captured in the Master Planning chapter of this report	The complete zone will be developed in two phases (Phase 1 of 1500 Ha and Phase 2 of 5500 Ha)	The complete zone will be developed in two phases over a period of 30 years	The complete zone will be developed in one phase	The complete zone has been developed in one phase
Land Lease (+length) or Sale	Annual land lease rates vary as per the type of development within the zone. • Accommodation & restaurants – BDT 20/ sq. ft./annum • Themed pavilion/museums – BDT 12/ sq. ft./annum • Themed gardens/parks – BDT 15/ sq. ft./annum • Villas & Cottages – BDT 20/ sq. ft./annum • Knowledge center – BDT 12/ sq. ft./annum • Eco-Science zone – BDT 12/ sq. ft./annum • Golf course & Club house – BDT 15/ sq. ft./annum	Land can be leased for up to 70 years and no minimum price has been fixed for leases	Land can be leased for up to 70 years	Lands and buildings can be leased to foreign investors for a period not exceeding fifty (50) years, renewable once for a period not more than twenty-five (25) years	Lands and buildings can be leased to foreign investors for a period not exceeding fifty (50) years, renewable once for a period not more than twenty-five (25) years

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
	• Adventure park – BDT 15/ sq. ft./annum These rates vary in case of PPP developer developing the project				
Onsite Independent Power (Y/N and Type)	Yes, there is provision for onsite power in the Master Plan	Capacity to provide electricity up to 100 MVA	Mandalika's projected power demand at full capacity will be 265 MVA. The State Electricity Utility (PLN) will be responsible for supplying reliable electricity to the Project while ITDC will be responsible for the transmission and distribution of electricity	Bases Conversion and Development Authority (BCDA) is constructing a mini hydroelectric power plant of 4 megawatt capacity	Power is supplied from Panay Island
Cost of Power (Taka/USD)	Cost of power is BDT 8.97/KwH	Cost of power varies between 0.075 USD / kWh to 0.11 cents USD / kWh according to type of business	0.07 USD per Kwh	0.14 USD/kWh	0.23 USD/kWh
Water Supply	Yes, provision for water supply is there in the Master Plan. The estimated water demand is 3.46 MLD	Drinking water Capacity of 100 ltr/sec and industrial water capacity of 300 ltr/sec	At full capacity, demand for potable water is estimated at 234 L/sec	Water supply to JHSEZ is provided from two natural springs as sources. Four more natural springs are planned to be developed which will supply water to the city and will have annual revenue of PHP 18 million.	Water supply is provided by Boracay Island Water Company
Cost of Water (Taka/USD)	Cost of water is BDT 33.21/'000 liters	Data not available	0.17 to 0.33 USD per cum	Data not available	Data not available

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
Onsite Wastewater Treatment Plant (Y/N)	Yes, there is provision for the same in the Master Plan	There is a waste water treatment plant to treat water from businesses	Wastewater Treatment Plants (WWTPs) in each of the western and eastern zones with a maximum total capacity of 20,000 m3 /day	There is a waste water treatment plant to treat water from businesses	Waste water treatment facility is provided by is provided by Boracay Island Water Company
Communication	Yes, there is provision for the same in the Master Plan	Wireless and fiber optic cables for high speed connectivity	Wireless and fiber optic cables for high speed connectivity	The Department of Communications and Technology (DICT), Transmission Corp. (Transco), and the Benguet Electric Cooperative (Beneco) have signed a memorandum of agreement (MOA) to implement the National Broadband Pilot Project (NBP) in Camp John Hay	High speed internet connectivity is available on the island through private players like Kalibo cable
Air	Nearest airport is Cox's Bazar Airport (domestic), 99 km from the proposed EZ	Nearest airport is Jakarta's Soekarno-Hatta International Airport (184 km). In the near future, government plans to build an airport in Banten Province (71 km)	Lombok International airport is 16 km (20 mins drive from the site). Air travel to Bali takes 25 mins from Lombok.	Nearest international airport is Clark International Airport which is 165 kilometers from Camp John Hay	Kalibo International Airport is the nearest international airport (80 km)
Water	Moheshkhali - Cox's Bazar boat line connects the Moheshkhali-Gorokghata ghat (8 km) with Kastura ghat (7.5 km).	Nearest seaport is Port of Merak which is almost 100 kilometers by road	The sea transport options for Lombok are fast boat services, RORO (Roll-on/Roll-off) ferries, and cruise ships. Foreign visitors typically take the frequent and direct 2-hour fast boats from Bali to the Gili Islands. Lembar Port located on the	San Fernando Seaport is the nearest to camp John Hay and is situated at a distance of 62 kilometers	Cagban Port (8 km) and Caticlan Port (10 km) serve passengers in Boracay

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
			western coast is the most important harbor in Lombok, primarily used for inter-island freight and passenger transport.		
Road	Dhaka Chittagong National Highway is one of the strategic highways in Bangladesh. Proposed EZ is located about 52 km from the national highway and access takes place via zilla roads and regional highway	Tanjung Lesung is well connected by road to nearby towns. Government has planned a toll road that's located not far away from SEZ Tanjung Lesung. In addition, the government has planned to build the Selat Sunda Bridge which will connect Sumatera Island and Java Island.	At full capacity, Mandalika will feature a 55.25 km road network, including 35.15 km of local roads (ROW8-30), 11.2 km of main collector roads (ROW45-50), a 6.03 km ROW60 east-west backbone, a 0.65 km ROW80 section and a 2.23 km ROW90 connecting to the future airport by-pass	Baguio is well connected by road to all major cities including Manila. Both shared and private vehicle are available for going to camp John Hay.	Nautical highways which area combination of highways and roll-on, roll-off services connect Boracay to major cities
Rail	Presently not connected by rail	Presently not connected by rail	Presently not connected by rail	Baguio is connected by rail to Manila and San Fernando. A monorail is being planned for the city.	Presently not connected by rail
Airline Operators	Major international airlines like Singapore airlines, Emirates, Air Asia, Air India, Qatar, Thai Airways operate flights from Dhaka	Major international airlines like Singapore airlines, Emirates, Air Asia, Air China operate flights to different parts of the world	Major international airlines like Singapore airlines, Emirates, Air Asia, Air China operate flights to different parts of the world	Major international airlines like Philippine Airlines, Qatar airways, Emirates, Cebu pacific, China Eastern Airlines operate flights to different parts of the world	Major international airlines like Air Seoul, Cebu Pacific, China Eastern airlines, Philippine Airlines fly from Kalibo International airport
Cost of Travel-round trip	• Washington DC ~ USD 1,050 • London ~ USD 850 • Beijing ~ USD 360 • Canberra ~ USD 500 Moscow ~ USD 680	• Washington DC ~ USD 1,260 • London ~ USD 1,070 • Beijing ~ USD 724 • Canberra ~ USD 850 • Moscow ~ USD 580	• Washington DC ~ USD 1,260 • London ~ USD 1,070 • Beijing ~ USD 724 • Canberra ~ USD 850 • Moscow ~ USD 580	Washington DC ~ USD 1,100 • London ~ USD 1,240 • Beijing ~ USD 360 • Canberra ~ USD 890 • Moscow ~ USD 730	Washington DC ~ USD 1,000 • London ~ USD 960 • Beijing ~ USD 500 • Canberra ~ USD 600 • Moscow ~ USD 640

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
Visa for Tourists	Bangladesh provides visa on arrival facility to nationals of some countries for single entry and staying up to a maximum of 30 days	Tourists from 169 countries holding valid passports can enter Indonesia without any visa for 30 days	Tourists from 169 countries holding valid passports can enter Indonesia without any visa for 30 days	Tourists from 157 countries holding valid passports can enter Philippines without any visa for 30 days	Tourists from 157 countries holding valid passports can enter Philippines without any visa for 30 days
Type	To be finalized during draft final report	Beach side hotels, villas and backpacker tents equipped with all modern amenities are available for accommodation	Hotels with different star ratings and all facilities are available	Quality accommodation categorized as superior, deluxe and suite are available both within and outside Camp John Hay	Rooms and dormitories with different facilities are available for accommodation. Function hall and plenary hall is also available for hosting events
Cost	To be finalized during draft final report	• Beach hotel ~ USD 85 • Villas ~ USD 177 • Backpacker tent ~ USD 35	For 5 star hotels, USD 140 / night For others, USD 30/ night[71]	• Superior ~ USD 65 • Deluxe ~ USD 72 • Studio Suite ~ USD 87 • One Bedroom Suite ~ USD 105	• 5 Star ~ USD 290 • 4 Star ~ USD 97 • 3 Star ~ USD 55
Average salary (per month)	• Manager ~ USD 533[72] • Engineer ~ USD 490[73] • Skilled labour ~ USD 114 Unskilled labour ~ USD 61	• Manager ~ USD 2247[74] • Skilled labour ~ USD 337[75]	• Manager ~ USD 2247[77] [78]Skilled labour ~ USD 337[79] • Unskilled labour ~ USD 218[80]	Manager ~ USD 2122[81] • Engineer ~ USD 713[82] • Labour ~ USD 112[83]	Manager ~ USD 2122[84] • Engineer ~ USD 713 • Labour ~ USD 112

[71] *https://tradingeconomics.com/bangladesh/indicators*
[72] *https://tradingeconomics.com/bangladesh/indicators*
[73] *https://paycheck.in/main/salary/minimumwages/west-bengal*
[74] *Source: https://tradingeconomics.com/bangladesh/indicators*
[75]*https://tradingeconomics.com/bangladesh/indicators*
[77] *https://paycheck.in/main/salary/minimumwages/west-bengal*
[78] *https://paycheck.in/main/salary/minimumwages/west-bengal*
[79] *https://paycheck.in/main/salary/minimumwages/west-bengal*
[80] *https://tradingeconomics.com/bangladesh/indicators*
[81]*https://tradingeconomics.com/bangladesh/indicators*
[82] *https://paycheck.in/main/salary/minimumwages/west-bengal*
[83] *https://paycheck.in/main/salary/minimumwages/west-bengal*
[84] *https://tradingeconomics.com/bangladesh/indicators*

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
		• Unskilled labour ~ USD 218[76]			
Activities	Captured in Master Plan chapter of this report	Spa, Bar, Café, Karaoke, Golf course, Theme park, Water park, Marina, Culture and nature tourism, Ujung Kulon National park	Water Sports, Leisure activities, Shopping, Beaches, MICE, Golf course, Cruise service, Underwater Tourism, Water Park, Theme Parks	Golf Course, Recreational and eco-cultural tourism, Wellness and medical tourism, Tree to adventure Zip line, Horseback riding and eco-walks	Para sailing, Trekking, Freediving, Scuba diving, Nature tour, Kite surf, Zipline, Zorb riding
Yes/No	Yes, there's a special regime incentive	No, there's no special regime for incentives	No, there's no special regime for incentives	Yes, there's a special regime for incentives	Yes, there's a special regime for incentives
Corporate Tax Reduction	50% Exemption of stamp duty and registration fees for registration of leaseholder land/factory space	• For an investment of greater than 1000 Billion Rupiah CIT reduction to the tune of 20% to 100% will be provided for a period of 10 to 25 years • For an investment between 500 to 1000 billion Rupiah CIT reduction of 20% to 100% will be provided for period of 5 to 15 years For an investment of less than 500 Billion Rupiah CIT reduction for a period of 5-15 years will be provided and value will be decided by Ministry of Finance	For an investment of greater than 1000 Billion Rupiah CIT reduction to the tune of 20% to 100% will be provided for a period of 10 to 25 years For an investment between 500 to 1000 billion Rupiah CIT reduction of 20% to 100% will be provided for period of 5 to 15 years • For an investment of less than 500 Billion Rupiah CIT reduction for a period of 5-15 years will be provided and value will be decided by Ministry of Finance	• New enterprises in Greenfield and Brownfield Tourism Zones shall be entitled to six (6) years ITH from start of business operations, which may be extended up to a maximum of six (6) years if the enterprise 18 Investment Incentives in the Philippines 2015 undertakes substantial expansion or upgrade prior to the expiration of its first six (6) years ITH. An existing enterprise in a Brownfield Zone may avail of a maximum of	• New enterprises in Greenfield and Brownfield Tourism Zones shall be entitled to six (6) years ITH from start of business operations, which may be extended up to a maximum of six (6) years if the enterprise 18 Investment Incentives in the Philippines 2015 undertakes substantial expansion or upgrade prior to the expiration of its first six (6) years ITH. An existing enterprise in a Brownfield Zone

[76] *https://tradingeconomics.com/bangladesh/indicators*

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
				six (6) years non-extendible ITH if it undertakes extensive expansion or upgrade of facilities. Net operating losses for any taxable year immediately preceding the current taxable year which had not been previously offset as deduction from gross income, may be carried over as deduction from gross income for the next six (6) consecutive years immediately following the year of the loss.	may avail of a maximum of six (6) years non-extendible ITH if it undertakes extensive expansion or upgrade of facilities. Net operating losses for any taxable year immediately preceding the current taxable year which had not been previously offset as deduction from gross income, may be carried over as deduction from gross income for the next six (6) consecutive years immediately following the year of the loss.
Income Tax Allowance	Income Tax exemption for 10 years	Taxpayers that have been rejected for the CIT Reduction facility and taxpayers carrying out other activities in a Special Economic Zone (Kawasan Ekonomi Khusus/KEK) may apply for Income Tax Allowance that provides the following: A reduction in net taxable income of up to 30% of the amount invested in the form of fixed assets (including land), prorated at 5% for six years of commercial production provided that the assets invested are not misused	Taxpayers that have been rejected for the CIT Reduction facility and taxpayers carrying out other activities in a Special Economic Zone (Kawasan Ekonomi Khusus/KEK) may apply for Income Tax Allowance that provides the following: • A reduction in net taxable income of up to 30% of the amount invested in the form of fixed assets (including land), prorated at 5% for six years of commercial production provided that the assets invested are not misused or transferred within a certain period	Final tax of five percent (5%) on gross income earned in lieu of all other national and local taxes, license fees, imposts and assessments, except real estate taxes, and such fees as may be imposed by Tourism Infrastructure and Enterprises Zone Authority (TIEZA), after the ITH.	Final tax of five percent (5%) on gross income earned in lieu of all other national and local taxes, license fees, imposts and assessments, except real estate taxes, and such fees as may be imposed by Tourism Infrastructure and Enterprises Zone Authority (TIEZA), after the ITH.

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
		or transferred within a certain period • Acceleration of fiscal depreciation and amortization deductions • A reduction in the withholding tax rate on dividends paid to non-residents to 10% or the applicable reduced tax treaty rate • Extension of tax-loss carry forward for more than five years but not more than ten years	• Acceleration of fiscal depreciation and amortization deductions • A reduction in the withholding tax rate on dividends paid to non-residents to 10% or the applicable reduced tax treaty rate • Extension of tax-loss carry forward for more than five years but not more than ten years		
Other Tax Facilities		On top of the Income Tax facilities mentioned above taxpayers in a KEK are also entitled to the following tax facilities: • Non-collection of VAT and LST on the importation or domestic purchases of certain goods • Non-collection of VAT and LST on the delivery of certain goods between taxpayers in a KEK Non-collection of Article 22 Income Tax on imports Postponement of import duty on capital goods and equipment, and goods and materials for processing. Import duty is exempted on the import	On top of the Income Tax facilities mentioned above taxpayers in a KEK are also entitled to the following tax facilities: • Non-collection of VAT and LST on the importation or domestic purchases of certain goods • Non-collection of VAT and LST on the delivery of certain goods between taxpayers in a KEK Non-collection of Article 22 Income Tax on imports • Postponement of import duty on capital goods and equipment, and goods and materials for processing. Import duty is exempted on the import of capital goods to develop a KEK	• Exemption of one hundred percent (100%) from all taxes and customs duties on importation of capital investment and equipment that will be used directly, actually, and exclusively by the enterprise in its registered activity • Exemption from customs duties and national taxes on importation of transportation equipment and accompanying spare parts that are reasonably needed and will be exclusively used by the accredited enterprise, provided they are not manufactured locally in	• Exemption of one hundred percent (100%) from all taxes and customs duties on importation of capital investment and equipment that will be used directly, actually, and exclusively by the enterprise in its registered activity • Exemption from customs duties and national taxes on importation of transportation equipment and accompanying spare parts that are reasonably needed and will be exclusively used by the accredited enterprise, provided they are not manufactured locally in

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
		of capital goods to develop a KEK • Exemption of excise on goods to be used to produce non-excisable goods	• Exemption of excise on goods to be used to produce non-excisable goods	sufficient quantity, of comparable quality, and at reasonable prices.	sufficient quantity, of comparable quality, and at reasonable prices.
Additional Tax Incentives for Tourism SEZ		The following tax facilities are available in a KEK that focuses on tourism: VAT refund for foreigners on the purchase of goods from participating stores • Exemption of LST and Article 22 Income Tax on the purchase of residences in a KEK area Reduction/exemption of regional taxes and retribution	The following tax facilities are available in a KEK that focuses on tourism: VAT refund for foreigners on the purchase of goods from participating stores • Exemption of LST and Article 22 Income Tax on the purchase of residences in a KEK area • Reduction/exemption of regional taxes and retribution	• Exemption of one hundred percent (100%) from all taxes and customs duties on importation of goods actually consumed in the course of services actually rendered by or through the registered enterprise, excluding goods imported for the purpose of operating a wholesale or retail establishment in competition with the Duty Free Philippines Corporation. Tax credit equivalent to all national internal revenue taxes paid on all locally sourced goods and services directly or indirectly used by the registered enterprise within the TEZ.	• Exemption of one hundred percent (100%) from all taxes and customs duties on importation of goods actually consumed in the course of services actually rendered by or through the registered enterprise, excluding goods imported for the purpose of operating a wholesale or retail establishment in competition with the Duty Free Philippines Corporation. Tax credit equivalent to all national internal revenue taxes paid on all locally sourced goods and services directly or indirectly used by the registered enterprise within the TEZ.

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
Social Responsibility Incentive				Tax deduction equivalent to a reasonable percentage, not exceeding fifty percent (50%), of the cost of environmental protection or cultural heritage preservation activities, sustainable livelihood programs for local communities, and other similar services.	Tax deduction equivalent to a reasonable percentage, not exceeding fifty percent (50%), of the cost of environmental protection or cultural heritage preservation activities, sustainable livelihood programs for local communities, and other similar services.
Employment		Permission to hire foreign workers who have position as directors or managers • Establishment of Wage council, Trade/Labor unions, Tripartite cooperation institution within SEZ	• Permission to hire foreign workers who have position as directors or managers • Establishment of Wage council, Trade/Labor unions, Tripartite cooperation institution within SEZ	Employment of foreign nationals in executive, supervisory, technical, and advisory positions for reasonable periods and under such terms as approved by TIEZA.	Employment of foreign nationals in executive, supervisory, technical, and advisory positions for reasonable periods and under such terms as approved by TIEZA.
Immigration	Resident visa for investment of US$75,000 or more Citizenship for investment of US$ 10,00,000 or more incentive	Ease of entry for foreign business people	Ease of entry for foreign business people	A foreign national with a minimum investment of US$200,000 in a registered enterprise shall be entitled to a special investor's resident visa enabling the foreign national to reside in the Philippines while his or her investment subsists. • Working visas renewable every two (2) years shall be issued to foreign personnel and other aliens possessing	A foreign national with a minimum investment of US$200,000 in a registered enterprise shall be entitled to a special investor's resident visa enabling the foreign national to reside in the Philippines while his or her investment subsists. • Working visas renewable every two (2) years shall be issued to foreign personnel and other aliens possessing

Factors	Sonadia Economic Zone	Tanjung Lesung SEZ	Mandalika Special Economic Zone	John Hay Special Tourism Economic Zone	Boracay Ecovillage Resort
				highly-technical skills, subject to certain conditions.	highly-technical skills, subject to certain conditions.
Licensing	One stop service is available	• Administered in Integrated One Stop Service • Easiness for business licensing, industry and trade activity, port activity and other business activities	Administered in Integrated One Stop Service • Easiness for business licensing, industry and trade activity, port activity and other business activities		
Land		• Ease in obtaining land rights and land acquisition • Granting land rights for those who already have land	Ease in obtaining land rights and land acquisition • Granting land rights for those who already have land	Subject to conditions set forth under the Investor's Lease Act, lands and buildings in each TEZ may be leased to foreign investors for a period not exceeding fifty (50) years, renewable once for a period not more than twenty-five (25) years. • Leasehold right acquired under long-term contracts may generally be sold, transferred, or assigned.	• Subject to conditions set forth under the Investor's Lease Act, lands and buildings in each TEZ may be leased to foreign investors for a period not exceeding fifty (50) years, renewable once for a period not more than twenty-five (25) years. • Leasehold right acquired under long-term contracts may generally be sold, transferred, or assigned.
Requisition of Investment				Protection from requisition of the property of the registered enterprise except in cases of war or national emergency, subject to payment of just compensation and repatriation of such compensation	Protection from requisition of the property of the registered enterprise except in cases of war or national emergency, subject to payment of just compensation and repatriation of such compensation

Source: PwC Research

3.5. Key Takeaways

Table in the previous page provides a detailed comparative study of four tourism based economic zones, which could compete with the proposed tourism zone. The tourism zones studied for comparative purpose are located in South East Asia region, have similar geography and have similar offerings as the proposed tourism zone. Key observations from this exercise are:

Table 24: Key Takeaways

Hospitality and Food services	• Hospitality and food service sectors form the base of tourism industry, availability of manpower at low cost in Bangladesh will help in bringing down the cost of offerings to the tourists as compared to other countries. • This will help attracting tourists from countries with a burgeoning middle class.
Cost of Air travel	• Low cost of air travel will help in attracting greater number of price sensitive tourists (especially from the neighboring countries)
Travel Policies	• Already in place economic zone policy which offer incentive to investors will bring in capital to develop facilities for tourism based economic zone development. • Offering resident visa and citizenship at lower investment value as compared to its competitors will attract more number of foreign investors.
Economic Competitiveness of Host Country	• Bangladesh ranks 125th on travel and tourism competitiveness index published by World Economic Forum owing to poor infrastructure and other facilities conducive to tourism as compared to its peers. Considerable investment on developing these facilities is required to be able to compete with other tourism zones. • Capping foreign workers to a total of 5% of total manpower in the business might restrict inflow of skilled manpower required in tourism industry. • Bangladesh fares poorly in English proficiency index and ranks 63 among a total of 88 countries. Not being able to communicate well with the tourists might hinder the growth of tourism.

Source: PwC analysis

The EZ's considered in Indonesia and Philippines are SEZs dedicated to tourism. The other tourist attractions considered in the countries such as Malaysia and Thailand are tourist spots, but they are not SEZs dedicated to tourism. We have provided these examples so as to highlight the Accessibility, Attractions, Accommodation, Amenities and Activities in these places so that the same can be replicated in case of Sonadia Eco-tourism zone. Therefore, the comparative analysis has been done with respect to the EZs from the Indonesia and Phillipines and not the others. Similar, global case studies on tourism spots are placed in the annexures.

The comparative assessment with respect to competing developments is duly considered while preparing the masterplan and other related sections of this report

4. Market assessment

4.1. Key Objectives

Market assessment is a detailed and objective evaluation of a potential new project, business idea or investment. It is a comprehensive analysis of environment forces, market trends, entry barriers, competition, risks, and the company's resources and constraints. Market assessment is the crucial first step when venturing into a new market and helps us to understand the potential of the project, promote tourism & align tourism facilities with regard to best international practices. This section captures the holistic assessment of tourism as a sector in Bangladesh and gradually analyses the proposed EZ and the region surrounding the proposed Sonadia Eco-Tourism Park to shape up as tourism specific economic zone. After setting the action agendas necessary for the proposed EZ to shape up as a tourism location, next chapter delves into demand forecasting exercise to estimate the expected annual footfall at the proposed EZ and also forms recommendation on the product mix.

4.2. Methodology of Market Assessment

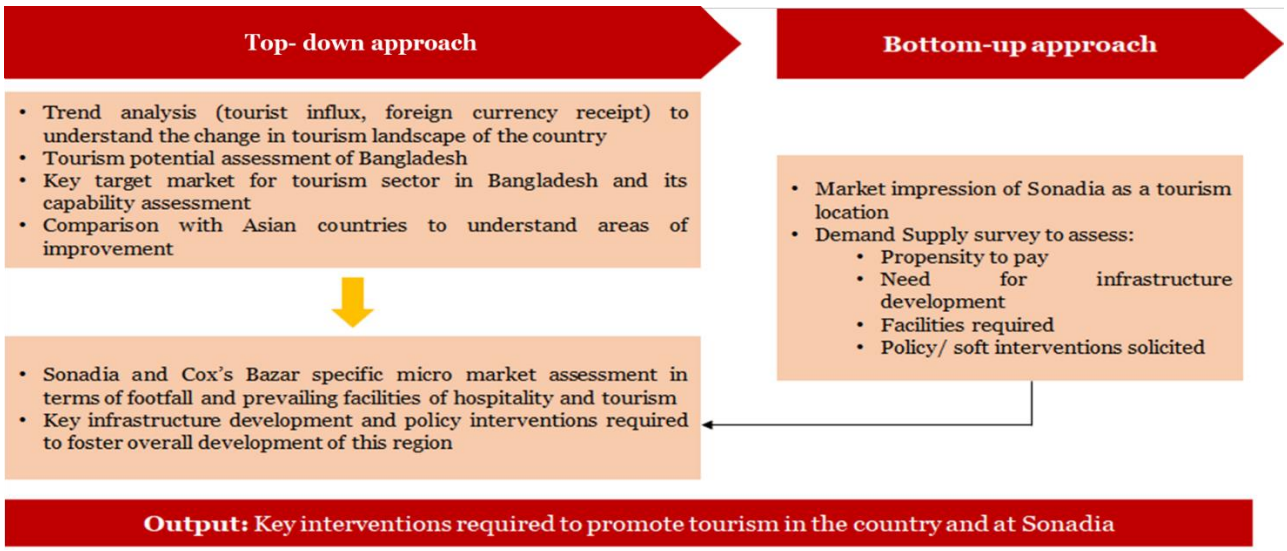
Market assessment exercise comprises of a two-pronged approach i.e. top-down and bottom-up.

The top-down approach takes into consideration a holistic assessment of the travel and tourism sector in the country context and brings out the key actions agendas for Government and key stakeholders. Trends of travel and tourism sector have been analyzed to understand the key interventions required to boost up this sector in Bangladesh. Further, this assessment converges to site and region specific attributes and analyze the key improvements solicited.

This assessment was undertaken using secondary data which was recorded by related authorities that are the Bangladesh Parjatan Corporation, Bangladesh Economic Review, World Bank Data, World Tourism and Travelling Council 2017 and the Travel and Tourism Competitiveness Report. Data and reports were reviewed and information from various tourism websites was also gathered to get a holistic view of the tourism sector outlook in Bangladesh. Using some simple statistical tools, all the data obtained from secondary sources are analyzed and finally a conclusion is drawn. Afterwards, some recommendations are made for the betterment of this sector so that the economy can get maximum benefit from tourism sector.

The bottom-up approach comprises of primary survey among domestic and foreign tourists and other key stakeholders (such as Govt. officials, hotels and hospitality sector professionals) to understand the market impression of Sonadia as a prospective location for tourism based development.

Figure 27: Approach for Market Assessment

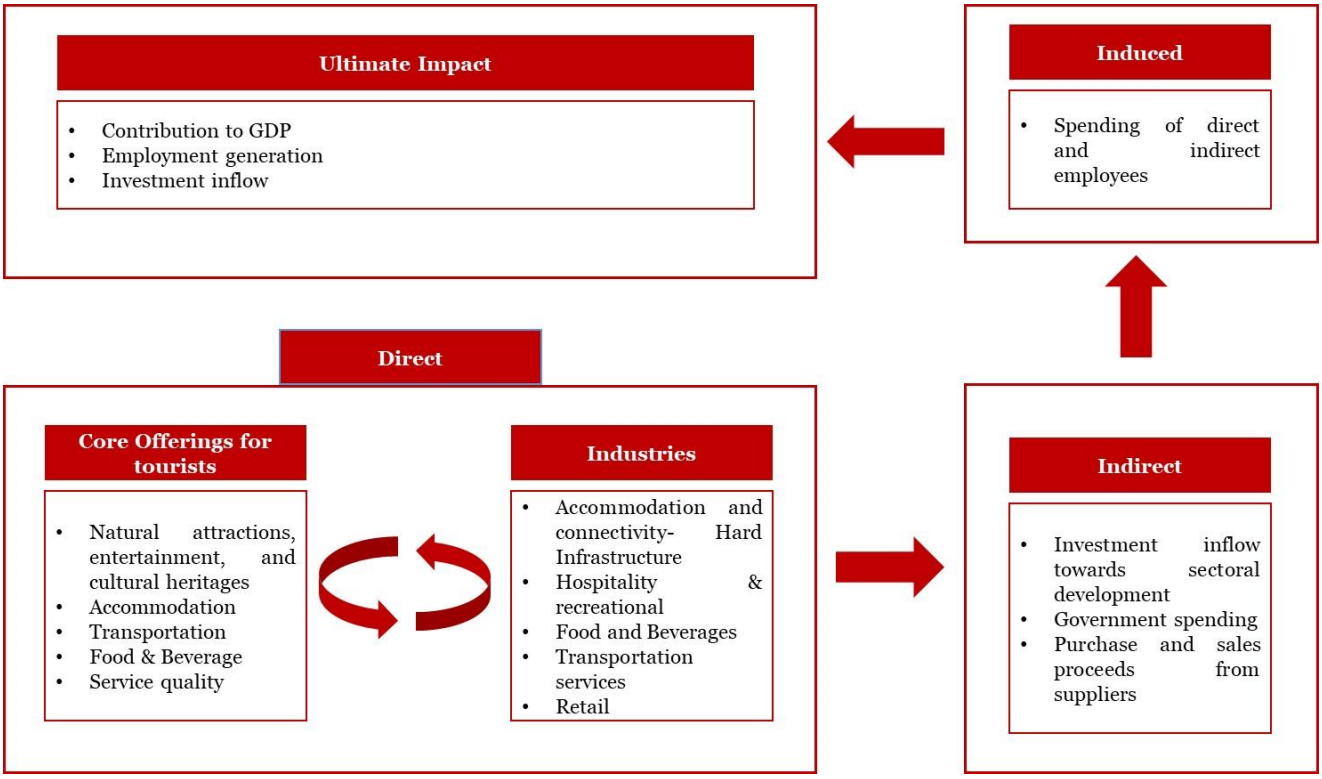


Source: PwC Methodology

4.3. Tourism Sector Outlook Assessment

Tourism sector plays an integral role in terms of foreign currency inflow, employment generation, and overall enhancement of Gross Domestic Product (GDP) of any economy. The core offerings of tourism sector are natural attractions & entertainments, accommodation, food & beverages, hospitality services, and transportation. These core offerings in turn drive various allied industries (such as but not limited to construction, retail, hospitality, service, transportation, medical, and food), which further contributes to investment inflow, employment generation and economic welfare of any economy.

Figure 28: Tourism sector- impact and ecosystem



Source: PwC Methodology

Following sections analyze the impact of tourism sector in Bangladesh context and the comparison with other countries.

4.3.1. How Tourism Sector is Changing Worldwide and in Bangladesh Context

Worldwide direct contribution of tourism sector to GDP in 2018 was USD 2, 570 billion (3.2% of global GDP), which is slated to rise up to USD 4,065 billion by 2029 (3.5% of global GDP). GDP contribution of tourism sector (in 2016) was greater than GDP contribution of automotive manufacturing and chemicals manufacturing sectors and it is nearly 60% of the size of the global construction sector. Tourism sector generated 122.8 million jobs directly in 2018 and it is forecasted to account for 154 million direct employment in 2029. Induced employment generated from this sector is almost twice the direct employment generated.[85]

While this sector has momentous contribution to economic welfare, worldwide international tourist arrival has surged from 0.81 billion (in 2005) to 1.40 billion (in 2018) registering 4.7% compounded annual growth rate (CAGR).[86] By 2028, international tourist arrival at world level is expected to grow up to 2.1 billion.[87]

[85] *World Travel and Tourism Council*
[86] *World Bank*
[87] *World Travel and Tourism Council*

South Asia and Association of South East Asian Nations (ASEAN) region is gradually shaping up as attractive tourist destination and tourism sector is thriving in this region. International tourist arrival to South Asia has increased seven times from 1995 (3.8 million) to 2017 (26.57 million).[88] Countries such as India, China, Thailand, Singapore, Maldives, Vietnam, and Sri Lanka have emerged out as attractive tourist locations. In addition to attractive natural beauties and cultural heritages, the key reasons behind this success story can be attributed to development and implementation of sectoral strategic roadmap, proactive government support & security, less restrictive visa policies, development of adequate allied infrastructure & transportation connectivity linkages, and preemptive skill development initiatives to bolster the service quality.

Comparison of Bangladesh with Asian countries reveals that the country lacks in terms of international tourist arrivals and tourism sector's contribution to economy. Further it is also understood that the perception of Bangladesh among the foreign tourists is relatively poor as compared to the other Asian countries. Countries such as Bhutan, Myanmar, and Cambodia had similar international tourist arrival figures in 1995, however, in recent times, these countries have surpassed Bangladesh; whereas, international tourist arrival to Bangladesh has remained almost same from 1995 to 2017.

Figure 29: International Tourist Arrivals in Asian Countries (Comparison with Bangladesh) - Figures in millions

Countries	1995	2000	2005	2010	2014	2016	2017
Bangladesh	**0.16**	**0.20**	**0.21**	**0.30**	**0.13**	**N/A**	**N/A**
India	2.12	2.65	3.92	5.78	13.11	14.57	15.5
China	20.03	31.23	46.81	55.66	55.62	59.27	60.7
Sri Lanka	0.40	0.40	0.55	0.65	1.53	2.05	2.11
Nepal	0.36	0.46	0.38	0.60	0.79	0.75	0.94
Bhutan	0.00	0.01	0.01	0.04	0.13	0.21	0.25
Myanmar	0.19	0.42	0.66	0.79	3.08	2.91	3.44
Vietnam	1.35	2.14	3.48	5.05	7.87	10.01	12.8
Cambodia	0.22	0.47	1.42	2.51	4.50	5.01	5.6
Thailand	6.95	9.58	11.57	15.94	24.81	32.53	35.4
Singapore	6.07	6.06	7.08	9.16	11.86	12.91	13.9
Maldives	0.32	0.47	0.40	0.79	1.21	1.29	1.38
Malaysia	7.47	10.22	16.43	24.58	27.44	26.76	26.0

Source: World Bank

As per World Travel and Tourism Council, International Tourist Inflow to Bangladesh in 2017 (projected) was 0.15 million. This laggard trend of tourist influx in the country can be attributed to various factors such as lack in security, inadequate infrastructure, lack in proliferation of technology, lack in promotion and marketing and many more. Following sections bring out the key agendas that need to be followed to boost tourism sector.

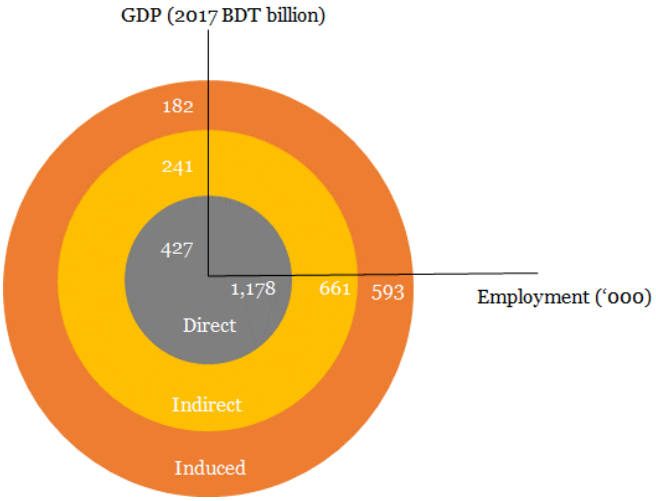
4.3.2. Overall Impact of Tourism Sector in Bangladesh

Tourism industry of Bangladesh has a number of positive impacts on the overall economy of this country. With tourism allied services (like hotels, restaurants, car rental agencies, tour companies, service stations, souvenir shops and much more) also thrive.

Travel & Tourism is an important economic activity in most countries around the world. As well as its direct economic impact, the industry has significant indirect and induced impacts. The direct contribution of tourism to GDP of Bangladesh is expected to rise from 2.2% of total GDP (in 2018) to 6.2% of total GDP (in 2028).

[88] *World Bank*

Figure 30: Bangladesh- Tourism sector impact (2017)



Source: World Travel & Tourism council

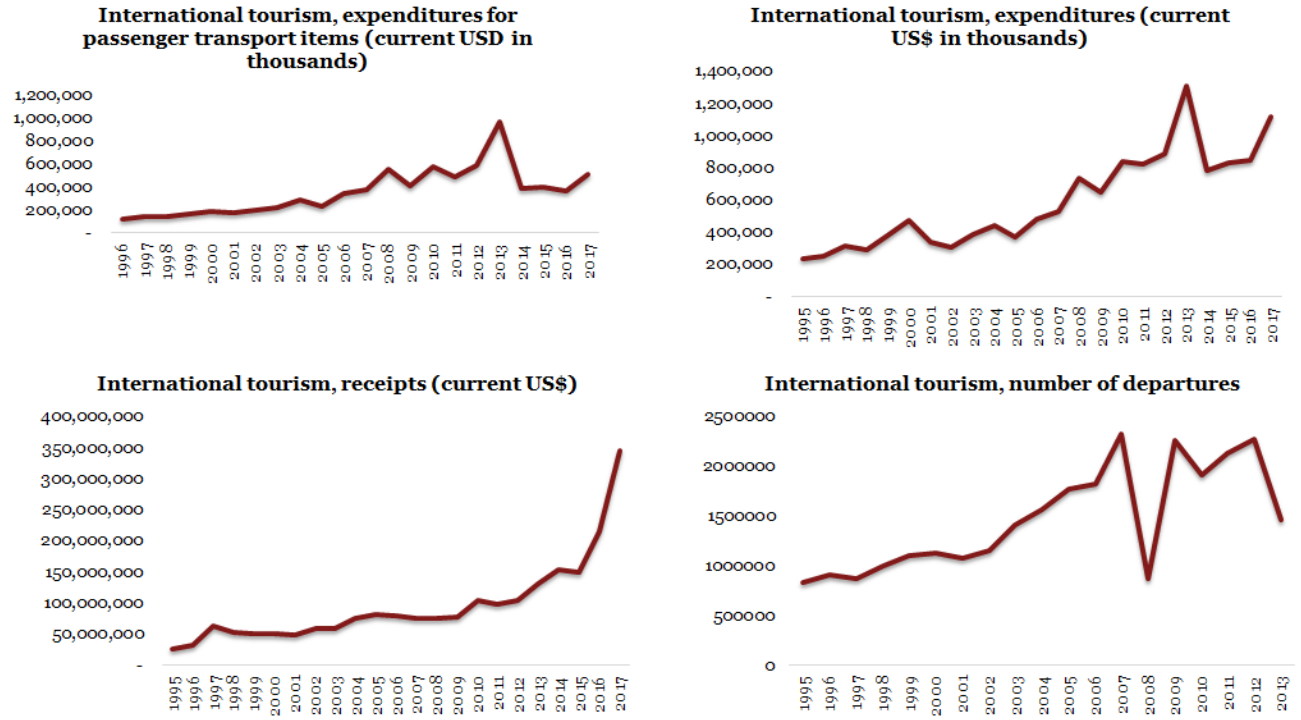
The contribution of travel and tourism to the employment including indirect jobs to the industry was 3.8% of total employment (24.32 lakh jobs). This is expected to rise by 2.5% in 2018 to 24.93 lakh jobs and rise by 2.7% pa to 32.44 lakh jobs in 2028 (4.2% of total).

Figure beside indicates the overall impact generated from tourism sector in the country.

Overall tourism sector is generating significant employment and also contributing to GDP, however a performance assessment with respect to the neighboring countries outlines that Bangladesh need to provide impetus in tourism sector growth.

Following figure capture the performance assessment of tourism sector in Bangladesh in light of various parameters.

Figure 31: Performance Assessment of Tourism Sector in Bangladesh



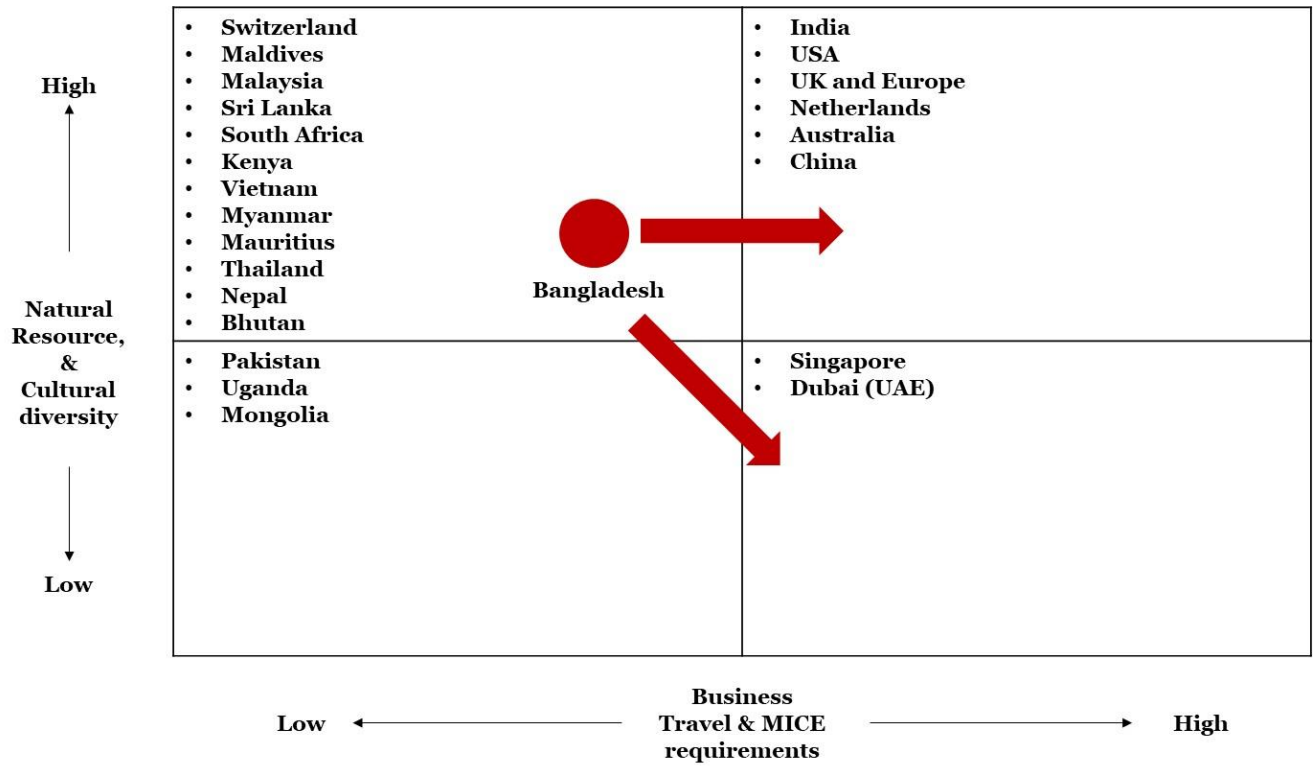
Source: Secondary Research and PwC analysis

While the receipts from international tourism is increasing with time, but it is explicit that the expenditure from the foreign tourists are not increasing in significant quantum. This can be attributed to the fact that the import in the country is increasing in rapid pace owing to increasing domestic consumption, however the inflow of foreign tourists is not surging significantly. Tourism sector in Bangladesh requires a structural transformation covering policy strengthening and infrastructure development. The country also lacks in terms of promotion and marketing, which does not create a long lasting impact about the country among the foreign tourists.

4.3.1. Performance Assessment of Tourism Sector in Bangladesh with respect to Other Countries

Bangladesh has prevailing natural resources and flora/ fauna which can be harnessed properly to promote tourism sector. Following figure elaborates the positioning of the country in terms of tourism potential assessment framework vis-à-vis globally.

Figure 32: Tourism Potential Assessment Framework- Positioning of Bangladesh



Source: PwC Analysis

Above figure indicates that the country (although rich in terms of natural resources and cultural diversity) has not attracted business travelers and MICE requirements (such as cosmopolitan ecosystem with upscale developments in entertainment/ recreational/ accommodation facilities). The aspirational position of the country could be to develop upscale entertainment and recreational facilities having focus on allied accommodation development so that it can cater to the premium segment (where currently countries like India, Singapore, Dubai, USA, and UK are positioned).

Case studies of countries which have excelled in tourism sector are furnished in the annexure. These case studies analyze key enablers required to promote tourism in Bangladesh context.

Table in the next page explains the comparison of Bangladesh with Asian countries in terms of Travel and Tourism Competitiveness Index (2017). This comparison elucidates how Bangladesh needs to focus on the following key aspects in order to promote tourism sector.

- Enabling environment
- Policy push
- Infrastructure
- Natural and Cultural resources

Table 25: Travel and Tourism Competitiveness Index – Comparison of Bangladesh with Asian countries

		Enabling Environment					Policy Push				Infrastructure			Natural & Cultural Resources	
Countries	Global Rank	Business Environment	Safety & Security	Health & Hygiene	HR and Labor Market	ICT Readiness	Sector Prioritization	International Openness	Price Competitiveness	Environmental Sustainability	Air Transport Infrastructure	Ground and port infrastructure	Tourist Service Infrastructure	Natural Resources	Cultural Resources & Business Travel
Taiwan, China	30	5.2	6.0	6.1	5.3	5.5	4.7	4.2	5.2	4.1	3.5	5.2	4.5	3.4	3.2
Singapore	13	6.1	6.5	5.5	5.6	6.1	6.0	5.2	4.7	4.3	5.3	6.3	5.4	2.4	3.1
Malaysia	26	5.4	5.8	5.2	5.2	5.2	4.7	4.1	6.1	3.5	4.5	4.4	4.7	4.1	2.9
Thailand	34	4.7	4.0	4.9	4.9	4.8	5.0	3.8	5.6	3.6	4.6	3.1	5.8	4.9	2.8
Indonesia	42	4.5	5.1	4.3	4.6	3.8	5.6	4.3	6.0	3.2	3.8	3.2	3.1	4.7	3.3
Sri Lanka	64	4.7	5.5	5.3	4.5	3.7	5.2	3.1	5.6	3.9	2.6	3.9	3.2	4.1	1.6
Vietnam	67	4.4	5.6	5.0	4.9	4.2	4.0	3.0	5.3	3.4	2.8	3.1	2.6	4.0	3.0
Philippines	79	4.3	3.6	4.8	4.8	4.0	4.8	3.4	5.5	3.6	2.7	2.5	3.4	4.0	1.9
Lao PDR	94	4.7	5.4	4.3	4.6	3.1	4.7	3.0	5.7	3.8	2.1	2.4	3.5	3.0	1.3
Cambodia	101	3.7	5.1	4.0	4.1	3.6	5.1	3.5	5.1	3.3	2.1	2.4	2.9	3.2	1.6
India	40	4.3	4.1	4.4	4.4	3.2	3.9	3.7	5.8	3.1	3.9	4.5	2.7	4.4	5.3
Bhutan	78	4.7	6.1	4.6	4.3	3.9	5.0	2.9	6.0	4.6	2.7	2.5	2.7	3.5	1.3
Nepal	103	4.1	4.8	5.0	4.2	2.6	4.8	2.8	5.6	3.4	2.0	1.9	2.3	4.2	1.3
Bangladesh	124	4.1	3.7	4.3	3.8	3.1	3.2	2.5	4.7	3.4	1.9	3.1	1.9	2.4	1.6

Source: World Economic Forum, Travel and Tourism Competitiveness Index (2017)

4.3.2. Types of Tourism in Bangladesh

The type of tourism depends on the reason for travel. Travel can be to destinations that are domestic or international. Domestic tourism involves residents travelling only within their country. International tourism may be inbound or outbound. Inbound tourism involves non-residents travelling within a country. Outbound tourism involves residents travelling within another country. Based on the purpose of visit, tourism is categorized into the following**:**

- **Leisure Tourism:** Tourists may travel to experience a change in climate and place and learn something new about the culture of a destination.
- **Cultural/Site tourism:** Cultural tourism gives insight to a way of people's life of a distant land, its dressing, jewelry, dance, music culture, as well as architecture, customs and traditions, fairs and festivals. Major number of tourists visiting Bangladesh is for scenic beauty and its culture (Leisure and Culture tourism). Around 46% of total number of foreign tourists visiting Bangladesh in 2009 came to enjoy the natural scenic beauty.
- **Religious tourism:** It is a form of tourism, where people travel individually or in groups for pilgrimage. Modern religious tourists visit holy cities and holy sites around the world. Bangladesh is the world's third-largest Muslim majority nation, with Muslims making up nearly 90 percent of its 144 million populations. She arranges so many religious programs like Bishwa Ijtema which attract Muslim around the world. In 2009, around 41% of total tourists come for religious purpose.
- **Family Tourism:** Family tourism involves the family unit and their participation in diverse forms of tourism activity.
- **Health/Medical Tourism:** Health tourism is also called as medical tourism. Today, many people travel great distances to exotic locations in search of medical treatment. Medical tourism is an old-aged concept that has gained popularity in the recent times. International standard hospitals in Bangladesh provide a good scope for medical tourism. Though Medical tourism isn't well recognized in Bangladesh, there is huge potential and opportunities in the future.
- **Sports Tourism:** Sports Tourism refers to travel which involves either viewing or participating in a sporting event staying apart from their usual environment. Normally these kinds of events are the motivators that attract visitors to visit the events like Olympic Games, FIFA World Cup etc.
- **Educational Tourism:** Educational tourism developed because of the growing popularity of teaching and learning of knowledge and the enhancing of technical competency outside of the classroom environment. In educational tourism, the focus of the tour is visiting another country to learn about the culture, such as in Student Exchange Programs and Study Tours, organizing specialized lectures of the eminent personalities and visiting for research. 2.42% for educational tourism in 2009.
- **Business Tourism:** Tourists visit a particular destination for various reasons pertaining to his work such as attending a business meeting, conferences, conventions selling products, meeting with clients. Business tourism is popularly called as MICE (Meetings, incentives, conferences, and exhibitions) tourism. Based on our natural resources galore, strategic geographic location, distinct competitive edge and comparative, industries have huge prospects to grow in Bangladesh to cater to the vast domestic market as well as to capitalize the privileged market access being enjoyed by Bangladesh from developed countries through export. 3.36% of tourists came for business tourism in 2009.
- **Office Tourism:** There are a number of global, international and multinational companies doing business in Bangladesh. Of these, mentionable are A. K. Khan & Co. Ltd, Avery Dennison Bangladesh Ltd., Berger Paints Bangladesh Limited, Bureau Veritas Consumer Products Services (Bangladesh) Ltd., and Novartis (Bangladesh) Limited. Many high officials and delegates visit Bangladesh for operation of their offices. 1.46% of tourists came for office tourism in 2009.

- **Other Tourism:** Other forms of tourism includes Bicycle touring, Boat sharing, Rural tourism, River cruise, Nautical tourism, Jihadi tourism, Halal tourism, Slum tourism, Virtual tourism, Walking tourism, Wildlife tourism and Water tourism.

As per the data available in Bangladesh Parjatan Corporation database, following is the pattern of visitor arrival by purpose (in descending order)-[89]

- Leisure
- Business
- Others
- Religious
- Study
- Office

4.3.3. Prospective Tourism Products in Bangladesh

Bangladesh has the potential to be a prime host of tourist destination as it has lots of tourists' attractions. The total scenario of tourism products/attractions can be discussed under the following broad categories of products:

Eco-Tourism products: Bangladesh is a country filled with natural wonders and untouched reserves and home to a variety of unique and magnificent creatures. With hills, valleys, forests, beaches, lakes and rivers, ecotourism in Bangladesh is ideal.

The Sundarbans is the world's largest mangrove forest and could be the goldmine for ecotourism in Bangladesh. The UNESCO has already declared Sundarbans as a world heritage site with a view to preserving and protecting biodiversity of the rare ecotourism.

Cox's Bazar is the tourist capital of Bangladesh with a 120 km long sandy, straight and drivable beach. Other special attractions of Cox's Bazar are Inani beach, the island of Moheshkhali (famous for its Buddhist and Hindu temples and a dry fish industry), Teknaf (the southernmost point of Bangladesh), Ramu, Sonadia, Himchhari, St. Martin Island (only Coral Island) etc.

The three Hilly Districts of Rangamati, Khagrachari and Bandarban are inhabited by a number of tribes, with their distinctive cultures, rituals, and traditions. Chimbuk, Ruma, Rain-Khyoung valleys, keocradang and Tazinsdang are highly attractive products in the hill tracts.

Sylhet, the most tea granary of the country, is another eco attraction of the country.

Kuakata beach, where both sunrise and sunset are seen, is another tourist landmark of the country.

Archeological Tourism products: Bangladesh is a country considerably rich in archeological wealth, especially of the medieval period both during the Muslim and pre-Muslim rules though most of it is still unexplored and unknown. The major archeological sites are Paharpur, Mahasthangor, Mainamati, Shait-Gumbad Mosque, and Kantanagar Temple.

Historical Tourism Products: Historical monuments of Bangladesh represent Hindu, Muslim, British periods and independent scattered all over the country. Major historical attractions are: Lalbagh Fort, Sonargaon, World War II Cemetery, Gandhi Ashram, Mujibnagar Memorial, National Memorial, Central Shahid Minar, Martyred Intellectual Memorial etc.

Religious Tourism Products: Key religious tourism products are: The Shrine of Hazrat Shah, Mosque (Dhaka has several hundred historic mosques), Bayazid Bostami Majar and Kantaji Temple

Cultural Tourism Products: Sonargaon, Natore - Dighapatiya Rajbari, Shilaidaha Kuthibari etc.

[89] *Tourism Statistics 2010, Bangladesh Parjatan Corporation*

Recreational Tourism Products: Bangladesh has world's largest unbroken sea beach, thousands of rivers and rivulets, numerous lakes and cannels which provide recreation facility like seed boat, paddle boat, simple boat, swimming, squash, etc. to the tourist such as angling, boating, swimming, fishing, etc. She also has rich classical dances, arts, and music, etc. that may attract both foreign and local tourists.

Adventure tourism Products: The Sundarban and Hill District in Chittagong offer unique and challenging opportunity for adventure tourists. They can gather thrilling experience seeing Royal Bengal Tiger, Spotted Deer, Barking Deer, Crocodiles, Other reptiles and highest peaks on the northern side of Bangladesh

Cox's Bazar consists of miles of golden sands, towering cliffs, surfing waves, rare conch shells, colorful pagodas, Buddhist temples and tribes. The most attractive tourist Resort full of bounties of nature in Bangladesh. Having the world's longest unbroken 120 km beach slopping gently down to the blue waters of the Bay of Bengal against the picturesque background of a chain of hills covered with deep green forests, Cox's Bazar is one of the most attractive tourist spots in the world. Cox Bazar has Adventure tourism, Recreational tourism, Cultural tourism, Site and Leisure tourism.

Sonadia which is very near to Cox Bazar can leverage its proximity to Cox Bazar and develop Recreational tourism, Site and Leisure tourism and Adventure tourism. Although there are challenges here (in the form of infrastructure, safety concerns, government support and policies), overcoming them will help in the development of the region as well as the country's economy.

The site intrinsic features and the regional characteristics of Sonadia establishes the fact that owing to availability of diversified flora and fauna, Sonadia is fit for eco-tourism development. Details of the same are captured in chapter 2.

4.4. Market Assessment of Tourism Sector in Bangladesh

4.4.1. PESTEL Framework based Assessment

Tourism can bring many economic, social and environmental benefits, particularly in rural areas and developing countries, yet mass tourism is also associated with negative effects. Tourism can only be sustainable if it is carefully managed so that probable negative effects on the host community and the environment are not permitted to outweigh the financial benefits.

There are economic, socio-cultural and environmental key benefits of tourism.

i) Economic benefit: Tourism can provide direct jobs to the community, such as tour guides and hotel housekeeping. Indirect employment is generated through other industries like agriculture, food production and retail. Infrastructure development and visitors' expenditure generates income for the local community and can lead to the alleviation of poverty.

ii) Social benefit: In addition to the revenue, tourism can bring about a real sense of pride and identity to communities. It allows them to look at their history, and community identity. This helps the local residents to maintain their tradition and culture.

iii) Environmental benefit: Tourism provides financial support for the conservation of ecosystems and natural resource management, making the destination more authentic and desirable to visitors.

There are negative effects of tourism too and these cannot be ignored. These are:

i) Negative economic effect: Jobs created by tourism are often seasonal and poorly paid, yet tourism can push up local property prices and the cost of goods and services. Place of tourism can be affected by terrorism.

ii) Negative social effect: Visitor's behavior can have a detrimental effect on the quality of life of the host community. For example, crowding and congestion, drugs and alcohol problems can occur. Interaction with tourists can also lead to an erosion of traditional cultures and values.

iii) Negative environmental effect: Tourism poses a threat to a region's culture and natural resources, through overuse.

In the subsequent sections, A PESTEL (Political, Economic, Social, Technological, Environmental, and Legal) assessment of the tourism sector in the country has been assessed. This assessment is undertaken to understand the challenges in the tourism sector of the country. Basis of this assessment is the discussion and analysis in the above sections and also the primary stakeholder consultations undertaken for this project.

Table 26: PESTEL assessment of Tourism Sector in Bangladesh

Framework	How these parameters are impacting tourism in the country
Political	• Very much affected by government change/instability/Rohingyas issue. • Laws are implemented but not properly monitored • Corruption in public sector • Involvement of private sector for tourism related service and food & beverages are politically influenced
Economic	• Not enough access to concessional loan • Increasing inflation • Tax, VAT are not properly paid to the exchequer due to corruption in public sector • Limited source of income of local people. Although middle and affluent segment is burgeoning in the country; however, the percentage of population who can afford tourism within the country is still less
Social	• Conservative society • Low/Moderate lifestyle of people • Ethnicity/Religiosity
Technological	• Lack of experts in technology • Less response to technological change • Lack of monitoring power Lack of interest in investing on technology • Technological use in confined to use for marketing in social media
Environmental	• Host and guest are not much aware of environment- results in pollution increase • Lack/don not have policies/ adequate measures for environment protection
Legal	• Visa and immigration process not prompt • Not properly maintained and monitored labour law, environment law etc. • Lack of strong regulatory bodies • Lack of strong labour union

Source: PwC Analysis

Above pointers are further explained in detail and subsequently the actions agendas are formed for the country to bolster the tourism sector growth.

4.4.2. Government's Stance and Policy Concerning the Tourism Sector in Bangladesh

Bangladesh government reformed the national tourism policy in 2010. Aims and goals of this policy is to increase employment, ensure economic development, environmental purity and sustainability. The major objective of the policy is to develop Eco-tourism through conservation of natural resources and promote well-being of the community, preservation of cultural values of the local community and their participation and sharing benefits.

Government of Bangladesh launched an act of "Protected areas of tourism and special tourism zone. Bangladesh is the country in the region that have the least arrivals and revenue earned from tourism industry. Tourism is one of the profitable sectors in Bangladesh. Tourism sector of Bangladesh is facing many obstacles.

Bangladesh Parjatan Corporation (BPC) is an autonomous body under the ministry of Civil Aviation and Tourism established in 1972. Basic target of BPC is to expand the tourism sector and provide the service for local and

foreign tourist. National Hotel and Tourism Training Institute (NHTTI) is an institute for professional tourism management training. NHTTI was established in 1974 under Bangladesh Parjatan Corporation. This institute offers courses to ensure trained personnel for hotel and tourism industry. NHTTI started a two-year long diploma course in hotel management in 1994. Institute also provides the job training for BPC personnel and arrange special seminar, workshop related to tourism development. Another important institution supporting the development of tourism is Bangladesh Tourism Board. Bangladesh Tourism Board established in 2010 to meet the strong demand for private sector and the tourism professionals. It is affiliated with United Nations World Tourism Organizations (UNWTO).

Initiatives undertaken by the Government to promote tourism sector within the country are enlisted in the following-

- In January 2011, two short films titled *Beautiful Bangladesh: School of Life* were produced by Bangladesh Tourism Board (partner of ICC World Cup Cricket 2011) to promote tourism in Bangladesh, both films show a tourist's journey through Bangladesh.[90]
- As part of various initiatives for the development of the tourism industry in Bangladesh, 2016 was declared as a Visit Bangladesh Year. The main objectives of this declaration are to brighten the image of Bangladesh abroad, and attract foreign tourists and foreign investment.[91]
- The government has also taken initiatives to engage the youth in tourism. Bangladesh Parjatan Corporation and Parjatan Bichitra (a travel magazine) has organized a three-day youth festival in Dhaka in 2016. Thousands of people thronged the fair and demonstrated different types of adventure tourism gears.[92]
- Bangladesh Parjatan Corporation has produced a romantic travel movie named 'Life in Rainbow (2016), which represents the beautiful, adventurous tourist attractions that are visited by a foreign couple.[93]
- A joint initiative was taken by BPC (Bangladesh Parjatan Corporation) and BTB (Bangladesh Tourism Board) to impart short-term Hospitality training to the staff of Hotels, Motels and DC's Circuit House under Dhaka Division in 2017.[94]
- Bangladesh Parjatan Corporation has come up with a study called 'Bangladesh Tourism Vison 2020', which forecasted that tourist arrivals to Bangladesh is likely to exceed 1.30 million foreign tourists by 2020.[95]

4.4.2.1. Recommendations to Design Robust Institutional Framework to Promote Tourism Sector in the Country

Policy Advocacy

A well-designed tourism policy is of immense importance for combating the detrimental effects of mass tourism. To achieve a sustainable tourism in Cox's Bazar area, environmental concerns are to be prioritized and the socio cultural imbalances are to be prevented.

Promote interests of particular groups with the aim of influencing tourism policy-setting

- Special interest groups that are not policy makers
- Policymakers that would like to influence policy areas outside their mandate
- Key players in specific tourism areas (e.g., players that have hands-on experience and insight such as regulators, operators, research entities, etc.)

[90] *www.daily-sun.com*
[91] *The daily star*
[92] *The daily star*
[93] *The daily star*
[94] *NHTTI (National Hotel and Tourism Training Institute, Bangladesh)*
[95] *www.tourtobangladesh.com*

Policy-setting

- Provide policy direction and develop policies to define principles and long term goals
- Develop strategies, initiatives and plans of actions that enable the achievement of the tourism agenda

Regulation setting

- Set rules, standards and legal restrictions that define direction for tourism areas, and that must be followed by the entities involved in such activities
- Regulating tourism areas: set clear laws, standards, regulations & guidelines for specific tourism areas – Translating regulations: Translate regulations into detailed codes of practices and directives to ensure proper delivery
- Regulating the regulator: ensure that the tourism area-specific regulator operates within the direction of the overall policy framework

Regulation Enforcement

- Providing licensing and permitting activities (applying standards) and
- Inspecting, ensuring compliance and monitoring performance

Development & Execution (D&E)

- Carry out activities, typically undertaken by entities with corporate structures (private sector, SoEs, PPPs) and where the end objective is developmental and output-oriented
- Conduct operational duties such as tracking and monitoring, managing resources, as well as delivering any other core services

4.4.2.2. Objectives of Bangladesh's Tourism Policy - 2010

- To construct various rules under the law where the main objective is to fill in the gap of existing tourism rules and let regulations proceed;
- To develop tourism industries through various planning related activities and side by side give advice as well as directions;
- To create general awareness regarding tourism protection, development and exploration;
- To execute responsible tourism through creation of some helping hand on behalf of government like as personal sector, local people, local administration, NGO, women federation, media;
- To create better communication channel for the International Tourists Organizations in Bangladesh with both government and private tourism related organizations;
- To create a strong and safe foothold for the Bangladeshi Tourist by coordinating with respective government organizations;
- To create a tourism friendly environment in Bangladesh and to market its tourism potential in both domestic and foreign nations;
- To develop human resource for tourism sector by creating training facilities and provide them with the right directions;
- To attract tourists by maintaining quality and relevant material which in turn can provide smooth tourism service and ensuring necessary actions that need to be taken for maintenance;
- To ensure the participation of physically challenged people;
- To protect women rights and ensure their participation in the tourism sector;

- To research on tourism industry, to survey international markets and to analyze the data.

4.4.2.3. Challenges and constraints faced by Bangladesh government in promoting tourism sector

- Lack of financial support from government
- Low rate of illiterate people/ inadequate education system.
- Absence of training institute related to tourism
- Lack of efficient infrastructure facilities
- Lack of market information
- Lack of contact with the market
- Lack of appropriate tourism policy
- Lack of transport links (air, rail, road and sea transport connecting major tourist destinations)
- Lack of sincerity and political will to promote Bangladesh as a common tourism destination
- Absence of effective coordination: This stands in the way of effective coordination among the relevant departments, agencies and ministries in Bangladesh
- Complicated visa and border formalities are the most crucial factor that stands in the way particularly of intra-regional tourism
- Government tax on hotel accommodation and food facility in Bangladesh is also not adequate (Hotel rates are high as the tax imposed is high)
- Corruption: Corruption is one of the major problems regarding tourism industry in Bangladesh
- Lack of Safety & Security

4.4.2.4. Probable measures that can be undertaken to improve and develop tourism industry in Bangladesh

- For rapid improvement and development of infrastructure necessary initiatives should be taken to attract both tourists (domestic and foreign) and foreign investors to invest in this industry
- Improve and modernize security system from capital city to tourists' spots
- Ensure modern recreation facilities for the tourists (like - Boating, wind surfing, Horse racing and other playing)
- Necessary initiatives to provide food stuff for the tourists and quality food should be available in the spot areas.
- Price of food and beverage in spot areas keep in a reasonable level ensuring the quality and standard of the food provided by the hotels and restaurant. Also, hotel / accommodation costs should be reasonable as compared to SAARC countries context
- Government may provide special facilities to both local & foreign investors to invest in this industry including PPP investment
- Set up and develop lighting system alongside roads from main city to tourist areas and high powered light in the beach area
- To improve security system there should be police station in the nearer places of the tourists' areas. Like other foreign countries, there should be mobile police in the tourists' areas to control any unwanted situation and ensure the safety of tourists'

- Government may provide Tax holiday to augment development of tourism industry and set up hotels and restaurants in the tourist's areas all over the country as a result foreign investor will be interested to invest in this industry
- Set up Training Institute for the tourism expert as well as resource persons. In this regard, BPC's initiative is inadequate and requires aggressive changes
- To control natural calamity, it is very important to develop weather forecasting system in the tourists' spots & zones
- For ensuring proper and timely communication facilities, Travel Agents should be available in the hotels / motels of the tourists' spots –Cox's Bazar and others for just and comfortable journey of tourists from one place to another in the country. Political stability may be developed by synergy between both ruling and political parties. Otherwise, no development would be ensured in this country especially for tourism development.

4.5. Micro-Market Assessment of Sonadia and the Surrounding region

The proposed EZ in Sonadia is located in Cox's Bazar district. Cox's Bazar is known for tourism in Bangladesh and it is one of the most attractive tourist destinations in the country. Detailed assessment of the proposed EZ has been undertaken in the chapter 2. This section attempts to cover a holistic micro-market assessment of the proposed EZ and bring out key issues which can be addressed in order to effectively promote tourism in the micro market area.

Cox's Bazar Sadar is under the Cox's Bazar district, which is located in Chittagong Division. The total area of Cox's Bazar Sadar is 228.23 sq. km, located in between 21°24' and 21°36' north latitudes and in between 91°59' and 92°08' east longitudes. It is bounded by Chakaria upazila on the north, Bay of Bengal and Ramu upazila on the south, Ramu upazila on the east, Moheshkhali upazila, Moheshkhali channel and Bay of Bengal on the west.

Cox bazar holds a major portion of eastern coastline with more advantageous geographical proximity as compared to its neighboring countries of the region. The main attraction of the influence area is the Cox's bazar which is the longest beach that starts from the Bagkhali River going till Teknaf. Cox Bazar is visited by a large number of tourists from Britain, America, Korea, Japan, India Nepal, Pakistan, and many other countries every year.

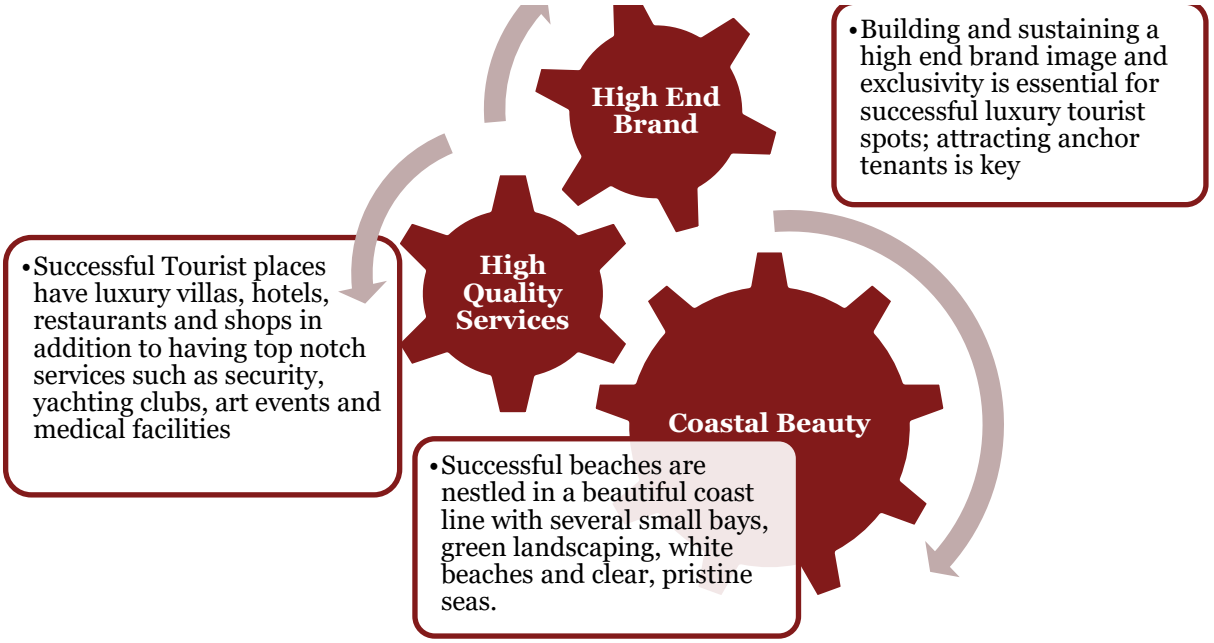
- Heritage Culture: Creation of an immersion experience with a full itinerary of offerings around the core product, such as adventure, discovery, or relaxation activities. The tourist come to visit some archaeological heritage/tourist spots like Adinath Temple, Moheshkhali Channel, Sonadia Island, Materbari Power Plant, Battle Leaf, Digital Island, Rakhayin Mandir, Moheshkhali Floating LNG Terminal, Sea Beach, Hill Forest. Salt pan, fish drying mohal and haseh char etc. are the other tourist attracting spots

- Interaction with Local community: Tourism culture derived from local offerings and interaction with local people. The local people are living in two specific areas. According to last IoL survey (Feb 2019), a total 395 families are living in Sonadia island. There are two villages namely east para and west para which are the initially originated human settlements. Sonadia Eco-tourism Park will contribute to economy in three different ways of benefits such as direct, indirect and induced benefits. Local people believe that they will get more employment opportunities and more income generating activities through this project.

- Favorable Geographical Location: Close proximity to emerging and growing markets. Sonadia Island falls under Moheshkhali Upazila of Cox's Bazar district which spreads in the north-west region of Cox's Bazar District**.** Moheshkhali Upazila is bounded by Chakaria on North, Bay of Bengal on South, Chakariaand Cox's Bazar Sadar on East, Bay of Bengal on West. Moheshkhali Upazila covers about 362.18 Sq.Km.

- Abundant Range of Activities within the Key Product: Broad range of offerings, within one main tourism product (e.g. large range of cultural sites, or sporting events, etc.) to capture and maintain the interest of the audience along their travel journey.

Figure 33: Recommendation on Tourism Components of Micro-market



Source: PwC Analysis

4.5.1. Hospitality (Resorts and Hotels, Tour Operators) Industry Trends in the Micro-Market

The nearest destination for Sonadia is iconic Cox's Bazar which is recognized as the beach resort district of the country with the longest sea-beach in the world. It is the most-visited domestic tourist spot in Bangladesh. Despite the promising potential that the destination holds, this city has not yet been able to enhance its desirability to attract tourists. This is primarily due to problems such as squatter settlement, rampant unplanned development of shops, hotels, motels, time-share condominiums and residences along with other overlapping administrative anomalies. Cox's Bazar is today a veritable concrete jungle with looming empty hotels that have been sold off as time share options to uninformed investors. Cox's Bazar municipality was constituted in 1869 and was turned into a town committee in 1959. The town committee was replaced by municipality in 1972 and it was elevated to B grade in 1989. The municipality covers an area of 32.90 sq km with 27 mahallas and 12 wards; population 60234; male 57.09%, female 42.91%.

Cox's Bazar is a highly seasonal market, which performs at an average year round occupancy of approximately 50% at an average rate of US$ 40. We have been seeing increasing stress on the market as both occupancy and average rates have been declining, while large unbranded supply continues to enter.

Cox's Bazar having been a great tourist resort various establishments have developed in the town including 6 big hotels, 30 medium hotels, 50 semi-medium hotels, Jhinuk market for the tourists and the Burmese market dealing in luxury goods from Burma, Thailand and China.

Many people are involved in hospitality and customer service orientated businesses. Number of high-end hotels in the city was about 2 or 3 about 5 years ago. Now-a-days there are dozens and counting, however no renowned international hotel chains operate in the city, but many hotel chains are planning to build hotels here.

Jhaotola main road was the hub for commercial activities and later new beach road and motel is developed to accommodate huge amount of tourist.

The city integrated core have a tendency to shift from Ramu road to motel road. Jhautola main road and Laldhighi is also important for city administrative and historical business center. But the motel road is adjacent to sea-beach due to this many development has taken place due to tourist's interest of staying night nearby the beach area.

Palongkhali and Whykong markets are located along the Cox's Bazar and Teknaf road. Jamtoli, Chakmarkul and Omani site markets are located at the precinct of the camps. Some vendors at Palongkhali Bazar mentioned fears that they might be displaced if planned road expansion works start. All market places remain open around 6-7 days per week.

4.5.2. Infrastructure Trends and Gap Analysis

Existing infrastructure facilities in Sonadia are inadequate which is evident from the large travelling time required to reach the island along with absence of seamless access through various modes of transportation. Lack of facilities of uninterrupted power supply, drinking water, healthcare, waste management and information and communication technology also need to be addressed in order to bring the proposed tourism zone into the consideration set of tourists.

Road connectivity: Existing low width road of 9 feet to 10 feet shall be broadened and strengthened in order to cater to large number of vehicles which will be using the road after development of tourism zone. The road shall also be connected to the proposed Dhaka Chittagong National Highway (N1) to facilitate comfortable travelling for tourists.

Rail connectivity: Railways is a low cost mode of transport and charge approximately 0.67 Taka per passenger per km. The proposed railway line connecting Cox's Bazar to Chittagong is planned to be operational by 2022. Proper road and water connectivity from Cox's Bazar railway station shall be provided to reduce travelling time. A separate railway line can also be provided to establish a railway station near the tourism zone.

Air Connectivity: Upgradation of Cox's Bazar airport from domestic to international shall be expedited so that international tourists can arrive directly to the nearest airport. Visa on arrival facility shall also be extended to the tourists at the upgraded airport. Current road connectivity to the proposed tourism zone is very poor and people have to travel 110 kms to reach the island. Investment shall be made in infrastructure to shorten this distance.

Waterway Connectivity: Moheshkhali - Cox's Bazar boat line connects the Moheshkhali-Gorokghata ghat with Kastura ghat. The Island is 7.5 kms from Kastura ghat and 8 km from Moheshkhali- Gorokghata ghat. The jetty facilities are available at these Ghats. This can be integrated with the proposed jetty facility at Sonadia Island. Currently, jetty services are the most used mode of transport to the proposed EZ from Cox's Bazar. But the service is slow compared to standard benchmarks. Better vessels with increased comfort, reduced travel time and roll-on/roll-off facility for carrying vehicles shall be introduced to add to convenience of tourists.

Power Availability: The nearest substation to the proposed EZ is at a distance of —4 km and has a capacity of 10 MVA. This substation is the 33/11 KV Kiranthuli substation and it has a surplus peak demand of 4 -6 MVA. During summers, the demand surges to above the capacity that results in load shedding in the region. The government has also planned a wind power plant with a capacity of 60 MW at Kurushkul, in Moheshkhali upazila. Early implementation of planned capacity enhancement projects will ensure uninterrupted power supply in the region.

Water availability: Since the proposed study area, falls adjacent to Bay of Bengal and Moheshkhali water channel having tidal influence from sea, the surface water will be saline and shall not be relied as a source of water for the proposed EZ. There is no freshwater source in the vicinity of the proposed study area. Desalination plant shall be constructed on the island to ensue availability of potable water for Sonadia Ecotourism Park.

Solid Waste Management: There is a proposed solid waste dumping site area by Cox's Development Authority in the vicinity of the Sonadia Island. A USD 4.8 million project, initiated jointly by UNDP and Sweden, has been planned to introduce a sustainable system for solid waste management in Cox's Bazar.

Telecom Availability: Moheshkhali Island has been chosen by Korea Telecom, a Korean telecommunications company to transform it into a digital island under 'GiGA Island' project with support from Government of Bangladesh. The proposed EZ would benefit immensely once this becomes a reality. At present, Grameenphone, Banglalink, Robi are the most prominent telecom service providers in Cox's Bazar district. While visiting a new area tourist often look for easy availability of SIM cards for temporary usage. Rules shall be made to ensure easy availability of SIM card to tourists.

Healthcare Facility: There is no international standard hospital in this upazila. Moheshkhali upazila health complex is located at around 11 km from the proposed EZ.

Quality healthcare facilities should be developed near the proposed EZ to cater to the needs of the work force employed and the visiting tourists.

Manpower availability: Skilled manpower for tourism industry is not available in the region. One tourism related job is created for every 30 tourists. The development of new tourism zone will create a number of jobs and will require both skilled and unskilled manpower to serve the tourists. Steps to create new institutes or increasing capacity of existing institutes shall be taken to provide manpower for this growing demand.

4.5.3. Tourism Landscape in the Micro-Market

Based on primary stakeholder consultation among domestic/ foreign tourists, hotels and resorts operators, and other stakeholders in this region, following landscape of tourism sector in Sonadia has been assessed.

4.5.3.1. Salient Features of the Tourism Sector in Sonadia

- Majority of arrivals is through air transport
- Yet ground & water transport is very relevant for shorter travel distances by neighboring countries & domestic travels
- Leisure tourism is dependent on weather, which greatly affects tourism cyclicality.
- To hedge against cyclicality, countries organize tourism events (e.g. MICE, sports and intangible cultural events) all year long.
- Majority of domestic tourism is intended to visit families.
- Inbound tourists tend to stay at least 2 days longer than domestic tourists

4.5.3.2. Spending Pattern of the Tourists

- Introduction of low-cost carriers increased international and domestic trips by country, mainly by the emerging middle class.
- Countries develop offerings focused on relaxation and short duration urban attractions, to encourage transit passengers to prolong their stay.
- Business travelers spend more than leisure travelers, but due to their smaller numbers, total spend from business travelers is much lower,
- Domestic tourists contribute to lower spend they stay with family and transport by road.
- Urban tourism, driven by shopping and entertainment constitutes a large share of tourists spend.
- Accommodation and food constitute ~50% of total spend.

4.5.4. SWOT Analysis

Above discussion about the micro-market surrounding the proposed EZ at Sonadia culminates into following SWOT analysis.

Table 27: SWOT Analysis for the Micro-Market surrounding Sonadia Proposed EZ

Strengths	Weaknesses
• Topography/scenery undulating, hills, lakes, rivers, longest beaches of the world in Cox Bazar. • Limited population density, space, escape. • Unique culture – population, traditions, languages, lifestyle, food differ from rest of the country. • Some progress has been made with capacity building, improved visitor facilities and connectivity Infrastructure. • Sonadia Island has a diverse collection of Flora & Fauna attracting Tourists. • Mangroves - Aesthetic Symbol of the Area.	• Resources are generally undervalued for tourism – almost all facilities and services offer entry level quality and pricing. • Increasing signs of environmental pressures, pollution, unsustainable agricultural practices and degradation of natural habitats • Limited tourism, hospitality and entrepreneurial skills and practices • Limited community trust and engagement. • Poorly developed tourism, agricultural value chains and linkages • Sensitive and unique social structure, traditions and beliefs prone to disruption by outside influences • Uncertainty of land tenure and approvals.
Opportunities	**Threats**
• Rise in household income and growing domestic tourism demand especially from main cities like Chittagong • Consistent growth in budget accommodations & guest house • Good supply of local guides • Increase in employment/ spending power in the country • Guides are organized with three local guide associations operating in the area. • Transport and hotels associations are fairly well organized • More investors are interested in investing • Aggressive promotion by public sector	• Demand suffers due to health and safety issues. • Low budget Visitors & Short stays in the Area. • Tourism demand is seasonal. • Tourism stakeholders' do not promote a clear market image. • Limited product diversity with similar kind of facilities. • Tourism infrastructure like sanitation, waste management needs improvement. • No effective rescue services and disaster management plans. • The local industry is poorly linked with tour operators in Dhaka and Cox's Bazar and the area does not feature on tourism circuits.

Source: PwC Analysis

4.5.5. 5 A's Analysis of the Micro-Market

4.5.5.1. Accessibility

Tourists look for comfortable and hassle free travel. Any location to be developed as a tourism zone is required to have multimodal connectivity. Comfort, cost, convenience, time and safety are some of the important factors which are considered before undertaking a journey.

Table 28: Global Ranking of various Modes of Transport in Bangladesh

Category	Rank	Score
Quality of air transport infrastructure	113	3.2
Quality of roads	111	2.9
Quality of railroad infrastructure	68	2.7
Quality of port infrastructure	88	3.5

Source: World Economic Forum

Roadway: Cox's bazar is having a total road infrastructure of 539.11 kilometers however, the road infrastructure in the country has been ranked 111th by the World Economic Forum. Fares for travelling by road is 1.56 Taka per

passenger per kilometer. An approach road width varies from 10 feet to 9 feet runs along the Kutubjom Union and connects with Zila road (Z1004). This shall be integrated with the internal road network while planning.

Airway: The nearest airport is Cox's bazar airport at a distance of 9kms through waterway and 110 kms through roadway. Biman Bangladesh operates the maximum number of flights from the airport. Cox's Bazar airport shall be upgraded to International airport in order to facilitate travel of international tourists. Road connectivity to the airport shall also be improved in order to reduce travel time and ensure a convenient travel.

Railway: Railway is the cheapest mode of transport available in the country and charged 0.67 Taka per passenger per kilometer[96]. Cox's Bazar railway station is planned to be operational by 2022 and will connect to the port city of Chittagong and the capital Dhaka. This 128 kilometer line is expected to boost tourism in Cox's bazar by providing low cost connectivity for domestic tourists. Proposed railway line is 8 km via waterway and 10 km via roadway from proposed zone.

Waterway: Sonadia Island is can be accessed by ferries and road. Roll-on roll-off services can be provided for tourists travelling by their own vehicles. Government has planned to connect port with bridges that will be completed by 2030. Moheshkhali - Cox's Bazar boat line connects the Moheshkhali-Gorokghata ghat with Kastura ghat. The Island is 7.5 kms from Kastura ghat and 8 km from Moheshkhali- Gorokghata ghat. The jetty facilities are available at these Ghats.

4.5.5.2. Accommodation

Accommodation plays a central role in tourism. Every tourist needs a place to stay and relax. Accommodation is the temporary home of the tourist at the destination and the base from which they pursue their activities.

A wide range of accommodation options exist at most destinations ranging from tourist lodges to five star deluxe hotels. Tourists look for clean, hygienic, and well maintained accommodation with a comfortable bed, clean linen, and sanitary facilities.

Bangladesh is a country that started with only two international standard hotels back in the 80s – Hotel Sheraton and Sonargaon. Today, the Hospitality industry of Bangladesh can now boast more than six international hotel chains. It is estimated that in the next ten years, more international brand hotels will emerge in the Hospitality market.

Currently nearest accommodation to Sonadia is available in Cox's Bazar district. Type of accommodation varies from budget hotels rooms charging BDT 600 per person per night to luxury rooms charging BDT 33000 per person per night. Facilities available in hotels are parking, restaurant, gym, airport shuttle, free WiFi, swimming pool and spa and wellness centre.

Table 29: Accommodation Details in the Micro-Market

Hotel Class	Number	Average Price(BDT)
5 Star	1	8000
4 Star	5	5200
3 Star	46	4300
2 Star	38	3000

Source: TripAdvisor

The current accommodation facility is situated very far away from Sonadia Island where the tourists are expected to spend most of their time. Accommodation facilities with all modern amenities shall be constructed to give visitors a wide range of options to stay. An increase in accommodation facilities should also be coupled with availability of manpower skilled in hotel industry. Research shows that for every 30 new tourists to a destination one new job is created. Thus, this increase in number of hotels will also provide employment opportunities to people.

[96]*Source:http://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b2db8758_8497_412c_a9ec_6bb299f8b3ab/SYB-2018.pdf*

The country also currently lags in extent of staff training, degree of customer orientation, ease of finding skilled employees. These issues can be solved by setting up new institutes to cater to demand of tourism industry or increase intake in the existing institutes.

4.5.5.3. Amenities

It refers to the facilities available at the destination which help in meeting the needs and wants of tourists. Tourist amenities include food and beverage facilities, drinking water, good communication network, local transport, automatic teller machines (ATMs), proper garbage and sewage disposal systems, medical facilities, etc. Electricity supply with minimum power cuts and adequate water supply are crucial facilities which must be available at the destination.

A number of these amenities require support from local and national government hence a high degree of co-operation is needed.

Power: Power generation is one sector where majority of the tourism sector is dependent on government support. In the year 2014, Per capita power consumption in the country is 320.20 kWh as compared to the world average 3132.15 kWh97. Providing adequate power supply on the island is essential to establish vivid tourism activities. 33 / 11 kV Kiranthuli sub-station within Moheshkhali Upazila with the total capacity of 10 MVA. The substation has a surplus peak demand from 4 MVA to 6 MVA. During summers, the demand surges to above the capacity that results in load shedding in the region. The government has also planned a wind power plant with a capacity of 60 MW at Kurushkul, in Moheshkhali upazila.

Healthcare: Providing access to improved sanitation, drinking water and waste management facilities is important in order to make sure that tourists visiting the island to fall ill. Adequate healthcare facilities shall be available nearby to the island to get proper treatment for any illness. Cox's bazar district hospital had a total sanctioned strength of 250 beds in the year 2013[98]. Bangladesh currently ranks poorly at 122 on the basis of number of hospital beds available per 10,000 of population. Low number of qualified doctors is also one on the factors that the country is currently grappling with.

There are no health facilities available in Sonadia Island. People are going to the nearby hospital located in Moheshkhali (Upazila headquarters) for availing required health services. This hospital holds 50 beds and 4 MBBS doctors.

Water: Surface water available is salty and cannot be used for daily use. There is no freshwater source available in the proposed tourism zone. The inhabitants rely mostly on ground water for which there are three boreholes within the proposed EZ area, the maximum depth is about 1000 ft. There are about 12 deep tube wells within Sonadia Island which forms the main source of drinking water for the inhabitants. The ground water is saline in nature and the officials of DPHE suggested to rely on desalination plant for Sonadia Ecotourism Park.

Solid Waste Management: There is a proposed solid waste dumping site area by Cox's Development Authority in the vicinity of the Sonadia Island.

Gas Availability: In 2017, the Bangladesh government said it planned to install an onshore liquefied natural gas (LNG) terminal at Moheshkhali with the capacity to handle 7.5 million tons of gas annually.

Telecom Availability: Moheshkhali Island has been chosen by Korea Telecom, a Korean telecommunications company to transform it into a digital island along with support from Government of Bangladesh. The proposed EZ would benefit immensely once this becomes a reality. At present, Grameenphone, Banglalink, Robi are the most prominent telecom service providers in Cox's Bazar district.

Safety and security: Safety of tourists is one such segment where most of the steps are to be taken by the government. Bangladesh currently ranks at 101 among 140 countries in Global peace index rankings. The main reason for this rank is greater number and duration of internal conflicts in the country. High risk owing to

97 *Source: https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?locations=US*
98Source: http://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b2db8758_8497_412c_a9ec_6bb299f8b3ab/SYB-2018.pdf

multiple climatic hazards also contributed to poor performance in rankings. Low reliability on country's police services adds to the apprehensions of incoming tourists.

Table 30: Ranking of parameters for Bangladesh

Parameter	Rank	Score
Safety and security	123	3.70
Reliability of police services	117	3.10
Health and hygiene	107	4.30
Physician Density/1000 population	104	0.40
Access to improved sanitation % population	104	60.60
Access to improved drinking water %population	105	86.90
ICT readiness	116	3.10
Internet users % population	125	14.40
Mobile network coverage % population	59	99.40
Quality of electricity supplied	109	3.20
Baseline water stress	17	0.30
Wastewater treatment	111	0.00
Presence of major car rental companies	129	1.00
Automated teller machines number/thousand adult population	113	9.20

Source: World Economic Forum

4.5.5.4. Attractions

This is the key objective for undertaking travel to a particular destination. Attractions are classified basically into four categories:

a) Natural attractions such as pristine beaches, waterfalls, scenic views, climate, heavy rainfall, snow clad mountains etc.

b) Man-made attractions such as theme parks, Ocean Park, Disney World, Snow City, etc.

c) Cultural attractions in the form of fairs, festivals, celebrations, theatre and museums, which depict the history and culture of a country.

d) Social attractions where one can meet and interact with the locals at a destination as well as meet friends and relatives.

Cox's bazar boasts of being the most frequented destination by tourists for the purpose of tourism. It is known for hosting longest unbroken beach in the world measuring 111 kilometers in length. Towering cliffs, surfing waves, delightful sea foods and colorful pagodas are some of the attractions for which most of the tourists visit the area.

Major tourist attractions within the district include:

a) Himachori beach and waterfall: Located at a distance of 12 kilometers from Cox's Bazar it is famous for Himachori waterfall and natural beauty besides the beach drive.

b) Inani Beach: Located at a distance of 22 kilometers from Cox's Bazar and bordered by hills and forests it is a pristine rocky beach with corals all around.

c) Ramu and Lamapara: It is Buddhist village located 16 kilometers from Cox's Bazar and accessible from the main highway leading to Chittagong. The village has monasteries, khyangs and pagodas. The Burmese Bara Khyang at lamapara has the country's largest bronze statue measuring 100 feet in length.

d) Dulahazra Safari Park: This safari park is situated at a distance of 50 kilometers from Cox's Bazar and has lions, Bengal tigers, crocodiles, Bears, etc.

e) Saint Martin Island: Located at a distance of 95 kilometers from Cox's Bazar Saint Martin's island is abundant in corals and some is exclusive to the island itself.

Sonadia is known for its calm and serene beaches. The island is also home to sea turtles and migratory bird species like sandpipers and seagulls. Presence of mangroves add to the tranquility and scenic beauty of the place. People also visit the island for camping, diving and nature photography.

Presence of a number of tourist attractions within and near to Cox's Bazar will give an opportunity to cross sell tourism offerings on the island by providing seamless connectivity with other attractive spots in the area.

4.5.5.5. Activities

People take a break because they want to see and do different things. Some like an active holiday and would like to go for water sports, fishing, nature trails, etc. while some would rather just sit back and relax. A number of activities may be available at the destination to suit various age groups and social backgrounds. Tourists may be attracted to a destination for any one or more of the above activities or attractions located there.

The following activities can be introduced on the island:

- **Diving**: Scuba diving provides an opportunity to absorb beauty of marine life attracts people looking for adventure sports. Sonadia Island has a very rich and diverse marine life and unexplored beaches of the island will provide great scuba diving site.
- **Snorkeling**: Snorkeling is swimming along the surface of the water and enjoying the underwater world equipped with a mask, a snorkel and usually swim fins. Snorkeling does not require any special training, major expenses or strong physical effort. It also does not require as much training as scuba diving. Vibrant marine life near the island will provide numerous snorkeling opportunities to the tourists.
- **Glass bottom boat tours and lagoon Cruise**: These activities can be organized for people who want to explore the marine life but do not dive or snorkel.
- **Watersports:** Sailing, windsurfing, stand up paddling, wakeboarding, para sailing, kitesurfing and kayaking are some of the surface water sport activities which can be provided on the island and will attract a number of water sports enthusiasts.
- **Ecotourism in mangrove areas**: The underlying concept is the reduction of local dependence on consumptive use of natural resources through benefits from tourism. By participating in ecotourism activities, local people can earn supplementary income while at the same time ensuring the conservation of biodiversity. The island has 138 plant species and dense vegetation coverage in the mangrove forest. These natural endowments offer ecotourism opportunities on the island.
- **Spa facilities**: People looking for relaxation on a tour often make use of spa facilities which provides both physical and mental relaxation. Beach side resorts having spa facilities can be established to offer these services.
- **Nightlife**: Island can have a vibrant nightlife after establishing restaurants, bars and clubs. Permission also needs to be given to operate these facilities till late in the night.

4.6. Primary Survey: Perception Study

Above sections detail out the top-down approach based market assessment. This section delves into perception based primary survey. This survey shall bring out the market impression about Cox's Bazar and Sonadia and also pin points the expectations of the tourists from this project. The instrument used for this survey was questionnaire and the same is furnished in the annexure.

4.6.1. Overview of the survey sample

The shortlist of probable visitors visiting Cox Bazar was created using a combination of data available on secondary domain, site visits and interactions with different kind of stakeholders from various backgrounds. In

furtherance to the above analysis, a primary survey was undertaken to validate the findings and perform a dipstick assessment so as to gauge the investor sentiment with regards to the challenges and opportunities at the proposed EZ. A total of 55 individuals were approached – 45 domestically based travelers and 10 internationals based out of Bangladesh. The questionnaire used was designed as per the sample with a few improvisations to effectively gauge the perception of the visitors with regards to the proposed EZ and the challenges associated with the location of Cox Bazar. These representatives were from different regions of Bangladesh such as Mongla, Dhaka, Chittagong and Gopalganj & International destinations.

4.6.2. Analysis of survey results

The findings of the survey have been summarized in the charts below that captures the willingness of the tourists to visit to the prosed EZ and their reasons associated with it:

Table 31: Willingness of the Tourists to Visit Sonadia- Survey Results

Description	Activities	Most Preferred	Somewhat Preferred	Least Preferred
Rank according to preference given to the following reason/activities in choosing a travel destination	Rest & relaxation	98%	2%	0%
	Business - Conferences & Seminars	20%	56%	24%
	Fun& Sport/Recreation	64%	22%	13%
	Religious	33%	33%	33%
	Beach	76%	13%	11%
	Eco-Tourism	33%	56%	11%
Rank according to preference given to the following sources of gathering information about a travel destination	Internet	84%	11%	4%
	Media	33%	58%	9%
	Word of Mouth	42%	40%	18%
	Exhibitions/Fairs	42%	31%	27%
	Travel Agency	51%	36%	13%
	Aspirational	47%	29%	24%
Rank according to importance given to the following aspects while travelling to a destination	Attraction	93%	7%	0%
	Accessibility	56%	42%	2%
	Accommodation	78%	22%	0%
	Amenities	56%	24%	20%
	Activities	67%	20%	13%

Source: Primary Survey

Above survey results can be summarized in the following:

- **Rest and relaxation, Beach, Fun Sports & Recreation are the most preferred selection** by high percentage of visitors for choosing a destination for travelling. Business and ecotourism preferred by 56 % of the visitors travelling in Bangladesh.
- **Internet, travel Agents and media are the most reliable sources used by tourists for getting information** about a tourist place in Bangladesh including Cox Bazar/ Sonadia

- **Local Attractions, accommodation facilities, Activities (Adventurous or Recreational) to do within the influence area are prioritized by the tourists while travelling to a destination in Bangladesh.**

The ranking of the Cox Bazar and Sonadia from the perspective of tourists was done by the tourists on basis of various parameters such as safety, ease of booking transportation, accommodation, and transportation facility etc. to get an idea of the perception of the both domestic and international visitors. Only 2 % of total visitors have given Rank 1 to any of criteria used in sampling suggests that there is lot of scope for improvement for rapid expansion of tourism in cox bazar.

Table 32: Perception Analysis of Cox's Bazar and Sonadia- Survey Results

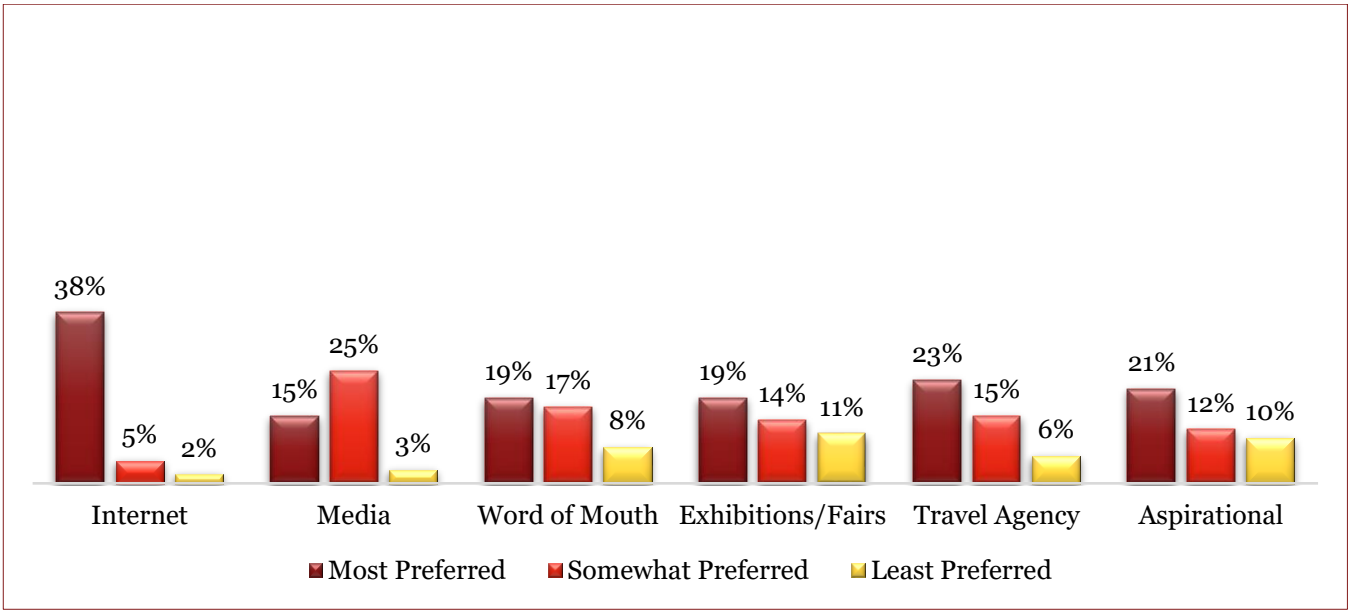
Criteria	Rank-1	Rank-2	Rank-3	Rank-4	Rank-5	Total%
Ranking done by tourists irrespective of visiting cox bazar and Sonadia						
Rank the Safety of tourist with respect to travelling in Bangladesh	0%	9%	38%	49%	4%	100%
Rank the Ease of booking Transportation with respect to travelling in Bangladesh	2%	9%	24%	64%	0%	100%
Rank the Ease of booking accommodation facilities with respect to travelling in Bangladesh	0%	16%	44%	40%	0%	100%
Rank the transport facility in Bangladesh	2%	13%	33%	51%	0%	100%
For tourists who have already visited Cox's Bazar and Sonadia						
Rank the Safety of tourist in Cox Bazar/ Sonadia	0	33%	30%	35%	2%	100%
Rank the transport facility in Cox's Bazar/ Sonadia	0%	32%	30%	36%	2%	100%

Source: Primary Survey

Survey results indicate that the infrastructure (ease in accessing Sonadia and Cox's Bazar) including safety concerns and transport facility are not well perceived by the tourists irrespective of the fact that they have visited Cox's Bazar/ Sonadia or not. **While developing the proposed EZ, safety concerns and transport facility related issues need to be addressed.**

The survey respondents were also asked about their source of obtaining tourism related information in Bangladesh context and in Cox's Bazar/ Sonadia context. Responses obtained from this question are summarized in the following figure.

Figure 34: Source of obtaining Tourism related Information- Survey Results

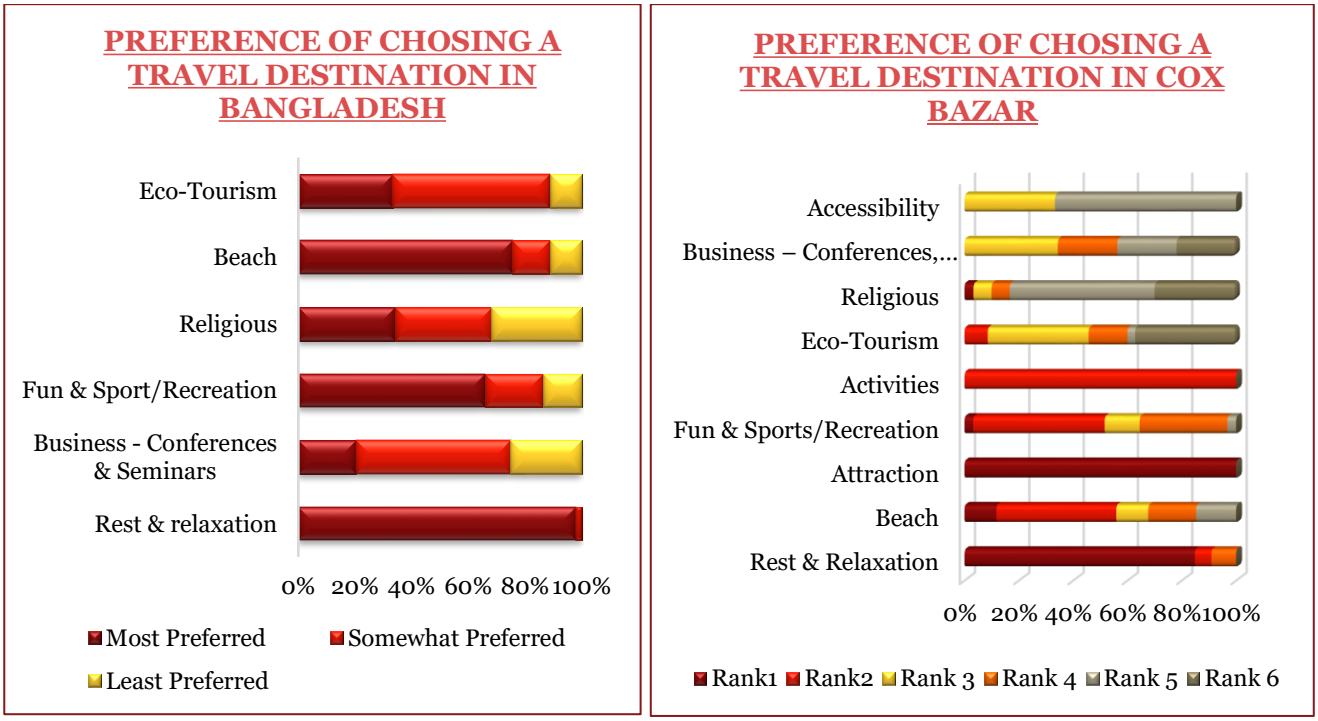


Source: Primary Survey

The **most preferred source of information for visitors travelling in Bangladesh is Internet and Travel Agencies** for planning a visit to Cox Bazar/ Sonadia. The tourist relied on the reviews given on various websites to book a hotel for Leisure or business activities within the influence area of Cox Bazar/ Sonadia.

These respondents were also asked about their preference of choosing a travel destination in Bangladesh and also choosing travel destination in Cox's Bazar area. Following figure elaborates the responses obtained.

Figure 35: Reasons for Choosing Travel Destinations- Survey Results



Source: Primary Survey

The rest and relaxation ranked topmost priority for the tourists visiting Bangladesh and area under study Cox bazar. The long beach area of 121 km attracts the tourist along with fun and recreational activities a

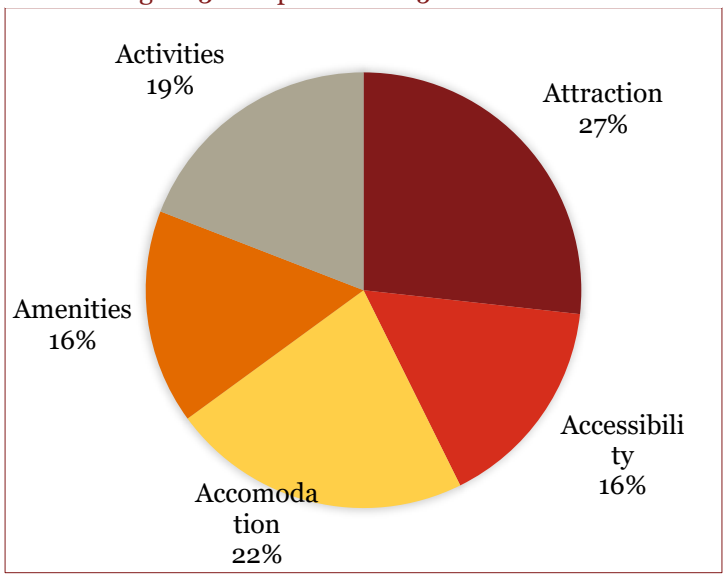
nearby the influence area. **Eco tourism is preferred by international visitors due to rich biodiversity of the state. Sea Turtles, Mangroves, migrating birds to the islands, rich source of flora and fauna adds to the magnificent beauty of the place.**

When asked about the importance of 5 A's for the tourists while travelling to Bangladesh/ Cox's Bazar and Sonadia area, majority opined that natural attraction and accommodation are the primary reasons which attract tourists.

27% of the tourists finds natural beauty as a major source of attraction for any place in Bangladesh which includes Cox Bazar.

Sonadia Island is known as the "island of miracle" and is a paradise for migrating birds. The tourists enjoy the natural beauty around the sea, bigger waves, taking a walk to main island Moheshkhali to enjoy beauty of this great island. The Canals, Mangrove, Fishing Boat, Fishing, sea food and blue sky over head is the source of attraction for both domestic & international traveler bucket list. Cox`s bazar sea beach, Teknaf, Ramu, Saint Martin, Ukhia, Malumghat, Shahporir deep, Moheshkhali, Kutubdi like lots of tourist spots in this beautiful place of Bangladesh.

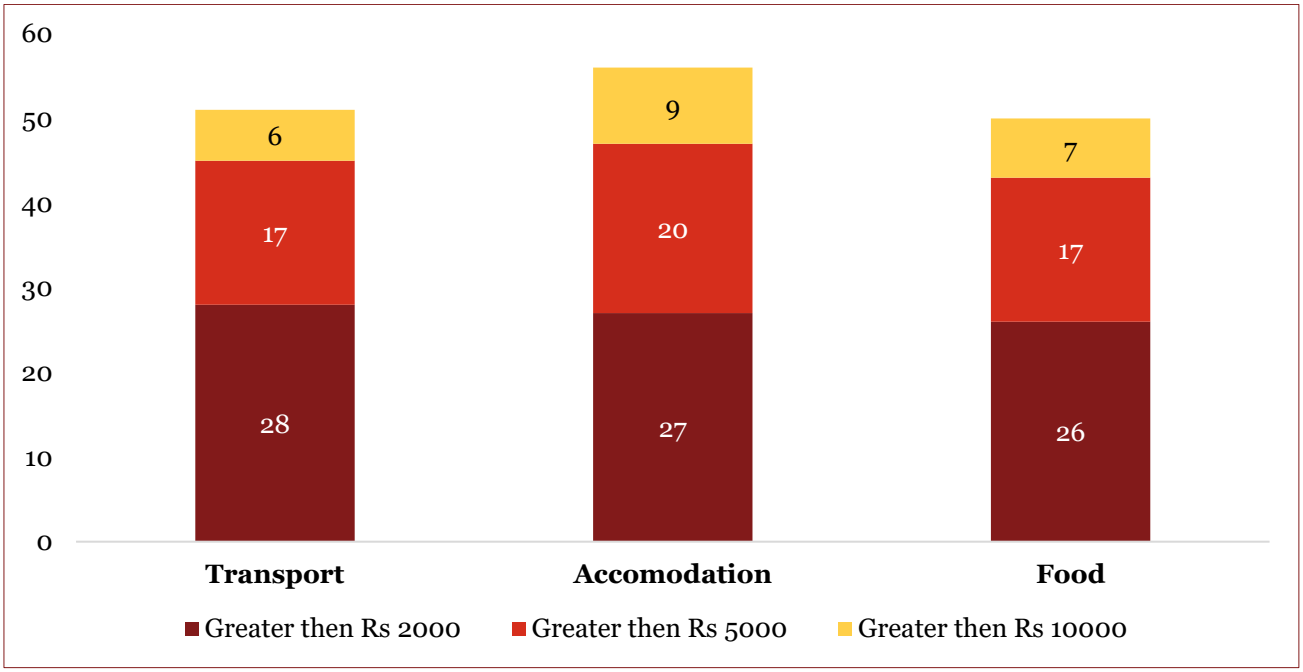
Figure 36: Importance of 5A's for Tourists



Source: Primary Survey

Accommodation is the second preference for the selection of destination. The hotels in Cox Bazar change rates depending on the season. The peak season of March to October charges are higher for even a decent room. The availability of the budget or luxury hotels depending upon the season visited is also prioritize by the tourists visiting the place.

Figure 37: Travel Expenses while Travelling to Cox's Bazar/ Sonadia- Survey Results



Source: Primary Survey

The daily costs varies in different regions of Bangladesh and services are provided for every budget. Most of the People travelling preferred decent facilities at prices between 2,000 BDT to 5,000 BDT. Cox Bazar area offers services to every segment of tourist's as described below.

Budget: Less than BDT 1,500

- Basic accommodation (no air-conditioner, no hot water) BDT 500–750
- Meal in local Bangladeshi restaurant BDT 80–150
- Regional bus ticket BDT 80–200

Midrange: BDT 1,500–4,000

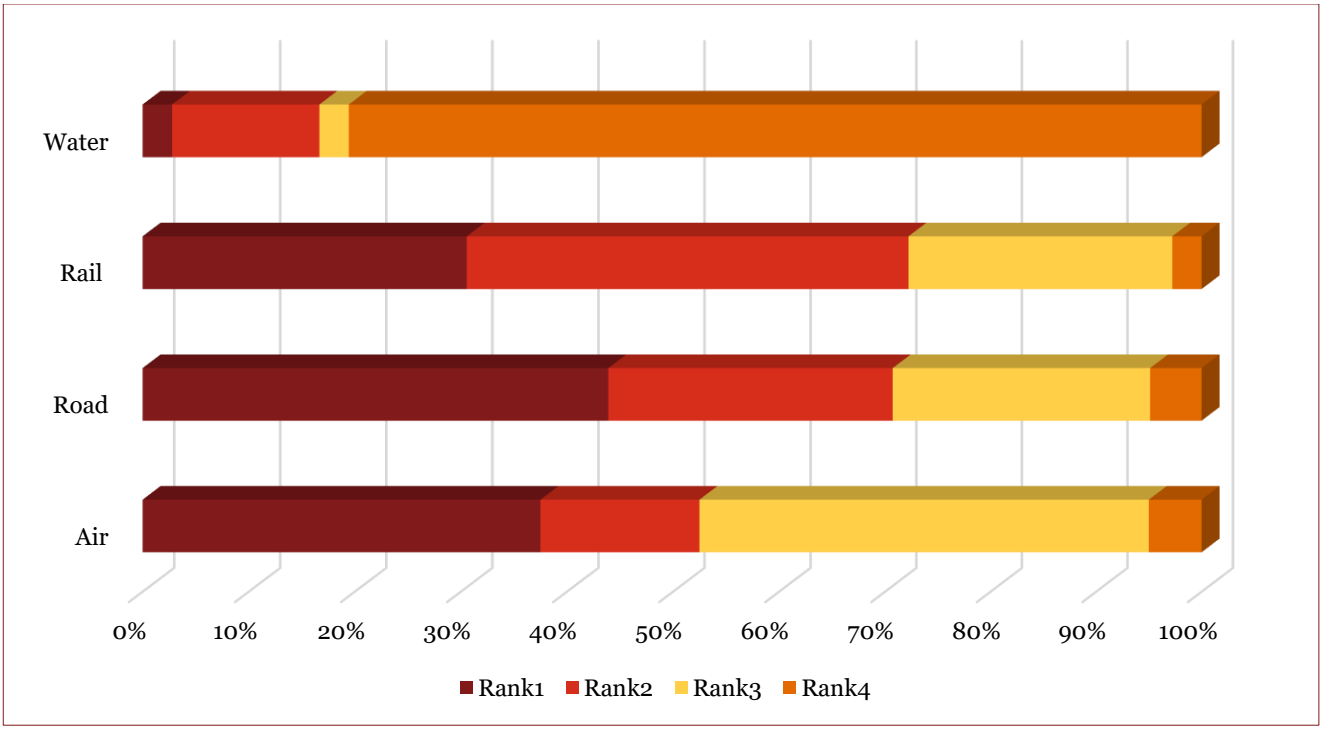
- Decent room with air-conditioner and hot-water shower BDT 2,000
- Meal at air-con restaurants serving Chinese, Indian and Bangladeshi food BDT 300
- Travel by non-air-con coach BDT 200

Top End: More than BDT 4,000

- Room in the best hotel in town, or any half-decent place in Dhaka BDT 4,000
- Meal in-house or at restaurants with international cuisine TK 1,800
- Travel by air-conditioner coach or hire car BDT 600

The respondents were also asked about their preferred mode of travelling to tourist destinations within the country. Figure in the next page reveals the responses received.

Figure 38: Preferred Mode of Transport while Travelling within the Country- Survey Results



Source: Primary Survey

Air, road and rail transportation systems are preferred mode of transportation for tourists travelling in Bangladesh.

Bangladesh has three international airports, located in Dhaka, Chittagong and Sylhet, and a multitude of domestic and private airports. Visa on arrival is available at the international airports for certain nationals. Low-

cost domestic flights to all major destinations in Bangladesh are provided by local airlines such as United Airways (www.uabdl.com), Regent Airways (www.flyregent.com), Novo Air (www.flynovoair.com), US-Bangla Airlines (www.us-banglaairlines.com) and the national flag carrier Biman Bangladesh Airlines (www.biman-airlines.com).

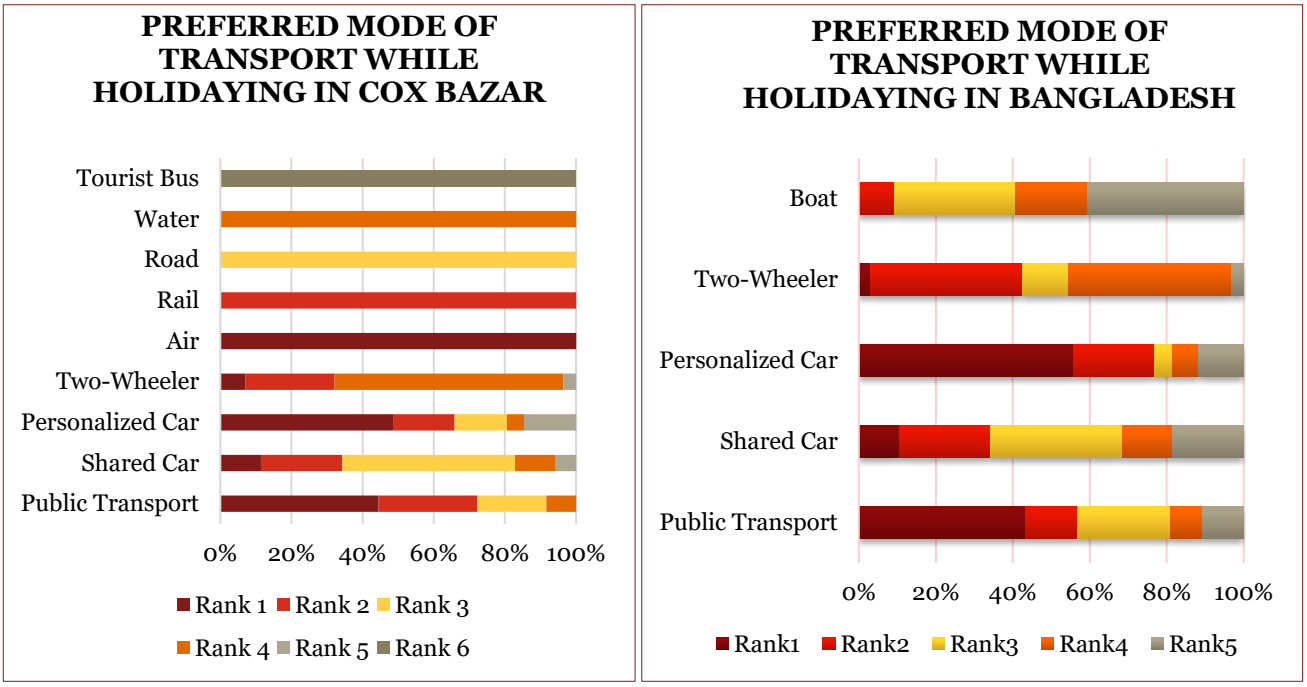
Inter-city trains and luxury air conditioned buses go to all major destinations within Bangladesh. During 'Eid or the winter season (November to January) there is usually a huge rush for tickets for travel between Dhaka, Chittagong, Cox's Bazar and the rest of Bangladesh. Train tickets must be purchased early all the time at least 10 days in advance.

As Bangladesh is a riverine country, boats and ferries also play an important role in the transportation system of Bangladesh. One can go to Khulna, Barisal, Patuakhali, Chandpur and most other destinations by ferry service.

Primary survey indicates that the tourists prefer air and road as the main modes of transport. Keeping view of the same, it is **crucial to provide impetus on improving road connectivity to access Cox's Bazar/ Sonadia area. Emphasis should be made to upgrade Cox's Bazar airport as international airport so that foreign tourists can easily access Sonadia and Cox's Bazar location from anywhere in the globe.**

The respondents were also asked about their preferred mode of transport during holiday in Cox's Bazar/ Sonadia area and also within the country. Figure in the next page reveals the responses received.

Figure 39: Preferred Mode of Transport while Holidaying - Survey Results



Source: Primary Survey

Findings from this question can be captured in the following-

- Tourists will find rickshaws the most inexpensive mode of transport in Bangladesh. Another version of rickshaw that is found in Northern and Southwestern districts is known as 'van'.
- Beside rickshaws, auto-rickshaws (widely known as CNGs), regular taxicabs, easy bikes are used when travelling within Bangladesh.
- Auto-rickshaws are also an environment friendly form of transport because they use Compressed Natural Gas (CNG) as fuel.

Respondents opined that eco-friendly vehicles can be arranged at the Sonadia Eco-Tourism Park which can cater to the local transportation need of the tourists within the EZ.

4.6.3. Suggestions by Survey Respondents

The survey respondents were asked to provide suggestions for development of tourism in Cox's Bazar/ Sonadia area and also for the country overall. Responses obtained from this survey are captured in the following table.

Table 33: Suggestions by Respondents to Improve Tourism in Cox's Bazar/ Sonadia and at the Country Level

Suggestions for development of Tourism in Cox's Bazar	Suggestions for development of Tourism in Bangladesh
• Respondents stated Rest & Relaxations is the most preferred activity in choosing a destination • Availability of low-cost labour • food quality should be kept under surveillance • infrastructure management • Improve Facility, Service, and Accommodation. • Develop amenities, facilities & service • Integrated Management • Integrated Infrastructure Development, Security Increase • Infrastructure Development, Hospitality, Transportation Improvement, Hospitality, infrastructure management • Cost Management, Skill Development • Required standard facility for tourist • Good approach needed from management • Establishment of a good system like Thailand • Need development for better service. • Well defined system for tourist. • Enhance transportation Service • Need lot of Foreign Investment to improve the current scenario • Required Economic Accommodation • Reduce the Price of Food • Fun & Sports • Rest & Relaxation • Tourist Friendly Business Development • Rest & Relaxation • Renovate Ramu Buddhist Temple • Improve Facility, Service, Accommodation • food quality should be kept under surveillance • infrastructure management • Garbage Management need to improve • food quality should be kept under surveillance • Integrated Management • Develop amenities, facilities & service • Required standard facility for tourist • food quality should be kept under surveillance • Hospitality, infrastructure management	• Needs special focus on customer satisfaction, environmental awareness and security of tourists. • Safety, Hygiene, Hospitality issues • Infrastructure Management, Ease of Accommodation & Security • Improve quality of service, facility, infrastructure development, safety • Crowd Management, Pollution Management, Infrastructural Development • Infrastructure Development, Hospitality Management, Pollution Control • Enhance Security, Integrated Infrastructure, Transport Availability, Regional Development • Overall development of a tourism area • Infrastructure, Hospitality, Service & Management, Safety management, skill development, cleaning measure & control • Integrated Management System • Need a good approach for development the existing situation • A good management or system • Safety, Hygiene, Hospitality issues best approach to flourish better tourism. • Infrastructure Development • Economic accommodation • Increase Coverage of Mobile Net Work • Improve quality of service, facility, infrastructure development, safety • Economic Food transport and accommodation • Improve quality of service, facility, infrastructure development, safety • Local Authority needs to fix the road condition • Need to Clean the City as it is full of garbage • Need to create economic accommodation Infrastructure need to be develop • Needs special focus on customer satisfaction, environmental awareness and security of tourists. • Infrastructure Development, Hospitality Management, Good monitoring at the beach after evening

Suggestions for development of Tourism in Cox's Bazar	Suggestions for development of Tourism in Bangladesh
• food quality should be kept under surveillance • Enhance transportation Service • Cost Management, Skill Development	• Crowd Management, Pollution Management, Infrastructural Development • Improve quality of service at the hotels, facility, infrastructure development, and lastly Bangladesh Parjatan Corporation need to create more economic accommodation • Create safe environment for the women so that they can safely roam at the beach after evening • Safety, Hygiene, Development of Hospitality issues • Infrastructure, Hospitality, Service & Management • Need to increase the service quality of the public transportation • Improve quality of service at the hotels and Transportation

Source: Primary Survey

4.6.4. Understanding the Key Consumer and Service Provider's Insights

4.6.4.1. Issues faced by the Visitors in Cox's Bazar area

- Tough to ensure accommodation facility during October to January though this is the best time to visit Cox's Bazar in terms of weather condition;
- There is no rail route to go to Cox's Bazar
- Lack of transport facility during October to January because of huge crowd;
- All kinds of costs like accommodation, foods and transport costs are increasing rapidly;
- The drainage system is so unhealthy;
- There is a lack of security system for the tourists;
- Lack of recreational facility in beach;
- There is a little facility of toilet and change room in the beach;
- lack of utility service in Cox's Bazar/ Sonadia area;
- Lack of proper Medicare service for the natives and tourists.

4.6.4.2. Recommendations by the Respondents

Tourism sites should be developed in collaboration with other sectors such as transport and communications, hotels, motels and catering establishments, etc.

- The private sector and non-governmental organizations should be encouraged to develop and run tourism sites and other recreational facilities;
- Low-cost tourism facilities should be developed for domestic tourists;
- The Tourism Training Institutes should be expanded through the country;

- Regional development authorities, district authorities and local councils should be associated with tourism development and promotional activities. They will be encouraged to undertake projects locally for developing domestic tourism;
- Wildlife should be preserved through parks, sanctuaries and game resorts on a national priority basis, and wildlife safari tours will be organized to promote tourism;
- Adventure sports should be included while planning for Sonadia Eco-Tourism Park.
- Four- and five-star hotels should be set up within the Sonadia Eco-Tourism Park.

These above pointers need to be synthesized in the master planning exercise to effectively cater to the requirements of the tourists.

4.7. Proposed Product Mix for this Project

Based on the responses received from the primary survey and analyzing the typical product mix for tourism SEZ/ eco-tourism parks/ similar developments across the globe, following product mix and zoning plan have been arrived at:

Table 34: Proposed Product Mix for the Project

Entrance Zone	Adventure Zone (Riverside)	Adventure Zone (Seaside)	Eco-Sciences Zone	Heritage Zone	Family and Entertainment Zone	Hospitality Zone
Entrance gate/arch	Floating restaurant	Entertainment hub	Open garden	Meditation hall	Water and amusement park	Viewing points
Security control room	Open kiosk	Marine and beach development	Cultivation area	Spiritual and yoga centre	Multi-cuisine food courts with fresh catch and eat sea food	Nature trail
Driveway	Adventure game parlor	Game parlor	Green houses	Water and pond zone	Open kiosk	MICE
Car parking lot	Angling – sports fishing	Angling – sports fishing	Plant nursery	Cultural zones	Health zone – Spa, sauna, clinic	Star hotel
Information kiosk/globe	Camp site	Camp site	Ornamental nursery	Heritage preserve	Toy train and child rides	Resorts
Walkway & seating pavilion	Tree houses	Resorts	Organic cultivation	Arts and crafts village	Water sports / cruise zone	Multi-cuisine restaurant
Heritage building front	Golf course	Parasailing	Villas	Multi cuisine restaurant	Laser show	Dry rides
Musical fountains	River deck	Paragliding	Birds Aviary	Themed pavilions	Electronic gaming zone	Convention centre
Viewing deck	River boats jetty	Jet skiing	Bird watching	Themed festivals	Resorts	Training centre
Seating area	River rafting	Multi-cuisine food courts	Botanical garden	Souvenir shops		Spa
Descending steps	Food courts – Multipurpose	Beach walkway	Telescopic tower			
	Cottages	Gazebo	Amphitheatre			

Entrance Zone	Adventure Zone (Riverside)	Adventure Zone (Seaside)	Eco-Sciences Zone	Heritage Zone	Family and Entertainment Zone	Hospitality Zone
	Multi-cuisine restaurant	Kiosk	Rope car / Ropeway bridge			
		Round island for angling	Butterfly park			
			Oceanarium			
			Marine biological research centre			
			Museum			

Source: Primary Survey and PwC/ MACE Research

The above outlined product mix is tentative and may vary during the on-ground implementation.

4.8. Key Takeaways

In this chapter a detailed discussion on the outlook of tourism sector in the country context and in regional (Cox's Bazar/ Sonadia) context has been undertaken. This discussion is supported by data from secondary research, which has been further validated through primary survey.

Key action agendas which need to be followed in order to boost tourism sector in Bangladesh and in Sonadia context are as following-

- Need to provide impetus on formulation of robust policy framework with focus on implementation and monitoring
- Aggressive marketing and promotion activities to promote tourism potential in Bangladesh among global arena
- Focus on security issues so that political turbulence and security concerns do not hamper the tourists
- Increased focus on infrastructure development across the country; especially the connectivity of Cox's Bazar/ Sonadia area needs to be augmented. Tourists opined that the Cox's Bazar airport needs to be upgraded to international airport and the road connectivity within Cox's Bazar district needs to be improved so that the tourists can move seamlessly.
- Lack of world class allied infrastructure (such as drainage, utility) in Cox's Bazar/ Sonadia area
- Lack of adequate local transport facility
- Lack of training among hospitality and tourism professionals
- Government should have keen focus on skill development and start promotion tourism training institute so that trained pool of human resources is readily available
- Lack of world class medical facilities in tourist spots to cater to the requirements of the foreign tourists
- Inclusion of automation in tourism and hospitality sector

This market assessment exercise also brings out the fact that the market wants to witness the following key components within the Sonadia Eco-Tourism Park:

- Wildlife, sanctuaries, and natural resources (flora and fauna)
- Recreational facilities in the sea beach (such as water sports, eateries)
- Adventure sports (such as hiking, biking)
- Good quality resorts and eco-huts (upscale), four/ five star hotels, and affordable segment hotels
- Commercial (restaurants, medical, retail)
- Security and support infrastructure

Synthesizing the response from the primary survey with the analysis of similar eco-tourism parks/ tourism based SEZs/ similar developments across the globe, following broad level product mix has been arrived at:

- Entrance Zone: Entrance gates, security, walkway, and beautification
- Adventure Zone: Riverside (water sports, entertainment facilities, camping) and Seaside (fishing, camping, paragliding, parasailing and others)
- Eco-Sciences Zone: Green house, cultivation area, bird watching, botanical garden, observatory
- Heritage Zone: Spa, meditation, theme pavilions
- Family and Entertainment Zone: Amusement park, food and retail, amusement facilities

- Hospitality Zone: MICE, hotels, Convention centre

Next chapter delves into demand forecasting exercise which aims at allocation of space in the product mix and estimating the average annual footfall in the proposed Sonadia Eco-Tourism Park.

5. Demand Forecasting

5.1. Purpose & Key Objectives

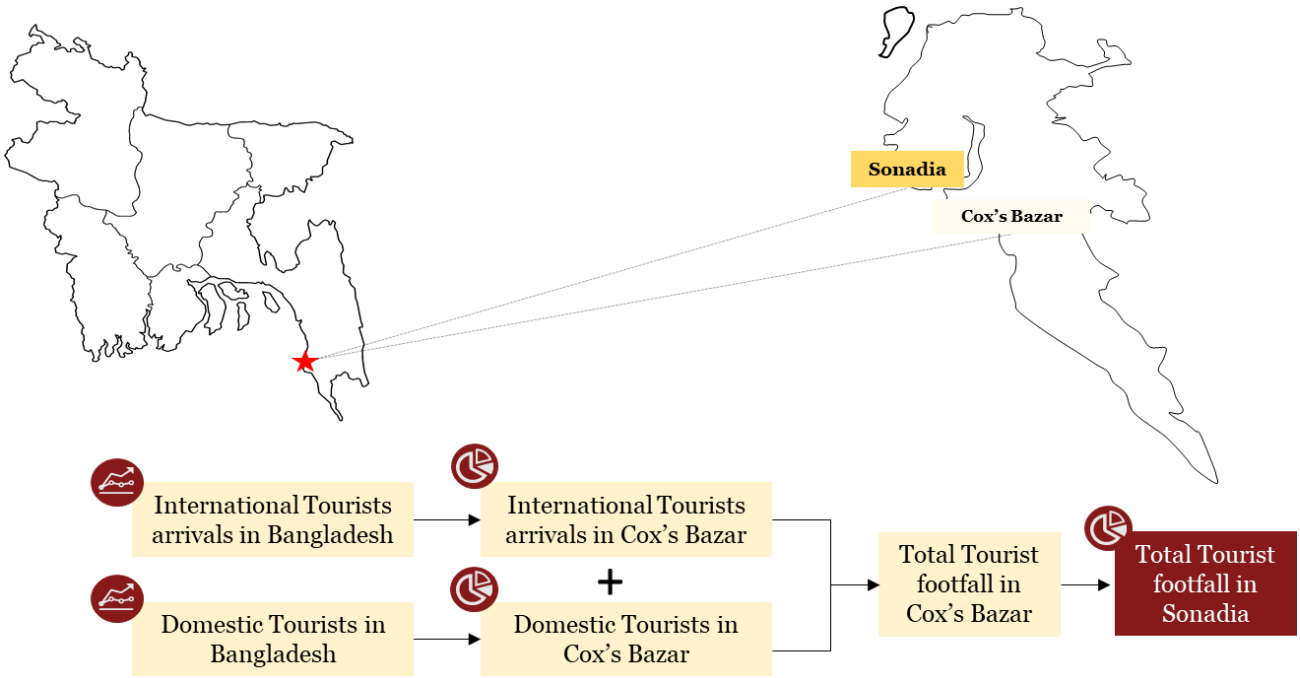
In the previous chapter the market potential for the proposed eco-tourism zone were established basis a comprehensive analysis of environment forces, market trends, entry barriers, competition, risks, and demand survey from the domestic and foreign tourists' perspectives. Based on the insights and through understanding the holistic scenario of tourism in the country Vis a Vis the site, some key components for the proposed eco-tourism zone were identified together with highlighting the best practices prevalent or adopted for similar developments in Southeast Asian countries. This exercise further culminates into a demand forecasting exercise to estimate the tourist footfall at the proposed EZ. In furtherance, space allocation among various components of this eco-tourism SEZ in Sonadia has been assessed in this chapter. Outcomes from this chapter shall aid in decision making for the feasibility of the proposed eco-tourism zone.

5.2. Methodology of Tourist footfall Forecasting and Land Use Assessment

The methodology adopted for forecasting tourist footfall at the proposed eco-tourism zone includes an associative forecasting method (based on population growth). Tourist footfalls both domestic and international in the influence region (i.e. Cox's Bazar) have been forecasted to arrive at future anticipated footfall in the region based on available data and informed assumptions as per market standards.

Land usage pattern and products mix of other similar eco-tourism parks/ similar developments across the globe has been studied since there is no precedence of eco-tourism based development in Bangladesh. Based on the available benchmarks and market knowledge, identified product mix (in the previous chapter) at the proposed eco-tourism park in Sonadia has been quantified to arrive at the land use pattern.

Figure 40: Tourist Footfall Forecast Methodology for Sonadia



Source: PwC Methodology

5.3. Forecasting Scenarios

Tourist footfall forecasting model takes into cognizance three scenarios.

- **Conservative case:** Economic conditions of Bangladesh and the region are not showing steady trend and behaving lower than expected; because of the same, macro-economic indicators are not showing good prospect which is leading to slower growth in disposable income for the domestic population; and potential infrastructure projects planned for the subject region are not commencing as scheduled resulting in difficulty in accessing the region which in turn is leading to below average growth in traffic in the region. These factors are adversely affecting the tourist footfall in Sonadia.
- **Base case:** Economic conditions of Bangladesh and the region are showing steady trend and behaving as expected; because of the same, macro-economic indicators are showing good prospect which is leading to increased growth in disposable income for the domestic population; and potential infrastructure projects planned for the subject region are commencing as scheduled. These factors are favorably affecting the tourist footfall in Sonadia.
- **Optimistic case:** Economic conditions of Bangladesh and the region are showing increasing trend and behaving better than expected; because of the same, macro-economic indicators are showing steadier prospect which is leading to a considerable increase in disposable income for the domestic population; and potential infrastructure projects planned for the subject region are commencing before schedule resulting in easier access to the region which in turn is leading to a good increase in international traffic in the region. These factors are influencing more tourists to visit the proposed EZ.

5.4. Key Inputs and Assumptions

5.4.1. Timeline related Assumptions

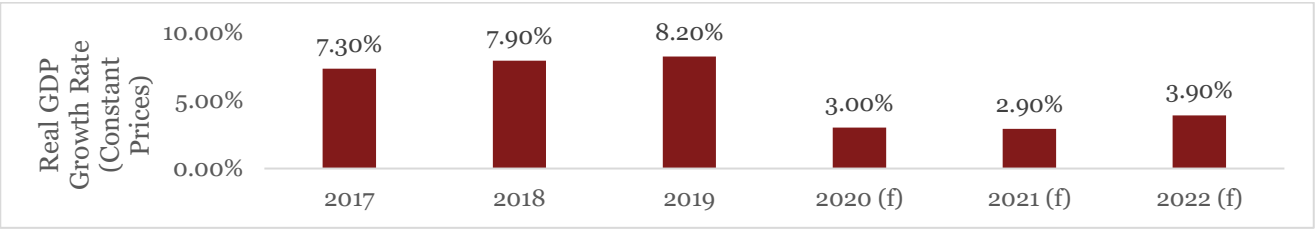
This project is at feasibility stage and development activities will take some time to commence. Moreover, Cox's Bazar is the prime tourist attraction in Bangladesh with a long coastline and natural beauty (flora and fauna). Anchoring Cox's Bazar and the natural attractions in the surrounding (such as Saint Martin Island, virgin sea beaches), Sonadia is expected to shape up as an eco-tourism hub, which is poised to attract tourist in the future. Although the ToR for this project outlines demand forecasting for 20 years, considering the developments proposed in and around Cox's Bazar/ Sonadia and expected augmentation in the physical/ social infrastructure (such as road network, transport infrastructure, utility) in this region, demand forecasting has been undertaken for a duration of 30 years (i.e. till 2050). Estimated tourist footfall in 2050 would portray the right picture of the demand, and the master plan can be prepared subsequently.

5.4.2. Footfall related Assumptions

1. COVID 19 impact on tourism industry growth related assumption

COVID 19 has reached to almost every corner of the globe, and Bangladesh is no exception to it. As lockdowns are placed al across the world, tourism industry is one of the most impacted industries due to the pandemic. Even if these lockdowns will be lifted, tourist will be skeptical to travel in short term, and hence significant fall in tourism industry growth is expected. COVID 19 is also likely to impact other major industries as well, and hence the economy growth rates are also expected to come down. The economic growth rates for Bangladesh in the coming years as estimated by the World Bank are depicted in the following figure.

Figure 41: Estimated growth rate by the World Bank for Bangladesh (Real GDP at Constant Prices)



Note: here, 'f' stands for forecasted.

Source: World Bank

The economic growth is expected to plunge down for few years after the pandemic cease to exist. The growth in real GDP (at constant prices) is estimated to be ~3% in 2020, ~2.9% in 2021, and ~3.9% in 2020. The growth rate in 2021 is estimated to have the lowest, as the COVID 19 has impacted the economy right from the start of the financial year 2020-21, and its considerable impact is likely to continue till the time the pandemic cease to exist. The growth is expected to revive back in the next years once the life comes back to normal and is estimated to get boost due to low base and untapped potential due to low economic growth in several years.

Along with the revival of the economy, tourism industry is expected to revive, and hence depict growth in tourist footfall and hence revenue. By the time the proposed tourism park will start operating, the economy will be back to normal and hence will not show any impact on the tourism footfall or its growth rate in long term. However, a laggard in terms of the growth rate of tourist footfall (both domestic and international) has been assumed which will have a short-term effect.

2. International Tourist related assumptions

Currently the eco-tourism zone is in planning stage with feasibility study being conducted. This zone, once operational will attract both international as well as domestic tourists.

Country level international tourists' arrival data has been collected from the World Bank database. However, data points after 2014 has not been updated in the database. In order to project this data further we have assumed that the international tourist arrival growth rate for Bangladesh from 2014 onwards will be same as per the Compound Annual Growth Rate (CAGR) for Receipts from International tourists (World Bank database) between 1995 and 2017. This CAGR of receipts from international tourists is 8.2% per annum. **It has been assumed that international tourist footfall at the country level increases by 8.2% per annum.** As mentioned earlier, a laggard in terms of the growth rate of tourist footfall (both domestic and international) has been assumed which will have a short-term effect. This will have an impact in the years 2020-2022, where the growth rate would be lower than the assumed value (8.20%) due to effect of COVID-19. Thus, a growth rate of 4%, 6% has been assumed between 2020-21 and 2021-22. Due to stringent lockdown protocols growth rate for the year 2020 has been assumed as 0%.

From the country level data for international tourists' arrival, it has been assumed that Cox's Bazar will have international tourists as per the following percentages for the three forecasting scenarios.

Table 35: Assumptions for International tourists visiting Cox's Bazar as a % of Total International visitors in Bangladesh

Forecasting Scenarios	% of international visitors in Cox's Bazar
Conservative Case	70%
Base Case	75%
Optimistic Case	80%

Source: Market Intelligence

Above numbers are based on the primary survey undertaken among international tourists and discussions with various other stakeholders (such as hospitality players and Govt. officials).

3. Domestic Tourist related assumptions

As per media reports (the independent, July 2019), domestic tourists in Bangladesh was 67.50 lakhs in 2017. Using this data point domestic tourists in Bangladesh has been projected (since 2017). **The rate of increase for domestic tourists is considered as 10.50% per year.** This has been fixed as per the assumption that domestic tourist growth will mainly depend on the population growth of Middle & Affluent Class (MAC) as the MAC population which has an annual income of USD 5,000 or above will have the highest disposable income to spare on tourism. According to BCG report: *Bangladesh: The Surging Consumer Market Nobody Saw Coming,* the MAC population will grow at a rate of 10.5% from 2015-20. But since there is no precedence of eco-tourism available in the country at present it is considered as 10.50%. It is to be noted that there is no updated data bank in this country recording the domestic and international tourist footfall. In absence of such data points, surge in MAC population has been considered as data proxy for the growth in domestic tourist footfall at country level. As mentioned earlier, a laggard in terms of the growth rate of tourist footfall (both domestic and international) has

been assumed which will have a short-term effect. This will have an impact in the years 2020-2022, where the growth rate would be lower than the assumed value (10.50%) due to effect of COVID-19. Thus, a growth rate of 3%, 7% has been assumed between 2020-21 and 2021-22. Due to stringent lockdown protocols growth rate for the year 2020 has been assumed as 0%.

In secondary domain, there is no pertinent data available to quantify the footfall of domestic tourist in Cox's Bazar area. Based on responses received from the primary survey among domestic tourists, in every 4 to 5 years' time span, domestic tourists visit Cox's Bazar at least once. Based on this, following assumptions have been formulated.

Table 36: Assumptions for domestic tourists travelling to Cox's Bazar

Forecasting Scenarios	% of domestic visitors in Cox's Bazar
Conservative Case	20%
Base Case	22.5%
Optimistic Case	25%

Source: Primary Survey

4. Forecasting Scenarios related assumptions

As explained previous portion, three scenarios have been taken into cognizance in order to forecast the tourist footfall in the proposed eco-tourism zone at Sonadia. It has been assumed that Sonadia being at a close proximity to Cox's Bazar, one of the most popular and prosperous tourist locations in Bangladesh, will be a spin-off tourist destination for the initial 30 years period, and will gradually transform into a standalone destination once the popularity and market for eco-tourism grows in the country. Spin-off tourist destination can be defined as a destination where tourist footfall is mostly diverted from a more popular tourist destination which is in close proximity to the subject destination. Thus, the following percentages of total tourists visiting Cox's Bazar has been assumed to be diverted to Sonadia according to the three forecasting scenarios:

Table 37: Assumptions for percentages of tourists visiting Sonadia while visiting Cox's Bazar

Forecasting Scenarios	% of tourist visiting Sonadia while visiting Cox's Bazar	
	Domestic tourists	International tourists
Conservative Case	5%	50%
Base Case	7.5%	55%
Optimistic Case	10%	60%

Source: Market Intelligence

Above numbers are obtained by taking reference from tourism hubs in South Asian context (such as Thailand, Indonesia, Malaysia, Hong Kong).

5.4.3. Space Allocation related Assumptions

The proposed EZ at Sonadia in Moheshkhali upazila in Cox's Bazar district of Bangladesh is **an ecologically sensitive zone as established earlier in the report. This has strengthened the case for development of an eco-tourism zone in the area.** In absence of any precedence in Bangladesh context for similar developments of eco-tourism zones which also have a considerable stretch of sea front, the land allocation pattern and tourism product mix determination for the subject zone is ascertained by benchmarking it with similar areas in countries like India, Thailand and similar South East Asian countries. This is exercised in symbiosis with the tourist footfall forecasting (for Base scenario) presented in the next section. The land allotment or usage pattern has been done keeping in mind that the area is ecologically sensitive which is also its unique selling proposition and thus only a limited portion of the total available area can be used for developmental purposes. The destination is also assumed to be a day stay destination which means that a very small percentage of tourists will opt to stay over at the island with most tourists visiting during the daytime and leaving the same day.

Previous chapter has discussed about the prospective product mix in the proposed EZ in Sonadia. **For some of the components proposed in the product mix, it is not possible to exactly quantify the demand.**

For the rest of the components, a benchmarking-based demand model has been undertaken to estimate the space allocation.

Following table elaborates the product mix and detailing of the components for which benchmarking based demand model can be undertaken. The primary reason to opt for a benchmarking-based demand model is that there has been no precedence of developing eco-tourism Park in Bangladesh context.

Table 38: Product Mix and Detailing of the Components

Product Mix	Remarks
Entrance Zone	• To be designed as per the estimated footfall of tourist after 30 years
Adventure Zone (Riverside and Seaside)	• It is difficult to quantify the demand of all the components; only demand/ space allocation for resorts/ eco-cottages have been estimated
Eco-Sciences Zone	• It is difficult to quantify the demand of all the components; only demand/ space allocation for residential properties/ villas and museum have been estimated
Heritage Zone	• Space allocation for entire heritage zone has been estimated through benchmarking method
Family and Entertainment Zone	• Space allocation for spa (health zone) and resorts have been undertaken
Hospitality Zone	• Space allocation exercise undertaken for MICE, hotels/ resorts, spa, and convention centre undertaken

Source: PwC Research

The following assumptions and examples have been considered to arrive at the land usage and allocation pattern for the site:

Water based Amusement Park: The proposed earmarked area for the eco-tourism zone is adjacent to the coastline in Sonadia, and further to explore a steady source of revenue generation, a water-based amusement park is being suggested for the site. The following examples of Water based amusement parks are considered for land allocation for the same.

Table 39: Examples of Water based Amusement parks considered for land allocation assumptions

Water Park	Area (In Acres)	Annual Footfall (In Million)	Acreage per million annual visitors
Wild Wadi (Dubai)	12	0.89	13.5
Lego Land (Dubai)	73	2.8	26.1
Water Kingdom (Mumbai)	22	1.8	12.2
Aquatica (Kolkata)	17	1.5	11.3

Source: PwC Research

Premium Resort: In order to cater to the premium tourists that would be expected to stay over in the island, a state-of-the-art resort is suggested. The following examples for the same have been considered to ascertain land to be demarcated for the same.

Table 40: Examples of Premium resort considered for land allocation assumptions

Premium Resort	Area (In Acres)
JW Marriott Resort, Phuket, Thailand	30
Park Hyatt Resort, Goa	45
St. Regis Bora Bora Resort, French Polynesia	44
ITC Grand, Goa	45

Source: PwC Research

The premium resort will also include a conference room facility to cater business guests visiting the island for annual meets, conferences or product launches etc. purposes. The area allocation for the same has been done in conjunction with area allocated for similar facilities in Bangladesh.

Table 41: Examples of Conference Rooms considered for land allocation assumptions

Conference Rooms	Area (In Acres)
Long Beach Suites, Dhaka	0.07
Hotel Purbani International, Dhaka	0.04
Six Seasons Hotel	0.12
Amari Dhaka	0.11

Source: PwC Research

The resort will also house a state-of-the-art Spa and Wellness center. The area allocation for the same has been done according to the following examples.

Table 42: Examples of Spa considered for land allocation assumptions

Spa & Wellness Center	Area (In Acres)
Jiva Grande Spa, Vivanta by Taj, Bekal	3.8
Park Hyatt Spa, Goa	0.82
Kaya Kalp Royal Spa, Agra	2.27

Source: PwC Research

Budget Hotels: In order to cater to the non-premium tourists that would be expected to stay over in the island, budget hotels are suggested. The following examples for the same have been considered to ascertain land to be demarcated for the same.

Table 43: Examples of Budget hotels considered for land allocation assumptions

Budget Hotel	Area (in acres)
Bottomhill Palace Hotel, Sylhet	0.08
Sea Welcome Beach Resort, Cox's Bazar	0.10
Galaxy Resort, Cox's Bazar	0.10
Neeshorgo Hotel, Cox's Bazar	0.28
Hotel Quality Home, Cox's Bazar	0.11

Source: PwC Research

Residential Properties/ villas: In order to keep a steady revenue stream and to tap into the real estate market, luxury residential villas or bungalows are suggested to be built in the island. These will be 4-bedroom villas with swimming pools having an average estimated area of 3,000 sq. ft. The size of the land parcel for the same have been considered as per similar properties in India listed in websites such as *Proptiger*, *99acres* and *Vedicrealty*. These will not only cater to the real estate investors but will also provide aggregators like Airbnb an easy gateway into the island.

Convention Center - In order to cater to the business or corporate guests, a state-of-the-art convention centre built on the lines of similar centers in Bangladesh and India, is suggested for Sonadia. It will be positioned as a place of holding national as well as international events such as business summit, music conferences, multi-cultural gatherings etc. The following benchmarks have been considered for the same, to ascertain land to be allocated for the same.

Table 44: Examples of Convention Centers considered for land allocation assumptions

Convention Center	Area (in acres)
Bangabandhu International Conference Center	12.35
Biswa Bangla Convention Center, Kolkata	14.06
Jaypee Palace Hotel and Convention Center	25
Le Meridian, Cochin	14

Source: PwC Research

Heritage Zone – The island will also house a Heritage Zone which will have several components highlighting the intrinsic offerings of the region as well as of Bangladesh. As a part of the land allocation exercise, we have

studied the different components that are mostly found in popular heritage zones across India and other Southeast Asian countries and finally selected the components fit for Sonadia based on similar examples. The following table shows the components that are planned to be part of the Heritage Zone along with the examples considered for each of them for land allocation purpose.

Table 45: Examples of Heritage Zone components considered for land allocation assumptions

Heritage Zone components	Examples	Area (in acres)
Meditation Hall	Osho Meditation Resort, Pune	27.9
Spiritual and yoga centre	Parmarth Niketan, Rishikesh	3
Cultural and Heritage zones	Seven Wonders Park, Kolkata	3
Arts and crafts village	Shilparamam Art and Crafts Village, Hyderabad	6
Museum	Mother's Wax Museum, Kolkata	0.6
	Indian Museum, Kolkata	0.9
Open Lake	Eco Lake, Eco Park, Kolkata	6.9
Souvenir shops	Mishti Hub, Eco Park, Kolkata	.05
Food Court/Themed Restaurants	Ekante Café, Eco Park, Kolkata	0.1
Total		**47.49**

Source: PwC Research

Eco-cottages or Tents– Since the island is ecologically sensitive, makeshift arrangements, which will made available to those who will exclusively visiting the island for bird watching, turtle researching and similar activities. These will be placed in locations with highest probability to spot the olive ridley turtles and the different migratory birds that are available in the island. The floor space for such tents has been captured from *Campetent.com* which is a leading eco-tour operator based out of USA.

Apart from these, since the Island is a breeding ground for an endangered species of Olive Ridley turtles and also hosts a variety of migratory birds and these forming an important component of the ecosystem of the island which needs to be preserved as well as needs to be made accessible for the nature lovers to enjoy, an eco-science zone is also suggested in the island. The area for the same has been demarcated since this is dependent on the behavior of the species. The beach front area is also assumed to be home to water sports activities which would be mostly sea based and would not require separate demarcation of area for operations.

5.5. Forecasting results and Key figures

5.5.1. Estimation of Footfall

In furtherance to the above assumptions, the tourist footfall forecasting calculations were carried out to arrive at the expected footfall at the for the proposed eco-tourism zone at Sonadia.

Following table elucidates the annual tourist footfall at the proposed eco-tourism zone in three scenarios.

The following table depicts the footfall projections after 30 years (i.e. in the year 2050).

Table 46: Annual Tourist footfall at the proposed Eco-tourism zone in millions (year-2050)

Tourists	Conservative	Base	Aggressive
Domestic	1.49	2.51	3.72
International	0.65	0.76	0.89
Total Annual Footfall	**2.13**	**3.27**	**4.61**

Source: PwC Analysis based on demand model

As mentioned earlier, the proposed zone is considered as a spin-off tourism destination to the popular Cox's Bazar area. It is evident from the above table that the **demand for the eco-tourism zone is quite healthy in terms of total annual footfall expected once the zone becomes operational which further bolsters the idea of an eco-tourism zone at the proposed EZ is explored by BEZA.**

5.5.2. Demand forecasting for Annual Tourist footfall

The following table represents the annual tourist footfall in Sonadia over a period of 30 years.

Demand forecasting for Annual Tourist footfall in Sonadia

Conservative	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Domestic Tourists	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
International Tourists	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Base																			
Domestic Tourists	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4
International Tourists	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Aggressive																			
Domestic Tourists	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6
International Tourists	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2

Demand forecasting for Annual Tourist footfall in Sonadia

Conservative	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
Domestic Tourists	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.5
International Tourists	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6
Base																		
Domestic Tourists	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.2	1.4	1.5	1.7	1.9	2.1	2.3	2.5
International Tourists	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8
Aggressive																		
Domestic Tourists	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.3	2.5	2.8	3.0	3.4
International Tourists	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.8	0.8

The following graph depicts the demand forecast for the total tourist footfall in Sonadia over the period of 30 years.

Figure 42: Demand forecast for annual tourist footfall (2020-50)

Source: PwC Analysis based on demand model

5.5.3. Space Allocation Pattern

The following list elucidates the space allocation for the different tourism attractions planned for the zone.

Table 47: Space Allocation for Different Components in the Proposed Sonadia Eco-Tourism Zone

Components	Elaboration
Water based amusement park	According to comparison between similar parks mentioned in the space allocation related assumptions section, it was observed that average acreage per million annual visitors for such parks is 15.8 acres/million. Accordingly, the area for the proposed water-based amusement park is ascertained to be 10 - 30 acres, where 20 acres can be considered for the Base scenario
Eco-Sciences Zone	As per above assumptions and according to the location of the birds feeding ground and turtles' nesting spots it would appropriate to demarcate the north eastern and north western extreme of the island as eco-science zones.
Premium Resorts	According to examples considered of similar facilities in Southeast Asia (mentioned above), it is planned to be spread over 45 – 50 acres including the Spa & Wellness center and Conference Room facilities, where 47.5 acres can be considered for the Base scenario. A single such facility is deemed sufficient as the destination is assumed as a day stay destination.
Budget Hotels	Keeping the above rationale in mind, in order to cater to the non-premium tourists, four (4) budget hotels spread across the island with easy access to the attractions could be planned. A cumulative area of 0.5 - 1 acre can be allotted for such developments, where 0.75 acres cab ne considered for the Base scenario
Residential Properties/ Villas	As per the assumptions in the previous section, 50-100 luxury residential villas or bungalows (75 for Base scenario) are suggested to be built in the island. A total of 5 - 10 acres spread across different locations (preferably along the beach front) can be considered for such development, where 7.5 acres can be considered for the Base scenario
Convention Center	As per the benchmarks and assumptions in the previous section, the island will comprise of a Convention center spread across 12 – 15 acres of land, where 13.5 acres can be considered for the Base scenario
Heritage Zone	According to the examples considered in the previous section, the Heritage Zone with its various components, will be spread across an area of 45 – 50 acres, where 47.5 acres can be considered for the Base scenario
Eco-Cottages or Tents	Eco cottages or tents with a floor space of 70 sq. ft. (4 person tents) are planned to be placed in strategic locations in the above-mentioned Eco-science Zone at the island.
Water Sports Zone	The waterfront area (coast/beach area) of the island will also cater to water sports lovers and this area is planned to be home to a variety of water sports

Components	Elaboration
	activities like jet ski, banana ride, para sailing etc. It is expected to be one of the most visited areas in the island.

Source: Demand Model

It is to be noted that the above space allocation exercise and footfall estimation results are based on mathematical model and benchmarking methods. These estimations are indicative in nature and might vary upon actual implementation of the project, the construction period and the economic landscape of the region in the future.

5.6. Key Takeaways

Demand forecasting takes into cognizance estimation of tourist footfall at the proposed Sonadia Eco-Tourism Park and also the estimation of space allocation of different components within this eco-tourism park. The tourist footfall forecasting exercise was undertaken considering three different scenarios viz. conservative, base, and aggressive. Estimation of space allocation exercise has been based on benchmarking exercise since there has been no similar precedence of eco-tourism parks in Bangladesh context.

In base case, macro-economic conditions, income level, and infrastructure growth at the country level and at Sonadia level are growing as per the projected, whereas in the conservative and aggressive cases, this growth trend is declining and increasing respectively.

Results from the demand forecasting are indicated in the following-

- The projections revealed that after 30 years, in 2050, the proposed economic zone would have an annual total footfall of 2.13 million to 4.61 million (in conservative and aggressive cases), whereas in the base case, the annual total footfall is estimated to be 3.27 million. The projections consider the short-term effect of COVID-19 which is slated to adversely affect the tourism growth rates between 2020-2022.
- The area being an ecologically sensitive one will need to be preserved for its most parts with developments limited to a certain extent of area. Seven key zones have been proposed as product mix for this eco-tourism park. Out of these, some tourism, products/ components are quantifiable, which are explained in the following (**for Base scenario**). Space allocation for these tourism products are based on benchmarking exercise since there is no precedence of developing an eco-tourism park in Bangladesh context.
    - Water based Amusement park – 20 acres
    - Eco-science Zone – since it is difficult to assess the space for this component, we have demarcated areas (the north eastern and north western extreme of the island as eco-science zones) for this zone
    - Premium Resort with Spa and Conference Rooms – 47.5 acres
    - Budget Hotels (4 in no.s) – 0.75 acre
    - Residential villas – 7.5 acres
    - Convention Center – 13.5 acres
    - Heritage Zone – 47.5 acres
    - Eco-cottages or Tents – 70 sq. ft per tent

- Water Sports Zone – the waterfront area adjoining the beach of the island is demarcated for accommodating water sports activities. There is no allocation of land for this component, as it will be mostly water based and would require less land area.

It would be prudent to consider the fact that these estimations are indicative in nature and might vary upon actual implementation of the project, the construction period and the economic landscape of the region in the future.

6. Transport Assessment

6.1. Purpose and Objective

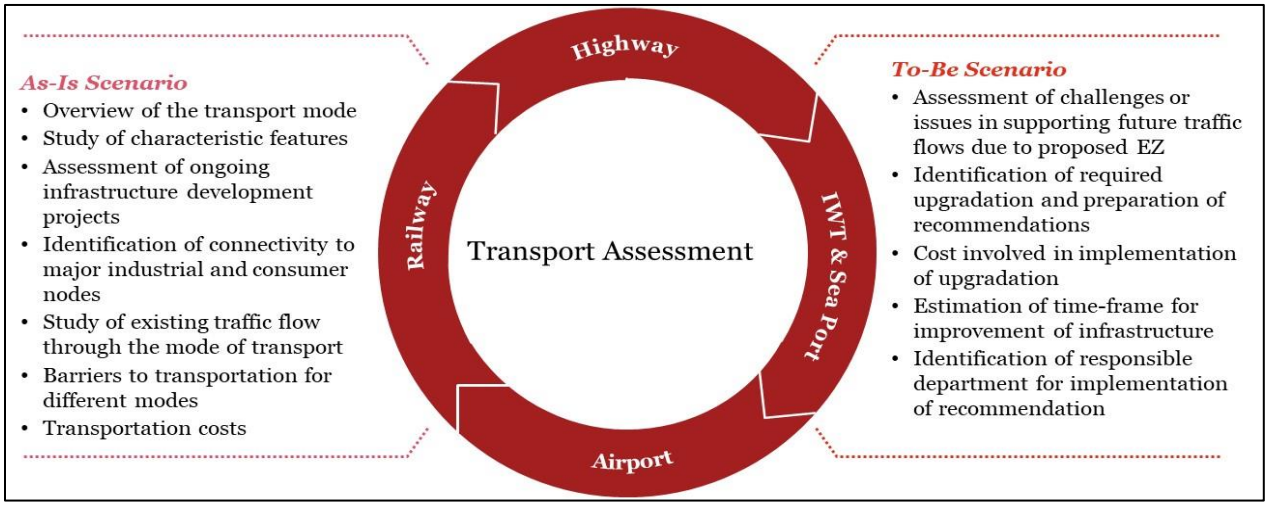
A robust transport infrastructure is the most vital enabler for any location to shape up as a potential tourism zone to enable seamless movement of tourists. Tourism is largely about traveling and exploring and the role of transportation in its operation is vital. For a tourist destination to gain popularity with domestic & international tourists, it needs to supported by seamless access from key transit gateways and urban agglomerations. The development of transport infrastructure, and use of technology to increase the ease of access in the sector speeds up the development of tourism.

This chapter will delineate the transport infrastructure available in the vicinity of proposed EZ and existing connectivity with major international transit points. A comprehensive study of transport infrastructure i.e. road, railway, IWT and airport will be performed to understand as-is scenario. The impact of the development of proposed EZ on all transport modes will be considered and proposals to upgrade the existing transport network in order to support the proposed EZ will be elucidated.

6.2. Methodology of Transport Assessment

The approach adopted to assess transport infrastructure supporting movement of tourists in the vicinity of the proposed EZ is segregated into 2 modules. 1st module deals with evaluation of the existing status of different modes of transport with respect to its features, connectivity, traffic flow, ongoing projects for upgradation and transit costs involved. 2nd module contains recommended upgradations of different modes of transport infrastructure to provide a seamless experience to the tourist footfall due to the proposed EZ, cost implication of such upgradations, timeframe over which the upgradation should take place and the departments responsible for the concerned upgradation.

Figure 43: Assessment Methodology

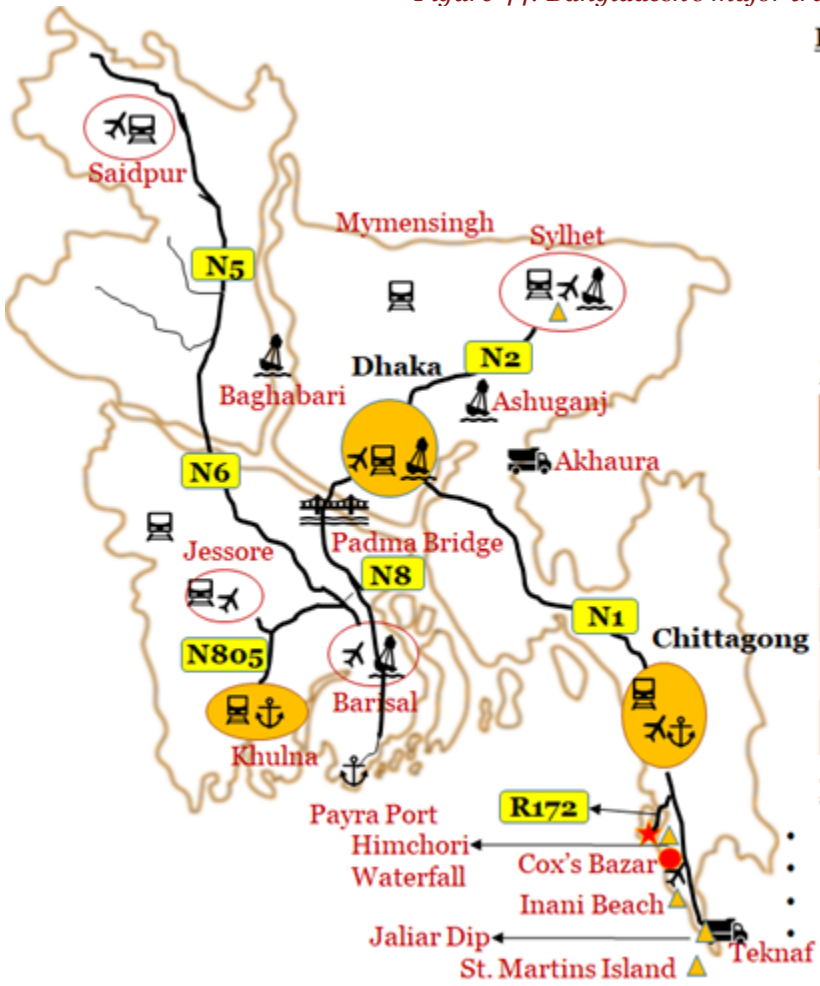


Source: PwC Research

6.3. Review of National Infrastructure with respect to site

A macro level view of major transport nodes across Bangladesh has been outlined in the figure below –

Figure 44: Bangladesh's major transport nodes with respect to Proposed EZ



Legends:

- Tourist Destinations
- Airport
- Major IWT Node
- Proposed EZ
- Major Rail Node
- Major National Highway
- Sea Port
- Major Hubs

Distance from the Major Hubs and Tourist Destinations:

Node	Distance (Km)	Node	Distance (Km)
Dhaka	381	Chittagong	127
Cox's Bazar	99	Bibirbazar	275
Jaliar Dip	101	Sylhet	502
Inani Beach	67	Teknaf	190
Himchori Waterfall	35	St. Martins Island	110

Major Highways:

- **N8** – Dhaka – Mawa Highway
- **N2** - Dhaka-Sylhet Highway
- **N6** – Dhaka – Rajshahi Highway
- **N5** - Dhaka-Rangpur Highway
- **N1** – Dhaka – Chittagong
- **N805** – Bhanga – Noapara Highway
- **R172** – Chakaria-Badarkhali Road

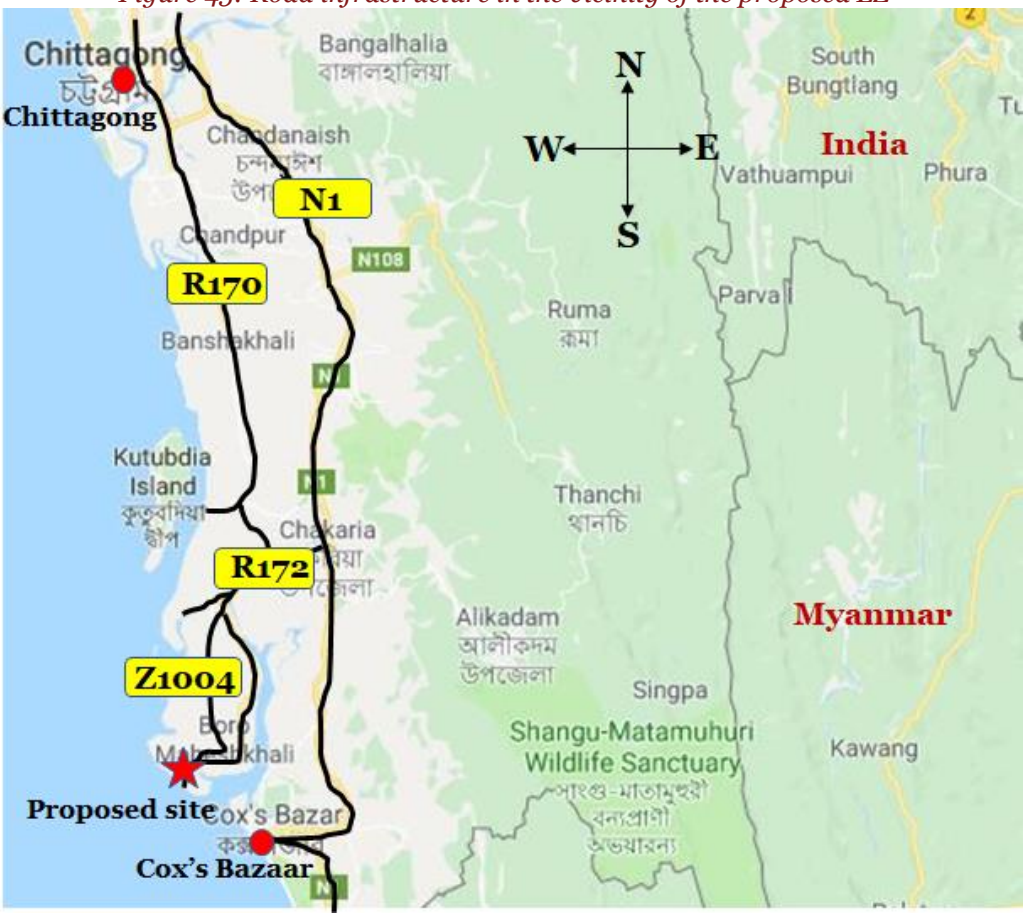
Source: PwC Analysis

6.3.1. Highways

Road connectivity is essential to foster last mile connectivity of tourists to and fro their destinations. Good access to roadways shall enable seamless movement of travelers from the proposed ecotourism site to domestic and international destinations.

The following figure captures the road infrastructure in the vicinity of the proposed EZ.

Figure 45: Road infrastructure in the vicinity of the proposed EZ



Source: Google Map and PwC Analysis

The figure above elucidates that the proposed EZ has direct road access to Cox's Bazar and Chittagong. One of the key features of the proposed EZ in terms of tourism is its proximity to the beach of Cox's bazar and the Moheshkhali Island. The Sonadia Island is separated from the mainland by the Moheshkhali channel and a Bara canal separates it from the Moheshkhali Island. N1 is the trunk highway which connects the site to Dhaka and Akhaura in the north for connectivity to international passengers and also goes up to Cox's Bazar in the South to connect other tourist destinations as well.

6.3.1.1. Roadways near the proposed EZ

The proposed Ecotourism site has an approach road of width ~10 feet, which runs along the Kutubjom Union and connects with Janatabaza – Gorakhghata road (Z1004) in Moheshkhali upazila.

Zila Road (Z1004) connects the site with Chakaria-Badarkhali Road (R172) which further connects to Dhaka-Chittagong Highway (N1). The proposed EZ is approximately 127 km from Chittagong and the travel time is 5 hours. Chittagong can also be accessed via R170 (Patiya-Chokoria Road).

Dhaka Chittagong National Highway (N1) is one of the strategic highways in Bangladesh. The proposed EZ is located about 52 km from the national highway and access takes place via Z1004 and R172. While R172 is 2-lane

road having average width of 5.58 m, Z1004 is single lane road having an average width of 3.77 m.[99] This could hinder smooth flow of bi-directional tourist movement on Z1004, resulting in congestion and risk of accident. In this context, the zila road Z1004 and its improvement and maintenance hold immense importance in elevating the connectivity of the site area. For any tourist destination to thrive, a seamless experience is foremost.

Figure 46: Last mile connectivity of the proposed EZ

Source: PwC and MACE analysis based on Google maps

Vehicular Traffic

As per data available in Roads and Highways Department (RHD) database, Average Annual Daily Traffic (AADT) for R172 is 5,402 vehicles, out of which 4,478 is motorized, rest is non-motorized. Traffic volume on R172 is significantly lower than the traffic volume of busiest road links in the country.

Data from RHD reveals that AADT for Z1004 is 3,807, out of which 3,167 is motorized and rest is non-motorized. AADT for N1 is 12,582 vehicles, out of which 11,896 is motorized, rest is non-motorized. N1 is currently a two lane road having an average width of 8.35 m. Expansion plans of N1 to four lanes are underway. The increase in tourist footfall needs to be supported by roads having appropriate capacity.

The zila road Z1004 and its widening plans holds immense importance in elevating the connectivity of the proposed EZ area. Widening of roads would greatly improve upon the already favorable last mile infrastructure. This would allow a faster 2-way movement of tourists.

The proposed EZ has an approach road of width ~10 feet. It is connected with the Zila road (Z1004) which provides last mile connecting infrastructure to the proposed ecotourism site. Upgradation of the existing roads to make it a 2-lane will ensure ease and comfort for movement of tourist vehicles.

6.3.1.2. Trunk Connectivity to Cox's Bazar and Chittagong

There are two major urban/tourist nodes in vicinity of the proposed EZ. These are –

- Cox's Bazar
- Chittagong

[99] *Roads and Highways Department*

Cox's Bazar is a city, tourism centre and district headquarters in Southeastern Bangladesh which is located around 10 km (aerial distance) away from the proposed ecotourism site location, requiring a travel time of around 40 minutes from the site location. This city is a major tourist attraction in Bangladesh and is home to Himchari National Park, Aggmeda Khyang and Bangabandhu Sheikh Mujib Safari Park.

Cox's bazar airport is located at a road distance of 99 km from the site and can be accessed via Z1004 which connects to R172 meeting with N1 at Chakaria. It can also be accessed through waterways, which cuts down the distance to 9 km. Travel time to the proposed EZ is around 2 hours by waterways and 3.5 hours by road.

Chittagong is a major coastal city and financial centre of Bangladesh. It is Bangladesh's second most significant urban center after Dhaka. This city is around 127 km away from proposed ecotourism site at Sonadia, requiring a travel time of around 5 hrs. It is the 2nd largest city of Bangladesh and is home to Chittagong Port and various industries like petroleum, steel, shipbuilding, jute, chemicals, pharmaceuticals, textiles, leather goods, motor vehicles etc.

Chittagong can be accessed from the EZ location through the zila road (Z1004), Chakaria-Badarkhali Road (R172) and Dhaka-Chittagong Highway (N1) requiring a travel time of around 5 hours. It can also be accessed via R170 (Patiya – Chokoria Road).

6.3.1.3. Trunk Connectivity from Dhaka

Dhaka is the commercial capital and the largest city of Bangladesh. The proposed EZ is around 381 km from Dhaka city and can be accessed via Z1004, R172 and Dhaka-Chittagong highway (N1). Travel time from the proposed ecotourism site to Dhaka is approximately 9 hours. The Dhaka-Chittagong highway (N1) is a main transportation artery in Bangladesh. Currently N1 is a two lane highway with a four lane expansion underway to reduce the traffic congestion. Road condition of the entire stretch is suitable for movement of tourist vehicles. An elevated expressway currently being built from Dhaka to Chittagong will help in further improving the connectivity and reducing travel time for tourists from Dhaka.

As per the RHD database, the vehicular traffic at Dhaka Chittagong Highway was observed to be ~24,000 in 2018, which accounts for traffic of ~58,900 PCUs. Given that the capacity of four laned road is to carry traffic of ~60,000 PCUs per day, Dhaka Chittagong Highway might require further augmentation in capacity from its current four laned capacity.

Additionally, most of the vehicles visiting Cox Bazar today from Dhaka need to pass through Chittagong city, which is in itself once of the congested cities in the country, majorly due to the cargo traffic which originates as well as is destined to Chittagong Port. This possible delay can be decreased for tourists vising Cox Bazaar from other parts of the country by making Chittagong city bypass available for the tourists. The construction of bypass will improve the connectivity of the proposed tourist location to the capital city Dhaka, and also the other parts of the country through road network.

Good trunk connectivity from Dhaka and Chittagong is very important from the context of both international and domestic tourists residing in these areas having the capacity to spend and the willingness to travel.

6.3.2. Water Transit

Waterway transport is one of the most fuel efficient, environment friendly and cheapest mode of transportation. Bangladesh is blessed with a riverine geography, especially towards its south, where distributaries of large rivers like Padma and Meghna drain the region. This creates a fairly widespread inland waterways network, creating an opportunity for Inland waterways transportation. Bangladesh also has a coastline of 580 km which creates good potential for sea transit of domestic & international tourists.

Proposed ecotourism site is located at a distance of 7.5 km from Kastura ghat and 8 km from Moheshkhali-Gorakghata ghat. Moheshkhali-Cox's Bazar boat line connects the Moheshkhali-Gorokghata ghat with Kastura ghat. At present, both these ghats have jetty facilities available. These ghats can be integrated with the proposed jetty facility at Sonadia island to facilitate the ease of movement of tourists from Cox's bazar. Currently, the waterway route is the most widely used mode of transport to the proposed EZ from Cox's bazar.

Additionally, water transit through the regions of Sundarbans in itself will act as a center of attraction for most of the tourists. Government can initiate tours from Dhaka/Chittagong/Other urban regions in the country to the proposed eco-tourism park through Cruise trips, and given the regions specialty as the biggest delta region in the world combined with the unique thrilling experience of travelling on cruise will indeed attract significant domestic as well as international tourists to the country. The similar experiment was conducted between Goa (popular tourist destination in India) and Mumbai by the government of India, where a cruise ship named Angriya is getting operated between two cities, and it has already turned out to be the attraction for the domestic as well as international tourists visiting the tourist destination of Goa.

6.3.3. Airport

Air travel is the fastest and most popular mode of tourist transport which enables faster movement of passengers. It is vital for tourists having busy schedules who can save substantial travel time by opting for this mode of transport. Apart from that, airports also serve the purpose of providing an immediate and less time consuming movement of managerial staff for supervision and strategic purposes for hospitality services. This necessitates the need to understand air travel facilities around the proposed EZ region.

The proposed ecotourism site is located at a road distance of approximately 99 km from Cox's Bazar domestic airport. It can be accessed via approach and the zila road (Z1004). It can also be accessed through the water way, which cuts down the distance to 9km. Travel time from Cox's Bazar airport to proposed EZ is around 2 hours by waterway and 3.5 hours by road via Z1004 and N1. The following table represents Passenger Airlines and their destinations from the 2 nearest airports to the site.

Table 48: Passenger Airlines and Destinations from Cox's Bazar Airport

Airlines	Destinations
Biman Bangladesh Airlines	Dhaka, Chittagong
Novoair	Dhaka
Regent Airways	Dhaka
US-Bangla Airlines	Dhaka
Bismillah Airlines	Jessore, Sylhet

Source: flightradar24

Nearest international airport to the proposed EZ is Shah Amanat International Airport in Chittagong. This airport provides both international as well as domestic flight services. It is Bangladesh's second largest international airport after Shah Jahal International Airport in Dhaka and has direct links to destinations in South Asia and the Middle East. This airport is around 127 km away from proposed EZ and requires around 5 hours of travel time. Currently, this airport has the capacity to handle 1.5 million passengers.

Table 49: Passenger Airlines and Destinations from Chittagong International Airport

Airlines	Destinations
Air Arabia	Sharjah
Air Asia	Kuala Lumpur-International
Biman Bangladesh Airlines	Cox's Bazar, Damman, Dhaka, Doha, Jeddah, Medina, Riyadh, Sylhet
Fly Dubai	Dubai-International, Dubai-World Central
SalamAir	Muscat
US-Bangla Airlines	Chennai, Colombo, Dhaka, Guangzhou, Hanoi, Yangon

Source: flightradar24

Chittagong airport also provides direct connectivity to Kolkata airport encouraging ease of travel for Indian tourists.

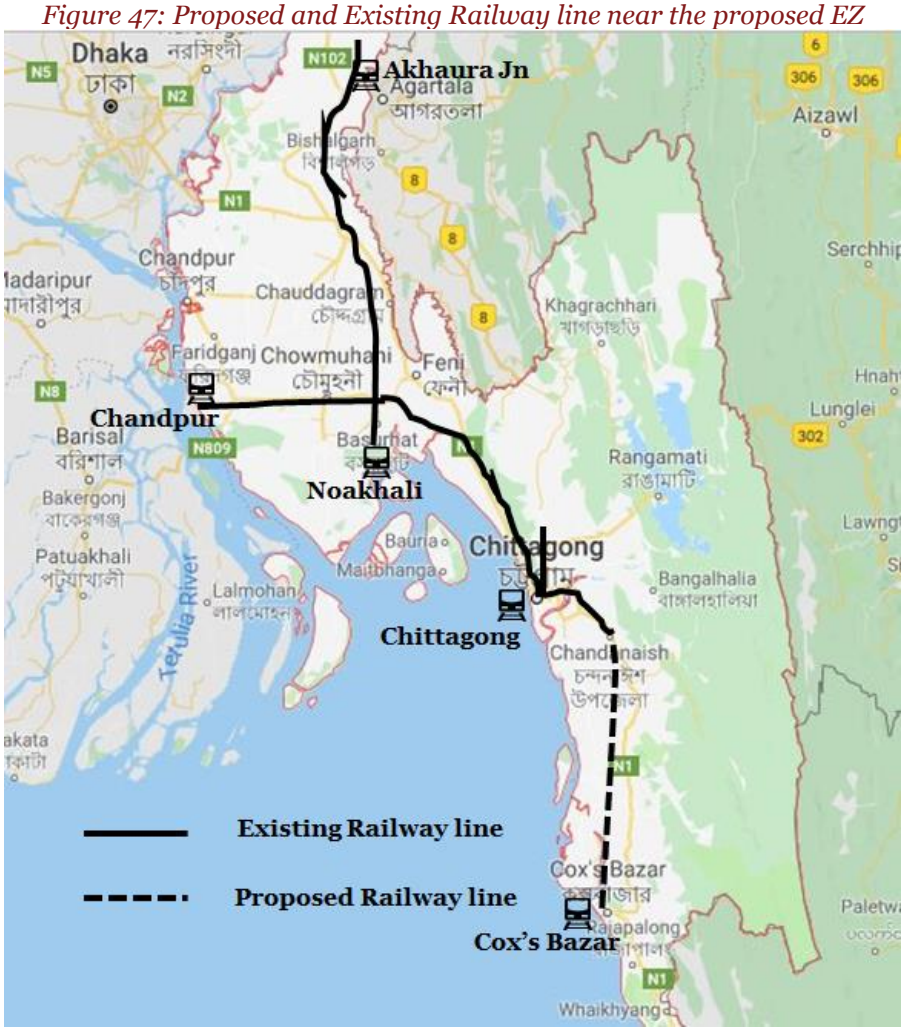
Emphasis should be made to upgrade Cox's Bazar airport as international airport so that foreign tourists can easily access Sonadia and Cox's Bazar location from anywhere. Direct services particularly to Kolkata and North East Indian airports should be started to encourage more regional tourist footfall.

6.3.4. Railways

Railways are the cheapest mode of transport after waterways and charge approximately 0.67 Taka per passenger per km and are preferred by tourists all over the world for ease of travelling. An overview of railway connectivity in the proposed EZ region is mentioned below.

Presently, there is no prevailing rail network in Cox's Bazar district. The nearest existing railway station is Chittagong railway station which is located at a distance of approximately 120 km from the proposed ecotourism site. The Chittagong railway station can be accessed by Patiya-Anowara-Banshkhali-Toitong-Pekua-Badarkhali-Chokoria (Eidmoni) highway (R170) or Dhaka-Chittagong highway (N1). Travel time from the proposed EZ to Chittagong rail station (by road) is around 4.5 hours.

Figure 47: Proposed and Existing Railway line near the proposed EZ



Source: PwC Research and Bangladesh Railways

However, a railway network is proposed in Cox's bazar, which is 8 km via waterway and 10km via roadway from the proposed EZ. Chittagong-Cox's bazar railway line is a proposed 128 km passenger line from Dohazari in North of Chittagong division and runs towards south to reach Cox's bazar district. This 128 kilometer line is expected to

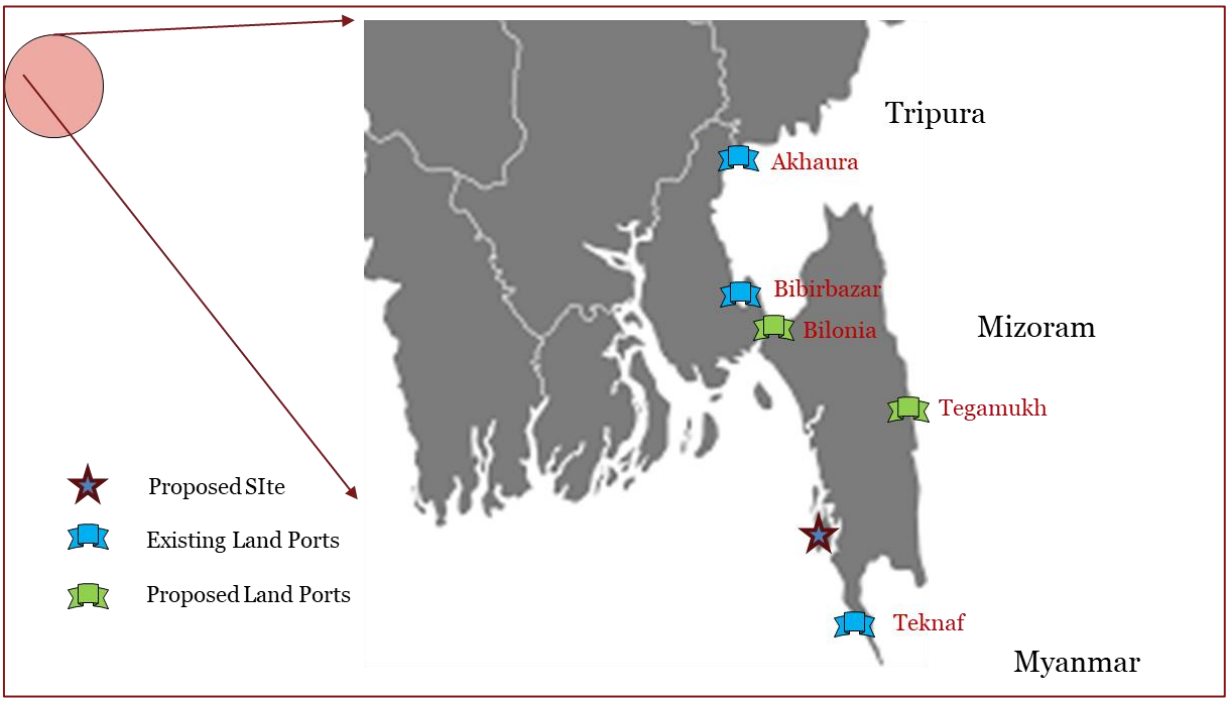
boost tourism in Cox's bazar by providing low cost connectivity for domestic tourists. This green field project is one of the seven investment sub-projects being undertaken by Bangladesh Railway (BR) to improve the country's rail connectivity with other Asian countries. The first phase of the project will include a single-track dual gauge rail line approximately 102km in length. It will pass through eight sub-districts (Upazilas) including the Chandanaish, Satkania and Lohagara sub-divisions in Chittagong district and the Chakaria, Cox's Bazar Sadar, Ramu and Ukhia sub-divisions in Cox's Bazar district. During the project's second phase, the rail line will be extended to the Myanmar border, as well as a planned deep-sea port on Matarbari Island.[100] Chittagong-Cox's Bazar railway project is expected to connect the national and sub-regional railway networks for the first time. This project aims to enhance the trade and tourism in the southern most parts of the country and is planned to be operational by 2022.

Once the railway network in the vicinity of the proposed EZ is established, it could benefit the tourists for their ease of travelling through different parts of Bangladesh, India and Myanmar.

6.3.5. Land Ports

Bangladesh and India share a border line of 4,096 km, which is the fifth longest border in the world.[101] Such a long land border creates opportunity for mutually beneficial foreign association. Land ports facilitates trade, commerce and movement of passengers (tourists and non-tourists) between two countries, since they provide secure gateways. Currently, India and Bangladesh have 23 land ports to facilitate trade between the two countries.[102] There is also 1 land port between Bangladesh and Myanmar at Teknaf.

Figure 48 Land Ports near the EZ



Source: Bangladesh Land Ports Authority

Teknaf and Bibirbazar are the two nearest operating land ports from the site providing access to international passengers from India and Myanmar respectively. They are located at ~190 km south and ~275km north of the proposed EZ respectively. Access to both these land ports takes place through Dhaka-Chittagong Highway (N1). This highway is part of the Asian Highway network, BIMSTEC corridor as well as SASEC corridor.

[100] *https://www.railway-technology.com/projects/chittagong-coxs-bazar-railway-line/*
[101] *http://www.thehindu.com/news/national/half-of-indiabangladesh-border-fenced/article17396794.ece*
[102] *Bangladesh Land Port Authority*

These land ports are yet to be modernized. Lack of digitization and absence of modern surveillance system results is poor immigration facilities. There is significant traffic congestion on the last mile connecting roads due to freight traffic.

Land acquisition for two other approved land ports Tegamukh and Belonia (which are nearer to the proposed EZ) is in process. If immigration facilities are improved across these four land ports it will result in large tourist footfall from Myanmar and North East India.

Good access to land ports shall ascertain tourist increase from India and Myanmar.

6.4. Potential Infrastructure Interventions to support proposed ecotourism site

Proposed Tourism zone at Sonadia is connected with Dhaka and other parts of the country through road network. The proposed EZ is connected to the existing zila road Z1004 through an approach road, which needs to be carpeted once the construction activity starts. Preliminary assessment suggests that the road needs an overhaul to support the magnitude of movements of passenger as well as goods once the developmental works begin at the proposed EZ.

The main trunk connectivity to the proposed EZ is provided by N1, which connects the Cox Bazaar with the other urban centers such as Dhaka and Chittagong. The route is already operating at a capacity of ~58,900 PCUs per day, and it is highly likely to cross the limit of ~60 thousand PCU per day for four laned road. Hence the further augmentation of the route is essential in order to decrease potential congestion on the road in future.

The route also passed through the port city Chittagong. Chittagong city, being a port city, involves significant traffic of EXIM related cargo trucks on the road. This traffic interferes with the daily traffic and may interfere with the tourist's traffic travelling towards the proposed EZ from Dhaka city via road. Government may consider construction of alternate city bypass in such a case, which may help in making journey from Dhaka to proposed EZ seamless for the tourists.

In order to cater to the increased traffic and demanding passengers, the Cox's Bazar airport needs to be upgraded and modernized which will provide domestic as well as international access to the proposed ecotourism site and thus hold immense importance.

While the EZ is well connected through multiple modes of transport (road, rail, air and ports) there could be a few additional improvements needed to be undertaken by GoB to improve the attractiveness of the ecotourism site with respect to transport infrastructure. This could include and not be limited to the following table on the next page.

The table on the next page captures present and potential future hindrances for tourists and infrastructure interventions that could be undertaken in order to make the proposed EZ attractive in terms of access and comfort to tourists. Interventions suggested in the table on the next page have been done after taking into considerations the infrastructure upgradation currently being planned by different departments of GoB. These interventions are indicative development activities that could be further studied apart from development activities already being implemented.

Table 50: Proposed Infrastructure Interventions

Key Asset	Existing Condition	Issues	Recommendation	Cost Implications and Timeframe for improvement	Jurisdictional Responsibility
Upgradation of Cox's Bazar Airport	Currently, the airport provides domestic services to different parts of Bangladesh	Proposed ecotourism site increases the traffic at the airport and increase in number of tourist arrivals	• Upgrading it to International airport to attract more tourists and cater the demand.	A detailed feasibility study needs to be undertaken in order to arrive at cost estimation and timeframe for improvement.	Civil Aviation Authority of Bangladesh
Expansion and upgradation of zila road (Z1004)	Currently, the average width of Z1004 is 3.77 m	Congestion of traffic once the developmental work begins at the proposed EZ	• Zila roads needs overhaul to support the magnitude of movements of passengers and goods	A detailed feasibility study needs to be undertaken in order to arrive at cost estimation and timeframe for improvement.	Roads and Highways Department, Bangladesh
Upgradation of Dhaka-Chittagong-Cox Bazaar Highway (N1)	Currently it is undergoing augmentation to four lane.	The utilization of the road is estimated to go beyond 100% in couple of years increasing congestion.	• Expansion to six lane capacity	Expansion to six lane within next couple of year (by 2022)	Roads and Highways Department, Bangladesh
Construction of Chittagong City Bypass	No dedicated bypass exist today	Tourist vehicles might face traffic in Chittagong city which currently encounters EXIM traffic due to port.	• Construct the Chittagong City Bypass Road (2 lane)	A detailed feasibility study needs to be undertaken in order to arrive at cost estimation and timeframe for improvement.	Roads and Highways Department, Bangladesh
River Jetty	The proposed EZ has a good connectivity with Cox's bazar town with limited jetty services	Absence of well-maintained jetty services which can be further improved as per standard benchmarks	• Improvements in the existing services with the use of sophisticated boats and well-maintained ferry services • Cruise services to Thailand or Myanmar could also be started from this location in the long run	A detailed feasibility study needs to be undertaken in order to arrive at cost estimation and timeframe for improvement.	Bangladesh Inland Waterways Authority

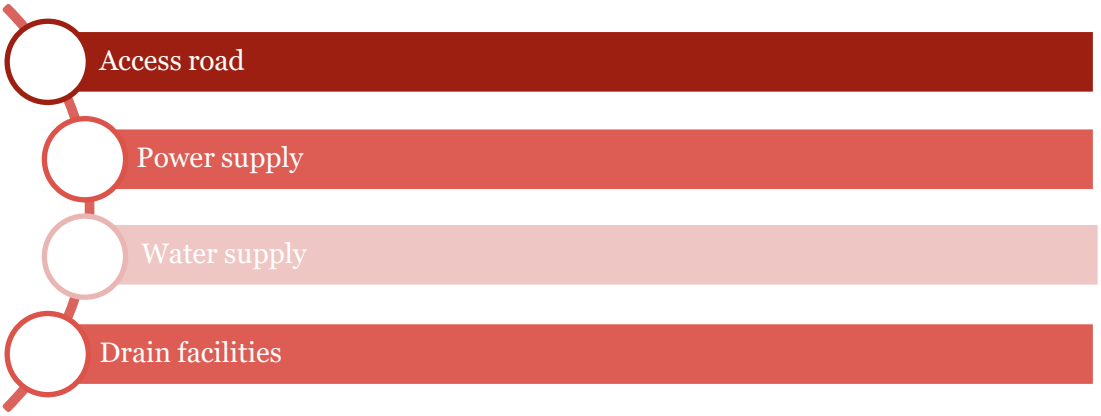
Land Port	Under development Tegamukh land port Limited capacity at Teknaf land port	The development works for this land port are not on priority	Immigration facilities need to be improved across the Tegamukh and Teknaf land ports. This will facilitate the movement of more international tourists from North East India and Myanmar	A detailed feasibility study needs to be undertaken in order to arrive at cost estimation and timeframe for improvement.	Bangladesh Land Ports Authority

It is necessary to develop as well as manage the all transportation modes such that they remain in unison with each other and provide seamless and hassle-free experience to the tourists visiting the proposed EZ. It is also necessary to ensure that all the transportation infrastructures are well maintained and operated helping the experience to remain in long term, and also authority managing the project to recover the invested investment.

7. Off-site Infrastructure

7.1. Off-site Infrastructure assessment

For the sustained operation of Sonadia Eco-Tourism Park (SE-TP), it is pertinent that off-site infrastructure and its connectivity to the proposed SE-TP are adequately addressed. To facilitate the integration of basic infrastructure facilities and utilities like water, power, approach road and drain for SE-TP, the existing infrastructure facilities in the vicinity of the site needs to be identified and gaps that could hinder the development of the SE-TP needs to be addressed. The major off-site infrastructure components considered for SE-TP are as follows:



Source: MACE analysis

The above listed off-site infrastructure components would be developed by BEZA in order to provide support to the developer who would undertake the construction of the SE-TP.

7.2. Methodology for Off-site Infrastructure Assessment

A stepwise approach has been adopted to assess the off-site infrastructure for the proposed SE-TP.

➲ Step 1: Identification of possible sources

The available infrastructures at the project site and its surrounding area have been identified by carrying out following activities:

- Study of satellite image;
- Site visit;
- Field investigation; and
- Discussion with the officials of RHD, REB and DPHE.

➲ Step 2: Feasibility study

The feasibility of utilizing the identified infrastructure depends upon several factors for different components which are as follows:

- Access road - The existing carrying capacity of the road and the probability of expansion if required;

- Power supply - The available surplus capacity of existing sub-station to cater to the power demand of the proposed SE-TP. The distance of sub-station from the proposed site and the possibility of bringing the feeder line to the SE-TP;
- Water supply
  - Surface water: Availability of water to meet the demand, distance, quality and possibility of bringing the main supply line from the source; and
  - Groundwater: Aquifer depth, yield to meet the demand and quality of groundwater.
- Drain - Capacity of existing drains/ channels to carry the additional water from the proposed project area. The terrain nature of the site to support the gravity flow through the drain of SE-TP to reach the identified external discharge point.

7.3. Review of Last-mile Off-site Infrastructure

7.3.1. Approach Road

An approach road of width varies between 9 to 10 ft. connects the site with Zila road (Z1004) at a distance of 12 km from the site and village road at a distance of 3.5 km from the site

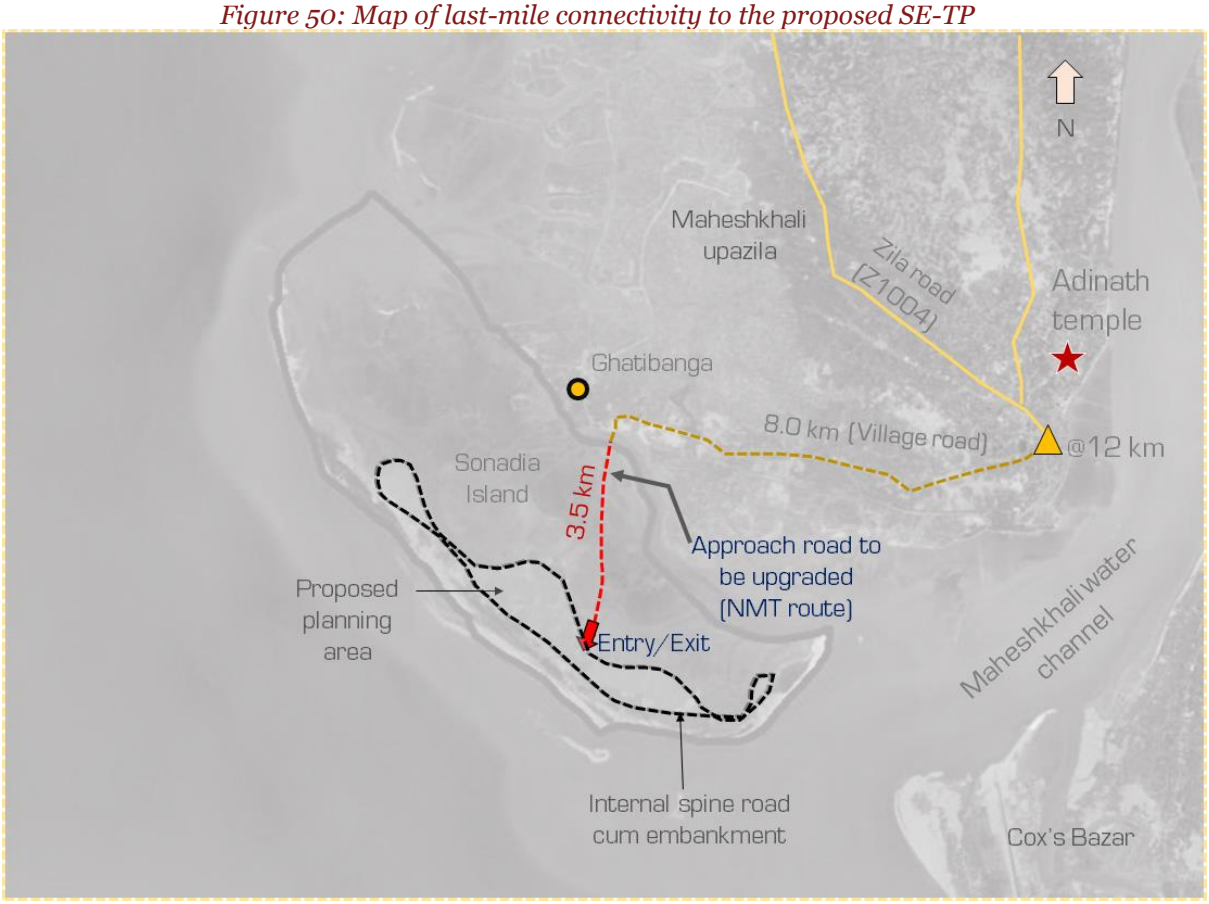
Figure 49: Approach road connecting the planning area

Source: MACE analysis

The approach road connecting the planning area is a mud road, and its width is even less than 9 feet at some stretches within Sonadia Island. In the chapter titled "Transportation Plan", it is proposed that there will be an NMT parking area on Maheshkhali side at the entry of Sonadia Island. From this junction, the tourists will be reaching the SE-TP through battery car via. NMT route for a length of about 3.5 km.It is proposed to widen this stretch of narrow mud road to 10 m wide pucca road for a length of

about 3.5 km. While planning SE-TP, this external approach road has been well integrated with the proposed internal road network.

Figure 50: Map of last-mile connectivity to the proposed SE-TP



Source: MACE analysis

Note: There is a proposal by the Cox's Bazar Road Division of RHD to construct a new road connecting Gorakghata and Sonadia Island. Hence only the stretch of 3.5 km has been proposed as approach road to be developed under the SE-TP project.

7.3.2. Power Supply to SE-TP

Based on the assessment, the estimated power requirement for the proposed SE-TP will be around 22.53 mVA.

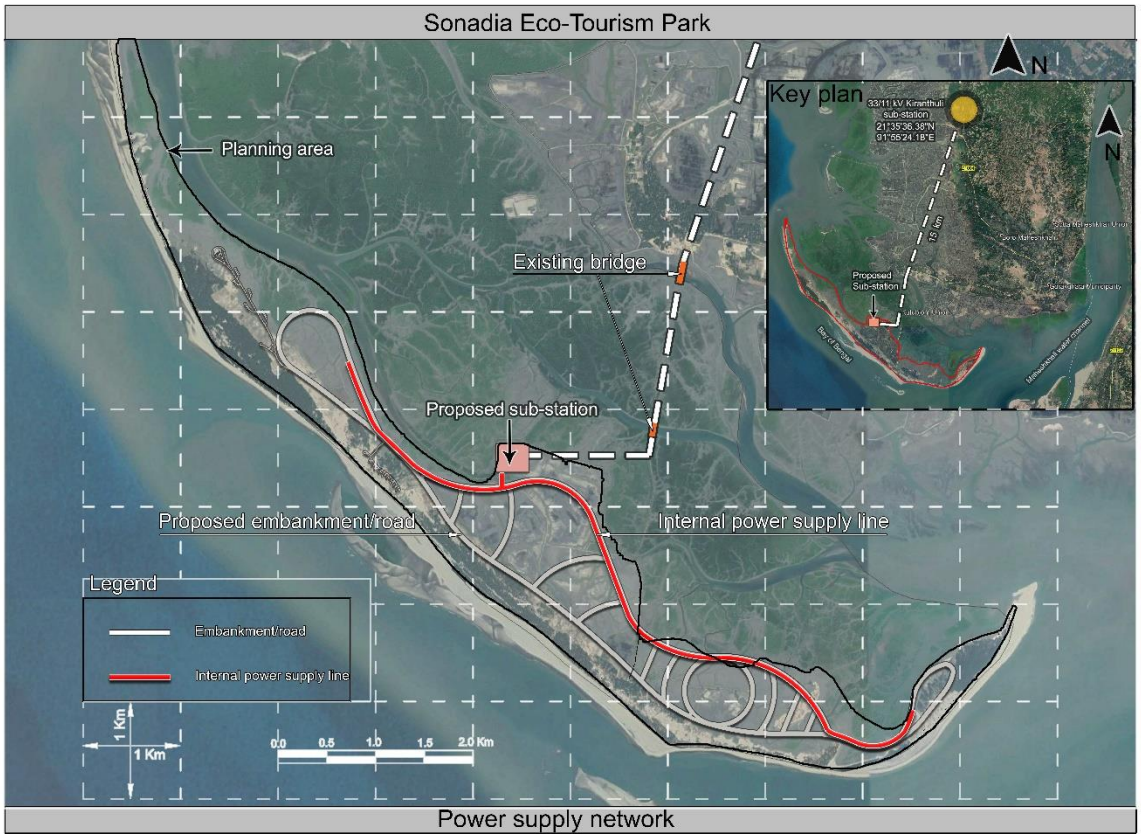
This demand is indicative in nature and may vary based on the on-ground implementation of the project. The developer may undertake a separate assessment and master planning exercise in order to validate this demand during the stage of implementation.

To cater to this ultimate power demand, the main receiving sub-station of 33/11 kV sub-station has to be established in the site. Power to this sub-station can be availed from the 33/11 kV Kiranthuli sub-station existing within Maheshkhali Upazila with the total capacity of 10 mVA located at a distance of 15 km from the site. It has a surplus peak demand from 4 mVA to 6 mVA. (Source: REB).

From the discussion had with the officials and locals, it is found that during the summer season, Ghatibanga area adjacent to proposed site has access to power from Kiranthuli sub-station. But during summer season, the demand exceeds the capacity of sub-station, resulting in frequent power cuts. Hence, it is recommended that Kiranthuli sub-station can be upgraded and utilized to meet the demand

of the proposed SE-TP. Further to the discussion had with REB officials, it is planned to build up a dedicated 33/11 kV sub-station within the Sonadia Island to supply the power requirement of SE-TP

Figure 51: External incoming power network line to the proposed SE-TP



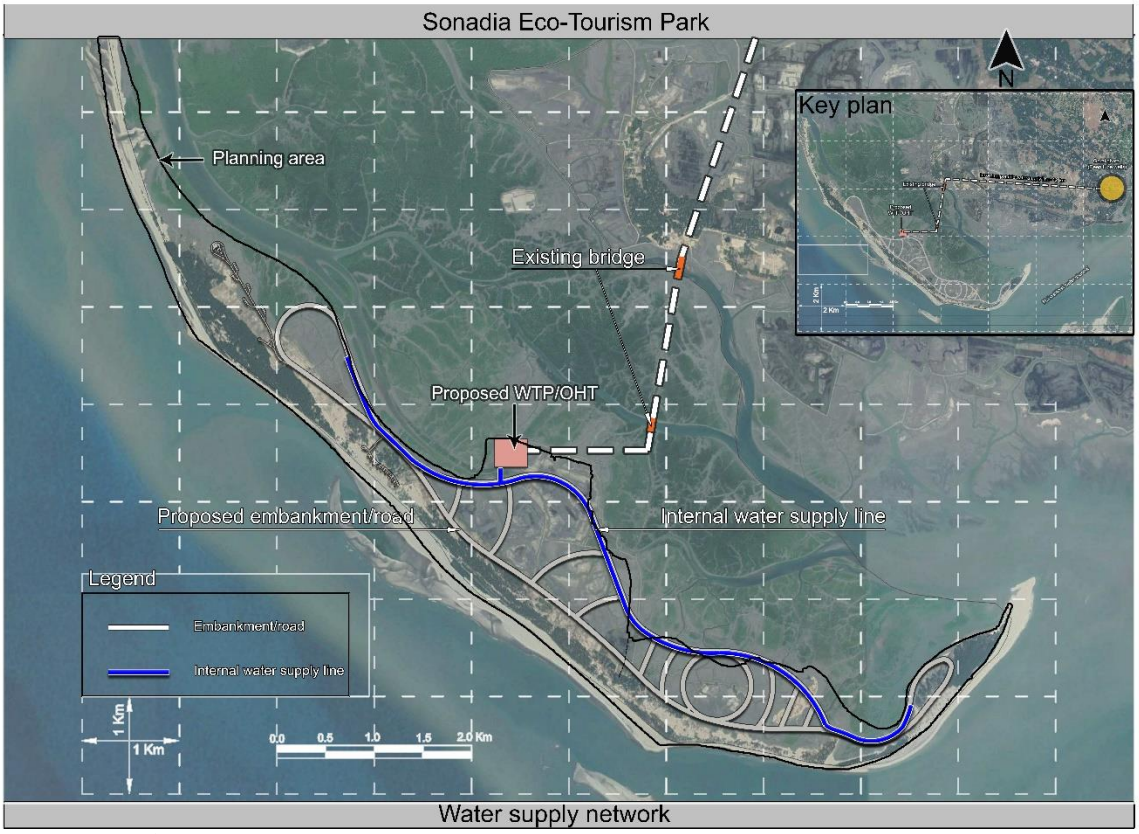
Source: MACE analysis

7.3.3. Water Supply to SE-TP

Based on the assessment and demand forecasting for the proposed SE-TP, the total water demand would be about 11.22 MLD. This demand is indicative in nature and may vary based on the on-ground implementation of the project. The developer may undertake a separate assessment and master planning exercise in order to validate this demand during the stage of implementation.

There is no existing water supply system at the proposed SE-TP area. Basis interaction with the DPHE officials infers that the groundwater within the Sonadia Island is non-potable due to more salinity. Based on the discussion had with the Environmental and Hydrologist officials of DPHE, it is found that the groundwater in the Maheshkhali region is potable and is in good condition. Since the potable water requirement is very minimal (1.80 MLD/day at ultimate year 2050 and 0.5 MLD/day during initial stages), it is suggested to rely on groundwater of Maheshkhali region to meet the initial potable water requirement by establishing 2 numbers of deep tube-wells in Gorakghata area and is planned to propose an exclusive external water supply line to the SE-TP from the source for the distance of about 12 km. The officials of DPHE recommended desalination plant to meet the ultimate requirement/additional demand in future.

Figure 52: External potable water supply line to the SE-TP



Source: MACE analysis

The total estimated non-potable water demand of SE-TP is 9.42 MLD. To meet this demand, it is suggested to rely on the excess available treated water of STP from Dhaulghata EZ. It is suggested that an exclusive non-potable water supply line can be established which needs to be connected with the proposed non-potable collection sump at the utility area of SE-TP.

7.3.4. Drainage

From the site visit, it is observed that there exists Maheshkhali water channel on the South side of the Island which connects with the Bay of Bengal. The major branch of this water channel is running on the East side of the Island bifurcating the Maheshkhali Island from Sonadia which continues and merges with the Bay of Bengal on the Northern side of the Island. Also, the sub-branches of this channel/streams are passing through the Island. The West side of the Island is bordered by the Bay of Bengal.

In general, the slope of the surrounding terrain will be towards the existing water channels, and also there is a continuous rise and fall of water in the water channel due to backwater from the sea during high tide. This might create chances of flooding due to surface runoff from the surrounding areas. Hence, it becomes mandatory that the SE-TP needs to be protected at its periphery. At the same time, the natural water course should not be disturbed. Accordingly, as a suitable measure, an embankment cum road all along the periphery of the proposed development area for a length of about 18 km has been proposed. Hence, the peripheral drain is not required.

However, from the topography study, it is found that the terrain is elevated on its West side and is sloping towards the East side with the terrain level varies between 1 to 5 m. It is planned to provide the

drain all along the inner edge of the embankment for collection of surface stormwater runoff from the proposed development area which is planned to be supplying the green area, and the excess quantity shall be collected in a stormwater collection sump which shall be pumped out. Due to backwater flow from the channel, it is not advisable to connect the stormwater drain discharge into the existing water channel. Hence, collection sump with a pumping system has been proposed.

7.4. Required Improvements or Upgrades

Based on the study, recommendations have been provided for developing various infrastructure components, in order to support the development and operation of SE-TP.

7.4.1. Approach Road

It has been proposed to upgrade an existing approach road to pucca road of 10 m wide for a length of 3500 m to connect the SE-TP. This approach road is emerging from the existing village road (mud road) connecting the site with the Zila road (Z1004). While connecting the approach road, the necessary turning radius should be provided, and the junction of the Zila road should be provided with necessary traffic management measures in safety aspects.

Already there is a proposal for construction of a new road between Gorakghata and Sonadia Island. Based on this, the existing village road will be upgraded to new pucca road by RHD. This up-gradation facilitates the tourists to reach SE-TP through the proposed approach road.

Chittagong-Cox's Bazar highway up-gradation to 4-lane from 2-lane is already proposed. Considering the future developments, it is recommended to upgrade this to 6-lane. The regional highway R170 is already proposed for up-gradation by the highway department. It is recommended to upgrade R172 considering the future economic developments proposed in the Maheshkhali region such as Matarbari power plant, SE-TP, Maheshkhali EZ etc.,

7.4.2. Power Supply

It is recommended to upgrade/ to increase the capacity of nearest existing 33/11 kV Kiranthuli sub-station to 132/33 kV substation to serve the proposed SE-TP. It is recommended to propose a dedicated transmission line from the sub-station to SE-TP.

7.4.3. Water Supply

No improvements or up-gradation have been suggested regarding water supply since there is no existing water supply system in the area. 2 numbers of tube wells with external supply network for a length of 12 km has been proposed for potable water supply, and is suggested that treated water of Dhaulghata EZ can be connected to SE-TP to meet its non-potable water requirement.

7.4.4. Drainage

At present, there is no existing stormwater drain nearby proposed site. However, there are natural water channels in and around the site. Since embankment cum road is proposed all along the periphery of the development area, the peripheral drain is not required.

7.5. Last-mile off-site infrastructure action plan

Table 51: Off-site infrastructure action plan

Key assets	Existing condition	Issues	Recommendations	Cost implication	Timeframe for improvement	Jurisdictional responsibility
Access road	No connectivity as of now. Only mud road connectivity of narrow width exists between 9-10 ft and less than 9 ft in some stretches.	Needs up-gradation to a pucca road of 10 m wide for a length of 3500 m.	Road of 10 m width and 3500 m length needs to be developed to connect the site with Zila road (Z1004) via existing village road.	193 million BDT	8 months	BEZA
Power supply	Existing 33/11 kV Kiranthuli sub-station at 15 km having 4-6 mVA surplus to meet the requirement.	During the summer season, the Ghatibanga region suffers from a power deficit. Recommended to upgrade the 33/11 kV Kiranthuli sub-station to 132/33 kV sub-station to utilize for SE-TP	To build a new dedicated power transmission line for a length of 15 km from Kiranthuli sub-station. To build a new dedicated 33/11 kV sub-station in Sonadia Island to cater the power requirement of SE-TP.	53 million BDT 100 million BDT	10 months 12 months	REB
Water supply	Not available at present	No connectivity to the site	Establishing external water supply network lines from proposed 2 numbers of deep tube wells with the potable supply line for a length of about 12 km.	120 million BDT	12 months	BWDB
Drainage	Not available at present	Embankment cum road has been proposed all along the boundary of the development area.	Peripheral drain is not required	NA	NA	NA

Source: MACE analysis

7.6. Key Takeaways

Off-site infrastructure captures the external basic infrastructure facilities which need to be developed. Development of off-site infrastructure is the responsibility of BEZA. The major off-site infrastructure considered for the proposed SE-TP is water supply, power supply, access road and drainage. These external infrastructure facilities and sources have been identified and well-integrated with the proposed SE-TP based on site visit, data collection, stakeholder consultations with various government agencies such as RHD, REB, and DPHE.

Key recommendations formulated from this exercise are:

- Proposed SE-TP development area is located adjacent to Zila road (Z1004) of Maheshkhali Upazila. An approach road of 10 m wide and 3.5 km length have been proposed to connect the SE-TP with Zila road via village road.
- Groundwater within the Island is not potable due to more salinity and is recommended to tap groundwater from the 2 numbers of deep tube wells which are to be proposed in Gorakghata area at a distance of 12 km wherein exclusive potable water supply line needs to be established.
- To meet the non-potable water requirement, it is suggested to establish an exclusive non-potable water supply line from Dhaulghata EZ.
- 33/11 kV Kiranthuli sub-station (located at a distance of 15 km from the proposed SE-TP) can act as a source of power for the initial stage. It is suggested to build a new dedicated 33/11 kV sub-station in Sonadia Island to cater the power requirement of SE-TP.
- Embankment cum road is proposed all along the periphery of the proposed development area of SE-TP which protects the site from the surrounding area/ water channel. Hence, peripheral drain is not required

8. Master Planning

8.1. Objectives of the master plan and planning framework

Sustainable eco-tourism, through SE-TP initiative, is a vehicle to foster economic and social growth of Bangladesh, through the achievement of the development imperatives, while minimizing negative social, cultural and environmental impacts. The master plan is a broad-brush plan providing a broad policy framework for an action plan and development plan. It also concerned with the development of broad strategies for managing and promoting organized and guided development over the medium and long-term attempts to integrate economic, physical and environmental objectives. In the master plan, many characteristics are incorporated to make SE-TP especially valuable as an agent for development. As a cross-cutting initiative, SE-TP stimulates productive capacities from trade and the provision of jobs linked to the tourism value chain and the master plan, including the components planning, facilitate this phenomenon.

The principles of sustainable eco-tourism are adopted while developing the master plan. The planning principles envisioned to be implemented in this uniquely conceived SE-TP, turn it into a fully integrated functionally best facility and to promote a new tourism image in Cox's Bazar, as well as to develop confidence for investors to undertake the development of the tourism project components and subsequent operation of their businesses.

Figure 53: Master planning principles

1. SE-TP planning shall make optimal use of environmental resources that constitute a key element in Sonadia Island tourism development. The planning shall minimize the use of scarce and non-renewable resources in the development and operation of tourism facilities and services and ensure resource efficiency;
2. SE-TP planning shall maintain essential ecological processes and help to conserve natural heritage and biodiversity of Sonadia Island. Meticulous efforts are taken in the planning to support the conservation of natural areas, habitats, endangered species and wildlife, and minimize damage to them and ensure to conserve biological diversity;
3. Respecting the socio-cultural authenticity of host communities;
4. SE-TP planning conserves built and living cultural heritage and traditional values, and contribute to inter-cultural understanding and tolerance;
5. Planning ensures viable, long-term economic operations. SE-TP planning ensures the economic viability and competitiveness of SE-TP destinations and enterprises inluding development companies, so that they are able to continue to prosper and deliver benefits in the long term including the proportion of visitor spending that is retained locally;
6. Planning elements and components provides socio-economic benefits to all stakeholders that are fairly distributed, including stable employment and income-earning opportunities and social services to host communities, and contributing to poverty alleviation. The aim is to maximize the contribution of tourism to the prosperity of the host destination thus enhancing local prosperity;
7. The components have been planned to enhance employment quality and strengthen the number and quality of local jobs created and supported by tourism, including the level of pay, conditions of service and availability to all;

8. The components have been meticulosity planned to seek a widespread distribution of economic and social benefits from SE-TP throughout the recipient community, including improving opportunities, income and services available to the poor and ensure social equity;
9. SE-TP is planned as a perfect blend of entertainment, education, information and learning meeting the diverse nature of tourist visitors across age groups, culture with vast and varied expectations. The planning provides a safe, satisfying and fulfilling experience for visitors, available to all without discrimination by gender, race, disability or in other ways and ensure visitor fulfilment;
10. The planning process to engage and empower local communities in planning and decision making about the management and future development of tourism in their area, in consultation with other stakeholders and enhance local control;
11. Maintaining and strengthening the quality of life in local communities, including social structures and access to resources, amenities and life support systems, avoiding any form of social degradation or exploitation is a key element in the planning so as to ensure community wellbeing;
12. The planning process shall respect and enhance the historic heritage, authentic culture, traditions and distinctiveness and depict the cultural richness;
13. Maintaining and enhancing the quality of landscapes of Sonadia Island and avoiding the physical and visual degradation of the environment and ensuring the physical integrity;
14. Meticulous efforts are taken to minimize the pollution of air, water and land and the generation of waste by tourism enterprises and visitors and ensure environmental purity; and
15. Provide an integrated tourism infrastructure system network to support the development comply with various norms and standards.

Source: MACE analysis

The master plan of SE-TP is to guide long-term growth within the planning areas by means of:

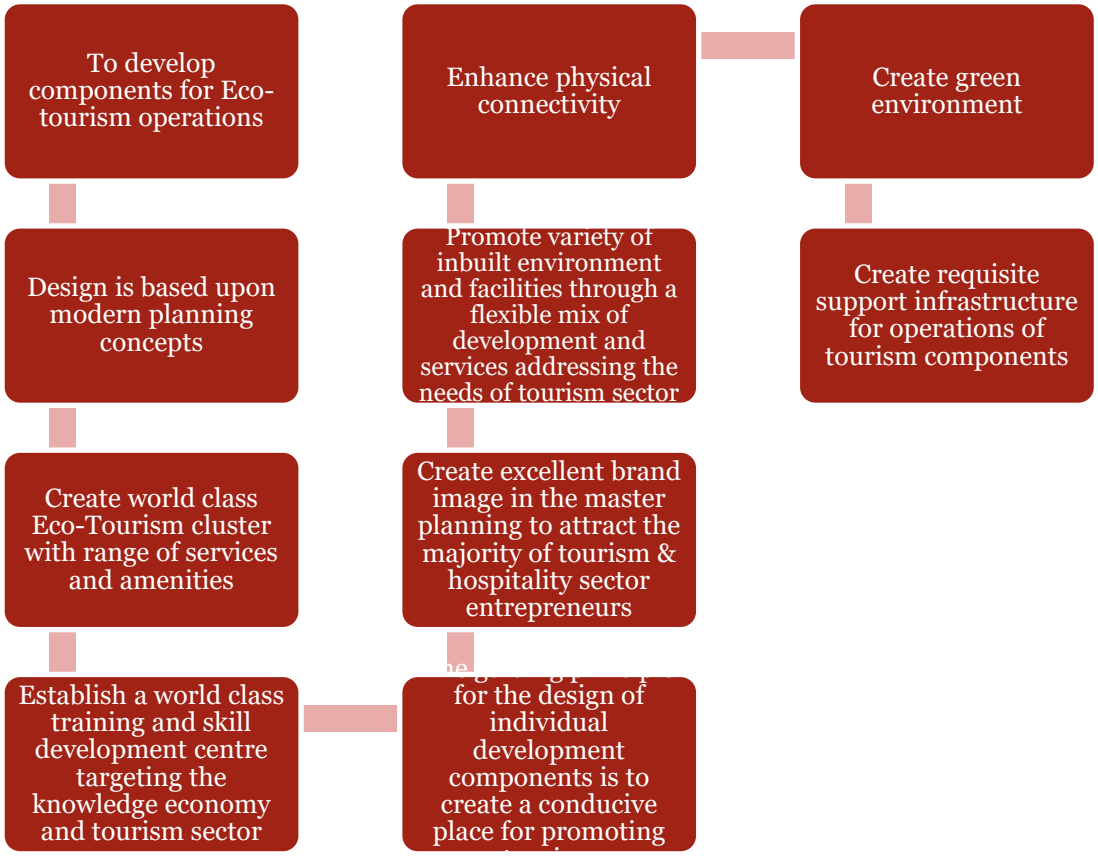
- Indication of potential locations of major development areas;
- Indication of important physical infrastructure; and
- Setting out policy recommendations for future development.

The objectives of the master plan are as follows:

- To identify the main development issues, major opportunities and constraints;
- To identify the possible growth and physical expansion of the areas as foreseen considering economic base and growth trend;
- To identify the required and suitable land for future physical expansion and development;
- To identify the strategies for pursuing future development control in a desirable direction;
- To establish goals, policies and general proposals for urban spatial development; and
- To identify the development options to offer maximum benefit for the tourist.

8.2. Planning concept

The SE-TP is a self-contained region with a salubrious surrounding and will eventually emerge as a "Sustainable-holistic-smart- intelligent-Eco-Tourism zone".



Source: MACE Analysis

8.3. Planning considerations

The planning for the proposed SE-TP is in line with the broad objective of establishing an excellent business environment targeted principally at the eco-tourism sector, including hospitality sectors. Each zone within the SE-TP will be dedicated to a particular activity and would be a self-sufficient eco-hub on the aspects of facilities, the ability to attract tourists, investments and revenue generation.

From the planning perspective, the SE-TP is a package of multiple land uses. The pleasure/recreational activities are prime activities, and several other activity zones enhance the efficiency of the core theme. These include linking infrastructures, social infrastructure, community facilities, green spaces and several other activities such as research & skill development services, basic infrastructures & amenities.

Recreational, social and commercial amenities planned in the SE-TP will provide convenience to visitors as well as to the working population within the SE-TP. Landscaping and greenery designed as part of SE-TP development will house the project in a lush green environment.

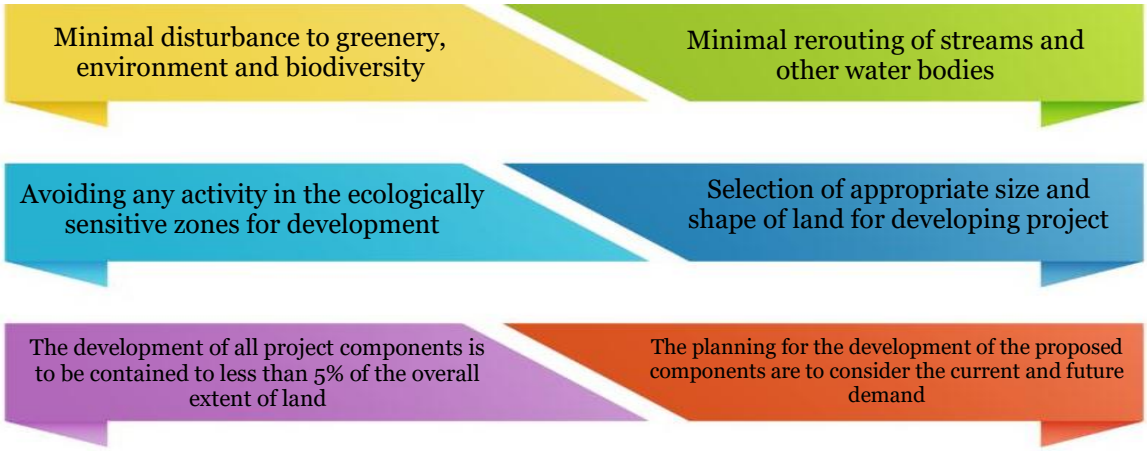
The zoning plan consists of a combination of various zones which are spatially distributed with trunk connectivity between the zones integrated with the external transportation connectivity. It deals with the main aspects of development over the next 30 years (2020-2050).

The vital issues and principal strategies considered while planning the SE-TP for successful implementation and sustained operation includes:

- Biodiversity conservation: Adequate measures are taken to conserve and protect biodiversity and ensuring the sustainability of the natural and cultural assets of the site.
- Land use and layout: The exercise includes appropriate division of the whole area into several zones and planning of various theme-based components and facilities under each zone. Development of the layout with a complete understanding of the phasing programme is a significant event. Integration of the environmental and financial aspects with physical planning aspects are the most important factor for successful implementation.
- Constraints and core offering of the site: As enumerated earlier, the planning considers all the site-specific constraints and appropriate mitigation measures to overcome the limitations. Similarly, the planning fully leverages the core and supplementary offering of the site.
- Services and amenities: The master plan takes into account planning for services and facilities.
- Addressing the stay requirement for the tourists/visitors: Different hierarchy of stay facilities in terms of customer tastes, preferences and affordability, to be planned within SE-TP, to accommodate the needs of tourists from various segments.
- Lack of enforcement/control on land use and growth of unauthorized activities: The well-conceived SE-TP guidelines and implementation framework adequately address this issue.
- Non-uniform distribution / concentration of development nodes: A structured zoning considers effective utilization of space, customer preferences, zone-specific requirements, infrastructure requirements and pollution level category. Accordingly, these considerations govern the planning of zones/subzones in the SE-TP.
- Conservation of groundwater and surface water resources: The activities include sustainable infrastructure planning, incorporation of eco-friendly concepts and environmental sustainability, water conservation schemes, environmental infrastructure, recycling and reuse options in the SE-TP development program.
- Transportation: The master plan looks at the transport linkages. As the SE-TP will have regional, national, as well as international linkages for tourist's movement, it will generate multi-fold traffic. Hence, planning of a well-developed transport network is a significant intervention.
- Environmental management: Various aspects such as adherence to pollution control norms & standards, protection of sensitive areas & provision of a suitable buffer, eco-friendly transportation system for internal movement within the Island, collection and handling of solid waste, efficient wastewater treatment system without polluting the environment are considered.
- Identification of the most suitable area for development: The zones and components are spatially distributed in suitable locations based on its function and the impact on the environment. An overview or inventory of existing physical, economic and infrastructure facilities have been considered for effective integration.

SE-TP development has a unique reason to be concerned about the sustainability of the natural and cultural environment owing to its dependency on the appeal of unspoilt landscapes and accessible local heritage, including the importance of the sustainable consumption of natural resources such as water and energy, besides the project site is ecologically sensitive.

Figure 54: Zonal planning considerations



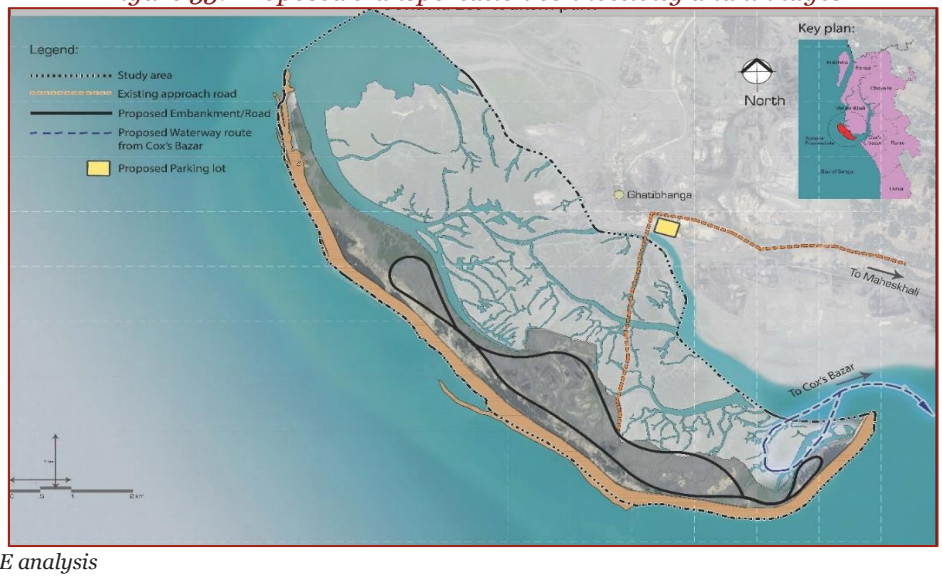
Source: MACE analysis

As a preliminary step of preparing the zoning plan, the internal trunk/spinal road alignment has been proposed. The total length of the proposed embankment which acts a spinal road for SE-TP is about 18 km. From this spinal road/embankment, internal driveways, pathways have been planned to connect the various development components within the SE-TP. This embankment serves as a protective structure from inundation due to water intrusion from an adjacent water channel.

Various site-specific features requiring considerations during the planning stage are addressed and presented below:

1) **Transportation connectivity and linkages** to the proposed site is depicted below. Two alternate connectivity linkages are considered for SE-TP. SE-TP shall have the main connectivity by waterways from Cox's Bazar and Maheshkhali through jetty provided in entrance zone of SE-TP for passenger movement and it will also used for transporting the materials during construction stage. For alternate road connectivity, the existing narrow access road will have to be upgraded for providing effective connectivity to the mainland.

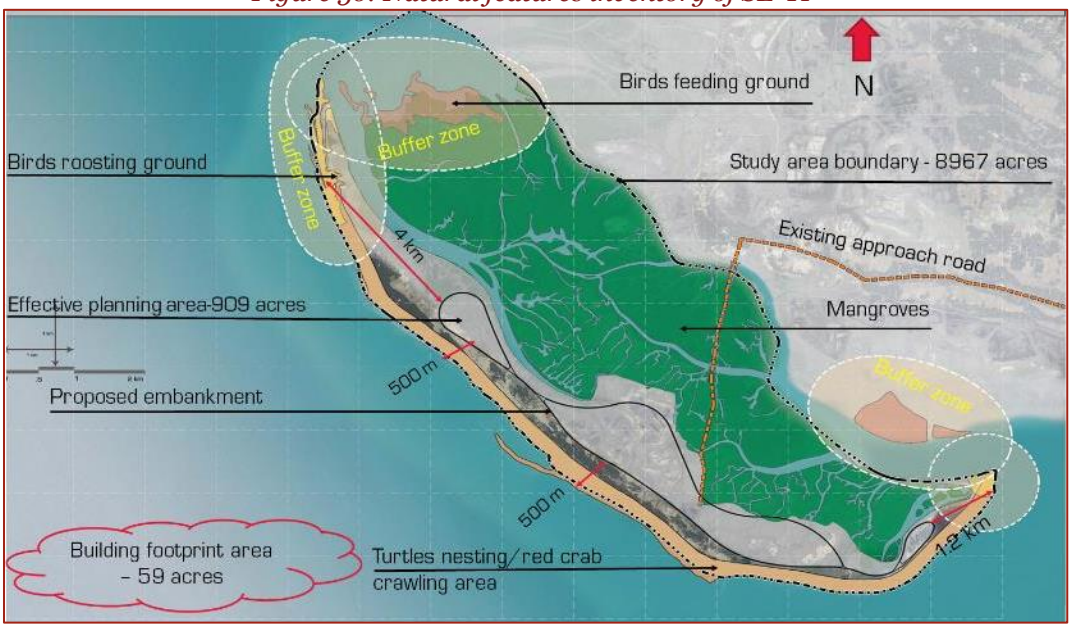
Figure 55: Proposed transportation connectivity and linkages



Source: MACE analysis

2) The **existing eco-sensitive areas** such as birds roosting and feeding ground, turtle's hatcheries & nesting area, red crabs crawling area along seashore, mangroves and water channels have been retained, and these areas are excluded from the overall development plan. Adequate buffer is provided from the shoreline along the coast for protecting turtles & red crabs and also for birds roosting and feeding ground.

Figure 56: Natural features inventory of SE-TP



Source: MACE analysis

- **Birds roosting ground**
  Birds roosting ground are found in the Northern and Southern side of the Island along the seashore. This ground acts as gathering spots for various local & migratory birds which is 1.2-4 km away from the proposed embankment. A minimum buffer of 500 m is reserved as "No development/ prohibited zone" surrounding this roosting ground area.

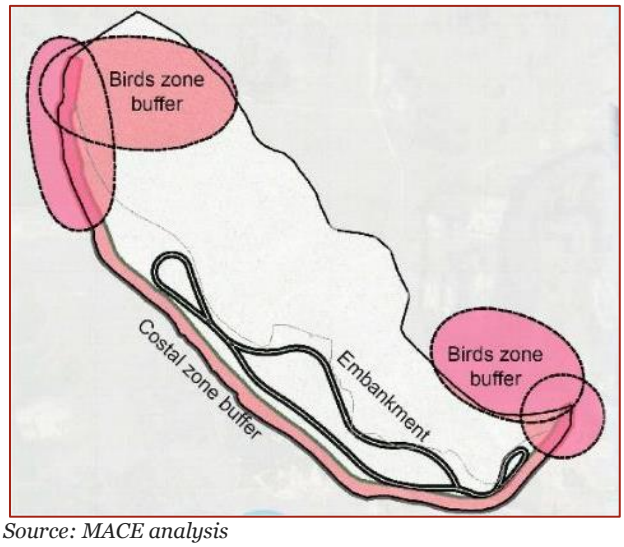
- **Birds feeding ground**
  Birds feeding ground falls adjacent to roosting ground on Northern and Southern side of the Island. A buffer of 500 m has been reserved as "No development/ prohibited zone" surrounding this feeding ground area.

- **Mangroves**
  Mangroves cover a considerable area of the Island and are a national asset which reflects an ecologically critical area for environmental conservation. This area is kept aside and undisturbed while planning the developments of SE-TP and is reserved as "No development/prohibited zone".

- **Red crab crawling area / turtle nesting area on seashore**
  Geographically Sonadia Island looks like curve shape along the South-West direction. The sea beach of this Island acts as turtle's nesting and red crab's crawling area.

The turtle nesting spots are scattered on Sonadia Island. Buffer zones varying from 200-500 m from the shoreline has been reserved as "No development/prohibited zone".

Figure 57: Proposed trunk road cum embankment based on the buffer zone



Source: MACE analysis

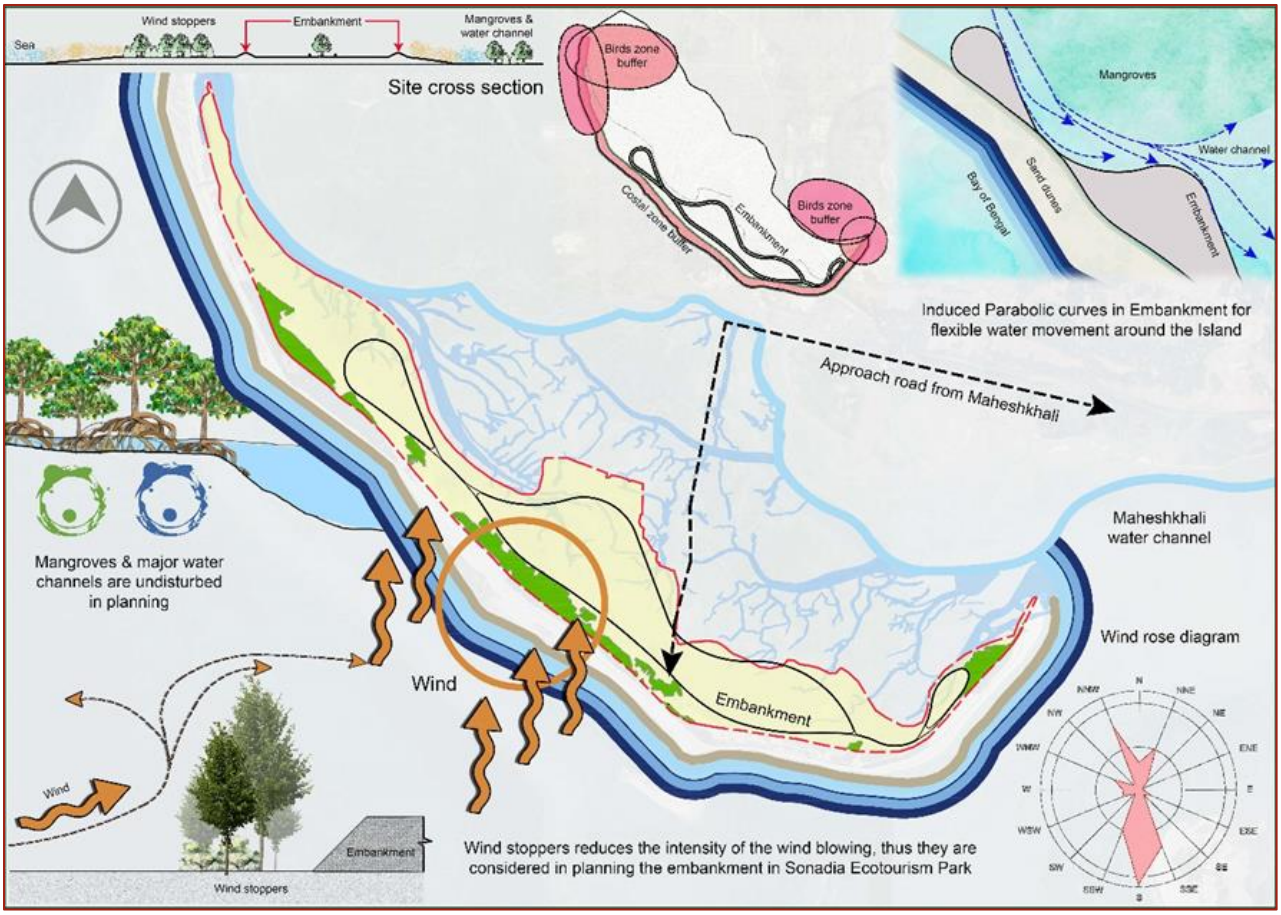
3) The **predominant wind direction** is from South to North. The existing thick vegetation in the south acts as a natural wind barrier. It is proposed to retain this natural vegetation so as to protect the proposed developments from natural hazards. Accordingly, the internal trunk road alignment has been proposed.

4) The top-level of proposed embankment including trunk road is planned above high flood level to protect the proposed developments from inundation due to water intrusion from adjoining water channels during high tide and heavy water flow.

5) The profile of parabolic curve has been adopted while planning the embankment / trunk road alignment. This geometrical profile offers better dissipation of water currents and reduces the rupturing of the embankment.

The below figure depicts the proposed internal trunk road alignment considering the above-mentioned factors such as external transportation linkages, eco-sensitive area to be retained, buffer considerations, natural wind barriers and water level fluctuations of Maheshkhali water channel.

Figure 58: Conceptual planning of embankment / road



Source: MACE analysis

The total area carved out for the development of SE-TP by providing embankment is 909.4 acres. Apart, an exclusive area of 60 acres for utility and public amenities is earmarked adjacent to the Northern entry point.

8.4. Zones spotting

The activity includes division of the whole area into various zones considering the compatibility among the identified sectors of SE-TP and their ability to share the common infrastructure and facilities. The zoning design has smooth pedestrian circulation by simplifying the movement patterns and allow inter-zone movement. Planning at strategic locations catering to the visitor's comfort and the surrounding feature is an essential element in the design.

It is prudent to consider the following parameters for effectively positioning the zones:

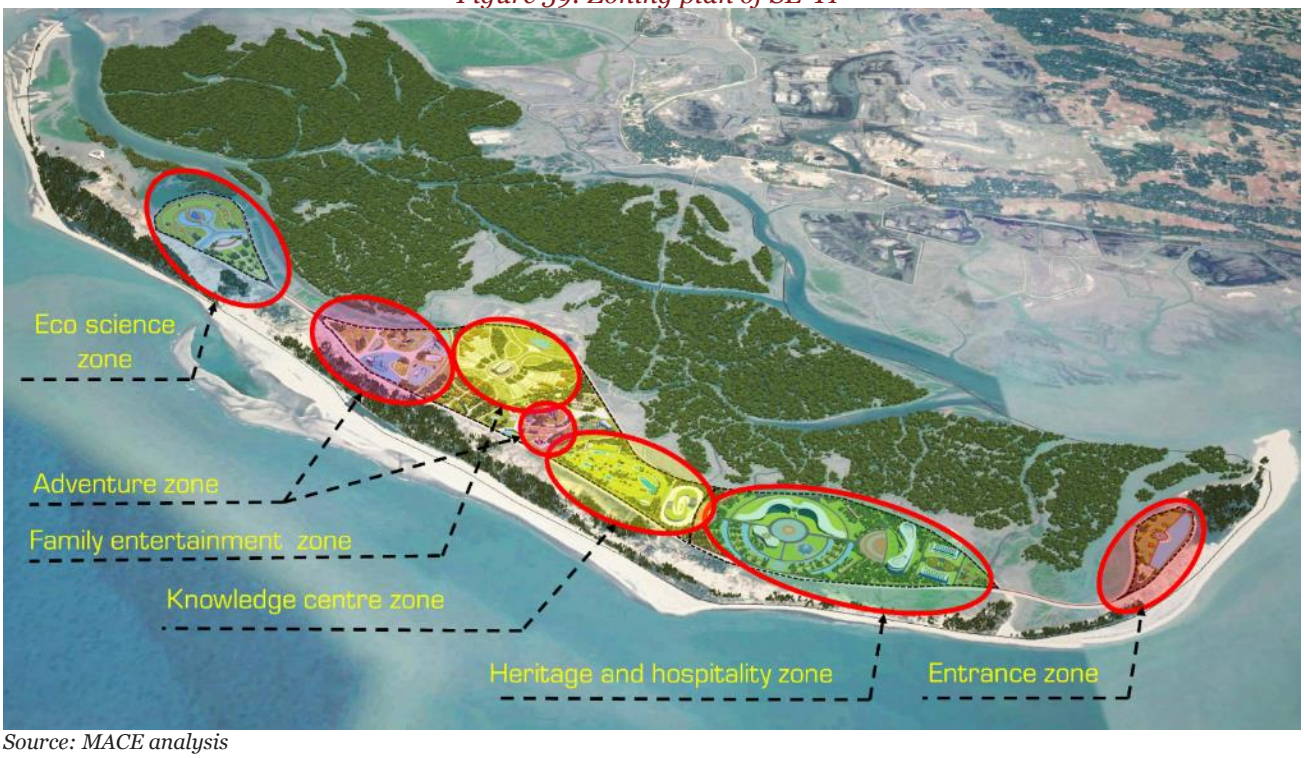
- Boundary shape;
- Physical site features;

- Area availability;
- Environmental considerations;
- Microclimatic conditions;
- Compatibility issues;
- Surrounding areas;
- Accessibility;
- Transportation issues; and
- Visibility.

8.5. Zoning plan

The meticulous exercise was undertaken for zoning and components configuration considering the findings of tourist survey, the study of various case studies (both national and international) and in compliance with sustainable tourism destination and innovation and research hub development guidelines.

Figure 59: Zoning plan of SE-TP



Source: MACE analysis

Table 52: Statement of zoning plan

S. No	Proposed zone	Area in acres	Area distribution in %
1	Entrance zone	37.8	4%
2	Heritage and hospitality zone	238.3	25%
3	Knowledge centre zone	100.3	10%
4	Family entertainment zone	217.4	22%
5	Adventure zone	172.4	18%
6	Eco-science zone	143.3	15%
7	Utility and public amenity	60	6%
	Total	**969.5**	**100%**

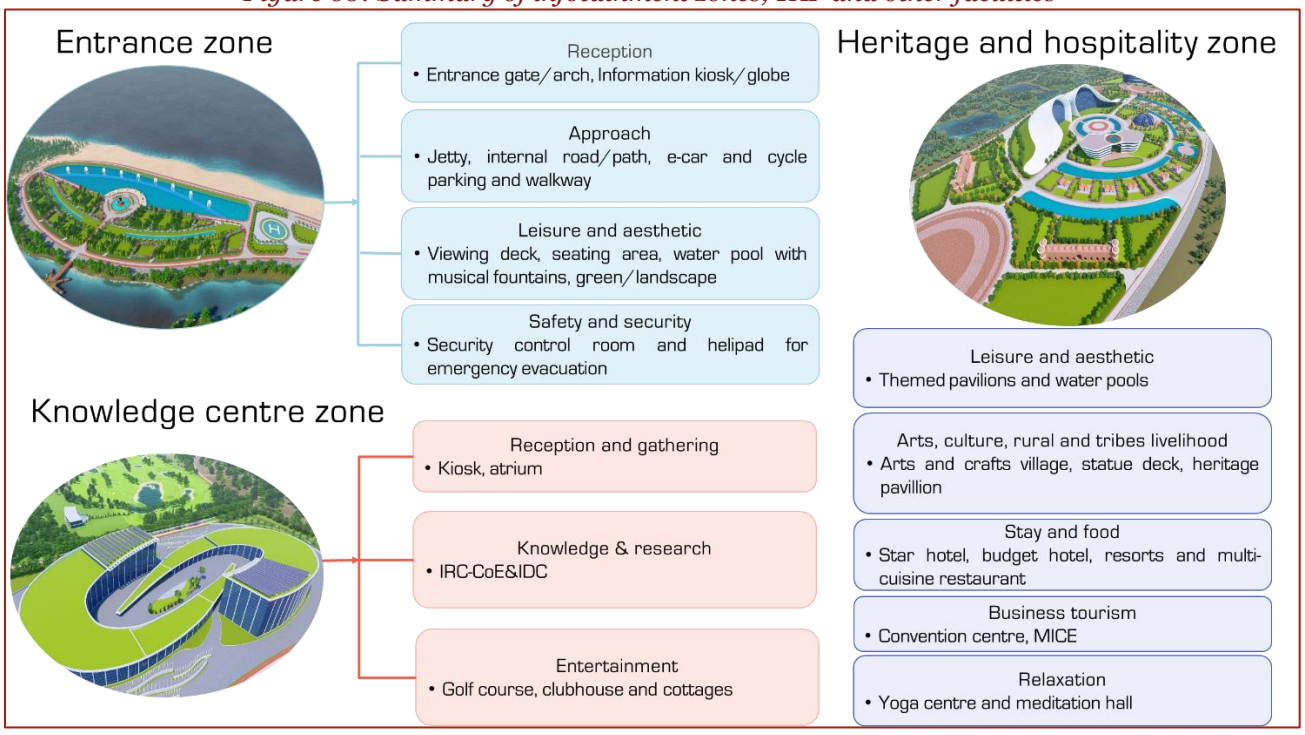
Source: MACE analysis

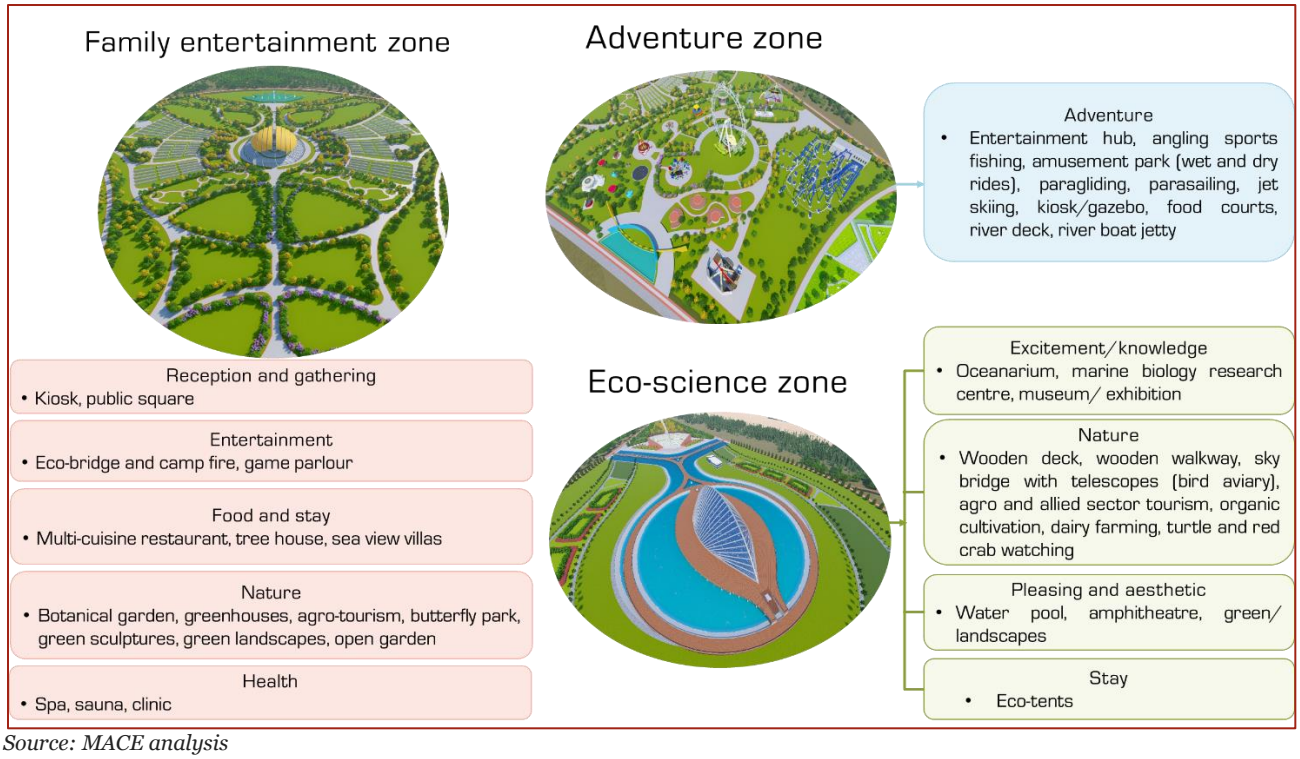
From the above table, it can be observed that the major land area of SE-TP is occupied by the heritage and hospitality zone followed by family and entertainment zone and adventure zone. This is in line with the derived expectation of the tourists as evident from tourist survey that the majority of the visitors are family members expecting a lot of pleasure/recreational activities and stay facilities.

8.6. Zones and components configuration

Multiple Tourist Attraction Facilities (TAF) and other facilities are proposed under each zone of SE-TP and are discussed in the following section.

Figure 60: Summary of infotainment zones, TAF and other facilities





Source: MACE analysis

8.6.1. Entrance zone

The proposed area of entrance zone is 49.4 acres which act as an entryway for the tourists from Cox's Bazar. This zone houses the TAF and other facilities which are essential for providing the tourist with all services including parking, information area, etc.

The waterway linkage from Cox's Bazar shall connect the SE-TP through the proposed jetty provided in the entrance zone on the Southern tip of the Sonadia Island. This facilitates all-weather embarking/disembarking of tourists and helipad is provided for emergency evacuation purpose. The internal access is provided through pedestrian walking, e-car & cycling, and all efforts have been taken to promote hassle-free pedestrian movements.

Table 53: TAF and other facilities of the entrance zone

Sl. No.	TAF and other facilities	Area in acres	In %
1	Internal road / path	9.7	26%
2	E-car and cycle parking	0.6	1%
3	Information kiosk/globe	0.4	1%
4	Helipad	0.7	2%
5	Viewing deck	0.6	1%
6	Water pool with musical fountains	11.5	30%
7	Green / landscape	14.1	37%
8	Jetty	0.3	1%
	Total area	**37.8**	**100%**

Source: MACE analysis

Figure 61: Aerial view of the entrance zone

Source: MACE analysis

It is assumed that entry to SE-TP is scheduled between 8 AM to 1 PM (for 5 hours). The entire expected 15,472 tourists will not be entering SE-TP and utilising the jetty at the same time. It is assumed that 60% of tourists (9300) will be using speed boat to reach SE-TP from Cox's Bazar side and remaining 40% of tourists (6200) coming from Maheshkhali side via approach road will be reaching SE-TP through battery car.

From Maheshkhali Island, it is suggested that the tourists can use the battery-operated vehicle to reach Sonadia Island. There are 2 number of jetties proposed-one at Sonadia Island and one at Cox's Bazar to exclusively facilitate the tourist's movement to Sonadia Island through waterway from Cox's Bazar. Based on the land use plan, an embankment cum spinal road of 7.5 m wide running for a length of about 17.9 km has been proposed linking the proposed jetty at the Southern tip of Sonadia Island. This spinal road is proposed to be connected with the footpaths/internal driveway for NMT vehicles. Provision for cycle tracks and pedestrian path have been proposed parallel to the main trunk road. Only NMT and small battery-operated cars will be allowed inside SE-TP.

The circular waterway route is proposed along the existing channel with a beautiful view of mangroves on either side, which will act as an attractive phenomenon of the Island. Few boat landing stations have also been suggested to be proposed along the route. Minor dredging has been suggested to be proposed at essential locations to ensure navigability

8.6.2. Heritage and hospitality zone

Considering the taste and preference of the tourist (both domestic and foreign tourists), an exclusive zone in an area of about 235.9 acres has been proposed with various hospitality and heritage-based components.

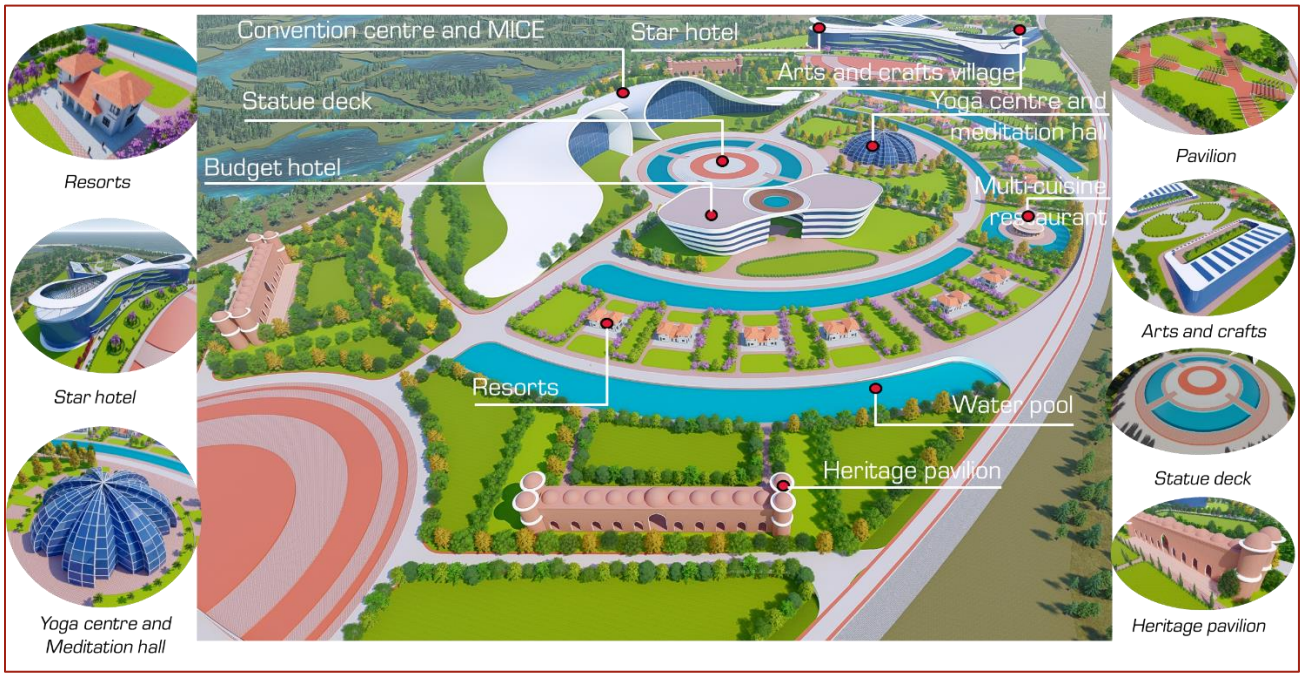
Themed pavilions depict the local heritage with space for artists to exhibit their artistic capability. The staying facilities, MICE and convention centre shall promote business tourism. A star hotel is also proposed considering the need. As part of inclusiveness, it is proposed to provide accommodation/stay facilities for all income category tourists and accordingly, a budget hotel, resorts and Eco cottages are provided.

Table 54: TAF and other facilities of heritage and hospitality zone

S. No	TAF and other facilities	Area in acres	Percentage
1	Pavilion	7.8	3%
2	Arts & crafts village	21.9	9%
a.	Themed pavilion	3.9	
b.	Internal road / path	3.4	
c.	Green / landscape	14.5	
3	Star hotel	31.5	13%
a.	Building	7.5	
b.	Internal road / path	4.1	
c.	Green / landscape	19.9	
4	Business and relaxation	177.0	74%
a.	Statue deck	17.0	
b.	Heritage pavilion	2.5	
c.	Convention centre and MICE	14.7	
d.	Budget hotel	1.2	
e.	Yoga centre and meditation hall	1.3	
f.	Resorts and multi-cuisine restaurant	1.2	
g.	Water pool	18.7	
h.	Green / landscape	85.9	
i.	Internal road / path	34.4	
Total area		**238.3**	**100%**

Source: MACE analysis

Figure 62: Aerial view of heritage and hospitality zone



Source: MACE analysis

8.6.3. Knowledge centre zone

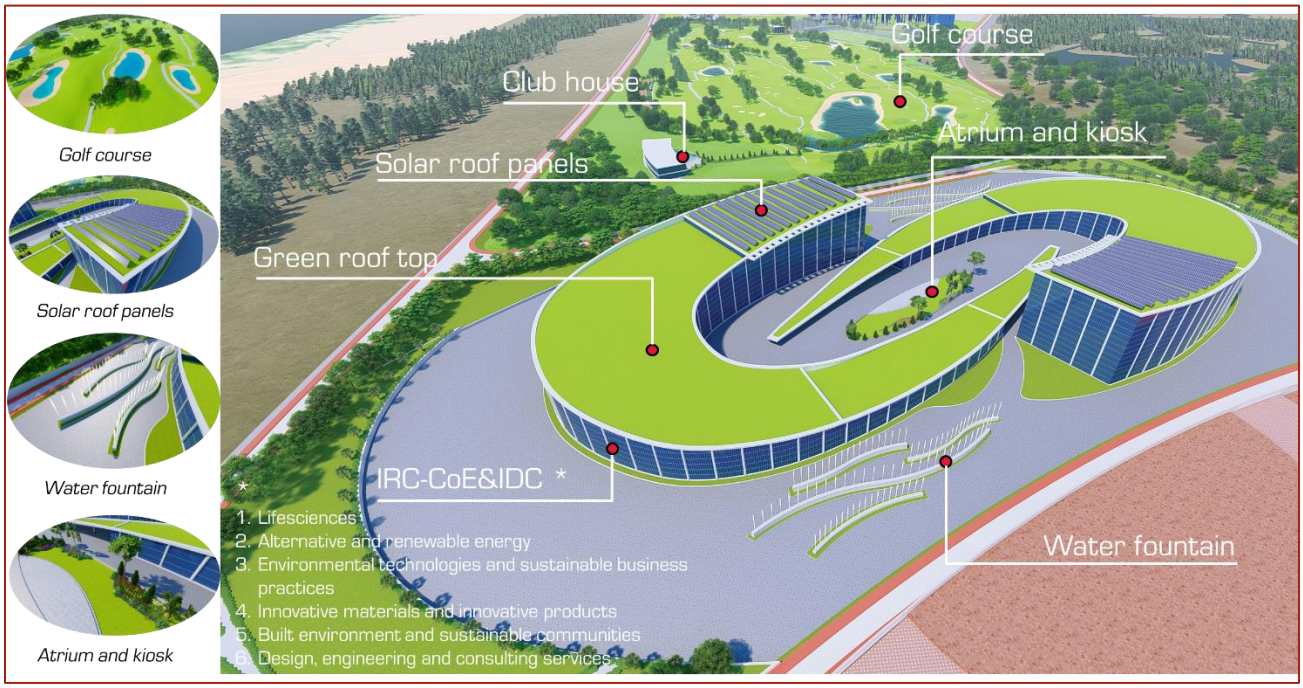
This zone provides a blend of tourism, education and entertainment facility with green and energy-efficient buildings with a rooftop solar and rooftop garden provide conducive business environment for knowledge workers. The objective is to perform innovation and research activities to promote green knowledge-based economy.

Table 55: Facilities of the knowledge centre zone

S. No	Facilities	Area in acres	Percentage
1	IRC-CoE&IDC	6.1	6%
2	Internal road/path	11.3	11%
3	Green/landscape	10.1	10%
4	Golf course	71.9	72%
5	Club house	0.4	0.4%
6	Kiosk	0.1	0.1%
7	Cottages	0.4	0.4%
Total area		**100.3**	**100%**

Source: MACE analysis

Figure 63: Aerial view of the knowledge centre zone



Source: MACE analysis

8.6.4. Family entertainment zone

From the tourist survey, it is inferred that the majority of the tourists visiting Cox's Bazar, constitutes families and hence it is imperative to provide a total family entertainment zone within the SE-TP. An area of 215.1 acres has been proposed for the family entertainment zone.

The family entertainment zone is meticulously configured as a confluence of natural living and getting back to nature while keeping the whole family engaged, thus making SE-TP as a memorable experience.

Table 56: Facilities of the family entertainment zone

S. No.	Components	Area in acres	Percentage
1	Botanical garden	189.8	87%
a.	Green houses and agro tourism	20.4	
b.	Butterfly park	15.8	
c.	Public square	5.3	
d.	Internal road / path	31.2	
e.	Green sculptures and eco-bridge	0.8	
f.	Green / landscape	115.5	
g.	Multi-cuisine restaurant	1.0	
2	Villas	0.4	0.2%
3	Open garden	27.2	13%
Total area		217.4	100%

Source: MACE analysis

Figure 64: Aerial view of family entertainment zone

Source: MACE analysis

8.6.5. Adventure zone

An area of 170 acres of land has been proposed for adventure zone of SE-TP. As a part of offering infotainment, excitement, recreational and adventurous trip for the domestic and foreign tourist, various adventurous TAF and other facilities are proposed in the adventure zone.

Table 57: TAF and other facilities of the adventure zone

S. No	TAF and other facilities	Area in acre	Area in %
1	Dry rides and other adventure activity	90.2	52%
2	Wet rides and other adventure activity	82.2	48%
Total		**172.4**	**100%**

Source: MACE analysis

8.6.6. Eco-Science Zone

To provide infotainment and knowledge about the bio-diversity of the Sonadia Island, an exclusive zone in the style of the eco-science zone has been proposed on 141 acres of land. 5th generation oceanarium with contemporary facilities, themes and state-of-art-infrastructure with the marine biology research centre to support R&D requirement of the oceanarium; is conceptualized. This TAF is dedicated to marine education and preservation of the marine environment. Other TAF includes elevated sky bridge with telescopic provisions for bird watching, eco-tents and night camps. Turtle watching make SE-TP an attractive and unique destination for entertainment and learning.

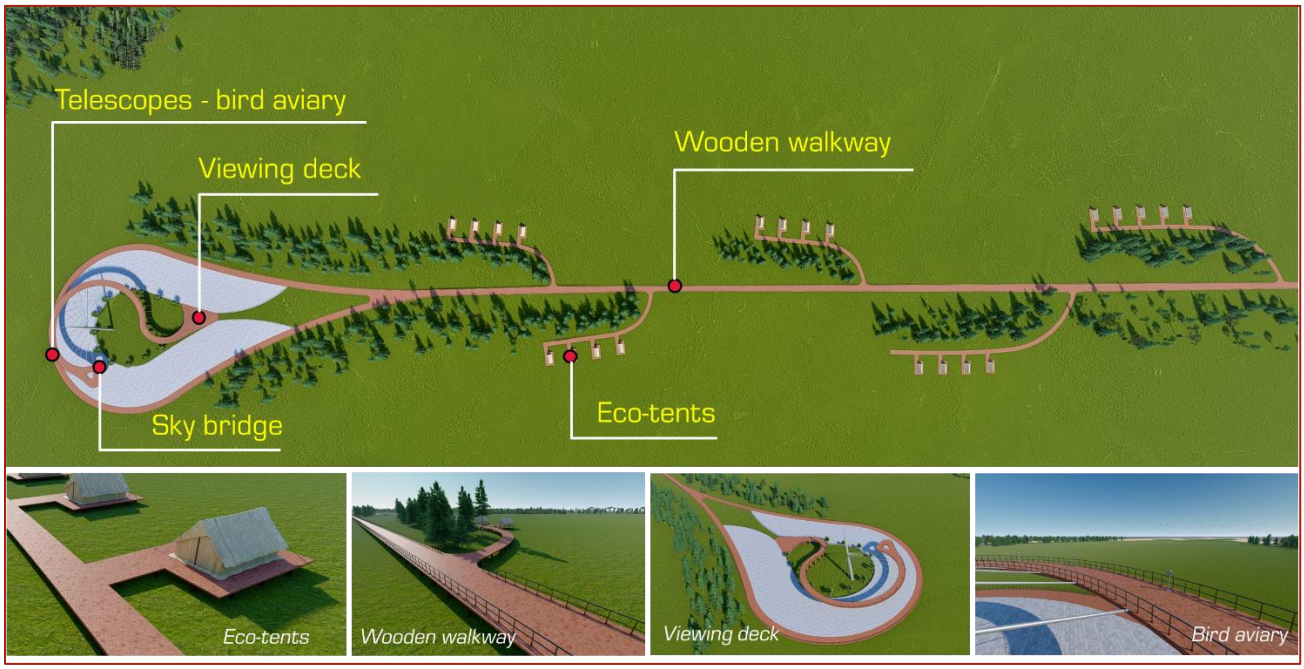
Table 58: TAF and other facilities of eco-science zone

S. No.	TAF and other facilities	Area in acres	Percentage

1	Oceanarium	2.3	1.59%
2	Marine biology research centre	1.0	0.69%
3	Internal road / path	15.0	10.50%
4	Wooden deck	7.7	5.39%
5	Water pool	20.6	14.37%
6	Amphitheatre	5.0	3.50%
7	Green and organic cultivation	83.9	58.53%
8	Wooden walkway	4.5	3.13%
9	Eco-tents	0.3	0.20%
10	Sky bridge	0.8	0.53%
11	Green / landscape	2.2	1.57%
Total area		**143.3**	**100%**

Source: MACE analysis

Figure 65: Aerial view of the eco-science zone



Source: MACE analysis

8.6.7. Amenity and utility area

Apart from the TAF and other tourism-related facilities, additional area to establish the basic utilities and public amenities is also planned within SE-TP. It is planned in a centralized location for easy access.

All essential supporting amenities are planned within the amenity zone of SE-TP as detailed below:

1) Administration building;
2) Training /skill development centre;
3) Primary health centre;
4) Disaster management centre;
5) Fire station; and
6) Police station.

All essential utilities are planned within the utility zone of SE-TP as detailed below:

- Substation;
- Water treatment plant;
- Sewage treatment plant;
- Pumping station;

Table 59: Utility and Public amenity facilities of SE-TP

S. No.	Utilities and amenities	Area in acres	Percentage
1	Administration building	5	8.33%
2	Training /skill development centre	5	8.33%
3	Primary health centre	3	5.00%
4	Disaster management centre	3	5.00%
5	Fire station	2	3.33%
6	Police station	2	3.33%
7	Substation	5	8.33%
8	Water treatment plant	8	13.33%
9	Sewage treatment plant	10	16.67%
10	Pumping station	2	3.33%
11	Internal road & green and open space	15	25.00%
	Total area	**60**	**100.00%**

The basic utilities planned within the earmarked utility area of SE-TP are water storage structures such as underground sumps, overhead tank (OHT) and pumping system to meet the potable, non-potable and fire demand, electrical receiving sub-station and sewage treatment plant (STP).

Figure 66: Location of public amenity and utility area

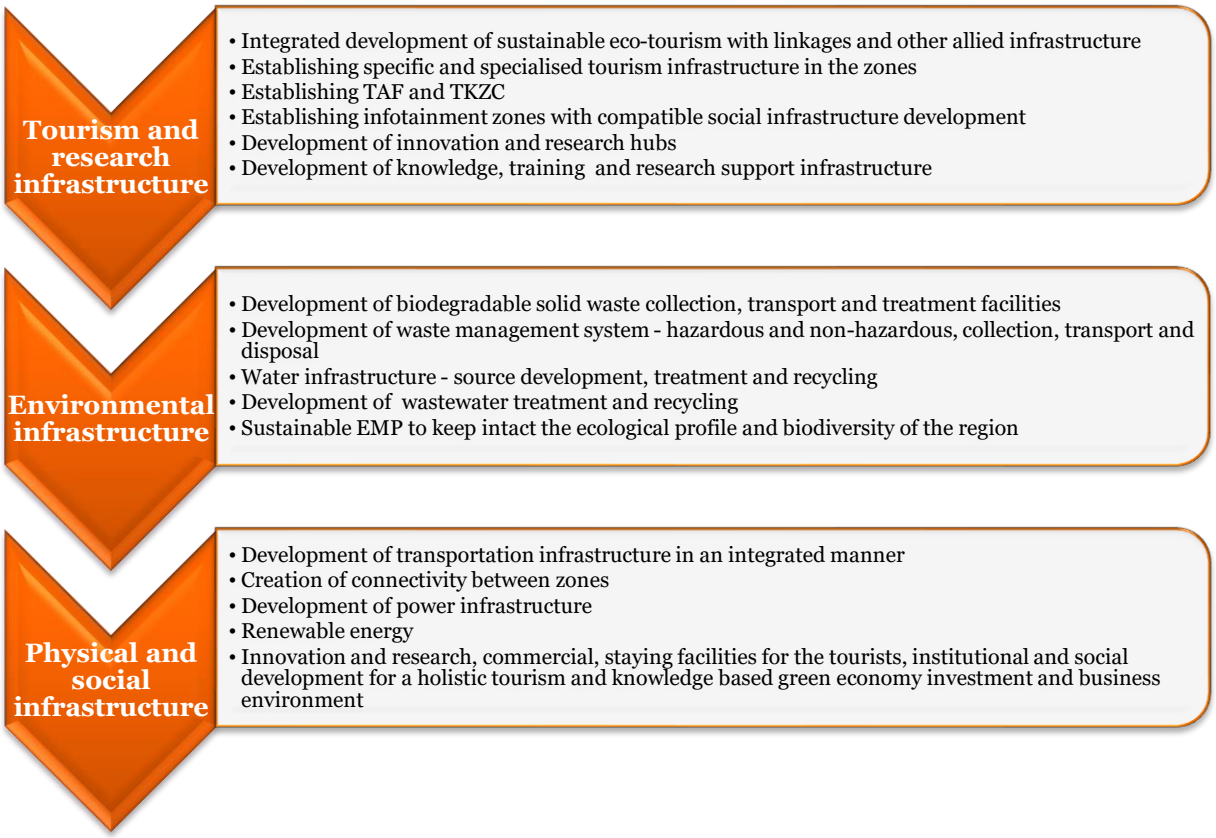
Source: MACE analysis

9. Infrastructure Plans

9.1. Purpose and objectives of the infrastructure plan

The tourism, research, environmental, physical and social infrastructure objectives of SE-TP are described in below figure.

Figure 67: SE-TP infrastructure objectives



Source: MACE analysis

Provision of infrastructure and facilities is crucial for the sustained development and operation of SE-TP. Identification and planning of various supporting infrastructure and facilities for establishing SE-TP constitute critical tasks. Accordingly, the chapter presents the details of SE-TP common infrastructure, including specialised tourism infrastructure but outside the periphery of earmarked TKZC zone. Also, the chapter presents the details of TKZC common structure, TAF and other facilities within the periphery of earmarked TKZC zone. The various supporting infrastructure and facilities in the context of IRC-CoE&IDC for creating a campus of excellence are identified based on the findings of the study. The common infrastructure facilities of SE-TP, TKZC common structure, TAF and other facilities shall be regularly maintained and continuously upgraded to be globally competitive.

The chapter dwells on SE-TP common infrastructure facilities which are grouped under following major heads;

- General infrastructure covering boundary wall and fencing; roads; non-motorized transport; bicycle movement; and pedestrian walkways; non-vehicle streets; smart parking; security and surveillance; robust IT connectivity and digitalization; specific features for differently-abled;
- Social infrastructure covering training centre, incubation centre; commercial infrastructure zone; utility and support infrastructure zone; innovative use of open space and visible improvement;

- Environmental and green infrastructure covering water treatment; adequate water supply including wastewater recycling and stormwater reuse; drainage; rainwater harvesting; sewerage network; sewage treatment and wastewater recycling infrastructure; sanitation including solid waste management (SWM); composting and environment/pollution abatement structures; assured electricity supply; renewable energy; waste to energy; site energy utilization; energy-efficient street lighting; and
- Specialised tourism infrastructure.

9.2. Considerations for infrastructure plans

The basic considerations and the methodology adopted for planning various infrastructure components within the SE-TP are provided in the below table.

Table 60: Details of components covered under the infrastructure plan

Components	Detailing of utilities, infrastructure within proposed SE-TP
A. Roads/driveways – general considerations	○ Embankment cum road is proposed all along the periphery of the development area; and ○ The spinal road and internal NMT driveways are well integrated and well planned to ensure internal movement within the SE-TP through NMT modes such as walking, cycling and e-car.
B. Roads – categories	○ Embankment cum road and internal driveways of 7.5m wide and 5.5m wide respectively are proposed within the SE-TP.
C. Pedestrian walkways and bicycle movement	○ The project shall have walkable paths; ○ Internal driveways and pedestrian walkways are provided for easy movement of visitors with sufficient care so that no transport system comes in the way of pedestrians; ○ Aesthetically designed walkways are provided along with lush green environment on either side of the road; ○ Pedestrian walkways are provided for all categories of roads; ○ A network of bicycle lanes are provided to promote cycling as a means of transport; ○ Bicycle lane network within the SE-TP site area to connect to all main buildings and basic amenities; ○ Bicycle parking at all important structures, TAF, main buildings/ basic amenities, within walking distance; ○ Necessary multilingual signage, name boards, zone guiding maps and visitor's guidance map, etc., are planned to be positioned at necessary locations, such as intersections and at various strategic locations in each zone; and ○ NMT is the only mode of transport proposed to be used within the SE-TP.
D. NMT- pavement structure	○ In the proposed SE-TP, paver block driveway has been proposed for the internal movement via NMT mode of transport such as walking, cycling and e-car.
E. Surface drainage – general considerations	○ Based on the topography of the SE-TP, the drainage pattern has been decided; ○ To prevent the entry of stormwater runoff from adjacent areas/ water intrusion from the adjacent channel, an embankment all along the periphery of the development area is considered; and ○ The internal drains are well planned according to the contour of the planning area.
F. Surface drainage – peak runoff	○ The peak run-off and discharge capacities are computed based on the following design parameters; • The peak run-off is planned to be computed based on the rational formula: - Q = C * I * A / 360 Where, Q = Quantity of runoff, m^3/s C = Coefficient of runoff I = Intensity of rainfall, mm/hr A = Catchment area, hectare

Components	Detailing of utilities, infrastructure within proposed SE-TP
	• Considering the nature of the soil/ surface, the coefficient of runoff adopted in the drainage computation are: 0.9 - for built-up area 0.5 - for road and other paved areas 0.2 - for greenery and open area
G. Surface drainage – sizing	• The sizing of the drains shall be designed based on the discharge capacity of Qc to cater adequately to the estimated peak runoff using Manning's formula: $Qc = (1/n) * A * R^{2/3} * S^{1/2}$ (m^3/sec) Where A = Area of a cross-section of the drain (m^2) R = Hydraulic mean radius (m) S = Hydraulic gradient n = roughness coefficient
H. Surface drainage – design & scheme	○ From the contour, it is observed that the site is elevated on the West and is sloping towards the Eastern side; ○ Hence, it is planned to propose the drain along the inner edge of the embankment cum road on the East side and is planned to discharge into the existing water channel through collection sump and pumping system; ○ The internal drainage system is planned to cater for the entire park through gravity flow; ○ Drains are proposed to be provided on both sides of the internal driveways; ○ An open trapezoidal drain is considered for the surface runoff collection due to easy maintenance; ○ It is recommended not to directly discharge the collected stormwater into the water channel, since, it will have backflow; ○ Enhancing the groundwater table and reduce water demand through effective rainwater management; ○ Rainwater harvesting through recharging structures are envisaged all along the drain at regular intervals, apart from individual rainwater harvesting through recharging structures at strategic locations; and ○ Rainwater harvesting structures are envisaged all along the drain at every 200 m interval.
I. Water demand	○ The project shall have 24x7 treated water supply adopting national and global standards with sufficient quantity. Unaccounted loss shall be less than 15%; ○ For tourism, TAF requirements, bathing and washing clothes, cooking, drinking and washing vessels, the proposal contemplates the use of potable water ○ The usage of non-potable water includes gardening, cleaning, cooling and toilet flushing; ○ The norms of estimating the water requirements for other usages are shown in Table 10.1. **Water demand estimation norms and assumptions** **Description** / **Reference – published standards, guidelines and best industry norms** Internal road/path: 1.8 cum/ hectare/day Green/landscaping/garden/park: 4.53 cum/ hectare/day

Components	Detailing of utilities, infrastructure within proposed SE-TP

Office area/institutional buildings	45 LPCD
Star hotel/budget hotel	180 litres per key
Themed pavilion/viewing deck/ oceanarium	15 LPCD
Restaurant	70 litres per seat
Hotel	180 litres per key
Golf-course	3.2 cum/ hectare/ day
Cottages/resorts/villas	135 LPCD
Gallery/open air theatre/pavilion/MICE/convention centre	15 LPCD
Wet rides	100 - 750 cum
Dry rides	15 LPCD
Green house	20 cum/hectare/day

Source: *MACE analysis, published standards, guidelines and best industry norms*

Water consumption pattern

For areas with bathing facilities	
Potable water	70%
Non-potable water	30%
Potable water	55%
Non-potable water	45%

Source: *MACE analysis, published standards, guidelines and best industry norms*

J. Water losses

- The project shall have meters for all its water supply and distribution network. It includes a smart mechanism for remote monitoring;
- Rainwater harvesting systems are proposed to be installed and utilized;
- Supply of recycled wastewater for secondary uses; and
- Water losses occur in the distribution and transmission network. The percentage of loss depends on the pipe material, joining the system. As this is a complete loss, it is attempted to keep these losses below 10% of the total demand.

K. Fire protection demand - non- potable

- Fire demand in litres per minute has been calculated based on the following formula:

$$Q_{FD} = 4000 \times (P)^{0.5} \times (1-0.01 \times (P)^{0.5})$$

Where P = Population in thousands per hectare

- Considering two hours of fire demand requirement, the total quantity of water required for fire protection has been calculated; and
- Demand for firefighting has not been considered under daily demand as one-time storage, i.e. 2 hours of fire demand will be created and maintained.

L. Average water demand

- Based on the computation and analysis, the total average water demand is estimated.

M. Water storage

- Based on the estimates, the following infrastructure for SE-TP is proposed;
- Underground storage tank:
  - The total storage capacity of the underground storage tank is based on 24 hours duration. Storage requirement details are shown in Table-Underground sump storage capacity; and

<table>
<tr><th>Components</th><th>Detailing of utilities, infrastructure within proposed SE-TP</th></tr>
<tr><td></td><td>

UG storage sumps are individually proposed to store the potable and non-potable water demand, including fire demand for SE-TP.

○ Elevated level service reservoir (ELSR):

The total storage capacity of the OHT is based on 2 hours duration.
An ELSR for storing potable and non-potable water including fire demand by providing separate compartments within the tank for potable and non-potable water distribution; and
As per standard norms, the tail end should have a minimum residual pressure of 12.0 m. To meet the norms, the staging height of ELSR shall be fixed accordingly by the project implementation agency.

</td></tr>
<tr><td>N. Water pumping station</td><td>
○ The proposal includes a water pumping station for potable and non-potable water for pumping from the underground storage sump to respective ELSR;
○ The water supply scheme including distribution, is planned based on the peak flow, minimum residual pressure, and pipe material.
</td></tr>
<tr><td>O. Water distribution network</td><td>
○ It is proposed to provide a separate water distribution network for potable and non-potable supply;
○ The design criteria for the design of water supply network include:

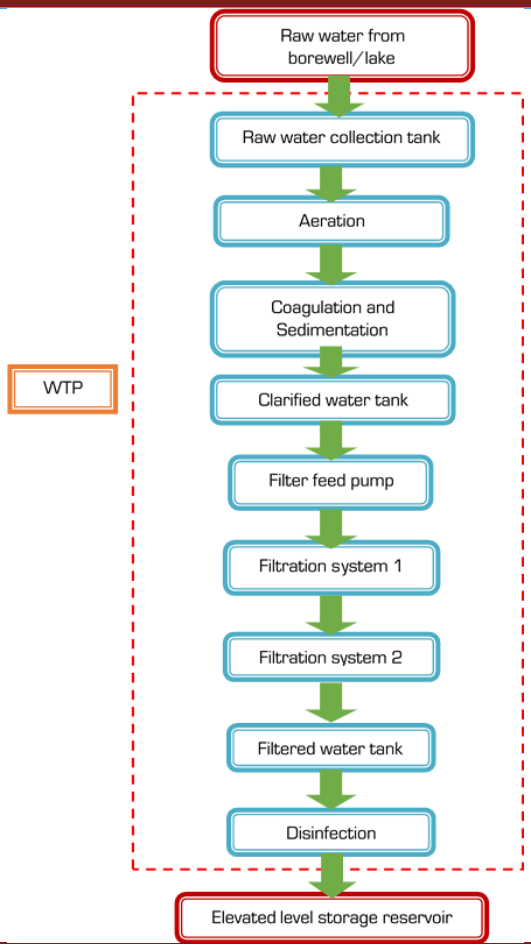
Demand computed based on the analysis;
Working hours per day – 24;
Pipe material;

For pumping main - DI (K9);
For distribution up to 200 mm diameter - HDPE (PE 100);
For distribution above 200 mm diameter - DI (K7);
Pipe roughness coefficient - 140 for DI and - 150 for HDPE;
The formula used for friction loss - Hazen Williams;
Minimum residual pressure at all tapping points - 12.0 m; and
ELSR staging height - as per design requirement.

</td></tr>
<tr><td>P. Water treatment plant</td><td>
<table>
<tr><th>Source</th><th>Quality</th><th>Process required</th></tr>
<tr><td>Groundwater with protected storage</td><td>Low turbidity, free from colour and odor</td><td>Plain chlorination</td></tr>
<tr><td>Ground Water</td><td>Having iron, turbidity, odor</td><td>Aeration, coagulation, sand filtration and chlorination</td></tr>
<tr><td>Pond, Lake with surface runoff</td><td>Turbidity, suspended solids, algae</td><td>Coagulation, sedimentation, sand filtration and chlorination</td></tr>
<tr><td>Sea</td><td>Saline</td><td>Desalination</td></tr>
</table>

The system selected shall ensure that the quality of water is within the drinking water standards,
For WTP with a source of water as storage tanks, coagulation, sand filtration, and chlorination are suggested
For WTP at lake/riverside, coagulation, sedimentation, sand filtration and chlorination are suggested;
For WTP with seawater intake, the desalination plant is suggested; and
The study shall include the optimization of the system depending on the actual quality of raw water.

<u>Typical WTP process flow diagram (to be finalised after testing the raw water quality)</u>
</td></tr>
</table>

Components	Detailing of utilities, infrastructure within proposed SE-TP
	
Q. Sewage quantity estimation	○ The sewerage system is planned to cater for the anticipated peak discharge requirements and to treat the waste to the required discharge standards; ○ The estimation of the sewage shall vary depending upon the land use distribution; ○ The domestic sewage to be generated has been assumed to be 80% of the domestic water consumption in addition to infiltration of 10%; ○ The proposal includes handling of wastewater generated from toilets (considered as sewage) and the wastewater generated from bath/shower, laundry, hand basin, and kitchen (considered as sullage, greywater); ○ Following design, criteria are proposed for sewerage, treated effluent collection system • Demand computed based on the analysis • Working hours per day - 24 • Pipe material - NP2 RCC for all areas except road crossing and NP3 RCC for road crossing • Pipe roughness coefficient - 0.011 • Peak flow factor - 3 • The formula used to calculate friction loss - Manning's • Infiltration - 10% • Self-cleansing velocity - 0.6 m/s ○ Minimum cover - 1 m • Utility hole spacing – 30 m up to pipe size 900 mm ○ The project shall have zero wastewater since all the wastewater is collected, treated and recycled; ○ Each TAF/occupant unit will treat its effluent to sewage standards before discharge into the sewerage network;

Components	Detailing of utilities, infrastructure within proposed SE-TP
	○ The activity includes a collection of treated effluent, sewage, and sullage through a single collection network based on the above design criteria. The project implementation company shall implement a sewerage network based on the topography of the site; ○ Based on the natural topography and other site constraints, trunk main and sub-mains form part of the network. The sewerage network includes a minimum pipe size of 150 mm;

Wastewater generation pattern

Description	Percentage
Bath/shower and laundry	55.97%
Hand basin, kitchen	12.29%
Toilet	31.74%

Source: MACE analysis, published standards, guidelines and best industry norms

Sewage and sullage generation pattern

For areas without bathing and washing facility		
Sewage	=	72.09%
Grey water	=	27.91%
Gardening - 19.53%		
Cleaning - 8.37%		
Sewage	=	31.74%
Grey water	=	68.26%
Gardening - 47.78%		
Cleaning - 20.48%		

Source: MACE analysis, published standards, guidelines and best industry norms

R. Quality of sewage

Sewage quality

S. N#	Parameters	Unit	Concentration
1	PH	-	5.5 – 9.0
2	Suspended solids	mg /l	300– 600
3	Biochemical oxygen demand	mg /l	250 – 350
4	Chemical oxygen demand	mg /l	400 – 600
5	Oil and grease	mg /l	<20

Source: MACE analysis

○ However, the preceding condition is that occupant units treat industrial trade effluent to the required level of pre-treatment before discharging to a common system; and
○ Based on this assumption of input quality, the design and treatment scheme has been worked out. It is proposed to treat both sewage and sullage in a single treatment system.

S. Sewage treatment plant (STP) considerations

○ Sewage treatment is the process of removing contaminants from wastewater, comprising of storm run-off, domestic sewage and primary treated effluent. It includes physical, chemical and biological processes to remove various contaminants; and

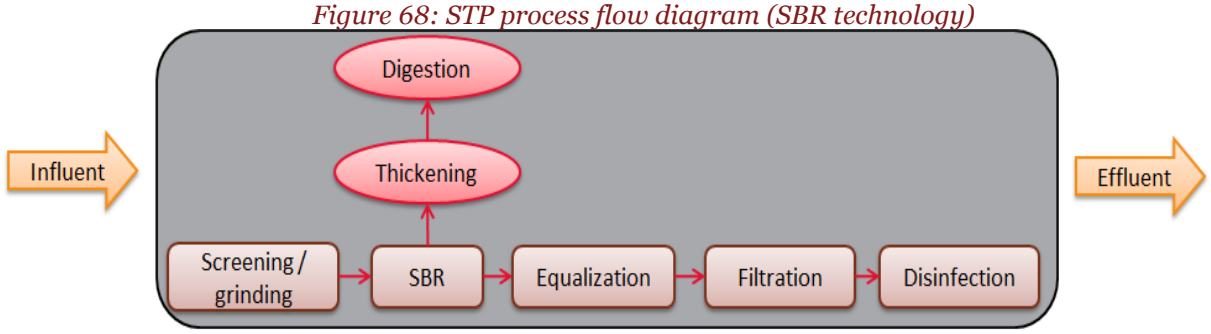
STP process and units

S. N#	Process	Units required	Accessories
1	Activated sludge – Extended aeration	Aeration tank and secondary clarifier	Surface aerators or membrane diffuser system for oxygen supply
2	Aerated lagoon	Earthen bund basins	Fixed or floating aerators for oxygen supply

Components		Detailing of utilities, infrastructure within proposed SE-TP	
3	Up-flow Anaerobic Sludge Blanket (UASB)	Reactor with liquid, solid and gas separation facilities	Gas collector, burner, and influent distribution system
4	Trickling filters	Circular tanks with media, underdrain and secondary clarifier	Rotary distributor for influent and re-circulation pumps
5	Rotating Biological Contactors (RBC)	A trough with polyvinyl chloride / plastic discs, secondary clarifier	Drive mechanism for rotating the discs
6	Fluidized aerobic bioreactor	Reactor tank with polypropylene media and diffusers followed by a secondary clarifier	Blowers for the supply of oxygen through membrane diffusers
7	Sequencing Batch Reactor (SBR)	It uses deep RCC basins, and very efficient oxygen transfer equipment's (diffused aeration mechanism)	Diffusers, blowers and aeration grid, which provides the highest aeration and oxygen transfer efficiency. Decanter assembly in Stainless steel equipped with variable frequency drive to automatically control the rate of decanting based on input feed condition
8	Membrane Bio-Reactor (MBR)	Aeration tanks followed by balancing tank and membrane bioreactor	Diffusers, blowers to supply oxygen, air compressors for backwashing, chemical dosing for pre-treatment.

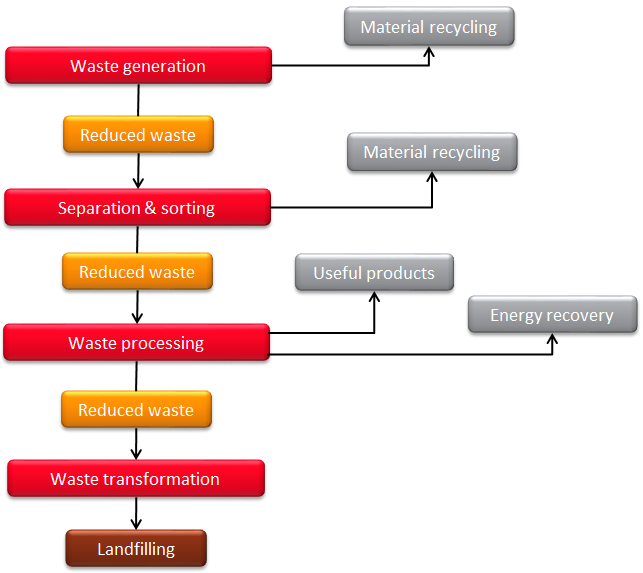
Source: MACE analysis

Figure 68: STP process flow diagram (SBR technology)



Source: MACE analysis

T. Selection of technology for the sewage treatment plant	○ Factors considered for selection of appropriate treatment system: • Reliability; • Vector nuisance; • Area availability; • Power requirement; • Capital cost; and • O&M cost. ○ The exercise includes analysis of process technologies regarding the performance and both capital and operating cost. Based on the above analysis Sequencing Batch Reactor (SBR) system is proposed; ○ This system has been widely used for municipal and industrial wastewater treatment applications to meet specific discharge requirements; ○ SBR technology advantages/benefits: • Consistent, high-quality, low nutrient level effluent; • Tolerates wide swings inflow and organic loading; • No clarifier required; • Better control over filamentous growth and settling problems; • Nutrient removal without chemicals – nitrification and de-nitrification, phosphate removal; and

Components	Detailing of utilities, infrastructure within proposed SE-TP
	• The system can also work with sewage inflow of 20 to 30 per cent of designed capacity due to the presence of variable frequency drive (VFD). ○ SBR system is filled and draws an activated sludge system; and ○ SBR process uses high-efficiency oxygen transfer aeration to satisfy the high-rate oxygen consumption requirement at the beginning of the "fill" and "aeration" cycles. SBR is efficient in carbonaceous pollutant removal and amenable to the modification to satisfy nutrient removal of nitrogen (N) and phosphorus (P). Because the fill, aeration, settlement, and draws take place in the same reaction tank, SBR tank itself would serve as the clarifier.
U. Sanitation (common and public restrooms)	○ Common and public restrooms are provided at strategic locations, apart from restrooms to be built by the TAF developers, and occupant units.
V. `SWM	○ SWM is one of the essential services for maintaining the quality of life in SE-TP and for ensuring better standards of health and sanitation; ○ If properly collected at source, SWM would reduce the number of downstream problems related to transportation and disposal of the same. The solid waste generated in SE-TP , can be broadly categorized as under: • Industrial non-hazardous waste; • Industrial hazardous waste; • Domestic wastes: kitchen and wood waste, plastic, paper, floor sweepings; • Road sweeping and sanitary waste: human waste; • Garden and agriculture waste: leaves, branches, plants; • Roads/building construction waste: earth, asphalt, concrete, brick, plaster, wood, glass, stones; • E-Waste: computer systems, peripheral equipment, mobile phone sets, TVs, audio sets and also household appliances; and • Hospital and biomedical waste. **Waste reduction by integrated SWM**  *Source: MACE analysis* ○ The project shall reduce landfill caused by waste so that it is minimal. Source segregation of solid waste generated is a prerequisite for recycling. The gardening in the project can effectively utilize composted

Components	Detailing of utilities, infrastructure within proposed SE-TP
	organic waste. Also, considerations include energy creation through waste; ○ The generation rates of industries, logistics, commercial and residential areas vary to such an extent that exact quantification of solid waste generation is not feasible; ○ However, an attempt has been made to quantify the solid waste generated from various zones of SE-TP: • Industries – 200 gm/per person/day; • Utilities – 100 gm/per person/day; • Residential area – 400 gm/person/day has been considered; • Road – 10.12 kg/ha/day considered for street sweeping; • Greenery – 30 kg/ha/day is considered; and • Commercial and recreation – 125 gm/per person/day are considered. ○ It is mandatory to implement source, and the activity includes adequate considerations for the planning of collection, transportation of waste within the site area. Users will be required to segregate their waste into the following categories and put in colour-coded bins: • Industrial non-hazardous waste; • Industrial hazardous waste; • Bio-degradable waste; • Non-biodegradable waste; • e-waste like parts of computer, floppies, monitor, cartridges, ribbons; • Construction debris, street sweepings; and • Hospital and biomedical waste. ○ From the above, the solid waste treatment facility contemplates treating only bio-degradable waste; ○ The rate of solid waste generation in the initial stages will be less than the estimated quantity, and hence during the initial stage, the solid waste generation rate can be considered as 50% of the estimated quantity;
W. Power supply and distribution	○ Provision of at least 10% of the energy used in the project from renewable sources with a long-term strategy to increase the percentage of renewable energy sources; ○ Electricity shall be available 24x7 in all parts of the site with smart metering linked to online platforms for monitoring and transparency; ○ The system parameters are as follows: • Transmission line – 33/11 kV; • Number of phases – 3; • System frequency – 50 Hz; and • Consumer supply voltage 33 kV /11kV/415/240 Volt. ○ As peak demand may vary from each facility in SE-TP, a diversity factor, which relates peak demand to rated load demand or calculated demand, is utilized in the computation of maximum demand; ○ The applicable diversity factor is 50 – 80%; ○ Power losses occur in the distribution network depending upon the type of conductors and equipment installed. As this is a complete loss of the system, the proposal envisages keeping this loss below 10% of the total load; ○ The proposal includes distribution substation in a strategic location, and individual facilitation and all power reticulation are to be carried out at 11 kV; ○ The advantage with reticulation at 11 kV is that it is the standard voltage and therefore electrical reticulation equipment for 11 kV systems would be readily available including spares;

Components	Detailing of utilities, infrastructure within proposed SE-TP
	○ The distribution network is the main backbone of the reticulation system. It is essential that the network must deliver uninterrupted power, in the right quantity and quality to individual facilities continuously; ○ A network of overhead lines or underground cables can distribute power; ○ For the initial phase, the considerations include an overhead distribution system, and however, the underground cable system shall replace the overhead distribution system over a period: • Lighting controls – All non-emergency exterior and common area lighting such as landscaping, surface and covered parking, pathways, bicycle lanes, street lighting shall have daylight sensor/ timer-based control.' • Pumps and motors – with the efficiency of 85% and duty greater than 3.5 H. P; and • Centralized HVAC systems. ○ Onsite renewable energy: • Use of on-site renewable technologies, to minimize environmental impacts associated with the use of fossil fuel energy; and • Rooftop solar photovoltaic (PV) panels are one of the proven methods of renewable energy. It has been envisaged to provide such solar PV panels for generating power leveraging the roof spaces available atop the various building. ○ Energy metering: • Sub-metering to improve energy performance, and thereby save energy; • Water pumping; • Groundwater pumping; • Treated wastewater pumping; • Exterior area lighting, including landscapes; • Centralized HVAC systems; • Renewable energy generation; and • Power backup systems. ○ Building-level energy consumption.
X. Street lighting, outdoor light pollution reduction	○ From the environmental consideration, it is planned to follow the strategy not to disturb the existing bio-diversities of the Island; ○ Light pollution is one of the major threats to the female turtle and hatching; ○ Artificial lights may disrupt hatching; ○ As a mitigation measure, it is proposed that usage of high-intensity lights is prohibited along the coastal area of SE-TP; ○ The proposal envisages two different forms of the street: • Street lights for the road network; and • Solar street lighting. ○ All the road and streets are provided with street lighting not only to assist pedestrians and traffic but also to increase safety and security in the area; ○ All lighting includes Light Emitting Diode (LED) street light fixtures mounted on power poles or streetlight columns; ○ In the scheme of illumination, lighting has been conceived in 3 different forms. ○ Street lights for the roads/ driveways ○ Decorative post–top-lanterns for the pathways ○ High mast from towers for open areas ○ The internal road within the zone and the connecting roads of all zones are provided with street lighting not only to assist pedestrians and traffic but also to increase safety and security in the area. It is

Components	Detailing of utilities, infrastructure within proposed SE-TP
	recommended that all lighting should be LED light fixtures mounted on street light poles; ○ Average illumination should be about 20 lux. ○ The decorative post top lantern should be provided to illuminate the walkways in the park. The post top lantern shall be LED light fixtures. ○ High mast lights shall be of 30 m height with 8x250 W LED flood light fixtures. ○ For major roads, the average illumination should be about 20 lux; ○ Tourism eco-friendly lights, musical fountain lightings, tourist guiding eco-friendly lightings etc. shall be provided; and ○ Exterior lighting shall be in such a manner that no external light fixture emits more than 5% of the total initial designed fixture.
Y. IT connectivity, telecommunication, and ICT-enabled occupant industry services	○ The project shall have Wi-Fi services with high-speed Internet across SE-TP area; ○ The concerned officials of the ministry and other private operators shall provide all telecommunication services; ○ The infrastructure includes value-added telecom services and internal communications for the users are not covered under the general infrastructure; ○ Provision of all major services through online and offline platforms; ○ The occupant units can access information through data available on the online system; and ○ Robust data infrastructure system shares information and enhances internal coordination.
Z. Landscaping, public open spaces and green cover or vegetation	○ The activity includes works associated with the landscaping within the area covering tree strips along the boundary, roads, public greenery; ○ Well, dispersion of public open spaces throughout the site; ○ The workspace shall have access to open space within 10 minutes walking distance; ○ Open spaces are of various types – natural, green, plazas, parks, or recreation areas – which serve various sections of people; ○ The green cover shall have a minimum of ten natives / adaptive trees per acreage or plant tree saplings that can mature into fully grown-up trees with large canopy in the next five years; and ○ The use of turf is limited to conserve water. Further, planting the landscape area with drought-tolerant /native/ adaptive species (excluding turf species).
AA. Management of irrigation systems	○ 50% of landscape planting beds shall have a drip irrigation system to reduce evaporation; ○ 75% of the turf area shall have a sprinkler irrigation system to reduce water loss; ○ Installation of the time-based controller for the valves to minimize the evaporation loss and for ensuring the plant health; and ○ Pressure-regulating device(s) are installed to maintain optimum pressure to prevent water loss.
BB. Safety and security	○ The site to have very high levels of public safety – all tourist and occupancy units to feel safe in all parts of the site during all hours of the day; and ○ The proposal includes a lighting system and CCTV surveillance system.
CC. Specialised tourism infrastructure	○ It is also envisaged to provide the specialised infrastructure within SE-TP catering to the specific requirements of the occupant units including: • CoE and IDC- hub (as a part of IRC); • Skill development; and • Other facilities.
DD. Air quality and biodiversity conservation	○ The project shall have clean air by international standards; ○ Live air quality monitoring shall cover the entire area, and the activity includes mapping of the data of air quality through the smart environment monitoring system; and

Components	Detailing of utilities, infrastructure within proposed SE-TP
	○ Indicators and monitoring mechanism to conserve and protect biodiversity.

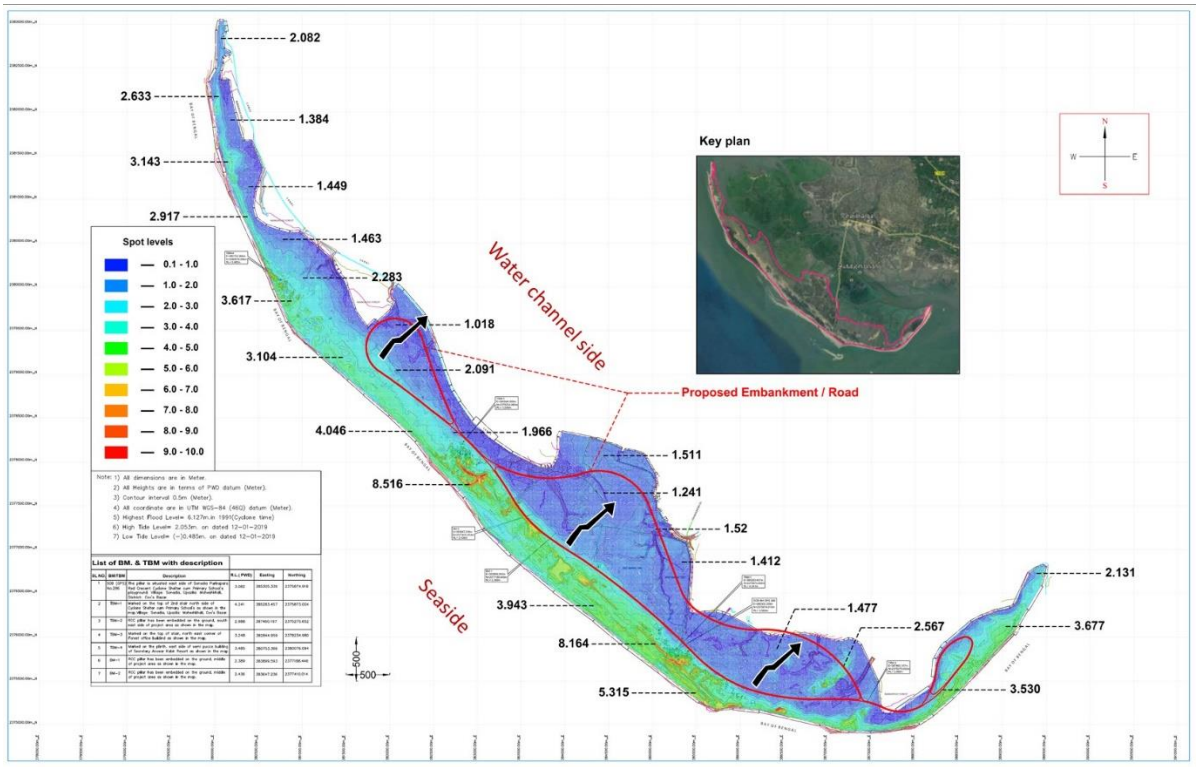
Source: MACE analysis

9.3. SE-TP infrastructure assessment and estimation

A. Site grading and development

- The average natural ground level for the proposed development area varies between +1 to +2 m;
- To avoid inundation due to intrusion of water from the adjacent sea and water channel, an embankment cum road has been proposed all along the periphery of the proposed development area;
- It is observed that the proposed development area is almost flat and is slightly elevated on the seaside and sloping towards the existing water channel on the Eastern side;
- Hence, the proposed embankment level is high on the water channel side and low on the Seaside;
- The proposed height of the embankment on the seaside is +4.5 m above mean sea level (MSL) and +6.00 m above MSL on the side of the water channel;
- These proposed levels are based on consideration of historical MFL data (for 50 years) and with the view of not restricting the beautiful sea view and sea breeze for the tourists;
- An average depth of 0.4m filling above the existing natural ground level is considered, and the total estimated quantity of site filling is 437057 cum;
- The site can be filled with the dredged soil from Maheshkhali water channel; and
- However, the detailed hydrographic study has to be carried out for identifying the suitable stretches for dredging.

Figure 69: Contour within the proposed planning area



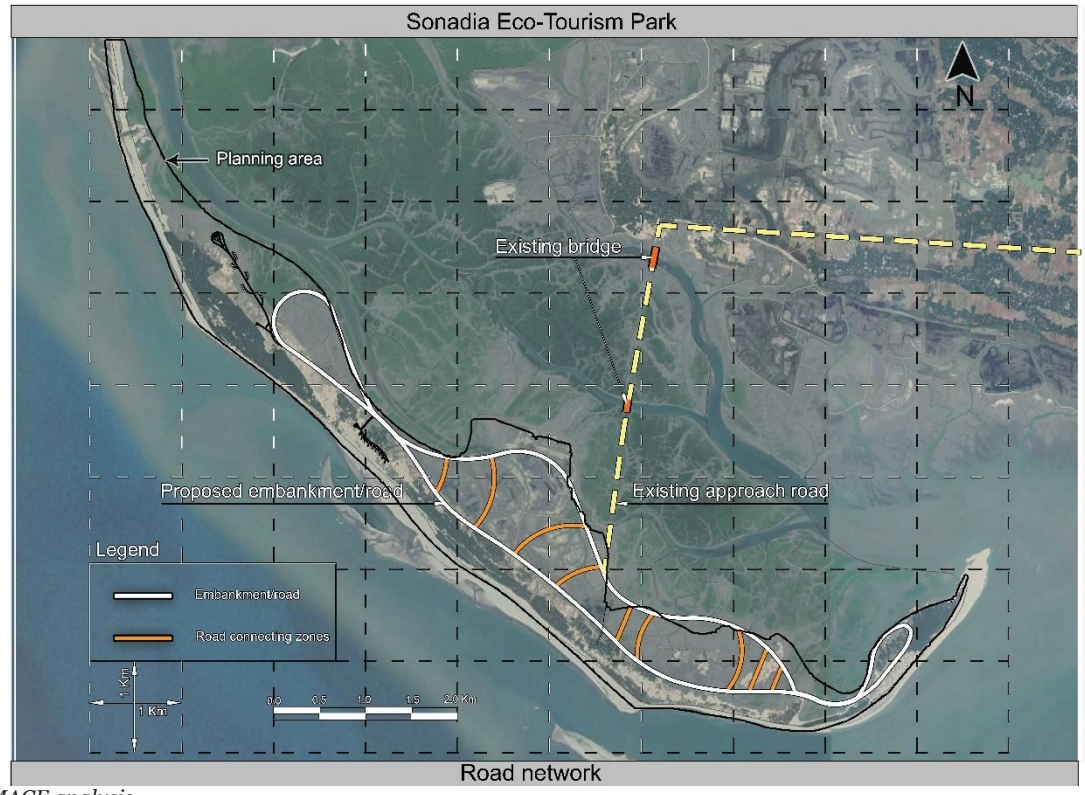
Source: MACE analysis

- Primary driveway networks are planned to give access to the development components within SE-TP;
- These are exclusively proposed to facilitate the internal movement of tourists and occupant units to access various components within the SE-TP via NMT modes such as battery car, bicycle and walking;
- The network is looped and well-integrated with all the proposed components and facilities within SE-TP;

Category	RoW width (m)	Length (km)
Embankment cum road	7.5	17.9
Road connecting zones	7.5	4.6
	Total	**22.5**

Source: MACE analysis

Figure 70: Road network layout

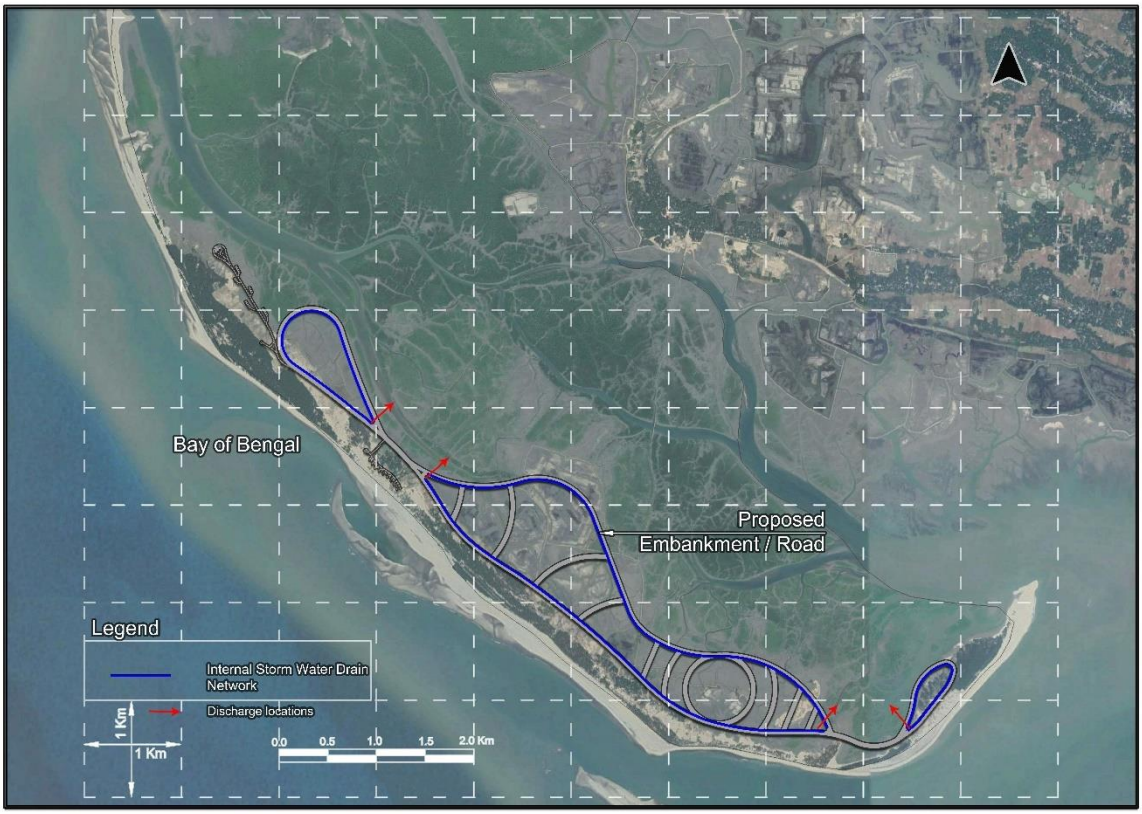


Source: MACE analysis

- Fire demand in litres per minute has been calculated based on the following formula:

  $Q_{FD} = 4000 \times (P)^{0.5} \times (1-0.01 \times (P)^{0.5})$
  Where,
  P = Population in thousands per ha
  Q_{FD} = 681.43 lpm
  = 40.89 cum/hr
- Considering two hours of fire demand requirement, the total quantity of water required for fire protection is 81 cum
- The consideration for the demand for firefighting include daily demand as onetime storage of 81 cum, i.e. 2 hours of fire demand will be created and maintained

Figure 71: Internal stormwater drain network



Source: MACE analysis

A. Average water demand

Estimated water demand

Sl. No.	Types of zones	Sea water demand (cum/day)	Potable demand (cum/day)	Non-potable demand (cum/day)	Total water demand (cum/day)
1	Entrance zone		3.63	926.92	930.55
2	Heritage and hospitality zone		119.32	141.71	261.03
3	Knowledge centre zone		13.81	62.82	76.63
4	Family entertainment zone		40.93	12.14	53.07
5	Adventure zone		1355.95	22.66	1378.61
6	Eco science zone	1563.56	251.09	127.90	378.99
7	Public amenity		254.83	131.27	386.10
	Total	1563.56	2039.55	1425.42	**3464.97**
	Total in MLD	1.56	2.04	1.43	3.46

Source: MACE analysis

Water demand for one-time water requirement

Zone	Component	One-time water requirement (cum)	
Adventure zone	Wet rides	4025	

Zone	Component	One-time water requirement - seawater (cum)	One-time water requirement - freshwater (cum)
Eco-science zone	**Oceanarium**		
	Main pavilion tank	10000	0
	Leisure pool with 1 m depth	0	850
	Aquarium - 80 numbers	120	0
	Aquarium - 80 numbers	0	120
	Small thematic pavilion with 1 m depth	343.75	687.5
	Total	**10463.75**	**1657.50**

Source: MACE analysis

- From the estimated water demand, it is observed that the total water demand is 3.46 MLD out of which 2.04 MLD is potable water requirement, and 1.43 MLD is non-potable water requirement.

- Individual sumps to store the potable and non-potable water are proposed;
- The potable freshwater can be from the deep tube wells, and the supply line will be connected to the potable water collection sump, which is proposed in the utility area of SE-TP;
- The non-potable water requirement can be met from the excess available treated wastewater of Dhaulghata EZ in the vicinity of the SE-TP from which the supply line needs to be connected with the non-potable water collection sump located in the utility area of SE-TP;
- From these underground sumps, the water shall be pumped to separate overhead storage tanks (potable and non-potable) from where the water can be distributed through gravity flow for all the zones proposed within SE-TP;
- These sumps and OHTs are located in utility area planned adjacent to the embankment on the Eastern side. The entire water distribution network is planned in the utility corridor proposed along the 7.5m wide embankment cum road from which this will get distributed to all the zones through the internal distribution network.
- It is to be noted that the non-potable water sump is planned to serve the fire demand too. Also, in view of the fire safety aspect, it is planned to propose the fire hydrant for every 300 m along with the non-potable water supply network within the zonal area. From this provision, the zones shall use the fire hydrant system during emergency time.
- The layout showing the proposed internal potable and non-potable water supply networks are depicted in Exhibit Nos.....

Underground sump storage capacity

S. N#	Description	Processing zone	Non-processing zone	Unit
1	Potable water	6915	162	cum
2	Non-potable water including fire demand	283	164	cum
	Total	**7198**	**326**	**cum**

Source: MACE analysis

- There will be four underground storage tanks for storing potable and non-potable water including fire demand for processing and non-processing zone respectively

- ***ELSR***

Overhead tank storage capacity

S. N#	Description	Processing zone	Non-processing zone	Unit
1	Potable water	1153	27	cum
2	Non-potable water	35	26	cum

	Total	**1188**	**53**	**cum**

Source: MACE analysis

- There will be 4 ELSR for storing potable and non-potable water including fire demand for processing and non-processing zone respectively
- As per standard norms, the tail end should have a minimum residual pressure of 7 m. The staging height of ELSR shall be fixed accordingly by the project implementation company

Pipe sizing for processing zone

Pipe size in mm	Length in m	
110	5723	-
140	1635	-
160	1635	-
200	1635	-
250	1635	-
300	1635	-
350	818	16351
400	818	-
450	818	-
Total	**16352**	**16351**

Source: MACE analysis

Pipe sizing for the non-processing zone

Pipe size in mm	Length in m	
40	8222	8222
50	5755	5755
63	1644	1644
90	822	822
Total	**16443**	**16443**

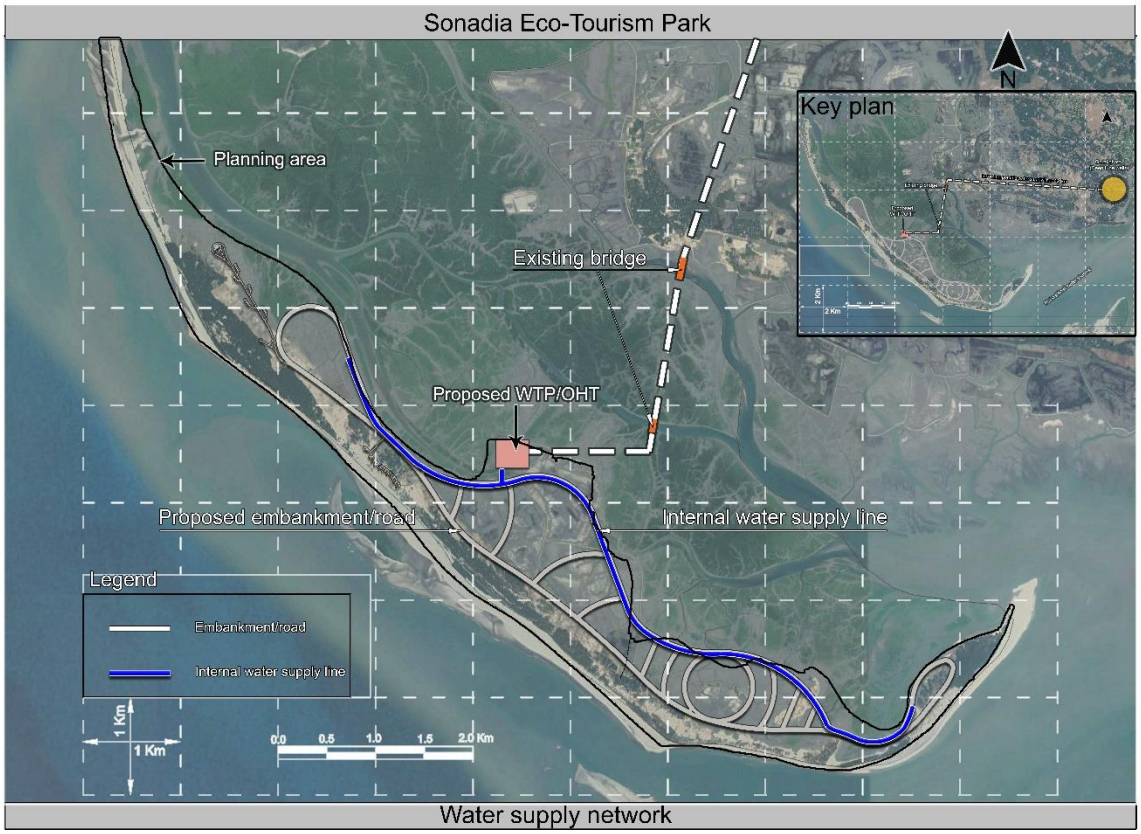
Source: MACE analysis

Pump capacity

Description		Processing zone	Non-processing zone	Unit
Potable water	Capacity	0.15	0.004122	cum/sec
	Number of pumps	2 W+1S	2 W+1S	
	The power requirement of each pump	37	1	kW
Non-potable water	Capacity	0.0048	0.0039	cum/sec
	Number of pumps	2 W+1S	2 W+1S	
	The power requirement of each pump	1	1	kW

Source: MACE analysis

Figure 72: Internal potable water supply network of SE-TP



Source: MACE analysis

Figure 73: Internal non-potable water supply network of SE-TP

Source: MACE analysis

- Sewage generation
- Treated sewage water available @ 90% = 5875.22 cum/day
- Non-potable water demand = 366 cum/day
- Balance treated sewage water to be discharged as non-potable water = 6238 cum/day

Sewage generation estimation

Sl. No.	Types of zones	Potable demand (cum/day)	Non-potable demand (cum/day)	Total water demand (cum/day)	Total sewage quantity (cum/day)
1	Entrance zone	3.63	926.92	930.55	5.77
2	Heritage and hospitality zone	119.32	141.71	261.03	144.42
3	Knowledge centre zone	13.81	62.82	76.63	20.81
4	Family entertainment zone	40.93	12.14	53.07	10.66
5	Adventure zone	1355.95	22.66	1378.61	44.04
6	Eco science zone	251.09	127.90	378.99	78.14
7	Public amenity	254.83	131.27	386.10	296.01
	Total	2039.55	1425.42	3464.97	599.85
	Total in MLD	**2.04**	**1.43**	**3.46**	**0.60**

Source: MACE analysis

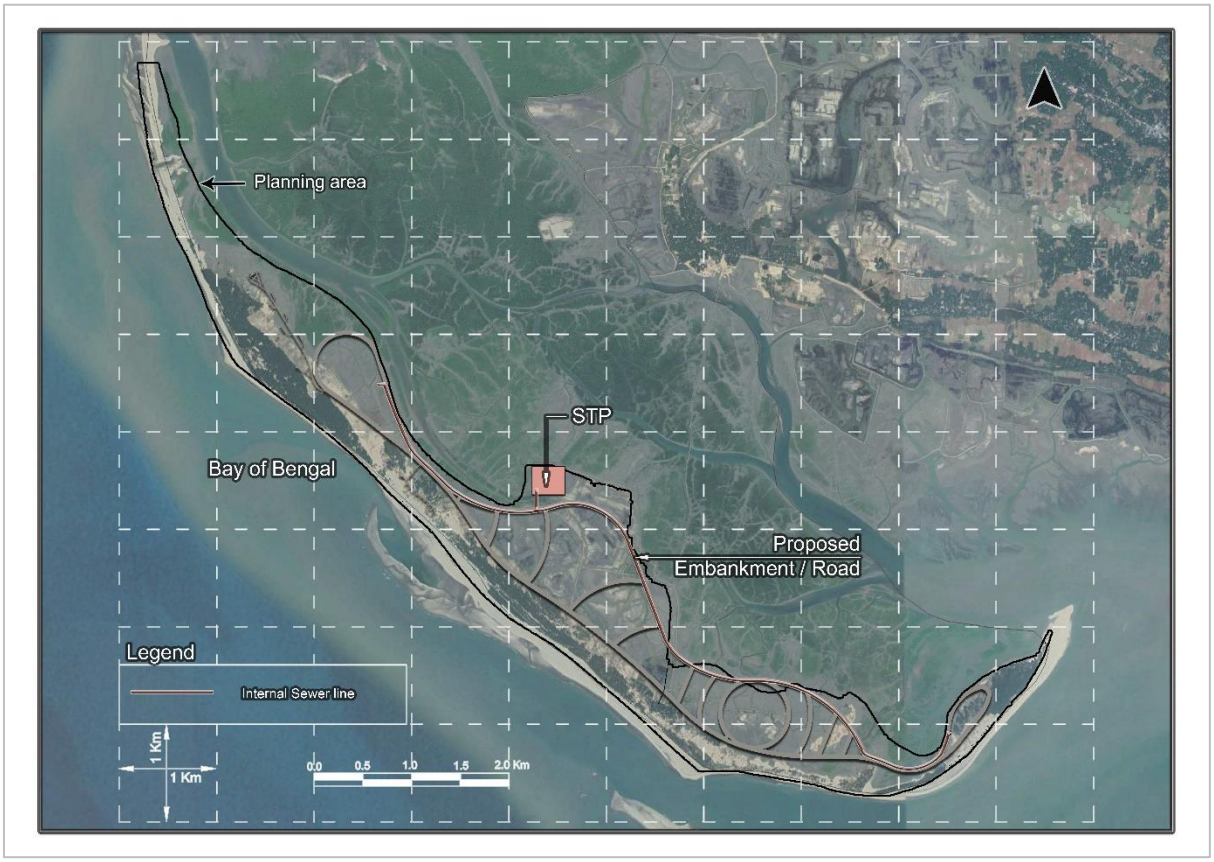
Pipe size – sewerage network

Pipe size in mm	Processing zone length in m	Non-processing zone length in m
150	5430	7065
200	3879	1766
300	3103	-
400	1551	-
500	776	-
600	465	-
700	310	
Total	**15514**	**8831**

Source: MACE analysis

- STP is proposed in the utility area, and the entire sewer network is planned along the utility corridor which is proposed along the inner edge of the 7.5m wide embankment cum road.

Figure 74: Sewerage network layout



Source: MACE analysis

- Two (2) numbers of sewage treatment plant of capacity 6.23 MLD and 0.3 MLD for processing zone and non-processing zone respectively are proposed.

C. Solid waste generation

Estimation of SW generation – zone wise

Solid waste quantity estimation

S.No	Types of zones	Solid waste generation quantity (kg/day)
1	Sonadia Island tourism facilitation development	172
2	Entrance zone	66
3	Heritage and hospitality zone	1709
4	Knowledge centre zone	124
5	Family entertainment zone	175
6	Adventure zone	305
7	Eco science zone	340
	Total solid waste quantity estimation (kg/day)	**2890**
	Total in TPD	**2.89**

Source: MACE analysis

Estimation of SW generation

S.No	Component	Basis	Unit	Solid waste generation quantity (kg/day)
1	Sonadia Island tourism facilitation development			
a	Embankment	10.12	kg/ha/day	136
b	Road connecting zones	10.12	kg/ha/day	35
2	Entrance zone			
a	Internal road / path	10.12	kg/ha/day	9
b	E-car and cycle parking			
c	Information kiosk/globe			
d	Helipad			
e	Viewing deck	100	gm/capita/day	40
f	Water pool with musical fountains			
g	Green / landscape	30	kg/ha/day	17
h	Jetty			
3	Heritage and hospitality zone			
a	Pavilion	100	gm/capita/day	20
b	Arts & craft village			
i	Themed pavilion	100	gm/capita/day	50
ii	Internal road / path	10.12	kg/ha/day	3
iii	Green / landscape	30	kg/ha/day	9
c	Star hotel			
i	Building	450	gm/capita/day	108
ii	Internal road / path	10.12	kg/ha/day	4
iii	Green / landscape	30	kg/ha/day	12
d	Business & relaxation			

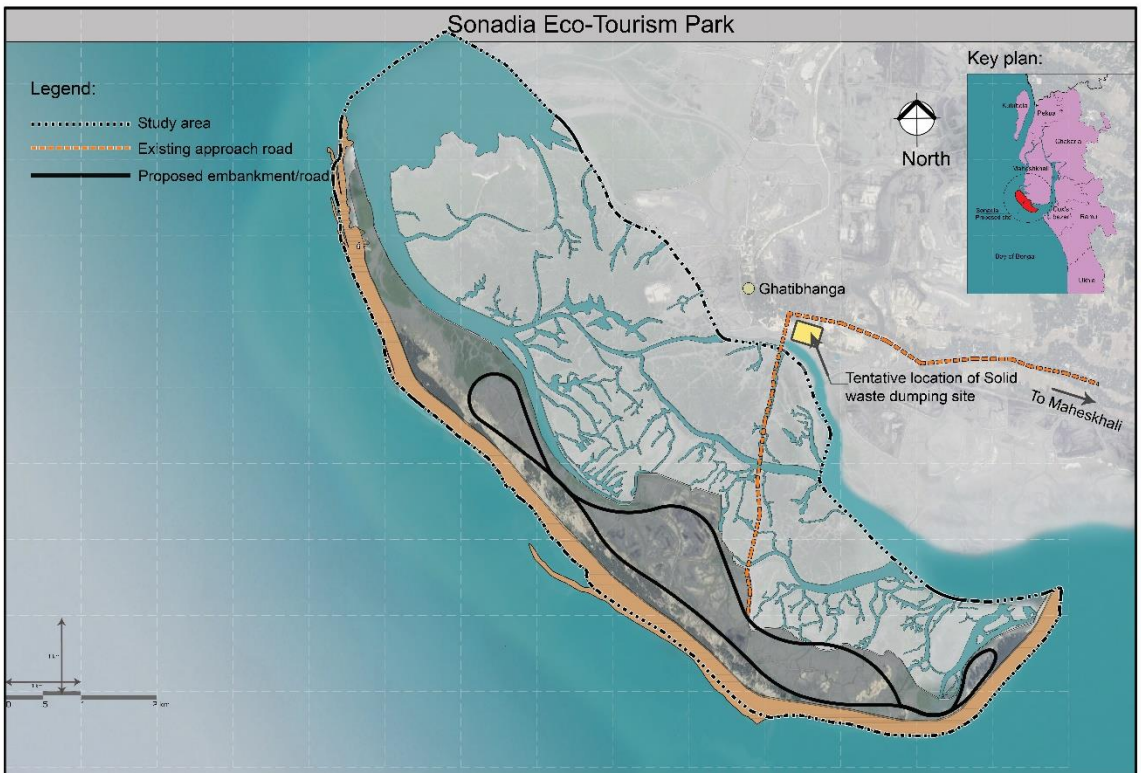
i	Statue deck	100	kg/ha/day	40
ii	Heritage pavilion	100	gm/capita/day	82.4
iii	Convention centre and MICE	0.2	kg/capita/day	1200
iv	Budget hotel	450	gm/capita/day	90
v	Yoga centre and meditation hall	0.2	kg/capita/day	60
vi	Resorts and multi-cuisine restaurant	400	gm/capita/day	14.4
vii	Water pool			
viii	Green / landscape	30	kg/ha/day	12
ix	Internal road / path	10.12	kg/ha/day	4
4	Knowledge centre zone			
a	IRC-CoE&IDC	0.2	kg/capita/day	40
b	Internal road / path	10.12	kg/ha/day	1
c	Green / landscape	30	kg/ha/day	6
d	Golf course	0.2	kg/capita/day	38
e	Club house	0.2	kg/capita/day	20
f	Kiosk	10.12	kg/ha/day	1
g	Cottages	450	gm/capita/day	18
5	Family entertainment zone			
a	Botanical Garden			
i	Greenhouses and agro-tourism	30	kg/ha/day	62
ii	Butterfly park	30	kg/ha/day	3
iii	Public Square	30	kg/ha/day	15
iv	Internal road / path	10.12	kg/ha/day	8
v	Green sculptures and eco bridge	30	kg/ha/day	3
vi	Green / landscape	30	kg/ha/day	30
vii	Multi-cuisine restaurant	450	gm/capita/day	31.5
b	Villas	450	gm/capita/day	10.8
c	Open garden	30	kg/ha/day	12
6	Adventure zone			
a	Dry rides and other adventure activity	100	gm/capita/day	152.6
b	Wet rides and other adventure activity	100	gm/capita/day	152.6
7	Eco science zone			
a	Oceanarium	100	gm/capita/day	160
b	Marine biology research centre	0.2	kg/capita/day	6
c	Internal road / path	10.12	kg/ha/day	2
d	Wooden deck	100	kg/ha/day	26
e	Water pool			
f	Amphitheatre	100	gm/capita/day	100
g	Green and organic cultivation	30	kg/ha/day	9
h	Wooden walkway	10.12	kg/ha/day	4

i	Eco-tents	400	gm/capita/day	27.6
j	Sky bridge	30	kg/ha/day	2
k	Green / landscape	30	kg/ha/day	4
	Total solid waste quantity estimation (kg/day)			**2890**
	Total in TPD			**2.89**

Source: MACE analysis

- The entire solid waste is planned to be collected and treated in the municipal solid waste composting plant within SE-TP, and the occupant units industrial waste (both hazardous and non-hazardous) shall be disposed to a suitable landfill outside the SE-TP;
- Earmarking suitable area for development of composting plant within SE-TP to handle the solid waste generated;
- With the aim of preserving the nature of the Island, it is planned, not to propose the SW dumping and treatment system within the Island; and
- It is suggested to have an efficient collection system within the SE-TP and is recommended to transport the generated SW to the proposed SW dumping yard;
- Based on the discussion with Maheshkhali upazila officials an area of 3 acres of government land is available near to the Ghatibhanga area, from this an area of 1 acre is suggested for the proposed SW dumping yard for the development of SE-TP;
- The detailed project cost for the development of SWM is mentioned on the Annexure 13.

Figure 75: Location map for Solid waste dumping site



Source: MACE analysis

D. Guidelines for effective Solid Waste Management (SWM)

Segregation at source

- It is mandatory to segregate waste at source in order to channelise the waste to wealth by recovery, reuse and recycle. Waste generators should segregate waste into three streams- Biodegradables, Dry

(Plastic, Paper, metal, Wood, etc.) and Domestic Hazardous waste (diapers, napkins, mosquito repellents, cleaning agents etc.) before handing it over to the collector.

- Institutional generators, market associations, event organisers and hotels and restaurants have been directly made responsible for segregation and sorting the waste and manage in partnership with local bodies. In case of an event, or gathering of more than 100 persons at any licensed/ unlicensed place, the organiser will have to ensure segregation of waste at source and handing over of segregated waste to waste collector or agency, as specified by the local authority.
- All hotels and restaurants will also be required to segregate biodegradable waste and set up a system of collection to ensure that such food waste is utilised for composting / bio methanation.

User fees for collection

- The generator will have to pay "User Fee" to the waste collector and a "Spot Fine" for littering and non-segregation, the quantum of which will be decided by the local bodies.
- Rules to be stipulated for zero tolerance for throwing; burning, or burying the solid waste generated on streets, open public spaces outside the generator's premises, or in the drain, or water bodies.

Waste processing and treatment

- It has been advised that the bio-degradable waste should be processed, treated and disposed of through composting or bio-methanation within the premises as far as possible and the residual waste shall be given to the waste collectors or agency as directed by the local authority.

Guidelines for proposing landfill site

- The landfill site shall be 100 metres away from a river, 200 metres from a pond, 500, 200 metres away from highways, habitations, public parks and water supply wells and 20 km away from airports/airbase. Emission standards are completely amended and include parameters for dioxins, furans, reduced limits for particulate matters from 150 to 100 and now 50. Also, the compost standards have been amended to align with Fertiliser Control Order.
- The standard operating procedure, a documentation of the infrastructure required to safeguard the environment from a waste processing industry, has to be compiled by the stakeholders as per relevant rules.

E. Power demand

➲ Construction phase

- The provision of two numbers batching plant, four number bore wells and power requirement for welding and other electrical tools during the construction phase of the project, leads to the power requirement of about 660 KW. The required power demand works out to around 500 Kilo Volts Ampere (KVA) including lighting, considering diversity. Temporary arrangements from the nearest available power source should suffice during the construction phase. Alternatively, by deploying an adequate number of portable/truck-mounted / trailer mounted 415 volts diesel generating (DG) sets of 160 kVA capacities, the construction power requirements are manageable.

➲ Operational and functional phase

- The total estimated demand for proposed SE-TP is 35.76 MVA.

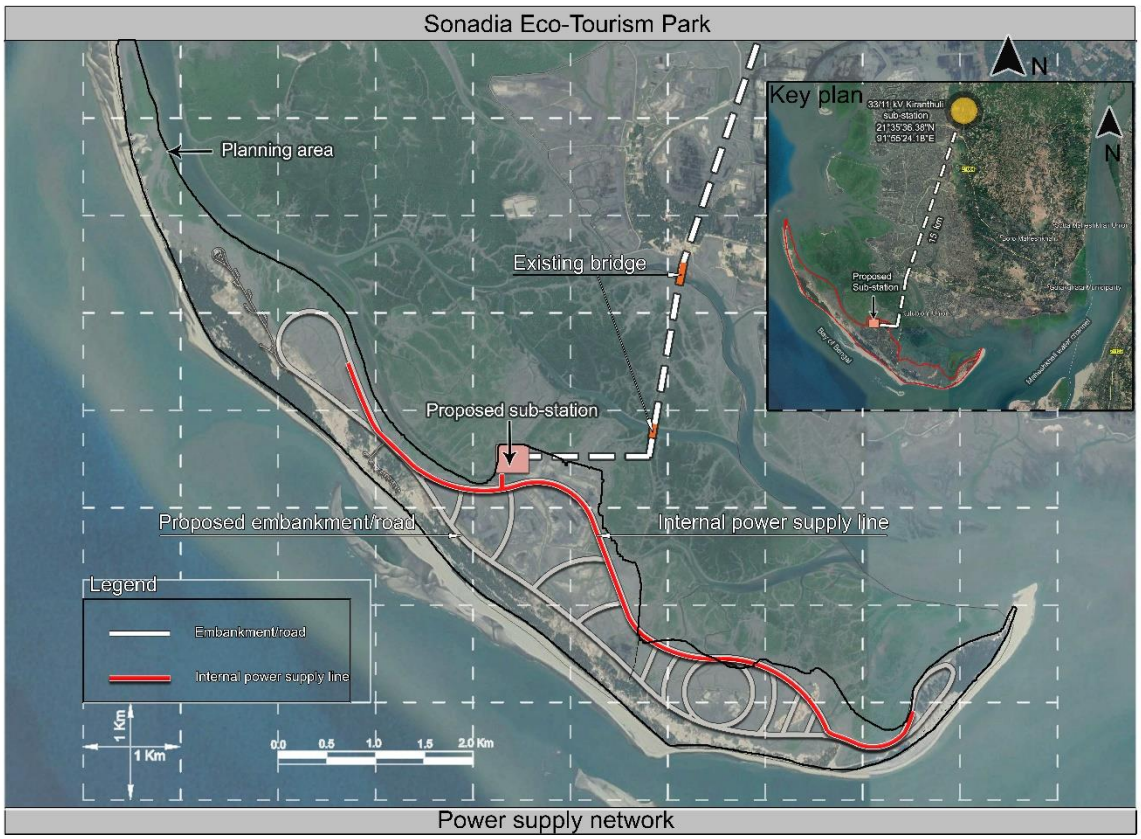
Estimated power demand – zone wise

SI. No	Type of zones	Load in kVA
1	Sonadia Island tourism facilitation development	92
2	Entrance zone	110
3	Heritage and hospitality zone	2,111
4	Knowledge centre zone	409
5	Family entertainment zone	419
6	Adventure zone	1,326
7	Eco science zone	1,845
	Total demand in kVA	**6,312**
	Total demand in mVA	**6.31**

Source: MACE analysis

- The identified source to meet the power demand of SE-TP is Kiranthuli sub-station at a distance of 15km. An exclusive 33/11 kV feeder line from Kiranthuli sub-station is proposed along the existing roads connecting the SE-TP;
- It is planned to establish the proposed 33/11 kV main receiving sub-station at the proposed utility area of SE-TP;
- From the sub-station, the internal distribution line network is planned along 7.5m wide embankment cum road and driveway networks proposed within the SE-TP to feed the individual components.

Figure 76: Internal power distribution network of SE-TP



Source: MACE analysis

Optical fibre cables are available in the region, and the bandwidth available is around 2 mbps;
At present, the internet and telecom services are provided by private telecom subscribers such as Grameen Phone, Bharti Airtel, Banglalink, Teletalk and Robi in this region;
Service by private operators has significantly improved the telecom connectivity in the region;
It is provided to establish the Underground lines in the utility duct proposed along the inner edge of the embankment from which each zone can facilitate it;

Figure 77: Internal telecom network of SE-TP

Source: MACE analysis

➲ **Renewable Energy Hub**

- Provision of at least 10% of the energy used in the project from renewable sources with a long-term strategy to increase the percentage of renewable energy sources;
- Onsite renewable energy:
  - Use of on-site renewable technologies, to minimize environmental impacts associated with the use of fossil fuel energy; and
  - Rooftop solar photovoltaic (PV) panels are one of the proven methods of renewable energy. It has been envisaged to provide such solar PV panels for generating power leveraging the roof spaces available atop the various building.

Summary of renewable energy (roof top solar pv power) – zone wise

Component	Total Built up area (in sq.mt)	Area for Solar panel area (in sq.mt)

Heritage and hospitality zone		
Themed pavilion	2000	1700
Building	8000	5600
Convention centre and MICE	4000	2400
Budget hotel	2400	1440
Resorts and multi-cuisine restaurant	720	432
Knowledge centre zone		
IRC-CoE&IDC	2500	1500
Club house	800	680
Kiosk	294	250
Cottages	715	607
Family entertainment zone		
Multi-cuisine restaurant	500	425
Villas	800	680
Eco science zone		
Oceanarium	9231	1846
Marine biology research centre	2000	1700
Total rooftop area in sq.mt		19,260
Deduct 30% of other equipment		13482
	Area required / kW in Sqm	10
	Solar power generation (in kW)	1348
	Solar power generation (in MW)	**1.3**

10. Social Review

10.1. Introduction

Sonadia Island is a beautiful spot in Cox's Bazar, Bangladesh. The Dwip (Island) lies in Maheshkhali upazila of Cox's Bazar district and is under Kutubjom union which is 9 km away from the Cox's Bazar (Airport). More specifically the island is in the south-eastern region of Bangladesh at 210N and 910E.

This Sonadia Island has the Geo-ecological advantage to develop eco-tourism. It is a paradise for migratory birds with diverse marine life, beautiful sandy soil and plenty of mangroves with tranquil environment.

From the discussion with the local people, it is understood that the Island is originated 125 years ago and is separated into two neighborhoods East and West. There are around two thousand people live in Sonadia Island.

Most of the people lives in Eastern part of the island. The Main occupation of the people are catching fish, gathering of shrimp and other minnows. During winter, Fishermen set up temporary camps on the island and dry sea fishes. Many people work as wage laborers in salt pan and fish pond. More than hundred acres of land are used for salt and shrimp cultivation. Some twenty families have been farming buffalo for generating income and employment.
Some people run their livelihood by driving engine boat, craft, and work as assistance. Some of these people cultivate crops. All the products of daily necessities need to be collected from Maheshkhali.

There are some existing infrastructures such as a primary school, two Mosques, one cyclone centre and about twelve deep tube-wells within the Sonadia Island.

10.1.1. Background

Within the planning area, a Social Impact Assessment (SIA) was conducted. The purpose of SIA is to define the present socio-economic conditions of the people within the project area which will provide sound reference and assess probable socio-economic impact of the proposed interventions. This will enable us to compare the changes and impacts of the project interventions in future.

The SIA helps to identify and assess a project's social impacts that are directly related to the project and propose measures to enhance potential positive impacts and strategies to avoid, manage, mitigate or offset the predicted negative project impacts.

The following sections outline the impact assessment process, including planning, acquiring information about the development which has triggered the assessment, exploring conditions within the relevant locality, identifying the potential social impact and segments of the affected community, consulting with stakeholders, and documentation.

10.1.2. The objective of SIA

The broad aim of the study is to carry out the assessment of needs and social impact review for the proposed Eco-Tourism Park in Sonadia Island.

- To make an inventory of present socio-economic situation to establish the base condition;
- Assessment of the social impacts of the proposed interventions;
- To identify the people's view about the proposed interventions;
- Prepare social management plan.

10.1.3. Approach and methodology of SIA

SIA was carried out in the study area to evaluate the impact that are directly related to the project. It is fundamental to SIA that, in all development projects, the distribution of costs and benefits is not equal across the stakeholder or community.

The multi-disciplined team intensively visited proposed location and had discussion with the community people who are the direct stakeholders. Primary and secondary data have been collected and used to reflect the socio-economic conditions in the project area. Primary data has been collected through communication with the local stakeholders at the village level using structured questionnaire. Secondary data has been procured from Census 2011, of BBS and from concerned Union Parishads as well as from various Government Offices of Upazila and at district level.

The team made several visits to observe & analyse the existing socio-economic situation and community setting scenario. A series of Focus Group Discussions (FGD) sessions have been conducted, and a socio-economic survey has been carried out with the project affected people. Participatory approach was followed for conducting the public consultation meetings. The study team used checklist for conducting the meetings to maintain consistency and relevancy in discussion and recorded the views and perceptions of the participants. The public consultations/FGDs had following objectives in mind:

- Build up awareness among the local people about the project, it's nature and implementation process;
- Facilitate the stakeholder to identify the problems and prospects of the project;
- Identify the conflict of interest and to encourage the local community for participation in the process of planning and implementation;
- Obtain people's views on the impact of proposed interventions;
- Obtain people's suggestions to the enhancement measures of the positive impact; and identify solutions to the apparent problems related to the project;
- Learn the present socio-economic condition and scope of its improvement.

10.2. Socio-economic condition

One of the purposes of SIA is to define the present socio-economic conditions of the people in the project area which will provide sound reference and assess probable socio-economic impact of the proposed interventions. This will enable us to compare the changes and impacts of the project interventions in future.

10.2.1. Administrative units

The project area lies in Maheshkhali upazila of Cox's Bazar district. It is located at the fringe of the Bay of Bengal with an unbroken sea-beach. It became a sub-division in 1854 and was upgraded to a district in 1984. The Maheshkhali Upazila consist of 1 Municipality, 8 Wards (PSA), 28 Mahallas, 8 Unions, 25 Mauzas, 151 Villages.

The survey area is under Kutubjom union which is 15 km. away from the upazila head quarter. Total area of Maheshkhali is 362.18 sq.km with land area is 249.8 sq.km, having 57.47 reserve forest and riverine area is 112.38 sq.km.

Upazila / Thana	1
Union	8
Mauza	25
Village	151
Municipality	1
Area	362.18 km

10.2.2. Location of the project

The Sonadia Island is very close (7.5 km) to Cox's bazar in the northwest direction of Cox's Bazar city, which can be reached through waterway. The total land area demarcated for the proposed Eco-Tourism Park is 8967 acres, the whole of which will be Khas/public land.

The site is at 9 km northwest of the Cox's Bazar International Airport. Cox's Bazar- Chittagong Highway is at a distance of 52 km from the proposed site and is 127 km away from the Chittagong, Business capital of Bangladesh.

Sonadia Island is separated from the mainland by the Maheshkhali channel and from Maheshkhali Island by the Bara Canal. The site's western and southern boundaries are delineated by Sonadia Island and the site's northern boundary by the Vanga Canal, Maheshkhali Island. The eastern boundary follows an earthen embankment

southward until it meets the Ghorokghata road, and from there generally follows the Ghotivanga Mouza boundary.

10.2.3. Archaeological heritage and relics

The tourist come to visit some archaeological heritage/tourist spots like Adinath Temple, Maheshkhali Channel, Sonadia Island, Materbari Power Plant, Battle Leaf, Digital Island, Rakhayin Mandir, Maheshkhali Floating LNG Terminal, Sea Beach, Hill Forest. Salt pan, fish drying mohal and haseh char etc. are the other tourist attracting spots.

10.2.4. Soil and land use condition

The soil of the survey area consists of sediments of sandy clay and sand which spreads along the course of water channels.

The project area is formed due to sedimentation of sand. This Offshore Island is formed in-between the water channels connecting Bay of Bengal. Various channels bring enormous load of sediments to the offshore territory, thereby forming a series of islands in the region.

Beaches, old and new dunes are along the length of Sonadia Island on the seashore side. This class is significant because it provides an excellent staging area and wintering ground for migratory waterfowl & shorebirds and provides nesting grounds for marine turtles.

Sand dunes in this island are so far the largest in Bangladesh that are strong barrier for cyclonic damages, and this features protected Sonadia island from devastating cyclone in the year 1991. People cultivate watermelon in the sand dunes. In recent days, this class is very much significant as the probable development of the largest deep-sea port in Bangladesh was proposed.

Land class: Tidal flats

This land class is found along the periphery of Maheshkhali island, especially outside of the protected Supratidal flat in Maheshkhali, Materbari and both inner and outer side of Sonadia islands. A narrow strip of the intertidal deposits was found in the eastern tidal flat of Maheshkhali Island. Considerable part of Sonadia Island and northwest and northeast of Maheshkhali Island gain huge intertidal flat when compared with the year of 1972 and 1989. Storm surges are the main hazard and causes serious damage in this region.

Land class: Mangrove

Mangrove forests, the natural safeguard of Maheshkhali, are categorized in this class. This land class is sparsely distributed throughout Maheshkhali, but the major portion is present in the Sonadia Island.

Land class: Water body

Major channels, a number of charas, numerous khals and lagoons are grouped under this class. Two major channels, i.e., the Matarbari in the west and the Maheshkhali in the East, connected with several sub-channels and creeks drained through the coastal plain, are tidal in nature.

Although, some salt production fields are converted to shrimp /fish farming and fish drying, eventually increases year to year. Its western coast is sandy and is rich in different kinds of shells.

10.2.5. Population and demography

There are around 58177 households with 5.52 household size found in the Maheshkhali area. The total population is 321,218 and sex ratio (number of males per 100 females) 107 which is slightly higher than national figure (100.3). The population density per square km is 887 in this area which is lower than national figure (976). Bangladesh is considered as one of the highly dense populated country and this area bears the different trend and it is found fifteen percent increment from to 2001 to 2011. The average HH size (5.52) is higher than national figure.

Population	:	321,218
Sex Ratio	:	107
Households (HH)	:	58177
Average HH size	:	5.52
Population density	:	887
Urbanization (%)	:	8.51
Annual growth rate	:	2.24

(Source: Census 2011, BBS). The average household size is found declining trend with minus .4 percent during the last decade. It seems joint family has lost its necessity or individualism is being increased. Urbanization rate is 15.36% which is less than previous census due to change in definition for urban people. (Source Census 2011, BBS)

10.2.6. Demographic profile and settlement history of Project Affected People (PAP)

According to IoL (inventory of losses, 2019) survey, total 395 households having 1762 people are living here. Of the 1762 PAPs, 894 are male and remaining 864 are female. The demographic data indicates that the female constitutes 49% of the total project affected population whereas the male constitutes 51% which is a fair distribution. A decade back, the total population of this island was 1176 from 223 households. This indicates that the population will be doubled within 20 years.

From the discussion had with the local inhabitants, it is understood that there were no settlements within the island during the initial stages. There were only commuters from neighbouring areas such as Matarbari, Bashkhali, Kutubdia and Chittagong for fishing along the coastline. They were using the island to catch fish and taking rest but didn't stayed permanently. A hundred years back, few fishermen began to stay with their families which was the origin for the existing settlements.

Traditional fishing is a profession where man goes to sea for fishing leaving the family in the mainland. Erstwhile island was often somewhat isolated and sited around a small natural harbour which provides haven for a fishermen community. This island naturally facilitates safe way of landing fish and boats.

At present, there are about four hundred families. The polygamy is very common as well as early marriage. These two factors played a significant role for increasing population.

Figure 78: Location of HHs in the effective planning area of Sonadia Island

Entitlements, Assistance and Benefits

As per policy of BEZA, the project affected households (PAHs) are entitled for compensation or at least rehabilitation provisions for losing their accommodation and business. Eligibility to receive compensation and assistance will be limited by the **cut-off date**. The cut-off date for compensation and assistance is considered for those identified at the time of conducting census survey in August 2017. Any households or persons identified on the project site on and before the 25 August, 2017, will be eligible for compensation and assistance from the project. **A census survey was administered (25 August, 2017) by BEZA through structured questionnaire and found 315 families/HHs with a total population of 1218 comprising 50.54 % males and 49.46 % females.** The list of these HHs is affixed at the end of these chapter. Only these **315** families will be compensated.

PAHs who settle in the affected areas after the cut-off date (25 August, 2017) will not be eligible for compensation (here relocation benefit). They, however, will be given sufficient advance notice, requesting to vacate premises and dismantle affected structures erected by them prior to project implementation.

The existing human settlement

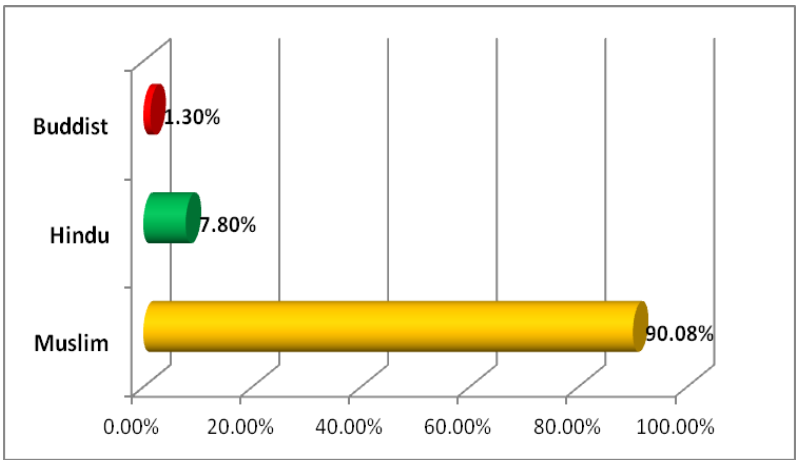
The local people are living in two specific areas. The above map depicts the settlement pattern. There are two villages namely east para and west para which are the initially originated human settlements. Then a kuccha road of approximately three kilometres in length crossing the site was developed. Later, another small dense settlement emerges to the east of east Village/para. This para/village is called Badarkhali where 50 families resides. The dominant para is west para where more than two hundred families reside and rest of families are residing at east para. All these families need to be relocated from the project area to the resettlement site which is proposed far north of the island.

10.2.7. Religion

The Muslim community people (population is 289096) are predominant in Maheshkhali upazila. This is followed by Hindus contributing 7.8% (population is 25055) and other groups are very negligible in percentage. Some 4175 people found Buddhist by faith and there are no Christians. Few ethnic minorities are living.

All 315 families within the Sonadia island are Muslims by religion or faith.

Figure 79: Distribution of community of Maheshkhali upazila



10.2.8. Education

The literacy rate in the Maheshkhali area is around 30.8% (Male 30.5%, Female 31.1%) whereas national figure is 51.8%. School Attendance (5 to 24 years) is around 40.6% in the project area, whereas the national figure is 52.7%. There is 8% increase in literacy rate during last decade. Female are slightly ahead in literacy rate and

school attendance rate is higher than male as well. Opting Higher education by female is very less. The literacy rate in Maheshkhali area is increasing rapidly whereas the literacy situation in the project area is very grave.

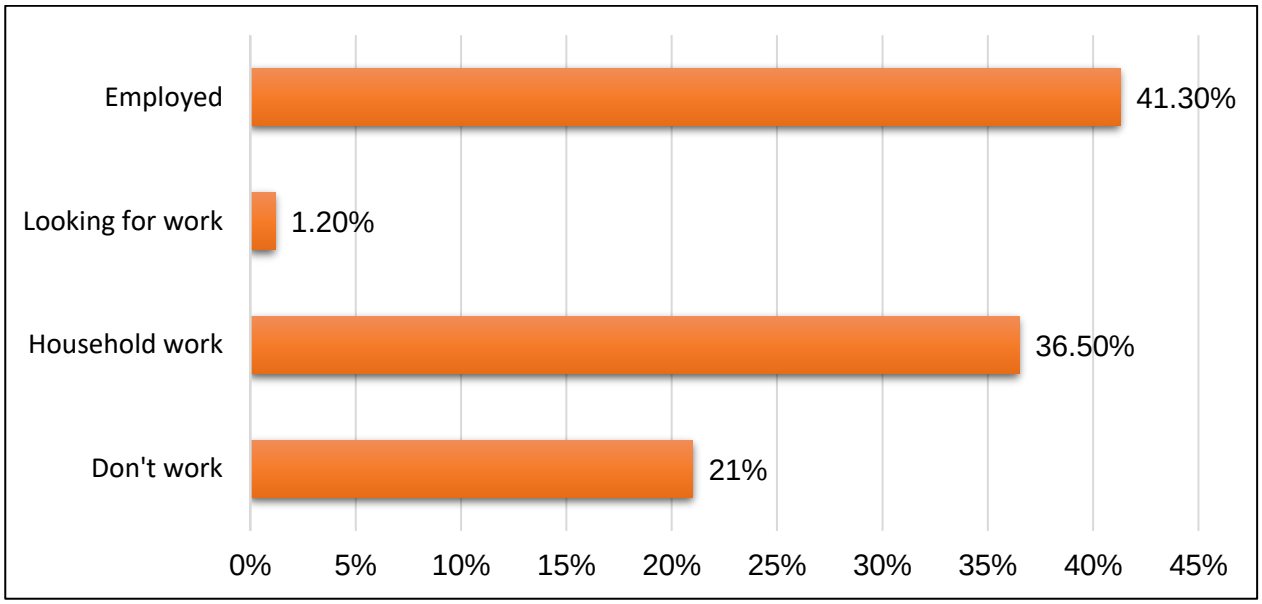
Among the total population in the project area, 2% have achieved secondary level of education whereas 25% of population has achieved primary level of education. Uneducated population comprise of 73% of the total PAPs. The low education levels emphasize the necessity of technical education and skill enhancement programs in the region. At present, only 1 primary school (Sonadia Primary School), 1 NGO run school and 1 madrasa exist in this area for half of the population of Sonadia). The local people are giving less importance on educating their children due to lack of interest and awareness about the importance of education.

10.2.9. Occupation and Economic Wellbeing

According to BBS 2011, 41.30% people of Maheshkhali are employed, and the household work occupied second position (36.5%) where fame are sole dominant. It is unfortunate that 21% people have no work for earning income. Very negligible numbers of women get opportunity in formal sector.

The economy of this upazila is based predominantly on agriculture. People produce varieties of crops, namely, local and HYV rice, wheat, vegetables, spices, cash crops, pulses, betel leaves and others. Various fruits like banana, jackfruit, guava, coconut, etc. are grown. Fish of different varieties abound in this district which enjoys the advantages of marine fishing.

Figure 80: Distribution of percentage of population by employment status



The main occupations of the people are fishing, shrimp cultivation and minnows etc. Fishermen set up temporary camps on the island and dry sea fishes during winter. Many people work as wage labourer in salt pan and fishpond. More than hundreds acre of land used in salt cultivation and simultaneously for shrimp cultivation. Some twenty families have been farming buffalo for generating income and employment. Every winter some of fishermen camp there and make great drag for drying fish.

Doing agriculture is the third dominant occupation, 13% people solely depend on agricultural activities they produce rice and water-melon particularly and work as day labourer in salt production and shrimp cultivation. Most of the profession has seasonality. Few people have engaged with business profession. Some people run their livelihood by driving engine boat and craft and also work as assistance. It is observed that people of teen age are taking fishing as profession without taking basic education.

10.2.10. Health

The participants of FGDs noticed that people suffer from water spreading diseases like diarrhoea, dysentery and cold fever etc. More than 15% of children suffer from those diseases followed by women and old citizens. The

people of the project area generally go to Upazila and District Government Hospital for treatment. The disability status of Maheshkhali is given below.

Table 61: Details of disability status of Maheshkhali Upazila

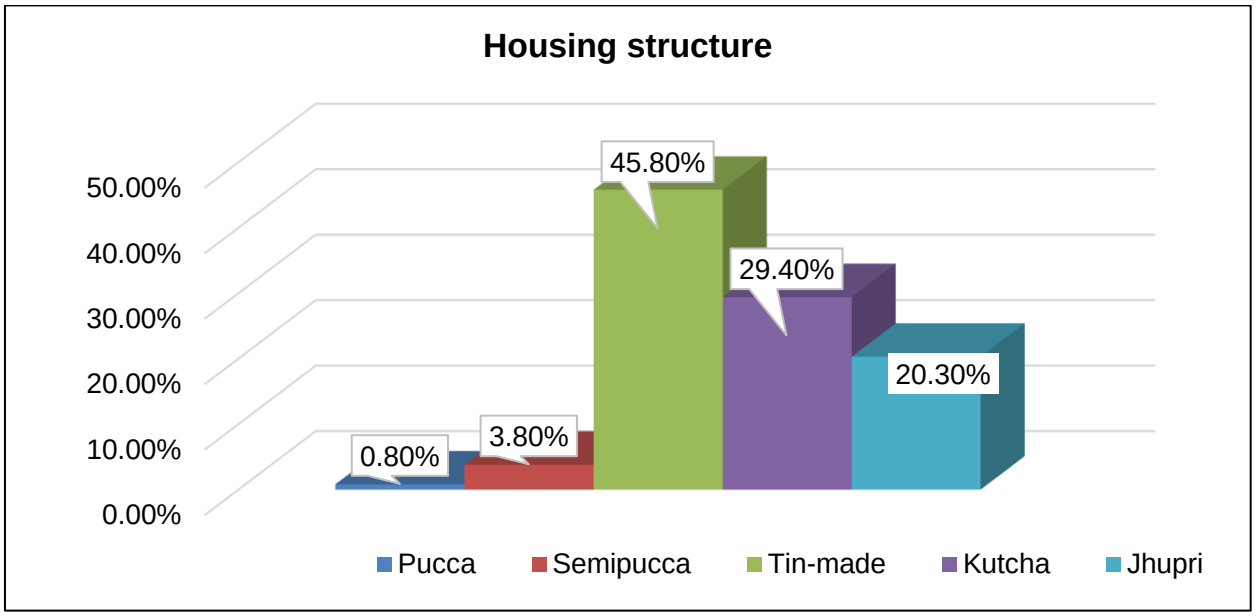
All	Speech	Vision	Hearing	Physical	Mental	Autism
1.4%	0.2%	0.3%	0.1%	0.5%	0.2%	0.1%

There are no health facilities available in Sonadia island. People are going to the nearby hospital located in Maheshkhali (Upazila headquarters) for availing required health services. This hospital holds 50 beds and 4 MBBS doctors.

10.2.11. Residence/housing Structure

According to the IoL survey (Feb 2019), in Sonadia Island, Tin-made (45.80%) houses are predominant which is followed by Kutcha houses (29.40%). The third major type is Jhupri/thatched which contributes 20.30%. The insignificant category is pucca which is only .80% whereas 2.80% of pucca structure are found Upazila level. Only 3 families have built pucca structure. The average size of the residential structure is 300 square feet. 5% people live in a structure which size is below 150 square feet. People have been living here for hundred years and their housing conditions are not in good condition. In urban area Pucca (24%) structure is six times higher than rural area. It is found that 20.30% of people are living in Jhupri.

Figure 81:Distribution of percentage by types of structure of residence



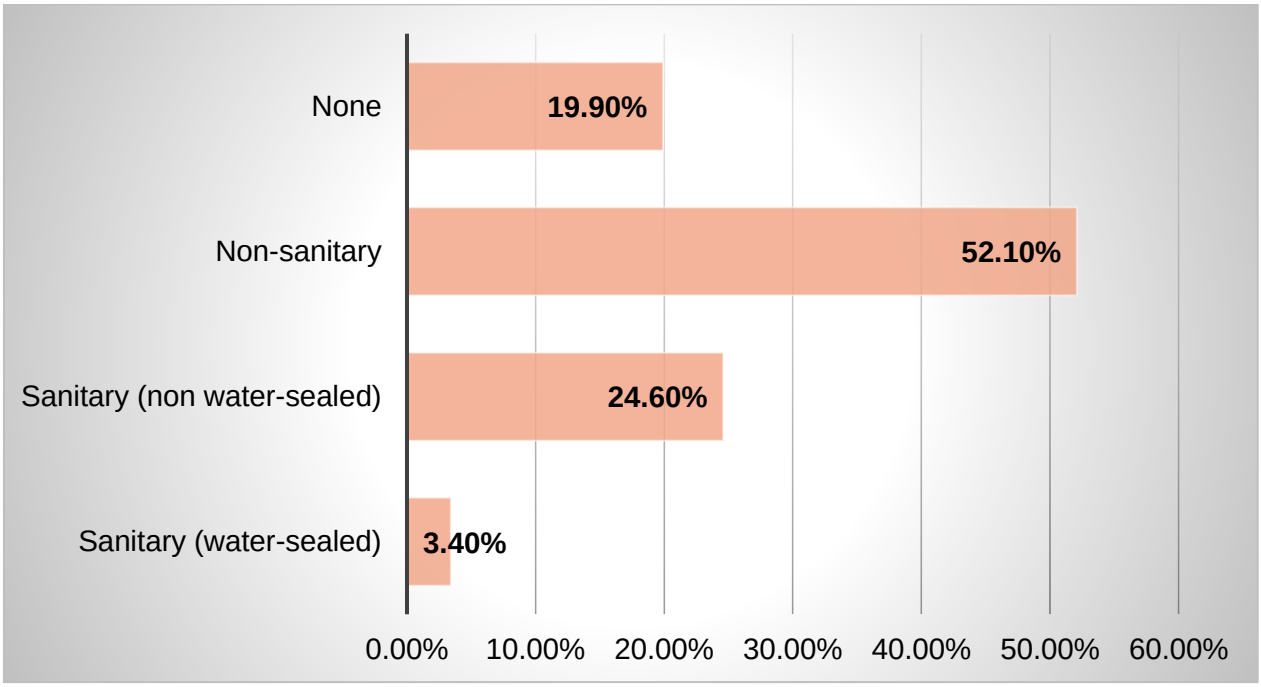
In the project area, 5.5 person live in a household. Sometimes, two or more families share same Jhupri. It seems this shelter is lack of offering minimum comfort. Lack of comfort and basic infrastructure, lack of awareness about the importance of education and lack of security are the three major social issues for the existing inhabitants. Upon Resettling/rehabilitating the people, these issues will be resolved by providing necessary basic facilities and comfortable living condition.

A typical housing structure is depicted in the following picture.

Housing tenancy: All the dwellers of this area resides in own house. Some fishermen will be building temporary structures to stay and dry fishes for 3 to 4 months.

10.2.12. Water and Sanitation

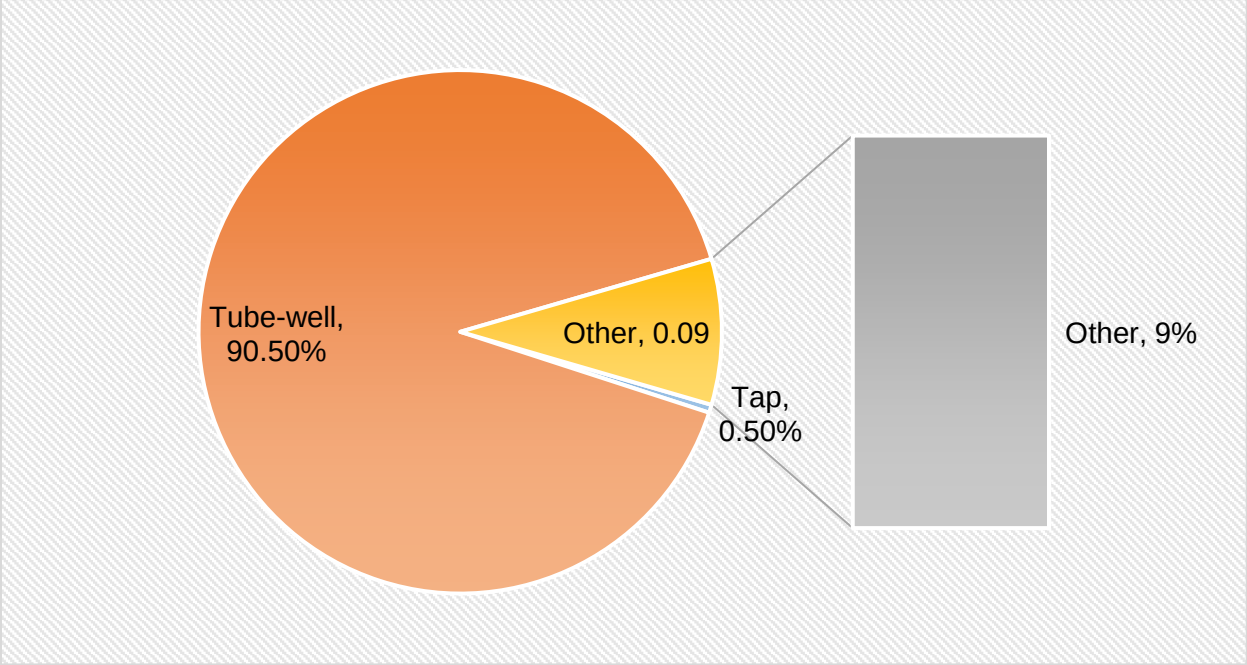
Figure 82: Condition of water and sanitation



The sanitation system is unsatisfactory in the impact influencing zone (Maheshkhali upazila), the majority 52.10% of household use non-sanitary latrine or kutcha latrine which is far over than national figure (35.1%). It is praiseworthy that some 24.60% people use sanitary latrine. People should give more importance on sanitation day by day; the cent percent sanitation program within the country is under progress. Still there is 19.9% HHs have no toilet facilities. (Source: Census, 2011, BBS).

According to the figure below, 90.5% household members of project influence zone drinks tube-well water followed by other water 9.54% (The other source means well, Pond, River, Ditch, Canal water etc., Source: Census, 2011, BBS). The facility of tap water is found basically confined in the urban area. The use of tube-well water is decreasing in urban in the last decade.

Figure 83: Distribution of percentage by sources of drinking water



Tube well is the prime source for drinking water in Sonadia Island. More than 90.0% general households get the facilities of drinking water from tube-well and the remaining household get water from well, Pond, River, Ditch, other sources. During field visit it is observed that water-head of ground water is 4-5 metre from surface. They use this water for generally agriculture as well as for drinking. According to the IoL survey (February 2019) 228 numbers of shallow tube wells are present in the Island. Half of the HHs share this tube-well water with owner. This is the only low-cost source of water. According to local people, a shallow tube-well can be installed with only ten thousand Taka. Even though the water quality is not potable, the local people got habituated.

10.2.13. Electricity

According to population and housing survey (BBS 2011) 36% of household are provided with electricity facilities in the Maheshkhali but no such facility is available in project study area. Almost cent percent people use solar energy and it acts as a common option in remote or char area of Bangladesh. Kerosene still occupies second position. No people/household are using Bio-gas.

10.2.14. Transportation

Waterways acts as a major mode of transportation. Since the Sonadia Island is separated from the mainland by several water channels, boats and fishing trawlers serves as the major commuting modes for many years.

Later, Rural road has been developed and it becomes the main access road connecting the Island. Taxis and auto rickshaws serve as important mode of transport within the Upazila running unto Ghotivanga which is adjacent to the Sonadia Island. Inside the island there is no paved road; only earthen road is the way of access to different village or para. There is no horse/buffalo carriage and bullock cart system within the island. People walk three to four kilometer upto Ghotivanga for availing Rickshaws, Van, Bike & auto-rickshaw, Tempo, Nochimon/korimon/bhotvoti to reach their destinations.

Sonadia Island is sited only 8 km away from Cox's Bazar through waterway. Speed Boats and Trawlers are available to reach the island from Maheshkhali Ghat (Jetty) and Kasturi Ghat of Cox's Bazar. It will take only 20 minutes by speed boat and 35 minutes by trawler.

10.3. Resettlement cost/budget

The resettlement budget includes for housing structure development at relocation site and livelihood restoration program through providing alternative livelihood training and compensation for land, trees, fish stock,

grants/benefits for loss of business, will not be entitled as per policy of BEZA. The budget also kept provision for access road to resettlement site.

sl. no	Category Of Losses	Quantity	Unit Cost (BDT)	Total (BDT)	Comment
1	Cost/Compensation for land			00.00	No private land will acquired
2	Compensation for structure or cost for structure	315 Housing structure	400,000.00	126,000,000.00	Each family will be given a 450 sft. sized structure
3	Compensation for trees			00.00	No private tree will be lost/damaged
4	Access road to resettlement site		lump-sum	20,00,000.00	
5	Livelihood restoration program		lump-sum	15,00,000.00	
	Total			129,500,000.00	

In word: Twelve crore, ninety-five lacs only.

10.4. Stakeholder consultation

As a part of SIA, stakeholder consultation was conducted to assess opinion of local people who will be impacted due to project intervention. Consultations have been conducted by arranging 5 sessions of Focus Group Discussions (FGDs) with local people for assessing their opinion and to share their expectation. Ten Key Informant Interviews (KIIs) were conducted to explore the views of the informants. Consultations were carried out with different stakeholders like Local Government Representatives; local influential people, Fishermen community, women group etc.

10.4.1. Objectives of public consultation

- Learn about the present socio-economic conditions of the study area and its existing scenario, problem, prospect and improvement.
- Try to build up awareness among the local people and society members about the project, its nature and implementation process.
- Encourage the local community to participate in the planning and implementation process.
- Identify and mitigate conflict of interest among the groups.
- Learn about people's participation on the impact of proposed interventions.
- Obtain people's suggestions on the enhancement measures of the positive impact. And identify solutions to the apparent problems related to the project and ideas on mitigating the negative impacts.

10.4.2. Approach of public consultations

A participatory approach was followed for conducting public consultation meetings. The consultant used checklist for conducting the meetings to maintain consistency and relevancy in discussion and recorded the views and perceptions of the participants properly. Socio-economic and some environmental issues have been discussed in detail, including potential impacts of the interventions on environmental and social parameters.

10.4.3. Summary of comments by participants

- If involuntary displacement/resettlement is required, they would prefer to stay within project area close to the first-bridge. Local people are willing to move from the island whenever the relocation site is ready .
- Since some people will lose agricultural land along with their home, they desire to get agricultural land when resettled (if possible).
- PAHs (315 families) demand housing for each family and assistance for livelihood restoration.

- Farmers requested to perform agricultural activities as long as the land keep idle.
- Few people said they have legal ownership over some land, these information need to verified.
- The life of local people is insecure and vulnerable during natural disaster particularly during cyclone. Suggested to take necessary measures for the same (build cyclone centre close to colony/relocated area, construct embankment/dike etc.).
- There are existing infrastructures such as one primary school, two Mosques, one cyclone centre and about twelve deep tube-wells in Sonadia Island. These facilities should be made available upon relocating to the new area.
- People demand adequate livelihood support and income restoration to the affected persons.
- Local people should be given preference during recruitment in civil work of different project implementation activities.
- This island has the geographical advantage for developing fish processing or fish-based industries. People demand to private /public entrepreneur for developing this sector.
- The relocation site should be selected considering the accessibility by both road and water. Most people have to go deep sea or nearby sea for fishing. They need the security for their boat, engine, and fishing based logistic. A relocation site close to river needs to ensure security facilities.
- Sonadia Eco-tourism Park will contribute to economy in three different ways of benefits such as direct, indirect and induced benefits. Local people believe that they will get more employment opportunities and more income generating activities through this project.

Figure 84: KII and Stakeholder consultations

10.5. Social impact

10.5.1. Pre-construction phase

Prior to the implementation of any development the SIA study tries to explore all the possible impacts of a proposed project in advance and suggests mitigation measures and required actions before implementation of the project. Accordingly, it collects baseline or benchmark data on Important Social Components (ISCs). The present study, therefore, selects some ISCs likely to be impacted by the project interventions.

Major impacts at this stage are;

1. Land acquisition and requisitions,
2. People displacement

Impact on land

Now BEZA is the owner of the total Island. The Ministry of land has already handover the land to BEZA. A survey of land ownership on Sonadia Island found 84% of the population were landless, 8% owned between 1-5 acres of land, 8% owned between 6-10 acres of land (DoE, 1998). However officially most land within the site is public (Khas) land and some are owned by the Coastal Forest Department and very small amount of land is privately owned. Accurate information on land tenure (previous) is difficult to obtain.

More than thousand people depend on this for producing crop, fishing, shrimp cultivation and salt production etc. Previously Land use was limited as the site was highly prone to natural disaster. The main activity that has shaped the present condition of the site is the conversion of mangrove and mudflats to shrimp and salt pan farms, which has been occurring since 1970s at Ghotivanga and its adjacent areas. Earthen embankments with sluice gates were created for intertidal exchange of water during the spring tide. Shrimp fry and other aquatic species will be entering the farms along with the tide and will be harvested after a few months. Production was relatively low using this method, but was reasonably environmentally friendly (M.S. Islam, 25 June 2006).

Impact on displacement of affected person

Any development project needs to relocate the existing human settlement within the proposed area for development. According to last IoL survey (Feb 2019), there are totally 315 families living in Sonadia island. There are two villages namely east para and west para which are the initially originated human settlements. Later, another small dense settlement emerges to the east of east Village/para. This para/village is called Badarkhali where 50 families reside. The dominant para is west para where more than two hundred families resides and rest of families are residing in east para. All the household need to be relocated from the project site to the proposed resettlement site situated to the north side of the island. The list of displaced 315 families (name of HHH with identification) are provided in Annexures.

10.5.2. Project intervention phase

During project intervention, the impacted major social components are livelihood/work opportunity, aquaculture and salt farming, shrimp farms, agriculture, fishing & transportation and Land development etc.

10.5.3. Post implementation phase

The long-term impact will take place at post implementation stage. This is mostly as same as implementation stage but in implementation stage the impact will continue for couple of years. The impacts of this stage are Livelihood, Aquaculture (salt farming & Shrimp farms), Agriculture, security and employment generation etc.

Impact on aquaculture (salt & shrimp farming)
Salt farming, Shrimp farmings and Salt pans are common at the site which covers 578 acres. The shrimp farms and salt pans are developed by clearing natural mangroves and converting mudflats and creating embankments. This acts as major economic activity of this island. Earthen embankments with sluice gates are created for intertidal exchange of water during the spring tide. Shrimp fry and other aquatic species entered the farms with the tide and were harvested after a few months. Some influential business man of outside the island involved with the salt and shrimp farming. But the activities such as clearance of mangroves and conversion of mudflats for shrimp cultivation affects the natural ecosystem of the environment within the Island which should not be encouraged.

Impact on agriculture
The main agricultural activities practiced in Sonadia Island is homestead gardening which includes Watermelon, Jujubi, Screw pine, Cucumber, Oil seed and planted Aman rice. From the IoL survey it is observed that 13% families solely depend on agriculture activities. Previously Land use was limited as the site is prone to natural disasters. 50 families depend on agriculture in 300 acre (approximately) of farm land and the average land holding size is 5-10 acre per family. Similar amount of land is used as grazing ground for cow, goat and sheep. Upon terminating these activities, the entire 50 family members will lose their livelihood. Hence, along with the resettlement, the rehabilitation needs to be considered for the affected people.

Impact on livelihood
The livelihood of 80% people depends on fishing. The fishermen who catch fish in deep sea or off shore may not be affected if they are rehabilitated properly but the fishermen who are depending on fishing in mangrove-fringed canals, creeks and mudflats of the site will be affected. Many people (both men and women) catching fish, gathering of shrimp, some outsider people came here in winter, build camps for the marine and coastal fisheries. After harvesting, marine fish is Sun-dried. The seasonal workers cut mangroves for fuelwood during their stay and to take back to their villages at the end of the season. Invertebrates such as Mollusca shells are collected from the beach at Sonadia Island, mostly by women and children. Collections are stored at homesteads until obtaining permit to transport to Ghotivanga for selling them.

More than hundred acres of land used in salt cultivation and simultaneously for shrimp cultivation. Many people work as wage laborers in salt pan and fish pond. Some twenty families have been farming buffalo for generating income and employment. Some people run their livelihood by driving engine boat and craft and work as assistance.

Employment generation
It is expected that if the eco-tourism park is developed in Sonadia Island, employment on tourism related business will be created. Local people will get more opportunity to involve in the profession. Tourism sector is a labour-intensive sector. Many tourism related business will be explored where many income generating activities will be created.

10.5.4. Impact Assessment Matrix

Table 62: Impact assessment matrix

ISCs	FWOP Condition *(Future without project)*	FWIP condition *(Future with project)*	Impact
Land acquisition	There will be no impact on land acquisition if the project is not implemented.	Acquisition of land will be required to establish the eco-tourism park. BEZA has already acquired 10,000 acres of land.	(-) 2
People displacement	In future without project, there will not be any displacement/Rehabilitation of inhabitants from their settlement.	In total 315 families having 1762 people living in project area needs to be rehabilitated and the nature will be involuntary. They are ready to relocate if necessary, compensation is granted and properly rehabilitated.	(-) 4

ISCs	FWOP Condition *(Future without project)*	FWIP condition *(Future with project)*	Impact
Aquaculture (salt & shrimp farming)	There will be no impact on salt & shrimp farming if the project is not implemented rather it will increase.	Aquaculture is the main economic activity inside the island. More than 500 acres of land is used, and hundreds of laborers involved in this sector. The future of this sector may get affected.	(-) 3
Livelihood	There will be no impact on livelihood if the project is not implemented. It is expected that the situation would be improved if skilled people with modern technologies are used in fishing profession.	The implementation of project will hamper the existing livelihood practice. Catching fish, gathering of shrimp, drying fish, livestock raising, wage labouring in salt & shrimp farming may not be possible. A laborer can earn BDT. 8000-10000 per month.	(-) 3
Agriculture	In future without project, the situation would be better at present.	Since all the crop field/arable land is already acquired for the project; farmer will not get opportunity for doing agricultural activities. Hence, Livelihood restoration for farmer is required.	(-) 2
Transportation	In future without project, the present situation will remain be same.	The implementation of project will facilitate better transportation infrastructure facilities and connectivity. Local people will enjoy faster and easier movement to the important places.	(+) 4
Employment generation/Work Opportunity	Work opportunity will remain same or may be reduced without project condition if more people would migrate from neighbouring areas.	Implementation of the project would generate some direct employment in this area. More labour force will be required in eco-tourism business. Womenfolk get opportunity in Income Generating Activities (IGA). Economic development would be flourished in three different ways of benefits such as direct, indirect and induced benefit.	(+) 4
Security (Law and order)	In future without project, the situation would be worse than present.	Unfortunately, there are different pirates (sea rover) staying/working here. They are involving in criminal activity by looting from other boats or trawlers. This situation will be changed as security system will be deployed here if the park is developed.	(+) 4
Legends			
+1 = Insignificant beneficial impact **+2 = Slight beneficial impact** **+3 = Moderate beneficial impact** **+4 = Significant beneficial impact** **+5 = Very Significant beneficial impact** **0 = No impact**		-1 = Insignificant adverse impact -2 = Slight adverse impact -3 = Moderate adverse impact -4 = Significant adverse impact -5 = Very significant adverse impact 0 = No impact	

10.6. Social Management Plan (SMP)

10.6.1. General Considerations for SMP and System

Social Management Plan (SMP) has been prepared for all the identified social impacts during pre-construction, construction and O/M stages as to be caused by various project activities and associated developments.

The methodology to be followed for preparing the social management plan and corresponding systems will consist of the following steps:

- Identification of key social impacts to be caused by the project.
- Deriving mitigation/protection measures for identified impacts of each project activities.
- Recommendation of mitigation, compensation and enhancement for each of the identified impacts and risks.
- Developing and clarifying the mechanism for monitoring the proposed mitigation measures.
- Identifying responsibilities of various agencies involved in project implementation and monitoring for adoption of mitigation measures.
- Description of the institutional set-up.

10.6.2. Social Management Action Plan

Table 63: Social management action plan

Social impact / issue	Mitigation/ enhancement measures	Location	Timing	Responsible organisation	
				Implementation	Supervision / monitoring
Land Acquisition	All necessary land acquisition process is completed in accordance with existing rules.	The proposed project area.	Before the commencement of construction.	DC office & BEZA	BEZA
People displacement	Providing them resettlement assistances or rehabilitation in a proposed relocation site	Proposed relocation/ rehabilitation site is inside the island.	Before the commencement of construction.	DC office & BEZA	BEZA
Aquaculture (salt & shrimp farming)	They can be allocated (leased) with similar kind of land if land is available inside the island.	Inside the project area	During and after commencement of construction.	BEZA	BEZA
Livelihood	Livelihood restoration program need to be developed and implemented.	Inside the project area	Before the commencement of construction	NGO	BEZA
Agriculture	Since there is no scarcity of land in this island, identification of land for agriculture is the solution. The identified area should be fertile enough which	Adjacent to park (inside the island)	After commencement of the project	BEZA/ Contractor	BEZA

Social impact / issue	Mitigation/ enhancement measures	Location	Timing	Responsible organisation	
				Implementation	Supervision / monitoring
	would act as food surplus zone.				
Transportation	Give the APs/ relocated people access to transportation facilities developed for SETP.	Inside the project area	Post implementation	Contractor	BEZA
Employment generation/ Work opportunity	Giving priority for local people to fetch employment in tourism business and related employment opportunities.	Inside or outside the project area.	During and after commencement of the project	Business community	BEZA
Security (law and Oder)	Enhance & link them with law and enforcing agency.	GoB	After commencement of the project	Law enforcing agency	BEZA

10.7. Livelihood Restoration and Training

Since physical and economic displacement cannot be avoided, an alternative livelihood restoration is required. The aim of this section is to provide a detailed plan to provide livelihood restoration strategy and options for the people affected due to physical and economic displacement and identify feasible livelihood restoration options and alternative economic activities that can be facilitated.

This proposed Economic Zone requires 315 families to be relocated. The main occupations of the PAPs are fishing, about 85% people are engaged in marine fishing and fish related occupation like shrimp cultivation and minnows etc. livelihood of some people depend on net making and repairing. Fishermen set up temporary camps on the island and dry sea fishes during winter. He second dominant (8%) occupation is business. Some people work as wage labourer in salt pan and fish pond. Some twenty families have been farming buffalo for generating income and employment. Women work force are confined in household activities inside the domestic level.

For livelihood restoration, the project is concern who will be economically displaced.

10.7.1. Requirement of Training

It is now widely accepted that promotion of large number of livelihoods required to develop practical skills. Only 50% respondents called for training. They require the training from two points of view;

1) To increase skill for better performing of existing livelihood; and
2) To involve in alternative livelihoods.

In terms of livelihood replacement, the substitution of a new type of livelihood for an existing one should only be considered when there is no feasible way of restoring the existing means of livelihood. People are interested to get training on very limited skill. The list of training is very limited and most of them are related to fishing. The following list show the name of training they wanted to be trained

Name of Training

1. Training on modern fishing and fishing equipment technology;
2. Training on Tourism Services & Tourism Management;
3. Training on fish processing and fish drying;
4. Training on Poultries and domestic animal farming;
5. Mobile servicing.

Budget for training: A lump-sum budget (BDT 15,00,000.00) is allocated for conducting training for livelihood restoration. This budget will be distributed equally among the following five types of training course e.g., 1) Training on modern fishing and fishing equipment technology; 2) Training on Tourism Services & Tourism Management; 3) Training on fish processing and fish drying; 4) Training on Poultries and domestic animal farming; 5) Mobile servicing.

11. Environmental Review

11.1. Purpose and objectives

The environmental review has been undertaken with the following objectives:

- To facilitate an understanding of the elements of the existing baseline conditions of project's area of influence;
- To identify the aspects of the project likely to result in significant impacts to environmental resources/receptors;
- To analyse and map relevant stakeholders involved in the project;
- To predict the significance of the impacts of the project;
- To develop an understanding for the management and monitoring of impacts; and
- Preparation of Environmental Management Plan (EMP)

11.2. Methodology of environmental review

The methodology for the environmental review of proposed project area are portrayed below:

- Review and identification of applicable local, National and International Environmental and social regulatory and Institutional frame work.
- Establishment of baseline conditions of the site and surrounding area through the following:
  - To observe environment and social characteristics of Sonadia Island area through detailed survey.
  - Consultation with the stakeholders during planning construction and operation phase of Sonadia Eco-tourism Park.
  - Baseline data collection of the site and project area with respect to ambient air and noise quality etc.,
  - Ecological assessment on flora and fauna of the project area through secondary data collection.
  - Assessment of the socio-economic environment through collation of secondary information of the site, supplemented by consultations with the local communities to understand community perception with regard to the project and its activities;
- Impact assessment and mitigation measures for environmental component for construction and operation phases. To minimize the adverse impacts mitigations measures will also be suggested
- Development of Environmental Management Action Plan which includes the following:
  - Mitigations for adverse environmental impacts and associated risks;
  - Institutional arrangement- Management tools and technique for the implementation of Environmental Impact and risk mitigations.
  - Monitoring arrangements for effective implementation of suggested mitigations for the proposed Sonadia Eco-tourism Park.

11.3. Overview of environmental legal, regulatory and policy requirements for the project (GoB, WB etc.)

This section highlights the regulatory requirement set out by Government of Bangladesh (GoB) and World Bank (WB) in relation to protection of environment and its resources as well as protection of the social environment from adverse impacts associated with the project development. These requirements are summarized below.

Table 64:Overview of environmental legal, regulatory and policy requirements

Name	Key requirement	Applicability	Remarks
Acts / Rules			
The Environment Conservation Act, 1995 and subsequent amendments in 2000, 2002 and 2010	Mandatory requirement of prior environment clearance for certain category of project for conservation and improvement of environment and control and mitigation of pollution of the environment.	Applicable. The project is classified under red category EIA study required to be undertaken	Site approval certificate is to be obtained from DoE
Environment Conservation Rules, 1997 (Subsequent Amendments in 2002 and 2003)	To ascertain responsibility for compensation in case of damage to ecosystem. Restriction on polluting automobiles, sale and production of environmental harmful items. Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes. Declaration of ecologically critical areas Promulgation of standard limit for discharging and emitting waste. Formulation and declaration of environmental guidelines.		
Environment Court Act, 2000 and subsequent amendments in 2002	To give high priority to environment pollution prevention.	Applicable as the project shall have environmental impacts	All the developments to be carried out as per ECR, 1997 and amendments.
The Private Forests Ordinance Act, 1959	Conservation of private forests and for the forestation on wastelands.	Applicable as the tree cutting is involved in development of off- site facilities	Tree cutting to be carried out after taking permission from Regional Forest Officer, Forest Department
The Protection and Conservation of Fish	Prohibit or regulate the construction, temporary or	Applicable. The project involves	Necessary permission would need to be taken for construction
Act, 1950 and subsequent amendments in 1982	Permanent of weirs, dams, bonds, embankment and other structures	construction of super dyke and other structures.	of super dyke and other structures
Water Pollution Control Ordinance 1970	Prevention of water pollution.	Applicable from the prospective of prevention of pollution	Applicable during both construction stage C e.g. sewage and equipment washing and maintenance liquid waste discharges

Name	Key requirement	Applicability	Remarks
			at construction camps) and operation phase
The ground Water Management Ordinance 1985	Management of Ground Water Resources. Tube well shall not be dug in any place without permission from Upazila parishad.	Applicable. 3-4 nos. bore wells will be dug to develop water supply system during initial phase	Permission should be taken before digging tube wells
The Embankment and Drainage Act 1952	An Act to consolidate the laws relating to embankment and drainage and to make better provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion and other damage by water.	Applicable. The project proposes construction of embankment i.e. super dyke.	Regulatory authority Ministry of Water Resources and FCD
Wetland Protection Act 2000	Adhere to a formal environmental impact assessment (EIA) process, as set out in ETA guidelines and manuals for water sector projects or related to alteration of natural drainage. No construction of roads if likely to affect the flow of navigable water ways without clearance from concerned authorities Upland flow in water channels to preserve eco-system Protection against degradation and resuscitation of natural water-bodies such as lakes, ponds, beels, khals, tanks, etc. affected by manmade interventions or other causes. Completely stop the filling of publicly-owned water bodies and depressions in urban areas for preservation of the natural aquifers and environment. Stop unplanned construction on riverbanks and indiscriminate clearance of vegetation on newly accreted land.	Applicable. The proposed site is located entirely in the submerged area.	Permission to be taken from the Ministry of Water Resources and DOE

Name	Key requirement	Applicability	Remarks
The Building Construction Act 1952 (with latest amendment 2006)	An Act to provide for the prevention of haphazard construction of building and excavation of tanks which are likely to interfere with the planning of certain areas in Bangladesh	Applicable as the project involves development of infrastructure	Regulatory authority is Ministry of Works
The Vehicle Act, 1927 The Motor Vehicles Ordinance, 1983 The Bengal Motor Vehicle Rules, 1940	To regulate vehicular exhaust emissions	Applicable as heavy vehicle movement is involved both during construction and operation phase	Regular maintenance and up keeping of the vehicles should be carried out. Regulatory authority is Bangladesh Road Transport Authority
The Factories Act, 1965 Bangladesh Labour Law 2006, amendment 2013 Bangladesh Labour Rules 2015	This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions.	Applicable as the workers will be employed during construction and operation phase	Regulatory authority is Ministry of labour
Policies			
National Environment Policy, 1992	For sustainable development	Applicable for all development projects	Usage of energy efficient building material, fuel etc. should be encouraged
National Environment Management Action Plan 1995	Conservation of natural habitats, bio-diversity, energy, sustainable development and improvement of life of people	Applicable for all development projects	Usage of energy efficient material, green building techniques, reduction of carbon foot prints etc.
National Conservation Strategy	Sustainable development of Industrial Sector	Applicable for all development projects	Usage of energy efficient material, green building techniques, reduction of carbon foot prints etc.
The National Energy Policy, 1995	Protecting the environment by requiring an ETA for any new energy development project, introduction of economically viable and environment friendly technology.	Applicable. ETA study is to be carried out	Energy efficient materials and techniques should be explored
The National Water Policy, 2000	To ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management	Applicable. Ground and surface water is required to be withdrawn for fulfilling water requirement	Conjunctive use of water should be explored

Name	Key requirement	Applicability	Remarks
The National Water Management Plan, 2001	Addresses options for water quality, considerations behind measures to clean up industrial pollution, where effluent discharge monitoring and zoning regulations for new industries are emphasized	Applicable as the proposed development will involve generation of sewage	Installation of sewage treatment facility within the premises
World Bank's safeguards			
OP 4.01 Environmental Assessment	Ensures sustainability and environmental feasibility of the project. Projects are classified into A, B & C category depending on the nature and extent of the impact	Triggered	Project classified as Category A considering impacts of project

Source: *MACE analysis*

11.3.1. Project specific regulations

The project specific regulations considered while preparing the master plan of the Sonadia Eco-tourism park are discussed below.

As per the coastal regulations, following guidelines have been adhered while planning the eco-tourism park.

Table 65: Coastal regulations

S.No	Component	Classification	Regulations to be followed
1)	Mangroves	Ecologically sensitive area (CRZ I-A)	Generally, no activities shall be permitted to be carried out in the CRZ-I A area, with following exceptions: 1) Eco-tourism activities such as mangrove walks, tree huts, nature trails, etc., are permissible subjected to consultative process, public hearing, etc., and further subject to environmental safeguards and precautions. 2) If area is more than 1000 square meters, a buffer of 50 meters along the mangroves shall be provided and such area shall also constitute CRZ–I. 3) Permitted activities within the Mangrove buffer- laying of pipelines, transmission lines, conveyance systems or mechanisms and construction of road on stilts, etc., that are required for public utilities.
2)	Sand dunes	Ecologically sensitive area (CRZ I-A)	
3)	Biologically active mudflats	Ecologically sensitive area (CRZ I-A)	
4)	Turtle nesting grounds	Ecologically sensitive area (CRZ I-A)	
5)	Horse shoe crabs' habitats;	Ecologically sensitive area (CRZ I-A)	
6)	Sea grass beds	Ecologically sensitive area (CRZ I-A)	
7)	Nesting grounds of birds	Ecologically sensitive area (CRZ I-A)	

11.3.2. Basis for demarcation of buffer zone for birds gathering spots

There are no specific guidelines available to adopt the buffer to be provided for migratory bird's gathering spots such as nesting and feeding ground. Hence, the case study of Sultanpur National park of Delhi (where there are lot of migratory birds and bio-diversities exists) has been considered from which it is found that "Construction of any building with more than 2 floors are not permitted within 300 m-500 m area from the boundary of protected area" and the area within 300 m, no construction of any kind will be allowed (*Reference: Guidelines for declaration of Eco-sensitive zones around national parks and wild life sanctuaries by Ministry of Environment and forests, Government of India*). This regulation has been adopted while preparing the master plan of Sonadia Eco-tourism park and accordingly suitable buffer has been provided from the birds nesting and feeding ground.

As per the guideline, Construction of hotels and resorts are permitted in the zone if the Master plan takes care of habitats allowing no restriction on movement of wild animals. The activities related to tourism like over-flying the Eco-sensitive area through any aircraft, air balloons etc., are strictly prohibited. Whereas in the Sonadia Eco-tourism park, the proposed Master Plan adhered to the regulation and is to be noted that the proposed helipad within the park is only for emergency evacuation.

11.3.3. Basis for demarcation of buffer zone for turtles nesting spots

As mentioned in the above table, turtles nesting spots along the seashore falls under CRZ I-A classification wherein no activities shall be permitted to be carried out. This has been adhered in the proposed Master plan. Hence accordingly, the entire coastal stretch has been declared as buffer zone wherein no components or activities are proposed and is considered as no development zone/restricted zone.

11.4. Project description

Government of Bangladesh (GoB) has decided to maximize the potential impacts through a more modern regime of Economic Zones (EZ's) including Tourism SEZ and has formulated Bangladesh Economic Zone Authority (BEZA) to execute the same.

In August 2010, the Economic Zone Act was passed in Parliament providing the overall framework for establishing EZs throughout Bangladesh. Under this Act, the Economic Zone Authority (BEZA) was established under the Prime Minister's Office and governed by a board chaired by the Prime Minister. The law provides the legal coverage for attracting and leveraging private investment in the development of economic zones as zone developers or operators, and in the provision of providing infrastructure services, such as connecting roads, power, water supply, wastewater treatment etc. The law also allows for development of SEZs and support infrastructure through a Public-Private Partnership (PPP) mechanism.

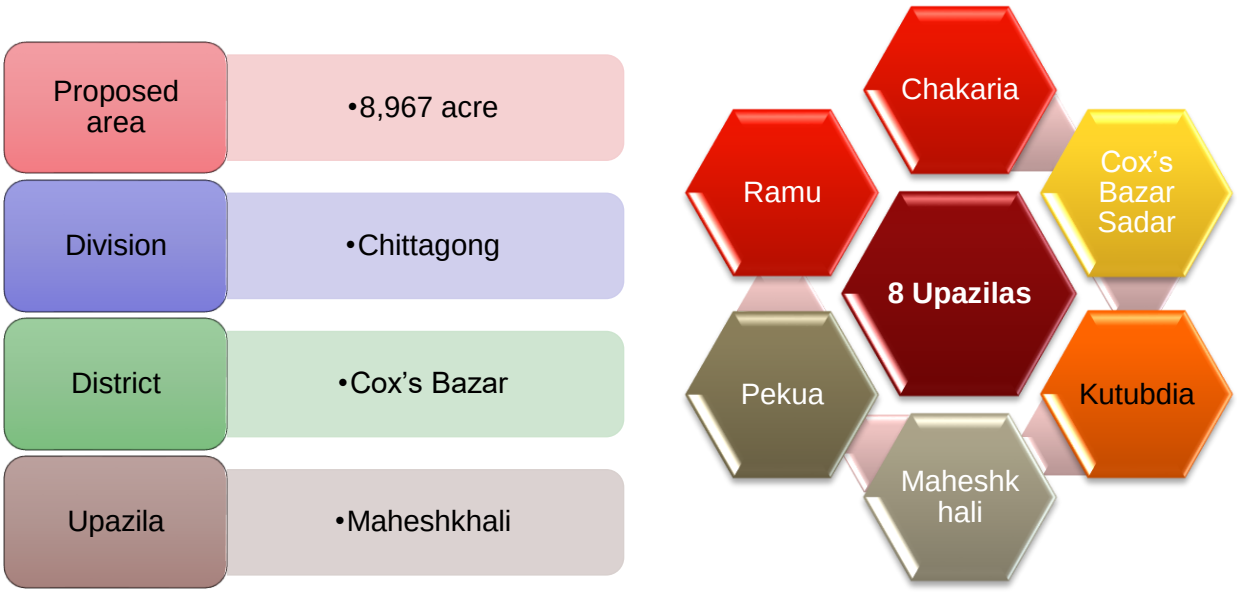
As a part of establishing Tourism SEZ, BEZA has appointed Mahindra Consulting Engineers Limited (MACE), Chennai, India and Dev Consultants Limited (DevCon), Bangladesh in joint venture to provide consultancy services for the preparation of detailed master plan for Sonadia eco-tourism park" which is one of the biggest Tourism SEZ to be supported by BEZA. The proposed project site is located at 3 km north of Cox's Bazar under Maheshkhali Upazila which is, a large-scale tourism development will be containing both public and private investment. This proposed eco-tourism park will have different tourism related facilities.

11.5. Baseline data

11.5.1. Location and study area

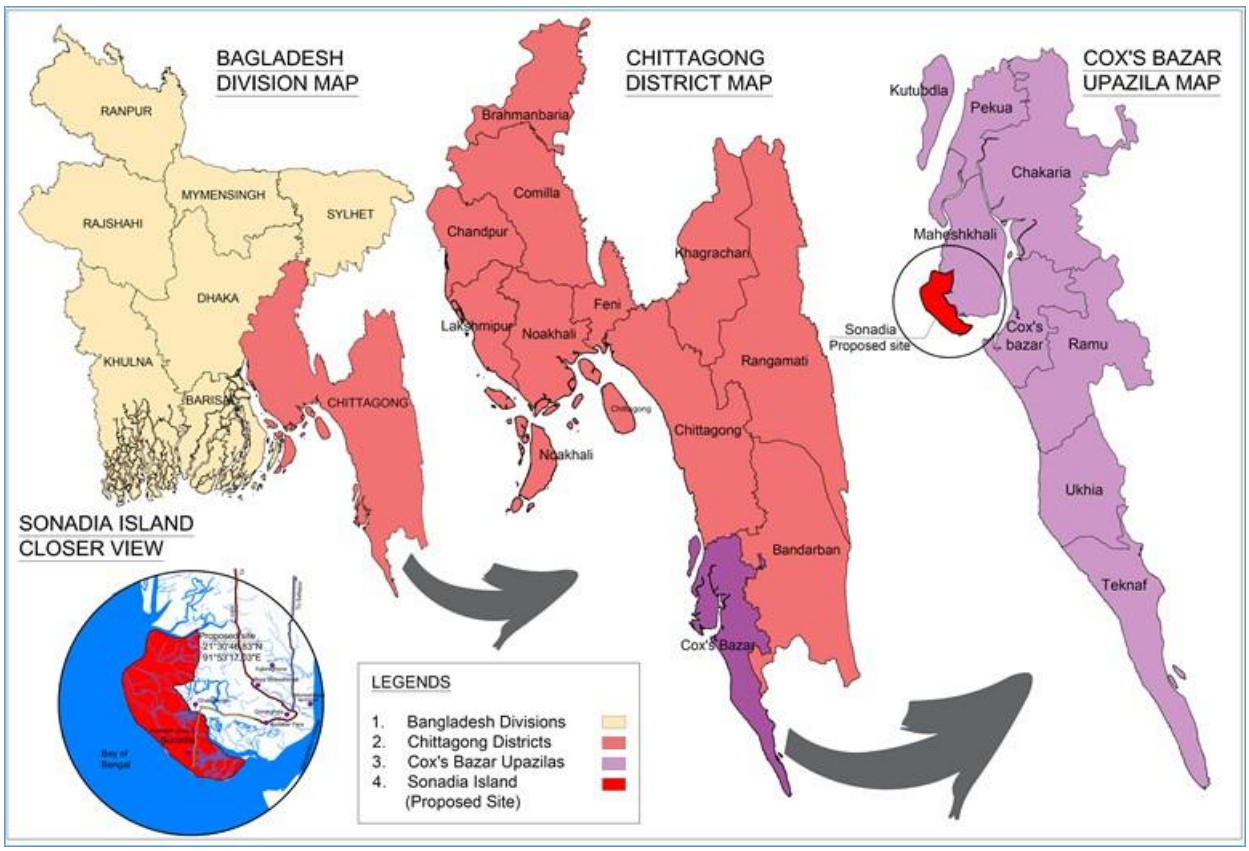
Sonadia Island is located at Maheshkhali Upazila of Cox's Bazar district which spreads in the north-west region of Cox's Bazar District**.** The regional setting of Cox's Bazar is depicted below

Figure 85: Regional setting of Cox's Bazar



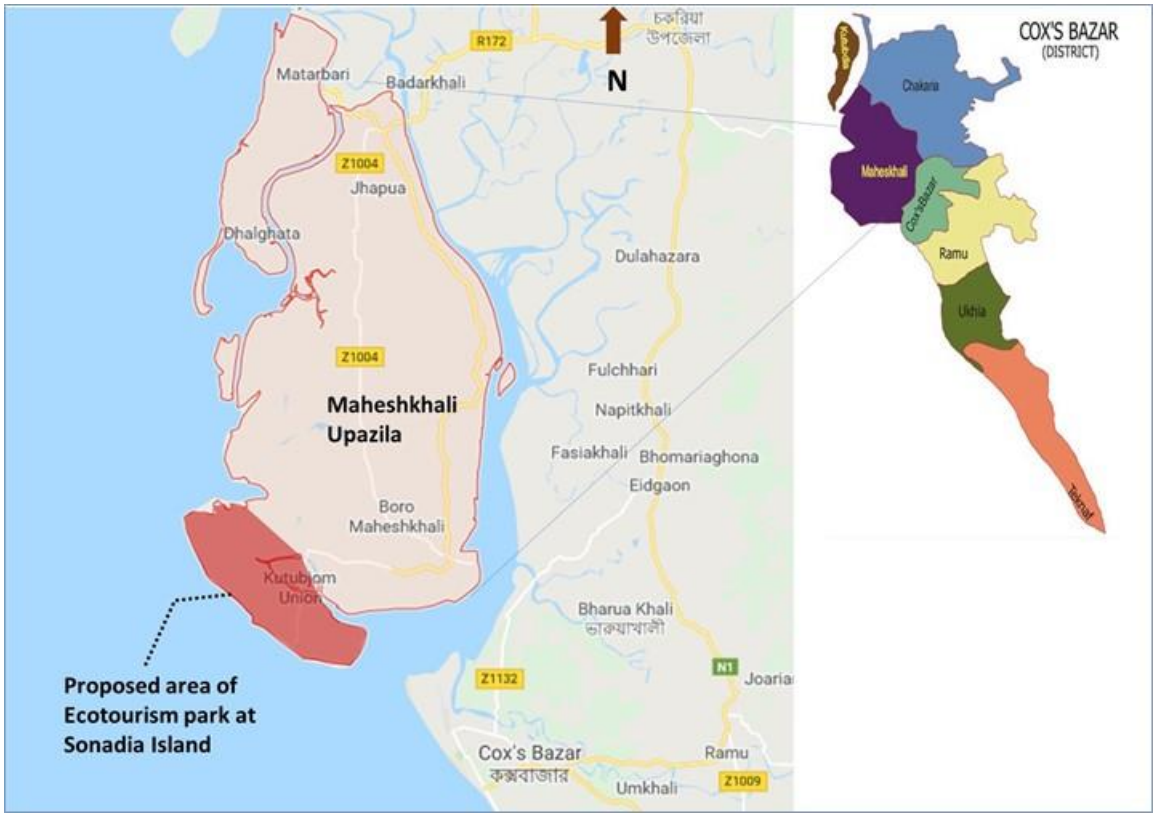
Source: *Statistical Handbook, 2016, Pg. No. 33*

Figure 86: Regional setting



Source: *MACE analysis*

Figure 87: Location Map



Source: *MACE analysis*

The Cox's Bazar district is dominantly known to be a potential tourist center with rich gift of nature within the southeast region of the country. The district resides on the coastal belt, which is bounded on the north by Chittagong district, on the east by Bandarban and Myanmar, on the south and on the west by the Bay of Bengal. It lies between 20°43' and 21°56' North latitudes and between 91°50' and 92°23' East longitudes. It is located 150 kilometers south of Chittagong. The district consists of 8 upazilas, 71 unions, 177 mauzas, 989 villages, 4 paurashavas, 39 wards and 164 mahallas. And it spreads over total area of about 2,491.85 Sq.km of which 940.58 sq. km is under forest.

In the national context, Cox's Bazar region is important for the natural attributes primarily including the sea beach and ranges of hills run parallel to the beach, which attracts millions of tourists every year. The nation can gain economically from a developed tourism industry. There are port activities, which have already been developed under private sector initiatives. Several off-shore islands reside in the Cox's Bazar district which are also prospective of tourism activities. The list includes Maheshkhali, Kutubdia, Matarbadi, Sonadia, Shah Pari and St. Martin or Jinjira as primary. This district can attract tourists from both the regions and all over the world. The baseline information of the upazilas in Cox's Bazar district is tabulated below.

Table 66: Sub-district baseline information

Sub-District (Upazila)	Total area Sq. Km	Reserve forest Sq. Km	Riverine area Sq. Km	Union	Mouza	Village	River
Cox's Bazar Sadar	228.23	-	3.50	10	18	163	Bakkhali
Chakaria	643.46	136.25	40.47	20	66	335	No
Kutubdia	215.80	-	-	6	9	30	No
Maheshkhali	362.18	-	112.38	9	31	170	Bakkhali & Maheshkhali channel
Ramu	391.71	145.29	-	11	39	101	No
Teknaf	388.68	159.80	1.36	6	13	131	Naf
Ukhia	261.80	155.14	0.91	5	13	54	Naf
Pekua	139.68	2.25	2.02	7	11	63	No

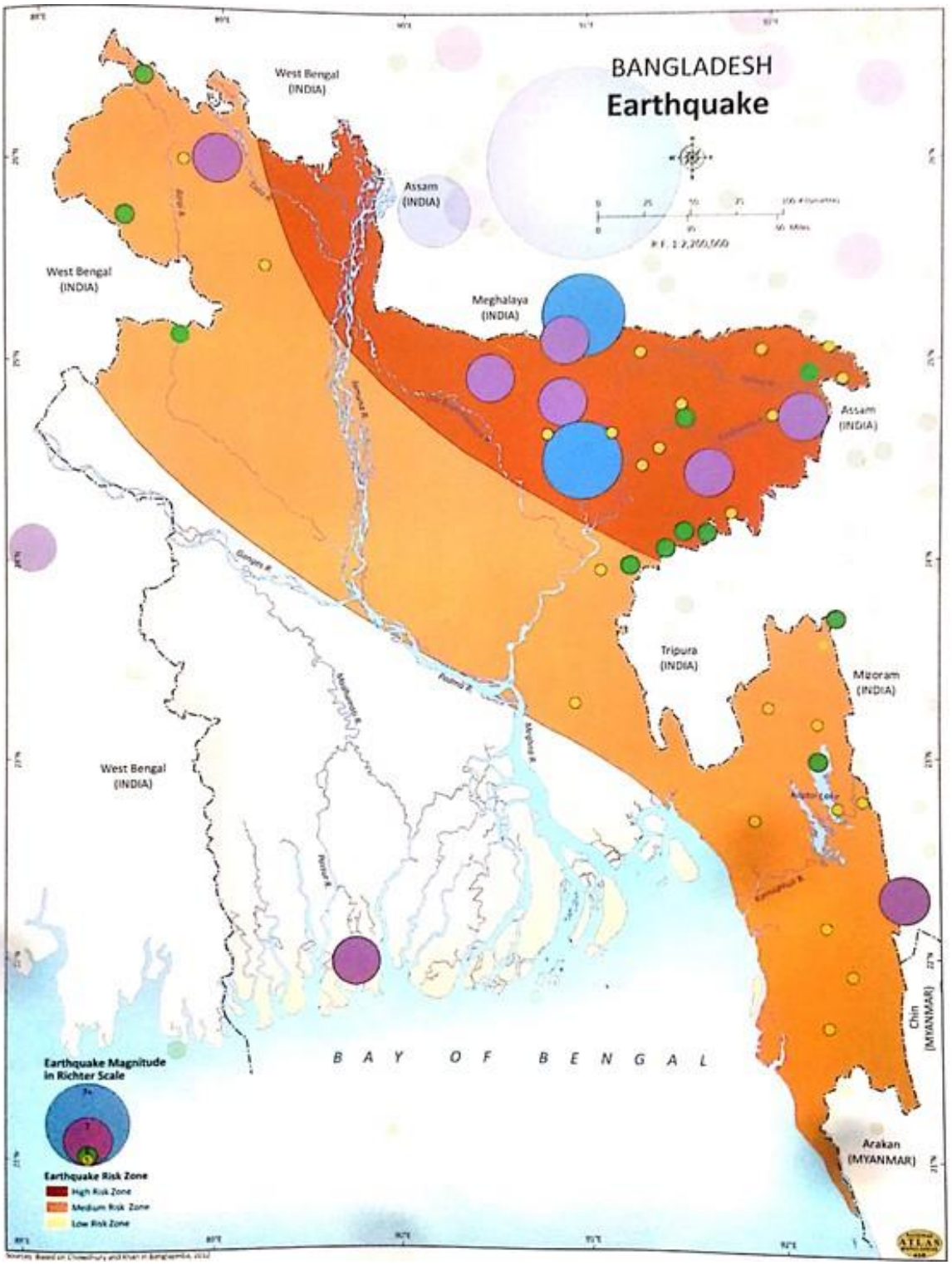
Source : *BBS (2011), Chapter 2, Pg. No : 15*

11.5.2. Topography and seismology

Eco-Tourism Park site is a located on relatively newly formed delta and is low lying in nature. The major part of the site remains submerged twice a day during high tide due to the proximity of Bay of Bengal.

Bangladesh has been divided into three generalized seismic zones. The north-eastern regions of Bangladesh are the most active zones and belong to the zone-I. The zone II consists of the regions of recent uplifted Pleistocene blocks and considered as moderately active. The southwest Bangladesh is seismically quiet zone and represented by zone III. Proposed site is located in Zone II.

Figure 88: Seismic zoning map of Bangladesh



Source: *Based on Chowdhury and Khan in Banglapedia, 2012*

11.5.3. Climatologically condition

According to District statistics in Cox's Bazar District, annual average temperature and Rainfall varies from maximum 34.8^{o}C to minimum 16.1^{o}C and the Annual Average Rainfall is 4285 mm. The District having been a coastal region often fall victim to sea storm, Tidal bore, Hurricane and Cyclone.

The sea has a tropical monsoon climate. It has three main seasons:

- Summer/Pre-Monsoon : March to May
- Rainy Season/Monsoon : June to October
- Winter Season : November to December.

11.5.4. Land use pattern

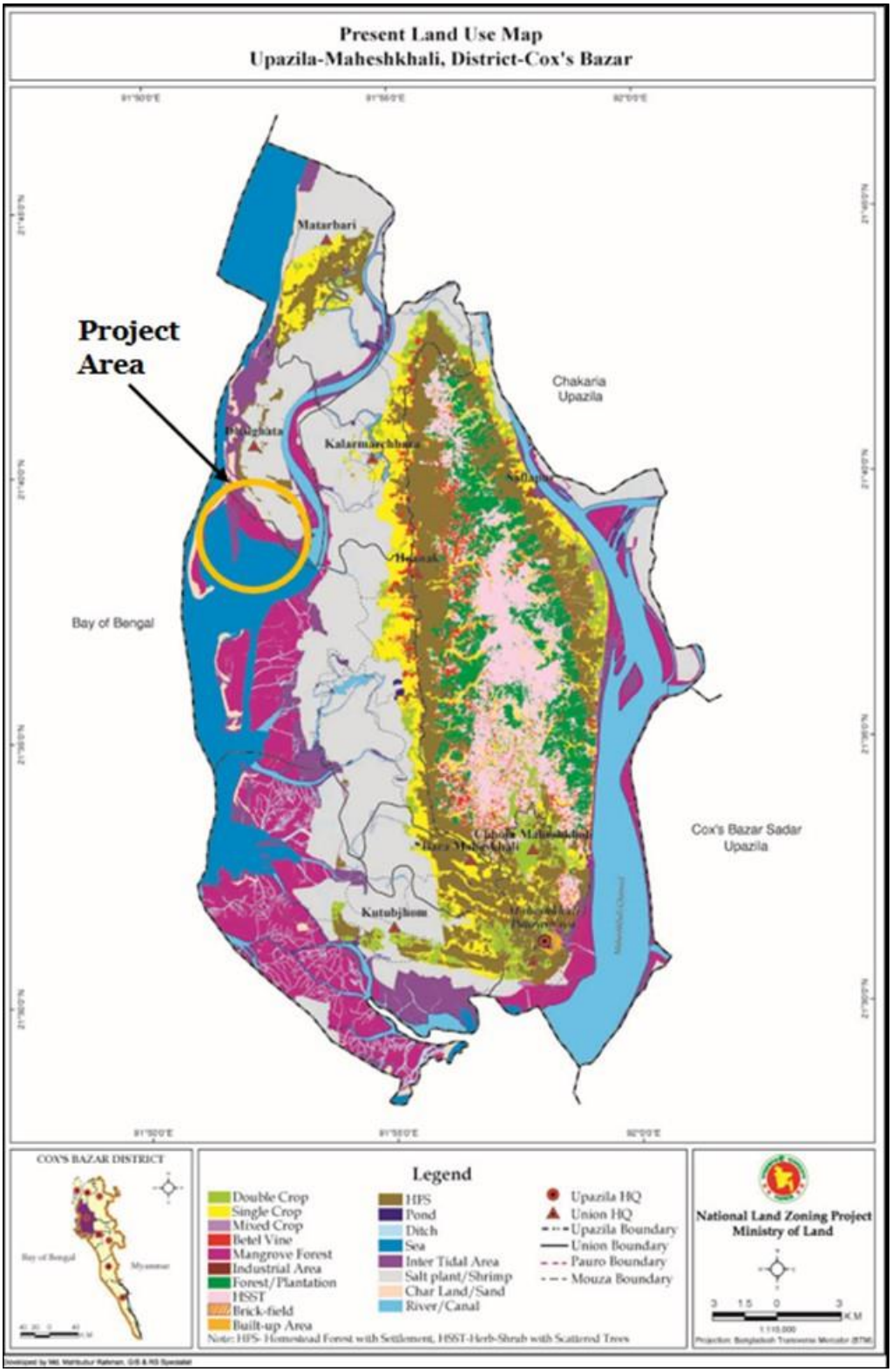
According to the land use map of Maheshkhali Upazila, Cox's Bazar district and the proposed site falls under the following zones:

- Sea
- Inter-tidal zone
- Mangrove forest
- Salt/Shrimp
- Char land/sand

From the above land use classification, it is found that the existing land use are more eco-sensitive in nature. Hence, the proposed tourism-based activities/land use components within the park shall be planned in eco-friendly nature. It is planned to retain the water bodies and Mangrove forests without disturbing. Also, the char land which acts as feeding ground for Birds due to availability of different habitats within, have also been planned to be retained while planning. It is also planned to retain the rest of the char lands to the maximum possible extent while preparing master plan.

The sand dune area which acts as nesting and hatching ground for turtles and crawling area for red crabs have also been planned to be retained as "No development zone". Since, the human settlements are going to get relocated, the activities such as salt and shrimp cultivation will also get diminished. Hence, it planned to rehabilitate the evacuated people and remove the salt and shrimp cultivation which obviously change the land.

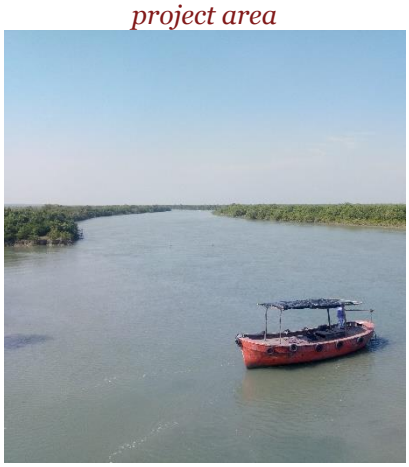
Figure 89: Topography and seismology



Source : [1] *http://www.landzoning.gov.bd/backend/product_picture/lum578.jpg*

Mangrove Cover

Figure 90: Land use of proposed project area



Water channel

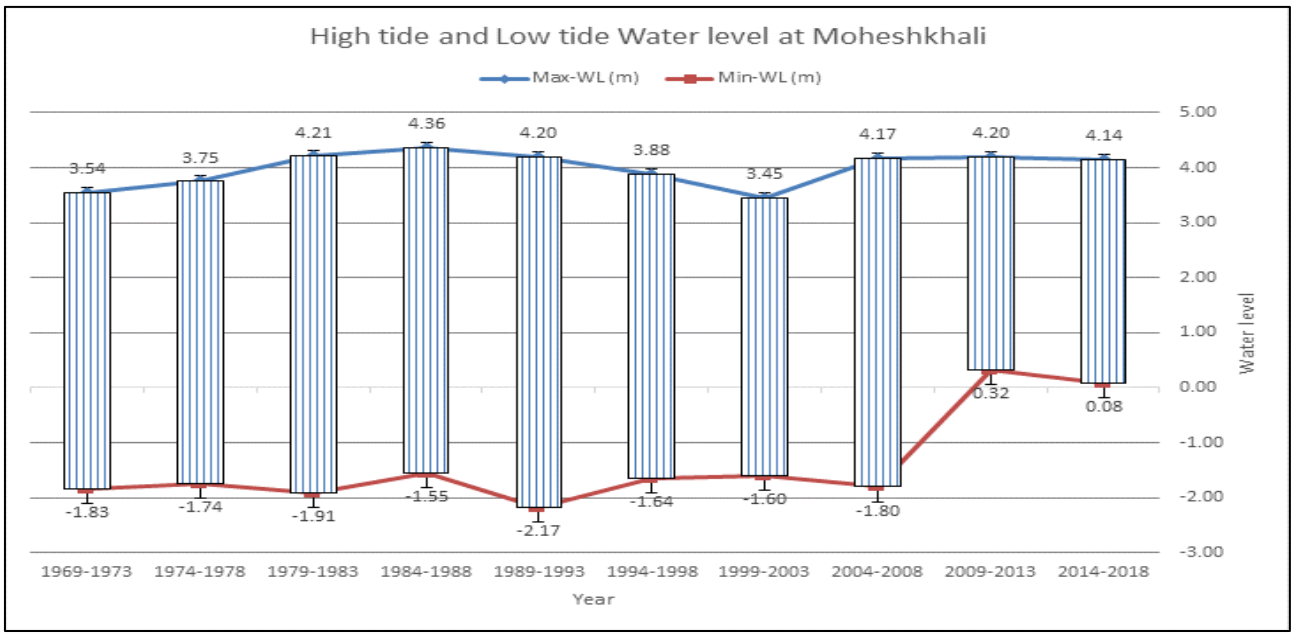
Trees on seashore acting as wind barriers

11.5.5. Flood / Drainage pattern

As per the data collected from BWDB, for the past 50 years (1969-2018), the maximum water level in Maheshkhali water channel is + 4.00 m and minimum water level is -2.00 m.

The Maximum high tide level and minimum low tide levels as per the record for the past 50 years (1969-2018) near Sonadia Island is depicted below

Figure 91: Maximum high tide and minimum low tide levels near Sonadia



Source: *Bangladesh Water Development Board (BWDB)- primary data collection*

From the above topography map of proposed effective planning area, it is observed that the effective planning area is elevated on its west and is sloping towards the existing water channel on its eastern direction. The level of majority land parcel varies between 1 to 5 m. Accordingly suitable embankment with raised levels above Maximum Flood level has been proposed. Peripheral drain all along the inner edge of the embankment has been proposed. From the entire surface the runoff flow will be collected and transmitted through proposed drain. From

this drain network, it is planned to supply the proposed green area and landscape within Eco-tourism park. Even though, the gravity flow is towards the water channel, the final discharge cannot be let out to the water channel because of chances for backwater intrusion. Hence, it is proposed to collect the excess of rainwater in a slump and is proposed to pump out from the sump.

11.6. Environment

11.6.1. Water Environment

Ground water

Sonadia Island currently has three numbers of Boreholes and its maximum depth is around 1000 ft (305m).

- All the three bore holes has chloride content varies from 3425 mg/L to 10200 mg/L which exceeds the Bangladesh Standards (BS) 150-600 mg/L, concluding the water in and around the Sonadia Island is Saline in nature.
- The iron content in the water from bore holes varies from 12.88-22.70 mg/L which exceeds the BS 0.3-1.0.
- The ph value ranges from 6.1 to 6.3 which is quite acidic in nature, and the hardness of the water varies from 3300-4780 mg/L which exceeds the BS 200-500 mg/L.

Table 67: Water quality of project area

S. No	Water quality parameters	Bangladesh standards	Concentration presence	Unit	Analysis method	LOQ
1)	Alkalinity	-	160	mg/L	Titrimetric	-
2)	Arsenic (As)	0.05	0.002	mg/L	AAS	0.001
3)	Chloride	150-600	3425	mg/L	Titrimetric	-
4)	Fluoride	1.0	0.351	mg/L	UVS	0.12
5)	Hardness	200-500	3300	mg/L	Titrimetric	-
6)	Iron	0.3-1	12.88	mg/L	AAS	0.05
7)	Manganese	0.1	4.14	mg/L	AAS	0.03
8)	Nitrogen	10.0	1.6	mg/L	UVS	0.10
9)	pH	6.5-8.5	6.2	-	pH meter	-
10)	Turbidity	10	50.2	NTU	Turbidity meter	-

Note: UVS-UV- Visible Spectrophotometer, LOQ- Limit of Quantitation
Source: *DPHE, Bangladesh- Primary data collection*

From the above water quality parameters, it can be concluded that the chloride and iron content is comparatively high around the Sonadia Island, so this water is not fit to be used for any drinking or construction purposes. Since the hardness of the water is also high, the usage on domestic purposes(cleaning/washing) is not recommended.

The Geo-technical investigation, Noise quality and air quality primary survey is under progress and the result of the same will be provided in the next deliverable.

Surface water

Water channels occupies a major part of the Sonadia Island it breaches, spreads and connect the sea, these providing a better water route to roam around the Island. This may provide an opportunity to overview the Island in single water trip. Water channels with Mangroves Forest on either site creates a scenic perspective, attention and attraction to the Tourist. From the Environmental and sustainable aspect, the water channels should be conserved, maintained and retained in the Island for future development of the site. Sonadia Eco-tourism Park must be planned to go and throughout the site. In order to meet the water requirement of the proposed project,

the existing water channels cannot be relied as a source since it is having more salinity due to backwater from sea. Hence, it is recommended to propose desalination plant for the proposed project.

The water channels within the proposed study area is shown in the **figure below.**

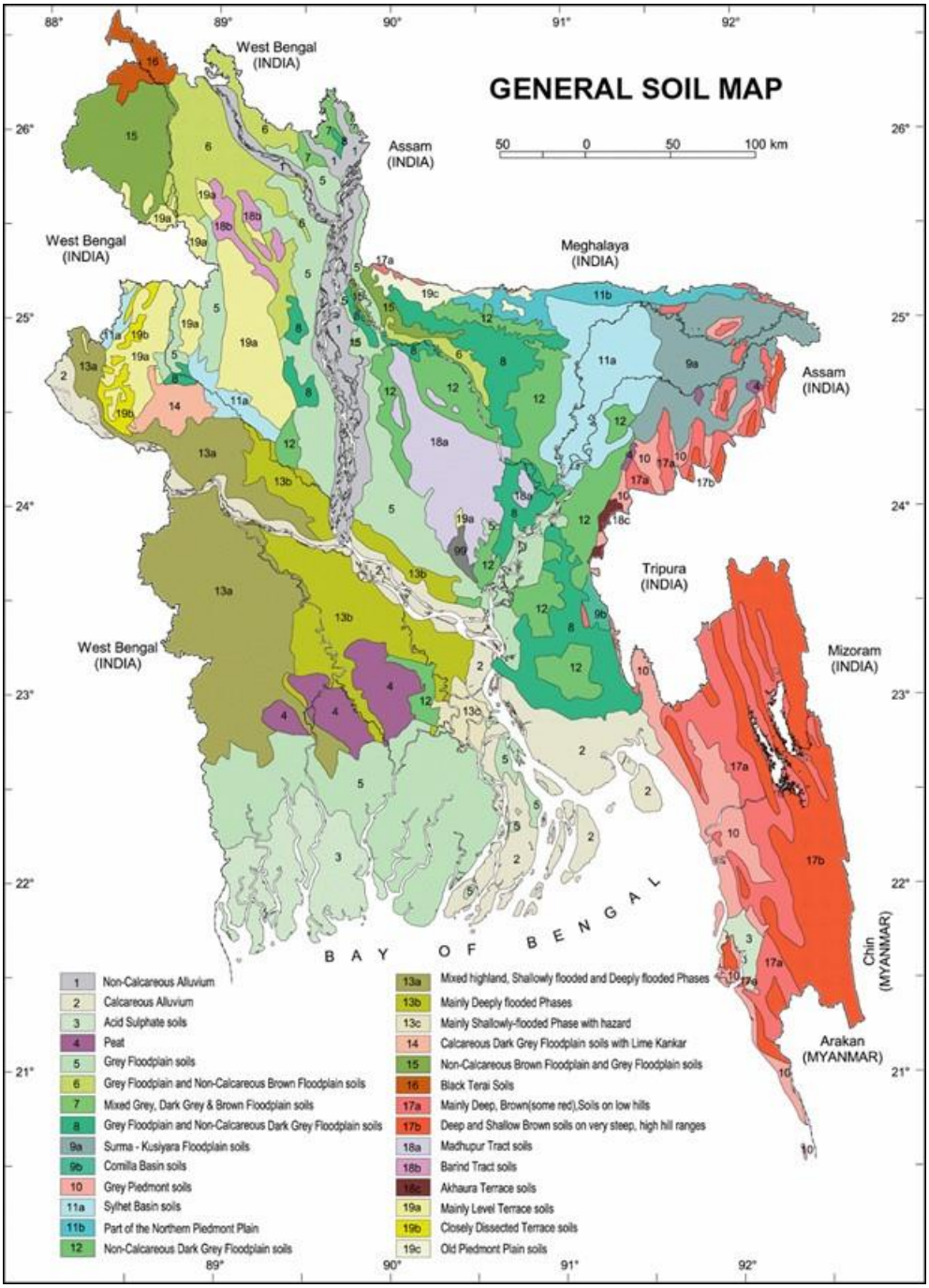
Figure 92: Water channels in Sonadia Island, Cox's Bazar

Source: *MACE analysis*

11.6.2. ***Soil environment***

The soil of Sonadia Eco-tourism Park site area is the admixture of sand and clay in varying proportion. The entire soil condition of Sonadia Island is mostly sandy and marshy.

Figure 93: Soil profile map of Bangladesh



Source: *Website of Tourism Directory of Bangladesh- www.thebangladesh.net/general-soil-map-f-bangladesh.html*

11.6.3. Air environment

Based on the secondary information and the site reconnaissance survey it was observed that baseline air quality was satisfactory and air pollution poses little or no threat presently. This may be due to the fact that the project area is located in a rural area with no significant industries in the surrounding area and the traffic was relatively less. However, it is envisaged that, once the Matarbari power plant is operational, the cumulative impact of Power Plant and operational Tourism park may create significant air pollution.

Figure 94: Ambient air quality of project area

Location	Concentration of pollutants			Remarks
	SPM (microgram/ m^3)	NOx (ppm)	SO_2 (ppm)	
Dhalghata, Near Kuhelia River	26	0.1	0.0	• Temperature: 27.1°C • Relative Humidity: 84 % • Weather Condition: Cloudy • Time: 12:30 PM to 01:30 PM
DoE Standard (ECR 97, Schedule 2, Amendment 200s)	200 (8hours)	0.53 (Yearly)	Not specified	-

Source: *Qtex Solutions Limited, Bangladesh*

11.6.4. Noise environment

Based on the secondary information and the site reconnaissance survey it was observed that baseline noise quality was satisfactory and noise pollution poses little or no threat presently

Table 68: Ambient noise quality of project area

Location	Time	Sound level in dB	Comparative Standards (dB)
Dhaulghata, Near Kuhelia River	12:30 PM to 01:30 PM	57.5	**ECR 97, Schedule-4:** Maximum permissible limit of ambient noise level at day time is 60 dB for mixed area **According to IFC standard:** Maximum permissible limit for ambient noise level is 55 dB at day time

Source: *Qtex Solutions Limited, Bangladesh*

11.6.5. Biological environment

Under the Environmental Conservation Act, ecologically sensitive and precious areas are designated as Ecologically Critical Area (ECA) by Department of Environment in Bangladesh in cases where an ecosystem or biodiversity area is considered to be threatened to reach to a critical state. On the other hand, protected areas such as national parks and protected forests are designated by Department of Forest under the Wildlife Order and Forest Act.

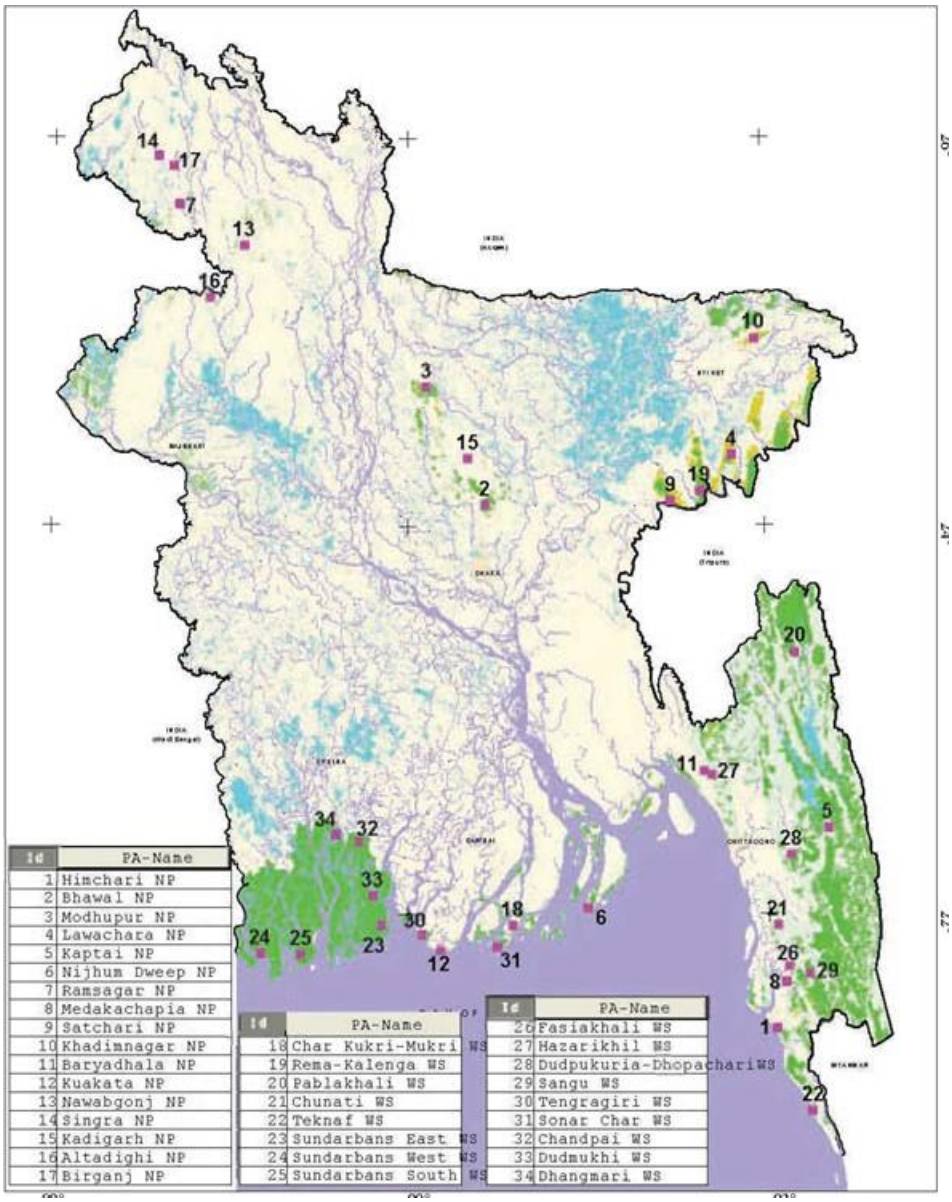
Sonadia Island's Ghatibanga (part) of 4,924 ha area was declared as ECA under the section of the Bangladesh Environment Conservation Act, 1995 (MoEF, 2015). Later on, the Ministry of Environment and Forests declared Cox's Bazar, Teknaf sea beach and some area of Sonadia Island area are out of ECA as per the Gazette notification dated 06/01/1406 বাংলা II 19/04/1999 under the amendment of পবম – ৪/৭/৮৭/৯৯/২৪৫. From the discussion had with the officials, it is found that the proposed area for development does not falls under ECA.

However, existing natural features within the island should not get disturbed due to the development of Eco-tourism park. This has been considered while planning, with the aim of retaining the beauty of the island (existing bio-diversities and ecology) to attract the tourist.

Major area of the island is occupied by natural mangrove vegetations. Critically endangered species like Spoon-billed Sandpiper (Eurynorhynchus pygmeus) is recorded here. Also, there are nos. of species like sea turtles, horse shoe crabs, red crabs, thick leafed and colo flowered ipomoea, other species of climbers, attracting birds. Bio-diversities acts as a major tourism attraction and adds inner beauty to this Island.

From the literature review, it is observed that there is an existing issue of clearing of trees and unauthorised Shrimp cultivation within the Island. Clearing of natural forest or trees, destroying habitats of animals and plants and activities that can change nature of land, water and ecosystem. These illegal activities may be happening due to less human movement within the island. Upon developing the eco-tourism park, this issue can be resolved.

Figure 95: Protected areas of Bangladesh



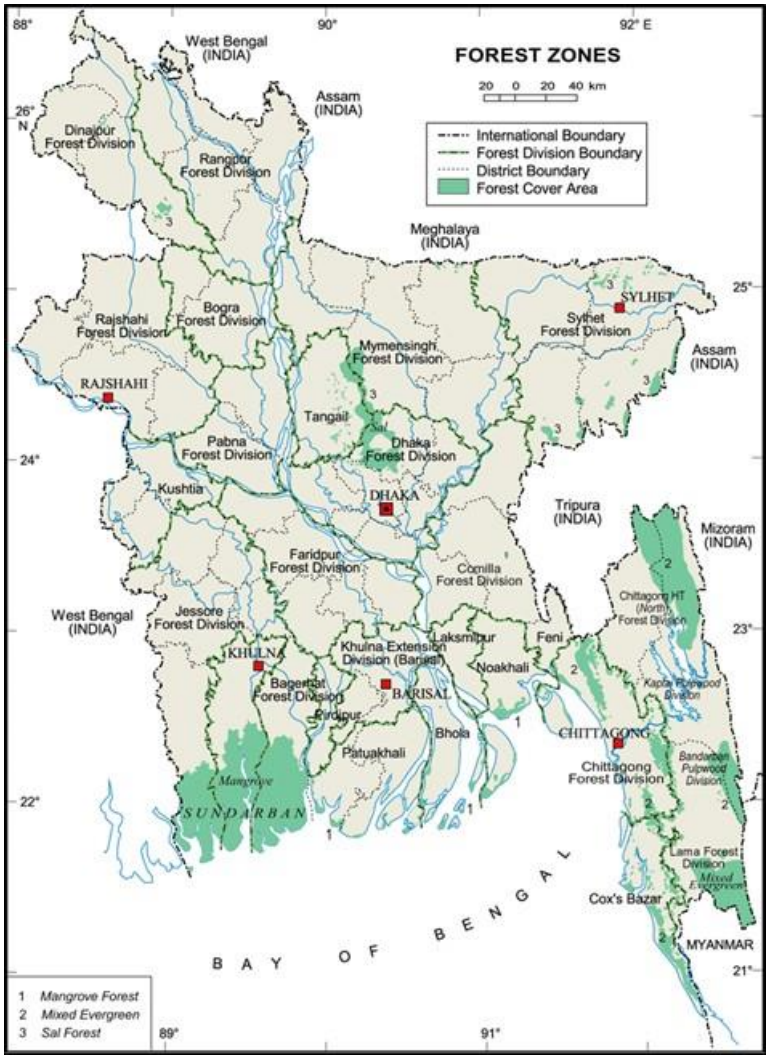
Source: *Forest Department of Bangladesh, from the document titled "Bangladesh Environment and climate change outlook, 2012"*

From the above exhibit, it is found that the proposed site area does not falls under the protected area.

Forest area/vegetation cover

There is no presence of forest land in and around the proposed site. However, the proposed project area supports mangrove vegetation (mostly of approximately 2-5 m height) to some considerable extent. The forest map of Bangladesh is furnished in figure below

Figure 96: Forest areas of Bangladesh



Source: *Prime Minister's Office Library, Dhaka*

Flora & Fauna

The proposed site is located in such a location where tidal influence is prominent. The major part of the site remains submerged twice a day during high tide due to the proximity of Bay of Bengal. Moreover, the Maheshkhali water channel flows along the northern, eastern and southern boundary of the site and Bay of Bengal forms the western boundary. Almost in the entire project area, the natural mixing of saline water (from Bay of Bengal) and fresh water (from Maheshkhali channel and other small creeks) create a brackish estuarine ecosystem. Such type of ecosystem is one of the most significant ecosystems from the point of view of species richness and biodiversity. The study area also supports substantial biodiversity. Information pertaining to ecological resources were collected from Chittagong Forest Division, local community, local fishermen and rapid site reconnaissance. The Matarbari Power Plant EIA report also considered to get an idea about the ecology of project area. The flora and fauna recorded from study area are presented in subsequent sections.

Flora

Primary successor species like Uri /Dhansi grass is seen. Mangrove species like Kalo Bain (Avicennia officinalis), Sada Bain (Avicennia marina), planted by forest department are the predominant species of the project area.

A total of 138 plant species belonging to 121 genera and 52 families were identified from the Sonadia island. Among the recorded 138 species, Poaceae appeared as the largest family with 8 species under 8 genera followed

by Cucurbitaceae (7 genera and 8 species), and Mimosaceae (8 species and 6 genera). Plant species recorded from Sonadia Island is listed below.

Figure 97:List of plant species recorded in Sonadia Island

SN	Scientific name	Local name	Family name	Habit	Habitat
1	*Acacia auriculiformis* A. Cunn. *ex* Benth. & Hook.	Akashmoni	Mimosaceae	T*	Homestead, Roadside
2	*Abelmoschus esculentus* (L.) Moench	Vandi	Malvaceae	H	Cultivated
3	*Acacia farnesiana* (L.) Willd.	Bilati Babla	Mimosaceae	T	Homestead
4	*Acanthus ilicifolius* L.	Hargoza	Acanthaceae	S	Mangrove
5	*Aegialitis rotundifolia* Roxb.	Nunia gach	Plumbaginaceae	S	Mangrove
6	*Albizia lebbeck* (L.) Benth.	Kala koroi	Mimosaceae	T	Homestead
7	*Albizia procera* (Roxb.) Benth.	Sada koroi	Mimosaceae	T	Homestead
8	*Alocasia macrorrhizos* (L.) G. Don	Mankachu	Amaranthaceae	H	Homestead
9	*Alternanthera philoxeroides* (Mart.) Griseb.	Helencha	Amaranthaceae	H	Cultivated, Roadside
10	*Alternanthera sessilis* (L.) R. Br. *ex* Roem. & Schult.	Saci Shak	Amaranthaceae	H	Cultivated
11	*Amaranthus spinosus* L.	Katashak	Amaranthaceae	H	Homestead
12	*Amaranthus tricolor* L.	Lalshak	Amaranthaceae	H	Homestead, Cultivated
13	*Amaranthus viridis* L.	Datashak	Amaranthaceae	H	Homestead, Roadside
14	*Anacardium occidentale* L.	Kajubadam	Anacardiaceae	T	Homestead
15	*Areca catechu* L.	Supari	Arecaceae	T	Homestead
16	*Argyreia capitiformis* (poir.) Oostr.	Voga Lata	Convolvulaceae	C	Roadside
17	*Artocarpus heterophyllus* Lamak.	Kathal	Moraceae	T	Homestead
18	*Asystasia gangetica* (L.) T. Anders.		Acanthaceae	H	Roadside
19	*Averrhoa carambola* L.	Kamranga	Averrhoaceae	T	Homestead
20	*Avicennia alba* Blume.	Sada Baen	Avicenniaceae	T	Mangrove
21	*Avicennia marina* (Forsk.) Vierh.	Moriccha Baen	Avicenniaceae	T	Mangrove
22	*Avicennia officinalis* L.	Kalo Baen	Avicenniaceae	T	Mangrove
23	*Azadirachta indica* A.Juss.	Neem	Meliaceae	T	Homestead
24	*Bambusa vulgaris* Schrad.*ex* Wendl.	Baijja Bans	Poaceae	T	Homestead
25	*Basella rubra* L.	Poi Shak	Basellaceae	C	Homestead
26	*Benincasa hispida* (Thunb.) Cogn.	Chal Kumra	Cucurbitaceae	C	Homestead
27	*Blumea lacera* (Burm.f.)	Kukur Muta	Asteraceae	H	Roadside
28	*Brassica juncea* (L.) Czern.	Rai Sorisa	Brassicaceae	H	Homestead
29	*Calotropis procera* (Ait.) R. Br.	Akanda	Asclepiadaceae	T	Homestead
30	*Canavalia virosa* (Roxb.) Wight & Arn.	Kalo Shim	Fabaceae	H	Homestead
31	*Capsicum frutescens* L.	Morich	Solanaceae	H	Homestead, Cultivated
32	*Carica papaya* L.	Pepe	Caricaceae	S	Homestead
33	*Carissa carandas* L.	Koromcha	Apocynaceae	S	Homestead
34	*Cassia fistula* L.	Sonalu	Caesalpiniaceae	T	Homestead
35	*Casuarina equisetifolia* Forst.	Jau	Casuarinaceae	T	Sandy beach, Roadside

(Contd.

SN	Scientific name	Local name	Family name	Habit	Habitat
36	*Catharanthus roseus* (L.) G.Don	Nayantara	Apocynaceae	H	Homestead
37	*Ceiba pentandra* (L.) Gaertn.	Burma Simul	Bombacaceae	T	Homestead
38	*Cicca acida* (L.) Merr.	Orboroi	Euphorbiaceae	T	Homestead
39	*Citrus aurantifolia* (Christm. & Panzer) Swingle	Lebu	Rutaceae	T	Homestead
40	*Citrus grandis* (L.) Osbeck	Jambura	Rutaceae	T	Homestead
41	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	Tormuj	Cucurbitaceae	C	Cultivated
42	*Clerodendrum inerme* (L.) Gaertn.	Bonjui	Verbenaceae	S	Roadside
43	*Cocos nucifera* L.	Narikel	Arecaceae	T	Homestead
44	*Colocasia esculenta* (L.) Schott	Kachu	Araceae	H	Homestead
45	*Commelina benghalensis* L.	Kanchira	Commelinaceae	H	Cultivated
46	*Corypha umbraculifera* L.		Arecaceae	T	Homestead
47	*Crotalaria juncea* L.	Junjuni	Fabaceae	H	Roadside
48	*Cucumis melo* L.	Bangi	Cucurbitaceae	C	Cultivated
49	*Cucumis sativus* L.	Khira	Cucurbitaceae	C	Cultivated
50	*Cucurbita maxima* Duch. *ex* Lamk.	Misti Kumra	Cucurbitaceae	C	Homestead, Cultivated
51	*Curcuma longa* L.	Halud	Zingiberaceae	H	Homestead
52	*Cynodon dactylon* (L.) Pers.	Durbagass	Poaceae	H	Roadside
53	*Cyperus javanicus* Houtt.	Kucha	Cyperaceae	H	Roadside
54	*Dalbergia spinosa* Roxb.	Churilla kanta	Fabaceae	C	Mangrove
55	*Delonix regia* Rafin.	Krishnachura	Caesalpiniaceae	T	Homestead
56	*Dendrocalamus giganteus* Wall. *ex* Munro	Budhum bans	Poaceae	T	Homestead
57	*Dioscorea bulbifera* L.	Pagla alu	Dioscoreaceae	S	Homestead
58	*Eclipta alba* (L.) Hassk.	Kesaraj	Asteraceae	H	Roadside
59	*Elaeis guineensis* Jacq.	Oil Palm	Arecaceae	T	Homestead
60	*Erythrina fusca* Lour.	Kata Mandar	Fabaceae	T	Homestead
61	*Eucalyptus camaldulensis* Dehnh.	Euclyptus	Myrtaceae	T	Homestead
62	*Eupatorium odoratum* L.	Assam Gach	Asteraceae	H	Cultivated
63	*Excoecaria agallocha* L.	Gewa	Euphorbiaceae	T	Mangrove
64	*Ficus benghalensis* L.	Bot	Moraceae	T	Homestead
65	*Garuga pinnata* Roxb.	Bhadi	Burseraceae	T	Homestead
66	*Gmelina arborea* Roxb.	Gamar	Verbenaceae	T	Homestead
67	*Hedyotis corymbosa* (L.) Lam.	Khetpapra	Rubiaceae	H	Roadside, Cultivated
68	*Heliotropium curassavicum* L.	Hatisur	Boraginaceae	S	Mangrove
69	*Heliotropium indicum* L.	Hatisur	Boraginaceae	H	Roadside
70	*Hibiscus rosa-sinensis* L.	Joba	Malvaceae	S	Homestead
71	*Hopea odorata* Roxb.	Telsur	Dipterocarpaceae	T	Homestead
72	*Hyptis suaveolens* (L.) Poit.	Tokma	Lamiaceae	S	Roadside
73	*Imperata cylindrica* (L.) P. Beauv.	Chan	Poaceae	H	Roadside

(Contd.)

SN	Scientific name	Local name	Family name	Habit	Habitat
74	*Ipomea batatas* (L.) Lam.	Misti alu	Convolvulaceae	C	Homestead, Cultivated
75	*Ipomea pes-caprae* (L.) R. Br.	Sagorlata	Convolvulaceae	C	Sandy beach
76	*Ipomoea aquatica* Forsk.	Kolmi Shak	Convolvulaceae	C	Homestead
77	*Ipomoea fistulosa* Mart. *ex* Choisy	Dolkolomi	Convolvulaceae	S	Roadside
78	*Jatropha curcas* L.	Baghverenda	Euphorbiaceae	S	Roadside
79	*Justicia gendarussa* Burm. f.	Jagmodon	Acanthaceae	H	Roadside
80	*Lablab purpureus* (L.) Sweet	Sheem	Fabaceae	C	Homestead
81	*Lagenaria vulgaris* Seringe	Lao	Cucurbitaceae	C	Homestead
82	*Lagerstroemia speciosa* (L.) Pers.	Jarul	Lythraceae	T	Roadside
83	*Lannea coromandelica* (Houtt.) Merr.	Bhadi	Anacardiaceae	T	Homestead
84	*Lantana camara* L.	Moggula	Verbenaceae	S	Homestead, Roadside
85	*Launaea sarmentosa* (Wild.) Sch. Bip. *ex* Kantze		Asteraceae	H	Roadside
86	*Lawsonia inermis* L.	Mendi	Lythraceae	S	Homestead
87	*Leucaena leucocephala* (Lam.) de Wit.	Ipil-Ipil	Mimosaceae	T	Homestead
88	*Leucas aspera* (willd.) Link.	Shetodhrona	Lamiaceae	H	Roadside
89	*Leucas cephalotes* (Roth) Spreng.	Bara-halkus	Lamiaceae	H	Roadside
90	*Lindernia ciliata* (Colsm.) Pennell	Bhui	Scrophulariaceae	T	Roadside
91	*Ludwigia adscendens* (L.) Hara	Kesra-dum	Onagraceae	H	Roadside
92	*Luffa cylindrica* M. Roem.	Dundul	Cucurbitaceae	C	Roadside
93	*Lumnitzera racemosa* Willd.	Kirpa	Combretaceae	T	Mangrove
94	*Lycopersicon esculentum* Mill.	Tomato	Solanaceae	H	Homestead, Cultivated
95	*Mangifera indica* L.	Aam	Anacardiaceae	T	Homestead
96	*Mimosa pudica* L.	Lojjaboti	Mimosaceae	H	Roadside
97	*Moringa oleifera* Lamk.	Shajna	Moringaceae	T	Homestead
98	*Musa paradisiaca* L.	Kola	Musaceae	H	Homestead
99	*Neolamarckia cadamba* (Roxb.) Bosser.	Kadam	Rubiaceae	T	Homestead
100	*Opuntia dillenii* Haw.	Foni Monsha	Cactaceae	C	Homestead
101	*Oryza sativa* L.	Dhan	Poaceae	H	Cultivated
102	*Oxystelma secamone* (L.) Karst.	Dudhia kata	Asclepiadaceae	H	Roadside
103	*Pandanus fascicularis* Lamk.	Keyakata	Pandanaceae	T	Sandy beach
104	*Pandanus foetidus* Roxb.	Keyakata	Pandanaceae	S	Sandy beach
105	*Paspalum vaginatum* Sw.		Poaceae	H	Cultivated
106	*Passiflora foetida* L.	Jumka lata	Passifloraceae	C	Homestead
107	*Phoenix sylvestris* (L.) Roxb.	Deshi Khejur	Arecaceae	T	Homestead
108	*Pithecellobium dulce* (Roxb.) Benth.	Jilapi	Mimosaceae	T	Homestead
109	*Porteresia coarctata* (Roxb.) Tateoka	Urigrass	Poaceae	H	Mangrove meadow
110	*Portulaca oleracea* L.	Nuinnashak	Portulacaceae	H	Mangrove meadow
111	*Psidium guajava* L.	Payara	Myrtaceae	T	Homestead

(Contd.)

SN	Scientific name	Local name	Family name	Habit	Habitat
112	*Psilotrichum ferrugineum* (Roxb.) Moq.-Tand.	Khetapada Shak	Amaranthaceae	H	Homestead, Roadside
113	*Raphanus sativus* L.	Mula	Brassicaceae	H	Cultivated
114	*Ricinus communis* L.	Varenda	Euphorbiaceae	T	Homestead
115	*Samanea saman* (Jacq.) Merr.	Raintree	Mimosaceae	T	Homestead
116	*Senna tora* (L.) Roxb.	Terasena	Caesalpiniaceae	H	Roadside
117	*Sida cordifolia* L.	Berela	Malvaceae	H	Homestead
118	*Solanum melongena* L.	Begun	Solanaceae	H	Homestead
119	*Sonneratia apetala* Buch.-Ham.	Keora	Sonneratiaceae	T	Mangrove
120	*Spinacia oleracea* L.	Palon Shak	Chenopodiaceae	H	Homestead
121	*Spondias pinnata* (L. f.) Kurz.	Amra	Anacardiaceae	T	Homestead
122	*Streblus asper* Lour.	Sheora	Moraceae	T	Homestead
123	*Suaeda maritima* (L.) Dumort.		Chenopodiaceae	H	Roadside
124	*Swietenia mahagoni* Jacq.	Mahogoni	Meliaceae	T	Homestead
125	*Synedrella nodiflora* (L.) Gaertn.	Not known	Asteraceae	H	Roadside
126	*Syzygium fruticosum* DC.	Putijam	Myrtaceae	T	Homestead
127	*Tamarindus indica* L.	Tentul	Caesalpiniaceae	T	Homestead
128	*Tamarix gallica* L.	Nona jau	Tamaricaceae	S	Mangrove
129	*Tephrosia purpurea* (L.) Pers.	Bon-neel	Fabaceae	H	Cultivated
130	*Terminalia arjuna* (Roxb. Ex DC.)	Arjun	Combretaceae	T	Roadside
131	*Terminalia catappa* L.	Kat Badam	Combretaceae	T	Homestead
132	*Thevetia peruviana* (Pers.) K. Schum.	Halde Karabi	Apocynaceae	T	Homestead
133	*Thysanolaena maxima* (Roxb.) O. Kuntze	Jahruful	Poaceae	H	Homestead
134	*Trichosanthes anguina* L.	Chichinga	Cucurbitaceae	C	Cultivated, Homestead
135	*Typha domingensis* (Pars.) *ex* Steud.	Hogla	Typhaceae	H	Wetland
136	*Vitex negundo* L.	Nil Nishinda	Verbenaceae	S	Sandy beach, Roadside
137	*Vitex trifolia* L. f.	Nishinda	Verbenaceae	S	Sandy beach, roadside
138	*Ziziphus mauritiana* Lamk.	Boroi	Rhamnaceae	T	Homestead

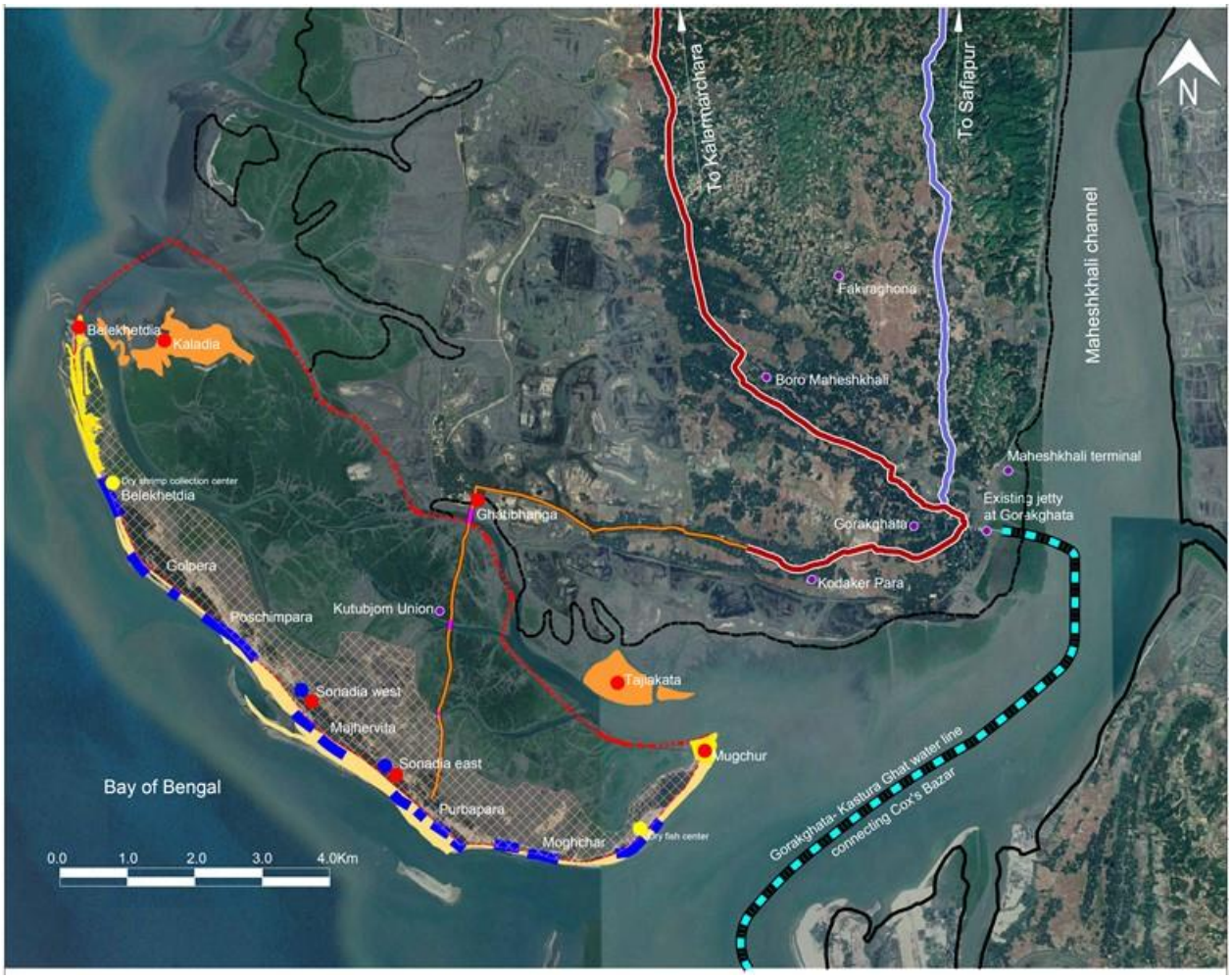
Source: *From Literature Review published by Institute of Forestry and Environmental Sciences*

Fauna

The major Faunas having high potential to attract the tourists are the endangered species of birds visiting the Island, other species of beautiful birds within the island, Red crabs crawling on seashore and different species of turtles which are detailed below.

The map depicting the spatial location of endangered species and ecologically sensitive areas such as Birds gathering spots, feeding and roosting ground, Red crabs crawling areas, Turtles Nesting spots & hatcheries and the delineated effective planning area is shown below.

Figure 98: Location of endangered species



Source: *MACE analysis*

The detailed description about each of the attracting faunas are as follows:

1) Turtles

Sonadia Island is one of the major nesting sites of turtles. Three species of Sea turtles have been reported to nest in Sonadia Island. A total of 260 turtle individuals were found and the highest nesting frequency of Olive Ridley (108) and Green Turtles (10).

- **Olive Ridley Turtles**

  - Found along the sandy beaches
  - It is grayish-brown as juveniles, olive green as adults, length: 50-75cm (smallest of the ocean-going turtles), weight: about 50 kg.
  - Olive riddle turtle are only seen at the Sonadia Island and breeding period of this threatened turtle is winter season. Several thousands of babies of olive riddle turtle are released at the Bay of Bengal every year as part of conservation of the wildlife.
  - Nesting by olive ridley turtles spanned October-April. Olive ridley nests are found from Belekerdia in the north-west to Moghchar in the south-east. olive ridleys were also recorded nesting at Kaladia beach, but the tidal surges associated with recent cyclones resulted in the loss of nesting habitat in this area. Most of the olive ridley nests were laid on the open beach, although a few were found in patches of groundcover vegetation (Ipomea pes-caprae, Vitex

spp.). Belekerdia had the highest density of nests observed (42%) and the Majhervita had 33% of nests in recent years. No daytime nesting was observed.

- **Green Turtles**

  - Green turtles had been found to nest on the mainland coasts and on island beaches. But they were found less widespread than Olive Ridleys.
  - It is brown (name derived from the colour of its green fat), hatchlings almost black, but lighten in colour within their first year, length: 80-120 cm, weight: 130-250 kg.

- **Hawksbill Turtles**

  - It was found that Hawksbill turtle was a rare visitor to the beaches of Bangladesh.
  - It is dark, greenish-brown, juveniles have the "tortoiseshell" pattern, length: 55-95 cm, weight: around 55 kg.

Female turtles come ashore on a sandy beach to nest a few weeks after mating. It must come ashore to build nests and lay their eggs. Females usually nest during the warmest months of the year. Females of most species usually come ashore at night, alone, most often during high tide. Sonadia Island is known as sea turtles breeding ground and offers the sandy shore area for nesting. Turtle breeding hatcheries are developed in and around the shore line of Sonadia.

- **Threats**

Major threats for the species of turtles are as follows:

- Thousands of sea turtles come to shallow water areas of the Bay where the Males mate with Females lay eggs on the beaches nearby. They may lose their breeding ground due to inundation by sea level rise caused by climate change.
- The expansion of *Casuarina* plantations on Sonadia in 2008-09 by the Forest Department is a potential threat to the sea turtle nesting habitat from Paschimpara to Belekerdia. In India *Casuarina* has been reported to cause a decline in olive ridley nesting (Mohanty 2002).
- Light pollution, which can be defined as the introduction of artificially produced light into pristine areas, is considered one of the greatest threats to nesting females and to hatchling survival. Hatchlings typically emerge from the nests at night and use visual cues to find the ocean. As such, artificial lights can disrupt hatchling sea-finding behaviour, making them more susceptible to mortality associated with exhaustion, dehydration, predation, among others, and can also disorient nesting females.
- **False Crawl:** Green turtle nesting activities were recorded from June - October each year. Most of the emergences occurred at Belekerdia and Majhervita. Green turtles had a lower false crawl nest ratio than Olive Ridley turtles, with primary disturbances consisting of predatory dogs, beach seine fishing, light disturbances and compacted sand after the monsoon.

- **Conservative measures**

- **Existing measures**

Seven hatcheries are found around the Cox's Bazar district, out of which two hatcheries are located around the Sonadia Island

1. Sonadia East Village Beach, Maheshkhali, Cox's Bazar by CV*1BMP, MLA.
2. Sonadia West Village Beach, Maheshkhali, Cox's Bazar by CWBMP, MLA.

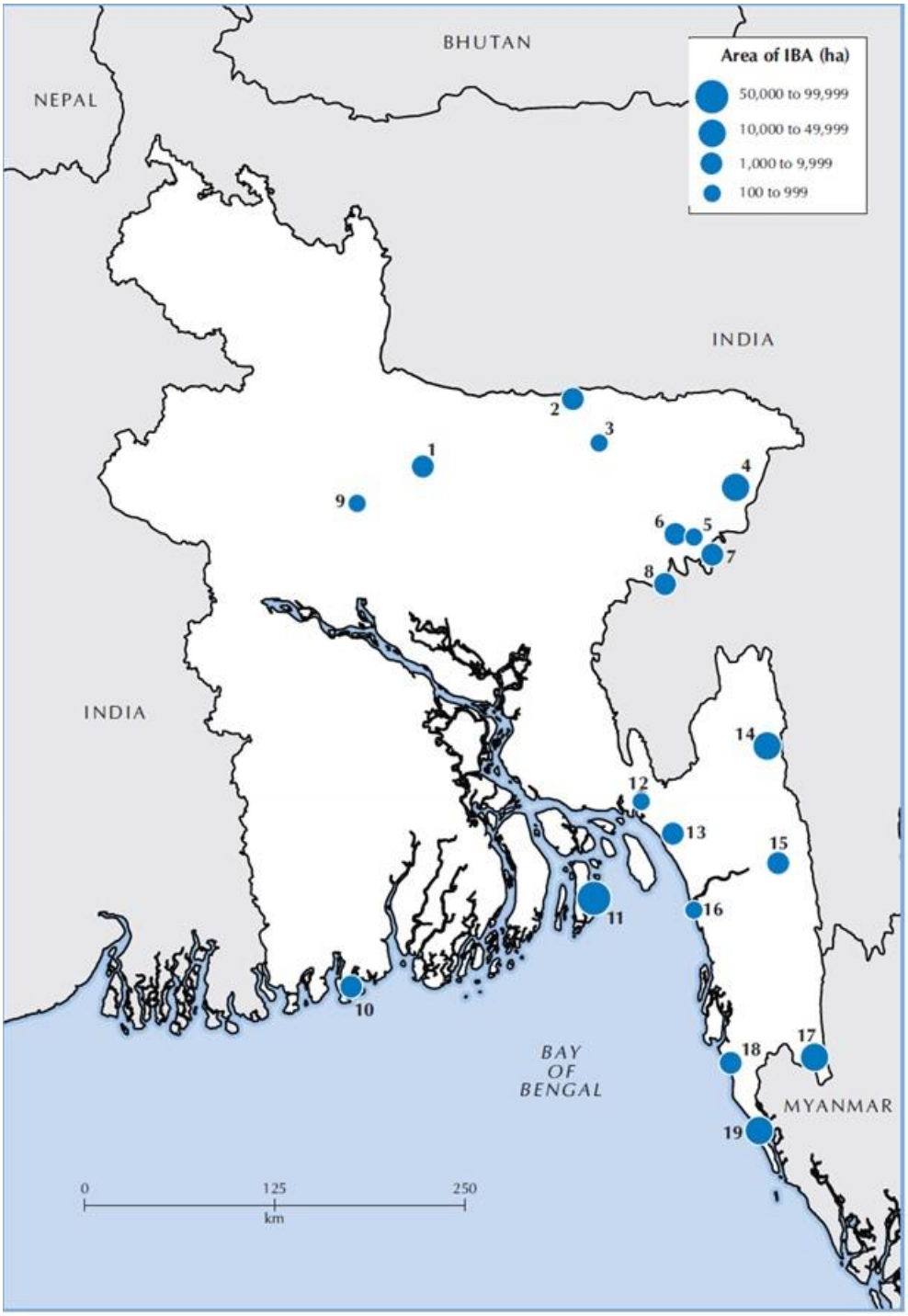
- **Suggested conservative measures/ planning considerations**

  - To conserve the turtles and to minimize the false crawling, the inclusion of nesting areas & protection while planning the Eco-tourism park needs to be considered. Planning of tourist's movement and circulation should not disturb the nesting ground, hatcheries and its return back way.
  - The metals have the capability to alter the earth's magnetic field which may alter the hatchlings imprinting. Hence, it is recommended to use the non-metals within the Eco-tourism park.
  - The High intensity lights also acts as a cause for false crawling. Hence, while planning it is recommended to propose dim lights within the park for the tourist's movement.
  - The eggs from nesting spots needs to be transmitted to the hatcheries within 2 hours. But the existing hatcheries are far away and there are only two hatcheries. Hence, it is recommended to increase the number of hatcheries and needs to be proposed nearby nesting grounds. It is recommended to provide shaded hatcheries which complies to the standards.

2) Birds

The spoon-billed sand piper which breeds in north-eastern Russia and the rare bird is seen during winter season at the Sonadia Island. The spoon-billed sandpiper is hurtling towards extinction. The spoon-billed sandpiper is facing imminent extinction as fewer than 100 pairs remain in the world. Sonadia Island has been declared as **20th Important Bird Area (IBA) of Bangladesh** by Bird life International. Sonadia Island also supports the globally endangered Nordmann's Greenshank, as well as other threatened birds such as Great Knot, Asian Dowitcher, Eurasian Curlew and Black-tailed Godwit. The map of IBA of Bangladesh is depicted in .

Figure 99: Map of IBA of Bangladesh



Source: *IBA data*

Commonly found bird's species in the project area are House Sparrow (Passer domesticus), Black Drongo (Dicrurus macrocercus), Pied Myna (Sturnus contra), Chestnut-tailed Starling (Sturnus malabaricus), Pale-bellied Myna (Acridotheres cinereus), Common Myne (Acridotheres tristis), Oriental Magpie-Robin (Copsychus saularis), Common Tailor Bird (Orthotomus sutorius), Common Pigeon (Columba livia), Eurasian Collared Dove (Streptopelia decaocto), Spotted Dove (Streptopelia chinensis), Red vented Bulbul (Pycnonotus cafer), Baya Weaver (Ploceus philippinus), White-breasted kingfisher (Halcyon smyrnensis), Common Kingfisher (Alcedo atthis), Chestnut-headed bee-eater (Merops leschenaulti), Asian palm swift (Cypsiurus balasiensis), Brown Fish Owl (Ketupa zeylonensis), Little Cormorant (Phalacrocorax niger), Indian Cormorant (Phalacrocorax fuscicollis), Little Egret (Egretta garzetta), Yellow-billed Egret (Egretta intermedia), Great Egret (Casmerudias albus), Cattle

Egret (Bubulcus ibis), Pond heron (Ardeola grayii), Indian River Tern (Sterna aurantia), Night Heron (Nycticorax nycticorax), Common Sandpiper (Actitis hypoleucos), Kalathot Panchil (Gelochelidon nilotica) etc. Various winter migratory species like Osprey (Pandion haliaetus), Eurasian Wryneck (Jynx torquilla), Black capped kingfisher (Halcyon pileata), Collared kingfisher (Todiramphus chloris), Common snipe (Gallinago gallinago), Bar-tailed godwit (Limosa lapponica), Common curlew (Numenius arquata) and many more. Critical avifaunal species like Spoon-billed Sandpiper (Eurynorhynchus pygmeus, IUCN Status: Critically Endangered), Nordmann's Greenshank (Tringa guttifer; IUCN Status: Endangered) have been recorded from study area by various expert studies.

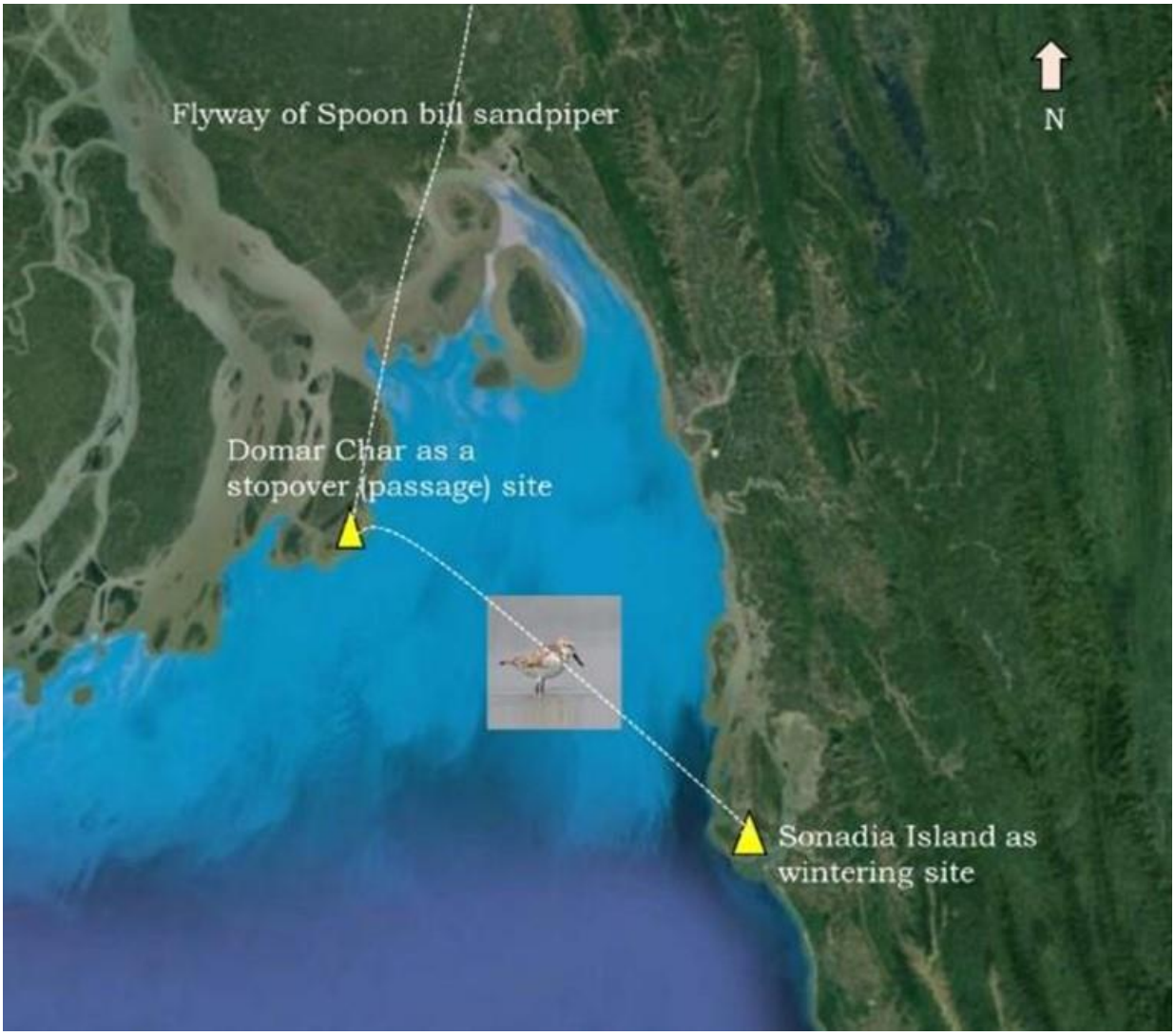
Sonadia Island known as an 'Island of miracle' acts as Paradise for Migratory Birds. Birds of about 70 species of migratory water fowl and shorebirds are visiting the site for resting, roosting, feeding and wintering.

Spoon bill sandpiper has a naturally limited breeding range in north-eastern Russia (Bird Life International 2001). They undertake long movements from their Arctic breeding grounds to warmer locations. It migrates down the western Pacific coast through Russia, Japan, North Korea, South Korea, mainland China, Hong Kong (China), Taiwan (China) and Vietnam, to its main wintering grounds in Bangladesh and Myanmar. Sonadia Island acts as a major withering ground. During winter, huge flocks of migratory birds gather to feed on the mudflats.

The feeding and resting grounds within the island are depicted below. It is observed that, the Feeding ground Taziakata present beside roosting ground Moghchar and feeding ground Kaladia present beside the roosting ground Belekardia. Roosting grounds are comparatively highland then the feeding grounds. The feeding grounds are marshy lands which serves the feeding requirement of the birds. They feed the insects, Fishes and Algae.

Sonadia Island acts as wintering site and the Domar Char in the NW direction of the Island as depicted in the following Figure acts as a stopover (passage) site for the migratory birds from north-eastern Russia.

Figure 100: Travelling path of migratory birds



Source: *MACE analysis*

- **Existing conservative measures**

The Bangladesh Spoon-billed Sandpiper Conservation Project has been working with Birdlife International to ensure that Sonadia Island's conservation importance is recognized. It is excellent that Sonadia has been given global recognition through being declared the 20th Important Bird Area (IBA) of Bangladesh by Birdlife International.

To conserve the species in Sonadia East Para, Sonadia West Para, Tajiakata, Ghotivanga, Borodia and Maheshkhali, some conservation initiatives have been already taken by the Bangladesh Forest Department.

- A voluntary bird protection team under Bird Protection Committee (BPC) has been formed which consist of 06 members. Team members have been chosen based on migratory birds feeding and roosting sites.
- School campaign and awareness program was given to the locals and 90 multi-disciplinary stakeholders received Alternative Income Generation (AIG) training.

- **Suggested conservative measures**

The various conservative measures which needs to be considered while planning / developing the Eco-tourism park in the island are as follows:

- Mudflat is the core feeding and roosting ground for the birds. Hence, it should be free from plantation or any developments. Coastal forest conservators are expanding the mangrove coverage to improve the bio-diversity of the area. Hence, it is recommended that the Plantation can be done only in the sand dunes not in the mudflats/Feeding/Resting grounds in order to conserve the mudflat habitat.
- It is planned to provide buffer area from the Feeding & resting ground of bird while planning. Also, it is recommended to restrict the movement of tourists within this buffer area to make the birds not to get disturbed due to tourist's movement. Accordingly, the bird watch tower/view area will be planned outside the buffer area.
- It is planned to propose only dim lights in the tourist's circulation area.

3) Crabs

➢ Different species of crabs

Sixteen species of crabs have been so far reported from Bangladesh waters, of which the common ones are Scylla serrata, Portunas pelagicus, P. sanguinolentus, Charybdis feriata, Charybdis rostrata, Matuta lunaris, M. planipes, Clappa lophos, C. pustulosa, Varuna litterata, Sartorina spinigera, Ocypoda cratopthalma, and Gelasimus annulipes. The six important genera used as food crabs are Scylla, Portunus, Charybdis, Matuta, Varuna and Sartorina.

Various species of portunid crab, Mud Crab and Blue Swimmer Crab are available in the Island. The most important species is the Indian Horseshoe Crab or King Crab, which is listed as a threatened species by IUCN. This species possesses high immune system and its blood can be used to treat cancer.

Red crabs are seen all along the coastal area of Bangladesh. Scrambling of red crabs on the sand dunes is a unique beauty of Sonadia Island. The sandy shore is the habitat for numerous red crabs. When undisturbed, one can observe the crabs moving around, going into the water, digging a nest in the beach. However, with the slightest movement on the outside, they will disappear into the sand in a blink.

Various research and record shows that there is vanishing of red crabs in many places along the coast and sea beaches due to Human disturbances and movement.

➢ Cause for existence in Island

Red crabs are seen all along the sea beaches and coastal areas of Bangladesh most predominantly in Kuakata Sea beach, St. Martin island and Sonadia island. Due to tourist's movement and noise pollution, the red crabs in Cox's Bazar beach reduces. Sonadia island remains calm & undisturbed due to human activities which favours the existence of different species in the island.

Crabs form a dominant aqua-terrestrial fauna in the estuary and intertidal zones, particularly of the Mangrove ecosystem. Due to the existence of mangroves in the Island, there are existence of Red crabs.

Crabs are scavengers, feeding on detritus feeders like polychaetes, crustaceans, molluscs, and dead fishes. They are opportunistic omnivores, carnivorous, but the graspid crab Varuna litterata is mainly herbivorous. The bio-diversity pattern of sonadia island favours the feeding habit of Crabs.

➢ Conservative measures

- Red crab is in the "least concern category" on the red list for Bangladesh of International Union for Conservation of Nature (IUCN) which needs to be altered and the species needs to be protected.
- The Red crabs will act as most attracting factor for tourists. Being the most sensitive species, the human activities or movement should not disturb it. Hence, it is planned to propose the developments and tourists' movement/circulation activities without disturbing the species and will be away from the Red crab crowded area (Sandy shore area).
- Due to availability of different species of crabs, the crab culture zone/museum can be proposed which will act as economic activity as well as tourist's attraction to visit different varieties of crabs.
- Eco food stalls can be proposed where the tourists can enjoy the edible species of crabs.

4) Fishes

Fishes recorded from area are Lote (Harpadon nehereus), Churi Fish (Trichiurus lepturus), Ilish (Hilsa ilsa), Bhola/Poa (Pama pama), Air (Sperata aor), Bele (Awaous grammepomus), Bhetki (Lates calcarifer), Kharu (Pisodonophis boro), Spined anchovy (Stolephorus tri), Speigler's mullet (Valamugil speigleri), Spottail needlefish (Strongylura strongylura), Ambassis sp, Tailla (Eleutheronema tetradactylum), Bele (Glossogobius giuris, Awaous grammepomus), Lal Chewa (Odontamblyopus rubicundus), Sada Chewa (Trypauchen vagina), Borguni (Terapon jarbua), Koi (Anabas testudineus), Bengal Tongue Sole (Cynoglossus cynoglossus). Other species like Golda Chingri (Macrobrachium rosenbergii), Badga Chingri (Penaeus monodon), Harina Chingri (Metapenaeus Monoceros), various crabs, snails, etc. are also found in abundance.

5) Others

Beside domesticated mammals like cow, buffalo, goat, dog, cat etc., the recorded mammalian species from the project and its surrounding are Jackal (Canis aureus), Wild cat (Felis chaus), Common Otter (Lutra lutra), House shrew (Suncus murinus), Mole Rat (Bandicota indica), House Rat (Rattus rattus), Squirrel (Callosciurus pygerythrus), Indian Flying Fox (Pteropus giganteus), Indian Pipistrelle (Pipistrellus coromandra). Sighting of Indo-Pacific Bottlenose Dolphin (Tursiops aduncus, IUCN Status - Data Deficient) is recorded from the study area as well.

Commonly seen herpetofauna are Southeast Asian toad (Bufo melanostictus), Green from (Euphlyctis cyanophlyctis), Cricket frog (Fejervarya sp), garden lizard (Calotes versicolor), Skink (Mabuya mabuya), Gekko (Gekko gecko), House Lizard (Hemidactylus brooki), Indian Black Turtle (Melanochelys trijuga), Median Roofed turtle (Pangshura tentoria), Common Vine snake (Ahaetulla prasina), Checkered keel back (Xenocrophis piscator), Cobra (Naja naja) etc. Endangered (IUCN) species like Spotted Pond Turtle (Geoclemys hamiltonii) has been recorded here as well.

Spoon-billed sandpiper (Calidris pygmaea)

Common Sandpiper (Actitis hypoleucos)

Asian Palm Swift (Cypsiurus balasiensis)

Pond Heron (Ardeola grayii)

Little egret (Egretta garzetta)

Number of species gathered around Fish Trap

Drongo (Dicrurus macrocercus)

Kalathot Panchil (Gelochelidon nilotica)

Lote Fish (Harpadon nehereus)

Churi Fish (Trichiurus lepturus)

Olive ridley turtle (Lepidochelys olivacea)

Horseshoe crab (Limulidae)

Uri / Dhonshi Grass grown on Char land

Kalo Bain (Avicennia officinalis) & Sada Bain (Avicennia marina)

Coconut Tree (Cocos nucifera)

Palm Tree (Borassus flabellifer)

11.6.6. Key facts about mangroves and global significance

- Mangroves are extraordinary ecosystems, located at the interface of land and sea in tropical regions, which offer a considerable array of ecosystem goods and services.
- Although they are found in 123 nations and territories, mangrove forests are globally rare. They represent less than 0.4% of all tropical forests worldwide, and less than 0.4% of the total global forest estate.
- Mangroves are disappearing three to five times faster than overall global forest losses, with serious ecological and socio-economic impacts.
- Management and restoration of mangrove ecosystems is an achievable and cost-effective way to help ensure food security for many coastal communities.
- These forested wetlands are rich in biodiversity. They provide a valuable nursery habitat for fish and crustaceans; a food source for monkeys, deer, birds, even kangaroos; and a source of nectar for honeybees. They support complex communities, where thousands of other species interact.
- Healthy mangrove ecosystems are vital for the wellbeing, food security, and protection of coastal communities worldwide.
- Mangroves can play an important role in reducing vulnerability to natural hazards and increasing resilience to climate change impacts.
- Mangroves act as a form of natural coastal defence: reducing erosion, attenuating waves (and tsunamis) and even reducing the height of storm surges.

Global effort for conservation of mangrove

- Mangroves for the Future (MFF): The devastation caused by the Indian Ocean tsunami of December 2004 laid bare the vital link between coastal ecosystems and human livelihoods. It was United States President Bill Clinton's vision that rebuilding in tsunami-hit areas should improve natural infrastructure and strengthen resilience against future natural disasters. In response to this vision, IUCN (International Union for Conservation of Nature) and the United Nations Development Programme (UNDP) developed Mangroves for the Future in 2006. Since then, MFF Project has grown to include eight institutional partners, plus a member country like Bangladesh, Cambodia, India, Indonesia, Maldives, Myanmar, Pakistan, Seychelles, Sri Lanka, Thailand, and Viet Nam. The objective of MFF is to achieve its goal of conservation, restoration and sustainable management of coastal ecosystems as key natural infrastructure which support human well-being and security

- 2016 marks UNESCO's first celebration of the International Day for the Conservation of the Mangrove Ecosystem. The proclamation of this international day, which was adopted on 6 November 2015 by the General Conference of UNESCO, underlined the importance of mangrove ecosystems as "a unique, special and vulnerable ecosystem, providing by virtue of their existence, biomass and productivity substantial benefits to human beings, providing forestry, fishery goods and services as well as contributing to the protection of the coastline and being particularly relevant in terms of mitigation of the effects of climate change and food security for local communities."

11.7. Social environment

BEZA is having the ownership of the total Island. The Ministry of land has already handover the land. A survey of land ownership on Sonadia Island found 84% of the population were landless, 8% owned between 6-10 acres (DoE, 1998), however officially most land within the site is public (Khas) land, some are owned by the Coastal Forest Department and only a very small amount of land is privately owned.

11.7.1. Demography

According to IoL survey (inventory of losses, 2019) total 394 households have been living here. Of the 1762 PAPs, 894 were males and remaining 864 were females. The demographic data as tabulated indicate that the females constitutes 49% of the total project affected populations while the males constituted 51% and it can be said fair distribution.

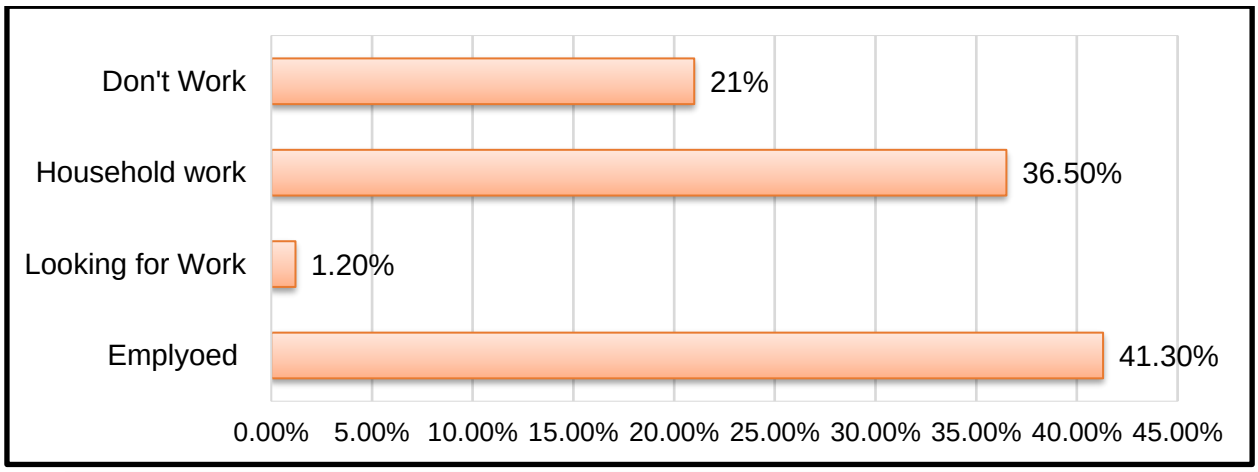
The literacy rate in the Maheshkhali area around 30.8 percent (Male 30.5%, Female 31.1%) whereas national figure is 51.8 percent. School Attendance (5 to 24 years) is around 40.6 percent in the project area, whereas the national figure is 52.7. The literacy rate has increased 8% during the last decade. Amazing indeed! Female are the slightly ahead in literacy rate and school attendance rate is faster than male as well. Male female discrimination is found in urban and rural area where male is ahead in both area. Female representation is very minimal in higher education. The literacy rate is also increasing fairly quickly.

But the literacy situation in the project area is very grave, among the total population, 2% have achieved secondary level of education whereas 25% of the population has achieved primary level of education. Uneducated populations comprise of 73% of the total PAPs. The low education levels emphasize the need for stress on technical education and skill enhancement programs in the region. At present, only 1 primary schools (Sonadia Primary School), 1 NGO run school and 1 madrasah exist in this area for half of the population of Sonadia). Lack of interest and understanding the importance of education the local people give little focus on educating their children, this approach should be removed.

11.7.2. Livelihood and economy

According to BBS 2011, 41.30% people are employed, and the household work occupied second position (36.5%) where fame are sole dominant. it is unfortunate that 21% people have no work for earning income Very negligible numbers of women get opportunity in formal sector.

Figure 101: Distribution of percentage of population by employment status



Source: *BBS, 2011*

The main occupations of the people are catching fish, gathering of shrimp and another minnow etc. Fishermen set up temporary camps on the island and dry sea fishes during winter. Many people work as wage labourer in salt pan and fish pond. More than hundreds acre of land used in salt cultivation and simultaneously for shrimp cultivation. Some twenty families have been farming buffalo for generating income and employment. Every winter some of fishermen camp there and make great drag for drying fish.

Doing agriculture is third dominant occupation, 13% people solely depend on agricultural activities they produce rice and water-melon particularly and work as day labourer in salt production and shrimp cultivation. Most of the profession has seasonality. Few people have engaged with business profession.

Some people run their livelihood by driving engine boat and craft and also work as assistance. It is observed people of teen aged take fishing profession without taking basic education.

11.8. Impact assessment and proposed mitigation measures

The environmental impact assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities. The proposed project involves development of tourism facilities and off-site facilities for upcoming Eco Tourism Park in Sonadia. Potential environmental impacts associated with tourism developments are classified as:

- Impacts during design/preconstruction phase
- Impacts during construction phase and
- Impacts during operation phase

At detailed master plan stage, based on the nature of upcoming facilities, the likely impact on surrounding environment have been covered in the report. However, the detailed analysis of specific impacts on basis of scale and magnitude of the individual developments should be carried out at later phase of design along with more specific mitigation measures. During the study Sensitive environmental components were identified during the site visits and qualitative and quantitative techniques have been applied for direct and indirect assessment of impacts on these components. The classification of environmental components is provided in the table below.

Table 69:Classification of social and environmental components

Components	Sub-component	Parameters
PHYSICAL Water	Surface water	Hydrology, water quality

Components	Sub-component	Parameters
	Ground water	
Air	Air	Air quality
Noise	Noise	Noise level
Land	Soil	Erosion, soil quality
ECOLOGICAL		
Aquatic/Marine	Fisheries/ Aquatic species	Species, diversity, economic value
Terrestrial	Aquatic/Marine Biology	Density, species
	Vegetation	Species, population
	Wildlife	Species, population
INFRASTRUCTURE		
Water Supply	Surface/ground water	Frequency, quality
Electricity	—	Generation, Transmission, requirement, Access, availability, type, utility of each mode
Transport	Highways/Roads	
	Rail	
	Air	
Land use		—
Drainage	Water	Flooding, drainage

11.8.1. Impact identification

During the site visit, various environmental sensitive features were identified which may potentially be impacted by the project at various stages. Identified impacts of the project activities on the environment components are given below along with the associated activities.

Table 70: Impact matrix for proposed off-site infrastructure

S. No.	Activities	Impacts	Negative impact		Positive impact		Not applicable
			Short term	Long term	Short term	Long term	
A	**Pre-construction phase**						
i	Land acquisition for site, access road and utility supply system	Change in land use pattern		√			
		Impact on livelihood		√			
		Shifting of utilities	√				
ii	Site Preparation	Removal of Vegetation		√			
		Impact on aesthetic aspects		√			
		Impact on estuary		√			
B	**Construction phase**						
i	Development of Eco Tourism Park and construction of	Loss of top soil		√			
		Soil contamination due to spillage of material	√				

S. No.	Activities	Impacts	Negative impact		Positive impact		Not applicable
			Short term	Long term	Short term	Long term	
	boundary wall, embankment, access road, electrical & water supply system and administration building	Surface water contamination	√				
		Air pollution	√				
		Noise pollution	√				
		Increase in traffic	√				
		Un pleasant view	√				
		Impact on health & safety	√				
		Social impact	√			√	
		Removal of trees	√				
		Disturbance to estuarine brackish ecosystem		√			
		Loss of mangrove vegetation		√			
C	**Operational phase**						
i	Development of off-site infrastructure, i.e. boundary wall, embankment, access road, water supply system, electrical supply line and administration building and operation of industries	Impact on the ambient air quality		√			
		Noise pollution		√			
		Potential surface/ marine water pollution due to industrial waste discharge		√			
		Impact on river hydrology due to construction of long embankment along the river/super dyke structure along shoreline		√			
		Disturbance to estuarine brackish ecosystem		√			
		Economic Development				√	
		Accessibility				√	
		Groundwater depletion		√			
		Potential for land contamination due to industrial activities		√			
		Increased Run-off		√			
		Generation of				√	

S. No.	Activities	Impacts	Negative impact		Positive impact		Not applicable
			Short term	Long term	Short term	Long term	
		Employment					
		Natural drainage pattern		√			

11.8.2. Impact on climate and meteorology

Pre-construction, construction and operation phase

Proposed project site is located in tropical region where summers are much rainier than winter. Though no change in the macro-climatic setting (precipitation, temperature and wind) is envisaged due to the project, the microclimate is likely to be temporarily modified by vegetation removal, the addition of increased pavement surface and tourism operation which in turn might lead to rise of temperature especially during the daytime.

Mitigation measures

- 10 to 40% greenery/open space inside the tourism park has been recommended
- Plantation shall be carried out at suitable location to minimize impact on micrometeorology

11.8.3. Impact on land and natural drainage

Pre-construction and construction phase

A major part site remains submerged in high tide twice in a day. The preconstruction and construction phase will involve backfilling of the land to a level higher than the High Flood Line (HFL) of the nearby area with respect to the site to keep the eventual site ground level more than the high flood level ever recorded. Moreover, to prevent tidal blow, an embankment has been proposed all along the periphery of the proposed development area for the proposed Eco-tourism Park of Sonadia Island. It will hinder mixing of fresh and marine water that naturally occurs in the estuarine zones. At present, the land-use of proposed site is predominantly mangrove-salt/silt zone.

The impacts on land due to the project are as follows:

- Dredging and landfilling activity
- Removal of mangrove vegetation
- Construction of embankment and hindered mixing of fresh and marine water
- Soil erosion due to vegetation clearance and excavation activities
- Topsoil degradation
- Generation of waste (hazardous and non-hazardous) from site clearance, excavations, civil works and activities of construction workers (general waste and sewage)
- Possible contamination of soil due to potential spills of lubricating oil, fuel oil, concrete etc.
- There could be alteration with the natural water flow pattern of the subject site due alteration of the natural contours. It may create problem pertaining to water logging, soil erosion, contamination of soil

Soil erosion

During the pre-construction and construction phase, the site clearance activities including clearing of vegetation, construction of the structures, labour camps, storage area, toilets will involve removal of top soil which will result in slope destabilization and the land will be more susceptible to soil erosion.

The soil erosion will result in the run-off of the silt to surface water affecting estuarine and marine ecosystem with increased suspended sediment load and associated nutrients.

Most importantly after landfilling, if the land is be kept for long without further development, it leads to soil erosion due to loose top soil.

Soil compaction

During construction activities, there will be compaction of soil in the project area due to construction of the internal access roads, movement of vehicles/ construction machinery and work force movement. The soil compaction would impact the soil physical properties such as reduction in pore spaces, water infiltration rate and soil strength etc. The extent of soil compaction is primarily limited to the Project foot print area and surroundings within 100 m distance. The impact is restricted to the construction phase of the project.

Landfilling with dredged material

The project site is located in low lying area and landfilling above the high tide level will be done during site development activity. It is proposed that sand for the backfilling operations will be obtained by dredging from the Bay of Bengal. Dredging activity may be carried out near the site location or away from site. Dredging activity will have two-fold impacts - firstly as a result of the dredging process itself and secondly as a result of the landfilling of the dredged material. Impacts during dredging are given in the later section.

In case the soil quality at dumping site is different from the sediment from the dredging sites, the ultimate soil quality of the disposal site can be affected. The soil used for landfilling should be free of any type of contamination and have similar characteristics as that of native soil to avoid impacts on the soil quality.

Waste generation

The construction waste generated onsite comprises of materials such as excavated soil, rocks, concrete, wooden pallets, steel cuttings/filings, packaging paper or plastic, wood, metals etc. Municipal domestic wastes consisting of food waste, plastic, glass, Aluminium cans and waste paper will also be generated by the construction workforce and labour camp site.

The waste generated during the construction phase will also include hazardous waste such as used oil, hydraulic fluids, waste fuel, grease and waste oil containing rags. If improperly managed, solid waste could create impacts not only to land but also to local air quality, water quality, and human health. Since the site will be raised above the high tide level, it is likely that the surface run off from site surrounding area will be drawn to the nearby surface water system and marine water. From the drainage pattern it is observed that, in general the flow of the surrounding area will be towards the Maheshkhali channel, eventually to the sea. If the waste and raw material are poorly managed, it will also be carried away by surface run off, which will eventually contaminate the aquatic system.

Soil contamination

Soil contamination during the construction phase may result from filling activity, leaks and spills of oil, lubricants, or fuel from heavy equipment and wastewater. Such spills could have a long-term impact on soil quality but are expected to be localized. Storm water run-off from the contaminated area can pollute the downstream soil and water quality of adjacent river, other waterbodies and sea.

Spill control measures such as the storage and handling of chemicals and fuel in concrete areas with secondary containment will be implemented to minimize impacts in the event of a spill.

The soil characteristics of the native soil may also be changed due to import of soil for filling and levelling purpose. It is envisaged that the filling activity may impact the native soil due to spillages during transportation of soil and run-off during filling and compaction. Apart from the embedded controls to be included in project design, the following mitigation measures will reduce the negative impacts on soil environment:

Mitigation measures

- Top soil should be preserved and should be reused in borrow area or green area development
- Stripping of topsoil should be scheduled as the last mile activity (maintain vegetation cover for as long as possible) in order to prevent the erosion (wind and water) of soil;
- Care should be taken to minimize percolation of soil used for filling to adjacent rivers and sea during filling operations. Proper embankment should be provided in the downstream areas to minimize soil percolation to rivers. Proposed embankment will also help to avoid soil erosion due to tidal influence.
- Provision for channels at suitable locations should be kept maintaining flow of marine water towards the riverine system.
- Vegetation should be planned and maintained for slope stabilization and to prevent soil erosion after construction period;
- The disturbed areas and soil stock piles should be maintained moist to avoid wind erosion of soil;
- The routes for movement of heavy machinery should be designated to avoid the soil compaction in other areas;
- Transport vehicles and equipment should undergo regular maintenance to avoid any oil leakages; designate routes for bringing construction material and outside soil;
- Construction contractor should designate the sites to be used for storage of hazardous wastes including waste oils, solvents, paint and batteries;
- The Contractor should ensure that no unauthorized dumping of hazardous waste is undertaken, and contractor should dispose of hazardous waste through licensed traders;
- Fuel and other hazardous substances should be stored in areas provided with roof, impervious flooring and bund/containment wall;
- The soil used for landfilling should have similar characteristics to the native soil and free of any type of contamination.
- Prior to dredging activity, analyse the soil sample to prevent impacts on the receiving environment as a result of mismatch in soil characteristics;
- During dredging activity, physical barriers such as silt screen/ curtains should be employed to prevent the spread of suspended sediments;
- The storm water drainage system shall be designed in synchronization with the existing natural drainage pattern. The direction of the flow shall be engineered to be same as that of the natural flow direction of rain water;
- The construction debris and high silt content of the virgin soil, post excavation, should be kept in a designated location so as to prevent leaching during monsoons. Storm water drains shall be designed and shall be connected with rainwater harvesting pits. All the construction wastes, and excavated soil shall be temporarily stacked on tarpaulin sheet (in order to prevent leaching to groundwater) and a temporary tin sheet shall be placed on the top to prevent rainwater to maximum extent to carry the soil and construction wastes to the adjacent aquatic system
- To demonstrate the commitment towards better environment, 40% of total area has been designated for green and open spaces. These green areas shall be declared as the green zone of the Tourism Park.
- Based on drainage pattern study it was seen that surface run off from northern side will be towards the effective planning area site. Hence, it is recommended to provide peripheral

structure to collect and divert the surface runoff from the surrounding area in Northern side protect the site

- Based on the site gradient, the drainage pattern has been decided. It has been planned to discharge the flow of the internal drain into nearby highway drain to be developed.
  - The drainage system is planned to cater for the entire Eco-tourism park through gravity flow.
  - Drains are proposed to be provided on both sides of the roads.
  - Open trapezoidal drain is considered for the surface run off collection due to easy maintenance for the primary road. Stone pitching is considered for the side walls and PCC for the base.
  - Covered rectangular brick masonry drain is considered for the remaining areas for optimization of area under drainage.
  - RCC box / pipe culverts of suitable sizes are considered for road crossings.
  - Rainwater harvesting structures are envisaged all along the drain at every 30m interval.

11.8.4. Impact during operation phase

Impact on soil quality

After development of Eco-tourism park, disposal of waste may contaminate land and soil quality of the area. The impact can be significant and long term in case of uncontrolled discharges. Improper disposal of waste may degrade soil, water, air quality and ecology of the area. As per the proposed plan, it is recommended to have well managed solid waste collection system within the Eco-tourism park and the collected waste shall be transported outside the Island for treatment. It is suggested to transport the collected waste to the proposed solid waste dumping yard by Cox's Bazar development authority in the Maheshkhali upazila.

Waste generation

The nature of solid waste likely to be generated in the Eco-tourism park are domestic, kitchen and garden waste. While collecting the waste, source segregation shall be complied through provision of different bins. Sludge generated from STP shall be dried using a filter-press and the dried sludge could be used as manure. If improperly managed, waste could pollute not only to land but also to local air quality, water quality, human health and the rich estuarine ecosystem. Hence, it is suggested to have an efficient and well managed solid waste collection system within the Eco-tourism park.

The estimation of solid and sewage waste likely to be generated have been presented in subsequent sections.

Table 71: Estimation of solid waste generation

Component	Area in acres	Built-up area in sq.m	Population	Solid waste generation quantity (kg/day)
Entrance zone	35.44	-	400	241
Pavilion	7.83	-	200	20
Arts & craft village	20.71	31593	500	236
Star hotel	31.52	-	340	394
Hospitality zone	175.88	-	3260	2442
R&D Centre	25.12	-	200	199
Golf Course	72.72		190	38
Adventure zone	170.12	-	3094	309
Botanical Garden	192.79	-	-	1820

Open garden	21.92	-	-	266
Eco-science zone 1	132.22	-	2600	1643
Eco-science zone 2	9.13	-	363	123
Connecting roads	14.01	-	-	57
Total	**909.41**	**31593**	**11147**	**7789**
	Total estimated solid waste quantity in TPD			**7.79**

Source: *MACE analysis (sum total figures might have minor aberrations due to rounding off of the decimals)*

Apart from the solid waste, there are sewage and sullage which will be generated during the operational phase of the Eco-tourism park. This waste water needs to be treated properly and generated treated water should be of good quality which should meet the standards such that it will not create any negative impact on the land, air or water quality. This treated water shall be utilised to meet the non-potable water requirement of the Eco-tourism park for the purpose of gardening, cleaning, fountains and landscaping etc.,

The estimated quantity of sewage and sullage quantity generation within the Eco-tourism park is provided in the following table.

Table 72: Sewage generation estimation - Component wise

Sl. No.	Types of zones	Potable demand (cum/day)	Non-potable demand (cum/day)	Total water demand (cum/day)	Total sewage quantity (cum/day)
1	Entrance zone	3.63	926.92	930.55	5.77
2	Heritage and hospitality zone	119.32	141.71	261.03	144.42
3	Knowledge centre zone	13.81	62.82	76.63	20.81
4	Family entertainment zone	40.93	12.14	53.07	10.66
5	Adventure zone	1355.95	22.66	1378.61	44.04
6	Eco science zone	251.09	127.90	378.99	78.14
7	Public amenity	254.83	131.27	386.10	296.01
	Total	2039.55	1425.42	3464.97	599.85
	Total in MLD	**2.04**	**1.43**	**3.46**	**0.60**

Source: *MACE analysis (sum total figures might have minor aberrations due to rounding off of the decimals)*

The quality of treated wastewater for reuse as per CPHEEO standards is provided in the following table.

Table 73: Quality standards for treated wastewater for reuse

S.No.	Parameter	Toilet flushing	Fire protection	Vehicle exterior washing	Non-contact impoundments	Landscaping, Horticulture & Golf-course
1)	Turbidity (NTU)	<2	<2	<2	<2	<2
2)	SS	Nil	Nil	Nil	Nil	Nil
3)	TDS	2100				
4)	pH	6.5 to 8.3				
5)	Temperature ^{o}C	Ambient				
6)	Oil and grease	10	Nil	Nil	Nil	10

7)	Minimum residual Chlorine	1	1	1	0.5	1
8)	Total Kjeldahl Nitrogen as N	10	10	10	10	10
9)	BOD	10	10	10	10	10
10)	COD	AA	AA	AA	AA	AA
11)	Dissolved Phosphorous as P	1	1	1	1	2
12)	Nitrate Nitrogen as N	10	10	10	5	10
13)	Faecal Coliform in 100 ml	Nil	Nil	Nil	Nil	Nil
14)	Helminthic eggs/litre	AA	AA	AA	AA	AA
15)	Colour	Colourless	Colourless	Colourless	Colourless	Colourless
16)	Odour	Aseptic which means not septic and no foul odour				

Source: *URDPFI guideline, January 2013 (Manual on sewerage and sewage treatment systems, CPHEEO 2013)*

Mitigation measures

- **Provision shall be made for proper collection and handling of waste.**
- **Special care must be taken to avoid any kind of accidental contamination which a threat to the surrounding estuarine and marine eco-system could be.**
- **Provisions shall be made to segregate e-waste with rest of the wastes generated.**
- **Alliance shall be done with e-waste recycling vendor and the segregated e-waste shall be send to the vendor for recycling purposes.**
- **Based on estimated quantity of sewage and effluent, a Sewage Treatment Plant (STP) of 0.19 MLD capacity have been proposed.**
- **Waste should be segregated at source into bio-degradable and non-biodegradable wastes. This shall be transported to the proposed dumping yard which is in Maheshkhali area.**
- **No hazardous/polluting materials/plastics should be allowed to enter the Island which should be monitored at the entry.**

11.8.5. Impact due to super dyke

The proposed site is in a location which is vulnerable for flooding during high tide. The major part of the site remains submerged twice a day during high tide due to the proximity of Bay of Bengal. The inundation is due to rise of water during heavy flow in the adjacent water channel owing to backwater from Bay of Bengal during High tide. Moreover, the Maheshkhali water channel & its major branch flows along the eastern side, southern side & northern side and Bay of Bengal forms the western boundary. There is natural mixing of Bay of Bengal and Maheshkhali water channel. Along the channel, there are some portions of char land with eco-system. The area supports significant growth of various mangrove species as well.

A super dyke structure cum road has been proposed all along the periphery of proposed development area of Eco-tourism park to protect the Eco-tourism park from inundation during high tide and heavy flow in water channel. The total length of the proposed embankment (Super Dyke) works out to 17 km and the suggested top level of the embankment (Super Dyke) are +4.50 m on seaside and +6.00 m on water channel side. These two levels of embankment are proposed based on existing terrain nature/profile of the planning area in which seaside is raised and water channel side is low-lying. This structure will have significant impact on the tidal flow and generation of char land. It may eventually cause decline in mangrove species population, which will be irreversible in nature.

As a mitigation measure, parabolic curve of embankment profile has been proposed in order to attain a smooth flow of approaching tides/water during heavy flow. This will also help to avoid scouring or rupture of area.

Mitigation measures

Though the impact due to the structure is likely to be irreversible in nature, following measures must be taken as a compensatory act and an effort to negate the impact to some extent -

- It is suggested to do plantation on the area which falls between the Eco-tourism park and the water channel.
- Parabolic curve of embankment profile has been proposed in order to attain a smooth flow of approaching tides/water during heavy flow. This will also help to avoid scouring or rupture of area.

11.8.6. Impact due to proposed developments

Pre-construction and construction phase

During the stage of construction, there are requirement of transporting the raw materials for construction through heavy vehicles. This may cause noise and air pollution. Also, the vibration may cause panic to the sensitive animals of the Island such as turtles and red crabs. The labours for construction shall also disturb the existing features and ecology of the Island. There will be generation of more construction waste while development. The usage of vibratory machines for mixing/handling of concrete /cement/ any other material during construction may disturb the migratory birds, turtles, red crabs and other bio-diversities of the island.

Mitigation measures

The various compensatory actions and efforts to negate the negative impact to some extent are as follows:

- It is recommended to carry-out the construction works during the non-visiting season of migratory birds.
- It is recommended to carry out the construction activities away from the birds nesting and feeding ground, turtles nesting area and red crab crawling area. Accordingly, suitable buffers have been considered and components are distributed away from sensitive areas.
- The movement of heavy vehicle can be limited and scheduled in a diversified manner. Hence, horn is not required and speed of movement of vehicles shall be limited to reduce the vibration due to movement. It is recommended to use CNG vehicles to avoid air pollution or smoke.
- Suitable techniques shall be adopted to reduce the accumulation of smoke and dust during construction.
- Recommended to instruct the labours about do's and don'ts' s within the Eco-tourism park before commencing the Construction. Also, they shall be transported through NMT vehicles.

Operation phase

The tourism-based project will attract lot of public gathering simultaneously within the Island, which create chances for noise pollution and land/water pollution due to throwing of plastics and other wastes. There are chances for disturbing existing bio-diversities and ecology of the island. Also, the development of concrete structure within the park will result in increase in temperature of the area which may disturb the existing bio-diversities of the Island. The vibration due to wet and dry rides, usage of high intense lights and motorised vehicles may affect the existing species and features of the Island. There are chances for intrusion of public to the sensitive areas and may disturb it.

11.8.7. Impact on environment due to proposed components

It is to be noted that the total study area of Sonadia island is 8976 acres out of which 909.4 acres have been delineated as proposed area for development of Eco-tourism park with a view of not disturbing sensitive features of the Island. Even though, 909.4 acres has been identified as Master plan area, only 6% (58 acres) has been planned with buildings the remaining area are planned as green & open space, walkways, fountains and landscape etc., Around 60% (540 acres) of area has been planned with Green & open space and water related components such as musical fountains, water pools etc., This infers that the existing land use profile/nature of Greenspace and water body are replicating more in the Eco-tourism park.

It is found that the proposed building component of 58 acres is just 0.6% of total study area of Island (8967 acres) which will act as high dense gathering spot of tourists. Hence, this will not have much negative impact on environment due to its minimal area concentration in a very large space. Also, these buildings are spatially distributed and are planned away from the sensitive area.

Another high dense component where lot of public gatherings will occur are amusement park wherein wet and dry rides are there which may cause vibration, noise pollution, solid waste disposal and air pollution due to use of motorised equipment & machineries to drive the rides. To minimise the negative impact, it is planned to disperse the huge gathering. Accordingly, wet rides and dry rides are spatially separated, and botanical garden is planned in between the spots to reduce the negative impact on environment.

Eco-science zones are planned away from birds gathering spot with required buffer of 500 m. There is an elevated skybridge with telescope provisions for bird watching without disturbing it. The Eco-cottages planned to see the turtle watching is less dense and the other zones/components planned within the Eco-tourism park are more of Green & open space with less public gathering which will not have any impact on Environment.

Mitigation measures

The various compensatory actions and efforts to negate the negative impact to some extent are as follows:

- The people shall be instructed regarding Do's and Don'ts within the Eco-tourism park before entering the park.
- Usage of plastics and spitting on public place shall be banned and imposed with penalty.
- Only NMT mode of vehicles are allowed within the park.
- The building footprints are very minimal which is just 6% of total developable area. Also, these are spatially distributed well.
- The wet and dry rides area proportionate is very minimal and is placed far away from sensitive areas which will not have much impact due to its distance apart.
- The operating machineries of rides should be well maintained with minimal smoke ejection & noise emission by using lubricants.
- The visitors who are going for trekking within the mangrove area are instructed about the do's and don'ts before commencing their trekking. Also, the only limited number of people shall be allowed in each batch of trekking with guide.
- Similarly, the people who are staying and visiting the turtles nesting and hatchling are also instructed before commencing their visit. They can also watch the red crabs crawling at their footsteps on the shore.
- People who would like to watch the migratory & native birds of Sonadia Island and beautiful sea view, sunrise and sunset can view from the proposed skywalk deck provided with telescopes.
- The solid waste collection bins and transmitting vehicles shall be the closed container vehicle.

11.8.8. Impacts due to dredging

Pre-construction and construction phase

The preconstruction and construction phase will involve backfilling of the land above the high tide level. It is proposed that sand for the backfilling operations will be obtained by dredging from the Bay of Bengal. The possible physical impacts due to dredging are as follows:

- Resuspension of bottom sediments, thereby increasing turbidity
- Riverbank erosion
- Dispersion from and accumulation into bottom sediment of toxic substances
- Reduced primary productivity due to decrease in the depth of the euphotic zone
- Impact on habitat and breeding/spawning ground of fishes and other aquatic fauna due to bottom disturbances
- Temperature alteration
- Increase in nutrient levels
- If the dredged material is polluted, it may affect the ecosystem, and fisheries activities at both dredging and dumping locations

The extent of impacts due to dredging activity is highly varied and site specific, depending upon a number of factors shown below:

- Method of dredging and disposal
- Channel size and depth
- The size, density and quality of the material
- Background levels of water and sediment quality, suspended sediment and turbidity
- Current direction and speed
- Rate of mixing
- Presence and sensitivity of animal and plant communities (including birds, sensitive benthic communities, fish and shellfish)

Mitigation measures

- Prior to dredging activity, analyse the soil sample to prevent impacts on the receiving environment as a result of mismatch in soil characteristics;
- During dredging activity, physical barriers such as silt screen/ curtains should be employed to prevent the spread of suspended sediments;
- Maintain the extent of the turbidity plumes close to the dredging and disposal areas to minimize impacts on aquatic fauna habitat;
- Visually inspect for aquatic life and terrestrial organisms and stop dredging activity in case of any organism in the vicinity.
- Conduct visual inspections for aquatic life and dredging must not be carried out when the fish are likely to be breeding in the river, or in the period normally from April to August between spawning and the subsequent emergence of juvenile fish. To the end, water samples will be collected upstream and downstream of the dredger while in full operation and tested for nutrient, sediment loads, heavy metals as well as oil and grease concentrations, and river bed dredged materials of the river need to be tested by the contractor.

11.8.9. Impact on air environment

Pre-construction phase

The pre-construction phase will involve site preparation activity for the tourism development zones, access road and water supply system which will lead to dust generations and other fugitive emissions. But these emissions will be localized and have impact for short duration only during site preparation activity.

Mitigation measures

To minimize the dust generation, water should be sprinkled regularly at the site and low Sulphur diesel should be used in land levelling equipment to control the SO2 emissions.

Construction phase

Air quality will be impacted from the following sources during the construction phase:

- Fugitive dust emissions from site clearing, excavation work, cutting and levelling work at sites and access/ internal roads, stacking of soils, handling of construction material, transportation of material, emission due to movements of vehicles, plying of heavy construction machinery etc.;
- Vehicular emissions due to traffic movement on site and on the connecting roads;
- Exhaust emissions (containing PM10, PM2.5, SPM, CO, HC, NOx, SO2 etc.) from construction machineries, other heavy equipment as bull dozers, excavators, compactors; and
- Emissions from diesel generator required for emergency power during construction period.

Mitigation measures

To mitigate the construction impacts, project proponent should have contract agreements with contractors as well as sub-contractors to ensure implementation of mitigation measures.

- Sprinkling of water at construction site and haul roads
- Preferable pre-fabricated houses should be built to limit construction activities as minimum as possible.
- Transportation of Raw materials in covered trucks
- Construction of barricades between the settlements and the site to minimize travel of fugitive emissions towards settlements
- Shrub Plantation (native species) on either side of the approach road to mitigate the fugitive dust emissions
- Construction vehicles and machinery should be regularly serviced and check for pollution control
- Prohibit usage of adulterated fuel in vehicles for running construction equipment and vehicles
- Covering the scaffolding (in case of any buildings) to reduce the dust emission in outside environment
- Speed of vehicles on site is recommended to be 10-15 km/hr which will help in minimizing fugitive dust emissions due to vehicular movement

Operation phase

Post development of the Eco-tourism park, the impacts on the air quality of the area will be from (a) air emissions from the proposed motorised components of dry rides in Adventure park (b) Odour from STP and wastewater and (c) Emissions from air-conditioning. The cumulative effect of these air polluting sources proposed within Eco-tourism park will have minimal negative impact on the air quality of the site and the nearby areas while considering the proportionate of minimal developments over large area. However, certain mitigation measures are proposed to minimise the impact on air environment which are as follows:

Mitigation measures

- Development of thick green belt and organized greens surrounding STP.
- Usage of power generators can be avoided, and continuous power supply shall be ensured.
- All proposed components shall adhere air pollution control measures in line with DOE permission.
- Odour should be managed at the site using odour suppressant and planting fragrant flowering trees.
- Usage of air-conditioners can be reduced by constructing the buildings with natural ventilations and air circulation.
- Proper maintenance of motorised equipment/machineries making it not to generate more smoke or greenbelt can be planted around the area of much smoke generating components within adventure park.

11.8.10. Impact on noise environment

Pre-construction and construction phase

Pre-construction phase will involve site clearance activity for development of access road and utilities. The site clearance will involve removal of vegetation and land levelling activities. Operation of different machineries and equipment for construction activities, running of heavy load traffic for construction materials transportation, and regular traffic movement may generate noise during construction period. The heavy equipment, machineries, transportation and earthworks used for the construction activities are the major sources of noise. It is envisaged that there will be an increase in traffic and thereby in traffic noise impacts on the receptors near the approach road from the transportation of equipment, construction materials. Few settlements located in the northern side of proposed site are likely to be exposed to higher level of noise due to construction activity if proper mitigation measures are not taken.

Mitigation measures

The following mitigation measures should be implemented to minimize potential noise impacts during preconstruction and construction phases:

- Regular maintenance of equipment such as lubricating moving parts, tightening loose parts and replacing worn out components should be conducted;
- Machinery and construction equipment that may be in intermittent use should be shut down or throttled down during idle time;
- Acoustic enclosure should be provided for the DG set;
- Equipment known to generate noise strongly in one direction should be orientated so that the noise is directed away from nearby sensitive receptors as far as practicable;
- Honking should be avoided;
- Construction work should be carried out only during day time (from 8.00am to 6 pm);
- Machinery to be used should comply with the noise standards prescribed by DoE.
- Low-Noise Environment friendly Standby Generators shall be preferably used
- To deal with noise exposure by construction workers in construction site, pocket guide by OSHA is helpful.
- At individual worker level, the construction contractor should be insisted to provide earmuffs to the workers exposed to high noise levels.

Operation phase

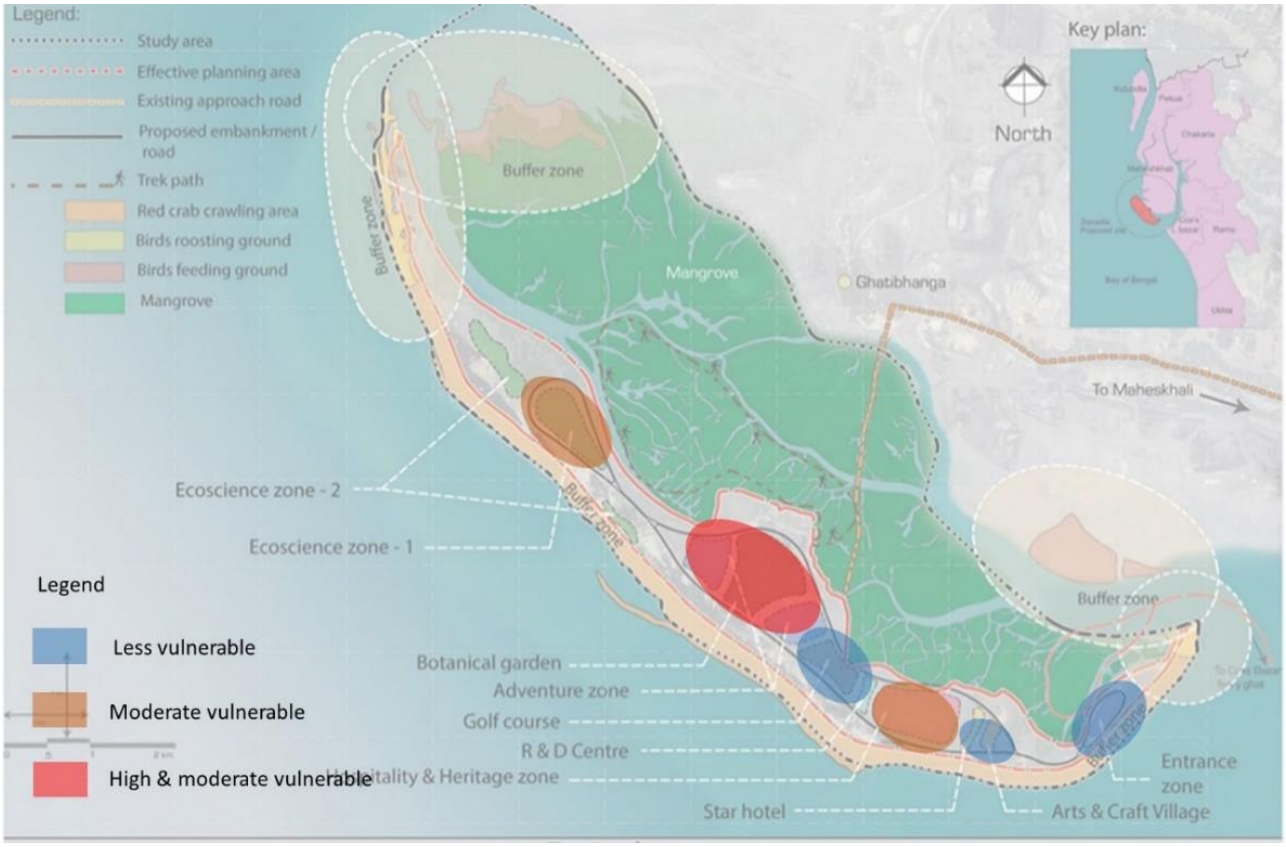
After development of offsite infrastructure and Eco-tourism park, the noise levels may rise due to vehicular movement, DG set, pump sets, Mechanical operations of rides and utility components, Auxiliary activities like operation of water pumps, booster pumps etc., Operations of ventilation units and fans can also add up to the

noise generation. Due to gathering of more tourists in a spot, high intense noise will be generated out of fun and entertainment. The major noise generating source are amusement park rides.

The following mitigation measures are suggested to mitigate the noise pollution during operation phase.

1) The proposed components and zones are spatially distributed in a manner that high & moderate intense noise generating components are planned between less noise generating components such that it will not have much impact on the environment.
   - Less noise generating zones/components- entrance zone, Arts & crafts village, star hotel, R&D centre and Golf course.
   - Moderate noise generating zones/components - Hospitality and heritage zone, botanical garden and Eco-science zone.
   - High intense noise generating zones/components- adventure zones where lot of wet and dry rides are planned where people will gather more and spend huge time within which will generate huge noise out of fun and entertainment. Also, the rides will have more mechanical equipment operation which will add on to the noise.
   - Low-noise environment friendly standby generators shall be preferably used.

Figure 102: Zones of vulnerability to noise



Source: *MACE analysis*

2) Pumps should be fitted in close room, preferably acoustic enclosure to reduce the noise generation
3) Green buffer should be developed more within the project boundary. This will help in reducing the impact of noise level significantly.
4) All components should comply with the noise standards prescribed by DoE, Bangladesh.
5) Acoustic design with sound proof glass panelling shall be provided for public gathering enclosed components planned within the Eco-tourism park.
6) Proper greasing, periodic check-ups for frictionless movements.
7) Honking should be regulated within the economic zone.

11.8.11. Impact on water environment

Pre-construction, construction and operation phase

Impact on surface water and groundwater resource

Our assessment suggests that basis assessment and demand forecasting for the proposed Eco-Tourism Park, potable water demand for the proposed tourism park would be about 1.8 MLD and total water demand would be 11.2 MLD. This figure is indicative in nature and may vary based on on-ground implementation of the project. The developer may undertake a separate demand assessment and master planning exercise in order to validate this figure.

Site is situated adjacent to Bay of Bengal on its Western side. It is proposed to bring the required potable water by establishing the borewells in Gorakghata area. To meet the ultimate requirement, it is proposed to establish two numbers of borewells. It is proposed to establish an exclusive non-potable water supply line from Dhaulghata EZ which will have excess amount of treated water and can be utilised to meet the non-potable water demand of Sonadia Eco-tourism park.

Impact on surface water and groundwater quality

An embankment structure has been proposed all along the periphery of proposed development area to protect the site from inundation during High tide. This structure will have significant impact on the water flow intrusion into site and char land formation. It may eventually cause decline in mangrove species population, which will be irreversible in nature.

The major source of wastewater generation during construction phase is from the labour camp, which will be established for project construction activity. There is a potential for contamination of surface and groundwater resources resulting from improper management of sewage.

The surface runoff carrying the loose top soil will lead to increased sedimentation in the receiving water bodies. Contamination of water bodies may result due to oil spilling during construction activities and/or surface runoff/ mixing of construction waste from the site to the adjacent water body. Also, during operation stage, there are chances for water bodies to get polluted due to throwing of waste by the tourists. Also, direct discharge of the untreated process and domestic effluent waste will lead to impacts in the surface water quality while operating the proposed Eco-tourism park. Thus, measures are required to be taken to minimize the surface water pollution.

Mitigation measures

- The embankment profile is planned with parabolic curves for smooth movement of water approaching the embankment. Also, concrete blocks are proposed to be provided on water channel side of embankment to minimize scouring or rupturing.
- To avoid excavation activities during rains
- To prevent piling up of excavated soil, raw material and construction debris at site by proper management and disposal.
- Check dams should be provided to prevent construction runoff from the site to the surrounding water bodies.
- Minimize run-off by using sprays for curing.
- Construction of adequate numbers of toilets and proper sanitation system for workers to prevent open defecation along the water body.
- Construction of soak pits/septic tanks to dispose-off the domestic wastewater generated from labour camps to prevent disposal of sewage in surface water bodies. Alternatively collect labour camp sewage and transport out of island for treatment.

- Proper collection, management and disposal of construction and municipal waste from site to prevent mixing of the waste in run-off and entering the water bodies.
- Use of licensed contractors for management and handling of waste and sludge;
- Labourers should be given training towards proactive use of designated areas/bins for waste disposal and encouraged for use of toilets. Open defecation and random disposal of sewage will be strictly restricted;
- To prevent surface and ground water contamination by oil/grease, leak proof containers shall be used for storage (preferably in paved area) and transportation of oil/grease
- Spill/ leakage clearance plan to be adopted for immediate cleaning of spills and leakages.
- Each proposed component should obtain consent of DoE Bangladesh before construction and operation and should comply to the conditions laid by them.
- The Eco-tourism park should obtain the consent from DoE, Bangladesh for the ground water extraction limit, to meet the potable water requirement of Eco-tourism park.
- No leachate, waste water and waste material should be stored in pervious unlined area/pond.
- Efficient rain water management plan will be adopted to reduce the impact due to surface runoff
- No untreated effluent should be discharged into any water body. The treated water of standard quality shall be reused for garden, landscape watering and other non-potable requirements.
- Sludge generated in sewage treatment plant should be sold to authorized recyclers or could be dried into cakes and used as manure for green pockets.
- Monitoring of surface and ground water quality should be done. Analysis of the wastewater should also be done on regular basis to check efficiency of STP.
- Rainwater harvesting structures are envisaged all along the internal drain at every 30 m interval.
- Each component shall practice rain water harvesting to minimize the water consumption and reduce run-off from the site. Also, it will help to keep the Eco-tourism park free from lack of water during the time of interruption in supply from the source.

11.8.12. Impact on biodiversity

An earthen embankment structure has been proposed all along the periphery of northern side to protect low-lying coastal areas from inundation of the sea. As a result of these, following impacts on biodiversity is envisaged-

- **Dredging** - Impact on habitat and breeding/spawning ground of fishes and other aquatic fauna due to bottom disturbances. Affect bottom dwellers; the Benthos are likely to be majorly affected. Possibility for loss of wildlife
- **Site preparation** - Vegetation cover including significant Mangrove cover will be lost from the area. The loss will be irreversible in nature. Various Avifauna, Herpetofauna, Pisces, Arthropods dependent with on the intertidal Char Land, Mangroves and other vegetation for various reason like shelter, basking, Hunting resting will be affected.
- **Construction of Dyke** - Almost in the effective planning area, the natural mixing of saline water (from Bay of Bengal) and fresh water (from Maheshkhali channel and other small creeks) creates a brackish estuarine ecosystem. The proposed dyke may act as a physical barrier and will have significant impact on the natural tidal flow. This will affect creation of brackish water which may eventually cause decline in mangrove population in the area. It will also hinder the movement of aquatic species specifically fishes which flows in and out in the fresh water stream during high tide and low tide respectively.
- **Contamination** - Accidental spillage, poor management of waste may contaminate the water, eventually aquatic life.

Once the tourism park is developed on proposed land, which is currently being used as habitat by various species, will be lost. It is envisaged that, during operational period very limited diversity will be found in the tourism park area. Poor waste-effluent-sewage management, mishandling of raw material, accidental spillage may

contaminate the river as well as marine ecosystem. This kind of occurrence can threat wildlife of a vast area of the tourism area surrounding. Therefore, proper mitigation measure is essential.

Mitigation measures

Following measures must be taken as a compensatory act and an effort to negate the impact on biodiversity -

- Wildlife awareness program among the workers (during preconstruction, construction and operation phase) should be conducted. Workers should report sighting of any uncommon species to the environmental expert, who immediately should inform the incidence to local forest/wildlife authority/ conservationists
- Strict instruction to the workers must be passed on, so that they not to harm-catch-kill any wildlife or cut down trees for any reason
- Awareness program on wildlife conservation among local community should be conducted so that they can also feel the necessity for conservation of wildlife of the area
- Emission, effluent and waste must comply to GoB standard norms
- No waste shall be discharged in water bodies
- Accidental spill management plan should be developed
- No infrastructure development activities shall be encouraged close to the river/sea shore line
- A half-yearly ecological assessment (preferably in winter and monsoon) during preconstruction, construction, operation phase should be conducted through specialists to record chronological trend of biodiversity in the project area surrounding

11.8.13. Impacts on occupation health and safety

The lack of adequate mitigation measures on the health and safety of the workers will result in accidents and injuries leading to loss of life or property. It is proposed to implement the following mitigation measures to ensure safe work place for the construction labour.

Mitigation measures

- The project proponent should ensure that the contractor (make part of contractor's contract) to have and occupational health and safety plan. The contractor should provide accidental insurance and medical insurance to all the workers.
- The contractor should conduct daily tool box meeting for all workers to discuss potential work-related hazards and other safety aspects.
- The contractor should conduct training for all workers on safety and environmental hygiene at no cost to the employees.
- The contractor should maintain first aid facilities for the workers and will instruct and induct all workers in health and safety matters (induction course) including construction camp rules and site agents/foremen will follow up with toolbox talks on a weekly basis. Workforce training for all workers starting on site will include safety and environmental hygiene.
- Fencing on all areas of excavation greater than 1m deep and sides of temporary works should be observed.
- Workers should be provided with appropriate personnel safety equipment such as safety boots, helmets, gloves, protective clothes, dust mask, goggles, and ear protection at no cost to the workers.
- Reversing signals (visual and audible) should be installed on all construction vehicles and plant.
- Contractor should be responsible for evacuation injured person to the nearest medical center.
- Pertinent H&S trainings should be provided to all the workers with respect to hazards linked to the activities. Additionally, the workers will be informed of precautions to be taken to avoid impacts to the local community;

- Monitoring of the PPE usage can be strengthened, in that, a mechanism can be adopted whereby defaulters receive a warning on non-usage and stringent actions can be taken on subsequent offences;
- Maintain H&S records of occupational H&S incidents, accidents, diseases and dangerous occurrences
- The contractors should ensure H&S standards of labour camps. The labour camps will be established in the proposed site area. Additionally, the representative of project proponent should conduct random spot checks to determine any issues related to improper waste disposal or the living conditions in these camps (i.e. presence of secure shelter and flooring, number of persons per room, number of toilets for the manpower, water availability etc.);
- Strong protocols should be built as part of contractual obligations around zero tolerance of child labour or harassment of women workers and even health and safety aspects. These should also be monitored by supervision and monitoring team.
- Individual tourism operators should also adopt best practice as per the industry standards for proper implementation of occupational health and safety.

11.8.14. Flood and cyclone risk

The project site is located adjacent to Bay of Bengal. Proposed site area falls under Cyclone and Flood Risk zone. It is recommended to prepare a proper emergency preparedness plan for the project to combat sudden strike of cyclone.

11.8.15. Sanitation and disease vectors

Potential sanitation and impacts from disease need to be controlled by maintaining hygienic conditions in the tourism area throughout the operational phase as well during construction by implementing appropriate social and health programs for the project. BEZA should ensure that improvements are made to site sanitation and should implement the mitigation measure below for all operational activities and also that the contractor (during construction phase)/ industries (during operation phase) ensures that:

- Measures to prevent malaria should be implemented by installation of proper drainage to avoid water stagnation, etc.
- Standing water should not be allowed to accumulate in the drainage facilities or along the warehouse sides to prevent proliferation of mosquitoes.
- Temporary and permanent drainage facilities should be designed to facilitate the rapid removal of surface water from all areas and prevent the accumulation of surface water ponds.
- Malaria controls should be implemented in line with social plans for the Project.
- HIV/AIDS awareness and HIV-AIDS education and prevention program should be implemented in line with social plans under the social development work stream.

11.8.16. Impact on sensitivity aspect

From the field investigation and analysis, it is understood that the proposed site area is highly sensitive in various aspects. Hence the study of impact and mitigation measures to be taken to minimize the negative impact are as follows:

➲ **Distress of aquatic life**

During construction and post development of eco-tourism park, there will be generation of waste and its disposal into water may change the quality of the water which will affect the aquatic life.

Mitigation measures

Proper handling and treatment/disposal of solid waste shall be adhered. Also, the effective solid waste handling and management system shall be formulated and followed during detailed engineering & implementation stage.

Rise in temperature

Due to developments and human crowd, there may be increase in temperature which may affect the ecological system of the Island.

Mitigation measures

The usage of bitumen/concrete road shall be avoided, and eco-friendly material pavement can be provided.

Concrete structures shall be avoided, and eco-friendly structures made of locally available materials such as Straw, jute sticks, tree leaves, jute sacks, mud brick, bamboo, sun-grass, etc., can be proposed.

Planning of more green space in the proposed eco-tourism to compensate the addon temperature due to development of eco-tourism park in the island.

Change in ecological system/cycle

There are lot of Algae, Mangroves, aquatic species and insects in the Mudflats which acts as major source of existence for various inhabitants of the island and immigratory birds. Due to establishment of eco-tourism park, there may be developments which leads to degradation of existing different types of inhabitants which sustain the ecosystem and beauty of the island.

Mitigation measures

The char land needs to be retained and protected as such in order to conserve the existing eco system.

Drop in Immigratory birds

Birds are visiting the island due to its idleness without much movement of people and also due to availability of food (fishes, Algae and insects in char land) and favourable temperature for resting. Due to development of eco-tourism, lot of tourist's movement will be there in the site which may disturb the immigratory birds.

Mitigation measures

The birds gathering grounds for feeding and resting should be retained and necessary buffer shall be provided declaring as restricted area. Hence, the birds will not get disturbed due to tourists' movement.

Disorientation of turtle hatchlings

The artificial high intense lights shall be a chance for disorient of the hatchlings from the nested females which may causes dehydration and exhaustion. Also, the movement of tourists on nesting area may disturb the turtles nesting which will cause diminishing of turtles visit to Island for nesting purpose.

- **Mitigation measures**

The Turtles nesting area should be retained, and necessary buffer shall be considered declaring it as restricted area for tourists' movement.

- **Distress of crabs**

The Red crabs are highly sensitive and is like touch me not plant. Human movement or vehicular movement will highly disturb the red crabs.

- **Mitigation measures**

The Turtles nesting area should be retained, and necessary buffer shall be considered declaring it as restricted area for tourists' movement.

11.9. Environmental Feasibility for the proposed embankment surrounding the project area along with other project interventions

i) From the study area how we excluded the mangroves, environmental and ecologically sensitive areas;

According to the land use map of Maheshkhali Upazila, Cox's Bazar district and the proposed site falls under the following zones:

- Sea
- Inter-tidal zone
- Mangrove forest
- Salt/Shrimp
- Char land/sand

From the above land use classification, it is found that the existing land use are more eco-sensitive in nature. Hence, the proposed tourism-based activities/land use is planned to retain the water bodies and Mangrove forests without disturbing. Also, the char land which acts as feeding ground for Birds due to availability of different habitats within, have also been planned to be retained while planning. It is also planned to retain the rest of the char lands to the maximum possible extent while preparing master plan.

The sand dune area which acts as nesting and hatching ground for turtles and crawling area for red crabs have also been planned to be retained as "No development zone". Since, the human settlements are going to get relocated, the activities such as salt and shrimp cultivation will also get diminished. Hence, it planned to rehabilitate the evacuated people and remove the salt and shrimp cultivation which obviously change the land.

ii) What are environmental guidelines we need to follow as per DoE guidelines;

Project specific regulations

The project specific regulations considered while preparing the master plan of the Sonadia Eco-tourism park are discussed below.

As per the coastal regulations, following guidelines have been adhered while planning the eco-tourism park.

S.No	Component	Classification	Regulations to be followed
1)	Mangroves	Ecologically sensitive area (CRZ I-A)	Generally, no activities shall be permitted to be carried out in the CRZ-I A area, with following exceptions: 4) Eco-tourism activities such as mangrove walks, tree huts, nature trails, etc., are permissible subjected to consultative process, public hearing, etc., and further subject to environmental safeguards and precautions. 5) If area is more than 1000 square meters, a buffer of 50 meters along the mangroves shall be provided and such area shall also constitute CRZ–I. 6) Permitted activities within the Mangrove buffer- laying of pipelines, transmission lines, conveyance systems or mechanisms and construction of road on stilts, etc., that are required for public utilities.
2)	Sand dunes	Ecologically sensitive area (CRZ I-A)	
3)	Biologically active mudflats	Ecologically sensitive area (CRZ I-A)	
4)	Turtle nesting grounds	Ecologically sensitive area (CRZ I-A)	
5)	Horse shoe crabs' habitats;	Ecologically sensitive area (CRZ I-A)	
6)	Sea grass beds	Ecologically sensitive area (CRZ I-A)	
7)	Nesting grounds of birds	Ecologically sensitive area (CRZ I-A)	

Basis for demarcation of buffer zone for birds gathering spots

There are no specific guidelines available to adopt the buffer to be provided for migratory bird's gathering spots such as nesting and feeding ground. Hence, the case study of Sultanpur National park of Delhi (where there are lot of migratory birds and bio-diversities exists) has been considered from which it is found that "Construction of any building with more than 2 floors are not permitted within 300 m-500 m area from the boundary of protected area" and the area within 300 m, no construction of any kind will be allowed (*Reference: Guidelines for declaration of Eco-sensitive zones around national parks and wild life sanctuaries by Ministry of Environment and forests, Government of India*). This regulation has been adopted while preparing the master plan of Sonadia Eco-tourism park and accordingly suitable buffer has been provided from the birds nesting and feeding ground.

As per the guideline, Construction of hotels and resorts are permitted in the zone if the Master plan takes care of habitats allowing no restriction on movement of wild animals. The activities related to tourism like over-flying the Eco-sensitive area through any aircraft, air balloons etc., are strictly prohibited. Whereas in the Sonadia Eco-tourism park, the proposed Master Plan adhered to the regulation and is to be noted that the proposed helipad within the park is only for emergency evacuation.

Basis for demarcation of buffer zone for turtles nesting spots

As mentioned in the above table, turtles nesting spots along the seashore falls under CRZ I-A classification wherein no activities shall be permitted to be carried out. This has been adhered in the proposed Master plan. Hence accordingly, the entire coastal stretch has been declared as buffer zone wherein no components or activities are proposed and is considered as no development zone/restricted zone.

iii) How this construction of this embankment will impact the existing environmental and ecologically sensitive areas, Flora and fauna;

It is to be noted that the total study area of Sonadia island is 8976 acres out of which 909.4 acres have been delineated as proposed area for development of Eco-tourism park with a view of not disturbing sensitive features of the Island. Even though, 909.4 acres has been identified as Master plan area, only 6% (58 acres) has been

planned with buildings the remaining area are planned as green & open space, walkways, fountains and landscape etc., Around 60% (540 acres) of area has been planned with Green & open space and water related components such as musical fountains, water pools etc., This infers that the existing land use profile/nature of Greenspace and water body are replicating more in the Eco-tourism park.

It is found that the proposed building component of 58 acres is just 0.6% of total study area of Island (8967 acres) which will act as high dense gathering spot of tourists. Hence, this will not have much negative impact on environment due to its minimal area concentration in a very large space. Also, these buildings are spatially distributed and are planned away from the sensitive area.
However, a super dyke structure cum road has been proposed all along the periphery of proposed development area of Eco-tourism park to protect the Eco-tourism park from inundation during high tide and heavy flow in water channel. The total length of the proposed embankment (Super Dyke) works out to 17 km and the suggested top level of the embankment (Super Dyke) are +4.50 m on seaside and +6.00 m on water channel side. These two levels of embankment are proposed based on existing terrain nature/profile of the planning area in which seaside is raised and water channel side is low-lying. This structure will have significant impact on the tidal flow and generation of char land. It may eventually cause decline in mangrove species population, which will be irreversible in nature.

iv) If its impacts how we are going to mitigate the same;

Mitigation measures

Pre-construction and construction phase

Though the impact due to the structure is likely to be irreversible in nature, following measures must be taken as a compensatory act and an effort to negate the impact to some extent -

- It is suggested to do plantation on the area which falls between the Eco-tourism park and the water channel.
- Parabolic curve of embankment profile has been proposed in order to attain a smooth flow of approaching tides/water during heavy flow. This will also help to avoid scouring or rupture of area.
- It is recommended to carry out the construction activities away from the mangrove area, birds nesting and feeding ground, turtles nesting area and red crab crawling area. Accordingly, suitable buffers (200 – 500 m) have been considered and components are distributed away from sensitive areas.
- The movement of heavy vehicle can be limited and scheduled in a diversified manner. Hence, horn is not required and speed of movement of vehicles shall be limited to reduce the vibration due to movement. It is recommended to use CNG vehicles to avoid air pollution or smoke.
- Suitable techniques shall be adopted to reduce the accumulation of smoke and dust during construction.
- Recommended to instruct the labours about do's and don'ts' s within the Eco-tourism park before commencing the Construction. Also, they shall be transported through NMT vehicles.

Operation stage

- The people shall be instructed regarding Do's and Don'ts within the Eco-tourism park before entering the park.
- Usage of plastics and spitting on public place shall be banned and imposed with penalty.
- Only NMT mode of vehicles are allowed within the park.
- The building footprints are very minimal which is just 6% of total developable area. Also, these are spatially distributed well.
- The wet and dry rides area proportionate is very minimal and is placed far away from sensitive areas which will not have much impact due to its distance apart.
- The operating machineries of rides should be well maintained with minimal smoke ejection & noise emission by using lubricants.
- The visitors who are going for trekking within the mangrove area are instructed about the do's and don'ts before commencing their trekking. Also, the only limited number of people shall be allowed in each batch of trekking with guide.

In addition, the water bodies and mangrove forests will be retained immediately to their earlier stage after the successful completion of the construction activities. The adjacent char lands which act as feeding grounds for avifauna due to the enriched biodiversity have also been recommended to retain to the maximum possible extent.

11.10. Stakeholder consultation

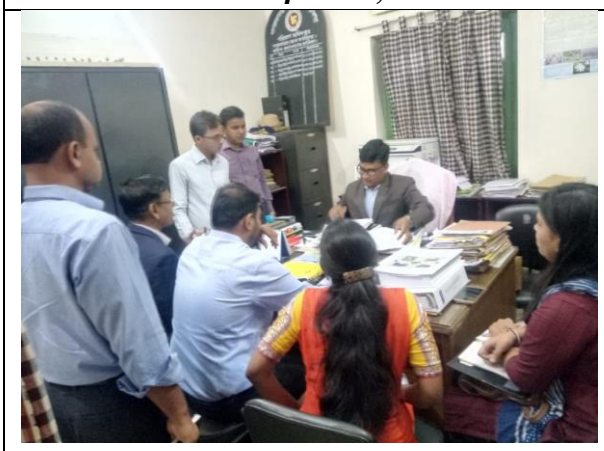
This section provides the stakeholder identification and analysis as well as a brief understanding of the engagement process for the project. "Stakeholder" refers to those who have plausible stake in the environmental/social impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate. It is highly desirable for all key stakeholders to arrive at a consensus on sensitive features, impacts and remedial actions. Stakeholder identification was done by examining the potential impacts of the project in terms of:

- ✓ Who may be affected directly (project affected people);
- ✓ Which agencies might have responsibility for the impact management;
- ✓ Which other organizations might have an interest in monitoring proponent activities or have local knowledge to contribute;
- ✓ Which private/non-government sector entities might face financial and social hardships if the predicted impact occurs

The stakeholders identified in the project comprise of project impacted people, project beneficiaries, various government officials. The points of discussion and key outcome of consultation with project impact people and beneficiaries are provided in the SIA chapter under the title "Focus group discussion". Consultation with various institutional stakeholders like REB, Department of Environment, DPHE etc., have also been conducted during the study period. The points of discussion had with various Government officials are provided below:

Table 74: Institutional stakeholder consultation

Departments	List of stakeholders and the points of discussion
 ***DPHE, Cox's Bazar*** ***Dated: 24th Nov, 2018***	**Assistant Engineer, DPHE, Cox's Bazar** ◉ Sonadia Island has three nos. of tube wells and its maximum depth is about 1000 ft. ◉ The ground water is saline in nature and they suggested to rely on desalination plant for Sonadia ecotourism park.

 ***Cox's Bazar Development Authority*** ***Dated: 24th Nov, 2018***	**Member Engineer- Lt Cnl. Anwar Ul Islam and Town Planner** • Stated that, the master plan of Sonadia ecotourism park should synchronize with the Cox's Bazar master plan and the proposals from the Cox's Bazar Development Authority. • Explained the ongoing and proposed projects of Cox's Bazar. • Listed the tourism spots in Cox's Bazar district and specified the annual footfall of tourists visiting Cox's Bazar and its surrounding area is approximately 1.5 Million.
 ***Department of DoE, Cox's Bazar*** ***Dated: 25th Nov, 2018***	**Assistant Director, DoE, Cox's Bazar** • Total land of Sonadia Island as per record is 4916 hectares. Out of which 50% of land is under the process of acquirement by BEZA for Ecotourism project. • Turtle hatcheries are developed in the Sonadia Island, in which 1200 egg hatches last year. • Also described the process of applying for Environmental clearance.
 ***Tour Operators Association of Cox's Bazar (TOAC)*** ***Dated: 3rd October 2019***	**Tour Operators Association of Cox's Bazar (TOAC)** • Everyday 100000 (1 lac) tourist comes in Cox's Bazar and only 5000 able to take government facilities others 95000 takes facilities from non-government agencies. • October-March more incoming tourists • Mode: (i) Non-AC bus, (ii) AC bus, (iii) Private transport, (iv) Picnic bus, (v) Airlines (10 flight), etc. • From Chittagong to Cox's Bazar transport buses are 1000 in number. • Existing available transport facility to serve 20,000 tourists but during peak season the tourists' arrival 50,000.
	**General Manager of Cox's Bazar Palli Bidyut Samiti** • Kiranthuli sub-station identified as source of power supply to Eco-tourism park. The capacity of Sub-station is 10 MvA and is 20-year-old sub-station which needs upgradation.

Rural Electricity board ***Dated: 3rd October, 2019***	◉ Other sub-stations in the region are ○ Gorakghata zonal office sub-station of 10 MvA capacity. ○ Nolbela sub-station of 10 MvA capacity ○ Proposed Dhaulghata sub-station for Economic Zone where land filling is completed. The capacity will be possibly 10 MvA but trying to establish 20 MvA. ○ Proposed Sonadia sub-station will be 10 MvA. It is mentionable the location of this proposed sub-station land will be provided by BEZA.
 **Environmental and Hydrogeologist consultant- DPHE** ***Dated: 3rd October, 2019***	**Environmental and Hydrogeologist consultant- DPHE of Cox's Bazar** ◉ To meet the non-potable water demand of proposed project, desalination can be one of the best options. Even though it is costly, it has no negative impact on environment. ◉ In Maheshkhali, aquifer water level is in a good condition. Since Maheshkhali is adjacent to Sonadia island, the potable water requirement can be met through installing deep tube-well in Maheshkhali and supply pipe line can be established to connect the Sonadia island.
 **Executive Engineer - DPHE** ***Dated: 3rd October, 2019***	**Executive Engineer – DPHE of Cox's Bazar** ◉ Rainwater harvesting system from Maheshkhali mountain and establishment of desalination plant can be done to meet the water demand of various upcoming projects and gradually increasing population and tourists

11.11. Environmental management plan and monitoring indicator

The environmental impacts associated with any development project are eliminated or minimized to an acceptable level through development of appropriate mitigation measures based on most suitable techno-economic options. The Environmental Management Plan (EMP) is a well-established tool to ensure effective implementation of the recommended mitigations measures throughout the subsequent project development stages. The EMP also ensures that the positive impacts are conserved and enhanced. An EMP provides location and time specific actions to be taken with defined responsibility.

11.11.1. Institutional arrangement

BEZA has developed Environmental Social Management Framework (ESMF[103]) with the help of World Bank. The institutional arrangement of EZ shall be aligned as per this framework. Proposed Eco-tourism park will have an Environmental and social cell which will coordinate with site engineers and PMC.

11.11.2. Overall project implementation arrangements

The overall management of the project will be carried out by Eco Tourism park which is the project implementing unit (PIU).

11.11.3. Institutional set up for environment management

The institutional arrangements for the implementation of various aspects of ESMF and environment management of the proposed project envisaged to be implemented as part of the Private Sector Development and Support Project (PSDSP) comprise the following.

- Project Environment Cell (PEC) at PIU to ensure adequate integration of environment management measures in the design phase and supervise implementation of ESMF and specific requirements of EMP
- Environment Management Unit (EMU) at Eco-tourism park to implement EMP and other regulatory requirements during construction & operation phase of Eco-tourism park.

➲ **Project Environment Management Cell (PEC) at PIU**

The Project Implementation Unit (PIU) will establish a Project Environmental Cell (PEC) headed by a 'Manager - Environment' and supported by environmental engineers. The PEC will function to:

- Supervise implementation of ESMF throughout project implementation period;
- Ensure integration of the EA and the EMP measures into the sub-project design and implementation plans such as contract documents, maintenance contracts, tenant lease agreements, etc;
- Supervise the implementation of the mitigation measures by the Master developers / Contractors;
- Assist the engineering staff and other PIU staff in addressing environmental issues during planning, design and implementation of the sub-projects;
- Prepare periodic progress reports on the implementation of the EMP throughout the project period.

➲ **Environment Management Unit (EMU)**

In order to implement various environmental management measures at the Eco Tourism Park, the master developer / contractor / operator will set up an EMU. The EMU will consist of environmental engineers with relevant experience on environmental issues associated with Eco-tourism park. The EMU will function all through construction and operation phase of the tourism park and perform the following functions.

- Identify regulatory requirements of the sub-project and initiate necessary actions / studies to ensure compliance to the same;
- Co-ordinate with DoE and PIU and ensure securing SCC and ECC as applicable for the project(s);
- Co-ordinate with the contractors / sub-contractors and all other agencies involved in the development and operation of Eco-tourism park and ensure that all the requirements of EMP are fully complied;

[103] *http://www.beza.gov.bd/wp-content/uploads/2015/10/ESMF-of-BEZA.pdf*

- Ensure that all the common environmental infrastructure in Eco-tourism park is operated and maintained in compliance with the regulatory requirements of GoB;
- Liaise with individual enterprise/tenants and ensure that all environmental management conditions of the tenant lease agreement are fully complied;
- Prepare regular reports on environment management and submit to PIU/GoB.

11.11.4. Monitoring indicators

The physical, biological and social components which are of particular significance to the proposed project are listed below:

- Air quality
- Water quality
- Noise levels
- Soil quality
- Solid & hazardous waste management
- Plantation success / survival rate
- Biodiversity and species richness
- Soil Erosion
- Siltation
- Contamination of area surrounding to the project site
- Record of accidents
- Recorded public grievance

These indicators will be evaluated periodically based on the monitoring results, baseline conditions, predicted impacts and mitigation measures.

11.11.5. Monitoring plan

The objective of environmental monitoring during the preconstruction, construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the surrounding environment based on national standards. A monitoring schedule has been sketched based on the environmental components that may be affected during the various phases of the project and is given below.

Table 75: Environmental monitoring plan

S. No.	Aspect	Source of impact	Monitoring methods and parameters	Frequency	Executing agency	Enforcement agency
1.0	**Pre-construction and construction phase**					
1.1	Local Manpower Absorption	Construction Works	Contractor's report no. of people working in the project	Monthly	Contractor	BEZA & PMC
1.2	Soil Erosion	Excavation, disposal, cut & fill and site preparation activities for site levelling	Survey & observation; Extent and degree of erosion; Structures for	Monthly	Contractor	BEZA & PMC

S. No.	Aspect	Source of impact	Monitoring methods and parameters	Frequency	Executing agency	Enforcement agency
		and internal roads, disposal	controlling soil erosion			
1.3	Greenbelt development	-	Survival rate of species planted; Density of vegetation	Half Yearly	Contractor	BEZA & PMC
1.4	Air Quality	Transportation of construction materials, road construction, construction of utilities	Survey & observations; Levels of PM_{10}, $PM_{2.5}$, SO_2, NOx, CO	Quarterly for two weeks at suitable locations	Contractor	BEZA & PMC
1.5	Waste Management	Restoration of disposal sites and construction areas	Status of protection measures	Quarterly	Contractor	BEZA & PMC
1.6	Noise Level	Noise levels compliance with respect to industrial standards	Ambient Equivalent continuous Sound Pressure Levels (Leq) at day and Night time	Quarterly at suitable locations	Contractor	BEZA & PMC
1.7	Drinking Water	Contamination due to seepage	All physio - chemical & biological parameters	Monthly	Contractor	BEZA & PMC
1.8	Inland surface and marine Water	Transportation of construction materials, various construction works, runoff from camp	All physio-chemical & biological parameters	Quarterly at suitable locations	Contractor	BEZA & PMC
1.9	Ecological assessment of surrounding area covering terrestrial and marine ecosystem	Various construction activity	Status of floral & faunal community, Species richness, species diversity	6 months (winter and monsoon)	Contractor	BEZA & PMC
2.0	**Operation phase**					

S. No.	Aspect	Source of impact	Monitoring methods and parameters	Frequency	Executing agency	Enforcement agency
2.1	Noise Levels	Noise levels compliance with respect to tourism standards	Ambient Equivalent continuous Sound Pressure Levels (Leq) at day and Night time	Quarterly at suitable locations	BEZA	BEZA
			Plant periphery and near noise generation sources	Monthly	Individual units	BEZA
2.2	Biological Environment	Horticulture / Greenbelt Development	Survival rate of plants and shrubs	Quarterly	BEZA	BEZA
			Survival rate of plants and shrubs at individual unit	Quarterly	Individual unit	BEZA
2.3	Ambient air quality	Ambient air quality levels compliance with respect to tourism standards	Ambient air quality monitoring at individual industries - Monitor levels of PM_{10}, $PM_{2.5}$, SO_2, NOx, CO	Monthly	Individual unit	BEZA
		Ambient air quality levels		Quarterly	BEZA	BEZA
2.4	Ground / Drinking water quality	water quality levels compliance with respect to industrial standards	Bore-wells installed/ Drinking water source at site (All physio-chemical & biological parameters)	Monthly	Individual unit/ BEZA	BEZA
				Quarterly	BEZA	BEZA
2.5	Inland surface and marine water quality	To cross check accidental contamination	Nearby surface water resource (All physio-chemical & biological parameters)	Quarterly	BEZA	BEZA
2.6	Soil Erosion	Maheshkhali channel /shore line	Survey & observation;	Monthly	BEZA	BEZA
2.7	Ecological assessment of surrounding area covering 5 Km radius	Various tourism development operation and traffic	Status of floral & Faunal community, Species richness, species diversity,	6 months (winter and monsoon)	BEZA	BEZA

11.11.6. Community development plan

It is recommended that tourism master developer involves the local community during the project development. The developer/ owner/its contractors may recruit local workforce to the extent possible during construction phase. The tourism developer would identify technically qualified unemployed youth around the project location and other nearby areas and employ as far as practical. The tourism developer should form a forum/ association/ trust along with its development units to look after community development activities of tourism park. All the tourism units should periodically contribute to this Trust. The Trust would represent Eco tourism park and its development units for all matters related to community and its development. This would act as interface between Tourism park and community. The Trust should encourage its development units to recruit local unemployed youth in the jobs during operational phase. For this if required arrange training for the local people to develop skilled manpower required if sufficient skilled manpower is not available to carry out technical work in the development units during operational phase.

The Trust will organize a community advisory group involving local representatives, representatives from tourism nodes and neighbouring developments; that would help them in finding ways to participate with its neighbours in addressing socio-economic concerns. With the advice of its community advisory panel, local officials, and other key individuals and groups, the trust along with its constituent tourism nodes may sponsor appropriate programs and projects to benefit its community as a whole.

Some specific community development programs that could be considered by the Trust in coordination with other tourism nodes in the locality are suggested here:

- Importance of wildlife and necessity for its protection
- Conducting awareness programs in surrounding villages on health impacts due to environmental pollution (air, noise, water, solid waste, etc.), and precautions to be taken to minimise health impacts.
- Conducting periodic health check-ups to the Eco-tourism staff and in the surrounding villages to identify pollution related diseases.
- Encouragement to residents in the nearby localities for self-employment ventures, such as by assisting them in arranging micro finances to develop them as artisans/ skilled personnel.
- Periodic training programs on health and sanitary education, women and child development, and income generation schemes.
- Participation in improving the existing medical and educational facilities of the area - for this purpose, it is suggested that the Trust provide funds for facilities improvement (providing toilets, furniture, additional space creation, any other needed) to the local hospitals and schools
- Development of greenbelt/greenery or tree plantation in the nearby vacant government lands to build a green and clean environment in the surrounding areas and to reduce pollution impacts to some extent.
- Sponsoring fellowships to students in surrounding villages to encourage them to go for higher education
- Construction of a hospital in collaboration with other industries to improve health status
- Conduct or sponsor camps to clean up river ghats, jetties and terminals in the surrounding areas.

11.11.7. Compensation plan

For the development of Eco-tourism park, the authority of BEZA proposed a land parcel for resettlement in Sonadia island. The connectivity to Maheshkhali and Eco-tourism park have to be established by concern authority. Also, it is suggested to provide necessary social and physical infrastructure with required amenities for the people. From the household survey and discussion had with the local people, it is found that fishing, buffalo farming, agriculture and working in salt production and shrimp cultivation are the major livelihood sources of the Project affected people. Hence, it is proposed to provide employment for the people in Sonadia Eco-tourism park and proper compensation based on present market rates.

11.11.8. Emergency preparedness plan (contingency plan)

In order to be in a state of readiness to face adverse effects of accidents, an emergency preparedness plan is required to be prepared which includes on-site and off-site emergency plan by the individual development nodes and Tourism Park.

The emergency preparedness plan will have the following minimal components:

- Accidents preventions procedures/ measures
- Fire prevention planning and measures
- Fire water storage and foam system
- Accident/emergency response planning procedure
- Grievance redressal mechanism
- Emergency control centre
- Emergency information system with role & responsibility and command structure
- Recovery procedure
- Assessment of damages and rectification
- Evaluation of functioning of disaster management plan
- Accident investigation
- Clean-up and restoration

11.12. Cost of EMP

The cost of EMP given here includes only for the Environmental Monitoring, Audit and greenbelt development. The costs are approximate and need calibration at the time of detailed design and estimation stage.

S. No.	Components	Unit cost (Tk)	Cost (million BDT.)
A	**Fixed cost**		
A.1.	**Construction phase (30 years)**		
A.1.1.	PPEs for staffs of project proponent	50,000/year	0.55
A.1.3.	Environmental monitoring (quarterly) from site and surrounding area • Ambient air • Ambient noise • Surface water • Ground/drinking water • Soil quality	400000/Quarter	17.60
A.1.4.	Greenbelt development at suitable locations and protection of Mangroves	Lumpsum	250.00
A.1.5.	Marine and terrestrial ecological study (Half Yearly)	1500000/study	33.00
A.1.6.	Environmental audit (Half Yearly)	120000/study	2.64
A.1.7.	Environmental Specialist - Full Time: 2 Nos	800000/year/person	17.60
A.1.8.	Social Analyst- Full Time	700000/year	7.70
A.1.9.	occupational health specialist and a safety specialist- Full Time: 2 Nos	700000/year/person	15.40
A.2.	**Fund for proposed community development activities**	Lumpsum	15.00
	Total Fixed Cost (BDT)		**359.49**

S. No.	Components	Unit cost (Tk)	Cost (million BDT.)
B	**Recurring cost (Yearly)**		
B.1.	**Operation phase (per year)**		
B.1.1.	PPEs for staffs of Project Proponent	80,000/year	0.08
B.1.2.	Solid waste bins for common areas	50,000/year	0.05
B.1.4.	Environmental monitoring (quarterly) from site and surrounding area • Ambient air • Ambient noise • Surface water • Ground/drinking water • Soil quality	600000/Quarter	2.40
B.1.5.	Maintenance of Green Belt	Lumpsum	15.00
B.1.6.	Environmental Audit (Half Yearly)	150000/half	0.30
B.1.7.	Environmental Specialist - Full Time: 2 Nos	900000/year/person	1.80
B.1.8.	Social Analyst- Full Time	800000/year	0.80
B.1.9.	occupational health specialist and a safety specialist- Full Time: 2 Nos	800000/year	1.60
B.1.10.	CETP/STP In-charge: 2 Nos	700000/year	1.40
	Total yearly recurring cost (BDT) up to 30 Years		**23.43**
C	**Additional Recurring Cost after completion of 30 Years of Construction period (Yearly)**		
C.1.	Marine and Terrestrial Ecological study (Half Yearly): To be added after completion of 11 Years of Construction period	4500000/study	9.00
	Additional Recurring Cost (BDT) after completion of 30 years of construction period		**9.00**
Note: The costs are approximate and need calibration at the time of detailed design and estimation stage * Monitoring/Mitigation cost at individual node level has not been covered ** If there is need of any specific mitigation according to Ecological study during Construction/ Operation phase, the cost for the same will be additional			

11.13. Conclusion and recommendations

Considering the sensitivity of the proposed site, it can be said that overall the impacts from preconstruction, construction and operation phase will have quite detrimental impacts to the surrounding environment. Many of the impacts are possibly irremediable in nature and can't be replenished. The proposed site is quite rich from ecological point of view. As Sonadia island falls under Ecologically Critical Area. A thorough EIA/EMP study needs to be conducted. It must also to be ensured that EMP plan is followed religiously as a compensatory act and an effort to negate the impact to some acceptable extent. BEZA will invest in land and related off-site infrastructure development so as to make zone accessible and resourceful. Thereafter Eco Tourism Park development will be responsibility of private unit developers. The off-site facilities proposed to be developed by BEZA includes development of administration building, embankment, electrical supply, access roads etc.

The recommendations made for the project development on the basis of Environmental study are given below:

- A detailed environmental impact assessment should be carried out by BEZA prior to any site preparation/construction activity and prior environment clearance certificate from DoE, Bangladesh should be taken.
- Construction activities for the development of project should be started after obtaining environment clearance certificate from DoE, Bangladesh.
- A half-yearly ecological assessment (preferably in winter and monsoon) during preconstruction, construction, operation phase should be conducted by environment specialists to record chronological trend of biodiversity in the project area surrounding.
- Wildlife awareness program among the workers (during preconstruction, construction and operation phase) should be conducted. Workers should report sighting of any uncommon species to the environmental expert, who immediately should inform the incidence to local forest/wildlife authority/ conservationists.
- Proposed environment management plan should be implemented strictly during preconstruction, construction and operation phase of the project.
- Green area development should be carried out.
- Proper training of maintaining environment, health and safety should be given to Project management unit in preconstruction, construction and operation phase.
- Provision of garland drain, thick green belt, STP, segregated storm water should be adhered to.
- Environmental monitoring should be conducted as suggested in environment management plan.
- Separate environment impact assessment study must be carried out by developer for whole zone before developing the Eco Tourism Park.

12. Project Cost

12.1. Approach for project cost estimation

The cost of developing the SE-TP covering hard infrastructure and soft elements are computed.
Table No. 76 provides the details of SE-TP common infrastructure including specialised tourism infrastructure, SE-TP connectivity and external infrastructure, and TKZC common development including TAF and IRC-CoE&IDC and specialised tourism infrastructure within the TKZC boundaries costing and total investment outlay of these development elements for all phases.

Table 76: Development elements cost detail

Major development elements considered for cost computation

- SE-TP common infrastructure including specialised tourism infrastructure;
- SE-TP connectivity and external infrastructure; and
- TKZC common development including TAF and IRC-CoE&IDC and specialised tourism infrastructure within the TKZC boundaries;

General considerations

- The proposal is to develop SE-TP common infrastructure including specialised tourism infrastructure, SE-TP connectivity and external infrastructure, and TKZC common development including TAF and IRC-CoE&IDC and specialised tourism infrastructure within the TKZC boundaries in deferred investment manner to facilitate the flow of investment and to recalibrate the development especially to the market needs; and
- The study includes an analysis of project development investment phasing and computation of investment requirement during each phase of development.

l. No.	Development element	Details
1	SE-TP common infrastructure including specialised tourism infrastructure	○ Planned to be developed in a deferred investment manner (in three phases) over nine years to facilitate domestic and foreign tourist visits to SE-TP and occupant units of IRC-CoE&IDC with flexibility for market calibration ○ Phase-I investment in 1st and 2nd year ○ Phase-II investment in 5th and 6th year and ○ Phase-III investment in 9th year.
2	SE-TP connectivity and external infrastructure	○ Planned to be developed over two years to facilitate domestic and foreign tourist visits to SE-TP and occupant units of IRC-CoE&IDC.
3	TKZC common development including TAF and IRC-CoE&IDC and specialised tourism infrastructure within the TKZC boundaries	○ Planned to be developed in a deferred investment manner (in three phases) over nine years to facilitate domestic and foreign tourist visits to SE-TP and occupant units of IRC-CoE&IDC with flexibility for market calibration; ○ Full operations of SE-TP including IRC-CoE&IDC from 10th year onwards ○ Phase-I investment in 1st and 2nd year ○ Phase-II investment in 5th and 6th year and ○ Phase-III investment in 9th year.

The approach towards cost estimation

- Besides the cost of the project development elements, the cost includes preliminary and pre-operative expenses, know-how fees, design, and detail engineering fees, project management expenses, training expenses;
- Further, the cost includes contingency provision for any unforeseen situation and increase in unit rates;
- The exercise includes the estimation of cost based on the schedule of rates published by the competent public authorities, prevailing market prices, in-house databank, and experience gained over similar/comparable development commensurate with the nature of development and the target market segment;
- The factors considered for project cost estimates for the identified development activities would include:

  - Type of construction for each project development elements and identified facilities;
  - Specification for developments and type of finishes required;
  - Special provisions for health and safety norms, eco-tourism projects & circular economy, biomimicry;
  - Special provisions for energy-efficient and green buildings;
  - Utility provisions as per applicable codes and standards;
  - Electro-mechanical utilities with power back-up for essentials and distribution network;
  - Special features concerning structures, civil works, equipment and facilities for SE-TP common infrastructure including specialised tourism infrastructure, SE-TP connectivity and external infrastructure and TKZC common development including TAF and IRC-CoE&IDC and specialised tourism infrastructure within the TKZC boundaries;
  - Environmental infrastructure covering water, wastewater, and solid waste management; and
  - Sustainability elements, smart features, smart monitoring, and green infrastructure.
- Refer to Figure No. 77, depicting the process of cost computation.

General development

- The cost computation excludes the land lease cost or other costs towards the land;
- The SE-TP:PIU need to consider the land compensation cost (if applicable), and this needs to be facilitated/funded by BEZA or through its designated nodal agencies. Further, necessary training and skill development need to be imparted, and SE-TP:PIU, SE-TP:SPV and TKZC:SPV shall provide employment opportunities besides land compensation. Also, efforts shall be taken for imbibing entrepreneur skills to the select rehabilitated people and provide necessary assistance for them to establish SME units in the SE-TP or provide rural tourism or provide backward linkages. As such, the project cost estimates exclude such provisions and training cost;
- For subsequent years, i.e., during the operational phase, the operational, administrative cost includes land lease rental;
- It is required to create the necessary site development as detailed in the earlier part of the report;
- Work on the site development would include the cost of development of the overall land area, laying roads, internal pathways, fencing, landscaping, main entrance & security; and
- The study appropriately earmarks various zones like entrance zone, heritage & hospitality zone, knowledge centre zone, family entertainment zone, adventure zone and eco-science zone with supporting facilities, taking into account various technological aspects and regulations.

Buildings & civil works

- The buildings & civil works consist of developing various tourism facilities, research facilities, social, facilities, commercial, administrative buildings, other buildings, open area facilities and other miscellaneous civil works; and
- Minimum ready-built IRC-CoE&IDC facilities are essential for triggering especially knowledge-based green economy investments, and Phase-I investment development incorporates specialised facility requirements to enable plug and play operation;
- Subsequent phases include additional ready-built factories established as per market demand.

Plant, machinery, and equipment's

- The plant, machinery and equipment's consist of environmental infrastructure, water treatment plants, water supply lines, waste management and sewerage lines;
- Further, it also includes electrical and communication networks comprising of transformer and captive backup power generation sets for the essentials, LT switchboards, and cables, special light fittings, an electrical installation; and
- Apart, air conditioning and ventilation system, utilities like ducting, piping, compressed air, solid waste management system, firefighting equipment's and other such infrastructure/utilities constitute plant and machinery.

Specialised and specific tourism and innovation & research infrastructure

- Specialised tourism infrastructure for TAF in the entrance zone, heritage & hospitality zone, knowledge centre zone, family entertainment zone, adventure zone and eco-science zone; and
- Specialised facilities for IRC-CoE&IDC to support innovation & research activities on life sciences, alternative & renewable energy, environment technologies & sustainable business practices, innovative materials and innovative products, built environment & sustainable communities, design, engineering, technical, consulting, advisory & research services.

Miscellaneous fixed assets

- The miscellaneous fixed assets would include furniture & fittings, office equipment's, audio-visual equipment and computer system.

Provision for marketing and consultancy expenses

- The exercise includes project consultancy expenses for meeting the design and detailed engineering expenses, project supervision and project management activity; and
- Also, expenses towards project launch and marketing also need to be met out from the project cost.

Preliminary expenses & entity formation expenses and others

- Apart from the cost of tangible assets described above, the exercise includes provision for other categories of expenditure necessary for the establishment of the various development elements. The preliminary expenses cover expenses involved in creating SPVs and sub-SPVs related expenditures;
- TKZC:SPV shall create several sub-SPVs in a phased manner for effectively providing the O&M services; and
- The company formation expenses include incorporation, memorandum of association, legal expense, and formation of governing bodies.

Pre-operative expenses

- The preoperative expenses relate to site establishment expenses during the project implementation period, travelling and conveyance, insurance, and other start-up expenses.

Provision for contingencies

- A provision at the rate of 10% on the non-firm cost of the estimated project cost such as site development, buildings, equipment's and support machinery, pre-operative expenses and miscellaneous fixed assets are made to meet the escalation in the prices of these items during the implementation period.

Interest during construction

- The exercise includes computation of interest during construction based on the deployment of debt towards capital expenditure. For the cost estimation, the exercise considers a 15% interest rate.

Sl. No.	Development element	Details
1	SE-TP common infrastructure including specialised tourism infrastructure	○ The contribution from SE-TP:PIU (financed through GoB/BEZA contribution), has no finance charges and is on the non-repayable basis from the perspective of SE-TP:PIU
2	SE-TP connectivity and external infrastructure	○ GoB shall enter an agreement with other financial institutions, if required and shall finance respective Government agencies on a non-repayment basis for funding SE-TP connectivity and external infrastructure. Hence this contribution has no finance charges and is on the non-repayable basis from the perspective of executing agencies.
3	TKZC common development including TAF and IRC-CoE&IDC and specialised tourism infrastructure within the TKZC boundaries;	○ Applicable for the term loan mobilised by the PPP concessionaire or private sector.

Total cost

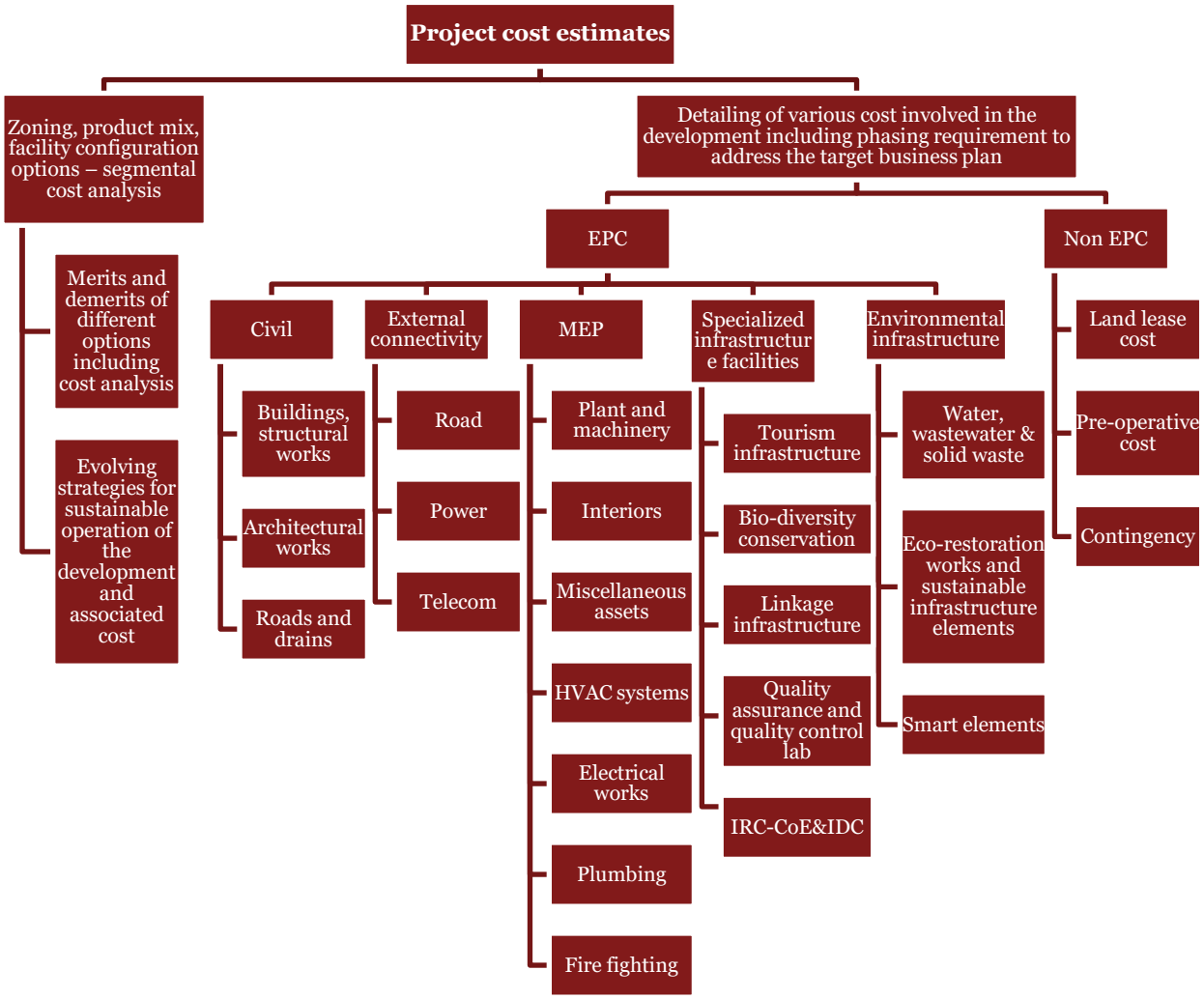
- The development elements are contemplated to be developed over nine years; and
- It is pertinent to understand that some of the developments need to be carried out in Phase-I investment itself, considering the project as a whole.

Sl. No.	Development element	Details for SE-TP
1	SE-TP common infrastructure including specialised tourism infrastructure	○ The cost of Phase-I development is estimated for common infrastructure at Taka 5488.77 million; and ○ The total investment outlay for all Phases is Taka 6170.74 million over the development period of 9 years.
2	SE-TP connectivity and external infrastructure	○ The total expenditure for connectivity and external infrastructure at Taka 547.82 million.
3	TKZC common development including TAF and IRC-CoE&IDC and specialised tourism infrastructure within the TKZC boundaries	○ The cost of Phase-I development is estimated to be Taka 1538.31 million; and ○ The total investment outlay for all Phases is Taka 10230.04 million over the development period of 9 years.

Source: MACE analysis

Below figure depicts the process and the considerations involved in project cost computation.

Figure 103:Computation of project cost



Source: MACE analysis

12.2. Details of Infrastructure cost estimates

Table 77: Detail of Infrastructure cost estimates

Sl No.	Component	Quantity	Unit	Amount in Taka
I	**Sonadia Island tourism facilitation development**			
a	Embankment - 7.5 m top width	17.94	Km	3599135820
b	Land filling	437057	Cum	82166735
c	Road connecting zones - 7.5 m top width	4.6	Km	91445015
	Sub total I			**3772747570**
II) 1	**Entrance zone**			
a	Internal road / path - 5.5 m top width	0.8	Km	11455119
b	E-car and cycle parking	686	Sqm	1566273

c	Information kiosk/globe	415	Sqm	1330952
d	Helipad	2000	Sqm	5995500
e	Viewing deck	1146	Sqm	7117061
f	Water pool with musical fountains	13956	Sqm	1350000
g	Green / landscape	5712	Sqm	2856000
h	Jetty	1067	Sqm	106662900
	Sub total - Entrance zone			**138333805**
2	**Heritage and hospitality zone**			
a	**Pavilion**	**19024.2**	**Sqm**	**9512100**
Sl No.	**Component**	**Quantity**	**Unit**	**Amount in Taka**
b	**Arts & craft village**			
i	Themed pavilion	2000	Sqm	108395118
ii	Internal road / path - 5.5 m top width	0.4	Km	3963681
iii	Green / landscape	2943	Sqm	1471675
	Sub total - Arts & craft village			**113830474**
c	**Star hotel**			
i	Building	2000	Sqm	830271648
ii	Internal road / path - 5.5 m top width	0.7	Km	6015565
iii	Green / landscape	4020	Sqm	2010150
	Sub total - Star hotel			**838297363**
d	**Business & relaxation**			
i	Statue deck	4000	Sqm	5535000
ii	Heritage pavilion	600	Sqm	33726706
iii	Convention centre and MICE	2000	Sqm	252695177
iv	Budget hotel	1200	Sqm	124769789
v	Yoga centre and meditation hall	530	Sqm	28657365
vi	Resorts and multi-cuisine restaurant	360	Sqm	32844113
vii	Water pool	1500	Sqm	5704332
viii	Green / landscape	4000	Sqm	2000000

Sl No.	Component	Quantity	Unit	Amount in Taka
ix	Internal road / path - 5.5 m top width	0.8	Km	6592400
	Sub-total - Business & relaxation			**492524882**
	Sub-total - Heritage and hospitality zone			**1454164819**
3	**Knowledge centre zone**			
a	IRC-CoE&IDC	2500	Sqm	467398677
b	Internal road / path - 5.5 m top width	0.7	Km	2518950
c	Green / landscape	2037	Sqm	1018251
d	Golf course	145395	Sqm	84553838
e	Club house	800	Sqm	24064000
f	Kiosk	294	Sqm	8762238
g	Cottages	715	Sqm	21492160
	Sub total - Knowledge centre zone			**609808114**
4	**Family entertainment zone**			
a	**Botanical Garden**			
i	Green houses and agro tourism	20619	Sqm	12134516
ii	Butterfly park	1000	Sqm	10593952
iii	Public Square	5000	Sqm	37980000
iv	Internal road / path - 5.5 m top width	2.3	Km	18953150
Sl No.	**Component**	**Quantity**	**Unit**	**Amount in Taka**
v	Green sculptures and eco bridge	1000	Sqm	2941180
vi	Green / landscape	9854	Sqm	4926877
vii	Multi-cuisine restaurant	500	Sqm	19387150
	Sub total - Botanical Garden			**106916825**
b	**Villas - 8 nos**	400	**Sqm**	**36236989**
c	**Open garden**	4000	**Sqm**	**3129412**
	Sub total - Family entertainment zone			**146283226**

5	**Adventure zone**			
a	Dry rides and other adventure activity	360667		165556477
b	Wet rides and other adventure activity	327783		84524710
	Sub total - Adventure zone			**250081187**
6	**Eco science zone**			
a	Oceanarium	9231	Sqm	3530000000
b	Marine biology research centre	2000	Sqm	1200000000
c	Internal road / path - 5.5 m top width	0.5	Km	4120250
d	Wooden deck	2610	Sqm	44589310
Sl No.	**Component**	**Quantity**	**Unit**	**Amount in Taka**
e	Water pool	2500	Sqm	9507220
f	Amphitheatre	1000	Sqm	31648000
g	Green and organic cultivation	3000	Sqm	1500000
h	Wooden walkway	3600	Sqm	59294118
i	Eco-tents - 25 nos	575	Sqm	18197600
j	Sky bridge	600	Sqm	26583600
k	Green / landscape	1233	Sqm	616305
	Sub total - Eco science zone			**4926056403**
III	**Amenity buildings**			
	Administration building	1000	Sqm	51987412
	Training /skill development centre	1000	Sqm	51987412
	Primary health centre	1000	Sqm	51987412
	Disaster management centre	500	Sqm	25993706
	Fire station	500	Sqm	25993706
	Police station	300	Sqm	15596224
	Sub total - Amenity buildings			**223545872**
IV	**Utility structures**			
	Internal water distribution network -Potable	16.60	Km	126650414.6
	Internal water distribution network - Non potable	13.28	Km	30560000
	Water treatment plant including utility structures	2.00	MLD	70000000
	Water utility structures (GLSR, ELSR & pump house)	1.00	LS	67294118
	Internal power distribution line (OHT)	14.6	Km	58588235
Sl No.	**Component**	**Quantity**	**Unit**	**Amount in Taka**

	Street light	22.47	Km	57433412
	Distribution transformers	225.00	Nos	86150118
	Internal sewerage network	16.60	Km	180163329
	Sewerage treatment plant	0.60	MLD	21176471
	Internal drain network and rainwater harvesting	18.00	Km	158823529
	Internal telecom network	16.60	km	87364941
	Solid waste management plant	2.86	TPD	28904941
	Sub total - Utility structures			**967881494**
	Total onsite project cost			**12488902489**
V	**Off-site infrastructures**			
	Access road (10 m wide)	3.5	Km	192500000
	Power supply incoming line	13.23	Km	52941176
	Sub-station 33/11 kV	8	mVA	100000000
	Water supply	12	Km	120000000
	Total offsite infrastructure cost			**465441176**
	Overall Infrastructure cost			**12954343666**

12.3. Resettlement and Rehabilitation cost

The resettlement budget includes for housing structure development at relocation site and livelihood restoration program through providing alternative livelihood training and compensation for land, trees, fish stock, grants/benefits for loss of business, will not be entitled as per policy of BEZA. The budget also kept provision for access road to resettlement site.

Table 78: Resettlement and Rehabilitation cost

sl. no	Category Of Losses	Quantity	Unit Cost (BDT)	Total (BDT)	Comment
1	Cost/Compensation for land			00.00	No private land will acquired
2	Compensation for structure or cost for structure	315 Housing structure	400,000.00	126,000,000.00	Each family will be given a 450 sft. sized structure
3	Compensation for trees			00.00	No private tree will be lost/damaged
4	Access road to resettlement site		lump-sum	20,00,000.00	
5	Livelihood restoration program		lump-sum	15,00,000.00	
	Total			129,500,000.00	

In word: Twelve crore, ninety-five lacs only.

12.4. Environmental Management Plan fixed cost

The cost of EMP given here includes only for the Environmental Monitoring, Audit and greenbelt development. The costs are approximate and need calibration at the time of detailed design and estimation stage.

Table 79: Environmental Management Plan fixed cost

S. No.	Components	Unit cost (Tk)	Cost (million BDT.)
A	**Fixed cost**		
A.1.	**Construction phase (30 years)**		
A.1.1.	PPEs for staffs of project proponent	50,000/year	0.55
A.1.3.	Environmental monitoring (quarterly) from site and surrounding area • Ambient air • Ambient noise • Surface water • Ground/drinking water • Soil quality	400000/Quarter	17.60
A.1.4.	Greenbelt development at suitable locations and protection of Mangroves	Lumpsum	250.00
A.1.5.	Marine and terrestrial ecological study (Half Yearly)	1500000/study	33.00
A.1.6.	Environmental audit (Half Yearly)	120000/study	2.64
A.1.7.	Environmental Specialist - Full Time: 2 Nos	800000/year/person	17.60
A.1.8.	Social Analyst- Full Time	700000/year	7.70
A.1.9.	occupational health specialist and a safety specialist- Full Time: 2 Nos	700000/year/person	15.40
A.2.	**Fund for proposed community development activities**	Lumpsum	15.00
	Total Fixed Cost (BDT)		**359.49**

13. Cost-Benefit Analysis

This chapter comprises of the financial and economic viability assessment of the Sonadia Eco – Tourism Park. The study team has assessed financial viability of the project with BEZA as master developer and also under Private Public Partnership model. Multiple scenarios within both the models have been assessed to identify and present the most viable model that can be adopted by BEZA based on assumptions highlighted in the chapter. The key objective of this chapter is to establish the cost-benefit analysis and summarize the financial and economic analysis for the proposed project.

13.1. Proposed Project Brief

BEZA has envisaged development of Moheshkhali SEZ (Ghatibanga – Sonadia) as a tourism hub. This study examines the site on various techno-commercial parameters to assess the feasibility of establishing tourism based economic zone.

The proposed ecotourism zone in Sonadia spreads over 8,967 acres is located in the Moheshkhali upazila of Cox's Bazar District in Chittagong Division. Proposed EZ is located at a distance of 22 km from Cox's Bazar district. Being adjacent to the coast, Sonadia Island offers tourists access to some of the most serene beaches, mangrove forest, large variety of migratory birds and breeding ground for turtles, this makes the zone more attractive from the tourism perspective. Despite having natural topography presence of forest and sea, the island does not rank amongst the most popular tourist spots in the country. Hence, an eco-tourism park will not only contribute in providing a safe, secure and enjoyable environment for the tourists, but also in the overall socio-economic upliftment of Sonadia area. The details of the site surrounding features is given in section 2.7.2 and reconfirmation of site location is given in 2.7.3. How the proposed EZ can shape up a hub for eco-tourism is briefed with a SWOT analysis of the proposed EZ in section 2.8.

It is envisaged that this tourism zone will be equipped with all required facilities and will attract visitors from both domestic and international population. Tourism zones from Philippines and Indonesia have been assessed for benchmarking because of the similar socioeconomic conditions and objectives of developing tourism zones. The other tourist attractions are taken from countries such as India, Sri Lanka, Malaysia and Thailand, and are tourist spots, but they are not SEZs dedicated to tourism. These examples highlight and showcase the Accessibility, Attractions, Accommodation, Amenities and Activities in these places so that the same can be replicated in case of Sonadia Eco-tourism zone. The details of the competition benchmarking are provided in the chapter 3.

Market assessment is the crucial first step when venturing into a new market and helps us to understand the potential of the project, promote tourism & align tourism facilities with regard to best international practices. The core offerings of tourism sector are natural attractions & entertainments, accommodation, food & beverages, hospitality services, and transportation. These core offerings in turn drive various allied industries (such as but not limited to construction, retail, hospitality, service, transportation, medical, and food), which further contributes to investment inflow, employment generation and economic welfare of any economy. Comparison of Bangladesh with Asian countries reveals that the country lacks in terms of international tourist arrivals and tourism sector's contribution to economy. Bangladesh has prevailing natural resources and flora/ fauna which can be harnessed properly to promote tourism sector. Case studies of countries which have excelled in tourism sector are furnished in the annexure. These case studies analyze key enablers required to promote tourism in Bangladesh context. The detailed market assessment has been provided in chapter 4.

Demand forecasting takes into cognizance estimation of tourist footfall at the proposed Sonadia Eco-Tourism Park and also the estimation of space allocation of different components within this eco-tourism park. The tourist footfall forecasting exercise was undertaken considering three different scenarios viz. conservative, base, and aggressive. Impact of COVID-19 on tourism industry has also been considered while conducting the study. Following table elucidates the annual tourist footfall at the proposed eco-tourism zone in millions in three scenarios.

Table 80: Annual Tourist Footfall (in million)

Tourists	Conservative	Base	Aggressive
Domestic	1.49	2.51	3.72
International	0.65	0.76	0.89

Total Annual Footfall	**2.13**	**3.27**	**4.61**

Source: PwC Analysis based on demand model

Estimation of space allocation exercise has been based on benchmarking exercise since there has been no similar precedence of eco-tourism parks in Bangladesh context. Detailed demand forecasting has been provided in chapter 5.

A robust transport infrastructure is the most vital enabler for any location to shape up as a potential tourism zone to enable seamless movement of tourists. The Sonadia Island is separated from the mainland by the Moheshkhali channel and a Bara canal separates it from the Moheshkhali Island. The detailed transport assessment has been provided in chapter 6.

For the sustained operation of Sonadia Eco-Tourism Park (SE-TP), it is pertinent that off-site infrastructure and its connectivity to the proposed SE-TP are adequately addressed. The major off-site infrastructure components considered for SE-TP are Access Road, Power Supply, Water Supply and Drain Facilities. These off-site infrastructure components would be developed by BEZA in order to provide support to the developer who would undertake the construction of the SE-TP. The demand provided is indicative in nature and may vary based on the on-ground implementation of the project. Last-mile off-site infrastructure action plan is provided in the section 7.5. These external infrastructure facilities and sources have been identified and well-integrated with the proposed SE-TP based on site visit, data collection, stakeholder consultations with various government agencies such as RHD, REB, and DPHE. The detailed off-site infrastructure assessment has been provided in Chapter 7.

The principles of sustainable eco-tourism are adopted while developing the master plan. The planning for the proposed SE-TP is in line with the broad objective of establishing an excellent business environment targeted principally at the eco-tourism sector, including hospitality sectors. The zoning plan consists of a combination of various zones which are spatially distributed with trunk connectivity between the zones integrated with the external transportation connectivity. It deals with the main aspects of development over the next 30 years (2020-2050). Statement of zoning plan has been provided in section 8.5. Multiple Tourist Attraction Facilities (TAF) and other facilities are proposed under each zone of SE-TP and are discussed in section 8.6. The master planning has been provided in chapter 8.

Provision of infrastructure and facilities is crucial for the sustained development and operation of SE-TP. Identification and planning of various supporting infrastructure and facilities for establishing SE-TP constitute critical tasks. The detailed infrastructure plans are provided in chapter 9.

The cost of developing the SE-TP covering hard infrastructure and soft elements are computed. The proposal is to develop SE-TP common infrastructure including specialised tourism infrastructure, SE-TP connectivity and external infrastructure, and Tourism and Knowledge Zone Component (TKZC) common development including TAF and Innovation Research Centre-Centres of Excellence & International Design Centre (IRC-CoE&IDC) and specialised tourism infrastructure within the TKZC boundaries in deferred investment manner to facilitate the flow of investment and to recalibrate the development especially to the market needs. The study also includes an analysis of project development investment phasing and computation of investment requirement during each phase of development. The details are given in chapter 10.

Within the planning area, a Social Impact Assessment (SIA) was conducted. The SIA helps to identify and assess a project's social impacts that are directly related to the project and propose measures to enhance potential positive impacts and strategies to avoid, manage, mitigate or offset the predicted negative project impacts. The details of the social review are given in chapter 11.

Environmental Review has also been conducted in chapter 12, highlighting the regulatory requirement set out by Government of Bangladesh (GoB) and World Bank (WB) in relation to protection of environment and its resources as well as protection of the social environment from adverse impacts associated with the project development.

Proposed project cost estimation is provided in the table given below.

Table 81: Proposed Project Cost Estimation

Sl No.	Component	Quantity	Unit	Project Cost (in million BDT)	Total Costs including other relevant costs (in million BDT)[104]	Reference
A	**On-Site Infrastructure Cost**					
A.1.	**Embankment - 7.5 m top width**	**17.94**	**Km**	**3,599.13**	**4,236.18**	Please refer to the section 14.13. Annexure 13
A.2.	**Land filling**	**437057**	**Cum**	**82.16**	**96.71**	
A.3.	**Road connecting zones - 7.5 m top width**	**4.6**	**Km**	**91.44**	**107.63**	
A.4.	**Entrance zone**					
A.4.1.	Internal road / path - 5.5 m top width	0.8	Km	11.45	13.48	
A.4.2.	E-car and cycle parking	686	Sqm	1.56	1.84	
A.4.3.	Information kiosk/globe	415	Sqm	1.33	1.59	
A.4.4.	Helipad	2000	Sqm	5.99	7.19	
A.4.5.	Viewing deck	1146	Sqm	7.12	8.53	
A.4.6.	Water pool with musical fountains	13956	Sqm	1.35	1.62	
A.4.7.	Green / landscape	5712	Sqm	2.86	3.36	
A.4.8.	Jetty	1067	Sqm	106.66	125.54	
	Sub total - Entrance zone			**138.33**	**163.17**	
A.5.	**Amenity Buildings**					
A.5.1.	Administration building	1000	Sqm	51.98	61.19	
A.5.2.	Training /skill development centre	1000	Sqm	51.98	61.19	
A.5.3.	Primary health centre	1000	Sqm	51.98	61.19	
A.5.4.	Disaster management centre	500	Sqm	25.99	30.59	
A.5.5.	Fire station	500	Sqm	25.99	30.59	
A.5.6.	Police station	300	Sqm	15.60	18.36	
	Sub total - Amenity buildings			**223.55**	**263.11**	
A.6.	**Utility structures**					
A.6.1.	Internal water distribution network - Potable	16.60	Km	91.19	107.33	
A.6.2.	Internal water distribution network - Non potable	13.28	Km	60.79	71.55	
A.6.3.	Water treatment plant including utility structures	2.00	MLD	70.00	82.39	
A.6.4.	Water utility structures (GLSR, ELSR & pump house)	1.00	LS	67.29	79.205	

[104] 1% of Manpower cost during pre-operative period, 5% of Project consultancy, detailed engineering and project supervision cost, 2% of Initial marketing and project launch expenses, 1% of Pre-operative and other expenses has additionally considered in the Financial Model

Sl No.	Component	Quantity	Unit	Project Cost (in million BDT)	Total Costs including other relevant costs (in million BDT)[104]	Reference
A.6.5.	Internal power distribution line (OHT)	14.60	Km	58.59	68.95	
A.6.6.	Street light	22.47	Km	57.43	67.60	
A.6.7.	Distribution transformers	225.00	Nos	86.15	101.40	
A.6.8.	Internal sewerage network	16.60	Km	180.16	212.05	
A.6.9.	Sewerage treatment plant	0.60	MLD	21.18	24.92	
A.6.10.	Internal drain network and rainwater harvesting	18.00	Km	158.82	186.935	
A.6.11.	Internal telecom network	16.60	km	87.36	102.83	
A.6.12.	Solid waste management plant	2.86	TPD	28.90	34.02	
	Sub total - Utility structures			**967.88**	**1,139.20**	
	Total onsite project cost			**5,102.49**	**6,006.00**	
B.	**Off-site Infrastructures**					
B.1.	Access road (10 m wide)	3.5	Km	192.50	226.57	Please refer to the section 14.13. Annexure 13
B.2.	Power supply incoming line	13.23	Km	52.94	62.31	
B.3.	Sub-station 33/11 kV	8	mVA	100.00	117.70	
B.4.	Water supply	12	Km	120.00	141.24	
	Total Off-site Infrastructure Cost			**465.44**	**547.82**	
C.	**Resettlement and Rehabilitation cost**					
C.1.	Cost/Compensation for land	N/A	Acres	00.00	00.00	Please refer to the section 12.3
C.2.	Compensation for structure or cost for structure	315 Housing Structure	Nos.	126.00	126.00	
C.3.	Compensation for trees	N/A	Nos.	00.00	00.00	
C.4.	Access road to resettlement site (lump-sum)	N/A	km	2.00	2.00	
C.5.	Livelihood restoration program (lump-sum)	N/A	N/A	1.50	1.50	
	Total Resettlement and Rehabilitation cost			**129.50**	**129.50**	
D.	**Environmental Management Plan fixed cost**					
D.1.	PPEs for staffs of project proponent (50,000/year)	N/A	Nos.	0.55	0.55	Please refer to the section 12.4
D.2.	Environmental monitoring (quarterly) from site and surrounding area • Ambient air • Ambient noise	N/A	N/A	17.60	17.60	

Sl No.	Component	Quantity	Unit	Project Cost (in million BDT)	Total Costs including other relevant costs (in million BDT)[104]	Reference
	• Surface water • Ground/drinking water • Soil quality (400000/Quarter)					
D.3.	Greenbelt development at suitable locations and protection of Mangroves (Lumpsum)	N/A	N/A	250.00	250.00	
D.4.	Marine and terrestrial ecological study (Half Yearly) (1500000/study)	2	Nos.	33.00	33.00	
D.5.	Environmental audit (Half Yearly) (120000/study)	2	Nos.	2.64	2.64	
D.6.	Environmental Specialist - Full Time: 2 Nos (800000/year/person)	2	Nos.	17.60	17.60	
D.7.	Social Analyst- Full Time (700000/year)	1	Nos.	7.70	7.70	
D.8.	Occupational health specialist and a safety specialist- Full Time: 2 Nos (700000/year/person)	2	Nos.	15.40	15.40	
D.9.	Fund for proposed community development activities (Lump-sum)	N/A	N/A	0.55	0.55	
			Total Fixed EMP cost	**359.49**	**359.49**	
			Total Project Cost	**6,056.92**	**7,042.81**	

Source: The study team analysis

Table 82: Proposed Project Financial Returns

Scenarios	Conservative			Base			Aggressive		
	@10% cost of equity	@12% cost of equity	@15% cost of equity	@10% cost of equity	@12% cost of equity	@15% cost of equity	@10% cost of equity	@12% cost of equity	@15% cost of equity
Case 1: BEZA is playing role of developer (Scenario A: Prevailing tariffs of BEZA i.e., Business As usual)									
Financial NPV[105]	145.35	-601.27	-1,241.9	309.32	-454.78	-1,117.5	541.15	-244.10	-934.21
Financial BCR	0.51	0.51	0.51	0.53	0.53	0.53	0.56	0.56	0.56

[105] NPV FCFF is considered as Financial NPV and Project IRR is considered as Financial IRR.

Scenarios	Conservative			Base			Aggressive		
	@10% cost of equity	@12% cost of equity	@15% cost of equity	@10% cost of equity	@12% cost of equity	@15% cost of equity	@10% cost of equity	@12% cost of equity	@15% cost of equity
Financial IRR[Error! Bookmark not defined.]	10.32%	10.32%	10.32%	10.70%	10.70%	10.70%	11.28%	11.28%	11.28%
Case 1: BEZA is playing role of developer (Scenario B: Increased space tariffs)									
Financial NPV[Error! Bookmark not defined.]	1,228.86	220.13	-670.23	1,431.12	400.82	-516.80	1,717.04	660.66	-290.70
Financial BCR	0.63	0.63	0.63	0.66	0.66	0.66	0.69	0.69	0.69
Financial IRR[Error! Bookmark not defined.]	12.58%	12.58%	12.58%	13.09%	13.09%	13.09%	13.88	13.88%	13.88%
Case 2: PPP developer develops the project (Scenario A: with Payout to BEZA)									
Financial NPV[Error! Bookmark not defined.]	1,534.90	489.95	-439.73	1,735.14	668.85	-287.84	2,018.20	926.08	-63.99
Financial BCR	0.67	0.67	0.67	0.70	0.70	0.70	0.75	0.75	0.75
Financial IRR[Error! Bookmark not defined.]	13.35%	13.35%	13.35%	13.90%	13.90%	13.90%	14.74%	14.74%	14.74%
Case 2: PPP developer developing the project (Scenario B: Without Payout to BEZA)									
Financial NPV[Error! Bookmark not defined.]	1,721.31	660.28	-285.85	1,923.57	840.98	-132.42	2,209.49	1,100.81	93.68
Financial BCR	0.70	0.70	0.70	0.73	0.73	0.73	0.77	0.77	0.77
Financial IRR[Error! Bookmark not defined.]	13.89%	13.89%	13.89%	14.47%	14.47%	14.47%	15.39%	15.39%	15.39%

Source: The study team analysis, (Financial NPV is in BDT million)

Table 83: Proposed Project Economic Returns

Scenarios	Conservative			Base			Aggressive		
	@10% equity discounting rate	@12% equity discounting rate	@15% equity discounting rate	@10% equity discounting rate	@12% equity discounting rate	@15% equity discounting rate	@10% equity discounting rate	@12% equity discounting rate	@15% equity discounting rate
Economic NPV	29384.50	18050.41	8867.26	47237.60	29860.64	15718.22	68112.18	43665.56	23722.89

Scenarios	Conservative			Base			Aggressive		
	@10% equity discounting rate	@12% equity discounting rate	@15% equity discounting rate	@10% equity discounting rate	@12% equity discounting rate	@15% equity discounting rate	@10% equity discounting rate	@12% equity discounting rate	@15% equity discounting rate
Economic BCR	5.77	4.20	2.76	8.66	6.29	4.13	12.05	8.74	5.72
Economic IRR[106]	25.0%	25.0%	25.0%	30.2%	30.2%	30.2%	35.1%	35.1%	35.1%

Source: The study team analysis, (Economic NPV is in BDT million)

13.2. Financial Analysis

13.2.1. Purpose and Objectives

Establishing of economic zone regime in Bangladesh is an effort by the GoB to boost manufacturing activity and employment in the country. However, in case of the proposed EZ, BEZA intends to attract developers who are interested in setting up tourist attraction units in Bangladesh through development of infrastructure, supply of utilities (water, power and gas), transport connectivity and business friendly policies.

However, in order to develop the infrastructure, it is paramount to understand the financial costs involved in developing such infrastructure and the expected returns that could be expected from operating economic zones. This chapter evaluate the financial feasibility of developing the proposed tourism-based economic zone which has been determined based on net financial benefits under different scenarios (conservative, base and aggressive) of land uptake in the proposed EZ and level of cash flows accruing to the developer.

This financial model takes into cognizance two scenarios viz. (i) **BEZA is the master developer of the project – Case 1** and (ii) **PPP developer develops the project where BEZA plays the role of facilitator and nodal agency – Case 2**.

First scenario considers that BEZA is responsible for land acquisition, resettlement and rehabilitation, and infrastructure developments at the proposed EZ and in turn leasing out space to private tenants. The major sources of revenue accruing to BEZA has been considered from (1) annual rental for land uptake and (2) mark-up on utility (power, water, gas) provided to operators, (3) service fees/maintenance fees from the EZ. In addition to the capital expenditure for developing this project, BEZA also needs to incur operational expenditure towards operation and maintenance (O&M) of this project.

Second scenario considers that BEZA (as nodal agency and facilitator of the project) is responsible for land acquisition, resettlement and rehabilitation, and off-site infrastructure developments at the proposed EZ as a condition precedent. The PPP developer is mandated to develop and maintain the on-site infrastructure and subsequently earn revenue through leasing of space at the proposed EZ.

This model is developed to analyze revenues generating sources and consequently Project Internal Rate of Return (PIRR), Equity Internal Rate of Return (EIRR), Debt Service Coverage Ratio (DSCR), and Net Present Value (NPV) for both the scenarios.

13.2.2. Definitions

Net Present Value (NPV): NPV is the difference between the present value of cash inflows and outflows over a period.

[106] Please refer to Interpreation of the results section, under Economic Analysis

Internal Rate of Return (IRR): The IRR is a financial measure that is used to evaluate the profitability of potential investments. In a discounted cash flow analysis, the IRR is a discount rate that makes the net present value (NPV) of all cash flows equal to zero.

Free Cash Flow to the Firm (FCFF): FCFF is the amount of cash flow from operations that is available for distribution after depreciation, taxes, working capital, and investments have been taken into consideration. FCFF is a metric for determining a company's profitability after all expenditures and reinvestments have been deducted.

Free Cash Flow to Equity (FCFE): Free cash flow to equity is a measure of how much cash is available to the equity shareholders of a company After all costs, investments, and debt have been paid.

Debt-Service Coverage Ratio (DSCR): In the context finance, the DSCR is a measurement of a firm's available cash flow to pay current debt obligations. The DSCR shows investors whether a company has enough income to pay its debts.

Benefit-Cost Ratio (BCR): BCR is a ratio used which summarize the overall relationship between the relative costs and benefits of a proposed project.

Cost of Equity: Cost of equity is the return that a company requires to decide if an investment meets capital return requirements. A firm's cost of equity represents the compensation that the market demands in exchange for owning the asset and bearing the risk of ownership.

Weighted Average Cost of Capital (WACC): WACC is a calculation of a firm's cost of capital in which each category of capital is proportionately weighted.

Discount Rate: Discount rate refers to the interest rate used in discounted cash flow (DCF) analysis to determine the present value of future cash flows.

13.2.3. Components of Cost & Benefit

13.2.3.1. Cost Assumptions

1. Assumptions related to Capital expenses

Case 1: BEZA playing the role of the master developer

For undertaking this project, BEZA has to incur the following cost outlays.

- Cost of land acquisition
- Cost pertaining to resettlement and rehabilitation
- Infrastructure cost
- Other costs (EMP & Pre-operating costs)

Cost of land acquisition and resettlement and rehabilitation

Since, the land considered for development of the zone is entirely Khas land or Government owned land, no cost associated with land acquisition has been considered in the model. As per primary stakeholder consultations with AC land and UNO officials, cost towards compensation for resettlement and rehabilitation is **BDT 129.50 million**. Details of these are captured in the Social Review chapter of the report.

Cost pertaining to Off-site infrastructure

Infrastructure assessment recommends that for developing this project, BEZA must undertake off-site infrastructure development pertaining to land filling, utility supply and boundary wall. Details of the same are captured in the Infrastructure Assessment chapter. The following table depicts the cost towards the above-mentioned elements.

Table 84: Off-site infrastructure cost estimates to be incurred by BEZA

Description of Item	Quantity	Unit	Price without tax (in million BDT)

Power sub-station	8	MVA	117.70
Water supply	12000	RM	141.24
Access Road	3500	RM	226.57
Power supply	15000	RM	62.31
Project Sub-total			**547.82**

Source: MACE analysis; costs have been calculated using updated references and scheduled rates of concerned nodal agencies of Bangladesh

Other costs

Cost associated with Environmental Management Plan is considered as **BDT 359.49 million.**

Cost pertaining to On-site infrastructure

Infrastructure assessment recommends that for developing this project, BEZA has to undertake on-site infrastructure development pertaining to internal road network, power network, water supply, wastewater treatment, support amenities etc. Details of the same are captured in the Infrastructure Assessment chapter. The following table depicts the cost towards the above-mentioned elements.

Table 85: On-site infrastructure cost estimates to be incurred by PPP developer and BEZA

Description of Item	Price without tax (In million BDT)
Embankment	4236.18
Site Grading	96.71
Road network connecting zones	107.63
Entrance zone	163.17
Amenity Buildings	263.11
Utility Structures	1139.20
Project Sub-total	**6006.00**

Source: MACE analysis; costs have been calculated using updated references and scheduled rates of concerned nodal agencies of Bangladesh

2. Assumptions Related to Operating Expenses

For undertaking this project, both BEZA and/or the PPP developer has to incur the following operating cost outlays.

Cost pertaining to operations and maintenance (O&M including Manpower costs)

In absence of precedence of similar projects in the country, **2% of total Capex cost (excluding embankment) per annum** towards operations and maintenance (O&M) has been considered for the financial model for Case 1 and Case 2 i.e. BEZA developing the project and PPP developer developing the project respectively. Similarly, pre-operating expense has been assumed as **1% of total Capex cost per annum** for both cases**.**

13.2.3.2. Revenue Assumptions

In case of BEZA being the master developer of the project i.e. Case 1, it will earn revenues through land leasing, mark-up on utilities and EZ service fees. The main revenue source for BEZA includes- (i) revenue from annual land lease premium for developable space, (ii) revenue from mark-up of utilities (water, power, and effluent treatment), and (iii) EZ Service Fees.

Similarly, as per Case 2, where the PPP developer comes onboard, it will also have the same revenue sources.

Assumptions for revenue generating from developable space

BEZA as nodal agency and facilitator is in process of allocating land plots to industrial and infrastructure tenants in different Government owned EZs such as Bangabandhu Sheikh Mujib Industrial City (Mirsarai EZ), Feni, Jamalpur EZ 1, Shreehatta and Maheshkhali (Dhaulghata). However, in this case, BEZA will lease land to individual developers for development of the various components of the tourism based EZ and thus charge differential lease rates based on the type of development. Similar assumptions have been taken in case of the PPP developer. However, rates charged by the PPP developer is assumed to be on the higher side based on similar precedence in case of manufacturing based EZs.

Table 86: Tariff assumption

S. No.	Category of Land/Type of Development	Land area (in Acres)	Annual Rent per sq. ft. (BDT) charged by BEZA	Annual Rent per sq. ft. (BDT) charged by PPP developer and in Increased space tariff case by BEZA
1	Accommodation & Restaurants	200.44	20.00	25.00
2	Themed pavilions/museums	66.00	12.00	15.00
3	Themed gardens/parks	204.52	12.00	15.00
4	Villas & Cottages	0.76	20.00	25.00
5	Knowledge centers	25.19	12.00	15.00
6	Eco science zone	143.27	12.00	15.00
7	Golf course & Club house	72.29	20.00	25.00
8	Adventure parks	170.12	20.00	25.00

Source: PwC analysis

Assumptions for revenue generating from Mark-up on utility charges

As per the land allotment brochures for Government owned EZs in Bangladesh, BEZA levies a service charge (Mark-up of 5%) on the prevailing utility tariffs. The same has been considered in case of the PPP developer as well.

Assumptions for revenue generating from EZ Service fees

As per the land allotment brochures for Government owned EZs in Bangladesh, BEZA charges a conservancy charge of **BDT 0.39 per annum/sq. ft. land**. However, the market rates may differ from the same. In case of the PPP developer, the same is assumed as **BDT 5 per annum/sq. ft. land.**

In the financial model all revenue related assumptions have been considered in line with the above.

13.2.4. Transferred in Monetary Value

The financial model created takes into consideration financial return to BEZA (when BEZA is responsible for the following activities as the facilitator (nodal agency) and master developer of the project) and the PPP developer (when the PPP developer is responsible for the construction and O&M of the project). For the first scenario where BEZA is the master developer, the functionality of this financial modelling is same as the prevailing models of development followed in Economic Zones such as Bangabandhu Sheikh Mujib Industrial City (Mirsarai EZ), Feni, Jamalpur EZ 1, Shreehatta and Maheshkhali (Dhaulghata).

Table 87: Responsibilities of BEZA and PPP developer in different financial models

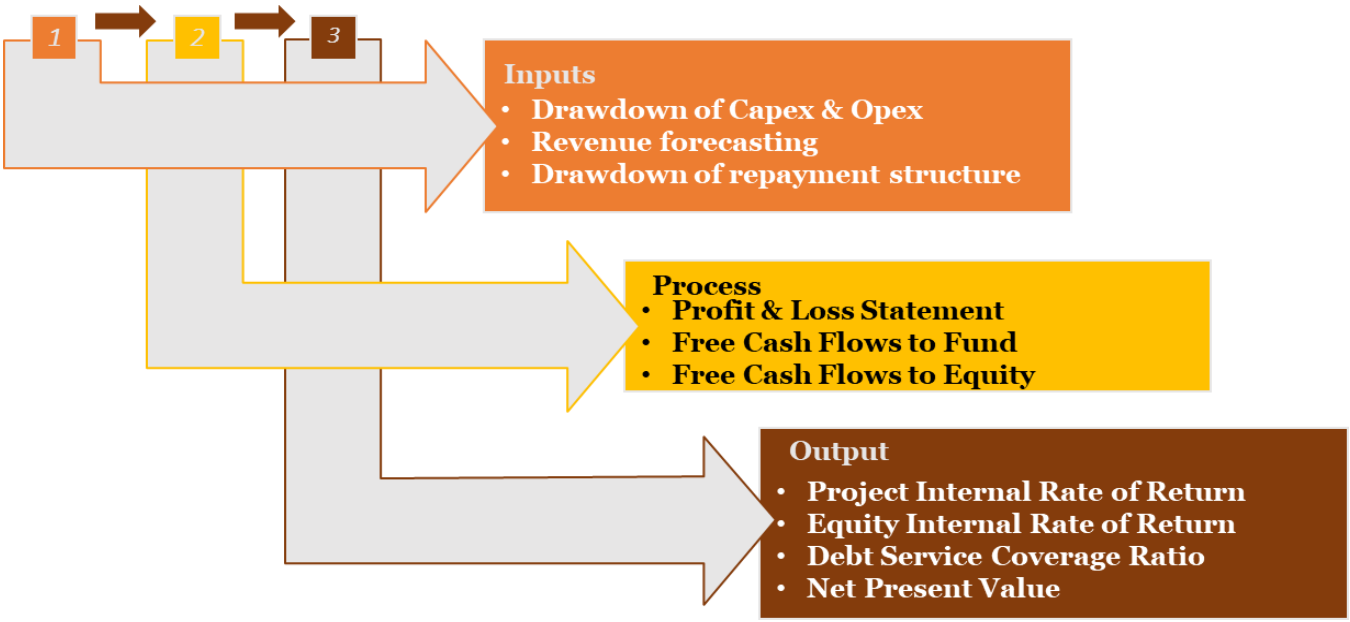
Aspects	Responsibilities of BEZA/ PPP Developer
Land acquisition and ownership	BEZA would acquire the land parcel and allocate the same to developers on leasehold basis for a period of 50 years and extendable on mutual consent basis
Resettlement & Rehabilitation	BEZA would be responsible for resettlement and rehabilitation activities for all social incumbencies prevailing within the proposed EZ
Infrastructure development (Business as usual scenario)	Development of off-site and certain on-site infrastructure components is the responsibility of BEZA as condition precedent. In case of PPP project, the private developer is responsible for developing the on-site infrastructure
Financing	Responsibility of BEZA (for BEZA model) and it is the responsibility of the PPP developer for the PPP model
O&M	Responsibility of BEZA (for BEZA model) and it is the responsibility of the PPP developer for the PPP model

Source: PwC analysis

To have a robust model in place, an exhaustive list of assumptions has been developed which duly indicates all the inputs considered for determining the expected return on the investment. Consent has been obtained from BEZA officers about these assumptions. A graphical diagram depicting the functionalities of financial model is shown below.

In the PPP model, the PPP developer shall inject equity in the SPV and borrow debt from financial institutions through Special Purpose Vehicle (SPV) to execute the project. The SPV shall obtain necessary regulatory approvals from BEZA and other regulatory bodies. The SPV shall lease out the industrial space and provide utility services to the industrial units against the lease payments, service fees and utility markup. Government may consider providing grants, if required.

Figure 104: Process flow of Financial Model



Source: PwC Analysis

Inputs

A yearly model has been developed to depict the Capex (cost of land acquisition, infrastructure, EMP, pre-operations) and Opex expenses along with debt (both commercial borrowing and concessional loan) drawdown structure, in order to have a granular insight into the capital cash outflows. Revenue Forecasting has been done on an annual basis to understand the cash inflows accruing to BEZA or the PPP developer through lease of land, surcharge on supply of utility services (like water, power, and water treatment), and EZ service fees.

Process

Considering the expenses and revenue sources above, pro-forma income statements have been calculated which captures the profits/loss and cash flows accruing to BEZA or the PPP developer. This process forms the backbone of the financial model which is used to determine the returns to BEZA or the PPP developer.

Outputs

BEZA being the Government nodal agency mandated for development of economic zones in Bangladesh, is concerned with the PIRR i.e., the overall returns accruing from the project and not on parameters such as equity IRR, Debt Service Coverage Ratio (DSCR); whereas the PPP developer is concerned with various ratios such as PIRR, EIRR, and DSCR

Thus, as a measure of calculating returns to BEZA on its investment in this project, parameters that have been considered are Rate of Return to providers of capital (debt + equity) i.e. project IRR.

Three scenarios (viz. conservative, base and aggressive) have been considered in this model based on the anticipated occupancy (land demand uptake) of the proposed economic zone in order to make provision for a dynamic investment climate. The land uptake in an industrial project are highly impacted by the country's and regional economic growth. These scenarios could occur due to trickledown effect of the changing economic context on macro and micro level. These scenarios would assist BEZA in assessing the range of expected return that it could anticipate through its investment in the proposed EZ.

Aggressive case assumes macro-economic conditions of Bangladesh and the region are improving; macro level economic conditions are improving; land uptake rate will be higher than the anticipated demand. Base case assumes macro-economic conditions of Bangladesh and the region are showing steady trend and behaving as expected; land uptake will be as per anticipated demand. Conservative case considers macro-economic conditions of Bangladesh and the region are showing declining trend; land uptake rate will be lower than the anticipated demand.

The broad level commercial aspects considered while developing the model for the scenario where BEZA plays the role of the master developer i.e., Case 1 are –

- BEZA would be responsible for financing, constructing infrastructure for the proposed EZ and subsequently the Operation and Maintenance.
- Cost of land acquisition is the prerogative of BEZA.
- Construction of the infrastructure of the proposed EZ is the prerogative of BEZA
- The project would be financed by BEZA's own equity and loans from commercial lenders & financial institutions (i.e., concessional loan).
- Marketing of the industrial plot will be done by BEZA.
- BEZA will enter into lease agreement with the developers of tourism units. These units will be the end users/tenants at the plots in economic zone.
- Complete ownership of the land demarcated for this project belongs to BEZA. The private tenants who would be allocated land parcels towards space in the EZ would be required to pay BEZA as per the following:
    - Annual Land Lease premium
    - Mark-up on Utilities (power, water, and effluent treatment)
    - EZ Service fees

Similarly, the commercial aspects considered when a PPP developer is assigned by BEZA to develop the project i.e., Case 2 are -

- The PPP developer would be responsible for financing, constructing on-site infrastructure for the proposed EZ and subsequently the Operation and Maintenance.
- Cost of land acquisition and construction of off-site infrastructure should be the prerogative of BEZA as per conditions precedent.
- Construction of the on-site infrastructure of the proposed EZ is the prerogative of the PPP developer
- The project would be financed by PPP developer's own equity and loans from commercial lenders & financial institutions (i.e., concessional loan).
- Marketing of the industrial plot will be done by the PPP developer.
- The PPP developer will enter into lease agreement with the individual developers of tourism units. These units will be used by the end users/tenants at the plots in economic zone.
- Complete ownership of the land demarcated for this project belongs to BEZA which will be transferred to the PPP developer on lease hold basis. The private tenants who would be sub-leased the land parcels towards space in the EZ would be required to pay the PPP developer as per the following:
    - Annual Land Lease premium
    - Mark-up on Utilities (power, water, and effluent treatment)
    - EZ Service fees

13.2.5. Cash Flow

Cash Flow Statement										
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Cash Inflow										
PAT	-32	-41	-48	-73	130	391	436	470	503	-46
Book depreciation	0	0	0	224	224	224	224	224	224	224
Equity infusion	348	370	327	347	346	345	366	401	303	0
Debt drawdown	813	862	762	809	807	805	854	936	707	0
Total cash inflow	1129	1191	1041	1306	1506	1765	1880	2031	1737	178
Cash Outflow										
Capex	1161	1232	1089	1155	1153	1150	1220	1337	1011	0
Dividend pay-out	0	0	0	0	0	0	0	0	0	0
Repayment (Principal)	0	0	0	0	0	0	0	0	0	797
Total cash outflow	1161	1232	1089	1155	1153	1150	1220	1337	1011	797
Net Cash Generation	**-32**	**-41**	**-48**	**151**	**353**	**614**	**660**	**693**	**726**	**-619**
Opening balance of cash and bank balance		**-32**	**-73**	**-121**	**30**	**383**	**998**	**1657**	**2350**	**3077**
Closing balance of cash and bank balance	**-32**	**-73**	**-121**	**30**	**383**	**998**	**1657**	**2350**	**3077**	**2458**

Cash Flow Statement										
	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Cash Inflow										
PAT	61	136	212	287	363	438	514	560	576	593

Book depreciation	224	224	224	224	224	224	224	224	224	224
Equity infusion	0	0	0	0	0	0	0	0	0	0
Debt drawdown	0	0	0	0	0	0	0	0	0	0
Total cash inflow	285	360	435	511	586	662	737	783	800	816
Cash Outflow										
Capex	0	0	0	0	0	0	0	0	0	0
Dividend pay-out	0	0	0	0	0	0	0	0	0	0
Repayment (Principal)	797	797	797	797	797	797	797	140	140	140
Total cash outflow	797	797	797	797	797	797	797	140	140	140
Net Cash Generation	**-512**	**-437**	**-362**	**-286**	**-211**	**-135**	**-60**	**643**	**660**	**676**
Opening balance of cash and bank balance	**2458**	**1945**	**1508**	**1147**	**861**	**650**	**515**	**456**	**1099**	**1758**
Closing balance of cash and bank balance	**1945**	**1508**	**1147**	**861**	**650**	**515**	**456**	**1099**	**1758**	**2435**

Cash Flow Statement										
	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Cash Inflow										
PAT	609	626	642	659	670	677	684	691	698	704
Book depreciation	224	224	224	224	224	224	224	224	224	224
Equity infusion	0	0	0	0	0	0	0	0	0	0
Debt drawdown	0	0	0	0	0	0	0	0	0	0
Total cash inflow	833	849	866	882	894	901	908	914	921	928
Cash Outflow										
Capex	0	0	0	0	0	0	0	0	0	0

Dividend pay-out	0	0	0	0	0	0	0	0	0	0
Repayment (Principal)	140	140	140	140	0	0	0	0	0	0
Total cash outflow	140	140	140	140	0	0	0	0	0	0
Net Cash Generation	**693**	**709**	**726**	**742**	**894**	**901**	**908**	**914**	**921**	**928**
Opening balance of cash and bank balance	**2435**	**3127**	**3836**	**4562**	**5304**	**6198**	**7099**	**8007**	**8921**	**9842**
Closing balance of cash and bank balance	**3127**	**3836**	**4562**	**5304**	**6198**	**7099**	**8007**	**8921**	**9842**	**10770**

Cash Flow Statement										
	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Cash Inflow										
PAT	711	718	725	732	739	745	752	759	766	773
Book depreciation	224	224	224	224	224	224	224	224	224	224
Equity infusion	0	0	0	0	0	0	0	0	0	0
Debt drawdown	0	0	0	0	0	0	0	0	0	0
Total cash inflow	935	942	948	955	962	969	976	983	989	996
Cash Outflow										
Capex	0	0	0	0	0	0	0	0	0	0
Dividend pay-out	0	0	0	0	0	0	0	0	0	0
Repayment (Principal)	0	0	0	0	0	0	0	0	0	0
Total cash outflow	0	0	0	0	0	0	0	0	0	0
Net Cash Generation	**935**	**942**	**948**	**955**	**962**	**969**	**976**	**983**	**989**	**996**
Opening balance of cash	**10770**	**11705**	**12647**	**13595**	**14551**	**15513**	**16482**	**17458**	**18440**	**19430**

and bank balance										
Closing balance of cash and bank balance	**11705**	**12647**	**13595**	**14551**	**15513**	**16482**	**17458**	**18440**	**19430**	**20426**

Cash Flow Statement										
	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Cash Inflow										
PAT	779	786	793	800	806	813	820	826	833	840
Book depreciation	224	224	224	224	224	224	224	224	224	224
Equity infusion	0	0	0	0	0	0	0	0	0	0
Debt drawdown	0	0	0	0	0	0	0	0	0	0
Total cash inflow	1003	1010	1017	1023	1030	1037	1043	1050	1057	1063
Cash Outflow										
Capex	0	0	0	0	0	0	0	0	0	0
Dividend pay-out	0	0	0	0	0	0	0	0	0	0
Repayment (Principal)	0	0	0	0	0	0	0	0	0	0
Total cash outflow	0	0	0	0	0	0	0	0	0	0
Net Cash Generation	**1003**	**1010**	**1017**	**1023**	**1030**	**1037**	**1043**	**1050**	**1057**	**1063**
Opening balance of cash and bank balance	**20426**	**21429**	**22439**	**23456**	**24479**	**25509**	**26546**	**27589**	**28639**	**29696**
Closing balance of cash and bank balance	**21429**	**22439**	**23456**	**24479**	**25509**	**26546**	**27589**	**28639**	**29696**	**30759**

Source: Financial model

13.2.6. Key Assumptions

In this section, the key assumptions used in developing the financial model (to assess the financial viability of the proposed project) have been elucidated.

13.2.6.1. Timing Assumptions

The proposed EZ is spread over an area of ~329.43 acres. Considering the fact that this project is a priority for BEZA, it has been assumed that in the coming six months (i.e., till June 2020) BEZA shall complete all the regulatory activities pertaining to the approval of the project. Hence, the model start date has been assumed from 1st July 2023. A 50-year model tenure has been considered. Following table captures the timing assumptions for this project.

Table 88: Timing related assumptions

S. No.	Details	Assumptions
1	Start date	2020 (financial year 2021)
2	Resettlement & Rehabilitation activities	2020-2021 (2 years)
3	Infrastructure developments	2020-2028 (9 years)
4	Start of operations	2023 (financial year)
5	Model end date	2069 (financial year)

Source: PwC Analysis

Considering the development trends and land acquisition related aspects in Bangladesh, above stated assumptions have been taken on the conservative side.

13.2.6.2. Land Use Pattern

In the earlier chapters, based on the prevailing infrastructure, best practice master planning has been formulated. In line with the same, following table elaborates the land use pattern for the proposed EZ.

Table 89: Land use pattern

S. No.	Details	Land Use (in Acres)
1.	Entrance Zone	**35.23**
2.	Heritage & Hospitality Zone	**231.22**
3.	Knowledge Centre Zone	**97.83**
4.	Family Entertainment Zone	**204.92**
5.	Adventure Zone	**170.12**
6.	Eco-Science Zone	**143.27**
Total Developable Area		**883**

Source: MACE analysis; figures are rounded up to the next decimal in the Total

Apart from these, the zone will also house area dedicated to support amenities and utilities. Details of the same is elaborated in the Master Plan chapter. However, since revenue calculation are based on the developable area therefore, the above components are highlighted.

13.2.6.3. Revenue Assumptions

In case of BEZA being the master developer of the project i.e. Case 1, it will earn revenues through land leasing, mark-up on utilities and EZ service fees. The main revenue source for BEZA includes- (i) revenue from annual land lease premium for developable space, (ii) revenue from mark-up of utilities (water, power, and effluent treatment), and (iii) EZ Service Fees.

Similarly, as per Case 2, where the PPP developer comes onboard, it will also have the same revenue sources.

Assumptions for revenue generating from developable space

BEZA as nodal agency and facilitator is in process of allocating land plots to industrial and infrastructure tenants in different Government owned EZs such as Bangabandhu Sheikh Mujib Industrial City (Mirsarai EZ), Feni, Jamalpur EZ 1, Shreehatta and Maheshkhali (Dhaulghata). However, in this case, BEZA will lease land to individual developers for development of the various components of the tourism based EZ and thus charge differential lease rates based on the type of development. Similar assumptions have been taken in case of the PPP developer. However, rates charged by the PPP developer is assumed to be on the higher side based on similar precedence in case of manufacturing based EZs.

Table 90: Land Tariff Assumptions

S. No.	Category of Land/Type of Development	Land area (in Acres)	Annual Rent per sq. ft. per annum (BDT) charged by BEZA	Annual Rent per sq. ft. per annum (BDT) charged by PPP developer	Contract Period
1	Accommodation & Restaurants	**200.44**	**20.00**	**25.00**	**50**
2	Themed pavilions/museums	**65.59**	**12.00**	**15.00**	**50**
3	Themed gardens/parks	**204.52**	**12.00**	**15.00**	**50**
4	Villas & Cottages	**0.76**	**20.00**	**25.00**	**50**
5	Knowledge centers	**25.19**	**12.00**	**15.00**	**50**
6	Eco science zone	**143.27**	**12.00**	**15.00**	**50**
7	Golf course & Club house	**72.29**	**20.00**	**25.00**	**50**
8	Adventure parks	**170.12**	**20.00**	**25.00**	**50**

Source: BEZA

Assumptions for revenue generating from Mark-up on utility charges

As per the land allotment brochures for Government owned EZs in Bangladesh, BEZA levies a service charge (Mark-up of 5%) on the prevailing utility tariffs. The same has been considered in case of the PPP developer as well.

Assumptions for revenue generating from EZ Service fees

As per the land allotment brochures for Government owned EZs in Bangladesh, BEZA charges a conservancy charge of **BDT 0.39 per annum/sq. ft. land**. However, the market rates may differ from the same. In case of the PPP developer, the same is assumed as **BDT 5 per annum/sq. ft. land.**

In the financial model all revenue related assumptions have been considered in line with the above.

13.2.6.4. Cost Assumptions

1. Assumptions related to Capital expenses

Case 1: BEZA playing the role of the master developer

For undertaking this project, BEZA has to incur the following cost outlays.

- Cost of land acquisition
- Cost pertaining to resettlement and rehabilitation
- Infrastructure cost
- Other costs (EMP & Pre-operating costs)

Cost of land acquisition and resettlement and rehabilitation

Since, the land considered for development of the zone is entirely Khas land or Government owned land, no cost associated with land acquisition has been considered in the model. As per primary stakeholder consultations with AC land and UNO officials, cost towards compensation for resettlement and rehabilitation is **BDT 129.50 million**. Details of these are captured in the Social Review chapter of the report.

Cost pertaining to Off-site infrastructure

Infrastructure assessment recommends that for developing this project, BEZA must undertake off-site infrastructure development pertaining to land filling, utility supply and boundary wall. Details of the same are captured in the Infrastructure Assessment chapter. The following table depicts the cost towards the above-mentioned elements.

Table 91: Off-site infrastructure cost estimates to be incurred by BEZA

Description of Item	Quantity	Unit	Price without tax (in million BDT)
Power sub-station	8	MVA	117.70
Water supply	12000	RM	141.24
Access Road	3500	RM	226.57
Power supply	15000	RM	62.31
Project Sub-total			**547.82**

Source: MACE analysis; costs have been calculated using updated references and scheduled rates of concerned nodal agencies of Bangladesh

Other costs

Cost associated with Environmental Management Plan is considered as **BDT 359.49 million.**

Cost pertaining to On-site infrastructure

Infrastructure assessment recommends that for developing this project, BEZA has to undertake on-site infrastructure development pertaining to internal road network, power network, water supply, wastewater treatment, support amenities etc. Details of the same are captured in the Infrastructure Assessment chapter. The following table depicts the cost towards the above-mentioned elements.

Table 92: On-site infrastructure cost estimates to be incurred by PPP developer and BEZA

Description of Item	Price without tax (In million BDT)
Embankment	4236.18
Site Grading	96.71
Road network connecting zones	107.63
Entrance zone	163.17
Amenity Buildings	263.11
Utility Structures	1139.20
Project Sub-total	**6006.00**

Source: MACE analysis; costs have been calculated using updated references and scheduled rates of concerned nodal agencies of Bangladesh

2. Assumptions Related to Operating Expenses

For undertaking this project, both BEZA and/or the PPP developer has to incur the following operating cost outlays.

Cost pertaining to operations and maintenance (O&M including Manpower costs)

In absence of precedence of similar projects in the country, **2% of total Capex cost (excluding embankment) per annum** towards operations and maintenance (O&M) has been considered for the financial model for Case 1 and Case 2 i.e., BEZA developing the project and PPP developer developing the project respectively. Similarly, pre-operating expense has been assumed as 1**% of total Capex cost per annum** for both cases**.**

13.2.6.5. Financing Assumptions

Case 1: BEZA playing the role of the master developer

Financing assumptions pertaining to Case 1 have been outlined below:

- Debt: Equity= 70:30; Debt could be sourced from either commercial borrowing or through concessional loan/ grant
- Commercial borrowing: Concessional borrowing = 50%:20%
- For commercial borrowing: moratorium period- 1 Years (after construction); rate of interest- 9% per year; repayment period- 8 years
- For concessional loan: moratorium period- 1 Years (after construction); rate of interest- 7% per year; repayment period- 15 years

The developer will be liable to pay income taxes as per Income Tax Ordinance, 1984. As per the ordinance 'Income from Business or Profession' are taxable, the ordinance allows deductions from total income or revenue for cash and non-cash expenses (i.e. depreciation and amortization), to arrive at Net Income before Tax (NIBT). The applicable corporate tax rate is then applied to NIBT to derive income tax to be paid. As per prevailing tax regulations, Income Tax rate of 35% is applicable for any private entity. However, BEZA being a Government agency, no tax liability has been assumed in the model.

Straight Line Method (SLM) of depreciation has been considered and annual depreciation rate of 2.22% has been taken in the model for a project tenure of 50 years. Depreciation assumptions for tax treatment are in line with prevailing corporate income tax ordinance 1984 guidelines in Bangladesh (10% per annum on WDV method).

Case 2: The project being developed by a PPP developer assigned by BEZA

Financing assumptions pertaining to Case 2 have been outlined below:

- Debt: Equity= 70:30; Debt could be sourced from either commercial borrowing or through concessional loan/ grant
- Commercial borrowing: Concessional borrowing = 50%:20%
- For commercial borrowing: moratorium period- 1 Years (after construction); rate of interest- 9% per year; repayment period- 8 years
- For concessional loan: moratorium period- 1 Years (after construction); rate of interest- 7% per year; repayment period- 15 years

The developer will be liable to pay income taxes as per Income Tax Ordinance, 1984. As per the ordinance 'Income from Business or Profession' are taxable, the ordinance allows deductions from total income or revenue for cash and non-cash expenses (i.e., depreciation and amortization), to arrive at Net Income before Tax (NIBT). The applicable corporate tax rate is then applied to NIBT to derive income tax to be paid. As per prevailing tax regulations, Income Tax rate of 35% is applicable for any private entity.

Straight Line Method (SLM) of depreciation has been considered and annual depreciation rate of 2.22% has been taken in the model for a project tenure of 50 years. Depreciation assumptions for tax treatment are in line with prevailing corporate income tax ordinance 1984 guidelines in Bangladesh (10% per annum on WDV method).

13.2.6.6. Other Assumptions

Usage Norms for utilities

In furtherance to the utility consumption data obtained from the primary survey, ultimate water and power requirement for each of the industries are based on the applicable sector norms in Bangladesh.

Since, this report captures only the tentative breakup of industries that could be established within the proposed EZ, utility consumption figures have been considered for the sector requiring the highest water and power supply per acre for the entire industrial plot. This is a conservative assumption made to ensure adequate supply of utility within the site in future.

Table 93: Utility Usage Norms

Power Requirement (MW per acre)	Water Requirement ('000 litres per acre per day)	Sewage Requirement ('000 litres per acre per day)	ETP Requirement ('000 litres per acre per day)
0.01	3.91	2.35	2.74

Source: MACE Analysis & Market intelligence

Based on standard benchmarks, 70% of water demand is considered as effluent generated and 60% of water demand is considered as sewage generated.

Prevailing tariffs for utilities

Referring to prevailing utility tariffs for EPZs in Bangladesh and other industrial units, following utility tariffs have been considered in the model[107]:

- Power tariff: **BDT 8.97/unit**
- Water tariff: **BDT 33.21/ '000 litres**
- Effluent treatment tariff: **BDT 36.95/ '000 litres**

Industrial space uptake rates

In line with the best practices prevailing in economic zone development, it has been assumed that developer will construct the basic shell infrastructure- public amenities, utilities and roads. This developed land in the proposed EZ will be provided on long-term lease to individual developers of tourism components planned for the EZ. It has also been considered that during the construction period, developer will simultaneously undertake marketing activities for unit plots, to attract investors. Once all infrastructure development is complete, services installed and the proposed EZ is completely ready for operation, the individual developers will start moving onto their respective plots. Three scenarios have been created for the space fill rate according to the various revenue

[107] *BEPZA rates prevalent in Dhaka Export Processing Zone*

generating components of the zone. Since, demand forecasting for this report projects the annual tourist footfall for the zone between 2020 and 2050, therefore space uptake for the different components (highlighted in Table 55) across the three scenarios have been assumed as per standard benchmarks.

Aggressive case assumes macro-economic conditions of Bangladesh and the region are improving; macro level economic conditions are improving; land uptake rate will be higher than the anticipated demand. Base case assumes macro-economic conditions of Bangladesh and the micro-market are showing steady trend and behaving as expected; land uptake will be as per anticipated demand. Conservative case considers macro-economic conditions of Bangladesh and the region are showing declining trend; land uptake rate will be lower than the anticipated demand. The following table elucidates on the uptake years assumed across the three scenarios.

Table 94: Land uptake across three cases

S. No.	Years	Conservative	Base	Aggressive
1	Accommodation & Restaurants	9 years	8 years	7 years
2	Themed pavilions/museums	5 years	4 years	3 years
3	Themed gardens/parks	4 years	3 years	2 years
4	Villas & Cottages	7 years	6 years	5 years
5	Knowledge centers	6 years	5 years	4 years
6	Eco science zone	4 years	3 years	2 years
7	Golf course & Club house	4 years	3 years	2 years
8	Adventure parks	4 years	3 years	2 years

Source: Demand Model

Uniform or equal yearly uptake of land has been assumed across all the above-mentioned scenarios.

Other assumptions

Referring to prevailing macro-economic conditions of the country and similar benchmarks, following escalation rates have been considered:

- Operating expenses: 3% per annum for both Case 1 & Case 2
- Revenue from space (industrial & Specialized infrastructure): 1% per annum for Case 1 & Case 2
- Revenue from utility mark-up: 5% per annum for both Case 1 & Case 2

13.2.7. Interpretation of the results

13.2.7.1. *Financial Net Present Value (FNPV)*[108]

Scenarios	Conservative (in BDT million)	Base (in BDT million)	Aggressive (in BDT million)
Case 1: BEZA playing the role of the master developer of the project			
Prevailing tariffs of BEZA i.e., Business As-usual scenario (Scenario A)	**-601.27**	**-454.78**	**-244.10**
Increased space tariffs (Scenario B)	**220.13**	**400.82**	**660.66**
Case 2: PPP developer develops the project with BEZA playing the role of facilitator and regulator			

[108] Considered NPV Free Cash Flow to the Firm (FCFF). NPV Free Cash Flow to the Equity (FCFE) is provided in the Summary section.

Scenarios	Conservative (in BDT million)	Base (in BDT million)	Aggressive (in BDT million)
Business As-usual scenario without payouts (Scenario A)	**660.28**	**840.98**	**1100.81**
Business As-usual scenario with payouts (Scenario B)	**489.95**	**668.85**	**926.08**

Source: Financial model

13.2.7.2. Financial Benefit Cost Ratio (FBCR)

Scenarios	Conservative (at 12% discount rate)	Base (at 12% discount rate)	Aggressive (at 12% discount rate)
Case 1: BEZA playing the role of the master developer of the project			
Prevailing tariffs of BEZA i.e., Business As-usual scenario (Scenario A)	**0.51**	**0.53**	**0.56**
Increased space tariffs (Scenario B)	**0.63**	**0.66**	**0.69**
Case 2: PPP developer develops the project with BEZA playing the role of facilitator and regulator			
Business As-usual scenario without payouts (Scenario A)	**0.70**	**0.73**	**0.77**
Business As-usual scenario with payouts (Scenario B)	**0.67**	**0.70**	**0.75**

Source: Financial model

13.2.7.3. Financial Internal Rate of Return (FIRR)[109]

Scenarios	Conservative	Base	Aggressive
Case 1: BEZA playing the role of the master developer of the project			
Prevailing tariffs of BEZA i.e., Business As-usual scenario (Scenario A)	**10.32%**	**10.70%**	**11.28%**
Increased space tariffs (Scenario B)	**12.58%**	**13.09%**	**13.88%**
Case 2: PPP developer develops the project with BEZA playing the role of facilitator and regulator			
Business As-usual scenario without payouts (Scenario A)	**13.89%**	**14.47%**	**15.39%**
Business As-usual scenario with payouts (Scenario B)	**13.35%**	**13.90%**	**14.74%**

Source: Financial model

[109] Considered Project IRR. Equity IRR is provided in the Summary section.

13.2.8. Scenario Analysis

The following scenarios have been analysed to determine the best case of project returns for Case 1 i.e., BEZA playing the role of the master developer of the project:

- **Business As-usual scenario (Scenario A) –** In this scenario, it is assumed that BEZA will be the bearer of all costs pertaining to the project and the fees charged for annual rent for different developable components space is as per the prevailing rates.
- **Increased space tariffs (Scenario B)** – In this scenario, it is assumed that BEZA will bear all costs pertaining to the project but in return will charge increased rates for annual rent for different developable components space.

Similarly, the following scenarios have been analysed to determine the best case of project returns for Case 2 i.e., when PPP developer develops the project with BEZA playing the role of facilitator and regulator:

- **Business As-usual scenario without payouts (Scenario A) –** In this scenario, it is assumed that the PPP will be the bearer of all costs pertaining to the on-site infrastructure of the project and BEZA will not charge payout in any form from the PPP developer.
- **Business As-usual scenario with payouts (Scenario B) –** In this scenario, it is assumed that the PPP will be the bearer of all costs pertaining to the on-site infrastructure of the project and BEZA will recover its cost outlay from the PPP developer in lieu of the following pay-out scenarios (or a combination of them):
  - Upfront payment (capped at BDT 100 million)
  - Annual Land lease
  - Gross revenue share
  - Equity stake

13.2.9. Sensitivity Testing on Key Inputs

Following parameters have been varied in the sensitivity analysis to assess the most sensitive variable in the financial model for **Case 1** i.e., **BEZA developing the project**:

- Annual rent from different components of developable space
- Mark-up charges on utility
- Interest expenses for commercial borrowing
- Interest expenses for concessional borrowing
- Escalation rate for revenue from developable space

Based on the same, a sensitivity check has been carried out to understand the most sensitive parameter (as per the Base case of land uptake), where each of the above-mentioned parameters have been varied by +/- 25% (keeping the other parameters constant) to understand the impact on the project IRR.

Table 95: Sensitivity variation of Project IRR for the Base case and Business as usual scenario – Case 1

Parameters	Project IRR		
	-25%	0%	+25%
Annual rent from different components of developable space	8.03%	10.70%	13.09%
Mark-up charges on utility	10.37%	10.70%	11.03%
Interest expenses for commercial borrowing	9.94%	10.70%	11.60%
Interest expenses for concessional borrowing	10.45%	10.70%	10.97%

Escalation rate for revenue from industrial and specialized infrastructure space	10.35%	10.70%	11.06%

Source:Financial model

Annual rent from developable space has emerged out to be the most sensitive revenue driver influencing the rate of return from the project. In order to maximise the return from this project, increasing tariffs of this parameter would result in maximum returns for both the cases.

13.2.10. Project Return Calculations: Case 1

As explained earlier, the following scenarios have been analysed to determine the best case of project returns for Case 1 i.e., BEZA playing the role of the master developer of the project:

- **Business As-usual scenario (Scenario A)**
- **Increased space tariffs (Scenario B)**

The flowing table elucidates on the returns accrued (Project IRR, Equity IRR, average DSCR, BCR) to BEZA as per the above-mentioned scenarios for the three cases of land uptake (Conservative, Base and Aggressive).

Table 96: Project returns (@ 12% cost of equity) across scenarios – **Case 1**

Scenarios	Project IRR			Equity IRR			Average DSCR			BCR# (@ 12% discount rate)		
	Consr.	Base	Aggr.	Consr.	Base	Aggr.	Consr.	Base	Aggr.	Consr.	Base	Aggr.
Prevailing tariffs of BEZA i.e. Business As usual= A	10.32%	10.70%	11.28%	6.70%	7.07%	7.64%	2.1	2.10	2.20	0.51	0.53	0.56
Increased space tariffs=B	12.58%	13.09%	13.88%	10.11%	10.84%	12.12%	2.70	2.70	2.70	0.63	0.66	0.69

Source: Financial Model; #BCR values with 15% cost of equity is furnished in proposed project brief

Thus, project IRR in Base case improves up to 13.09% with a healthy average DSCR of 2.70 when BEZA develops the project and charges increased space tariffs. Even in the Business-as-Usual scenario, the project IRR is 10.70% which is desirable for the project. This indicates the sound profitability of the project when BEZA acts as the developer of the project. The project profitability further improves if BEZA decides to opt for higher percentage of Concessional loan from financial institutions.

Table 97: NPV (@ 12% cost of equity) calculations across scenarios – Case 1

Scenarios	NPV# FCFF (in BDT million)			NPV# FCFE (in BDT million)		
	Conservative	Base	Aggressive	Conservative	Base	Aggressive
Prevailing tariffs of BEZA i.e. Business As usual= A	-601.27	-454.78	-244.10	-1,240.46	-1,093.97	-883.28
Increased space tariffs=B	220.13	400.82	660.66	-419.06	-238.36	21.47

Source: Financial Model; #NPV values with 15% cost of equity is furnished in proposed project brief

Thus, NPV of FCFF in Base case can be -454.78 BDT million (with BEZA charging prevailing tariffs from developers), which improves up to 400.82 BDT million when charges increased space tariffs for the developable land.

13.2.11. Project Return Calculations: Case 2

As mentioned earlier, the following scenarios have been analysed to determine the best case of project returns for Case 2 i.e., PPP developer is developing the project:

- **Business As-usual scenario A**

Table 98: Project returns across scenarios – Case 2

Project returns	Business As-usual scenario		
	Conservative	Base	Aggressive
Project IRR	13.89%	14.47%	15.39%
Equity IRR	12.43%	13.49%	15.48%
Avg. DSCR	3.10	3.11	3.12
NPV# FCFF (in BDT million)	660.28	840.98	1100.81
NPV# FCFE (in BDT million)	82.56	263.26	523.09
BCR# (at 12% discount rate)	0.70	0.73	0.77

Source: Financial Model; #BCR and NPV values with 15% cost of equity is furnished in proposed project brief

Thus, it is evident that in case of the PPP developer developing the project, the project generates sound returns even when the developer charges prevalent tariffs (Scenario A). These returns will improve to a much higher value (with a project IRR of close to 30%) if BEZA decides to fund the infrastructure cost associated with the development of the embankment, which accrues significant cost of approximately BDT ~4,300 million.

These returns will deteriorate in case of pay-outs to be made to BEZA in order for BEZA to recover its cost related to land acquisition, R&R and off-site infrastructure development.

- **Business As-usual scenario B**

BEZA will recover its cost outlay from the PPP developer in lieu of the following pay-out scenarios (or a combination of them):

  - **Upfront payment** (capped at BDT 100 million)
  - **Annual Land lease**
  - **Gross revenue share**
  - **Equity stake**

Through this project, BEZA is striving towards holistic development of the communities related to the project and overall economic upliftment of the region. Therefore, in order to determine the best mode of pay-out amongst the above-mentioned scenarios, all the pay-out scenarios and their necessary permutations and combinations have been evaluated or varied to understand which one or which combination of them helps BEZA in recovering its cost outlay for the project which is indicated by the ratio of the NPV of BEZA's income from the PPP developers (subject to the above-mentioned scenarios) to the NPV of its cost outlay throughout the tenure of the project. The combination of the above-mentioned modes pertaining to which the NPV of cost equals that of income is deemed best for BEZA to go forward with. Subsequently, the values corresponding to that scenario should be the guiding principles for BEZA in terms of determining or formulating the appropriate bidding parameters while appointing the PPP developer.

The following table elucidates on the results obtained from the simulations performed to determine the best combination of the above-mentioned scenarios for the Base case. Two scenarios are generally evaluated in the simulations – (i) BEZA bearing costs towards land acquisition and offsite infrastructure without embankment, and (ii) BEZA bearing costs towards both land acquisition and off-site infrastructure development including

embankment. However, since in this case entire land is owned by the Government, therefore cost lay-out for BEZA towards land acquisition is only limited to R&R cost, which is not significant. Therefore, only the second scenario i.e. BEZA bearing costs towards both land acquisition and off-site infrastructure development has been analysed.

Table 99: Simulation results to determine the best-case pay-out mode for BEZA - Base case (**Case 2**)

		BEZA bearing costs towards land acquisition and off-site infrastructure
1	Annual Land lease mode (I)	• An Annual land lease of **BDT 2.00 per sq. ft.** per annum will correspond to the NPV of cost being equal to that of income for BEZA
2	Gross revenue share mode (II)	• A Revenue share of **11%** per annum will correspond to the NPV of cost being equal to that of income for BEZA
3	Equity stake to BEZA mode (III)	Not Viable
4	Annual Land lease mode (I) + Gross revenue share mode (II)	• An Annual land lease of **BDT 1.00 per sq. ft.** per annum together with a gross revenue share of **5%** will correspond to the NPV of cost being equal to that of income for BEZA
5	Upfront payment + (I)	• An Annual land lease of **BDT 1.50 per sq. ft.** per annum will correspond to the NPV of cost being equal to that of income for BEZA
6	Upfront payment + (II)	• A Revenue share of **9%** per annum will correspond to the NPV of cost being equal to that of income for BEZA
7	Upfront payment + (III)	Not Viable
8	Upfront payment + (I) + (II)	• An Annual land lease of **BDT 1.00 per sq. ft**. per annum together with a gross revenue share of **3%** will correspond to the NPV of cost being equal to that of income for BEZA

Source: Financial Model

As per the simulations, it is evident that combinations corresponding to S.No. 5 and 8 present the most viable option for BEZA in terms of determining the project structuring for this particular project. Thus, from a project structuring and determination of bidding parameters perspective, a combination of **upfront payment, together with an annual land lease charge and revenue share to BEZA** emerges as the most suitable option for BEZA in case of a PPP developer developing the project. The following table elucidates on the returns accrued in this case for the PPP developer across Scenario A (mentioned earlier; with PPP developer making pay-outs to BEZA).

Table 100: Project returns across Scenario A when BEZA bears the cost of land acquisition and off-site infrastructure – **Upfront payment + Annual Land lease + Revenue share to BEZA pay-out mode**

Project returns	Business As-usual scenario		
	Conservative	Base	Aggressive
Project IRR	13.35%	13.90%	14.74%
Equity IRR	11.58%	12.47%	14.05%
Avg. DSCR	3.07	3.08	3.09
NPV# FCFF (in BDT million)	489.95	668.85	926.08
NPV# FCFE (in BDT million)	- 87.76	91.13	348.36
BCR# (at 12% discount rate)	0.67	0.70	0.75

Source: Financial Model; #BCR and NPV values with 15% cost of equity is furnished in annexure

In case of pay-out to BEZA in the mode of upfront payment, annual land lease and revenue share, the project returns for the PPP developer deteriorates but still salvages a value which is border line financially sound. This further implies that it would be a slight challenge for BEZA to attract private developers (with the above-mentioned pay-out structure) to develop the project.

13.2.12. Summary on Financial Model

Financial modelling exercise highlights the entire gamut of cost and revenue assumptions taken in order to evaluate the financial feasibility for BEZA which would envisage development and operation of the proposed EZ. It is to be noted that this financial modelling exercise takes into consideration two cases – Case 1 - where BEZA is playing the role of a master developer for this project and Case 2 – where BEZA assigns a PPP developer to develop the project thus imbibing private sector efficiency into the project. The following key points elucidate on the assumptions and findings of the financial modelling exercise.

Cost Assumption

Table below summarises the cost assumptions considered for financial model.

Table 101: Cost Assumptions for Financial Model

Description of item	Price without tax (In million Taka)
Onsite Infrastructure cost	6006.00
Offsite Infrastructure cost	547.82
Resettlement and Rehabilitation cost	129.50
Environmental Management Plan cost	359.49

Source: MACE analysis

Revenue Assumption

Table 102: Tariff assumption

S. No.	Category of Land/Type of Development	Land area (in Acres)	Annual Rent per sq. ft. (BDT) charged by BEZA	Annual Rent per sq. ft. (BDT) charged by PPP developer and in Increased space tariff case by BEZA
1	Accommodation & Restaurants	200.44	20.00	25.00
2	Themed pavilions/museums	66.00	12.00	15.00
3	Themed gardens/parks	204.52	12.00	15.00
4	Villas & Cottages	0.76	20.00	25.00
5	Knowledge centers	25.19	12.00	15.00
6	Eco science zone	143.27	12.00	15.00
7	Golf course & Club house	72.29	20.00	25.00
8	Adventure parks	170.12	20.00	25.00

Source: Financial model

Return Calculation

Table below summarises the return for the project.

Table 103: Project Returns in Base Case

Scenarios	@10% cost of equity	@12% cost of equity	@15% cost of equity
BEZA is playing role of developer (Prevailing tariffs of BEZA i.e., Business As usual= A)			
Project IRR	10.70%	10.70%	10.70%
Equity IRR	7.07%	7.07%	7.07%
Average DSCR	2.10	2.10	2.10
BCR (@12% Discount Rate)	0.53	0.53	0.53
NPV FCFF (in BDT million)	309.32	-454.78	-1,117.55
NPV FCFE (in BDT million)	-887.32	-1,093.97	-1,167.62
BEZA is playing role of developer (Increased space tariffs=B)			
Project IRR	13.09%	13.09%	13.09%
Equity IRR	10.84%	10.84%	10.84%
Average DSCR	2.70	2.70	2.70
BCR (@12% Discount Rate)	0.66	0.66	0.66
NPV FCFF (in BDT million)	1,431.12	400.82	-516.80
NPV FCFE (in BDT million)	234.49	-238.36	-566.87
PPP developer develops the project (with Payout to BEZA)			
Project IRR	13.90%	13.90%	13.90%
Equity IRR	12.47%	12.47%	12.47%
Average DSCR	3.08	3.08	3.08

Scenarios	@10% cost of equity	@12% cost of equity	@15% cost of equity
BCR (@12% Discount Rate)	0.70	0.70	0.70
NPV FCFF (in BDT million)	1,735.14	668.85	-287.84
NPV FCFE (in BDT million)	653.58	91.13	-333.09
PPP developer developing the project (Without Payout to BEZA)			
Project IRR	14.47%	14.47%	14.47%
Equity IRR	13.49%	13.49%	13.49%
Average DSCR	3.10	3.10	3.10
BCR (@12% Discount Rate)	0.73	0.73	0.73
NPV FCFF (in BDT million)	1,923.57	840.98	-132.42
NPV FCFE (in BDT million)	842.01	263.26	-177.67

Source: Financial model

Table 104: Project Returns in Conservative Case

Scenarios	@10% cost of equity	@12% cost of equity	@15% cost of equity
BEZA is playing role of developer (Prevailing tariffs of BEZA i.e., Business As usual= A)			
Project IRR	10.32%	10.32%	10.32%
Equity IRR	6.70%	6.70%	6.70%
Average DSCR	2.1	2.1	2.1
BCR (@12% Discount Rate)	0.51	0.51	0.51
NPV FCFF (in BDT million)	145.35	-601.27	-1,241.94
NPV FCFE (in BDT million)	-1,051.28	-1,240.46	-1,292.01
BEZA is playing role of developer (Increased space tariffs=B)			
Project IRR	12.58%	12.58%	12.58%
Equity IRR	10.11%	10.11%	10.11%
Average DSCR	2.70	2.70	2.70
BCR (@12% Discount Rate)	0.63	0.63	0.63
NPV FCFF (in BDT million)	1,228.86	220.13	-670.23
NPV FCFE (in BDT million)	32.23	-419.06	-720.30
PPP developer develops the project (with Payout to BEZA)			
Project IRR	13.35%	13.35%	13.35%
Equity IRR	11.58%	11.58%	11.58%
Average DSCR	3.077	3.077	3.077
BCR (@12% Discount Rate)	0.67	0.67	0.67
NPV FCFF (in BDT million)	1,534.90	489.95	-439.73
NPV FCFE (in BDT million)	453.34	-87.76	-484.98
PPP developer developing the project (Without Payout to BEZA)			
Project IRR	13.89%	13.89%	13.89%
Equity IRR	12.43%	12.43%	12.43%
Average DSCR	3.10	3.10	3.10
BCR (@12% Discount Rate)	0.70	0.70	0.70
NPV FCFF (in BDT million)	1,721.31	660.28	-285.85
NPV FCFE (in BDT million)	639.75	82.56	-331.10

Source: Financial model

Table 105: Project Returns in Aggressive Case

Scenarios	@10% cost of equity	@12% cost of equity	@15% cost of equity
BEZA is playing role of developer (Prevailing tariffs of BEZA i.e., Business As usual= A)			
Project IRR	11.28%	11.28%	11.28%
Equity IRR	7.64%	7.64%	7.64%
Average DSCR	2.20	2.20	2.20
BCR (@12% Discount Rate)	0.56	0.56	0.56
NPV FCFF (in BDT million)	541.15	-244.10	-934.21
NPV FCFE (in BDT million)	-655.48	-883.28	-984.27
BEZA is playing role of developer (Increased space tariffs=B)			
Project IRR	13.88	13.88%	13.88%
Equity IRR	12.12%	12.12%	12.12%
Average DSCR	2.70	2.70	2.70
BCR (@12% Discount Rate)	0.69	0.69	0.69
NPV FCFF (in BDT million)	1,717.04	660.66	-290.70
NPV FCFE (in BDT million)	520.41	21.47	-340.76
PPP developer develops the project (with Payout to BEZA)			
Project IRR	14.74%	14.74%	14.74%
Equity IRR	14.05%	14.05%	14.05%
Average DSCR	3.082	3.082	3.082
BCR (@12% Discount Rate)	0.75	0.75	0.75
NPV FCFF (in BDT million)	2,018.20	926.08	-63.99
NPV FCFE (in BDT million)	936.64	348.36	-109.24
PPP developer developing the project (Without Payout to BEZA)			
Project IRR	15.39%	15.39%	15.39%
Equity IRR	15.48%	15.48%	15.48%
Average DSCR	3.10	3.10	3.10
BCR (@12% Discount Rate)	0.77	0.77	0.77
NPV FCFF (in BDT million)	2,209.49	1,100.81	93.68
NPV FCFE (in BDT million)	1,127.93	523.09	48.43

Source: Financial model

13.2.13. Conclusions and Recommendations

Financial modelling exercise highlights the entire gamut of cost and revenue assumptions taken in order to evaluate the financial feasibility for BEZA which would envisage development and operation of the proposed EZ. It is to be noted that this financial modelling exercise takes into consideration two cases – Case 1 - where BEZA is playing the role of a master developer for this project and Case 2 – where BEZA assigns a PPP developer to develop the project thus imbibing private sector efficiency into the project.

For Case 1 - since the ultimate objective of this project is to generate employment and improve the socio-economic conditions of the region surrounding the proposed EZ, it is imperative that BEZA plays the role of facilitator and developer of this project. Financial modelling reveals that in case of BEZA developing the project, the project generates favourable returns (with a project IRR of ~11%). This further increases to ~13% once BEZA charges increased tariffs for the developable tourism space.

BEZA should also scout for concessional borrowing options as this appears to be a capital-intensive project. Higher proportion of concessional borrowing options would result in higher project returns.

For Case 2 – BEZA will assign a PPP developer who will play the role of a developer for the project and charge annual land lease from different tourism unit developers. The project in such a scenario generates sound returns for the PPP developer with a project IRR of ~14% and an Equity IRR of ~13% (corresponding to the Base case).

However, in order to recover its cost related to land acquisition and off-site infrastructure development, BEZA may decide to set bidding parameters in the form of pay-outs. Analysis suggests a combination of upfront fee (capped at BDT 100 million, annual land lease (BDT 1.1 per sq. ft.) and a revenue share (1%) as the most suitable pay-out option for BEZA to recover its cost. In this case, it is observed that the project still generates healthy returns (PIRR of ~13.9% in the Base case).

Viability Gap Funding (VGF) is a measure by Govt. authorities to make a PPP project profitable. Thus, in order to make the project returns improve further and consequently to increase the profitability of the project Government may further explore VGF in terms of capital subsidy or operational subsidy (annuity for a pre-determined time period) or a combination of both not exceeding 40% of the total hard cost of the project. This would further increase the project returns. However, since the project showcases financial viability even in case of pay-outs to BEZA, the need for the same could be avoided.

Thus, if BEZA decides to embark on the project as a developer, it would realize healthy returns from it and enhance BEZA's ultimate objective of socio-economic development of lagging regions of Bangladesh through commercial activities. The returns will improve further if BEZA avails concessional borrowing (in higher proportion than commercial borrowing) for funding the project. On the contrary, in case of PPP developer, the project accrues healthy returns in case there is no mandated pay-out structure in place. Even, in case of pay-outs to BEZA, the project remains an attractive option since the returns generated are at par with desired returns for similar projects.

13.3. Economic Analysis

13.3.1. Purpose and Objective

The objective of economic modeling is to analysis and quantify the impact of the development of the proposed Economic Zone on the economy of Bangladesh. Financial analysis (or Financial IRR) estimates the return accruing to the project operating entity (EZ developer), whereas Economic Internal Rate of Return (EIRR) estimates the return on the investment to the national economy. Economic analysis is essential to develop a rationale for Government of Bangladesh to support the development of the proposed EZ and illustrate the measure of the accrued economic benefits.

13.3.2. Direct, Indirect and Associated Cost and Benefit Components

Economic cost for the project includes:

- All the direct costs (both capital expenditure and operational expenditure) associated with the project development were enlisted and broken down into the three factors of production viz. capital (material and equipment), land and labour. The pertinent financial costs were converted to the economic costs using conversion factors as elucidated below in section 1.3.4.

Economic benefit for the project includes:

- Economic benefit (through gains for the exchequer) as a result of the tourist activities within the proposed EZ
- Employment generation owing to the development of the proposed economic zone.
- Tax paid by the developer is a gain (economic benefit) for the exchequer.

13.3.3. Methodology of Economic Modelling

13.3.3.1. EIRR Framework

EIRR is a holistic approach which takes into consideration the following stakeholders (directly/ indirectly) associated with the project:

- The project financers (whose return was calculated as the financial internal rate of return),
- The employment (both direct and indirect employment during construction and during operation period) generated because of the project,
- The suppliers and customers of the project,
- Residents who are being affected by the implementation of the project and

The purpose of EIRR calculation is directly aligned with the objectives of the multilateral agencies i.e. alleviation of poverty, employment generation and overall development of the country.

EIRR replicate the wider spectrum of project on regional and countries economy. The model accounts the direct benefit in form of tax and VAT to the government as well as employment which will be generated due to the project.

The Economic Rate of Return (ERR) can loosely be defined as “The net benefits to all members of society, as a percentage of cost, taking into account externalities and other market imperfections.” In a Harvard Business School Professor Benjamin Esty defined a two-step process for calculating an Economic Rate of Return. This method is described briefly thus:

EIRR = Actual Revenues – Opportunity Costs

= Actual Revenues – Opportunity Costs + (Actual Costs – Actual Costs)

= (Actual Revenues – Actual Costs) + (Actual Costs – Opportunity Costs)

EIRR = Private Returns + Cost Gains, where

Private Returns = Actual Revenues – Actual Costs

Cost Gains = Actual Costs – Opportunity Costs

This simple calculation assumes the exclusion of taxes and other social complexities.

The analysis presented above highlights the fact that there is a difference between Private and Social Returns. Though the difference between opportunity costs and actual costs is the only difference noted above, other reasons for this difference could include:

- Taxes, Tariffs and other forms of Government intervention which could reduce private returns;
- Transaction Costs; and
- Non-market effects such as the impact of the project on the environment.

In addition to highlighting the differences between the EIRR and the FIRR (or social returns and private returns), the analysis also shows, through the gains in costs, that investments in large-scale projects should result in economic development. Model works on principal of with project and without project scenario, so all tax subsidies have been excluded for computation of EIRR. The impact of inflation has been excluded while calculating the EIRR.

Economic analysis requires quantification of various costs and benefits converted to 'economic equivalent' terms. EIRR also requires identification of 'externalities' and valuation of inputs and outputs at their true economic prices, or the 'opportunity costs'.

Financial analysis only looks at the project from the perspective of the implementing agency (the private developer). Financial analysis is only concerned with line items that entail monetary outlays. Economic analysis on the other hand looks at cost and associated benefits to the economy. In economic analysis, a resource must be priced at its opportunity cost (its value in the best possible use), even if it is obtained free since use of the resource is a cost to the economy. Economic analysis measures both the positive and negative impact of the project.

The economic cost reflects the degree to which the consumption elsewhere in the ecosystem is sacrificed due to the diversion of the resources required for the project. Whereas the economic benefit portrays the extent to which the project contributes to the increasing value of consumption available to the society.

Some important aspects to be considered while undertaking economic analysis are:

- Economic analysis is considered at constant prices in local currency terms. Thus, in case of accounting for economic costs and benefits, all costs and benefits must be measured in 'real' terms. In such analysis, all the costs and benefits are considered at the commencement year.
- For undertaking the economic analysis, financial costs are to be converted to their economic cost equivalents. By and large the financial components are capex (capital investment in land, construction cost etc.) and Opex (operational expenditure).
- Items like taxes, duties and subsidies included in the financial cost are excluded as these are market distortions.
- Debt service costs (interest during construction) are not included as economic cost in the analysis as the same doesn't require usage of resources.
- Cost owing to Environmental Management Plan has been included in the economic cost calculation.

13.3.3.2. Methodology Adopted

The economic analysis for proposed EZ was undertaken in three major steps:

a) *Step 1:* In this step, the total economic cost for the project was calculated. All the direct costs (both capital expenditure and operational expenditure) associated with the project development were enlisted and broken down into the three factors of production viz. capital (material and equipment), land and labour. The pertinent financial costs were converted to the economic costs using conversion factors as elucidated below.

b) *Step 2:* The financial benefits from the proposed EZ project was calculated and converted to economic terms to capture the economic benefits which (directly/indirectly) impact the economy of Bangladesh. In this step, the cumulative economic benefit accrued from this project was computed.

Economic benefits considered are:

1) Economic benefit (through gains for the exchequer) as a result of the tourist activities within the proposed EZ
2) Employment generation owing to the development of the proposed economic zone.
3) Tax paid by the developer is a gain (economic benefit) for the exchequer.

c) *Step 3:* Economic return for the project tenure was calculated by deducting the economic cost from the total economic benefit. IRR was calculated considering the base case.

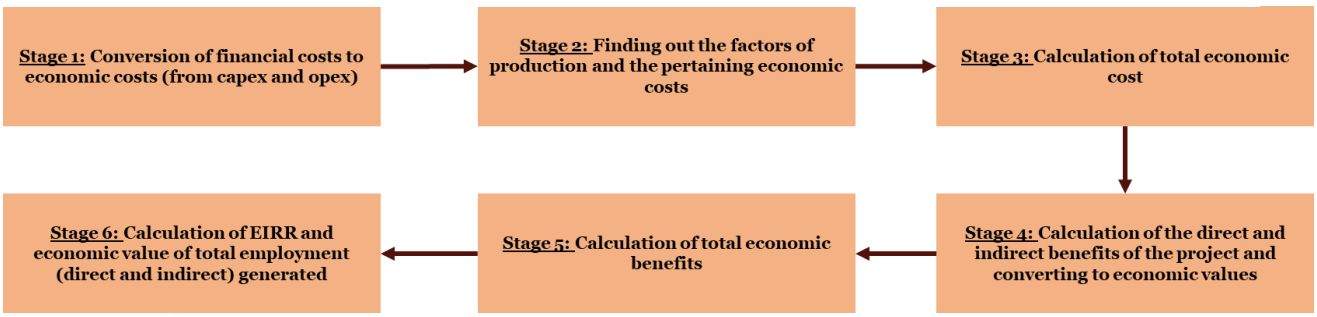
Economic modelling exercise has been undertaken for three scenarios as elucidated in the following-

- Aggressive scenario: Macro-economic conditions of Bangladesh and the region are improving; Potential infrastructure projects are commencing prior to CoD
- Base scenario: Macro-economic conditions of Bangladesh and the region are showing steady trend and behaving as expected; potential infrastructure projects are commencing as scheduled
- Conservative scenario: Macro-economic conditions of Bangladesh and the region are showing declining trend; potential infrastructure projects are delayed

Proceeds from the demand forecasting exercise have been taken into cognizance to undertake the economic modelling exercise for the above stated three scenarios. Tourist footfall projections corresponding to the above scenarios have been considered from the demand model to undertake this economic modelling.

The approach & methodology adopted for each of the three scenarios has been illustrated in the following diagram.

Figure 105: Framework for Economic IRR calculation



Source: PwC Analysis

13.3.4. Value of Cost & Benefit Components Converted into Economic Price by using Standard Conversion Factor (SCF)

The study team has used the following conversion factor for Capex and Opex to convert economic equivalents/ market costs using the following assumptions:

- *Shadow Exchange Rate Factor (SERF)* of 1.05 was considered. The basis is that BDT is overvalued by about 5%.[110] SERF is the ratio of economic price of foreign currency to its market price. Alternatively, it is the ratio of the shadow to the official exchange rate. For economic analysis using the domestic price numeraire, the SERF is applied to all outputs and inputs, including labour and land that have been valued at border price equivalent values, with project effects measured at domestic market price values left unadjusted.
- *Shadow Wage Rate Factor (SWRF)* of 1.00 for skilled labour and 0.75 for unskilled labour was assumed.[111] Further it was considered that the project will have a mix of 75% skilled labour and 25% unskilled labour. Hence, SWRF of 0.9375 has been arrived. SWRF is the ratio of the shadow wage rate of a unit of a certain type of labour, measured in the appropriate numeraire, and the project wage for the same category of labour. Alternatively, the ratio of the economic and the SWRF can be used to convert the financial cost of labour into its economic cost.

110 Additional Financing to the Third Primary Education Development Project RRP BAN 42122 by ADB (2015)

111 Similar assumption was taken for ADB-Khulna water supply project

These figures are in conformity with the information provided by Bangladesh Planning Commission and ADB economic analysis reports for Bangladesh. These were applied to tradable inputs and labour component to get domestic equivalents. It may be noted that since SERF is applied on the costs, factors such as the import duty is considered to be adjusted in the SERF and hence import duty has not been considered separately.

13.3.5. Cash Flow

(in BDT million)

Total Economic Costs										
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Capital Expenditure										
Capex Expenses	1056	1056	845	845	775	704	704	704	352	0
Total (cost of the private developer)	1056	1056	845	845	775	704	704	704	352	0
(1) Material	449	449	359	359	329	299	299	299	150	0
(2) Equipment	318	318	255	255	234	212	212	212	106	0
(3) Labor	436	436	349	349	320	291	291	291	145	0
Total O&M Cost	32	41	48	55	63	70	78	86	91	93
Operating Expenditure										
O&M Cost	23	29	33	39	44	49	54	60	64	65
Manpower Cost	10	12	14	17	19	21	23	26	27	28
(1) Material	19	24	28	33	37	42	46	51	54	55
(2) Equipment	0	0	0	0	0	0	0	0	0	0
(3) Labor (Cost of Personnel)	10	12	14	17	19	21	23	26	27	28
Total Economic Costs	**1232**	**1240**	**1005**	**1012**	**939**	**865**	**872**	**879**	**483**	**83**
Total Economic Benefits (base)										
Output from Tourist income	0	0	0	0	0	0	3080	3379	3708	4069
Employment Generation	10	18	18	18	18	9	115	116	127	140
Tax Incentive Availed by the Developer (Loss for Exchequer)										

Tax Paid by the Developer (Gain for Exchequer)	0	0	0	0	0	0	0	0	0	0
Total Economic Benefits	**10**	**18**	**18**	**18**	**18**	**9**	**3195**	**3495**	**3835**	**4208**

Total Economic Costs										
	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Capital Expenditure										
Capex Expenses	0	0	0	0	0	0	0	0	0	0
Total (cost of the private developer)	0	0	0	0	0	0	0	0	0	0
(1) Material	0	0	0	0	0	0	0	0	0	0
(2) Equipment	0	0	0	0	0	0	0	0	0	0
(3) Labor	0	0	0	0	0	0	0	0	0	0
Total O&M Cost	95	97	99	102	104	106	109	111	114	117
Operating Expenditure										
O&M Cost	67	68	70	71	73	75	76	78	80	82
Manpower Cost	29	29	30	31	31	32	33	33	34	35
(1) Material	57	58	59	61	62	63	65	66	68	69
(2) Equipment	0	0	0	0	0	0	0	0	0	0
(3) Labor (Cost of Personnel)	29	29	30	31	31	32	33	33	34	35
Total Economic Costs	**85**	**87**	**89**	**91**	**93**	**95**	**97**	**100**	**102**	**105**
Total Economic Benefits (base)										
Output from Tourist income	4465	4901	5380	5906	6484	7119	7817	8585	9429	10356
Employment Generation	153	168	185	203	223	244	268	295	324	355

Tax Incentive Availed by the Developer (Loss for Exchequer)										
Tax Paid by the Developer (Gain for Exchequer)	0	0	0	0	0	52	108	183	186	188
Total Economic Benefits	**4618**	**5069**	**5564**	**6108**	**6706**	**7415**	**8193**	**9063**	**9938**	**10900**

Total Economic Costs										
	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Capital Expenditure										
Capex Expenses	0	0	0	0	0	0	0	0	0	0
Total (cost of the private developer)	0	0	0	0	0	0	0	0	0	0
(1) Material	0	0	0	0	0	0	0	0	0	0
(2) Equipment	0	0	0	0	0	0	0	0	0	0
(3) Labor	0	0	0	0	0	0	0	0	0	0
Total O&M Cost	120	122	125	128	132	135	138	142	145	149
Operating Expenditure										
O&M Cost	84	86	88	90	92	94	97	99	102	104
Manpower Cost	36	37	38	39	39	40	41	42	44	45
(1) Material	71	73	75	76	78	80	82	84	86	88
(2) Equipment	0	0	0	0	0	0	0	0	0	0
(3) Labor (Cost of Personnel)	36	37	38	39	39	40	41	42	44	45
Total Economic Costs	**107**	**110**	**112**	**115**	**118**	**121**	**124**	**127**	**130**	**133**
Total Economic Benefits (base)										

Output from Tourist income	11376	12498	13731	15088	16580	18221	20026	22012	24196	26600
Employment Generation	391	429	471	518	569	625	687	687	687	687
Tax Incentive Availed by the Developer (Loss for Exchequer)										
Tax Paid by the Developer (Gain for Exchequer)	190	191	192	192	191	190	188	187	184	181
Total Economic Benefits	**11957**	**13118**	**14395**	**15798**	**17340**	**19036**	**20902**	**22885**	**25068**	**27469**

Total Economic Costs										
	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Capital Expenditure										
Capex Expenses	0	0	0	0	0	0	0	0	0	0
Total (cost of the private developer)	0	0	0	0	0	0	0	0	0	0
(1) Material	0	0	0	0	0	0	0	0	0	0
(2) Equipment	0	0	0	0	0	0	0	0	0	0
(3) Labor	0	0	0	0	0	0	0	0	0	0
Total O&M Cost	152	156	160	164	169	173	177	182	187	192
Operating Expenditure										
O&M Cost	107	109	112	115	118	121	124	127	131	134
Manpower Cost	46	47	48	49	51	52	53	55	56	57
(1) Material	91	93	95	98	100	103	106	108	111	114
(2) Equipment	0	0	0	0	0	0	0	0	0	0
(3) Labor (Cost of Personnel)	46	47	48	49	51	52	53	55	56	57

Total Economic Costs	**136**	**140**	**143**	**147**	**151**	**155**	**159**	**163**	**167**	**171**
Total Economic Benefits (base)										
Output from Tourist income	29245	29245	29245	29245	29245	29245	29245	29245	29245	29245
Employment Generation	687	687	687	687	687	687	687	687	687	687
Tax Incentive Availed by the Developer (Loss for Exchequer)										
Tax Paid by the Developer (Gain for Exchequer)	184	180	176	172	167	162	157	151	144	137
Total Economic Benefits	**30116**	**30113**	**30109**	**30104**	**30100**	**30095**	**30089**	**30083**	**30077**	**30070**

Total Economic Costs										
	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Capital Expenditure										
Capex Expenses	0	0	0	0	0	0	0	0	0	0
Total (cost of the private developer)	0	0	0	0	0	0	0	0	0	0
(1) Material	0	0	0	0	0	0	0	0	0	0
(2) Equipment	0	0	0	0	0	0	0	0	0	0
(3) Labor	0	0	0	0	0	0	0	0	0	0
Total O&M Cost	197	202	207	213	218	224	230	236	243	249
Operating Expenditure										
O&M Cost	138	141	145	149	153	157	161	165	170	174
Manpower Cost	59	61	62	64	65	67	69	71	73	75
(1) Material	117	120	123	127	130	133	137	141	144	148

(2) Equipment	0	0	0	0	0	0	0	0	0	0
(3) Labor (Cost of Personnel)	59	61	62	64	65	67	69	71	73	75
Total Economic Costs	**176**	**181**	**185**	**190**	**195**	**201**	**206**	**211**	**217**	**223**
Total Economic Benefits (base)										
Output from Tourist income	29245	29245	29245	29245	29245	29245	29245	29245	29245	29245
Employment Generation	687	687	687	687	687	687	687	687	687	687
Tax Incentive Availed by the Developer (Loss for Exchequer)										
Tax Paid by the Developer (Gain for Exchequer)	130	122	113	104	94	84	73	61	49	36
Total Economic Benefits	**30062**	**30054**	**30046**	**30037**	**30027**	**30016**	**30005**	**29994**	**29981**	**29968**

Source: Economic model

13.3.6. Key Assumptions

The Economic IRR for the project has been calculated considering economic costs and benefits generating out of the project over the project tenure. The assumptions adopted for computation of economic IRR are based on the assumptions as depicted in our financial analysis. Base case was used for calculating the EIRR for the project. In addition to the above, the following assumptions were considered for arriving at the EIRR:

- *Cost of land:* Since this project does not envisage land being acquired by BEZA (in case of BEZA playing the role of the master developer), cost of land has not been considered in this economic model.
- *Environmental costs:* Costs related to Environment have been also included in the model. Costs associated with technical support, development of green belt, solid and hazardous waste management, waste and wastewater, construction safety etc. have been included as part of capital expenditure. In the operational expenditure section, maintenance costs for heads like operation of CETP/ STP/ waste facilities, establishment & training and monitoring of performance indicators have been considered.
- *Capital Expenditure (Capex):* The capex incurred for various components (for both on-site and off-site infrastructure components) of the project is obtained from the financial model. This has further been segregated into three components:

  a) Material – 50% of total capex
  b) Equipment – 30% of total capex
  c) Labour – 20% of total capex

- *Operating Expenditure (Opex):* We have assumed that 100% Opex will generate on account of the materials and the consumables; 0% of opex will generate on account of the equipment. The operating cost for personnel is calculated separately in the economic model.
- *Land lease expenses:* Land lease expense is not included in the economic analysis
- *Import of Equipment:* We have assumed that 75% of the equipment and machinery used for the project would be imported. This is based on the standard practice and market benchmark of similar industries in Bangladesh.
- Capex and Opex have been converted to economic equivalents/ market costs using the following assumptions:
  - *Shadow Exchange Rate Factor (SERF)* of 1.05 was considered. The basis is that BDT is overvalued by about 5%.[112]
    SERF is the ratio of economic price of foreign currency to its market price. Alternatively, it is the ratio of the shadow to the official exchange rate. For economic analysis using the domestic price numeraire, the SERF is applied to all outputs and inputs, including labour and land that have been valued at border price equivalent values, with project effects measured at domestic market price values left unadjusted.
  - *Shadow Wage Rate Factor (SWRF)* of 1.00 for skilled labour and 0.75 for unskilled labour was assumed.[113] Further it was considered that the project will have a mix of 75% skilled labour and 25% unskilled labour. Hence, SWRF of 0.9375 has been arrived.
    SWRF is the ratio of the shadow wage rate of a unit of a certain type of labour, measured in the appropriate numeraire, and the project wage for the same category of labour. Alternatively, the ratio of the economic and the SWRF can be used to convert the financial cost of labour into its economic cost.

These figures are in conformity with the information provided by Bangladesh Planning Commission and ADB economic analysis reports for Bangladesh. These were applied to tradable inputs and labour component to get

112 Additional Financing to the Third Primary Education Development Project RRP BAN 42122 by ADB (2015)
113 Similar assumption was taken for ADB-Khulna water supply project

domestic equivalents. It may be noted that since SERF is applied on the costs, factors such as the import duty is considered to be adjusted in the SERF and hence import duty has not been considered separately.

- VAT rate (for both capex and opex) has been considered as 15% according to the prevailing rate for Bangladesh.
- Due to absence of similar precedence in Bangladesh, estimation of direct employment is calculated based on information collected on employment created due to tourism sector from news article[114]. This is further divided by the total tourist number in Bangladesh for the corresponding (from demand forecasting). This ratio is further multiplied by the annual tourist footfall in Sonadia to arrive at a year-on-year direct employment generated from the project. The employment numbers thus obtained are further discounted by a factor (5.0%) to make conservative assumptions.
- Estimation of indirect and induced employment generation (due to generation of downstream industries) is based on Employment Multiplier Coefficient of 1.2.
- In order to calculate, the gross income from the project, information based on tourism expenditure has been used from World Bank. Figures corresponding to historical data obtained was then extrapolated based on tourist footfall projections for the proposed EZ from demand model. The data obtained from World Bank was further increased with a multiplier of 2.5 as it is assumed that tourists travelling to Sonadia would spend more money compared to travelling in other locations of the country (due to its distances from the commercial centres of the country and also due to its premium location)
- *Tax Treatment:* Since the model consider the scenario with project and without project, tax subsidies will be not treated as loss to the economy.

Detailed calculations are placed in the annexure.

13.3.7. Interpretation of the results

13.3.7.1. Economic Net Present Value (ENPV)

Scenarios	@10% equity discounting rate	@12% equity discounting rate	@15% equity discounting rate
Conservative	29384.50	18050.41	8867.26
Base	47237.60	29860.64	15718.22
Aggressive	68112.18	43665.56	23722.89

Source: PwC analysis

13.3.7.2. Economic Benefit Cost Ratio (EBCR)

Scenarios	@10% equity discounting rate	@12% equity discounting rate	@15% equity discounting rate
Conservative	5.77	4.20	2.76
Base	8.66	6.29	4.13
Aggressive	12.05	8.74	5.72

Source: PwC analysis

[114] http://www.theindependentbd.com/post/211827

13.3.7.3. Economic Internal Rate of Return (EIRR)

Base case Economic Internal Rate of Return (EIRR) has been calculated as **30.20%**, which indicates that the project is providing attractive returns throughout the tenure of the project. Following table depicts the scenario analysis of the proposed EZ.

Scenario	Conservative	Base	Aggressive
Economic Internal Rate of Return	25.0%	30.2%	35.1%

Table above indicates that in conservative case, project generates **25.00%** economic return which is good in nature. Aggressive scenario indicates that economic return of the project is **35.10**%, which is highly attractive.

It appears from the above analysis that the proposed EZ generates good to highly attractive economic return in the context of Bangladesh's economy and growth targets.

13.3.8. Economic Impact Analysis

Economic modelling quantifies the economic benefits of a particular project to the government but does not quantify the impact on local population. The motive of this section is to scale the impact of the project on the economy of the micro market and regional population. The indirect impact of the project are more than direct visible impacts. Economic impact analysis framework analyzes the impact of the project on basic five capitals of community which are essential part of any social development.

13.3.8.1. Core features of the Economic Impact Analysis Framework (EIAF)

The EIAF will help to analyze the impact of project on the micro level, local population and the people who will lose or gain maximum from the proposed project. The framework will broadly analyze the impact of project on following aspects.

- Education, information, technologies, training and better nutrition, and health;
- Social environment;
- Natural resources;
- Basic infrastructure;
- Access to financial resources; and
- Policy and institutional environment that supports multiple livelihood strategies and promotes equitable access to competitive markets for all.

The application of the Economic Impact Analysis framework (EIAF) involves consideration of the following aspects:

- **Human Capital:** It represents the abilities, experience, work skills and the physical state of good health which, when combined, allow populations to engage with different strategies and fulfil their own objectives for their livelihoods.
- **Social Capital:** It refers to the social resources, which populations will rely on when seeking their objectives relating to livelihoods (in the present study this refers specifically to local social capital, this being networks, associations, local authorities, local officials and broader population receiving program assistance).
- **Natural Capital:** It is the term used to refer to the stocks of naturally occurring resources (soil, water, air, genetic resources, etc.) which can be used as inputs to create additional benefits, such as food chains, protection against soil or coastal erosion, and other natural resources which can support livelihoods.
- **Physical Capital:** This refers to the basic infrastructure and production inputs needed to support livelihoods.
- **Financial Capital:** This refers to the financial resources which population employ to achieve their objectives regarding livelihoods.

13.3.8.2. Core Concept of the Economic Impact Analysis Framework (EIAF)

The EIAF approach aims to focus on the development of the people which is equally important at higher levels (when we think about the achievement of objectives such as poverty reduction, economic reform or sustainable development) as it is at the micro or community level (where in many cases it is already well entrenched). At a practical level, this means that the approach:

- starts with an analysis of people's livelihoods and their economic conditions and how these conditions have been changing over time;
- focuses on the impact of different policy and institutional arrangements upon people/households and dimensions of poverty (rather than on resources or overall output);
- works to support people to achieve their livelihood goals

Development activity tends to focus either at the macro or micro level. The EIAF approach attempts to bridge this gap, emphasizing the importance of macro level policy and institutions to the livelihood and economic options of communities and individuals on micro level.

The first step is to propose a way to provide a qualitative evaluation, which can also act as a numerical quantifier, of each capital relevant to the formation of sustainable economic development. Typical ranges are between 0-5. an analysis of the proposed development will be judged on basis of following:

- Unsustainable: 0 <= capital < 1
- Limited sustainability: 1 <= capital < 2
- Sustainable: 2 <= capital < 3
- Progressively sustainable: 3 <= capital < 4
- Abundant: 4 <= capital <= 5

The framework considers different parameters under five capital to analyze the projects impact on the micro level. Theses parameters are decided based on the impact that project would have on regional population.

The following parameters have been analyzed under each capital which have impact on economic development of the region.

Table 106: Impact indicators under each capital

Sl. No.	Human Capital	Physical Capital	Financial Capital	Natural Capital	Social Capital
1	Capacity Building in government institution	Infrastructure development	Increase in services for local development	Sustainable industrialization	Issues of Rehabilitation and resettlement
2	Training for project stakeholders	Improved productivity	Increase in value for regional produce	Introduction of sustainable industrial practices	Community participation
3	Capacity building for local residents	Investment in production infrastructure	Impact on minimum daily wages for unskilled labour	Environmental Sustainability	Promotion of the participation of different actors
4	Institutional intervention	Technology transfer	Indirect employment generation	Introduction of eco-friendly energy production	Positive impact on existing social webs

Source: PwC Analysis

13.3.8.3. Assumptions

Following table summarizes the assumptions and their sources which have been taken into account for quantifying the impact of the proposed development.

Table 107: Assumptions for Economic Impact Analysis

Attributes	Assumptions	Source
Human Capital		
Literacy Rate	73.9%	Bangladesh Bureau of Statistics
Unemployment Rate	4.37%	Bangladesh Bureau of Statistics
Institutional Intervention	Very few as of now, Not organized	NA
Financial Capital		
Per capita Income (on PPP basis $ /year)	4,992	IMF
Poverty Rate	7.50%	World Bank
Score on Global food security index parameters	53.2	Food Security index by Economist Intelligence Unit
Indirect employment generation factor	0.7	Standard from developing countries
Physical Capital		
Existing physical infrastructure	Basic infrastructure	Site Visit
Industrial Infrastructure	Basic infrastructure	Site Visit
Existing production technology	In process of modernization	Secondary Research
Natural Capital		
Tourism practice	Manual or semi-mechanized	Secondary Research
Tourism units	Very few	Secondary Research
Tourism in region	Moderate	Secondary Research
Means of industrial energy	Mostly from non-renewable sources, 93% of the country's power producing thermal plants are gas-based	Energypedia
Social Capital		
Rehabilitation	Resettlement is required for huge chunk of land parcel	Site visit

Source: PwC Analysis

13.3.8.4. Results

All the impact parameters are rated based on the assumptions and the impact it would have on local economy.

Table 108: Results of Economic Impact Analysis

Different form of capital in sustainable projects and there rating on scale of 5							
Sl. No.	**Impact Indicators**	**Human Capital**	**Physical Capital**	**Financial Capital**	**Natural Capital**	**Social Capital**	**Marking Rational**
1.	Capacity Building in government institution	3					Existing expertise pertaining to tourism is moderate
2.	Training for project stakeholders	3					Basic training for local administrative agency is required for implementation of project, it will have trickle down impact on local population
3.	Capacity building for local residents	3					Knowledge related to tourism practices will trickle down from EZ to the locals
4.	Institutional intervention	4					Institutional intervention is required for making project viable, and would have major effect on knowledge base of local population
5.	Infrastructure development		4				As of now presence of physical infrastructure is not developed in immediate region, the proposed project demands development of other infrastructure which will further boost economy in the region
6.	Improved productivity		4				The proposed tourism facilities will boost the industrial productivity in the region
7.	Investment in production infrastructure		5				To become more sustainable tourism units will tend towards investing more in local production infrastructure that in turn will help in local procurement of raw materials
8.	Technology transfer		5				Bangladesh lags in technological advancement in tourism sector, the investment from outside country will help in technology transfer to country as well as in local region
9.	Increase in services for local development			5			Once the EZ will start working in full fledge it will attract other services such as banking, security, local market etc. which will equally benefit the local population
10.	Increase in value for regional produce			5			Industrialization in the region will boost the demand for other FMCG and other daily consumable goods, this will provide the

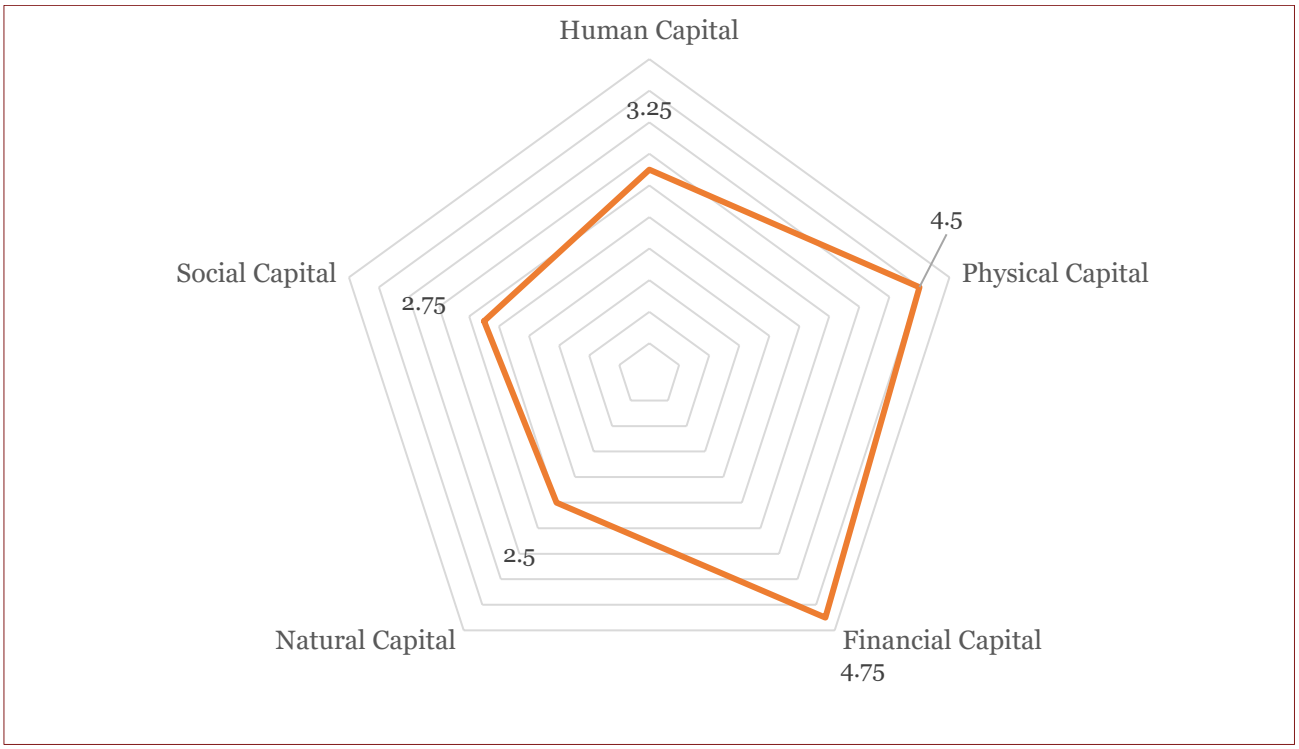
Different form of capital in sustainable projects and there rating on scale of 5							
Sl. No.	**Impact Indicators**	**Human Capital**	**Physical Capital**	**Financial Capital**	**Natural Capital**	**Social Capital**	**Marking Rational**
							market for regional produce, that will increase the value for regional produce in turn
11.	Impact on minimum daily wages for unskilled labour			4			60% of the total employment generated by the proposed EZ will for unskilled labour, development of this scale will boost the labour demand directly and indirectly in the region
12.	Indirect employment generation			5			The proposed development will require various services for tourism industries and employee engaged in these industries on local level which will generate indirect employment for locals.
13.	Sustainable Industrialization				3		The proposed development will promote environmentally sustainable industrialization under guidance and instruction of various governing agencies
14.	Introduction of sustainable industrial practices				4		The proposed development will attract a lot of investment and competition within firms will promote sustainable tourism practice
15.	Environmental Sustainability				2		The proposed development will not have significant negative impact on local environment, as it would disturb the regional ecosystem
16.	Introduction of eco-friendly energy production				1		The proposed do not have any component to promote eco-friendly energy production
17.	Issues of Rehabilitation and resettlement					2	Rehabilitation is required as the proposed EZ covers huge chunk of private land
18.	Community participation					3	The proposed development will promote community participation by increasing demand for various services for smooth functioning of EZ
19.	Promotion of the participation of different actors					3	The EZ will promote participation of different stakeholders from local community in limited scope
20.	Positive impact on existing social webs					3	Development of this scale will help in strengthening social ties by providing platform for locals to interact with each other.
	Average Impact on capital	**3.25**	**4.5**	**4.75**	**2.5**	**2.75**	

Source: PwC Analysis

13.3.8.5. Economic Impact pentagon

The pentagon summarizes the impact of proposed development on different types of capital; which have impact on micro level economy. It is the average of impact on each parameter under different capital. Value on each arm of pentagon shows the scale of impact on that particular capital of local population of region.

Figure 106: Economic impact on micro market population



Source: PwC Analysis

From the economic impact pentagon, it can be inferred that apart from natural and social capital, the project has progressively sustainable impact on the different capital of the micro market. However, impact on social issues can be mitigated by resolving rehabilitation issue in best interest of local population. It can be concluded that the envisaged EZ is sustainable and will help in uplifting the economic condition of the population in the area or residing in the project impact region.

The proposed EZ project will have positive economic impact on macro market as well as micro market and in turn help the economic upliftment of the country.

13.3.9. Conclusion and recommendations

The proposed EZ will have multi-dimensional impact on both micro and macro economy. Industrialization being one of the priorities of Bangladesh government, this envisaged project will help to move one step forward in that direction. The proposed EZ will ensure better job opportunity and services for the local population. The other indirect benefits include improved social services such as banking, medical and hospitality.

The benefits that are highlighted in this chapter will help the economic development of Bangladesh, especially the tourism sector. The proposed EZ at Sonadia will attract tourism industries, looking to set up their facilities within the park and hence will enable technology transfer to country. This will be beneficial for the tourism sector in the long run.

14. Annexures

14.1. Annexure-1: Photographs of the Proposed EZ

Olive ridley sea turtle nesting ground

Internal road within the site

Red horse shoe crab found in the site

Mangrove vegetation in the site

Navigable water channels within the site

Panoramic view of the beach water front

14.2. Annexure-2: Global Case Studies on Tourism

Thailand (Popular tourist location in ASEAN region)

Aspect	Description
International tourist arrival (2000)	9.58 million
International tourist arrival (2016)	32.53 million (3.4 times as compared to 2000)
Global Rank in tourism as per World Economic Forum Travel and Tourism Competitiveness Report 2017	34 (increased by 1 since 2015)
Strategic framework Development to promote tourism sector	Thailand has developed a tourism master plan (National Tourism Development Plan and Tourism Development Operation Plan) involving central government ministries, local administrations, private sector, educational institutions, and other countries in this region (towards promoting regional cooperation).
Initiatives taken by country government	• Development of land (road and water) infrastructure to support tourism. Road condition and inland water connectivity is as per international standard thus conducive for international tourists • Seamless air connectivity (domestic and international) with all major nodes • Tourist friendly visa on arrival policy • Development and restoration of existing natural and historical resources • Constant development of new destinations in areas with potential for linking nature, culture, and local lifestyles • Improvement in standards of facilities, safety, and hygiene • Encourage investment by private sector and local administration • Improvement in skill development of local personnel in this sector • Improvement in public services • Promote inter agency (government and private) cooperation to provide quality services to tourists • Environment and eco-friendly initiatives • Revise laws and regulations to improve the effectiveness of law enforcement for facilitating tourism
Unique selling propositions that the country possesses/ has developed over the years	• Abundance of natural resources (such as waterfalls, mountains, rainforests, sea beaches) • Cultural heritage of Buddhism and culinary • Entertainment (man-made attractions) shows • World class support infrastructure • Open visa on arrival policy including waiver of visa fees for Thailand's FTA partner countries • International standard service quality and accommodation facilities • Availability of quality accommodation and food (various cuisines) across the locations and for diversified price range-making it conducive for tourists with varied affordability ranges • Safety and security
Key target segment	Leisure and MICE

Source: World Bank, World Economic Forum, Thailand- Tourism Development Plan, and Research Articles

Singapore (Tourist hub catering to MICE and business travelers):

Aspect	Description
International tourist arrival (2000)	6.06 million
International tourist arrival (2016)	12.91 million (2.1 times as compared to 2000)
Global Rank in tourism as per World Economic Forum Travel and Tourism Competitiveness Report 2017	13
Strategic framework Development to promote tourism sector	• Integrated structure of tourism board entailing clear description of responsibilities: Board of Directors, Senior Management, Marketing Group, Business Development Group, Policy & Planning, Chief Executive's Office, Experience Development Group, and International Group • Each department coordinates with local level bodies and private sectors towards smooth execution of strategic objectives across work arenas. • Tourism master plan formulated and implemented since 1986. • Proactive global marketing with aggressive campaign; marketing offices located across the globe in seven locations such as Americas, Europe, Greater China, North Asia, South Asia, Middle East & Africa, Southeast Asia I & Southeast Asia II & Oceania.
Initiatives taken by country government	• Setting up of Singapore Tourist Promotion Board in 1964; public engagement initiatives to raise awareness. • Strengthening of destination attractiveness from 1984 by restoration of existing attractions and developing new facilities. • Tourism development plan formulation in 1986. • Smooth integration of private sector for infrastructure development and service quality. • In order to attract tourist influx from the regional countries, Singapore focused on development of integrated resorts in locations such as Marina Bay Sands and Sentosa. • In addition to accommodation, these resorts offer facilities such as dining, entertainment & amusement, and casinos. • Based on these resorts, downstream industries (such as hotels, transportation, allied services etc.) proliferated. • Other key attractions such as Singapore Grand Prix and Singapore Flyer were also developed subsequently. • Singapore strategically tapped the tourists visiting the neighboring countries. Majority of tourist influx in this country is from Indonesia, China, Australia, UK, and Malaysia. • Development of world class road network and airline connectivity across the globe. • Proactive marketing targeting four segments: working millennials, families with young children, retirees, and business travelers. • Integration with ICT (software programming)
Unique selling propositions that the country possesses/ has developed over the years	• Attractions such as integrated resorts, amusements and entertainments • Diversified sources of entertainment to business and MICE travelers
Key target segment	Leisure, business and MICE

Source: World Bank, World Economic Forum, Singapore Tourism Board, and Research Articles

Myanmar (International tourist arrival figure similar to Bangladesh in 1995, but in 2016 international tourist arrival is almost 17 times to Bangladesh):

Aspect	Description
International tourist arrival (2000)	0.42 million
International tourist arrival (2016)	2.91 million (7 times as compared to 2000)
Global Rank in tourism as per World Economic Forum Travel and Tourism Competitiveness Report 2017	Not analyzed
Strategic framework Development to promote tourism sector	• Formulation and implementation of various country level and local administration level development plan projects such as Inle Lake - Regional Destination Management Plan; Conservation Action Plan for Inle Lake – UNDP; Bagan - JICA Regional Tourism Development Project; Chin State Government Comprehensive Development Plan. • Developing vocational training and education programs to involve the local populace towards skill development for tourism sector. • Environment friendly and eco-friendly development of tourism sector projects through leveraging on natural resources. • Zonal planning framework for prevailing and upcoming tourist destinations and strategic impact assessment for large developments
Initiatives taken by country government	• Infrastructure development particularly hotel zones • Restoration and modernization of natural resources (such as wild life, natural forests) taking into consideration eco-friendly and environment-friendly initiatives • Thorough due diligence on land parcels for development as tourist spots • Strong regional collaboration with neighboring countries towards attracting tourist influx within the region and from other geographical locations • Proliferation of information centers across the country • Setting up of guidelines for the convenience of international visitors • Empanelment of tourism based agencies (accommodation, services, and transportation) • Proactive marketing campaigns
Unique selling propositions that the country possesses/ has developed over the years	• Natural resources and attractions (such as national forests, hills) • Ecotourism
Key target segment	Leisure

Source: World Bank, World Economic Forum, Ministry of Hotels and Tourism-Myanmar, Myanmar Tourism Federation, and Research Articles

Sunway Lagoon (Malaysia)

Sunway Lagoon is a theme park in Bandar Sunway, Subang Jaya, Selangor, Malaysia owned by Sunway group. The park began operations in 1992 and was officiated by the then Prime Minister of Malaysia. Since its opening it has made many changes and added newer rides and attractions to keep things interesting for the visitors.

Figure 107: Sunway Lagoon Theme Park

Source: Google images

The detailed profiling of this park is provided below.

Table 109: Detailed profiling of Sunway Lagoon Theme Park

Factors	Sunway Lagoon Theme Park
Site	
Area	The park is spread over an area of 88 acres and is built 150 feet below ground level
Amenities	Menara Sunway, Sunway Medical Center, Sunway University College, Sunway pyramid shopping mall, Sunway Resort and Spa are some of the facilities available at the park
Entrance fees	Adult (13 years old and above) : RM202 Child (12 years old and below) : RM170 Senior Citizen (60 years old and above) : RM170 (RM – Malaysian Ringgit)
Accessibility	
Road	Sunway Lagoon is located in the bustling township of Sunway City, within the district of Petaling Jaya in the state of Selangor. It is a mere 15-minutes' drive from Kuala Lumpur in smooth traffic conditions and is accessible via a network of expressways including the Federal Highway, Damansara-Puchong Expressway, New Pantai Expressway and KESAS Highway. Also, the park can be reached by the Sunway City Bus Rapid Transit System
Rail	• Via KTM Komuter Train: Take the train to the Subang Jaya Station then catch a feeder bus to the Sunway Pyramid stop • Via Putra LRT: Take the train to the Kelana Jaya Station then catch a feeder bus to the Sunway Pyramid stop.

Factors	Sunway Lagoon Theme Park
Air	Subang Airport is the nearest airport to the park and it mainly serves domestic route. The remaining distance can be covered by rail or roadways. International tourists can arrive at Kuala Lumpur International airport and connect accordingly.
Accommodation	
Sunway Resort Hotel and Spa	If one needs a place to sleep, the Sunway Resort Hotel and Spa is just next door to the Sunway Lagoon Theme Park. There are dining options available here too.
Attractions	
Water Park	The first park to be introduced in the park and it features Waters of Africa with 13 attractions and Surf Beach with 9 attractions. The Waters of Africa has 2 water playground areas for young children. Other water rides includes Cameroon Climb, African Python, Congo Challenge, Vuvuzela and Waterplexx 5D.
Scream Park	The Scream Park designed strictly for ages above 7 years old, provides 4 interactive "scare" experience by using audio, visual effects and live actors
Amusement Park	The park are divided to 2 sides, Wild West with 4 rides and World of Adventure with 9 rides/ attractions.
Extreme Park	The Extreme Park features activities including paint ball, bungee trampoline, kayaking, paddle boat, swan ride, All-terrain vehicles (ATV), archery, flying fox, go kart, g-force and bungee jump.
Wildlife Park	The Wildlife Park is an interactive and educational zoo with exotic, small and friendly animals from a range of birds, reptiles and mammals. The Wildlife Park is home to more than 140 species
Nickelodeon Lost Lagoon	The first Nickelodeon-themed land in Asia, opens with 14 new rides that cater for all ages. Among the attractions are the SpongeBob Splash Adventure, Primeval, Jungle Fury and Monsoon 360
Activities and Shows	
Shows	Swashbuckling Pirates Show, SLIME Time, Wildlife Animal Show, Tale of Mount Berapi & Waves of Fun, Chill…Lah : Bring on the 60's Show
Activities	Beach Soccer and Aqua Valley
Meet and Greet	Captain Quack & Lady Quack, Bani, Patches, Ara, Zola and Nickelodeon Meet & Greet: SpongeBob & Patrick
Concerts and Events	Sunway Lagoon has hosted some of the international lifestyle, music and sporting events including MTV World Stage and Quiksilver Revolution Tour. Other concert hosted are deadmau5, The Native Tour by OneRepublic, Pitbull and many more.

Source: https://sunwaylagoon.com

New Town Eco Park (India)

New Town Eco Park is an Urban Park located in New Town, Kolkata and is one of the biggest parks in India. The park is situated on 480 acres plot, surrounded by 104 acres waterbody with an island on the middle. The park is divided into three parts:

1. Ecological zones like wetlands, grasslands, and urban forest
2. Theme gardens and open spaces
3. Urban recreational spaces

Figure 108: New Town Eco Park

Source: Google images

The detailed profiling of this park is provided below.

Table 110: Detailed profiling of New Town Eco Park

Factors	New Town Eco Park
Site	
Land Size	Park is situated on 480 acres land plot surrounded by 104 acres of waterbody with an island in the middle
Areas	The park is divided into the following areas: • Active Zone - Consisting of Visitor center, Restaurants, Food courts, Urban Museum, Crafts Haat • Theme Area (North) - Consisting of Maidan (open field), Amphitheatre, children's play area, Chinese garden, formal garden, Bonsai garden, Cactus walk, Butterfly garden, heliconia garden and mist house and bamboo garden

Factors	New Town Eco Park
	• Theme Area (South) - Play area, tea plantation, Water garden and utility area • Lake Zone - A bridge connecting the island, Bengali restaurant, Sculpture court, Lakefront Promenade, Wildflower meadows • 3 different Eco-zones consisting of wetlands, grasslands, tropical and mixed-moist deciduous forests.
Visiting Hours	The Eco Tourism Park is opened on: Summer Timings: (1 March to 31 October) • Tuesday to Saturday = 2:30 P.M. to 8:30 P.M. • Sunday & Holidays = 12 P.M. to 8:30 P.M. Winter Timings: (1 November to 28 February) • Tuesday to Saturday = 12 P.M. to 7:30 P.M. • Sunday & Holidays = 11 AM. to 7:30 P.M. The park is closed on Monday. Park entry and Ticket counter closes at 07:30 P.M.
Entry fee	Entry fee is Rs 30/- per person Children of 3 years and above require full ticket
Accessibility	
Air	The park is located at an approximate distance of 10 kms from Netaji Subhash Chandra Bose International Airport. It takes around 17 minutes to reach the park from the airport
Rail	Anyone coming to Kolkata through rail, can easily come to the park by covering the remaining distance through Bus or Car/Taxi
Road	The park is located near to many urban hubs such as Ultadanga and Chingrighata. These places are well connected to the park through buses that travel at a high frequency on these roads. The same can even be done through personal cars or cabs by the roads
Conveniences	
Eco Carts	Eco Carts are provided to the visitors for their convenience at low prices. (Rs 100 per head, one round as per existing route)
Food Kiosks	Snacks and water are available for purchase at various locations inside the park, as outside food and beverages are not allowed
Parking Lots	Presently there are two parking lots for the Eco Park. The old one near the Eco Children's Park has capacity to park about 100 cars, while the newly developed place near the Southern entrance has capacity over 250. Parking charges are as below: Rs. 50/- per for 4 wheelers Rs. 20/- for 2 wheelers
Toilet	Pay to use toilet facilities are available inside the park at eight locations
Thematic Areas	
Areas	Glass House, Amphitheatre, Lake Front Promenade, Rabi Aranya, Tropical Tree Garden, Wild Flower Meadow, Rose Garden, Artist's Cottage, Eco Children's Park, Graffiti Walls, Butterfly Garden, Bamboo garden, Food Court, Adda Zone, Tea Garden etc. are some of the main thematic areas inside the park
Activities	
Type of activities	Paddle Boating, Shikara Riding, Rowing Charges, Duo Cycling, Speed Boat, Bird Watching, Gun Shooting, Archery Charges, Kayaking, Adventure, Land Zorbing and Water Zorbing, Cultural Events and Gaming Zone
Special Events	Vokatta – a kite festival was organized by park officials on Eco Park ground. There was on open invitation for all to participate after 11 A.M. onwards. Hot Air Ballon was another major attraction

Source: https://www.ecoparknewtown.com

Khao Yai National Park

Khao Yai is one of the best national parks in Thailand for visitors, where it is relatively easy to see number of interesting animals. Established in 1962 as Thailand's first national park, it is the third largest national park in Thailand.

Situated mainly in Nakhon Ratchasima Province, Khao Yai extends into Prachinburi, Saraburi and Nakhon Nayok provinces. Khao Yai checkpoint is just 2.5 hours away from Bangkok. The park covers an area of 2,168 km², including rain/evergreen forests and grasslands. 1,351 meters high Khao Rom is the highest mountain within the park.

Figure 109: Khao Yai National Park

Source: Google images

The detailed profiling of this park is provided below.

Table 111: Detailed profiling of Khao Yai National Park

Factors	Khao Yai National Park
Site	
Area	The park covers an area of 2,168 km², including rain/evergreen forests and grasslands
Visiting Hours	The park is open from 6 A.M. to 6 P.M. everyday all year around. Vehicles already inside the park can leave late hours.
Accessibility	
Road	It is possible to explore the park by private car or motorcycle/scooter, but best experience gained by exploring via a tour company. The Park visitor center is nearly 13 km from the northern checkpoint. • Public services - It is possible to get to park entrance by public transportation from Bangkok. Public transportation options that starts from a hotel in Bangkok and ends at north of Khao Yai could take around 4-5 hours • Private transportation - A single trip from any hotel/airport in Bangkok to north of Khao Yai costs from 2,300 Baht up. The trip takes around 2h 15 mins to 2h 30mins in good traffic
Air	Suvarnabhumi Airport is the nearest airport to the park, which is at a distance of 170 km. It takes approximately 2h 31mins to cover this distance
Accommodation	
Bungalows	Plenty of hotel and guesthouses can be found right outside the national park boundaries. There are few bungalows in two different spots inside

Factors	Khao Yai National Park
	the national park. There are few bungalows in two different spots inside the national park.
Cost	The bungalows cost 800 Thai Baht for 2 people, 2400 Thai Baht for 8 people and 9000 Thai Baht for 20 people
Attractions	
Wildlife of the Park	Some often seen mammals include elephant, macaque, barking deer, sambar deer, gibbon, porcupine, civet. Other not too easily seen mammals are bear, gaur, otters, dhole, jackal. There hasn't been any sign of Tigers in the park, but adjacent parks have Tigers. The national park is home to around 300 resident and migratory birds and has one of Thailand's largest populations of hornbills
Other attractions	Visitor Center, Camp sites, Lam Takong Camp Site, Pha Kluaymai Camp site, watch tower, Bat cave, waterfalls and viewpoint are some of the main attractions in the park
Activities	
Guided Tours	The professional tour partners offer the opportunity to discover the national park in an unique manner in the form of different packages as mentioned below: Group Tours: • 1-day wildlife tour in Khao Yai • 2-days wildlife tour in Khao Yai Private Tours: • 1-day wildlife tour in Khao Yai • 1-day wildlife tour with night safari in Khao Yai • 1.5-days wildlife tour in Khao Yai • 2-days wildlife tour in Khao Yai • 2.5-days wildlife tour in Khao Yai • 3-days wildlife tour in Khao Yai • Birdwatching tours in Khao Yai • Photo tours in Khao Yai The distances between attractions/trails can be big and not so easy to get around by foot. Visitors won't be allowed to walk on the road at certain routes. Although, it is possible to hitchhike if there is enough traffic.

Source: https://www.thainationalparks.com/khao-yai-national-park

Wilpattu National Park

Wilpattu National Park (Wilpattu meaning Land of Lakes) is a park located on the island of Sri Lanka. The unique feature of this park is the existence of "Willus" (Natural lakes) - Natural, sand-rimmed water basins or depressions that fill with rainwater.

Located in the Northwest coast lowland dry zone of Sri Lanka. The park is spread over an area of 1,317 square kilometers. Wilpattu is the largest and one of the oldest National Parks in Sri Lanka. Wilpattu is among the top national parks world-renowned for its leopard population.

Figure 110: Wilpattu National Park

Source: Google images

The detailed profiling of this park is provided below.

Table 112: Detailed profiling of Wilpattu National Park

Factors	Wilpattu National Park
Site	
Area	The park is spread over an area of 1,317 square kilometers It is located approximately 188 kms away from Colombo
Visiting Hours	Park visiting hours are from 6 A.M. to 6 P.M. Best time to visit in the day is from 6 A.M. to 10 A.M. and from 3 P.M. to 6 P.M. Though this National Park can be visited throughout the year, February to October is the prime time.
Entrance fees	There is no entry fees to the park. There are different package for Safaris and depending on the duration of the stay and type of service demanded, the price vary accordingly. These packages include the entry fees to the park.
Accessibility	
Road	Wilpattu is located 30 kms north of Puttalam, approximately 190 kms from Colombo. Wilpattu National Park extends from the northwest coast towards inland ancient capital city of Anuradhapura which is about 50 km to the east of the Park, covering 425 sq miles approximately. The route from Colombo is via Negombo, Chilaw, Palaviya and Puttalam, The Park office and the main entrance where one can obtain a ticket and enter the park is at Hunuwilgama, 7 km from the turn-off from Puttalam - Anuradhapura road.

Factors	Wilpattu National Park
Air	The nearest airport to the park is the Colombo airport. The remaining distance can be covered by road through a cab or personal vehicle
Accommodation	
Guest House	• Wiipattu Wild Watch: Your stay at the Wilpattu Wild Watch will be a definite experience that encapsulates local hospitality and serene wildlife of Sri Lanka. Cost is US $ 85 • Wilpattu Tree House: Tree house Luxury room is situated at the entrance of Wilpattu National Park. Cost is US $ 125
Hotels	There are many hotels in the region such as Thamaravila, Heritage hotel, Hotel Sinharagama, Hotel Alakamanda, Ulagalla Resort etc.
Activities	
Wilpattu Safari Camp	Night camping experience: Meet with the crew and drive to campsite of Wilpattu National Park. The people stay at is a campsite adjacent to the Wilpattu National Park. Cost is around US $ 490 per person
Jeep Safaris	Sri Lankan Expeditions provide Safari jeep tours in Wilpattu National Park with experienced drivers for half day and full day safaris. Cost is approximately US $ 100 per passenger
Attractions	
Climate	The annual temperature in the Park is between 27°C to 30°C and its annual rainfall is approximately 900 mm. The Wilpattu National Park is situated in the dry zone but most of the time flora is very greenish and has plenty of water sources
Flora	Wilpattu is home for many species of flora and they are Palu, Satin, Milla, Weera , Ebony and Wewarna.
Reptiles and Amphibians	Monitor Lizard, Mugger Crocodile, Common Cobra, Rat Snake, Indian Python, Pond Turtle and the Soft Shelled Turtle can be seen in Wilpattu National Park.
Birdlife	Wetland bird species found in the Wilpattu National Park include the Garganey, Pin tail, Whistling Teal, Spoonbill, White Ibis, Large White Egret, Cattle Egret and Purple Heron. Also, many species of Gulls, Terns, Owls, Kites and Eagles are also living here. The endemic Sri Lanka Jungle fowl, Little Cormorant and the Painted Stork can also Can be seen.
Wildlife	There are approximately 30 species of mammals in the Wilpattu National Park which include the Sri Lankan Elephant, Sri Lankan Leopard, Lankan Sloth Bear, Sri, Spotted Deer, Buffalo, Sambar and Mongoose.

Source: http://www.wilpattunationalpark.com

14.3. Annexure-3: Questionnaire used for the Primary Survey

Sonadia Ecotourism Zone

Demand side Survey

- **Name:**
- **Age:**
- **Gender:** Male ☐ Female ☐
- **Nationality:**
- **Occupation:** Govt. Service ☐ Private Service ☐
  Business ☐ Student ☐
  Retired ☐ Unemployed ☐
- **Annual frequency of travel within Bangladesh:**
- **Rank according to preference given to the following activities in choosing a travel destination:** *(1 being the most preferred)*
  Rest & Relaxation ☐
  Business – Conferences, Seminars etc. ☐
  Fun & Sports/Recreation ☐
  Religious ☐
  Beach ☐
  Eco-Tourism ☐
  Other ☐ please specify:
- **Rank according to preference given to the following sources for gathering information about travel destination:** *(1 being the most preferred)*
  Internet ☐
  Media – Newspaper, Magazines, TV, Radio etc. ☐
  Word of Mouth ☐
  Exhibitions/Fairs ☐
  Travel Agency ☐
  Aspirational ☐
  Other ☐ please specify:
- **Rank according to importance given to the following attributes for travelling to a destination:** *(1 being the most preferred)*
  Attraction ☐
  Accessibility ☐

Accommodation ☐
Amenities ☐
Activities ☐

- **Tentative expenditure on each of the following during travelling to or within Bangladesh or any Southeast Asian country:**

  Transport:

  Accommodation:

  Food:

- **Preferred mode of transport for reaching the destination:** *(1 being the most preferred)*
  Air ☐
  Rail ☐
  Road ☐
  Water ☐

- **Preferred mode of transport while holidaying:** *(1 being the most preferred)*
  Personalized Car ☐
  Public Transport ☐
  Two-Wheeler ☐
  Boat ☐
  Shared Car ☐
  Other ☐ please specify:

- **Preferred mode of Travel bookings:** *(Tick the correct option)*
  Online ☐
  Offline ☐

- **Preferred Travel Partner:** *(Tick the correct option)*
  Family ☐
  Spouse/Partner ☐
  Alone ☐
  Colleague ☐
  Tour Group ☐
  Other ☐ please specify:

- **According to you what are challenges in visiting any destination:**
  1.
  2.
  3.

- **According to you what is a must-have for any destination:**

For Bangladeshi Nationals

- **Have you ever visited Cox's Bazaar before?**

  Yes ☐

  No ☐

- **If Yes:**
  1. **Purpose of visit:**
  2. **Place of visit:**
  3. **Rate the following attributes with respect to your last visit to Cox's Bazaar:** *(1 being the best)*

     Attraction ☐

     Accessibility ☐

     Accommodation ☐

     Amenities ☐

     Activities ☐
  4. **Rank according to preference given to the following reasons in choosing a travel destination in Cox's Bazaar:** *(1 being the most preferred)*

     Rest & Relaxation ☐

     Business – Conferences, Seminars etc. ☐

     Fun & Sports/Recreation ☐

     Religious ☐

     Beach ☐

     Eco-Tourism ☐

     Other ☐ please specify:

  5. **Rank the transport facilities with respect to travelling to/within Cox's Bazaar:** *(1 being the 'World Class'; 2 – 'Comparable to any other Southeast Asian country'; 3 – Average; 4 – Needs a lot of improvement; 5 – Very Poor)*

     ☐

  6. **Preferred mode of transport while holidaying in Cox's Bazaar:** *(1 being the most preferred)*

     Personalized Car ☐

     Public Transport ☐

     Two-Wheeler ☐

     Boat ☐

     Shared Car ☐

     Other ☐ please specify:

  7. **Rank the Safety of Tourists with respect to travelling to/within Cox's Bazaar:** *(1 being the 'Absolutely Safe '; 2 – 'Comparable to any other Southeast Asian country'; 3 – 'More or Less Safe'; 4 – Needs a lot of improvement; 5 – 'Dangerous')*

☐

8. **Best part about travelling in Cox's Bazaar:**

9. **Worst part about travelling in Cox's Bazaar:**

10. **Did your last trip to Cox's Bazaar meet your expectations?**

Yes ☐

No ☐

11. **Suggestions for development of Tourism in Bangladesh:**

Irrespective of whether the respondent has visited Cox's Bazaar:

- **Rank according to preference given to the following reasons in choosing a travel destination in Bangladesh:** *(1 being the most preferred)*

  Rest & Relaxation ☐

  Business – Conferences, Seminars etc. ☐

  Fun & Sports/Recreation ☐

  Religious ☐

  Beach ☐

  Eco-Tourism ☐

  Other ☐ please specify:

- **Rank the transport facilities with respect to travelling in Bangladesh:** *(1 being the 'World Class'; 2 – 'Comparable to any other Southeast Asian country'; 3 – Average; 4 – Needs a lot of improvement; 5 – Very Poor)*

  ☐

- **Tentative expenditure on each of the following during your last travel to Bangladesh:**

  Transport:

  Accommodation:

  Food:

- **Preferred mode of transport for travelling within Bangladesh:** *(1 being the most preferred)*

  Air ☐

  Rail ☐

Road ☐
Water ☐

- **Preferred mode of transport while holidaying in Bangladesh:** *(1 being the most preferred)*
  Personalized Car ☐
  Public Transport ☐
  Two-Wheeler ☐
  Boat ☐
  Shared Car ☐
  Other ☐ please specify:

- **Rank the Safety of Tourists with respect to travelling to/within Bangladesh:** *(1 being the 'Absolutely Safe '; 2 – 'Comparable to any other Southeast Asian country'; 3 – 'More or Less Safe'; 4 – Needs a lot of improvement; 5 – 'Dangerous')*
  ☐

- **Rank the Ease of booking Transportation with respect to travelling within Bangladesh:** *(1 being the 'Absolutely Seamless '; 2 – 'Hassle-free"; 3 – 'More or Less Seamless; 4 – Needs a lot of improvement; 5 – 'Too Difficult')*
  ☐

- **Rank the Ease of booking Accommodation facilities with respect to travelling within Bangladesh:** *(1 being the 'Absolutely Seamless '; 2 – 'Hassle-free"; 3 – 'More or Less Seamless; 4 – Needs a lot of improvement; 5 – 'Too Difficult')*
  ☐

- **Best part about travelling in Bangladesh:**
- **Worst part about travelling in Bangladesh:**
- **Did your last domestic trip meet your expectations?**
  Yes ☐
  No ☐

- **Suggestions for development of Tourism in Bangladesh:**

For Foreign Nationals

- **Have you ever visited Bangladesh before?**

  Yes ☐

  No ☐

- **If Yes:**
  12. **Purpose of visit:**
  13. **Place of visit:**
  14. **Rate the following attributes with respect to your last visit to Bangladesh:** *(1 being the best)*

      Attraction ☐

      Accessibility ☐

      Accommodation ☐

      Amenities ☐

      Activities ☐

- **If No:**
  1. **Purpose of current visit:**
  2. **Place of visit:**

If Place of visit is not Cox's Bazaar in any of the above:

- **Rank according to preference given to the following activities in choosing a travel destination in Bangladesh:** *(1 being the most preferred)*

  Rest & Relaxation ☐

  Business – Conferences, Seminars etc. ☐

  Fun & Sports/Recreation ☐

  Religious ☐

  Beach ☐

  Eco-Tourism ☐

  Other ☐ please specify:

- **Rank the transport facilities with respect to travelling in Bangladesh:** *(1 being the 'World Class'; 2 – 'Comparable to any other Southeast Asian country'; 3 – Average; 4 – Needs a lot of improvement; 5 – Very Poor)*

  ☐

- **Tentative expenditure on each of the following during your last travel to Bangladesh:**

  Transport:

  Accommodation:

  Food:

- **Preferred mode of transport for travelling within Bangladesh:** *(1 being the most preferred)*

Air ☐
Rail ☐
Road ☐
Water ☐

- **Preferred mode of transport while holidaying:** *(1 being the most preferred)*
  Personalized Car ☐
  Public Transport ☐
  Two-Wheeler ☐
  Boat ☐
  Shared Car ☐
  Other ☐ please specify:

- **Rank the Safety of Tourists with respect to travelling to/within Bangladesh:** *(1 being the 'Absolutely Safe'; 2 – 'Comparable to any other Southeast Asian country'; 3 – 'More or Less Safe'; 4 – Needs a lot of improvement; 5 – 'Dangerous')*
  ☐

- **Best part about travelling in Bangladesh:**

- **Worst part about travelling in Bangladesh:**

- **Suggestions for development of Tourism in Bangladesh:**

If Place of visit is Cox's Bazaar in any of the above:

- **Place of Visit:**

- **Rank according to preference given to the following reasons of travel/holiday of choosing Cox's Bazaar as a destination:** *(1 being the most preferred)*
  Rest & Relaxation ☐
  Business – Conferences, Seminars etc. ☐
  Fun & Sports/Recreation ☐
  Religious ☐
  Beach ☐
  Eco-Tourism ☐
  Other ☐ please specify:

- **Rank following attributes with respect to Cox's Bazaar as a tourist destination:** *(1 being the 'World Class'; 2 – 'Comparable to any other Southeast Asian country'; 3 – Average; 4 – Needs a lot of improvement; 5 – Very Poor)*

  Attraction ☐

  Accessibility ☐

  Accommodation ☐

  Amenities ☐

  Activities ☐

- **Rank the transport facilities with respect to travelling to/within Cox's Bazaar:** *(1 being the 'World Class'; 2 – 'Comparable to any other Southeast Asian country'; 3 – Average; 4 – Needs a lot of improvement; 5 – Very Poor)*

  ☐

- **Preferred mode of transport while touring/holidaying in Cox's Bazaar:** *(1 being the most preferred)*

  Personalized Car ☐

  Public Transport ☐

  Two-Wheeler ☐

  Boat ☐

  Shared Car ☐

  Other ☐ please specify:

- **Rank the Safety of Tourists with respect to travelling to/within Cox's Bazaar:** *(1 being the 'Absolutely Safe '; 2 – 'Comparable to any other Southeast Asian country'; 3 – 'More or Less Safe'; 4 – Needs a lot of improvement; 5 – 'Dangerous')*

  ☐

- **Best part about travelling to Cox's Bazaar:**

- **Worst part about travelling to Cox's Bazaar:**

- **Suggestions for development of Tourism in Cox's Bazaar:**

14.4. Annexure-4: Profiling of the Respondents from the Survey

S. No.	Name	Age	Gender	Nationality	Occupation
1.	Khondaker Mohammed Mohiuddin Ekram	26	Male	Bangladeshi	Govt. Service
2.	Razea Bari	27	Female	Bangladeshi	Private job
3.	Saidur Rahman	37	Male	Bangladeshi	Private job
4.	Dr. Sujat Morshed	28	Male	Bangladeshi	Govt. Service
5.	Baki Billah	45	Male	Bangladeshi	Private job
6.	Rafiqul Islam	67	Male	Bangladeshi	Retired
7.	Md. Mamun Chowdhury	33	Male	Bangladeshi	Private job
8.	Rawshan Islam	57	Female	Bangladeshi	Business
9.	Humayun Rasheed	36	Male	Bangladeshi	Private job
10.	Dr. Nazmul Hasan	38	Male	Bangladeshi	Private job
11.	Anika Proma	27	Female	Bangladeshi	Govt. Service
12.	Anji Sultana	28	Female	Bangladeshi	Business
13.	Tasleem Deep	27	Male	Bangladeshi	Business
14.	Sadia Islam	24	Female	Bangladeshi	Student
15.	Emam Babu	25	Male	Bangladeshi	Business
16.	Md. Rassel	28	Male	Bangladeshi	Private Job
17.	Bikrom Roy	25	Male	Bangladeshi	Student
18.	Mr. Araf	21	Male	Bangladeshi	Student
19.	S. M. Akash	26	Male	Bangladeshi	Private Job
20.	Tanisha Hoque	19	Female	Bangladeshi	Student
21.	Md. Asraful Khandaker	35	Male	Bangladeshi	Private Service
22.	Mr. Sajidul Islam	28	Male	Bangladeshi	Private Service
23.	Farhan Noor Galib	30	Male	Bangladeshi	Private Service
24.	Mahbub Khan	35	Male	Bangladeshi	Private Service
25.	Jarif Uz Zaman	32	Male	Bangladeshi	Private Service
26.	Fauzia Khanum	27	Female	Bangladeshi	Private Service
27.	Aklima Marjia Tofa	26	Female	Bangladeshi	Private Service
28.	Ahmed Faruque	26	Male	Bangladeshi	Private Service
29.	Arshiyan Ahsan	20	Female	Bangladeshi	Student
30.	Shafneen Shah	20	Female	Bangladeshi	Student
31.	Md. Omar Faruk	32	Male	Bangladeshi	Private Service
32.	Subah Akbar	26	Female	Bangladeshi	Private Service
33.	Hasan Mehedi	28	Male	Bangladeshi	Private Service
34.	Adeeb Chowdhury	34	Male	Bangladeshi	Private Service
35.	Jishan Rumee	28	Male	Bangladeshi	Private Service
36.	Ahsan Habib	38	Male	Bangladeshi	Private Service
37.	Animesh Paul	38	Male	Bangladeshi	Business
38.	Utzal Kumar Paul	34	Male	Bangladeshi	Private Service
39.	Kanta Paul	28	Female	Bangladeshi	Govt. Service
40.	Salman Afsar Rahman	36	Male	Bangladeshi	Private Service
41.	Md. Abul Hashem	39	Male	Bangladeshi	Private Service
42.	Md. Masud Hossain Mizi	34	Male	Bangladeshi	Private Service
43.	Anup Kumar Mishra	34	Male	Bangladeshi	Private Service
44.	Mr. Sajib Kumar Raouth	35	Male	Bangladeshi	Govt. Service

S. No.	Name	Age	Gender	Nationality	Occupation
45.	Mr. Tonmoy Das	35	Male	Bangladeshi	Private Service
46.	Sabyasachi Chakraborty	31	Male	Indian	Private Service
47.	Prabir Mitra	52	Male	Indian	Private Service
48.	Anish Moda	29	Male	Indian	Private Service
49.	John Martin	34	Male	German	Private Service
50.	Neeraj Rawat	32	Male	Indian	Private Service
51.	Akshat Pushp	38	Male	Indian	Private Service
52.	Christian Forthhouber	55	Male	Australian	Business
53.	Amit Kumar	36	Male	Indian	Private Service
54.	Sanglap Saha	38	Male	Indian	Private Service
55.	Hannah Shane	25	Female	Canadian	Student

14.5. Annexure-5: Financial Model Calculations – Case 1 (BEZA as the Master Developer) – Base Case

Profit and Loss Statement (BDT millions)										
Financial year	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Revenue	0	0	0	206	416	684	737	779	817	856
O&M expenses	32	41	48	55	63	70	78	86	91	93
EBIT	-32	-41	-48	-73	130	391	436	470	503	540
Interest	0	0	0	0	0	0	0	0	0	586
Profit before tax (PBT)	-32	-41	-48	-73	130	391	436	470	503	-46
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	-32	-41	-48	-73	130	391	436	470	503	-46

Financial year	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Revenue	896	905	914	922	931	940	949	959	968	977
O&M expenses	95	97	99	102	104	106	109	111	114	117
EBIT	578	584	591	597	604	610	617	623	630	637
Interest	517	448	379	310	241	172	103	64	54	44
Profit before tax (PBT)	61	136	212	287	363	438	514	560	576	593
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	61	136	212	287	363	438	514	560	576	593

Financial year	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**	**Year 26**	**Year 27**	**Year 28**	**Year 29**	**Year 30**

Revenue	987	996	1006	1016	1026	1036	1046	1056	1066	1077
O&M expenses	120	122	125	128	132	135	138	142	145	149
EBIT	644	650	657	664	670	677	684	691	698	704
Interest	34	25	15	5	0	0	0	0	0	0
Profit before tax (PBT)	609	626	642	659	670	677	684	691	698	704
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	609	626	642	659	670	677	684	691	698	704

Financial year	**Year 31**	**Year 32**	**Year 33**	**Year 34**	**Year 35**	**Year 36**	**Year 37**	**Year 38**	**Year 39**	**Year 40**
Revenue	1087	1098	1109	1120	1131	1142	1153	1165	1176	1188
O&M expenses	152	156	160	164	169	173	177	182	187	192
EBIT	711	718	725	732	739	745	752	759	766	773
Interest	0	0	0	0	0	0	0	0	0	0
Profit before tax (PBT)	711	718	725	732	739	745	752	759	766	773
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	711	718	725	732	739	745	752	759	766	773

Financial year	**Year 41**	**Year 42**	**Year 43**	**Year 44**	**Year 45**	**Year 46**	**Year 47**	**Year 48**	**Year 49**	**Year 50**
Revenue	1200	1212	1224	1236	1248	1261	1274	1286	1299	1312
O&M expenses	197	202	207	213	218	224	230	236	243	249
EBIT	779	786	793	800	806	813	820	826	833	840
Interest	0	0	0	0	0	0	0	0	0	0

Financial year	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50
Profit before tax (PBT)	779	786	793	800	806	813	820	826	833	840
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	779	786	793	800	806	813	820	826	833	840

FCFF Calculation (BDT million)

Financial year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
EBIT	-32	-41	-48	-73	130	391	436	470	503	540
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	0	0	0	224	224	224	224	224	224	224
Less: Capex	1127	1127	916	916	845	775	775	817	421	0
IDC	34	105	173	240	308	376	445	521	590	0
FCFF	-1125	-1063	-790	-525	-184	215	330	398	896	763

Financial year	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
EBIT	578	584	591	597	604	610	617	623	630	637
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	224	224	224	224	224	224	224	224	224	224
Less: Capex	0	0	0	0	0	0	0	0	0	0
IDC	0	0	0	0	0	0	0	0	0	0
FCFF	801	808	814	821	827	834	840	847	854	860

Financial year	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
EBIT	644	650	657	664	670	677	684	691	698	704

FCFF Calculation (BDT million)										
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	224	224	224	224	224	224	224	224	224	224
Less: Capex	0	0	0	0	0	0	0	0	0	0
IDC	0	0	0	0	0	0	0	0	0	0
FCFF	867	874	881	887	894	901	908	914	921	928

Financial year	Year 31	Year 32	Year 33	Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40
EBIT	711	718	725	732	739	745	752	759	766	773
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	224	224	224	224	224	224	224	224	224	224
Less: Capex	0	0	0	0	0	0	0	0	0	0
IDC	0	0	0	0	0	0	0	0	0	0
FCFF	935	942	948	955	962	969	976	983	989	996

Financial year	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50
EBIT	779	786	793	800	806	813	820	826	833	840
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	224	224	224	224	224	224	224	224	224	224
Less: Capex	0	0	0	0	0	0	0	0	0	0
IDC	0	0	0	0	0	0	0	0	0	0
FCFF	1003	1010	1017	1023	1030	1037	1043	1050	1057	1063

FCFE Calculation (BDT million)

Financial year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
EBIT	-32	-41	-48	-73	130	391	436	470	503	540
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	0	0	0	224	224	224	224	224	224	224
Interest	0	0	0	0	0	0	0	0	0	586
Repayment	0	0	0	0	0	0	0	0	0	797
Equity	348	370	327	347	346	345	366	401	303	0
Free Cash Flow to Equity	-381	-410	-374	-196	7	269	294	292	423	-619

Financial year	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
EBIT	578	584	591	597	604	610	617	623	630	637
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	224	224	224	224	224	224	224	224	224	224
Interest	517	448	379	310	241	172	103	64	54	44
Repayment	797	797	797	797	797	797	797	140	140	140
Equity	0	0	0	0	0	0	0	0	0	0
Free Cash Flow to Equity	-512	-437	-362	-286	-211	-135	-60	643	660	676

Financial year	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
EBIT	644	650	657	664	670	677	684	691	698	704
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	224	224	224	224	224	224	224	224	224	224
Interest	34	25	15	5	0	0	0	0	0	0
Repayment	140	140	140	140	0	0	0	0	0	0
Equity	0	0	0	0	0	0	0	0	0	0

Financial year	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Free Cash Flow to Equity	693	709	726	742	894	901	908	914	921	928

Financial year	Year 31	Year 32	Year 33	Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40
EBIT	711	718	725	732	739	745	752	759	766	773
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	224	224	224	224	224	224	224	224	224	224
Interest	0	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0	0
Equity	0	0	0	0	0	0	0	0	0	0
Free Cash Flow to Equity	935	942	948	955	962	969	976	983	989	996

Financial year	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50
EBIT	779	786	793	800	806	813	820	826	833	840
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	224	224	224	224	224	224	224	224	224	224
Interest	0	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0	0
Equity	0	0	0	0	0	0	0	0	0	0
Free Cash Flow to Equity	1003	1010	1017	1023	1030	1037	1043	1050	1057	1063

14.6. Annexure-6: NPV and BCR Calculations – Case 1 (BEZA as the Master Developer)

Table 113: NPV (@ 15% cost of equity) calculations across scenarios – **Case 1**

Scenarios	NPV FCFF (in BDT million)			NPV FCFE (in BDT million)		
	Conservative	Base	Aggressive	Conservative	Base	Aggressive
Prevailing tariffs of BEZA i.e. Business As usual= A	**-1,241.94**	**-1,117.55**	**-934.21**	**-1,292.01**	**-1,167.62**	**-984.27**
Increased space tariffs=B	**-670.23**	**-516.80**	**-290.70**	**-720.30**	**-566.87**	**-340.76**

Source: Financial Model

Table 114: BCR (@ 15% cost of equity) calculations across scenarios – **Case 1**

Scenarios	BCR		
	Conservative	Base	Aggressive
Prevailing tariffs of BEZA i.e. Business As usual= A	**0.51**	**0.53**	**0.56**
Increased space tariffs=B	**0.63**	**0.66**	**0.69**

Source: Financial Model

14.7. Annexure-7: Financial Model Calculations – Case 2 (PPP Developer developing the Project) –without pay-out– Base Case

Profit and Loss Statement (BDT millions)										
Financial year	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Revenue	0	0	0	206	416	684	737	779	817	856
O&M expenses	30	37	42	48	53	59	65	71	75	76
EBIT	-30	-37	-42	-44	160	423	471	506	540	578
Interest	0	0	0	0	0	0	0	0	0	529
Profit before tax (PBT)	-30	-37	-42	-44	160	423	471	506	540	49
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	-30	-37	-42	-44	160	423	471	506	540	49

Financial year	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Revenue	896	905	914	922	931	940	949	959	968	977
O&M expenses	78	80	81	83	85	87	88	90	92	94
EBIT	616	623	630	637	644	652	659	666	673	681
Interest	467	405	342	280	218	155	93	58	49	40
Profit before tax (PBT)	149	219	288	357	427	496	566	608	625	641
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	149	219	288	357	427	496	566	608	625	641

Financial year	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Revenue	987	996	1006	1016	1026	1036	1046	1056	1066	1077
O&M expenses	97	99	101	103	106	108	111	113	116	119
EBIT	688	695	703	710	718	725	733	741	748	756
Interest	31	22	13	4	0	0	0	0	0	0
Profit before tax (PBT)	657	673	690	706	718	725	733	741	748	756
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	657	673	690	706	718	725	733	741	748	756

Financial year	Year 31	Year 32	Year 33	Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40
Revenue	1087	1098	1109	1120	1131	1142	1153	1165	1176	1188
O&M expenses	121	124	127	130	134	137	140	144	147	151
EBIT	764	772	779	787	795	803	811	819	827	835
Interest	0	0	0	0	0	0	0	0	0	0
Profit before tax (PBT)	764	772	779	787	795	803	811	819	827	835
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	764	772	779	787	795	803	811	819	827	835

Financial year	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50
Revenue	1200	1212	1224	1236	1248	1261	1274	1286	1299	1312
O&M expenses	155	159	163	167	171	176	180	185	190	195
EBIT	843	851	859	867	875	883	891	899	907	916
Interest	0	0	0	0	0	0	0	0	0	0

Financial year	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50
Profit before tax (PBT)	843	851	859	867	875	883	891	899	907	916
Tax	0	0	0	0	0	0	0	0	0	0
Profit after tax (PAT)	843	851	859	867	875	883	891	899	907	916

FCFF Calculation (BDT million)

Financial year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
EBIT	-30	-37	-42	-44	160	423	471	506	540	578
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	0	0	0	202	202	202	202	202	202	202
Less: Capex	1019	1019	828	828	764	700	700	738	380	0
IDC	31	95	157	216	278	339	403	471	533	0
FCFF	-1018	-961	-713	-453	-123	265	375	441	896	780

Financial year	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
EBIT	616	623	630	637	644	652	659	666	673	681
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	202	202	202	202	202	202	202	202	202	202
Less: Capex	0	0	0	0	0	0	0	0	0	0
IDC	0	0	0	0	0	0	0	0	0	0
FCFF	818	825	832	839	847	854	861	868	875	883

FCFF Calculation (BDT million)										
Financial year	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**	**Year 26**	**Year 27**	**Year 28**	**Year 29**	**Year 30**
EBIT	688	695	703	710	718	725	733	741	748	756
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	202	202	202	202	202	202	202	202	202	202
Less: Capex	0	0	0	0	0	0	0	0	0	0
IDC	0	0	0	0	0	0	0	0	0	0
FCFF	890	898	905	912	920	928	935	943	950	958

Financial year	**Year 31**	**Year 32**	**Year 33**	**Year 34**	**Year 35**	**Year 36**	**Year 37**	**Year 38**	**Year 39**	**Year 40**
EBIT	764	772	779	787	795	803	811	819	827	835
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	202	202	202	202	202	202	202	202	202	202
Less: Capex	0	0	0	0	0	0	0	0	0	0
IDC	0	0	0	0	0	0	0	0	0	0
FCFF	966	974	981	989	997	1005	1013	1021	1029	1037

Financial year	**Year 41**	**Year 42**	**Year 43**	**Year 44**	**Year 45**	**Year 46**	**Year 47**	**Year 48**	**Year 49**	**Year 50**
EBIT	843	851	859	867	875	883	891	899	907	916
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	202	202	202	202	202	202	202	202	202	202
Less: Capex	0	0	0	0	0	0	0	0	0	0
IDC	0	0	0	0	0	0	0	0	0	0
FCFF	1045	1053	1061	1069	1077	1085	1093	1101	1109	1118

FCFE Calculation (BDT million)

Financial year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
EBIT	-30	-37	-42	-44	160	423	471	506	540	578
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	0	0	0	202	202	202	202	202	202	202
Interest	0	0	0	0	0	0	0	0	0	529
Repayment	0	0	0	0	0	0	0	0	0	720
Equity	315	334	295	313	313	312	331	363	274	0
Free Cash Flow to Equity	-345	-371	-337	-155	50	314	342	345	468	-469

Financial year	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
EBIT	616	623	630	637	644	652	659	666	673	681
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	202	202	202	202	202	202	202	202	202	202
Interest	467	405	342	280	218	155	93	58	49	40
Repayment	720	720	720	720	720	720	720	127	127	127
Equity	0	0	0	0	0	0	0	0	0	0
Free Cash Flow to Equity	-369	-300	-230	-161	-91	-22	47	684	700	716

Financial year	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
EBIT	688	695	703	710	718	725	733	741	748	756
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	202	202	202	202	202	202	202	202	202	202
Interest	31	22	13	4	0	0	0	0	0	0
Repayment	127	127	127	127	0	0	0	0	0	0
Equity	0	0	0	0	0	0	0	0	0	0
Free Cash Flow to Equity	732	749	765	781	920	928	935	943	950	958

Financial year	Year 31	Year 32	Year 33	Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40
EBIT	764	772	779	787	795	803	811	819	827	835
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	202	202	202	202	202	202	202	202	202	202
Interest	0	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0	0
Equity	0	0	0	0	0	0	0	0	0	0
Free Cash Flow to Equity	966	974	981	989	997	1005	1013	1021	1029	1037

Financial year	Year 41	Year 42	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50
EBIT	843	851	859	867	875	883	891	899	907	916
Tax	0	0	0	0	0	0	0	0	0	0
Add: Depreciation	202	202	202	202	202	202	202	202	202	202
Interest	0	0	0	0	0	0	0	0	0	0
Repayment	0	0	0	0	0	0	0	0	0	0
Equity	0	0	0	0	0	0	0	0	0	0
Free Cash Flow to Equity	1045	1053	1061	1069	1077	1085	1093	1101	1109	1118

14.8. Annexure-8: NPV and BCR Calculations – Case 2 (PPP Developer developing the Project)

Table 115: NPV (@ 15% cost of equity) calculations across scenarios – **Case 2**

Scenarios	NPV FCFF (in BDT million)			NPV FCFE (in BDT million)		
	Conservative	Base	Aggressive	Conservative	Base	Aggressive
Business As-usual scenario without payouts (Scenario A)	**-285.85**	**-132.42**	**93.68**	**-331.10**	**-177.67**	**48.43**
Business As-usual scenario with payouts (Scenario B)	**-439.73**	**-287.84**	**-63.99**	**-484.98**	**-333.09**	**-109.24**

Source: Financial Model

Table 116: BCR (@ 15% cost of equity) calculations across scenarios – **Case 2**

Scenarios	BCR		
	Conservative	Base	Aggressive
Business As-usual scenario without payouts (Scenario A)	**0.70**	**0.73**	**0.77**
Business As-usual scenario with payouts (Scenario B)	**0.67**	**0.70**	**0.75**

Source: Financial Model

14.9. Annexure 9: Economic Model Calculations

Total Economic Benefits (conservative)

Financial year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Output from Tourists Income	0	0	0	0	0	0	2093	2292	2511	2751
Employment Generation	10	18	18	18	18	9	81	79	86	94
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	0	0	0	0	0	0	0	0	0	0
Total Economic Benefits	**10**	**18**	**18**	**18**	**18**	**9**	**2174**	**2371**	**2597**	**2845**

Financial year	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Output from Tourists Income	3013	3302	3618	3965	4345	4763	5221	5724	6277	6883
Employment Generation	103	113	124	136	149	163	179	196	215	236
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	0	0	0	0	0	52	108	183	186	188
Total Economic Benefits	**3117**	**3415**	**3742**	**4101**	**4494**	**4978**	**5508**	**6104**	**6678**	**7307**

Financial year	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Output from Tourists Income	7548	8279	9081	9962	10930	11993	13161	14443	15852	17401
Employment Generation	259	284	312	342	375	412	452	452	452	452
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	190	191	192	192	191	190	188	187	184	181
Total Economic Benefits	**7997**	**8754**	**9585**	**10496**	**11497**	**12595**	**13801**	**15082**	**16488**	**18034**

Financial year	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Output from Tourists Income	19102	19102	19102	19102	19102	19102	19102	19102	19102	19102
Employment Generation	452	452	452	452	452	452	452	452	452	452
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	184	180	176	172	167	162	157	151	144	137
Total Economic Benefits	**19738**	**19734**	**19730**	**19726**	**19721**	**19716**	**19711**	**19705**	**19698**	**19691**

Financial year	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Output from Tourists Income	19102	19102	19102	19102	19102	19102	19102	19102	19102	19102
Employment Generation	452	452	452	452	452	452	452	452	452	452
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	130	122	113	104	94	84	73	61	49	36
Total Economic Benefits	**19684**	**19676**	**19667**	**19658**	**19649**	**19638**	**19627**	**19615**	**19603**	**19590**

Total Economic Benefits (Base)

Financial year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Output from Tourists Income	0	0	0	0	0	0	3080	3379	3708	4069
Employment Generation	10	18	18	18	18	9	115	116	127	140
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	0	0	0	0	0	0	0	0	0	0
Total Economic Benefits	**10**	**18**	**18**	**18**	**18**	**9**	**3195**	**3495**	**3835**	**4208**

Financial year	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Output from Tourists Income	4465	4901	5380	5906	6484	7119	7817	8585	9429	10356
Employment Generation	153	168	185	203	223	244	268	295	324	355
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	0	0	0	0	0	52	108	183	186	188
Total Economic Benefits	**4618**	**5069**	**5564**	**6108**	**6706**	**7415**	**8193**	**9063**	**9938**	**10900**

Financial year	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Output from Tourists Income	11376	12498	13731	15088	16580	18221	20026	22012	24196	26600
Employment Generation	391	429	471	518	569	625	687	687	687	687
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	190	191	192	192	191	190	188	187	184	181
Total Economic Benefits	**11957**	**13118**	**14395**	**15798**	**17340**	**19036**	**20902**	**22885**	**25068**	**27469**

Financial year	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Output from Tourists Income	29245	29245	29245	29245	29245	29245	29245	29245	29245	29245
Employment Generation	687	687	687	687	687	687	687	687	687	687
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	184	180	176	172	167	162	157	151	144	137
Total Economic Benefits	**30116**	**30113**	**30109**	**30104**	**30100**	**30095**	**30089**	**30083**	**30077**	**30070**

Financial year	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Output from Tourists Income	29245	29245	29245	29245	29245	29245	29245	29245	29245	29245
Employment Generation	687	687	687	687	687	687	687	687	687	687
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	130	122	113	104	94	84	73	61	49	36
Total Economic Benefits	**30062**	**30054**	**30046**	**30037**	**30027**	**30016**	**30005**	**29994**	**29981**	**29968**

Total Economic Benefits (aggressive)										
Financial year	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Output from Tourists Income	0	0	0	0	0	0	4230	4646	5103	5606
Employment Generation	10	18	18	18	18	9	154	159	175	192
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	0	0	0	0	0	0	0	0	0	0
Total Economic Benefits	**10**	**18**	**18**	**18**	**18**	**9**	**4384**	**4805**	**5278**	**5798**

Financial year	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Output from Tourists Income	6159	6767	7436	8171	8980	9870	10850	11927	13112	14416
Employment Generation	211	232	255	280	308	339	372	409	450	495
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	0	0	0	0	0	52	108	183	186	188
Total Economic Benefits	**6370**	**6999**	**7691**	**8452**	**9289**	**10261**	**11330**	**12519**	**13748**	**15099**

Financial year	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Output from Tourists Income	15852	17431	19170	21083	23190	25508	28061	30871	33966	37373
Employment Generation	544	598	658	724	796	876	963	963	963	963
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	190	191	192	192	191	190	188	187	184	181
Total Economic Benefits	**16586**	**18221**	**20020**	**21999**	**24177**	**26574**	**29213**	**32021**	**35113**	**38518**

Financial year	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Output from Tourists Income	41125	41125	41125	41125	41125	41125	41125	41125	41125	41125
Employment Generation	963	963	963	963	963	963	963	963	963	963
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	184	180	176	172	167	162	157	151	144	137
Total Economic Benefits	**42272**	**42268**	**42264**	**42260**	**42255**	**42250**	**42245**	**42239**	**42232**	**42225**

Financial year	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Output from Tourists Income	41125	41125	41125	41125	41125	41125	41125	41125	41125	41125
Employment Generation	963	963	963	963	963	963	963	963	963	963
Tax Incentive Availed by the Developer (Loss for Exchequer)	0	0	0	0	0	0	0	0	0	0
Tax Paid by the Developer (Gain for Exchequer)	130	122	113	104	94	84	73	61	49	36
Total Economic Benefits	**42218**	**42210**	**42201**	**42192**	**42183**	**42172**	**42161**	**42149**	**42137**	**42124**

All figures are in BDT millions

14.10. Annexure 10: List of displaced family/household and their identity

Sl no	Name	F/H's Name	NID	Profession	Cell phone
1	রাবেয়া বেগম	মোস্তাফা আলী	২২১৪৯৬২১১৩৪৩৭	জেলে	০১৮২১৫৬৬৭৯৬
2	নুর হোসেন	এ.কে.এ ফজলুল হক	২২১৪৯৬২১২৩১৪২	জেলে	০১৮৭৭১১২৪৭৫
3	আইয়ুব আলী	মাহফুজুর রহমান	২২১৪৯৬২১১৩৬৭৮	কৃষক	০১৮৪৯৮৩৯৩৩৭
4	আকতার কামাল	মৃত: করম সিকদার	২২১৪৯৬২১১৩৩১১	জেলে	০১৮৬৬৬৯৩০৯৯
5	আজিজ নুর	আবুল কালাম	২২১৪৯৬২১১৩১৩৩	জেলে	০১৮২৯১৩৮৫১৬
6	আজিজ মিয়া	বদিউল আলম	২২১৪৯৬২১১৩৪৬২	ব্যবসা	০১৮৩৩৮৭৭৭৬৬
7	আজিজুল হক	ইউনুছ মিয়া	২২১৪৯৬২১১৩২৭৯	জেলে	০১৮৪৬১০০৯২১
8	আনছার করিম	ফরোখ আহমদ	২২১৪৯৬২১১৩৪৭০	জেলে	০১৮৬৪৩৯০৩৫৭
9	আনছারুল করিম	শাহ আলম	১৯৯১২২১৪৯৬২০০০০৮২	জেলে	০১৮৬৩২৭৪৫৯৮
10	আনছারুল করিম	নুর আহমদ	২২১৪৯৬২১১৩৬৬৪	জেলে	০১৮৫৭০১৮৮৭০
11	আনসারুল করিম	বদিউর রহমান	২২১৪৯৬২১১৩১০৮	জেলে	০১৮৫৮০১৭২৪৪
12	আনারসি বেগম	সিরাজ মিয়া	২২১৪৯৬২১১৩৪৫২	জেলে	০১৮৩৭৩১০০২৬
13	আনোয়ার পাশা	মৃত: এজাহার মিয়া	২২১৪৯৬২১১৩১১৪	কৃষক	
14	আনোয়ারা বেগম	মৃত: নজির আহমেদ	২২১৪৯৬২১১৩৬৭৫	ব্যবসা	০১৮৮৩৩৬৯৯৭৪
15	আবদু রহমান	মৃত: আলী আকবর	২২১৪৯৬২১১৩৮৯৯	জেলে	০১৮২৯১৩১০৭৯
16	আবদুর রহমান	মৃত: এজাহার মিয়া	২২১৪৯৬২১১৩৪৩৮	কৃষক	০১৮২৯২৯৫১৩৩
17	আবদুল আজিজ	মৃত: মো: শরীফ	২২১৪৯৬২১১৩৬৩২	জেলে	০১৮২৭৩৩৩৪১১
18	আবদুল করিম	ফরোখ আহমদ	২২১৪৯২১১৩৩৩৯	জেলে	০১৮৩০৬৮৭২৬৯
19	আবদুল খালেক	জালাল আহমদ	২২১৪৯৬২১১৩৩৩০	জেলে	০১৮৪০২৮০৩১৪
20	আবদুল জব্বার	আবদুর রহমান	২২১৪৯৬২১১৩৪৯২	প্রবাসী	০১৮২৬৩০৪৬৪৪
21	আবদুল বাতেন	হুমায়ুন কবির	২২১৪৯৬২১১৩৯১	জেলে	০১৮৫৬৭৩১৭১২
22	আবদুল মজিদ	মৃত: কাছিম আলী	২২১৪৯৬২১১৩৫৪১	জেলে	০১৮৬০৬১৬৯০৪
23	আবদুল মোনাফ	আবদুর রহমান	১৯৯৪২২১৪৯৬২০০০০৫৯	জেলে	০১৮৩২২৪৭০৬৭
24	আবদুল হামিদ	বাবু মিয়া	১৯৯৫২২১৪৯৬২০০০২৫৮	জেলে	০১৮৭৭১১৩৬৫৪
25	আবুল কালাম	মৃত: রাহামত আলী	২২১৪৯৬২১১৩৪৬২	জেলে	০১৮৮৩৩৬২১৬৯
26	আবুল কাসিম	মৃত: রহমত আলী	২২১৪৯৬২১১৩৫৯৯	ব্যবসা	০১৮৮১৩৯৫৬৮০
27	আবুল হোছন	ফেরদৌস মিয়া	১৯৯১২২১৪৯৬২০০০	জেলে	০১৮৫৫২৯৩৬৪২
28	আবুল হোসেন	মৃ: কালু মিয়া	২২১৪৯৬২১১৩৩০৯	জেলে	০১৮৩৫৮৪৭৩৭৯
29	আবেদা বেগম	মৃত: শাহাবুদ্দীন	২২১৪৯৬২১১৩২৭৫	জেলে	০১৮১৬৪২৫৩৩১
30	আব্দু ছালাম	মৃত: আবদু ছাত্তার	২২১৪৯৬২১১৩৩০৮	জেলে	০১৮৩১৯৪১৬৩২
31	আব্দু রহিম	মৃত: জলিল আহমদ	১৯৮৯২২১৪৯৬২০০০০১৪	জেলে	০১৮৪০৫০৬৫৯৫

Sl no	Name	F/H's Name	NID	Profession	Cell phone
32	আব্দু রহিম	মোস্তফা আলী	২২১৪৯৬২১১৩৫৮৬	ব্যবসা	
33	আব্দুর রশিদ	মৃত: মো: সুলতান	২২১৪৯৬২১১৩১৩৯	জেলে	
34	আব্দুল আমিন	কামাল পাশা	১৯৮৭২২১৪৯৬২০০০০০৯	জেলে	০১৮৩৫৬৪১৬৭৭
35	আব্দুল গফুর	আবদুর রহমান	১৯৯৩২২১৪৯৬২০০০০৫১	চাকরীজীবি	০১৮৫৮০১৬৯৬৮
36	আব্দুল মজিদ	নুরু মোহাম্মদ	২২১৪৯৬২১১৩১৯৯	ব্যাবসা	
37	আব্দুল মান্নান	নুরল ইসলাম	২২১৪৯৬২১১৩২৯৬	জেলে	
38	আব্দুল মান্নান	হুমায়ুন কবির	২২১৪৯৬২১১৩৫৭১	জেলে	০১৮৪৯১৯৪৩১৮
39	আব্দুল মালেক	নুরল ইসলাম	২২১৪৯৬২১১৩২৮১	জেলে	
40	আব্দুল হক	ইউনুছ মিয়া	২২১৪৯৬২১১৩২২৮	ব্যবসা	০১৮১২৭৩৩৫১৯
41	আব্দুল হামিদ	শাহ আলম	২২১৪৯৬২১১৩৫৯২	জেলে	০১৮৪৮১৫৯৭১৫
42	আব্দুল হালিম	মৃত: আবুল ফজর মাষ্টার	১৯৫৪২২১৪৯৬২০০০০০১	জেলে	
43	আব্দুশুকুর	আনোয়ার পাশা	২২১৪৯৬২১১৩৩১৫	জেলে	
44	আব্বাস	আবুল কাসিম		জেলে	০১৮৬৭৯৬৪৪৫৭
45	আব্বাস মিয়া	মৃত: নেয়ামত আলী	১৯৯০২২১৪৯৬২০০০০৬৫	জেলে	০১৮৩৭০১৪২২৯
46	আমিনা খাতুন	আব্দু খালেক	২২১৪৯৬২১১৩১৬৪	জেলে	০১৮২৭২৫৮৯০৯
47	আমিনুল ইসলাম	মোহাম্মদ জালাল	২২১৪৯৬২১২৫৮৭১	ব্যবসা	১৭১৪৩৭৫০১২
48	আমির হোসেন	মৃত: ঠান্ডা মিয়া	২২১৪৯৬২১১৩১০৬	ব্যবসা	০১৮২২৬৯১৯৫৯
49	আমেনা বেগম	এখলাস মিয়া	২২১৪৯৬২১১৩৪৩৯	গৃহীনি	০১৮৩২৮৩২১৬৭
50	আয়াতুন্নাহার	মৃত: সাবের আহমাদ	২২১৪৯৬২১১৩৫৫৩	গৃহিনী	০১৮২৭৯৪৪৪৩১
51	আলতাজ মিয়া	ইউনুছ মিয়া	২২১৪৯৬২১১৩৩০৬	জেলে	
52	ইউনুছ মিয়া	মৃত: রহমান আলী	২২১৪৯৬২১১৩১১১	ব্যবসা	
53	ইমতিয়াজ উদ্দীন	আব্দুল গফুর	১৯৯৪২২১৪৯৬২০০০৪০১	ব্যবসা	
54	ইমরুল হাসান রাকিব	আবদুল গফুর	১৯৯৯২২১৪৯৬২০৩৭৮২৪	ব্যবসা	০১৬৭৫১৩৫০৪৬
55	ইমাম উদ্দীন	হুমায়ুন কবির	২২১৪৯৬২১১৩৬০৮	জেলে	০১৮৮২৭১২৮৫২
56	ইলিয়াছ মিয়া	জবির হোসেন	২২১৪৯৬২১১৩১৯১	জেলে	
57	একরাম মিয়া	এখলাচ মিয়া	২২১৪৯৬২১১৩৬১৪	ব্যবসা	০১৮১৪৪১৭৪৬৫
58	এনামুল হক	আবুল হোসেন	১৯৯৬২২১৪৯৫৯০০৫৪৭০	ব্যবসা	০১৮১৩৮৭৯৮১০
59	এমদাদ মিয়া	মৃত: নেয়ামত আলী	২২১৪৯৬২১১৩২২৯	জেলে	০১৮৬৩৮৮৩৭৪৩
60	ওমর ফারুক	মৃত: এজাহার মিয়া	২২১৪৯৬২১১৩১০২	খজিদ	০১৮২৪২৮৬৬৩
61	কবির খান	মোস্তফা আলী	২২১৪৯২১১৩৪৭১	ব্যবসা	০১৮৭২০৩৩৮৯১
62	কবির হোসেন	ছৈয়দ নুর	১৯৮৯২২১৪৯৬২০০০১৩৭	জেলে	০১৮৪৫৬২১৮৪১
63	করিম মিয়া	বদিউর রহমান	২২১৪৯৬২১১৩১৮৩	জেলে	০১৮৮৩১২৫২০৩
64	করিম মিয়া	নাজির আলী	২২১৪৯৬২১১৩৩১০	জেলে	০১৮৬৪৫৯৪৭৬২

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65	কাজল আক্তার	আব্দুল গফুর	২২১৪৯৬২১১৩৪১৪	মৎস্য উৎপাদন	০১৮৩২৪৮৪৯০৯
66	কামাল পাশা	মৃত: এজাহার মিয়া	২২১৪৯৬২১১৩১১৪	জেলে	০১৮৩৫৬৪১৬৭৭
67	কালা খাতুন	রৌশন আলী	২২১৪৯৬২১১৩২৩৮	জেলে	
68	কালা বানু	আলতাজ মিয়া	২২১৪৯৬২১১৩৫৭২	গৃহিনী	০১৮৩২২১৫৩০০
69	কালা মনু	মৃত: খুইল্যা মিয়া	১৯৮২২২১৪৯৬২০০০০০৩	জেলে	০১৮৩৯৬৫৪৯৫৭
70	কুতুব উদ্দীন	আব্দু ছালাম	১৯৯৩২২১৪৯৬২০০০৩৫৯	জেলে	০১৮৭৭১১৩৫০৭
71	খাইরুল বশর	মোস্তাক আলী	২২১৪৯৬২০০০৪৩৭	জেলে	০১৮৩২৮০০১৯৯
72	খুইল্যা বিবি	রশিদ মিয়া	২২১৪৯৬২১১৩২৪৪	জেলে	
73	খুকুমনি (মাসুক)	মো: হোসেন	২২১৪৯৬২১১৩২০৫	জেলে	০১৮২৭০০৩৬২৪
74	খুরশিদা আক্তার	মৃত: এরশাদুল্লাহ	১৯৯১২২১৪৯৬২০০০০৪০	জেলে	০১৮৩৮৬৭৪০২৯
75	খুরশেদ মিয়া	আবদু ছালাম	২২১৪৯৬২৪১৩২৮৬	জেলে	০১৮৮৪৭৬৮১১৩
76	গিয়াস উদ্দীন	মৃত: মোস্তাক আহমেদ	২২১৪৯৬২১১৩১২৩	ব্যবসা	01825026133
77	গিয়াস উদ্দীন	মো: ফোরকান	২২১৪৯৬২১১৩১৭২	জেলে	০১৮৭২২৯৪৯৪৬
78	গিয়াস উদ্দীন	সাহেব মিয়া	২২১৪৯৬২১১৩২২৬	জেলে	০১৮১২২২৪৪১২
79	গোলারাজ বেগম	মৃত:আমির হোছন	২২১৪৯৬২১১৩১৫৭	গৃহিনী	০১৮২০৪২৯৪০২
80	ছাদেক মিয়া	নুরুল ইসলাম প্রকাশ	২২১৪৯৬২১১৩১৮১	জেলে	০১৮৪৫৩৫৮৪৮০
81	ছালামত উল্লাহ	মৃত: নুর আলী	২২১৪৯৬২১১৩৩২৯	জেলে	
82	ছেনোয়ারা বেগম	নুরু আলম	২২১৪৯৬২১১৩২৭১	জেলে	০১৮৭৭৪৮৭৮৯০
83	ছেয়দ নুর	মৃত: রাহামত আলী	২২১৪৯৬২১১৩৪৭২	চাকুরীজীবি	০১৮৫৭৭৩৬৩২৮
84	ছোট মিয়া	বদিউল আলম	২২১৪৯৬২১১৩৪৫৪	জেলে	
85	ছৈয়দ আহম	মৃত: এজহার মিয়া	২২১৪৯৬২১১৩২৭২	ব্যবসা জেলে	০১৮১৯৬৯৮২৪৬
86	ছৈয়দ হোছন	এ.কে.ফজল	২২১৪৯৬২১১৩৬৭৭	জেলে	০১৮১৩৬৭৩৮৭৩
87	ছৈয়দ হোসাইন	ছৈয়দ নুর	১৯৯৫২২১৪৯৬২০০০০০২	জেলে	
88	ছৈয়দ হোসেন	আবুল কামিম	১৯৯৫২২১৪৯৬২০৩৩৫৯৯	জেলে	০১৮৬২৪২৯৫৯৭
89	ছৈয়দুল হক	আবদুল জব্বার	২২১৪৯৬২১১৩৬১৭	ব্যবসা	০১৮৩৩৭২৮০৫০
90	জন্নাত বেগম	লালু মিয়া	২২১৪৯৬২১১৩১৪৬	ব্যবসা	০১৮১১৯১৩৭৫৮
91	জয়নাল আবেদীন	আবুল কাসেম	২২১৪৯৬২১১৩৩৮৫	জেলে	০১৮৩৭১৯২৪৯২
92	জসিম উদ্দীন	জল্লির আহমদ	১৯৯৫২২১৪৯৬২০০০০৮৪০	জেলে	০১৮৫১৩৩৯৮২১
93	জসিম উদ্দীন	মৃত: আকবর আহমদ	২২১৪৯৬২১১৩৫৪৫	জেলে	০১৮৬৩১১৫১৩২
94	জসিম উদ্দীন	মো: হোসেন	১৯৮৮২২১৪৯৬২০০০০৩৮	ব্যবসা	০১৮৩১২২০৩৫১
95	জসিম উদ্দীন	মৃত: আ: সালাম	২২১৪৯৬২১১৩১২৫	জেলে	

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96	জসিম উদ্দীন	আবদু আজিজ	২২১৪৯৬২১১৩৫১৭	জেলে	০১৮৩০৮৯৬৩১১
97	জাগির মিয়া	মৃত: কাসিম আলী	২২১৪৯৬২১১৩৩৪০	জেলে	০১৮৫৮৫৮৩৩৮২
98	জাগির হোসেন	মোস্তফা আলী	২২১৪৯৬২১১৩৫১১	ব্যবসা	০১৮৭৮৫০৭৫০৪
99	জাগির হোচন	সুলতান আহমদ	২২১৪৯৬২০০০০৭৮	প্রবাসী	০১৮৩৫০৩৩০৫০
100	জান্নাত বেগম	জাকের হোসেন	২০০২২২১৪৯৬২০০২৪৯	গৃহিনী	০১৮৮৪০৪৯০১৪
101	জাফর আলম	মৃ: খলিলুর রহমান	২২১৪৯৬২১১৩১০৪	জেলে	০১৮৫৮০২০১০০
102	জাফর আলম	মৃত: আজিজ	২২১৪৯৬২১১৩১৮৪	জেলে	০১৮৭৮৮৬৬৯০২
103	জাফর আলম	ওমর ফারুক	২২১৪৯৬২১১৩৩০৭	জেলে	০১৮৩৫৬১৯৮০৭
104	জামাল উদ্দীন	শাহ আলম	২২১৪৯৬২১১৩৩৮০	জেলে	০১৮৭২০২৭৭০০
105	জামাল হোছন	মো: সুলতান	২২১৪৯৬২১১৩৩৭৯	জেলে	০১৮৩৬৪৪৭৬৪৫
106	জামাল হোসেন	মৃত: কবির আহামদ	২২১৪৯৬২১১৩১৩৬	জেলে	০১৮৫২১৩৮০৯৪
107	জালাল আহমদ	মৃত: নুর আলী	২২১৪৯৬২১১৩১২১	চাকুরীজিবী	১৮২১২৩২০০১
108	জালাল আহমদ	মৃত: তাজর মুল্লুক	২২৪৪৯৬২১১৩৬৭৪	জেলে	০১৮৩৪০৯৩২৮৪
109	জাহানারা বেগম	জবির হোসেন	২০০০২২১৪৯৬২০০০৭৩৮	জেলে	
110	জাহানারা বেগম	স্বামী- খলিলুর রহমান	২২১৪৯৬২১১৩৪৯৮	গৃহিনী	০১৮৮১২২০৮৬১
111	জুবেদা খাতুন	নাজির হোসেন	২২১৪৯৬২১১৩৩২৩	জেলে	০১৮৫০৬৫২২০৯
112	জুমা খাতুন	একে ফজল	২২১৪৯৬২১১৩৫২৬	গৃহীনি	০১৮৪৬০১২৮২২
113	জেয়াবুকুন নাহার	ছৈয়দ আহমদ	২২১৪৯৬২১১৩১৭৫	গৃহিনী	০১৮১২০২০৩৮৩
114	তসলিমা বেগম	নুরল ইসলাম	১৯৯১২২১৪৯৬২০০০০৭১	ব্যবসা	০১৮৫২৫৮৪৯১১
115	তাজুমুদ্দীন	হুমায়ুন কবির	২২১৪৯৬২১১৩৫৬৯	জেলে	০১৮৬৬১৫৮৫৩৪
116	তোফাইল	মো: হোছন	১৯৯৫২২১৪৯৬২০০০১৭৬	ব্যবসা	
117	তৈয়বা আকতার	একে ফজলুল হক	১৯৯২২২১৪৯৬২০০০৭৮১	জেলে	০১৮৮১৭৬৬৭২৪
118	দানু মিয়া	বদিউল আলম	২২১৪৯৬২১১৩৩৮৪	প্রবাসী	০১৮২৫৭৬২৪১৩
119	দিদারুল ইসলাম	মৃত: মো: শরীফ	২২১৬৬৩৮৬৬৮৪৩১	ব্যবসা	০১৮১৩৩২৭১১১
120	দিনদার মিয়া	সিরাজ মিয়া	১৯৯১২২১৪৯৬২০০০০৭৮	ব্যবসা	০১৮২১৩২৫৮৫৮
121	দিলদার বেগম	নাজির হোসেন	১৯৯৪২২১৪৯৬২০০০৪৩৩	দিন মুজুর	০১৮৭৮৪১৫৮৫৮
122	দিলুয়ারা বেগম	মৃত: খুইল্যা মিয়া	২২১৪৯৬২১১৩৫৫৮	গৃহিনী	০১৮৮১১২২১৮৯
123	দুধু মিয়া	বদিউল আলম	২২১৪৯৬২১১৩৪১০	জেলে	০১৮৩৫৬৩৮৭৭২
124	নবী হোসেন	ছৈয়দুর রহমান	২২১৪৯৬২১১৩৫৪০	জেলে	
125	নাছিমা খাতুন	মৃত: মোহাম্মদ হোছন	২২১৪৯৬২১১৩৫৫৬	গৃহিনী	০১৮৩২৭৭৮১৪২
126	নাছির উদ্দীন	সাহেব মিয়া	২২১৪৯৬২১১৩২১৮	ব্যবসা	০১৮৬১৩৯২২৯৯
127	নাজির হোসেন	নেয়ামত আলী	২২১৪৯৬২১১৩৬৯৪	জেলে	০১৮৬৪৯৮৪৪৪৬
128	নাসিমা আক্তার	আবুল কাছিম	১৯৯০২২১৪৯৬২০০০০৬০	দিনমুজুর	০১৮৩৬৪৪৭৯৮৭

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129	নাসির উদ্দীন	হুমায়ুন কবির	২২১৪৯৬২১১৩৫৯৭	জেলে	০১৮৬৯৬৪০০০৫
130	নাহিদা আকতার	ছৈয়দ আহমদ	১৯৯৭২২১৪৯৬২০০০২১৬	ব্যবসা	০১৮১১১০৫০৬৬
131	নুর বেগম	হোছন আলী	২২১৪৯৬২১১৩২৯০	জেলে	০১৮২৯৯৬০৩৪৮
132	নুর মোহাম্মদ	আবদুল কাদের	২২১৪৯৬২১২৬৭৪৫	জেলে	০১৮৩৫৯৪৮২১৩
133	নুর হোসাইন	ছৈয়দ নুর	১৯৯৯২২১৪৯৬২০০০৫৩৭	জেলে	০১৮৪৫৩০০৬৯০
134	নুর হোসেন	তজু মিয়া	২২১৪৯৬২১১৩৬০৩	জেলে	০১৮৩৫৯৯৫৪৯৬
135	নুর হোসেন	ওমর ফারুক	১৯৮০২২১৪৯৬২০০০০০২	জেলে	
136	নুরন্নাহার	ছৈয়দ নুর	১৯৬৪২২১৪৯৬২০০০০০৩	গৃহিনী	০১৮৮১২৭৫২৪৬
137	নুরল আজিম	সিরাজ মিয়া	২২১৪৯৬২১১৩১১৬	ব্যবসা	
138	নুরল আমিন	মো: সুলেমান	২২১৪৯৬২১১৩৬০৪	জেলে	০১৮৫৪৪৯২৩৭৪
139	নুরল ইসলাম	মৃত: কালামিয়া	১৯৫৭২২১৪৯৬২১১৩১৮৮	জেলে	০১৮২৮৬৪৮৩৫৪
140	নুরল ইসলাম	ওমর ফারুক	১৯৭৮২২১৪৯৬২০০০০১০	কৃষক	০১৮৭৪২৭৩৫২৪
141	নুরল ইসলাম	মৃত: মো: শরীফ	২২১৪৯৬২১১৩৬৭৩	জেলে	০১৮৭৯৬৫৩১৩৯
142	নুরল কবির	হোছন আলী	২২১৪৯৬২১১৩৩২৮	ব্যবসা	০১৮২৩৭৪৭৫৫৫
143	নুরু আহামদ	মৃত: কালু মিয়া	২২১৪৯৬২১৩২৭৭	জেলে	০১৮৬২৮৮৮৮০৭
144	নুরুজ্জাহান	ফারুক আহমদ	২২২১৬০২১৯৮৬১	গৃহীনি	০১৮৩২৮১১০৬৫
145	নুরুন্নার	মো: ফোরহান	২২১৪৯৬২১১৩২০৪	জেলে	০১৮৪৯৯২৫৯১৫
146	নুরুন্নাহার বেগম	শফি আলম	২০০৩২২১৪৯৬২০৩৭৭৯৬	জেলে	০১৮২৫৩৭৯১৫৬১
147	নেজাম উদ্দীন	বদিউর রহমান	২২১৪৯৬২১১৩৬৫৭	জেলে	
148	পারজা খাতুন	মৃত: আবুল কাছিম	২২১৪৯৬২১১৩১৮০	দিনমুজুর	
149	ফজল করিম	বদিউর রহমান	২২১৪৯৬২১১৩১৮২	জেলে	০১৮৮৫০০১৬৪৭
150	ফজল করিম	নুরুল ইসলাম	২২১৪৯৬২১১৩৩৫৮	জেলে	০১৮১৬৭৬৬৯৯৮
151	ফরিদ আলম	আবুল হোছেন	২২১৪৯৬২১১৩৫৯০	জেলে	০১৮৩৫২৪৪৬০২
152	ফরিদ মিয়া	মৃত: মতিউর রহমান	২২১৪৯৬২১২৬৫৭২	জেলে	০১৮৮৩৩৬৫২৬৪
153	ফরিদা খাতুন	মৃত: বাবুল মিয়া	২২১৪৯৬২১১৩২০৮	জেলে	
154	ফরিদুল আলম	ছৈয়দ আহমদ	১৯৭১২২১৪৯৬২০০০০০৫	ব্যবসা	০১৮১৬৮৬৩১৩২
155	বদিউল আলম	মৃত: মকগুল মিয়া	২২১৪৯৬২১১৩৪৫৩	জেলে	০১৮৫৪৫৭৩৫১৫
156	বাদশা মিয়া	মৃত: নেয়ামত আলী	২২১৪৯৬২১১৩৬৫৬	জেলে	০১৮৮৩৮২৫১১১
157	বাবু মিয়া	মৃত: আব্দু ছাত্তার	২২১৪৯৬২১১৩৩৩৬	জেলে	০১৮৩১৭২৯০৬৪
158	বাবুল মিয়া	বদিউল আলম	২২১৪৯৬২১১৩৩৮৩	জেলে	০১৮৭৯৬৭৬২৫২
159	বুড়ি খাতুন	দলিলুর রহমান	২২১৪৯৬২১১৩২১৮	গৃহিনী	০১৮৬৯৬২৬৯২৯
160	বেবী	জালল আহমদ	২০০০২২১৪৯৬২০০০১৪৪	জেলে	০১৮৪৩৮২১৬২৭

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161	বেবী আক্তার	সাবের আহমদ	১৭৮২২২১৪৯৬২১১৩২২৫	প্রবাসী	০১৮৬৭৫৪৫১২৮
162	বেবী আক্তার	ফরিদুল আলম	২২১৪৯৬২১১৩৫৫৫	গৃহীনি	০১৮৬১৩৯২২১০
163	বেবী আক্তার	শাহাবুদ্দীন	২২১৪৯৬২১১৩৬১৮	জেলে	০১৮৭১২৭৪৮৪৬
164	বেলাল উদ্দিন	শাহাব মিয়া	১৯৯৪২২১৪৯৬২০০০৪৩৬	জেলে	০১৮৬৭৪৮৪৩৪০
165	ভেল্লা খাতুন	রাহামত আলী	২২১৪৯৬২১১৩৬৯৫	জেলে	০১৮৭৮৫৫৭০৯২
166	মকসুদ মিয়া	এখলাছ মিয়া	১৯৯২২২১৪৯৬২০০০৩৪১	ব্যবসা	০১৮৫০৩৬২৫৭৩
167	মদিনা বেগম	আবুল কালাম	১৯৯১২২১৪৯৬২০০০০৭৪	দিনমুজুর	
168	মমতাজ বেগম	জাকির হোসেন	২২১৪৯৬২১১৩২৫৬	জেলে	০১৮৮৫৫৬৮৮৪১
169	মমতাজ বেগম	নুরল আবচার	২২১৪৯৬২১১৩৫৮০	গৃহিনী	০১৮৭৯৬৭৭০৬০
170	ময়না আক্তার	গিয়াস উদ্দীন	২২১৪৯৬২১১৩১৭৮	ব্যবসা	০১৮২৯৯০৪৪৯০
171	ময়শা বেগম	মৃত: একলাস মিয়া	১৯৬২২২১৪৯৬২১১৩৪৬৬	জেলে	০১৮৩৮৯৭৮৪৫৮
172	মহরম বিবি	চান মিয়া	১৯৯৮২২১৪৯৬২০০৩৬৪৪	জেলে	
173	মামুন	মোস্তফা আলী	২২১০৯৩৯০০০১৪৮	ব্যবসা	০১৮১৪০৭৫৬০৬
174	মাহাবুব আলম	মোহাম্মদ আলী	২২১৪৯৬২১১৩৫৯৮	জেলে	০১৮৮২৪২৮১৮৮
175	মাহাবুল আলম	একে ফজল	২২১৪৯৬২১২৬৩৬১	ব্যবসা	
176	মীনু আরা বেগম	নুরল আলম	২২১৪৯৬২১১৩৫৭৩	গৃহিনী	০১৮৬২৫৭৮০৮৮
177	মুসর উদ্দীন	জালাল আহমদ	১৯৯২২২১৪৯৬২০০০০৬৪	ব্যবসা	০১৮৩৫৮৬১৬৫২
178	মো: আবচার	আবুল বশর	২২১৪৯৬২১১৩৫৭৫	জেলে	০১৮২৮৭০০৯১১
179	মো: আবু	সোনা আলী মৃধা	২২১৪৯৬২১১৩১৩৪	জেলে	০১৮৭৯৯১৬৯৯৮
180	মো: আবু বক্কর	নুরল ইসলাম	২২১৪৯৬২১১৩৪৩৪৪	জেলে	০১৮৬৩২৭১০৪১
181	মো: আবু বক্কর	নুরল ইসলাম	২২১৪৯৬২১১৩৪৩৪৪	জেলে	০১৮৬৩২৭১০৪১
182	মো: আব্দুল করিম	মো: হোছেন	১৯৯০১৫৯০৬০২০০৮	ব্যবসা	০১৮৩৮২০৪১৯৫
183	মো: আমিন	আবদুল কাদের	২২১৪৯৬২১১৩৫০৭	ব্যবসা	০১৮৫৮৫৮৩৪২৫১
184	মো: আলম	গোলাম হোসেন	২২১৪৯৬২১১৩৬৫৫	ব্যবসা	০১৮৬৫১১৭৩২৪
185	মো: আলমগীর	আব্দুর হালিম	২২১৪৯৬২১১৩১১৩	জেলে	০১৮৭৬৭৬৫৪৪২
186	মো: আলমগীর	ইউনুছ মিয়া	২২১৪৯৬২১১৩১১৫	ব্যবসা	০১৮১৮৮৫৭৯৫১
187	মো: আলী	বাদশাহ মিয়া	২২১৪৯৬২১১৩৫৩৭	ব্যবসা	০১৮৩৩৫২৭৫৮৮
188	মো: ইউছুফ	নুরল ইসলাম	২২১৪৯৬২১২৬৭৫৫	জেলে	০১৮৫০৮৪০৪১৭
189	মো: ইসহাক	বদিউর রহমান	২২১৪৯৬২১১৩১১০	জেলে	০১৮৪০০১৩৯৭১
190	মো: ওসমান	আবুল কাসিম	২২১৪৯৬২১১৩৩৪২	জেলে	
191	মো: কাইছার	বাবু মিয়া	১৯৯৬২২১৪৯৬২০০০১৯১	জেলে	০১৮৪৯৬১৯৭৪০
192	মো: কাছিম	আব্দু খালেক	১৯৯০২২১৪৯৬২০০০৪৩৭	প্রবাসী	০১৮৬২৬৫৭৯৪১

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193	মো: কামাল উদ্দীন	সোলতান আহমদ	২২১৪৯৬২১১৩২৯৩	জেলে	০১৮২৭৭৫৩৩০৪
194	মো: কালু	মৃ: সৈয়দ নুর	২২১৪৯৬২১১৩১৩২	ব্যবসা	
195	মো: খোকন	গুরা মিয়া	১৯৯৯২২১৪৯৬২২০০০৬৯১	জেলে	০১৮৭৫৭৯০৯০৩
196	মো: গুড়া মিয়া	বদিউল আলম	২২১৪৯৬২১১৩৪৪৩	জেলে	
197	মো: জকরিয়া	আবদুল কাদের	২২১৪৯৬২১১৩৫৩০	ব্যবসা	০১৮২৪৮০৬৯৩১
198	মো: জহির	মৃত: জুনু মিয়া	২২১৪৯৬২১১৩১৯৮	জেলে	০১৮৮২২১৬২৭৬
199	মো: জাহাঙ্গীর	পিতা আবদুল হালিম	২২১৪৯৬২১১৩১১২	ব্যবসা	০১৮৩২১৪২২৮৪
200	মো: জুয়েল	নুর হোছন	১৯৯১২২১৪৯৬২০০০০০৯	জেলে	০১৮৫৩২১৮৫৫৭
201	মো: ফজল করিম	মৃত: গুনু মিয়া	১৯৯০২২১৪৯৬২০০০০৬৬	জেলে	০১৮৭২১১১৯৪০
202	মো: ফারুখ	মোজাফ্ফর	২২১৪৯৬২১১৩৬৭১	জেলে	০১৮৫১২৪১৩৩৭
203	মো: ফোরকান	শাহ আলম	২২১৪৯৬২১১৩৫৯৪	জেলে	০১৮৮৪২৫৩১৮৫
204	মো: মিজান	একে ফজল	১৯৯৫২২১৪৯৬২০০০৭৮০	ব্যবসা-জেলে	০১৮৬৫১৩২৫০১
205	মো: মিয়া	মৃত: সুলতান আহমদ	২২১৪৯৬২১১৩৬৯২	জেলে	
206	মো: মোকারম মিয়া	এখলাছ মিয়া	২২১৪৯৬২১১৩৬২৭	ব্যবসা	০১৭৮২৭০৭০২০
207	মো: রুবেল	মো: হোসেন	১৯৯০২২১৪৯৬২০০০৩৪৬	জেলে	০১৮৫৫০৪১৪৫৭
208	মো: লোকমান	শাহ আলম	১৯৮৯২২১৪৯৬২০০০০১৩	জেলে	০১৮৮৪১৪৬৮১২
209	মো: সরওয়ার	দুদু মিয়া	১৯৯৭২২১৪৯৬২০০০৬৮০	জেলে	০১৮৮১২৭৪৮০২
210	মো: সেলিম	ফরোক আহমদ	২২১৪৯৬২১১৩৫০৯	ব্যবসা	০১৮৬১৯৭০৪৬১
211	মো: সেলিম	নাজির হোসেন		জেলে	০১৮৬৪৭৪৬২০৭
212	মো: সৈয়দ হোছন	মৃত: আবদুল করিম	১৫২০৮০৭৯১৪৫৫১	জেলে	০১৮২৬৩০৭৬৩৪
213	মো: হোছন	মৃত: নেয়ামত আলী	১৯৬৯২২১৪৯৬২০০০০১	কৃষক	০১৮৪৫৬৭৬১৫৬
214	মোকরামুল হক	মোহাম্মদ মিয়া	১৯৯৯২২১৪১৯৬২০০০১২৬	জেলে	০১৮২১১৪২৯২১
215	মোক্তার হোসেন	জামান হোসেন	১৯৯৭২২১৪৯৬২০০০০১২	জেলে	০১৮৬৫৬৬০৯৬৪
216	মোজাফ্ফর আহমদ	মখলেছুর রহমান	২২১৪৯৬২১১৩৪৩৩	জেলে	০১৮২৪৪৫১৫১১
217	মোবাশেরা বেগম	মনজুর আলম	১৯৯৭২২১৪৯২৩০০১১১৫	জেলে	০১৮২২৭৯৭০৫২
218	মোস্তাক আহমদ	আবুল হোসেন	২২১২১৯৬২১১৩৪০০	জেলে	০১৮৩৫০৩২৬৮৬
219	মোস্তাক মিয়া	মৃত: নুর আআলী	২২১৪৯৬২১১৩২৪৫	জেলে	০১৮৩৫৮৪৬৮৯৭
220	মোহমেনা বেগম	মো: ইউনুছ	২২১৪৯৬২১১৩৪৯৯	জেলে	০১৮৬২৪২৯৬০২
221	মোহাম্মদ আলী	মৃত: আবদুল হামিদ	২২১৪৯৬২১১৩৫৫০	জেলে	০১৮২২৫১৭০৫৮
222	মোহাম্মদ ইসলাম	মৃত: ওয়াজ উদ্দীন	২২২২৪১১৪৫০১১৪	ব্যবসা	০১৭১৫১৮৭৬২৬

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223	মোহাম্মদ করিম	আবদু রহমান	২২১৪১৬২১১৩৬২১	জেলে	০১৮২৫৬৬১৭৮২
224	মোহাম্মদ জকরিয়া	মৃত: বেলাল আহমদ	২২১৪৯৬২১১৩৩৫১	জেলে	০১৮৭৫৭০৬৯১৪
225	মোহাম্মদ নুর	মৃত: আলী আহমদ	১৯৯০২২১৪৯৬২০০০২২৯	জেলে	০১৮৭৬৯১৬৮৯৪
226	মোহাম্মদ নুর	আবুল কালাম	২২১৪৯৬২১১৩১৪১	জেলে	০১৮৬০৩৪২৬৪৮
227	মোহাম্মদ মনির	নুরুন নবী	১৯৮৯২২১১৬১০০৩১৭৫	জেলে	০১৮৮১২২০৭৫৯
228	মোহাম্মদ মিয়া	নুর আলী	২২১৪৯৬২১১৩১৩০	জেলে	০১৮৮৫৩৫৮৯৫৪
229	মোহাম্মদ মিয়া	মৃত: মোহাম্মদ বকসু	২২১৪৯৬২১১৩৪৬১	জেলে	০১৮৮১২২০৮৭৪
230	মোহাম্মদ মোজাম্মেল	নুরু আহামদ	২২১৪৯৬২১১৩৩৪৩	জেলে	০১৮৩১৬৯৪৩৩০
231	মোহাম্মদ রফিক	বদিউর রহমান	২২১৪৯৬২১১৩৫৬	জেলে	
232	মোহাম্মদ রুপা আকতার	আব্দুল গফুর	১৯৯৬২২১৪৯৬২০০০১৬৬	ব্যবসা	০১৬১৯০৮৪৩৮৯
233	মোহাম্মদ শহিদুল ইসলাম	ইউনুছ মিয়া	১৯৯০২২১৪৯৬২০০০৪১৯	ব্যবসা	
234	মোহাম্মদ হোসেন	মো:সুলতান	২২১৪৯৬২১১৩৩৫৫	জেলে	০১৮৭৯৪৮১৬৮৬
235	মোঃওসমান	মৃত: আক্কল আলি	১৯৮৮২২১৪৯৬২০০০০০৫	ব্যাবসা	০১৮৫৬৬৩৩৮৬
236	মোস্তফা বেগম	মৃত: ফজল করিম	২২১৪৯৬২১১৩২৪১	ব্যবসা	০১৮২১১৫৫০৩৯
237	মোহাম্মদ নুর	মৃত: আলী আহমেদ	১৯৯০২২১৪৯৬২০০০২২৯	জেলে	০১৮৭৬৯১৬৮৯৪
238	রইজা খাতুন	ছমদ আলী	২২১৪৯৬২১১৩১৫৫	জেলে	০১৮৩৬০২৪৪৩৫
239	রফিক মিয়া	সিরাজমিয়া	২২১৪৯৬১১৩১৭১	ব্যবসা	০১৮৮৩৩৬৬০৬
240	রফিক মিয়া	মো: মিয়া	২২১৪৯৬২১১৩৫৬৭	জেলে	০১৮৩১৫০৮৫৩৪
241	রবিউল আলম	হাজী ছৈয়দ আহমদ	১৯৮০২২১৪৯৬২০৩৩৯৭১	ব্যবসা	০১৮৫৫৩৩০৯০৫
242	রমজান আলী	মৃত: নেয়ামত আলী	১৯৮৫২২১৪৯৬২০০০০২৭	জেলে	০১৮৭৮৩৮৪৮২৫
243	রশিদ মিয়া	মৃত: জুলু মিয়া	২২১৪৯৬২১১৩১২৬	ব্যবসা	০১৮২৭২৮৯৩২২
244	রশিদা বেগম	আবুল বশর	২২১৪৯৬২১১৩৫৬৩	জেলে	০১৮১১৯৪৬০৮৬
245	রহমত উল্লাহ	হাজী ছৈয়দ আহমদ	২২১৪৯৬২১১৩২২৭	ব্যবসা	০১৮৫১৩৩৯০১১
246	রহিম বকসু	মৃত: আবদুল গণি	২২১৪৯৬২১১৩৬১৩	ব্যবসা	
247	রহিমা বেগম	আব্দু ছালাম	২২১৪৯৬২১১৩৬০১	জেলে	০১৮৬৬৩৪৬৬১২
248	রাজিয়া আক্তার	আব্দুর গফুর	২২১৪৯৬২১১৩১৬০	জেলে	০১৮১৮৬১১৮৫৬
249	রাবিয়া আক্তার	রমজান আলী	২২১৪৯৬২১১৩৫৮১		০১৬৩১৮১৬১১৪
250	রাবিয়া খাতুন	রেজাউল করিম	২২১৪৯৬২১১৩২৪৮	জেলে	০১৮৮৪৯৭৮১৫০
251	রাবিয়া খাতুন	বদর মিয়া	২২১৪৯৬২১১৩৩০১	জেলে	০১৮৮৩৩৬৫২৬৯
252	রাসেল	আমির হোছন	১৯৮৫২২১৪৯৬২০০০০০৪	জেলে	০১৮৮৫৩৫৮৯৪২
253	রিজিয়া বেগম	জসিম উদ্দীন	২২১৪৯৬২১১৩৫৪৭		০১৮৫১৪৫৬৮৯৪
254	রিজিয়া বেগম	স্বামী- মো: ফোরকান	২২১৪৯৬২১১৩১৮৬	জেলে	০১৮৮১৫৮২৭৭১

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255	রিদুয়ান আরা	মোহাম্মদ হোসেন	২২১৪৯৬২১১৩৪৪১	ব্যবসা	০১৮৫০৯৭৩৭৬২
256	রিয়াজ উদ্দীন	এখলাছ মিয়া	১৯৯৯২২১৪৯৬২০০০০৯৫	ব্যবসা	০১৮২১৯৭৩৩৬৭
257	রুপবান খাতুন	মো: হোছন	১৯৯৬২২১৪৯৬২০৩৩৫৮৩	জেলে	০১৮৮৫২৯৮১৩৮
258	রুহুল আমিন	মৃত: গুনু মিয়া	২২১৪৯৬২১১৩৫২৭	জেলে	০১৮৪৬১০৫৩৯৪
259	রেজাউল করিম	নুরল ইসলাম	২২১৪৯৬২১১৩২৮৫	জেলে	০১৮৮৪৮৬৯৬৮৯
260	রেশম খাতুন	মৃত: এরশাদ উল্লাহ	২২১৪৯৬২১১৩২০৬	দিন মুজুর	
261	রেশম খাতুন	ফেরদৌস মিয়া	২২১৪৯৬২১১৩৬৯৮	দিনমুজুর	
262	রোকন উদ্দীন	শাহাব মিয়া	১৯৯২২২১৪৯৬২০০০২৬৮	ব্যবসা	০১৮৬০৩৪৮৮৮৫
263	রোকসানা আকতার	মো: হোসাইন	১৯৯০২২১৪৯৬২০০০৫৪২	গৃহীনি	
264	লায়লা বেগম	মোস্তাক আহমদ	২২১৪৯৬২১১৩২৭০	জেলে	
265	শফি আলম	সিরাজ মিয়া	২২১৪৯৬২১১৩১১৭	ব্যবসা	০১৮৮২৯০৩৯০৩
266	শফি আলম	নুরল ইসলাম	১৯৯৪২২১৪৯৬২০৩৭৭৯৯	জেলে	০১৮৭৮৯৭৩৪৩৬
267	শফিউল আলম	ছৈয়দ আহমদ	২২১৪৯৬২১১৩১৪০	ব্যবসা	০১৮২৯৮২৫৩৩৫
268	শফিউল আলম	মোস্তফা আলী	২২১৪৯৬২১১৩৫৬২	ব্যবসা	০১৮২৯৪১০৪৩০
269	শাকেরা বেগম	মৃত: মোহাম্মদ আলম	২২১৪৯৬২১১৩৬৫৮	ব্যবসা	০১৮৩০৯৭৮৭২৫
270	শাফর আহমদ	মৃত: আবদুল নবী	২২১৪৯৬২১১৩২৪৭	জেলে	
271	শামসুন্নাহার	শফিউল আলম	২২১৪৯৬২১১৩৬৪৫	জেলে	০১৮৫৭৭৪০৪৭৮
272	শামসুল আলম	মৃত: আব্দুল জব্বার	১৯১২২১৪৯৬২০০০০৮৩	জেলে	০১৮২৮৭০২৬৭৪
273	শামসুল আলম	ছৈয়দ আহমদ	১৯৭৮২২১৪৯৬২০০০২১১	ব্যবসা	০১৮৩৭৬০৬৫৬৩
274	শামসুল আলম	খুইল্যা মিয়া	১৯৮৭২২১৪৯৬২১১৩৮৯৭	জেলে	০১৮৬৪৬২০২১৮
275	শামসুল আলম	মো: মিয়া	২২১৪৯৬২১১৩৪৩১	ব্যাবসা, জেলে	০১৮৬৮৬৭৯০৬৪
276	শামারুক বেগম	মৃত: মাহবুব আলম	২২১৪৯৬২১১৩৩২৪	জেলে	০১৮৮৪৭৬৫১৬৯
277	শায়রা বেগম	মোস্তফা আলী	২২১৪৯৬২১১৩৪১২	ব্যবসা	০১৮১১৩৬৪৪৬৬
278	শাসসুল আলম	একে ফজল	২২১৪৯৬২১২৬১১৬	ব্যবসা	
279	শাহ আলম	মৃত:ঠান্ডা মিয়া	২২১৪৯৬২১১৩৫৪৯	জেলে	০১৮৯৫৩০০৬৮৫
280	শাহ আলম	মোহাম্মদ হোছন	২২১৪৯৬২১১৩৬২২	জেলে	০১৮২৭২৯৩০১২
281	শাহাব উদ্দীন	ছৈয়দ আলম	২২১২৪৪৫৩১৪০৫৩	ব্যবসা	০১৮১২৮৮২১৩৯
282	শাহাব উদ্দীন	মৃত: আ: নবী	২২১৪৯৬২১১৩২৪৬	জেলে	০১৮৮৫৩৮৭২৩০
283	শোভা রানী দাস	শচী রাম দাস	২২২৪৯০৭১০৮৫৫২	শিক্ষক	০১৮১৫৩৫২৩৪৪
284	সক্কুনী বেগম	মৃত: করম আলী	২২১৪৯৬২১১৩২৩৪	জেলে	০১৮২১৩৫৮৪৬৯
285	সখিনা খাতুন	হাফেজ আহমদ	২২১৪৯৬২১১৩৬৮৪	জেলে	
286	সরওয়ার আলম	সিরাজ মিয়া	২২১৪৯৬২১১৩২৯৫	ব্যবসা	০১৮২৯৪৬৫০৩৫
287	সাইফুল আলম	মৃত: ঠান্ডা মিয়া	২২১৪৯১১১৬২১৩৯	চাকরি	০১৮২৪৮৫৫৫৭১

Sl no	Name	F/H's Name	NID	Profession	Cell phone
288	সাইফুল ইসলাম	ইউনুছ মিয়া	১৯৯০২২১৪৯৬২০০০২৫৩	জেলে	০১৮৪৩৮১৭৪০৮
289	সাইফুল ইসলাম	নুরল ইসলাম	২২১৪৯৬২১১৩১৭০	জেলে	০১৮২৮৫৩২৬১০
290	সাইফুল ইসলাম	নুরল ইসলাম	২২১৪৯৬২১১৩১৭০	জেলে	
291	সাজু আকতার	মোহাম্মদ হোসেন	১৯৯৩২২১৪৯৬২০০০০৬০	দিনমুজুর	০১৮৪৩৮২০১৩২
292	সাদিয়া আকতার	আবু তাহার	১৯৯৯২২১৪৯৬২০০০৩৫১	জেলে	০১৮২৫৯৩২৭৮৮
293	সাদ্দাম হোসেন	আনোয়ার পাশা	১৯৯৬২২১১৪৯৬২০০০৯০৩	জেলে	০১৮৩৫৮৫৮৯৮২
294	সাদ্দাম হোসেন এনী	মো: আবুল কাশেম	১৯৯৭২২২২৪০৬০০০০৪০	জেলে	
295	সাবেকুন্নাহার	মৃত: নজির আহমদ	২২১৪৯৬২১১৩৫৮৩	জেলে	০১৮৩৮৯৩২৫৯৪
296	সাবের আহমদ	মৃত: ছেয়দ নুর	২২১৪৯৬২১১৩২৯৭	জেলে	০১৮৬৬২১৯২৪৫৮
297	সালাহ উদ্দীন	মোস্তাক আহমদ	২২১৪৯৬২১১৩১৩১	জেলে	০১৮৬৬৪৬৮৯৭৩
298	সালেহা বেগম	পিতা- নুরল হক	২২১৪৯৬২১১৩২২৩	জেলে	০১৮৪৫০২৬৮১১
299	সাহেব মিয়া	মৃত: এজাহার মিয়া	২২১৪৯৬২১১৩২০১	ব্যবসা	০১৮৬০৩৪৮৮৮৫
300	সিরাজ মিয়া	খুইল্যা মিয়া	১৯৯৩২২১৪৯৬২০০০৫৩৮	জেলে	০১৮৮১১২২১৮৯
301	সিরাজ মিয়া	এজহার মিয়া	২২১৪৯৬২১১৩১৩৮	ব্যবসা	০১৮২১৩২৫৮৫৮
302	সিরাজুল মোস্তফা	আবুল বশর	২২১৪৯৬২১১৩৫৯৩	জেলে	০১৮৬৫১১৪৮৭৭
303	সুফিয়া আকতার	মো: হাসেম	২২১৪৯৬২১১৩৬৬০	ব্যবসা	
304	সেলিনা আক্তার	কামাল পাশা	১৯৯১২২১৪৯৬২০০০০৬৯	জেলে	০১৮৩৫৬৪১৬৭৭
305	সোনাই খাতুন	জালাল আহমদ	২২১৪৯৬২১১৩১৯০	গৃহীনি	০১৮৮৪০৩৬৯১০
306	সোলতান আহমদ	মৃত: খলিলুর রহমান	২২১৪৯৬২১১৩৩২৭	জেলে	
307	সৈয়দ আলম	তৈয়ম গোলাপ	২২২৪৯০৯১০০৬২৭	জেলে	০১৮৮২২১৬১৫২
308	হাছিনা আকতার	শামসুল আলম	২২১৪৯৬২১১৩৫৬৬	জেলে	০১৮২৪৭৩২৫৫৭
309	হাজেরা খাতুন	নুর হোসেন		দিনমুজুর	০১৮৩২২১৫৮০৭
310	হাবিবুর রহমান	মৃত: আলী আকবর	২২১৪৯৬২১১৩৮৯৬	জেলে	০১৮৬০৬১৬৯২০
311	হামিদ হোসেন	আবুল কালাম	১৯৯৫২২১৪৯৬২০৩৩৫৯৭	জেলে	০১৮৬২৪২৯৫৯৭
312	হাশেমা খাতুন	মো: রফিক	২২১৪৯৬২১১৩১৬৩	ব্যবসা	০১৮৭৭১১৩৫০৮
313	হাসনা আকতার	শাহাব মিয়া	২২১৪৯৬২১১৩১৭৭	ব্যবসা	০১৮৩৬১০৮০৯৪
314	হোছন	নুর আহমদ	১৯৮৬২২১৪৯৬২০০০০৩৬	জেলে	০১৮৩৮৬৩১০৮৫
315	হোসেন আরা	শাহ আলম	২২১৪৯৬২১১৩৫৯৫	জেলে	০১৮৮৫৩৫৩০৩৪

14.11. Annexure 11: Geo-Technical Investigation, Air Quality & Noise Level and Water Quality Monitoring at Sonadia Eco-Tourism Park, Chattogram, Bangladesh

For the economic and industrial development of a country, investment is a crucial component that cannot be overlooked. Bangladesh has a broad market oriented economy and offers the most investor friendly regulatory regime in South Asia. The country provides trainable, enthusiastic, hardworking and competent labor force for labor intensive industries. Bangladesh is a highly populated country. Economic growth will enhance the purchasing power of that population and make the country a significantly big market. Bangladesh is endowed with abundant supply of natural gas, water, and its soil is very fertile. The Geographical location of the country is ideal for global trade with very convenient access to international sea and air route. Current government has targeted to make Bangladesh a middle income country within 2021 by creating economic zones in different investment sectors under the constitution of Bangladesh Economic Zone Authority (BEZA).

Sonadia Eco-Tourism Park is located at Sonadia Island at Maheshkhali Upazila. The total land area is 9467 acres, which has been adopted by BEZA on March 27, 2017 from the district administration of Cox's Bazar. BEZA has already taken the initiative for feasibility study and Master Plan to set up Eco-tourism park in Sonadia Island. To build eco-tourism parks in Sonadia, BEZA has initially planned to use only 30% of the space so that there is no adverse impact on the environment. Local residents living illegally now have been cultivating fish by creating illegal ways, which are very dangerous for environment and biodiversity. To build the eco-tourism park illegal construction of the Ghar will stop, on the other hand, planned tourism park will create a lot of FDI and employment.

Geo-Technical Investigation

Total Six (6) no. boreholes was drilled with maximum depth of 30.00m or up to three consecutive refusals have been attained, whichever comes first. One undisturbed sample collected by Shelby tube for each cohesive layer and maintains all necessary caution. In drilling through soil, Standard Penetration Test (SPT) was performed at every 1.5m/3.00m interval up to the final depth. All relevant sub-soil data such as soil description, standard penetration test, blow counts, water level and other information was logged during the course of the drilling.

The soils of Sonadia Island are sandy loam to clay loamy soils in some areas. Most of the farmlands in nearby areas are on sandy loams with some black cotton soils in the low lands. Black cotton soils characteristically host Acacia wood plant. Soils change to more sandy and gravel texture all the way to the foot of the escarpment. The top soil near the Sonadia Eco-Tourism Park is mainly very soft to medium silt with clay or clay-laden silt and with a trace of find sand. According to the sub-soil investigation record of this area (north-west of Chittagong District) the soil profile at shallow beyond shallow depth is mainly dominated by non -cohesive soil with a comparatively low SPT (Standard Penetration Test) value at the upper level.

All foundations shall be designed to meet satisfactory performance levels for bearing capacity and settlement. The need for field monitoring systems should be considered. Where embankments are found to have potential for significant settlement, due to the presence of compressible foundation layers, a settlement analysis should be performed. Significant settlement shall be defined as a settlement likely to adversely impact the performance of the project including construction, operation and maintenance. The analysis should include an assessment of the impact of settlement on the road pavement. Where appropriate, consideration should be given to foundation improvement options such as preloading, surcharging, dynamic compaction and vibrofloatation etc. The requirements for drainage control measures, to protect the integrity of cut slope batters and pavement structures, should be assessed as part of the geotechnical investigation.

Based on our liquefaction analysis and calculation (Considering PGA=0.15g for seismic zone 2, As per BNBC-2006), we found that a probability of liquefaction exist up to 21m soil from E.G.L. Countermeasures should be taken as this zone lies in highly seismic prone area.

Air Quality Monitoring

The condition of environmental quality in the locality of project site serves as the basis for identification, prediction and evaluation of impacts. The environmental quality was assessed through extensive field visits within the project impact zone for various components of the environment and in order to depict the existing physical environment in the project area. A few of the major parameters are considered like drainage system, air pollution, noise and vibration, surface and groundwater quality, waste management etc. During the field observation and data collection, contractor and consultant also held consultations with the person of designated site engineer. Outcome of these consultations were used in impact assessment and devising mitigation measures. The result found for ambient air quality monitoring shows the PM2.5, PM10 & SPM concentrations of the ambient air. From the results it is discernible that all the parameters are within the allowable limits.

Monitoring of Noise Level

Noise is an important environmental pollutant. A survey by the U S. Federal Council of Science and Technology has revealed that noise is a technology generated problem and that the overall loudness of environmental noise doubles every ten years in pace with our social and industrial progress. This geometric progression wise growth of noise could be mind-boggling in view of the ever-increasing pace of technological growth. Noise quality has been measured instantly on the site by Noise level meter. At each location 10 to 12 times reading were taken over a short period of time. Three measurements such as maximum, minimum and mode were recorded. At the time of measurement, whenever there was an interfering effect like mike noise, human voice from house and bazaar, vehicular sound, sound of machine and tool from workshop etc., was also recorded. According to the Department of Environment (ECR-1997), the standard for ambient noise level in the industrial zone is 75 decibels at day & 70 decibels at night. In that case all the results were found within the limit as per DoE Standards.

Monitoring of Surface & Ground Water

Water quality is one of the important indicators of the environment. Surface and groundwater samples were collected from upstream and downstream area Paschimpara (Noachira Khal) and Purbapara of Sonadia Island respectively to understand the baseline condition of the water quality in the study area. Major physicochemical parameters such as pH, DO, TDS, EC of the surface water quality were measured in-situ during the field visit while the rests were measured in the lab. For the groundwater, water samples were collected from the tube-wells at two points at the upstream and downstream area of Paschimpara and Purbapara respectively of Sonadia Island and tested in BEETLSL Environmental Laboratory. The tube-wells at Paschimpara was 20ft depth and Purbapara was 30ft depth. Most of the parameters of surface and ground water were found within the DoE standard limit except the EC, oil and grease which may arise from high salinity and navigational activities in the surface water. Besides, hydro-geological condition of the aquifer, groundwater availability and quality needs to be extensively studied within the study area to understand the environmental implications and identify potential sources of domestic/industrial water for eco-tourism park development.

1. 5 WORK DETAILS:

i. Drilling and Sampling

- Six (6) boreholes was drilled with maximum depth of 30.00m or up to three consecutive refusals have been attained, whichever comes first.
- One undisturbed sample collected by Shelby tube for each cohesive layer and maintains all necessary caution.
- In drilling through soil, Standard Penetration Test (SPT) was performed at every 1.5m/3.00m interval up to the final depth.

- All relevant sub-soil data such as soil description, standard penetration test, blow counts, water level and other information was logged during the course of the drilling.

ii. Laboratory Testing

Soil Samples obtained was properly sealed, labeled and brought to the laboratory. The following tests shall be conducted on selected samples in accordance with the ASTM Standards:

CHAPTER-2 FIELD RECONNAISSANCE

2.1 LOCATION OF SITE

As described earlier the site is at Sonadia, Chattagram. To keep record of the elevation of the soil surface/Road level (at Bore holes locations) all depends are measured from the existing soil surface. The existing soil surface is not at road/land level; here the Surface elevation (R.L) is the PWD/SOB reference level.

Figure-2.1: Upazila Map, Upazila-Moheshkhali, District Chattagram

2.2 SITE RECONNISSANCE

Sonadia Eco-Tourism Park is located at Sonadia Island at Maheshkhali Upazila. The total land area is 9467 acres, which has been adopted by BEZA on March 27, 2017 from the district administration of Cox's Bazar. BEZA has already taken the initiative for feasibility study and Master Plan to set up Eco-tourism park in Sonadia Island. To build eco-tourism parks in Sonadia, BEZA has initially planned to use only 30% of the space so that there is no adverse impact on the environment.

Maheshkhali Upazila (COX'S BAZAR DISTRICT) area 362.18 sq km, located in between 21°28' and 21°46' north latitudes and in between 91°51' and 91°59' east longitudes. It is bounded by CHAKARIA upazila on the north, COX'S BAZAR SADAR upazila and BAY OF BENGAL on the south, Chakaria and Cox's Bazar Sadar upazilas on the east, KUTUBDIA upazila and Bay of Bengal on the west.
Water bodies Main rivers: Kohalia; Maheshkhali Channel, Boddar Canal, Noachi Canal, Koria Canal are notable.

2.3 DESK STUDY

The desk study is the first phase of a site investigation, bringing together existing, or researched information and identifying potential areas of information conflict or deficiency. The desk study needs to consider a broad range of issues, all of which may affect a project both practically and logistically.

The desk study should include a review of all sources of appropriate information, and collect and evaluate all available relevant data for the site including, for example:

- ☐ Evidence of groundwater
- ☐ Behaviour of neighbouring structures
- ☐ Exposures in quarries and borrow areas
- ☐ Areas of instability
- ☐ Difficulties during excavation
- ☐ History of the site
- ☐ Geology of the site
- ☐ Survey data with plans showing the structure and the location of all investigation points
- ☐ Local experience in the area
- ☐ Geological and bathymetric information
- ☐ Information and records of seismic activity of the area
- ☐ Existing geotechnical data and information.
- ☐ Previous experience with foundations in the area
- ☐ Meteorological and oceanographic information including tides, currents, wind and wave regimes.

Some desk studies, for example for cable routes, wind farms and dredging sand searches, may include additional, non-technical data such as seabed congestion, restricted areas, shipping movements, fishing or military activity, permitting etc.

2.4 REQUIREMENT OF DETAILED GEOTECHNICAL INVESTIGATION

Proper attention to the geo technical aspects is needed for a structure protection, river bank and training works to prevent failure. This guideline document has been prepared to assist in the planning, cost estimation, conduct and reporting of geotechnical investigations at sites. Hence forth for ease of reporting, reference is made only to requirements at bridge sites however corresponding requirements at waterway structures are implicit in this term.

The type of soil properties to be collected, their reliability, and the location must be directly related functional requirements of the proposed design alternatives. In a summary of the main soil parameters to be determine for the various type of geotechnical failure mechanisms, including shallow and deep–seated slip failure, liquefaction, dynamic failure excessive settlement and erosion. The reliability of the data to be collected is mainly a matter of economics. Accurate description of the failure mechanism (at higher cost of soil investigation) may lead to a optimized design at lower construction costs. Once the relevant soil parameter has been identified, the suitable soil tests (laboratory and field) can be achieved. The evaluation of geotechnical information will include, but not be limited to, the following: Review of the field and laboratory work. Any particularly adverse test results should be considered carefully in order to determine whether they are misleading or represent a real phenomenon that must be accounted for in the design. Tabulation and graphical presentation of the results of the field and laboratory work in relation to the requirements of the projects. Determination of the depth to the ground water table and its seasonal fluctuations.

CHAPTER-3 GEOTECHNICAL EXPLORATION

3.1.1 Guidelines the Number of Boring:

There is no hard-and-fast rule exists for determining the number of borings are to be advanced. For most buildings, at least one boring at each corner and one at the center should provide a start. Spacing can be increased or decreased, depending on the condition of the subsoil. If various soil strata are more or less uniform and predictable, fewer boreholes are needed than in non homogeneous soil strata.

The following table gives some guidelines for borehole spacing between for different types of structures:

Type of project	Spacing(m)
Multistory building	10–30
One-story industrial plants	20–60
Highways	250–500
Residential subdivision	250–500
Dams and dikes	40–80

Table-3.1: Borehole spacing between for different types of structures

3.1.2 Soil Classification and Group Symbol

This classification system was originally developed in 1942 by Arthur Casagrande for airfield construction during World War II. This work was conducted on behalf of the U.S. Army Corps of Engineers. At a later date, with the cooperation of the United States Bureau of Reclamation, the classification was modified. More recently, the American Society of Testing and Materials (ASTM) introduced a more definite system for group name of soils. In the pre-sent form, it is widely used by foundation engineers all over the world. Unlike the AASHTO system, the Unified system uses symbols to represent the soil types and the index Properties of the soil.

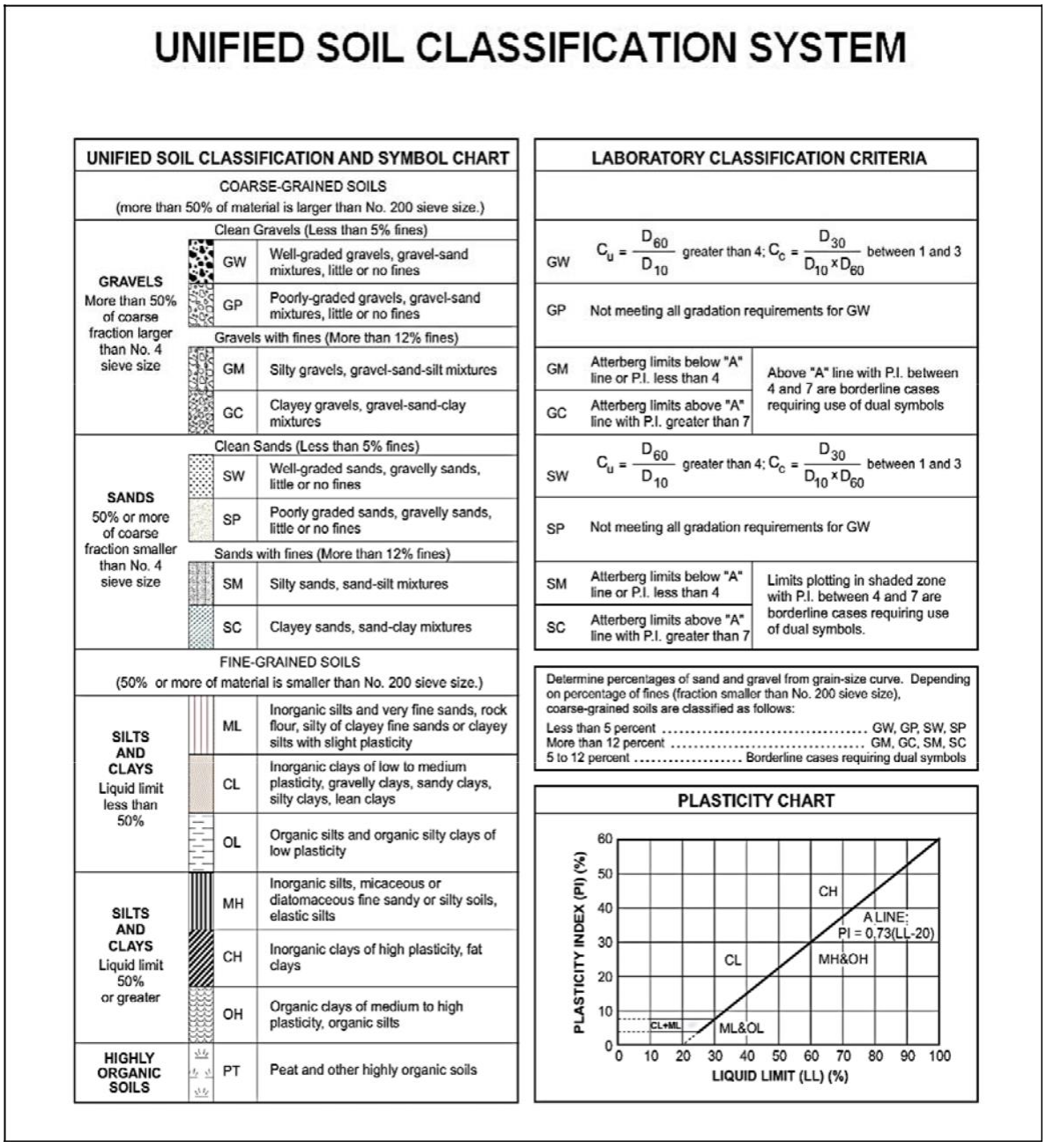


Figure-3.1: Unified Soil Classification System Chart

Soil Texture: Since the particle size is provable the most obvious characteristic of a soil. The visual appearance of a soil called its texture. The texture depends upon the particle size, shape of particles and gradation of particles. The term texture is used to express the percentage of the three constituents of soils, namely, sand, silt and clay. According to the textural classification system, the percentage of sand (size 0.05 to 2.0mm) silt (size 0.005 to 0.05mm) and clay (size less than 0.005mm) are plotted along the three sides of an equilateral triangle. The equilateral triangle is divided into 10 zones; each zone gives a type of soil.

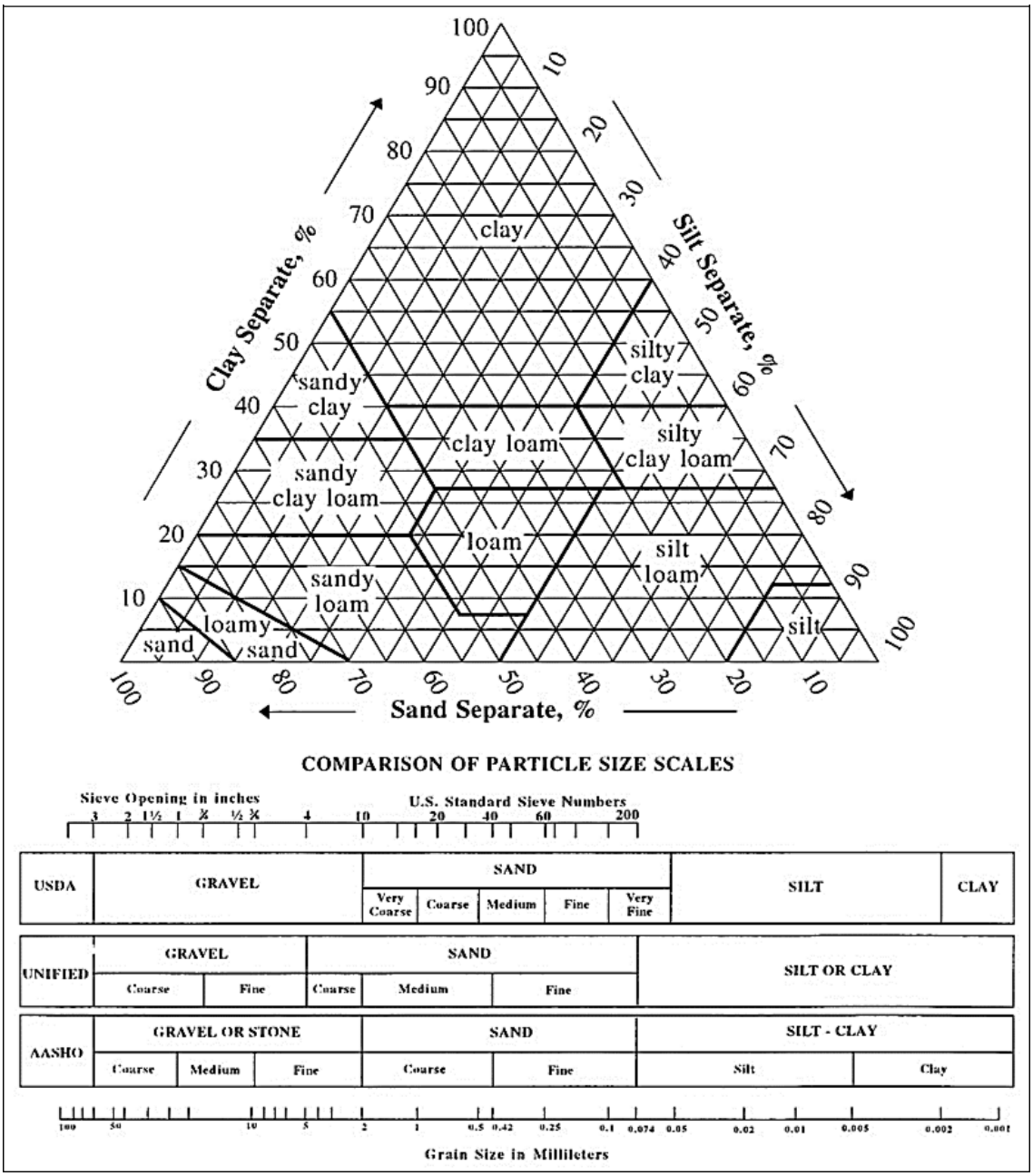


Figure-3.2: Soil textural classification plotting

3.1.3 Size of Different Types of Soil Particle

A soil may contain various size of grains ranging from large boulder, gravel, sand and size of silt and clay.

This is given below.

Boulder	Greater than 75 mm (3 inch)
Gravel	75 mm(3 inch) to greater than 4.75 mm.
Sand	4.75 mm to greater than 0.075 mm
Silt & clay	Less than 0.075 mm

Table-3.2: Grain size ranging of soil

3.1.4 Percentage of Different Size of Particles

The percentage of Gravel, Sand, and Fines (silt & clay) may be stated in the terms of indicating a range of percentage as follows.

Trace	1% to 5%
Few	5% to 10%
Little	15% to 25%
Some	30% to 45%
Mostly	50% to 100%

Table-3.3: Range of percentage of different size of soil particles

3.1.5 Consistency of Cohesive Soil

Standard penetration test (SPT) data or 'N' value is available for a particular soil layer, then consistency can be defined as the following.

Consistency	N - Value
Very-Soft	0 to 2
Soft	2to 4
Firm	4 to 8
Stiff	8 to 16
Very Stiff	16 to 30
Hard	> 30

Table-3.4: Consistency defined by SPT value for cohesive soil

3.1.6 Compactness of Non Cohesive Layer

For non cohesive soil the compactness can be defined as the following if the N-values are available.

N -

Compactness	Value
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very Dense	Over 50

Table-3.5: Compactness defined by SPT value for non cohesive soil

3.1.7 Correction of Standard Penetration Test (SPT):

(Ref. Foundation Engineering Hand Book by Robert W. Deen)

Factor that can affect the SPT: The measured N value can be influenced by the type of soil, such as the amount of fines and gravel size particles in the soil. Saturated sands that contains appreciable fine soil particles, such silty or clayey sands, could be abnormally high N values if they have a tendency in dilate or abnormally low N values if they have a tendency to contract during the undrained shear condition associated with driving the SPT sampler tip or barrel the driving resistance (hence increase N value) by becoming stuck in the SPT sampler tip or barrel. A factor that could influence the measured N value is ground water. It is important to maintain a level of water in the borehole at the above the in situ ground water level. This is to prevent ground water from rushing into the bottom of the borehole, which could loosen the sand and result in low measured N values. Besides soil and ground water conditions, there are different testing factors that can influence the accuracy of the SPT reading. For example, the hammer efficiency, borehole diameter and the rod length could influence the measured N value. The following equation is used to compensate for these testing factors by multiplying together four factors as follows (Skempton, 1986)

$$N60 = Cb\ CrCs\ N(\ Em\ /60)$$

Where,

- N60 = standard penetration test N value corrected for field testing procedure
- Cb = borehole diameter correction (Cb = 1.00 for borehole of 65 to 115mm, 1.05 for 150mm diameter and 1.15 for 200 mm diameter hole)
- Cr = rod length correction (Cr =0.75for up to 4m of drill rods, 0.85 for 4 to 6m of drill rods, 0.95 for 6 to 10 m of drill rods, and 1.00 for drill rods excess of 10m)
- Cs = Sampler correction (Standard Sampler, Cs=1.00)
- N = measured standard penetration test N value
- Em = Hammer efficiency (0.45-0.70 as per hammer type)

Correction of SPT value for Overburden Pressure

In cohesionless soils, the overburden pressure affects the penetration resistance. For SPT made at shallow levels, the values are usually too low. At a greater depth, the same soil at the same density index would give higher penetration resistance. It was only as late as in 1957 that Gibbs & Holtz (1957) suggested that corrections should be made for field SPT values for depth.

As the correction factor came to be considered only after 1957, all empirical data published before 1957 like those by Terzaghi is for uncorrected values of SPT. Since then a number of investigators have suggested overburden correction. Gibbs & Holtz took standard pressure of 280KN/m2 (corresponding to depth of 14 m) and duly made overburden correction for other overburdens. Thornburn suggested a standard pressure of 138 kN/m2 (corresponding to depth of 7m). Finally, peek et . al. (1974) suggested a standard pressure of 100 kN/m2 (Equivalent to 1 tsf or 1 kg/cm2 overburden corresponding to a depth of 5 m). As such, all field SPT values are to be corrected by the correction factor given by them as;

$$(N1)60 = CN \times N60 \leq 2N60$$

Where,

CN = Overburden pressure correction factor

The following relationships are widely used for CN.

Peek et. al.'s relationship (1974): (BNBC 2015 Eq. 6.D.2)

$CN = 0.77 \log (2000/6')$

Correction of SPT Value for Water Table

In addition to corrections of overburden, investigators suggested corrections of SPT-value for water table in the case of fine sand or silt below water table. Apparently, high N-values may be observed especially when observed value is higher than 15 due to dilatancy effect. In saturated, fine or silty, dense or very dense sand the N-values may be abnormally great because of the tendency of such materials to dilate during shear under undrained conditions. The pore pressure affects the resistance of the soil and hence the n value. In such cases, following correction is recommended (Terzaghi and Peek, 1948).

$(N1)60(Corr) = 15+1/2[(N1)60 -15]$

For coarse sand this correction is not required. In applying this correction, overburden correction is applied first and this diltancy correction is used.

3.1.8 Correlation between SPT-N & Soil Parameters

SPT N-value		0 to 4	4 to 10	10 to 30	30 to 50	>50
Compactness		Very loose	Loose	Medium	Dense	Very dense
Relative Density, Dr (%)		0 to 15	15 to 35	35 to 65	65 to 85	85 to 100
Angle of Internal Friction, φ(0)		<28	28 to 30	30 to 36	36 to 41	>41
Unit Weight (moist)	Pcf	<100	95 to125	110 to 130	110 to 140	>130
	kN/m3	<15.7	14.9 to 19.6	17.3 to 20.4	17.3 to 22.0	>75
Submerged unit weight	Pcf	<60	55 to 65	60 to 70	65 to 85	>75
	kN/m3	<9.4	8.6-10.2	9.4 to 11.0	10.5 to 13.4	>11.8

Table-3.5: Penetration resistance and soil properties on the basis of SPT (Cohesionless soil: Fairly reliable)

(Peck et. al. 1974; Bowles, 1997; BNBC 2015 Table 6.D.6)

SPT N-value		0 to 2	2 to 4	4 to 8	8 to 16	16 to 32	>32
Consistency		Very soft	Soft	Medium	Stiff	Very stiff	Hard
Unconfined Comp. Test	Ib/ft2	0 to 250	250 to 500	500 to 1000	1000 to 2000	2000 to 4000	>4000
	kPa	0 to 25	25 to 50	50 to 100	100 to 200	200 to 400	>400
Unit Weight (Saturation)	Pcf	<100	100 to 120	110 to 125	115 to 130	120 to 140	>130
	kN/m3	<15.7	15.7 to 18.8	17.3 to 19.6	181 to 20.4	18.8 to 22.0	>20.4

Table-3.6: Penetration resistance and soil properties on the basis of SPT (Cohesive soil: rather unreliable)

(Peck et. al. 1974; Bowles, 1997; BNBC 2015 Table 6.D.7)

CHAPTER-4 METHODOLOGY OF INVESTIGATION

4.1 FIELD INVESTIGATION

Drilling was executed by wash boring manual method. A hole was started by driving vertically a 10 cm diameter steel casing into the ground to some depth and then the formation ground casing was broken up by repeated drops of a chopping bit attached to the lower and of drilling pipe. The upper end of the same was forced at high pressure through pressure pipe. Forced slurry or water emerges at high velocity through the pores of the chopping bit, and returns to the surface through the annular space between drilling pipe and the side of the casing or hole, carrying with it the broken-up soils. In this way drilling is advanced up to a level of 15cm above the depth, where Standard Penetration Test (SPT) has to be executed

4.1.1 Equipments, Method of Boring & SPT using the Work

For the boring work own Boring/SPT set (with Tripod stand, Sampling Tube, Spoon, etc) of the firm has been used manually. Wash Boring method was used for advancing the Bore hole. A simple procedure for making relatively deep holes in soil deposits is wash boring. This is a most common method for advancing test hole.

Exploratory boring operation at proposed site BH-1 (21°30'43.66"N, 91°51'51.48")

Exploratory boring operation at proposed site BH-2 (21°29'55.61"N, 91°52'59.62"E)

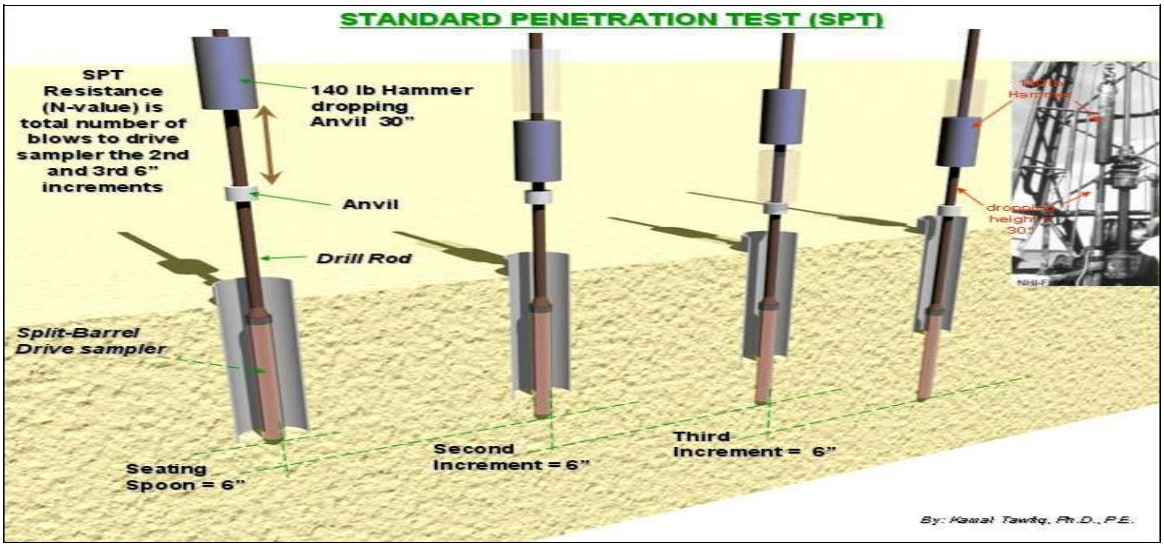
Exploratory boring operation at proposed site BH-3 (21°29'41.08"N, 91°53'21.18"E)

Exploratory boring operation at proposed site BH-4 (21°29'6.28"N, 91°53'38.58"E)

Exploratory boring operation at proposed site BH-5 (21°28'50.99"N, 91°55'27.45"E)

Exploratory boring operation at proposed site BH-6 (21°28'39.28"N, 91°54'35.93"E)

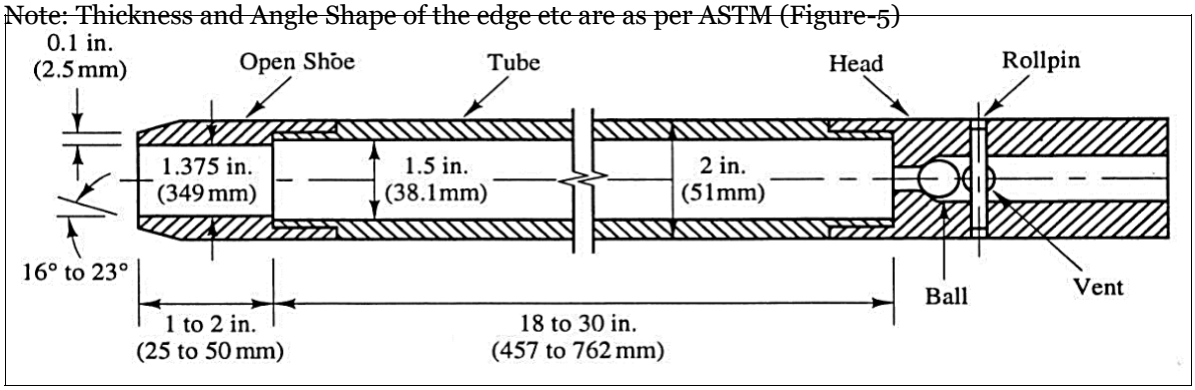
SPT-The tests consist of driving a SPILT SPOON SAMPLER having 50.80 mm (2 in.) outer diameter and 35 mm (1.375 in) inner diameter. The spilt spoon is driven 450mm (18 in) into the ground by means of a 63.5 kg (140 lbs) hammer falling freely from a height of 750 mm (30 in) into the drill rod. The number of hammer blows for 150 mm (6 in) of penetration of the sampler is recorded. The total number of blows required to drive the sampler for the 2nd 15 cm (6 in) and 3rd 15 cm (6 in) of penetration is called the Standard Penetration Resistance, which is represented by 'N'. The 1st 15 cm (6 in) penetration of the sampler is discarded as seating drive.



Schematic diagram of method of SPT

The standard penetration tests were performed at 1.50 m (5.00 ft.) Intervals in the all bores up to the final depth. The depth–wise SPT values have been presented in the from of curves in the respective Bore Logs.

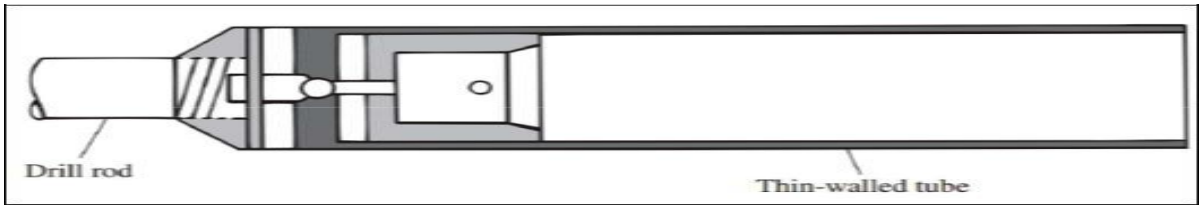
Note: Thickness and Angle Shape of the edge etc are as per ASTM (Figure-5)



Schematic Diagram of Split Spoon Sampler

4.1.2 Laboratory Tests Required and those Actually Performed

For economic and safe foundation designs; we need reliable laboratory testing. Undisturbed samples should be of proper quality also. Less tests should be done but with reliability. During boring, the SPT have been done and recorded. Disturbed soil has been visually classified to identify its plasticity, soil type etc.



Schematic diagram of thin walled sampler

4.1.3 Procedures for Sampling Soil

There are two types of samples:

Disturbed Samples: These types of samples are disturbed but representative and may be used for the following types of laboratory soil tests:

Grain size analysis.

Determination of liquid and plastic limits.

Specific gravity of soil solids.

Determination of organic content.

Classification of soil.

But disturbed soil samples cannot be used for consolidation, hydraulic conductivity, or shear tests, because these tests must be performed on the same soil of the field without any disturbance (to be representative) The major equipment used to obtain disturbed sample is (Split Spoon) which is a steel tube has inner diameter of 34.93 mm and outer diameter of 50.8mm.

Laboratory test for Specific gravity and Moisture content test

4.1.4 Test of Undisturbed Samples: These types of samples are used for the following types of laboratory soil tests:

Consolidation test.

Hydraulic Conductivity test. Shear

Strength tests.

These samples are more complex and expensive, and it's suitable for clay, however in sand is very difficult to obtain undisturbed samples. The major equipment used to obtain undisturbed sample is (Thin-Walled Tube).


Laboratory test for unconfined compression and Direct shear test.

4.1.5 Degree of Disturbance

If we want to obtain a soil sample from any site, the degree of disturbance for a soil sample is usually expressed as: AR (%) = (Do2−Di2) x100/Di2

AR=area ratio (ratio of disturbed area to total area of soil)

Do=outside diameter of the sampling tube.

Di=inside diameter of the sampling tube.

If (AR) ≤10% → the sample is undisturbed.

If (AR) >10% → the sample is disturbed

4.1.6 Recording of Ground Water Table

The ground water table is determined by measuring to the stabilized water level in the bore hole after a suitable time lapse- often 24 to 48 hour later. In soils with high permeability, such as sands and gravel, 24 hour is adequate for the water level to stabilize unless the hole has been somewhat sealed with drilling mud. In soil with low permeability such as silt, fine silty sands and clays, it may take several days to several weeks for the GWT to stabilize.

4.2 LABORATORY TEST

All Laboratory tests done on soil samples collected either in disturbed or undisturbed state as per ASTM procedures, are as follows.

Moisture content determination:

Most laboratory tests in soil mechanics require the determination of water content. Water content is defined as

w = weight of water present in a given soil / mass weight of dry soil

Water content is usually expressed in percent. For better results, the minimum size of the most soil specimens should be approximately as given in Table. These values are consistent with ASTM Test Designation D-2216.

Specific gravity:

The specific gravity of a given material is defined as the ratio of the weight of a given volume of the material to the weight of an equal volume of distilled water. In soil mechanics, the specific gravity of soil solids (which is often referred to as the specific gravity of soil) is an important parameter for calculation of the weight-volume relationship. Thus, specific gravity Gs is defined as,

Gs = unit weight (or density) of soil solids / unit weight (or density) of water.

For further details concerning the specific gravity test, see ASTM D 854-02 (2004), "Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer."

Sieve analysis:

A basic element of a soil classification system is the determination of the amount and distribution of the particle sizes in the soil. The distribution of particle sizes larger than 0.075 mm (No. 200 sieve) is determined by sieving, while a sedimentation process (hydrometer test) is used to determine the distribution of particle sizes smaller than 0.075 mm. A sieve is a piece of laboratory equipment that consists of a pan with a screen (square woven wire mesh) at the bottom. U.S. standard sieves are used to separate particles of a soil sample into various sizes. A sieve analysis is performed on dry soil particles that are larger than the No. 200 U.S. standard sieve (i.e., sand size, gravel size, and cobble size particles). This identification is used for the finer sieves and it refers to the number of opening per inch. For example, a No. 4 sieve has four openings per inch, which are 0.19 in. (4.75 mm) wide. Commonly used U.S. Standard Sieve numbers and their sieve opening are as follows:

The laboratory test procedures for performing a sieve analysis are presented in ASTM D 42202 (2004). The basic steps include first determining the initial dry mass of the soil (M). Then the soil is washed on the No. 200 sieve in order to remove all the fines (i.e., silt and clay size particles). The purpose of the washing of the soil on the No. 200 sieve is to ensure that all the fines and surface coatings are washed-off of the granular soil particles.

Hydrometer test:

A sedimentation process is used to determine the particle distribution for fines (i.e., silt and clay size particles finer than the No. 200 sieve). A hydrometer is used to obtain the necessary data during the sedimentation process. The hydrometer test is based on Stokes law, which relates the diameter of a single sphere to the time required for the sphere to fall a certain distance in a liquid of known viscosity. The idea for the hydrometer test is that a larger, and hence heavier, soil particle will fall faster through distilled water than a smaller, and hence lighter, soil particle. The hydrometer test uses the diameter of an equivalent sphere as the definition of particle size. If the number of fines (i.e., percent passing No. 200 sieve) is less than 5 percent, typically a hydrometer test is not performed. Likewise, if the percent passing the No. 200 sieve is between 5 percent and 15 percent, the soil may be non-plastic and

once again a hydrometer test may be unnecessary for classifying the soil. Usually if the percent passing the No. 200 sieve is greater than 15 percent, a hydrometer test could be performed. The test procedure is as follows:

Preparation of Soil:

The first step in the hydrometer test is to obtain a representative soil sample, i.e., the same soil that was used for the sieve analysis. Then the larger soil particles are removed (i.e., plus No. 40 sieve material). For the hydrometer test, it is desirable to have about 50 g of soil finer than the No. 40 sieve if it consists primarily of fines and about 100 g if it consists mostly of coarse grained particles (i.e., sand particles and fines). A mass of 5.0 g of sodium hexametaphosphate is then added to the pan of soil and distilled water is added.

Mixing of Soil:

The water, soil, and sodium hexametaphosphate are thoroughly mixed and allowed to soak overnight. The purpose of the sodium hexametaphosphate is to act as a dispersing agent that prevents the clay size particles from forming flocs during the hydrometer test. At the end of the soaking period, a mechanical mixer is used to further disperse the soil-water-sodium hexametaphosphate slurry.

Atterberg limits tests:

The term plasticity is applied to silts and clays and indicates an ability to be rolled and molded without breaking apart. The Atterberg limits are defined as the water content corresponding to different behavior conditions of silts and clays. Although originally six limits were defined by Albert Atterberg (1911), in geotechnical engineering, the term Atterberg limits only refers to the liquid limit (LL), plastic limit (PL), defined as follows:

Liquid limit (LL)

The water content corresponding to the behavior change between the liquid and plastic state of a silt or clay. The liquid limit is determined by spreading a pat of soil in a brass cup, dividing it in two by use of a grooving tool, and then allowing it to flow together from the shock caused by repeatedly dropping the cup in a standard liquid limit device. In terms of specifics, the liquid limit is defined as the water content at which the pat of soil cut by the grooving tool will flow together for a distance of 0.5 in. (12.7 mm) under the impact of 25 blows in a standard liquid limit device. For laboratory testing details, see ASTM D 4318-00 (2004), “Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.”

Plastic limit (PL):

The water content corresponding to the behavior change between the plastic and semi-solid state of a silt or clay. The plastic limit is determined by pressing together and rolling a small portion of the plastic soil so that its water content is slowly reduced with the end result that the thread of soil crumbles apart. In terms of specifics, the plastic limit is defined as the water content at which a silt or clay will

just begin to crumble when rolled into a thread approximately 1/8 in. (3.2 mm) in diameter. For laboratory testing details, see ASTM D 431800 (2004).

Direct shear test:

A direct shear test is a laboratory or field test used by geotechnical engineers to measure the shear strength properties of soil material, or of discontinuities in soil or rock masses. The U.S. and U.K. standards defining how the test should be performed are ASTM D 3080 respectively. For rock the test is generally restricted to rock with (very) low shear strength. The test is, however, standard practice to establish the shear strength properties of discontinuities in rock. The test is performed on three or four specimens from a relatively undisturbed soil sample. A specimen is placed in a shear box which has two stacked rings to hold the sample; the contact between the two rings is at approximately the mid-height of the sample. A confining stress is applied vertically to the specimen, and the upper ring is pulled laterally until the sample fails, or through a specified strain. The load applied and the strain induced is recorded at frequent intervals to determine a stress–strain curve for each confining stress. Several specimens are tested at varying confining stresses to determine the shear strength parameters, the soil cohesion (c) and the angle of internal friction, commonly known as friction angle (Ø).

The results of the tests on each specimen are plotted on a graph with the peak (or residual) stress on the y-axis and the confining stress on the x-axis. The y-intercept of the curve which fits the test results is the cohesion, and the slope of the line or curve is the friction angle. Direct shear tests can be performed under several conditions. The sample is normally saturated before the test is run, but can be run at the in-situ moisture content. The rate of strain can be varied to create a test of undrained or drained conditions, depending whether the strain is applied slowly enough for water in the sample to prevent pore-water pressure buildup. Direct shear test machine is required to perform the test. The test using the direct shear machine determinates the consolidated drained shear strength of a soil material in direct shear. The advantages of the direct shear test over other shear tests are the simplicity of setup and equipment used, and the ability to test under differing saturation, drainage, and consolidation conditions. These advantages have to be weighed against the difficulty of measuring pore-water pressure when testing in undrained conditions, and possible spuriously high results from forcing the failure plane to occur in a specific location. The test equipment and procedures are slightly different for test on discontinuities.

Consolidation test:

This test is performed as per ASTM D 2435 - Standard Test Method for One-Dimensional Consolidation Properties of Soils. This test is performed to determine the magnitude and rate of volume decrease that a laterally confined soil specimen undergoes when subjected to different vertical pressures. From the measured data, the consolidation curve (pressure-void ratio relationship) can be plotted. This data is useful in determining the compression index, the recompression index and the

pre-consolidation pressure (or maximum past pressure) of the soil. In addition, the data obtained can also be used to determine the coefficient of consolidation and the coefficient of secondary compression of the soil. The consolidation properties determined from the consolidation test are used to estimate the magnitude and the rate of both primary and secondary consolidation settlement of a structure or an earth fill. Estimates of this type are of key importance in the design of engineered structures and the evaluation of their performance.

Unconfined compression strength test:

This test is performed as per ASTM D 2166 - Standard Test Method for Unconfined Compressive Strength of Cohesive Soil. The primary purpose of this test is to determine the unconfined compressive strength, which is then used to calculate the unconsolidated undrained shear strength of the clay under unconfined conditions. According to the ASTM standard, the unconfined compressive strength is defined as the compressive stress at which an unconfined cylindrical specimen of soil will fail in a simple compression test. In addition, in this test method, the unconfined compressive strength is taken as the maximum load attained per unit area, or the load per unit area at 15% axial strain, whichever occurs first during the performance of a test. For soils, the undrained shear strength is necessary for the determination of the bearing capacity of foundations. The undrained shear strength of clays is commonly determined from an unconfined compression test. The undrained shear strength of a cohesive soil is equal to one-half the unconfined compressive strength when the soil is under the f = 0 condition (f = the angle of internal friction). The most critical condition for the soil usually occurs immediately after construction, which represents undrained conditions, when the undrained shear strength is basically equal to the cohesion

4.2.1 Standard Followed for Laboratory Test

All the tests were done as per standard procedure as in ASTM specification.

Name of Laboratory Tests	Specification
Water content test (moisture content)	ASTM D 2216
Specific gravity test	ASTM D 854
Sieve analysis	ASTM D 421
Hydrometer test	ASTM D 422

Atterberg limits test	ASTM D 4318
Soil classification (USCS)	ASTM D 2487
Direct shear test	ASTM D 3080
Unconfined compression strength test	ASTM D 2166
Consolidation test	ASTM D 2435

Standard followed (ASTM specification) for laboratory test

4.2.2 Performed of Laboratory Test
The following laboratory tests have been performed of proposed bridge.

Name of Laboratory Tests	Number of Test Performed	Remarks
Water content test (moisture content)	1	
Specific gravity test	6	
Sieve analysis	12	
Atterberg limits test	2	
Direct shear test	12	
Consolidation test	1	
Unconfined compression strength test	1	
Density test (Wet & dry)	1	

Name and quantity of laboratory test performed

CHAPTER-5 PHYSICAL AND ENGINEERING PROPERTIES OF SOIL

5.1 PHYSICAL PROPERTIES OF SOIL

The physical properties of the subsoil formation of the project area have been evaluated by the execution of 6(Six) numbers of borings up to required depth. The overall physical properties may summarized as follows:

5.1.1 Stratification of soil: The top soil layers at around each of grey/brown soft to firm clay/silty clay/fine sand and intermediate layers are grey medium dense to dense-very dense silty fine sand up to the final depth of investigation, (Ref. Bore logs).

5.1.2 Consistency of soil- Index property of soil: The soil properties on which their classification and identification are based index properties. The index properties which are used are: Grain Size distribution, Specific gravity of soil solids, Density, Atterberg limit.

5.2 ENGINEERING PROPERTIES OF SOIL

The engineering properties of soil, including the cohesion, compressibility and the angle of internal friction have been determined by performing laboratory tests on the soil samples collected field investigation, these are as follows:

5.2.1 Cohesion: The values of cohesion, as reported from the performance of unconfined compression tests

5.2.2 Compressibility: The clay layers are overall low plastic soil usually has been observed very low compressible and sand layers non plastic as a incompressible a in nature. The values of compressible as reported from the performance of consolidation tests.

5.2.3 Angle of Internal Friction: The angle of internal friction values of the investigated values of soil, as reported from the performance of direct shear test.

5.3 GEOTECHNICAL, GEOLOGICAL AND SEISMIC ASPECTS

5.3.1 Geotechnical Boundary Conditions and Data Collection: Proper attention to the geotechnical aspects is needed for a safe and reliable structure to prevent failure. The manner in which failure can occur can be related to a failure mechanism. Major failure mechanism that can be develop on a structure's foundation and associated structure of controlling factors are internal shear stress, excess pore water pressure, liquefaction, densification of loose soil, consolidation of soft sub-soil layer, collapse of underground cavities etc. Depending on the functional requirement structure should be designed and constructed to withstand a combination of action induced winds, fluctuation of water

level, seepage pressure, cyclic loads (earthquake) etc. These including the self weight of the structures have to be transferred to the sub-soil in such a way that:

i) The deformation of the structure are acceptable and

ii) The probability loss of stability is sufficiently low

The soil data (or parameter) relevant geotechnical aspects of design are to be collected through sub-soil investigation program.

5.3.2 Geological of site: Geologically Bangladesh can be divided into three broad physiographic regions. These are Tertiary Hills, Pleistocene Uplands and Recent Plains, which are also the major relief feature of the country. The Recent Plains can be further subdivided into Piedmont Alluvium Floodplains and Tidal and Estuarine Flood plain.

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Chittagong officially known as Chattogram and also known as the Port City of Bangladesh, is a major coastal city and financial center in southeastern Bangladesh. The city has a population of more than 2.5 million while the metropolitan area had a population of 4,009,423 in 2011, making it the second-largest city in the country. It is the capital of an eponymous District and Division. The city is located on the banks of the Karnaphuli River between the Chittagong Hill Tracts and the Bay of Bengal. Modern Chittagong is Bangladesh's second most significant urban center after Dhaka.

5.3.3 Seismic Consideration: History of earthquake in Bangladesh is located in an active tectonic region related to the convergence and collision of the Eurasian and Indian Plates. The results of such tectonic activity are the existence of several deep-seated faults, structural up warping or down warping and episodic earthquakes. During the last 150 years, seven major earthquakes (with M>7.0) have affected the zone that is now within the geographical borders of Bangladesh. Out of these, three had epicenters within Bangladesh.

In the 19th and 20th century over 200 major earthquakes occurred in an around Bangladesh, but there seems to be no seismically active fault in the territory. However, causative faults and regions of high seismic activity exist in neighboring India and Burma in the North and East and exist of Bangladesh. Earthquakes in this area can affect the adjacent regions in Bangladesh as well. Recognizing this, committee of expert on Earthquake Hazard Minimization has recommended that Bangladesh can be sub-divided into three seismic zones; Zone-I, Zone-II Zone-III and Zone-IV (Fig-5.4). These are Horizontal Seismic coefficient of 0.12, 0.20, 0.28.and 0.38 for Zone-respectively.

The site is located at a shallow depression of the terrace. Tectonically the site is located in the deeper part of Bengal Basin. No surface folding or faulting could be identified in and around the area. The project area is located in the Seismic Zone-II and coefficient=0.20 and Seismic Zoning Map of Bangladesh (Ref. BNBC-2015).

General Considerations in the Seismic Design of Foundations

- ☐ Site investigations and determination of soil properties
- ☐ Details of geological and geotechnical environment
- ☐ Identification of loads - static and dynamic
- ☐ Type of foundation
- ☐ Safety verification as per codes
- ☐ Liquefaction potential

5.3.4 Liquefaction Potential

Liquefaction refers to the sudden, temporary loss of soil shear strength during strong ground shaking. Liquefaction-related phenomena include liquefaction-induced settlement, flow failure, and lateral spreading. These phenomena can occur where there are saturated, loose, granular deposits. These deposits were encountered in the subsurface exploration.

Development of liquefaction evaluation started when Seed and Idriss (1971) published a methodology based on empirical work termed as “simplified procedure”. It is a globally recognized standard which has been modified and improved through Seed (1979), Seed and Idriss (1982), Seed et al.(1985),National Research Council (1985), Youd and Idriss (1997), Youd et al. (2001); Idriss and Boulanger (2006).Youd and Perkins (1978), show that geologic maps of liquefaction susceptibility can be created using data collected at the surface .Historically, most cases of earthquake induced liquefaction have occurred in alluvial deposits of loose silt sands (Yamamuro, 1999). Criteria for the assessment of liquefaction.The range of MSF values Recommended by the NCEER Committee is provided in figure.

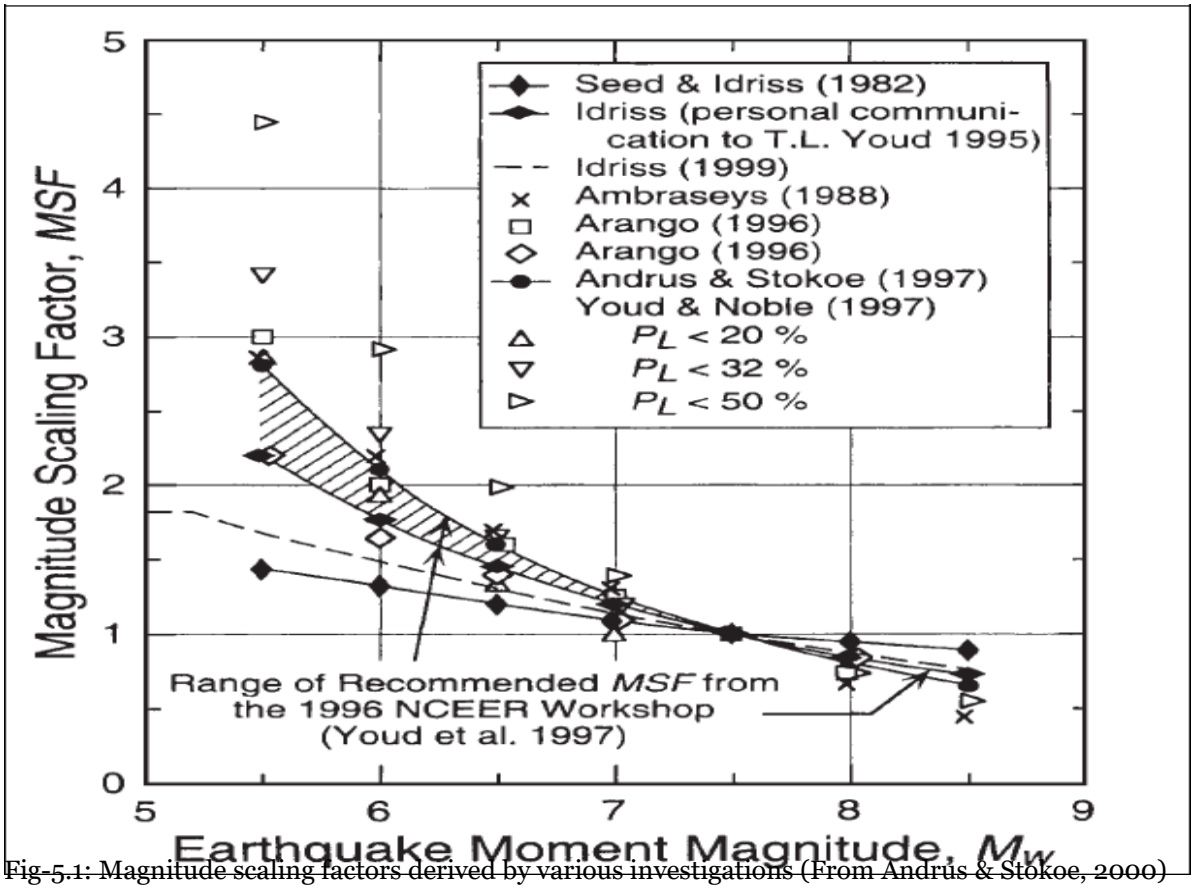


Fig-5.1: Magnitude scaling factors derived by various investigations (From Andrus & Stokoe, 2000)

Popular mitigation methods to reduce effects of soil liquefaction are:

Mitigation by deep soil mixing method

Compaction, Permeation, and Jet Grouting

Drain Pile technique

Dynamic compaction and construction of stone column

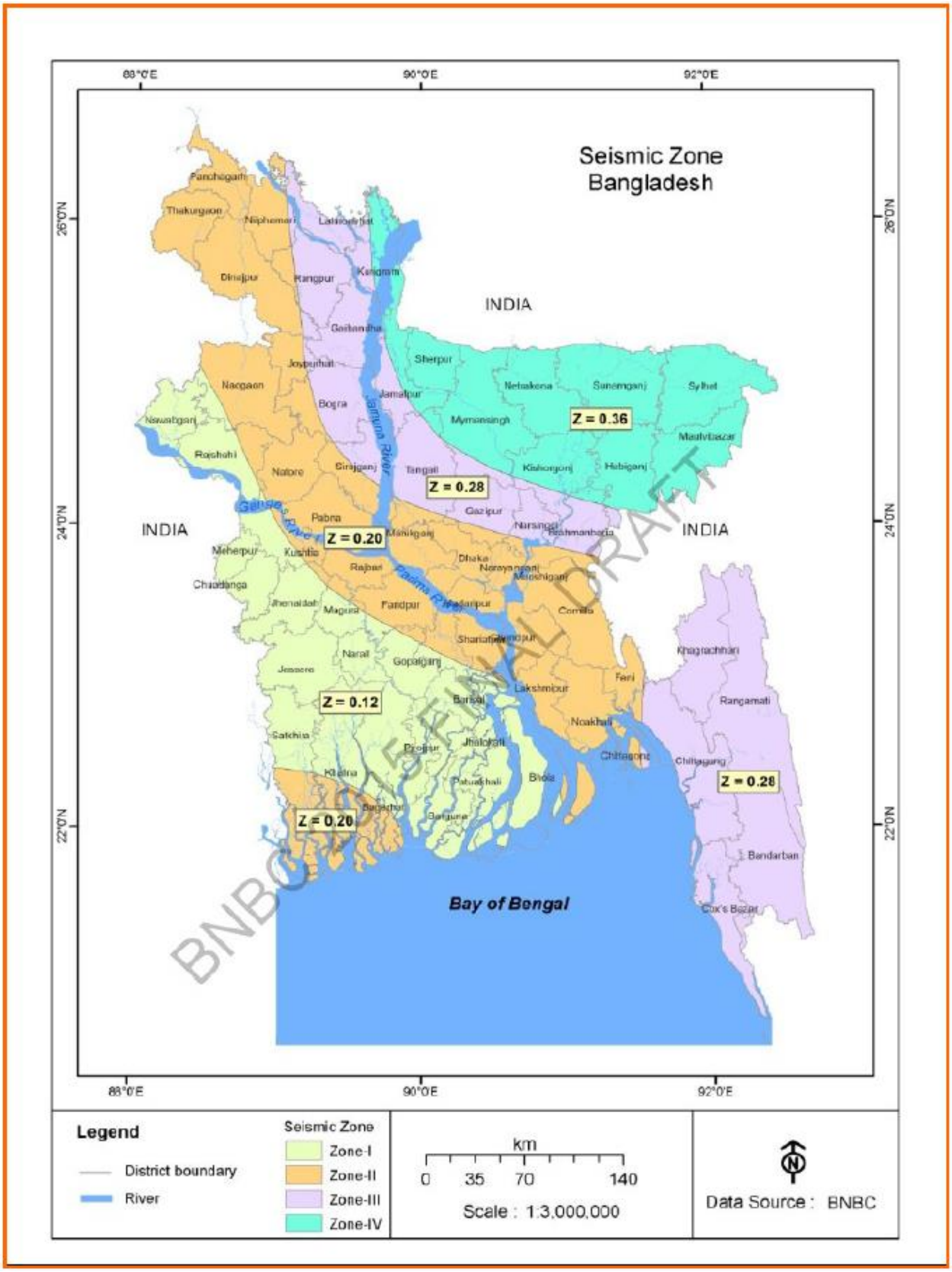


Figure-5.2: Seismic Zoning Map of Bangladesh, BNBC 2015

CHAPTER- 6 GEOTECHNIAL DESIGN, EVALUATION, CONCLUSION AND RECOMMENDATION

6.1 GEOTECHNICAL DESIGN:

Sub-surface condition were determined by of 6 (Six) nos. boreholes up to the maximum depth 30.0 m soil borings drilled by wash boring method. Boring was executed with 1.5 m long steel casing. In this method drilling bit used for cutting soil is connected to 50 mm outer diameter and 35 mm inner dia drill rod through which drilling mud is pumped. The mud slurry flows out at high pressure from the base of the drilling bit and carries cuttings of the soil to the surface.

Standard penetration tests (SPT) were performed at the interval of 1.5 m for the whole depth of boring in all the bore holes. Tests were executed by using a split-spoon sampler of 35 mm internal diameter and a 63.5 kg hammer falling freely from a constant height of 76cm on the drill rod. Numbers of blows produce the penetration are recorded in three different 15cm intervals. The 'N' values were counted as the summation of the number of blows required in the 2nd and 3rd 15cm of penetration against the respective interval of depth.

6.2 EVALUATIONS, CONCLUSIONS AND RECOMMENDATIONS

The evaluation of geotechnical information will include, but not be limited to, the following:

According to the soil investigation the soils of Sonadia Island are sandy loam to clay loamy soils in some areas. Most of the farmlands in nearby areas are on sandy loams with some black cotton soils in the low lands. Black cotton soils characteristically host Acacia wood plant. Soils change to more sandy and gravel texture all the way to the foot of the escarpment. The top soil near the Sonadia Eco-Tourism Park is mainly very soft to medium silt with clay or clay-laden silt and with a trace of find sand. According to the sub-soil investigation, record of this area (north-west of Chittagong District) the soil profile at shallow depth is mainly dominated by non -cohesive soil with a comparatively low SPT (Standard Penetration Test) value at the upper level.

Ground water levels along the project alignment were measured during drilling operation and 24 hours afterward. Specific ground water readings are indicated on the boring logs. It is noted, however, that ground water levels may fluctuate seasonally, climatically and due to other factors not evident at the time of field exploration.

All foundations shall be designed to meet satisfactory performance levels for bearing capacity and settlement. The need for field monitoring systems should be considered. Where embankments are

found to have potential for significant settlement, due to the presence of compressible foundation layers, a settlement analysis should be performed. The structural analysis should include an assessment of the impact of settlement on the road pavement. Where appropriate, consideration should be given to foundation improvement options such as preloading, surcharging, dynamic compaction and vibrofloatation etc. The requirements for drainage control measures, to protect the integrity of cut slope batters and pavement structures, should be assessed.

Precautionary Measure

a) In case of any excavation, it should be designed properly taking care of existing structure, utility lines & available techniques.
b) Earthquake forces must be considered in design (According to BNBC 2015, Figure 6.2.24 and Seismic Zoning map of Bangladesh.

Note

i. The excavated base should be compacted thoroughly after sufficient compaction the allowable bearing capacity of the shallow foundation at the above depth shall be considered.
ii. Bearing capacity calculation of typical shallow foundation has been shown, which are submerged below along the recommended allowable bearing capacity (application for the mat/footing of particular size and depth).
iii. Settlement should be calculated prior to the structural design.
iv. Whenever any soil improvement measures are taken or is driven must be carried out to ensure that the bearing capacity settlement criterion commensurate to design pile value.
v. The estimated pile capacity should be confirmed by load test results. If Pile load test is not performed then the value of pile capacity should be considered half.

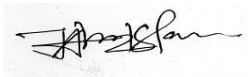
From the field and confirmatory laboratory test results, it can be concluded as follows;

The sub-soil formation encountered at the proposed site is homogeneous. The sequence of lithological composition as well as consistency of the soil at different depths has been depicted in the respective bore logs. However; we enclosed the allowable bearing capacity of soil for footing and pile with this report in "Determination of Pile Bearing Capacity" considering the magnitude of the structure, the structural designer may put his justice to select the suitable type and depth of foundation.

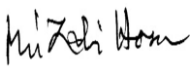
This report consists of various relevant data, drawings, bore logs, curves etc. for entire satisfaction of the design Engineer. However, design engineer will select the suitable type of foundation. Subsequent sections of this report contain descriptions of the field exploration and laboratory testing results and general sub-surface conditions.

Based on our liquefaction analysis and calculation (Considering PGA=0.15g for seismic zone 2, As per BNBC-2006), we found that a probability of liquefaction exist up to 21m soil from E.G.L. Countermeasures should be taken as this zone lies in highly seismic prone area.

Necessary soil parameters those may be required for any foundation such as footing, mat, pile or any other alternative foundation design are provided in different graphs, data, tables etc. in the sub-soil report.



Engr. Md. Jahirul Islam
B.Sc.Engg.(Civil)
Geotechnical Engineer



Engr. Mir.Zakir Hossain
M.Sc.Engg.(Civil)
M-12116, IEB

ATTACHMENT-1

SITE PLAN, BOREHOLE LOGS, LAB

LOCATION OF BORE HOLES

Bore holes location at Sonadia Eco-Tourism Park

BORE LOG

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

Bore Hole # 01

Logged by: Engr. Mosammel	Project	: Consulting Services for "Geo-Technical Investigation"	BH # : 01
Drilled by: Goni Mia & Gong			Depth : 30.00 m
Method of Boring: Manual	Client	: DevConsultant Ltd. Banani, Dhaka	GWT : (-) 1.500 m
Diameter of Borehole: 100 mm	Location	: Sonadia Eco-Tourism Park, Chattogram, Bangladesh	Started : 25/01/2020
Inclination: Vertical			Completed : 25/01/2020

Surface elevation: RL= 2.00 m N: 21°30´43.66´´ E: 91°51´51.48´´

Depth form EGL	SPT data N1= 15cm	N2= 15cm	N3= 15cm	N-Value=N2+N3	SPT Graphical Representation	Graphic Log	Thickness	Lithological Description: Strata Composition	Consistency or Compactness	USCS	Plasticity	Penetration	Type of samples collected	Scale, m	Additional Observation
m					0 20 40 60		m					cm	D,U		
1.5	2	3	5	8								45	D1		
3.0	6	10	14	24			6.0	Brown fine to medium SAND	Loose to medium dense	SM	Non plastic	45	D2		
4.5	7	9	15	24								45	D3		
6.0	7	12	17	29								45	D4		
9.0	2	2	5	7			6.0	Dark grey CLAY	Firm	CL	Low plastic	45	D5		
12.0	3	3	4	7								45	D6		
15.0	4	6	8	14			3.0	Grey silty fine SAND with little clay	Med. dense	SM	Non plastic	45	D7		
18.0	6	8	10	18			15.0	Grey silty SAND with mica	Medium dense	SM	Non plastic	45	D8		
21.0	4	6	8	14								45	D9		
24.0	5	7	9	16								45	D10		
27.0	8	14	17	31								45	D11		
30.0	10	16	20	36								45	D12		

Legend: Disturbed Sample: D Undisturbed Sample: U

Gravel		Sand		Silt		Clay	
Sandy Silt		Silty Sand		Sandy clay		Clayey sand	
Silty Clay		Clayey Silt		Organic		GWL	▼

BORE LOG

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

Bore Hole # 02

Logged by: Engr. Mosammel	Project : Consulting Services for "Geo-Technical Investigation"	BH # : 02
Drilled by: Goni Mia & Gong		Depth : 24.00 m
Method of Boring: Manual	Client : DevConsultant Ltd. Banani, Dhaka	GWT : (-) 1.700 m
Diameter of Borehole: 100 mm	Location : Sonadia Eco-Tourism Park, Chattogram, Bangladesh	Started : 26/01/2020
Inclination: Vertical		Completed : 26/01/2020

Soil surface elevation: RL= 2.000m N: 91°29´55.61´´ E: 91°52´59.62´´

Depth form EGL	SPT data N1= 15cm	N2= 15cm	N3= 15cm	N-Value=N2+N3	SPT Graphical Representation	Graphic Log	Thickness	Lithological Description: Strata Composition	Consistency or Compactness	USCS	Plasticity	Penetration	Type of samples collected	Scale, m	Additional Observation
m					0 20 40 60		m					cm	D,U		
1.5	1	1	1	2			4.5	Grey CLAY	Loose to firm	CL	Low Plastic	45	D1		
3.0	1	2	1	3								45	D2		
4.5	2	3	3	6								45	U1, D3		
6.0	10	18	26	44			25.5	Brown medium to coarse SAND	Medium dense to dense -very dense	SP	Non plastic	45	D4		
9.0	5	7	7	14								45	D5		
12.0	3	5	8	13								45	D6		
15.0	6	10	15	25								45	D7		
18.0	8	14	20	34								45	D8		
21.0	19	33	17	50								42	D9		
24.0	21	40	10	50								40	D10		
27.0	24	42	8	50								38	D11		
30.0	26	44	6	50								35	D12		

Legend: Disturbed Sample: D Undisturbed Sample: U

Gravel		Sand		Silt		Clay	
Sandy Silt		Silty Sand		Sandy clay		Clayey sand	
Silty Clay		Clayey Silt		Organic		GWL	▼

BORE LOG

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

Bore Hole # 03

Logged by: Engr. Mosammel	Project : Consulting Services for "Geo-Technical Investigation"	BH # : 02
Drilled by: Goni Mia & Gong		Depth : 27.00 m
Method of Boring: Manual	Client : DevConsultant Ltd. Banani, Dhaka	GWT : (-) 1.500 m
Diameter of Borehole: 100 mm	Location : Sonadia Eco-Tourism Park, Chattogram, Bangladesh	Started : 26/01/2020
Inclination: Vertical		Completed : 26/03/2020

Soil surface elevation: RL= 2.030m N: 21°29´41.08´´ E: 91°53´21.18´´

Depth form EGL	SPT data N1= 15cm	N2= 15cm	N3= 15cm	N-Value=N2+N3	SPT Graphical Representation	Graphic Log	Thickness	Lithological Description: Strata Composition	Consistency or Compactness	USCS	Plasticity	Penetration	Type of samples collected	Scale, m	Additional Observation
m					0 20 40 60		m					cm	D,U		
1.5	3	3	5	8								45	D1		
3.0	2	1	1	2			6.0	Grey CLAY	Loose to firm	CL	Low Plastic	45	D2		
6.0	3	5	8	13								45	D3		
9.0	2	3	4	7								45	D4		
12.0	6	11	15	26								45	D5		
15.0	8	15	19	34								45	D6		
18.0	7	17	20	37								45	D7		
21.0	12	21	26	47			24.0	Brown medium to coarse SAND	Medium dense to dense -very dense	SP	Non plastic	45	D8		
24.0	16	24	26	50								45	D9		
27.0	20	26	24	50								42	D10		
30.0	22	30	20	50								40	D11		

Legend: Disturbed Sample: D Undisturbed Sample: U

Gravel		Sand		Silt		Clay	
Sandy Silt		Silty Sand		Sandy clay		Clayey sand	
Silty Clay		Clayey Silt		Organic		GWL	

BORE LOG

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

Bore Hole # 04

Logged by: Engr. Mosammel	Project : Consulting Services for "Geo-Technical Investigation"	BH # : 02
Drilled by: Goni Mia & Gong		Depth : 24.00 m
Method of Boring: Manual	Client : DevConsultant Ltd. Banani, Dhaka	GWT : (-) 1.600 m
Diameter of Borehole: 100 mm	Location : Sonadia Eco-Tourism Park, Chattogram, Bangladesh	Started : 27/01/2020
Inclination: Vertical		Completed : 27/01/2020

Soil surface elevation: RL= 1.990m N: 21°29´6.28´´ E: 91°53´38.58´´

Depth form EGL	SPT data N1= 15cm	SPT data N2= 15cm	SPT data N3= 15cm	N-Value=N2+N3	SPT Graphical Representation	Graphic Log	Thickness	Lithological Description: Strata Composition	Consistency or Compactness	USCS	Plasticity	Penetration	Type of samples collected	Scale, m	Additional Observation
m					0 20 40 60		m					cm	D,U		
1.5	1	1	1	2								45	D1		
3.0	1	1	4	5								45	D2		
6.0	2	3	5	8			9.0	Grey fine SAND with little clay	Very loose to loose	SP	Non plastic	45	D3		
9.0	2	3	6	9								45	D4		
12.0	3	5	8	13								45	D5		
15.0	5	7	11	18								45	D6		
18.0	7	13	19	32								45	D7		
21.0	11	16	20	36			21.0	Grey silty SAND with mica	Dense	SM	Non plastic	45	D8		
24.0	11	20	24	44								45	D9		
27.0	14	22	28	50								45	D10		
30.0	16	24	26	50								45	D11		

Legend: Disturbed Sample: D Undisturbed Sample: U

Gravel		Sand		Silt		Clay	
Sandy Silt		Silty Sand		Sandy clay		Clayey sand	
Silty Clay		Clayey Silt		Organic		GWL	▼

BORE LOG

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

Bore Hole # 05

Logged by: Engr. Mosammel	Project : Consulting Services for "Geo-Technical Investigation"	BH #	: 02
Drilled by: Goni Mia & Gong		Depth	: 12.00 m
Method of Boring: Manual	Client : DevConsultant Ltd. Banani, Dhaka	GWT	: (-)1.400 m
Diameter of Borehole: 100 mm	Location : Sonadia Eco-Tourism Park, Chattogram, Bangladesh	Started	: 28/01/2020
Inclination: Vertical		Completed	: 28/01/2020

Soil surface elevation: RL= 2.000m N: 21°28´50.99´´ E: 91°55´27.45´´

Depth form EGL	SPT data N1= 15cm	N2= 15cm	N3= 15cm	N-Value=N2+N3	SPT Graphical Representation	Graphic Log	Thickness	Lithological Description: Strata Composition	Consistency or Compactness	USCS	Plasticity	Penetration	Type of samples collected	Scale, m	Additional Observation
m					0 20 40 60		m					cm	D,U		
1.5	5	11	15	26								45	D1		
3.0	10	20	24	44			6.0	Brown fine to medium SAND	Medium dense to dense-very dense	SP	Non plastic	45	D2		
6.0	12	26	24	50								42	D3		
9.0	15	22	28	50								41	D4		
12.0	15	24	26	50			9.0	Grey fine to medium SAND with little clay	Very dense	SP	Non plastic	40	D5		
15.0	18	26	24	50								38	D6		
18.0	20	28	22	50								35	D7		
21.0	22	30	20	50								37	D8		
24.0	23	33	17	50			15.0	Light grey fine to medium SAND	Very dense	SP	Non plastic	35	D9		
27.0	25	35	15	50								33	D10		
30.0	28	37	13	50								31	D11		

Legend: Disturbed Sample: D Undisturbed Sample: U

Gravel | Sand | Silt | Clay

Sandy Silt | Silty Sand | Sandy clay | Clayey sand

Silty Clay | Clayey Silt | Organic | GWL

BORE LOG

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

Bore Hole # 06

Logged by: Engr. Mosammel	Project : Consulting Services for "Geo-Technical Investigation"	BH # : 06
Drilled by: Goni Mia & Gong		Depth : 12.00 m
Method of Boring: Manual	Client : DevConsultant Ltd. Banani, Dhaka	GWT : (-)1.450 m
Diameter of Borehole: 100 mm	Location : Sonadia Eco-Tourism Park, Chattogram, Bangladesh	Started : 29/01/2020
Inclination: Vertical		Completed : 29/01/2020

Soil surface elevation: RL= 2.010m N: 21°28´39.28´´ E: 91°54´35.93´´

Depth form EGL	SPT data N1= 15cm	N2= 15cm	N3= 15cm	N-Value=N2+N3	SPT Graphical Representation	Graphic Log	Thickness	Lithological Description: Strata Composition	Consistency or Compactness	USCS	Plasticity	Penetration	Type of samples collected	Scale, m	Additional Observation
m					0 20 40 60		m					cm	D,U		
1.5	6	10	12	22			6.0	Brown fine to medium SAND	Medium dense to dense-very dense	SP	Non plastic	45	D1		
3.0	11	18	22	40								45	D2		
6.0	13	20	30	50								45	D3		
9.0	15	22	28	50			24.0	Grey fine to medium SAND	Very dense	SP	Non plastic	41	D4		
12.0	15	24	26	50								40	D5		
15.0	18	26	24	50								38	D6		
18.0	20	28	22	50								35	D7		
21.0	22	30	20	50								37	D8		
24.0	23	33	17	50								35	D9		
27.0	25	35	15	50								33	D10		
30.0	28	37	13	50								31	D11		

Legend: Disturbed Sample: D Undisturbed Sample: U

Gravel | Sand | Silt | Clay

Sandy Silt | Silty Sand | Sandy clay | Clayey sand

Silty Clay | Clayey Silt | Organic | GWL

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

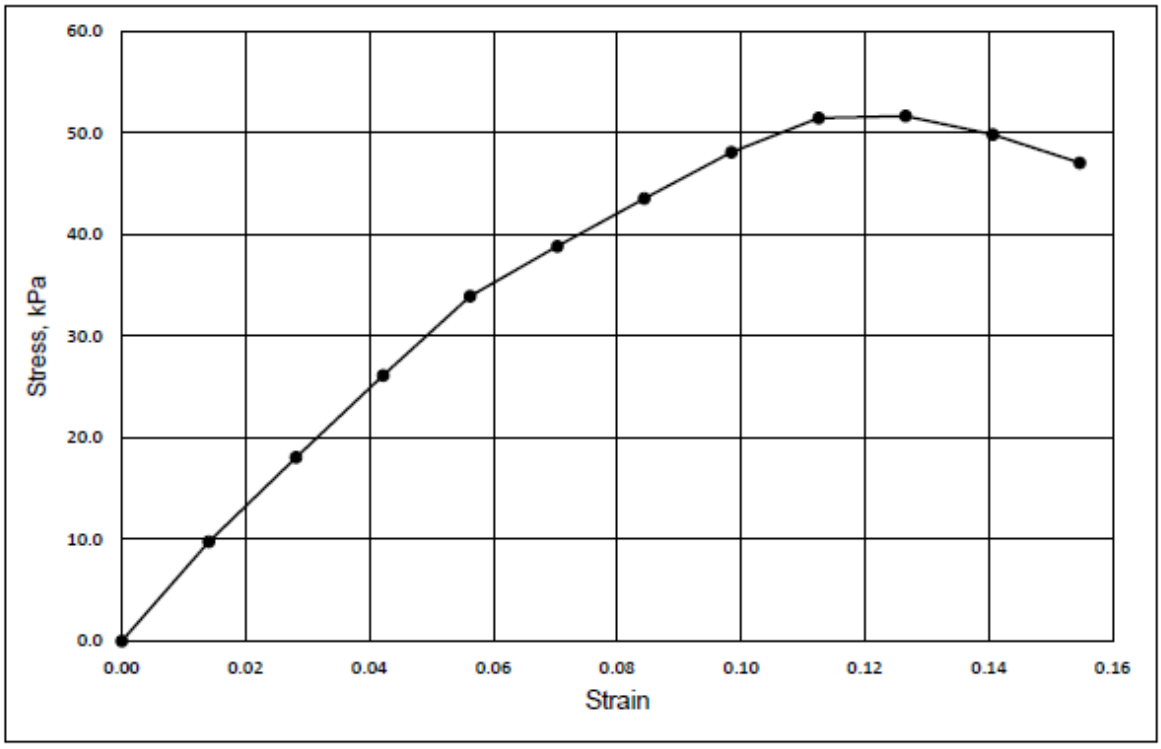
SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	DevConsultant Limited (DEVCon), Banani, Dhaka	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

Unconfined Compression Test (ASTM D 2166)

Bore Hole # 2	Depth: 3.50-4.50m	Sample #: U1	Description of sample: Clay soil

Density determination	
Weight of the sample, gm	1022.25
Diameter of the sample, cm	7.112
Area of the sample, cm^2	39.706
Height of the sample, cm	14.224
Volume of the sample, cm^3	564.77
Wet density of the sample, gm/cc	1.81
Wet density of the sample, kn/m^3	17.7
Dry density of the sample, kn/m^3	14.2

Moisture content determination	
Depth in m	3.50-4.00
Initial weight of sample + Can gm	123.03
Final weight of samole + Can	101.23
Weight of water	21.80
Weight of can gm	23.62
Weight of Sample gm	77.6
Moisture content, %	28.1



Results :	
Cohession, qu (kPa)	51.7
Cohession, C (kPa)	25.8
Strain (%)	13

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	DevConsultant Limited (DEVCon), Banani, Dhaka	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

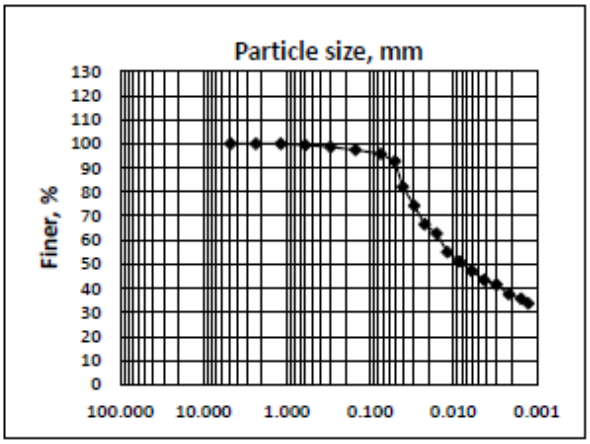
Specific Gravity test (ASTM D854-100)

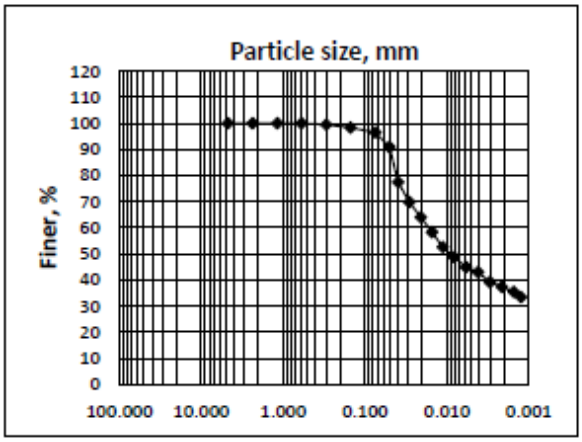
BH No	1	2	3	4	5	6
Depth in m	12.00	4.50	15.00	24.00	9.00	30.00
Pycnometer. no.	D	A3	P	C4	C1	A1
Observed temparature, Tx in oC	21	21	21	21	21	21
Weight of soil in Oven dried, Ws gm	20.00	20.00	20.00	20.00	20.00	20.00
Weight of Pycnometer + water, W2 (at Tx) in gm	149.31	165.28	149.80	162.77	161.77	165.45
Wt. of Pycnometer + water + soil, W1 (at Tx) in gm	161.83	177.79	162.27	175.24	174.22	177.93
Specific Gravity, Gt (at Tx)= Ws/(Ws+W2)-W1	2.668	2.665	2.651	2.651	2.644	2.654
Density of water at Tx oC in gm/cc	0.9980					
Density of water at Tx 20 oC in gm/cc	0.9982					
Specific Gravity, G at Tx 20 oC in gm/cc	**2.664**	**2.660**	**2.646**	**2.646**	**2.639**	**2.649**

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	DevConsultant Limited (DEVCon), Banani, Dhaka	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

Hydrometer Test (ASTM D422)



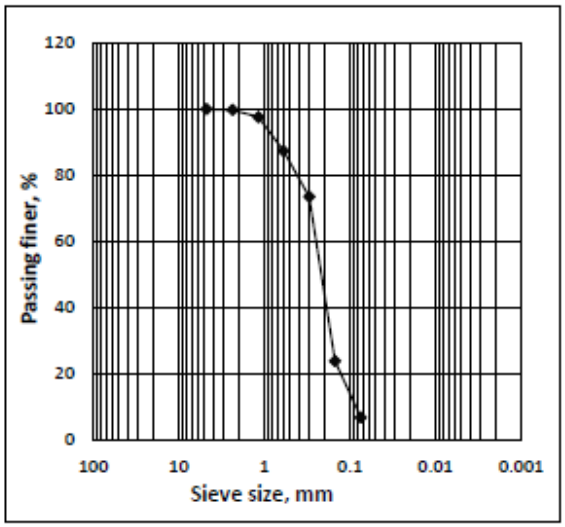


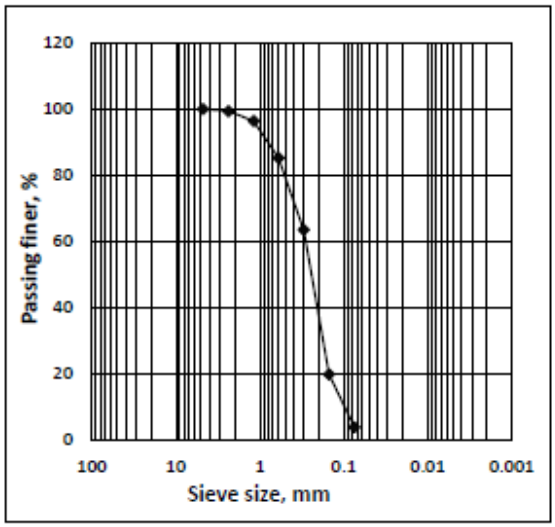
BH -No.	Depth in m	Sand (%)	Silt (%)	Clay (%)	BH -No.	Depth in m	Sand (%)	Silt (%)	Clay (%)
1	12.00	4	49	47	2	4.50	4	51	45

BANGLADESH ENVIRONMENTAL ENGINEERING
TRAINING & LAB SERVICES LTD.

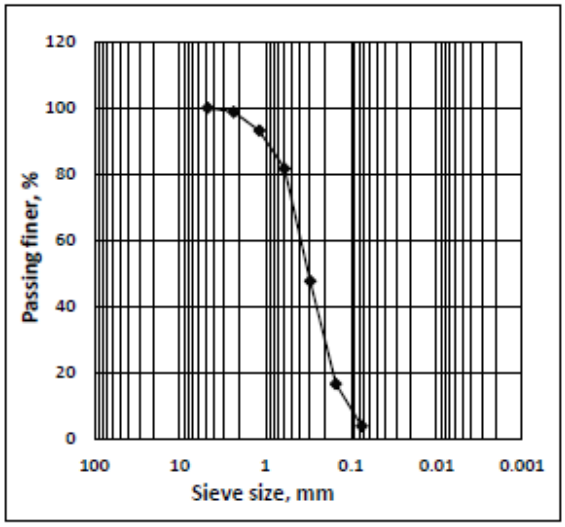
SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	DevConsultant Limited (DEVCon), Banani, Dhaka	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

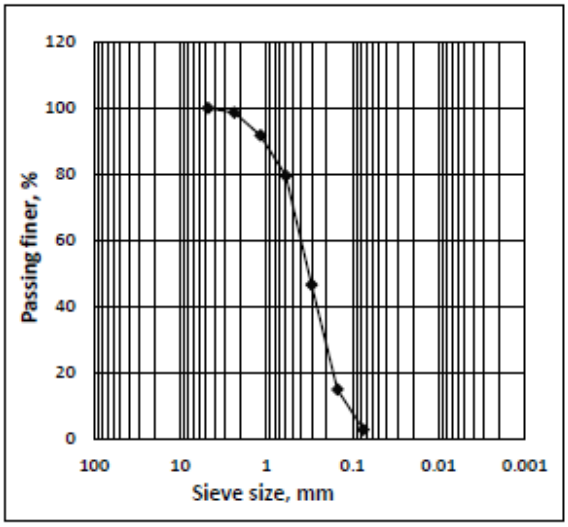
Sieve Analysis Test (ASTM D421-38)





BH -No.	Depth in m	F.M	Sand, %	Silt & clay, %	BH -No.	Depth inm	F.M	Sand, %	Silt & clay, %
1	1.50	1.18	93	6.8	1	18.00	1.36	96	3.8



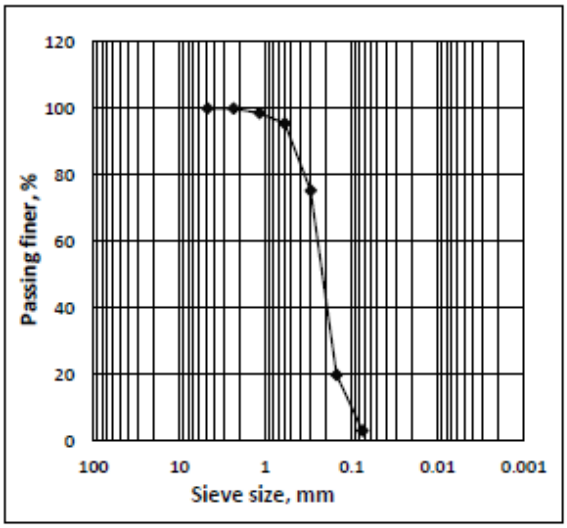


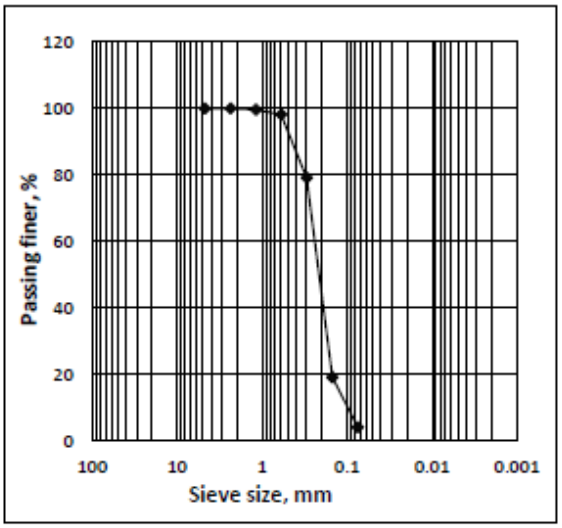
BH -No.	Depth in m	F.M	Sand, %	Silt & clay, %	BH -No.	Depth inm	F.M	Sand, %	Silt & clay, %
2	6.00	1.62	96	3.8	2	24.00	1.69	97	2.7

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

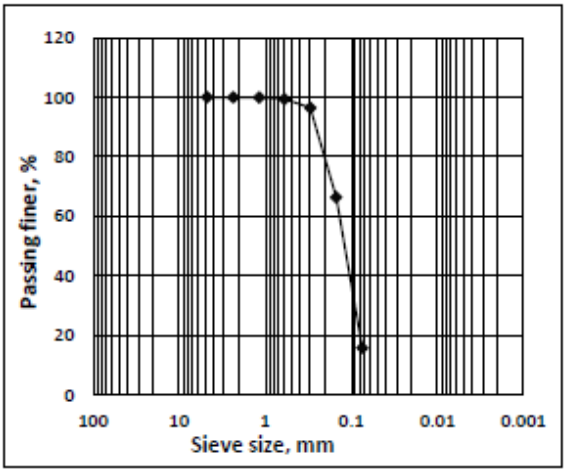
SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	DevConsultant Limited (DEVCon), Banani, Dhaka	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

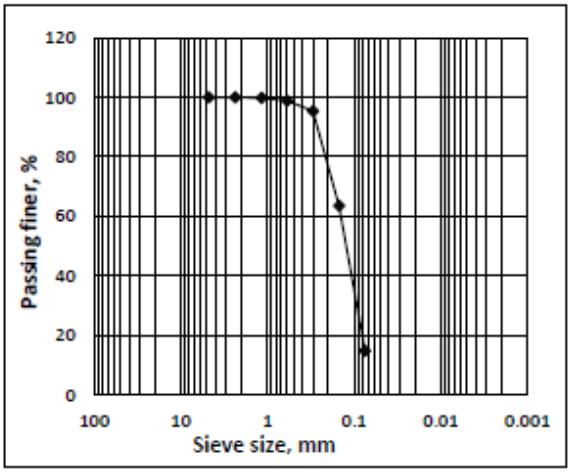
Sieve Analysis Test (ASTM D421-38)





BH -No.	Depth in m	F.M	Sand, %	Silt & clay, %	BH -No.	Depth in m	F.M	Sand, %	Silt & clay, %
3	7.50	1.11	97	3.0	3	27.00	1.04	96	4.1



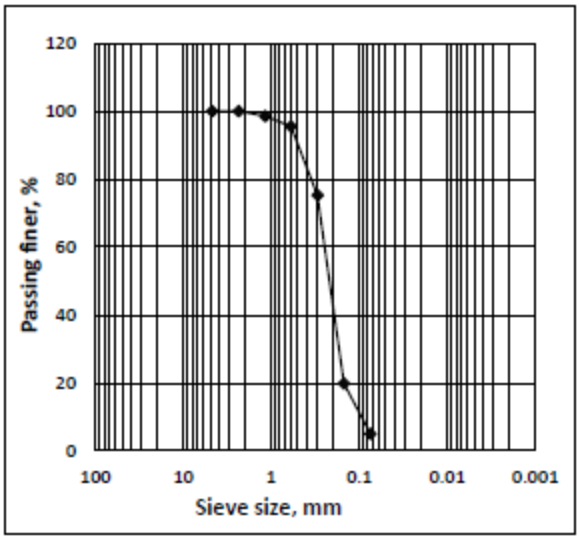


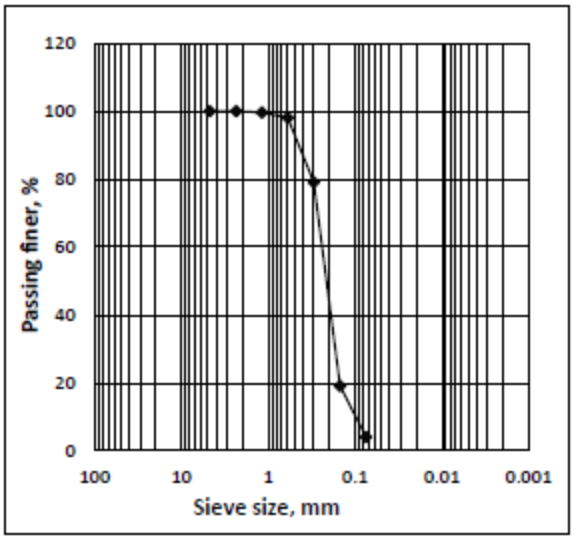
BH -No.	Depth in m	F.M	Sand, %	Silt & clay, %	BH -No.	Depth inm	F.M	Sand, %	Silt & clay, %
4	6.00	0.38	84	15.8	4	18.00	0.43	85	14.8

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

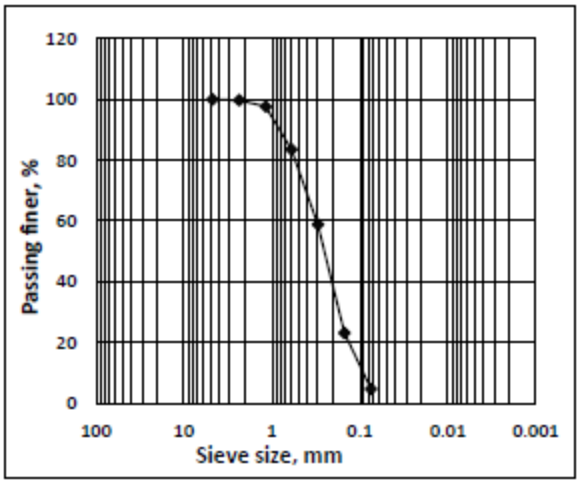
SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	DevConsultant Limited (DEVCon), Banani, Dhaka	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

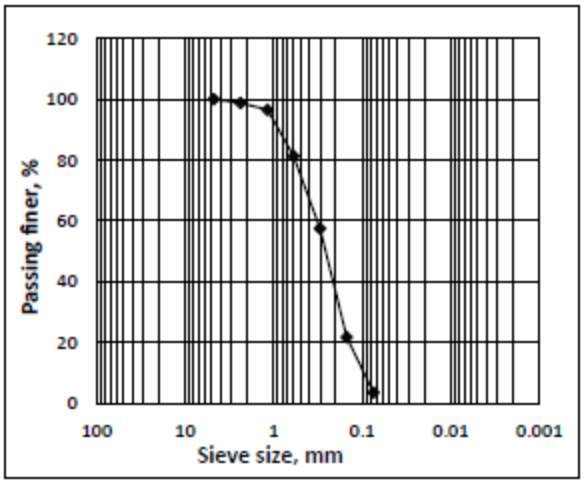
Sieve Analysis Test (ASTM D421-38)





BH -No.	Depth in m	F.M	Sand, %	Silt & clay, %	BH -No.	Depth in m	F.M	Sand, %	Silt & clay, %
5	9.00	1.11	95	5.0	5	21.00	1.04	96	4.1





BH -No.	Depth in m	F.M	Sand, %	Silt & clay, %	BH -No.	Depth inm	F.M	Sand, %	Silt & clay, %
6	12.00	1.37	95	4.7	6	30.00	1.44	96	3.5

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	DevConsultant Limited (DEVCon), Banani, Dhaka	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

Consolidation Test (ASTM D2435)

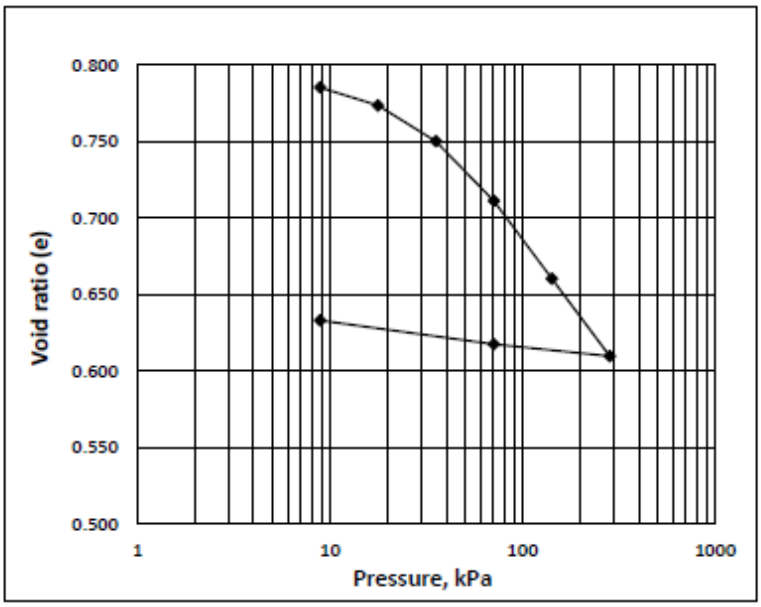


Figure: Void ratio vs Stress, e log p crve

BH--1
Sample no. UD-1
Depth: 3.50m-4.00m
Sample : Grey clay

Data:

Height of sample,Hi (cm)	2.30
Dia of sample, cm	6.00
Area of sample, cm²	28.3
Height of solid,Hs (cm)	1.28
Wt of wet sample, gm	122.46
Wt of dry sample, gm	96.43
Sp. Gravity, Gs	2.660

Resutls

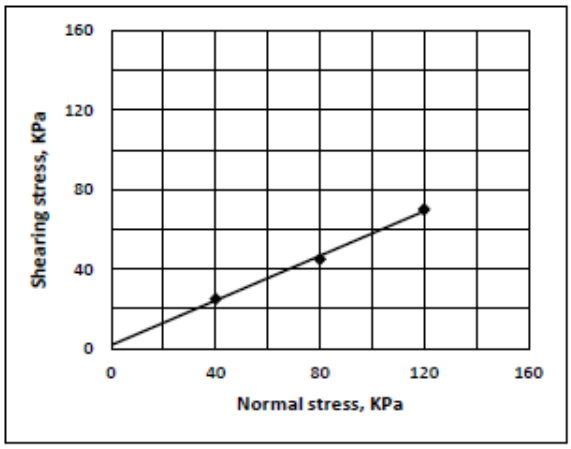
Intial void ratio, e	*0.793*
Compression Index, Cc	*0.168*
Swelling Index, Cs	*0.017*
Wet density γ_o, gm/cc	1.88
Dry density, γ_d, gm/cc	1.47

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	DevConsultant Limited (DEVCon), Banani, Dhaka	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

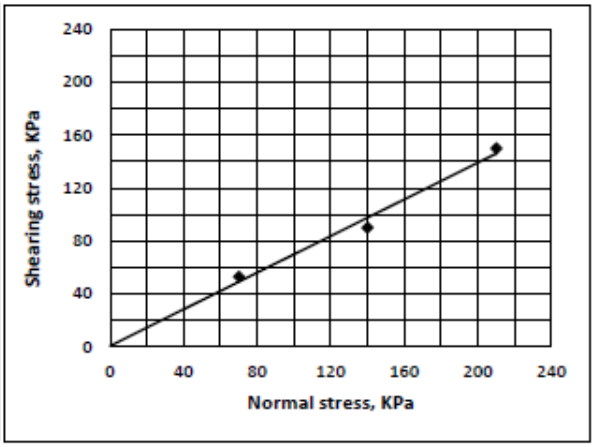
Direct Shear Test (ASTM D3080-72)

B.H 1,Depth : 3.00-4.50 m



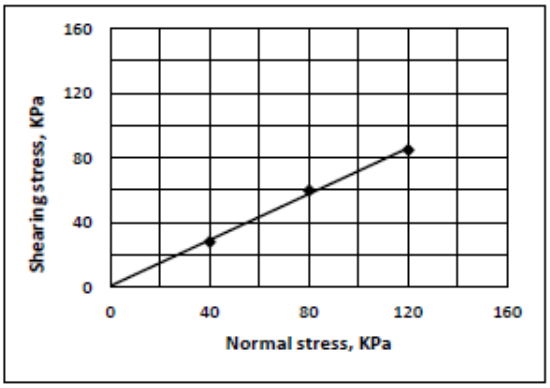
Shearing Angle, degree	30
Cohesion C, Kpa	0

B.H 1,Depth : 27.00-30.00 m



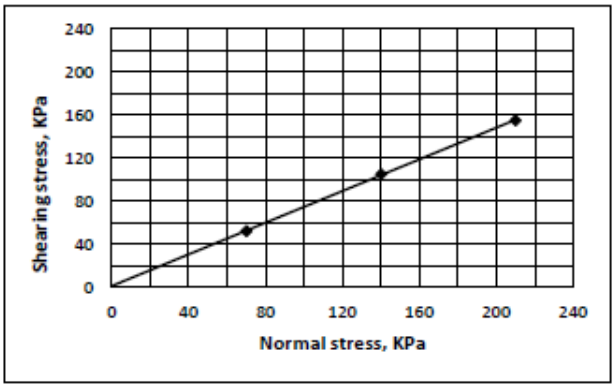
Shearing Angle, degree	35
Cohesion C, Kpa	0

B.H 2,Depth : 6.00-9.00 m



Shearing Angle, degree	36
Cohesion C, Kpa	0

B.H 2,Depth : 21.00-24.00 m



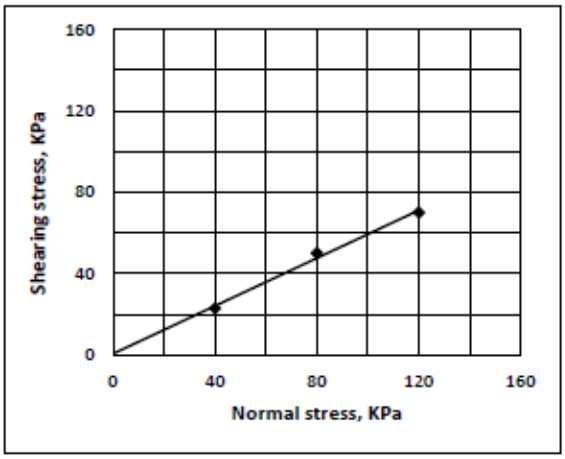
Shearing Angle, degree	37
Cohesion C, Kpa	0

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	Managing Director, Sadia Textile Mills Ltd.	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

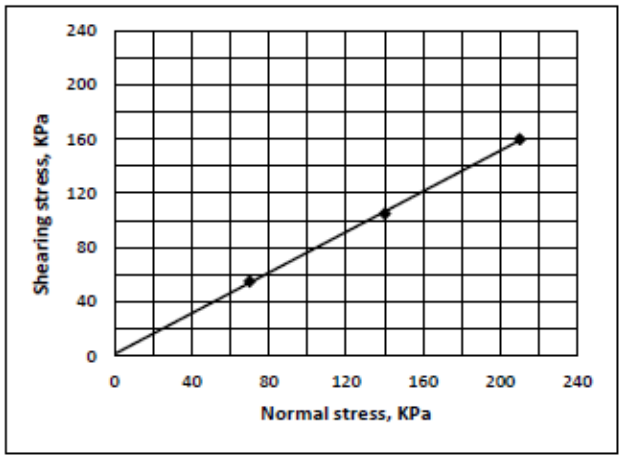
Direct Shear Test (ASTM D3080-72)

B.H 3,Depth : 12.00-15.00 m



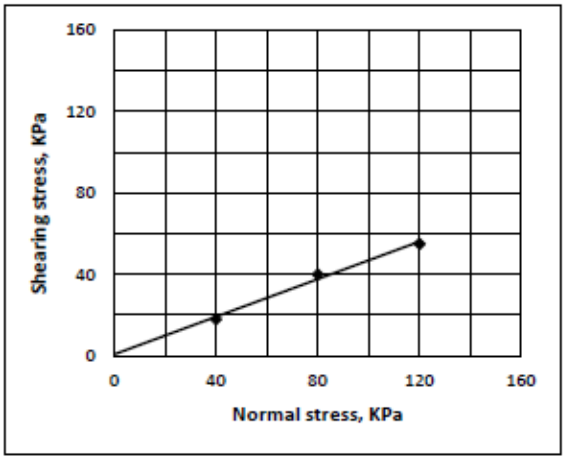
Shearing Angle, degree	31
Cohesion C, Kpa	0

B.H 3,Depth : 24.00-27.00 m



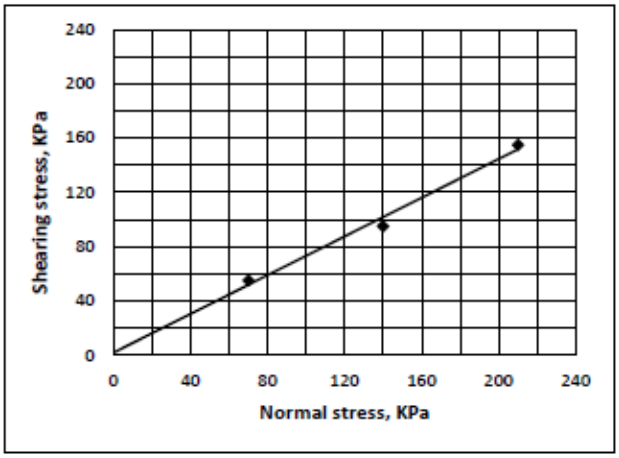
Shearing Angle, degree	38
Cohesion C, Kpa	0

B.H 4,Depth : 3.00-6.00 m



Shearing Angle, degree	25
Cohesion C, Kpa	0

B.H 4,Depth : 21.00-24.00 m



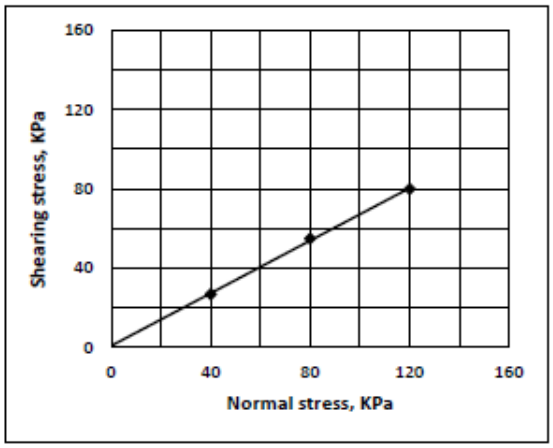
Shearing Angle, degree	36
Cohesion C, Kpa	0

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

SCHEME	CLIENT	LOCATION
Construction of Boiler Plant	DevConsultant Limited (DEVCon), Banani, Dhaka	Kadimdhalla, Post office- Baniara, Upazila-Mirzapur, Tangail

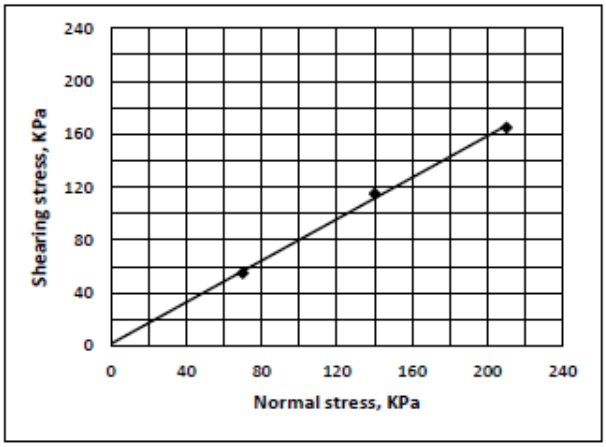
Direct Shear Test (ASTM D3080-72)

B.H 5,Depth : 1.50-3.00 m



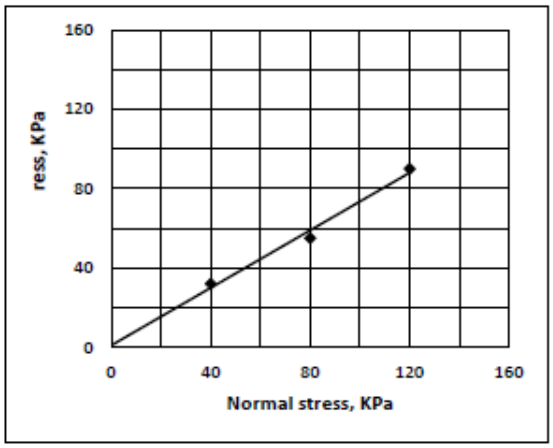
Shearing Angle, degree	34
Cohesion C, Kpa	0

B.H 5,Depth : 9.00-12.00 m



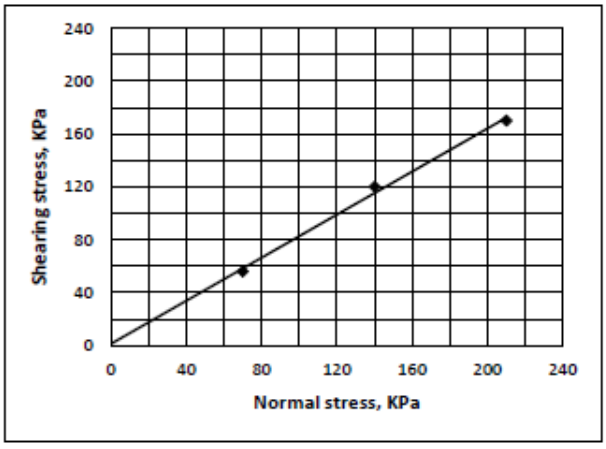
Shearing Angle, degree	39
Cohesion C, Kpa	0

B.H 6,Depth : 6.00-9.00 m



Shearing Angle, degree	37
Cohesion C, Kpa	0

B.H 6,Depth : 27.00-30.00 m

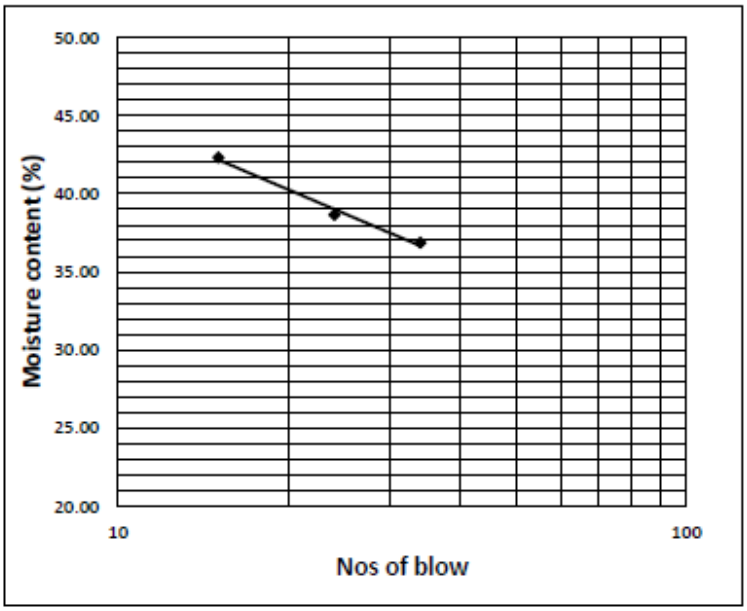


Shearing Angle, degree	40
Cohesion C, Kpa	0

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.

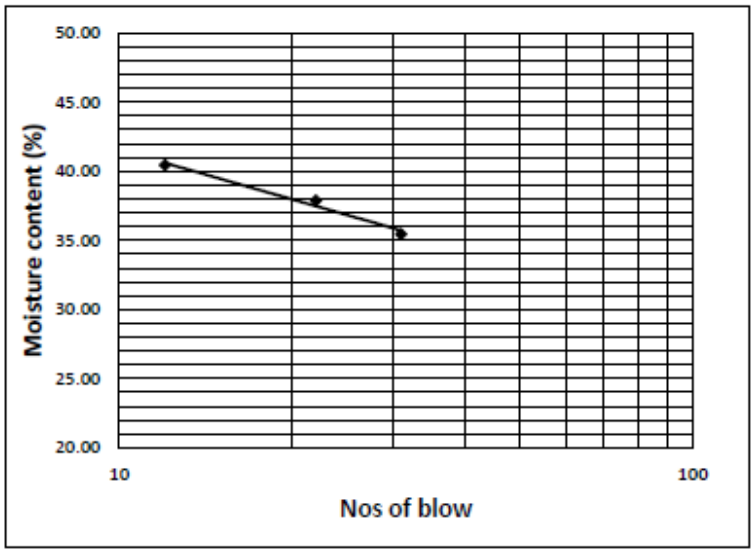
SCHEME	CLIENT	LOCATION
Consulting Services for "Geo-Technical Investigation"	DevConsultant Limited (DEVCon), Banani, Dhaka	Sonadia Eco-Tourism Park, Chattogram, Bangladesh

Atterberg Limit Test (ASTM D 4318)



Bore hole no	1
Depth, m	9.00
Sample description:	Clay soil

Results	
Liquid Limit (LL), %	39
Plastic Limit (PL), %	26
Plasticity Index (PI), %	13



Bore hole no	2
Depth, m	4.50
Sample description:	Clay soil

Results	
Liquid Limit (LL), %	37
Plastic Limit (PL), %	25
Plasticity Index (PI), %	12

Summary of Laboratory Test Results

Sl #	Name of Test	BH #	Depth in m	Unit	Results obtainted					
i	Grain size analysis	1	1.50	%	Sand	93	Finer	7		
ii	do	1	18.00	%	Sand	96	Finer	4		
iii	do	2	6.00	%	Sand	96	Finer	4		
iv	do	2	24.00	%	Sand	97	Finer	3		
v	do	3	7.50	%	Sand	97	Finer	3		
vi	do	3	27.00	%	Sand	96	Finer	4		
vii	do	4	6.00	%	Sand	84	Finer	16		
viii	do	4	18.00	%	Sand	85	Finer	15		
ix	do	5	9.00	%	Sand	95	Finer	5		
x	do	5	21.00	%	Sand	96	Finer	4		
xi	do	6	12.00	%	Sand	95	Finer	5		
xii	do	6	30.00	%	Sand	96	Finer	4		
i	Direct shear test	1	3.00-4.50	o°, kPa	φ	30	c	0		
ii	do	1	27.00-30.00	o°, kPa	φ	35	c	0		
iii	do	2	6.00-9.00	o°, kPa	φ	36	c	0		
iv	do	2	21.00-24.00	o°, kPa	φ	37	c	0		
v	do	3	12.00-15.00	o°, kPa	φ	31	c	0		
vi	do	3	24.00-27.00	o°, kPa	φ	38	c	0		
vi	do	4	3.00-6.00	o°, kPa	φ	25	c	0		
vii	do	4	21.00-24.00	o°, kPa	φ	36	c	0		
ix	do	5	1.50-3.00	o°, kPa	φ	34	c	0		
x	do	5	9.00-12.00	o°, kPa	φ	39	c	0		
xi	do	6	6.00-9.00	o°, kPa	φ	37	c	0		
xii	do	6	27.00-30.00	o°, kPa	φ	40	c	0		
i	Specific gravity	1	12.00		G_s	2.664				
ii	do	2	4.50		G_s	2.660				
iii	do	3	15.00		G_s	2.646				
iv	do	4	24.00		G_s	2.646				
v	do	5	9.00		G_s	2.639				
vi	do	6	30.00		G_s	2.649				
i	Hydrometer analysis	1	12.00	%	Sand	4	Silt	49	Clay	47
ii	do	2	4.50	%	Sand	4	Silt	51	Clay	45
i	Atterberg limit	1	9.00	%	L_L	39	P_L	26	P_I	13
ii	do	2	4.50	%	L_L	37	P_L	25	P_I	12
i	Unconfined Compression	2	3.50-4.00	kPa, %	c_u	25.8	ε	13		
i	Density (Wet & Dry)	2	3.50-4.00	kN/m³	γ_w	17.7	γ_d	14.2		
i	Natural moisture content	2	3.50-4.00	%	m	28				
i	Consolidation test	2	3.50-4.00		C_c	0	e_o	0.793	C_v	0.017

ATTACHMENT-2

BEARING CAPACITY OF SHALLOW FOUNDATION & DEEP FOUNDATION

BEARING CAPACITY OF SHALLOW FOUNDATION

Introduction

All civil engineering structures impose a loading on the underlying soil (or rock). The lowest port of the structure, usually lying below the ground level, which transmits the load to the supporting soil/rock strata is known as foundation. The ability of the underlying soil to bear the load of the foundation without overstressing the soil in terms of either shears failure or excessive. Settlement is termed as bearing capacity of soil. This is often termed as bearing capacity of foundation.

The bearing capacity of a soil depends mainly on the types of foundation encountered by the soil. Foundations of structures are basically of two types; shallow and deep. The classification indicates the depth of foundation on installation and the depth of the soil strata providing most of the support. A number of definitions are relevant the context of types of foundation and bearing capacity.

Shallow Foundation

Shallow foundation is one that is placed on a firm soil near the ground and beneath the lowest part of the superstructure. e.g. spread footing or simply footing, mat or raft etc. The most useful definition of a shallow foundation refers to the founding depth being less than the breadth of the foundation. However, for wide foundation this is not acceptable.

It is sensible to limit the term shallow to mean less than 3m or less than the breadth of the foundation footing. Terzaghi (1948) developed a bearing capacity theory, assuming a failure surface consisting of three wedges (I, II and III) as illustrated in Fig. He considers a strip footing with rough base placed at a depth Df on a homogeneous and isotropic soil mass. In the analysis the shearing resistance of the soil above the base of the footing is neglected, but the effect of soil weight above the base is considered by superimposing an equivalent surcharge of intensity q=γDf. The development of the failure surface in the soil is governed by the general shear failure.

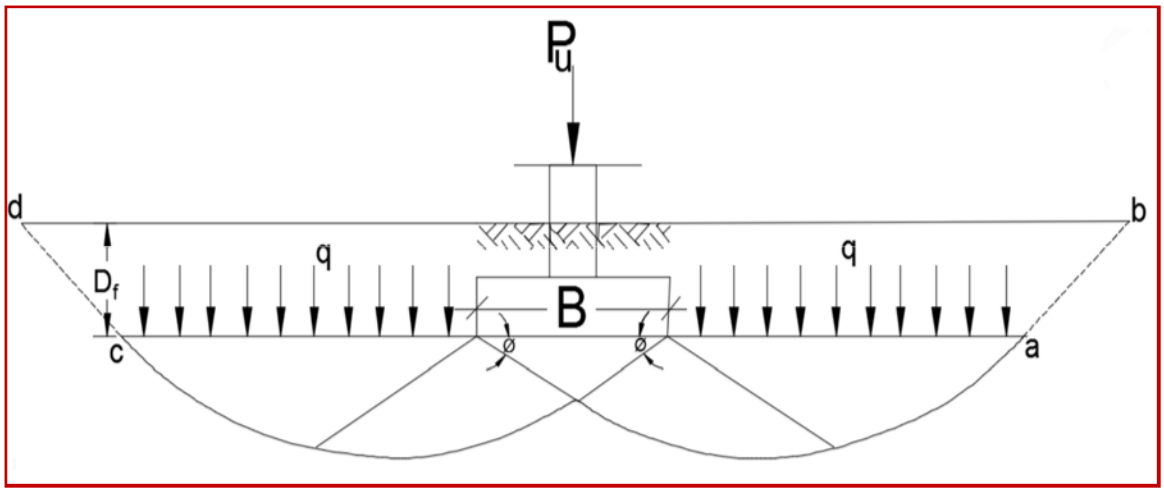


Fig: Terzaghi's Bearing Capacity

Terzaghi Equation of shallow foundation for c - φ soil qult = cNcSc+ q¯Nq + 0.5BɣNy

Allowable Bearing Capacity from N-value for Cohesionless Soil

It is difficult to collect undisturbed sample in cohesionless soil hence extensive research have been made to find out the allowable bearing capacity of shallow foundation in cohesionless soil from SPT N-value. Among them, Terzaghi and Peck (1948, 1967), Meyerhof (1956, 1965, 1974), Bowles (1968, 1977, 1982, 1988, 1997), Teng (1962), D"Allolonia et al. (1968) Parry (1977), Peck and Bazarra (1969), Peck (1974), Mohan et al. (1971), Burland and Burbridge (1985) are extensively used all over the world. Some are in graphical form and others are in equations.

There is no particular method incorporated in BNBC 2015 to calculate the bearing capacity. According to BNBC 2015, any established method to calculate bearing capacity is applicable. Author modified the Bowles (1997) method slightly for 60% energy correction including overburden pressure correction and water table correction if applicable. Since water table correction is already reflected in N-value hence no need for water table correction factor. Allowable bearing capacity equations are given in Equation 2.3 to 2.5.

Meyerhof (1956), Allowable bearing capacity equation is given below.

qa (kPa) = 8*N*(3.28*B+1/3.28*B)^2* Fd*(s) / (25.4) for B > 1.2 m

Fd = Depth factor =1+0.33*Df/B ≤ 1.33 s = Tolerable settlement

(mm)

B = Width of foundation (m)

Df = Depth of foundation, (m)

N = Average uncorrected N-value from depth of footing to Df+B, only water table correction suggested.

Allowable Bearing Capacity from N-value for Cohesive Soil

Extensive research have been made on granular soil to find the bearing capacity from field test but few on cohesive soil since penetration test data is unreliable. Skempton (1951) proposed equations for bearing capacity of footings founded on purely cohesive soils based on extensive investigations which can be modified to establish a relationship among net allowable bearing capacity, SPT N-value and bearing capacity factor Nc. According to him the bearing capacity factor Nc is a function of the depth of foundation and also of its shape. The equation for net ultimate bearing capacity, qnet-ult is as follows:

qnet-ult = cNc = 6.25*N60*Nc

Where, c= Cohesion, kPa

Nc = Bearing capacity factor, 6(1+0.2Df/B) ≤ 9 for Square footing

Table: Permissible Total Settlement, Differential Settlement and Angular Distortion (Tilt) for Shallow Foundations in soils (in mm) (Adapted from NBCI, 2005) (BNBC 2015 Table 6.3.8)

Type of Structure	Isolated Foundations						Raft Foundation					
	Sand and hard Clay			Plastic Clay			Sand and hard Clay			Plastic Clay		
	Maximum Settlement	Differential Settlement	Angular Distortion	Maximum Settlement	Differential Settlement	Angular Distortion	Maximum Settlement	Differential Settlement	Angular Distortion	Maximum Settlement	Differential Settlement	Angular Distortion
Steel Structure	50	0.0033 L	1/300	50	0.0033 L	1/300	75	0.0033 L	1/300	100	0.0033 L	1/300
RCC Structures	50	0.0015 L	1/666	70	0.0015 L	1/666	75	0.0021 L	1/500	100	0.002 L	1/500
Multistoried Building												
(a) RCC or Steel framed building with panel walls	60	0.002 L	1/500	75	0.002 L	1/500	75	0.0025 L	1/400	125	0.0033 L	1/300
(b) Load bearing walls												
(i) L/H=2*	60	0.0002 L	1/5000	60	0.0002 L	1/5000	Not likely to be encountered					
(ii) L/H=7*	60	0.0004 L	1/2500	60	0.0004 L	1/2500	Not likely to be encountered					
Silos	50	0.0015 L	1/666	75	0.0015 L	1/666	100	0.0025 L	1/400	125	0.0025 L	1/400
Water Tank	50	0.0015 L	1/666	75	0.0015 L	1/666	100	0.0025 L	1/400	125	0.0025 L	1/400

Notes: The values given in the Table may be taken only as a guide and the permissible total settlement, differential settlement and tilt (angular distortion) in each case should be decided as per requirements of the designer.

L denotes the length of deflected part of wall/ raft or Centre to Centre distance between columns.
H denotes the height of wall from foundation footing.
*For intermediate ratio of L/H, the values can be interpolated.

Factor of safety: Where the extensive soil investigation has been done the lower value of the range is suggested; in case of limited sub-soil investigation the higher range of of factor of safety has been recommended. Bowles suggested to following factor of safety for the types of foundation.

Spread Footing: 2 to 3, Mat Foundation: 1.7 to 2.5 and Footing subjected to Uplift forces: 1.7 to 2.5

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Hatkhola, Tikatuli, Dhaka

Allowable Bearing Capacity from N-value for Cohesive Soil

Extensive research have been made on granular soil to find the bearing capacity from field test but few on cohesive soil since penetration test data is unreliable. Skempton (1951) proposed equations for bearing capacity of footings founded on purely cohesive soils based on extensive investigations which can be modified to establish a relationship among net allowable bearing capacity, SPT N-value and bearing capacity factor Nc. According to him the bearing capacity factor Nc is a function of the depth of foundation and also of its shape. The equation for net ultimate bearing capacity Nnet-ult is as follows

qnet-ult = cNc = 6.25*N60*Nc

Where,

c= Cohesion, kPa, N60= Correction of N-value

Nc = Bearing capacity factor, 6(1+0.2Df/B) ≤ 9 for Square footing

Square footing

Bore Hole #	Footing Size (m)	Depth of footing (m)	N-value, Corrected N60	Bearing capacity factor, Nc	Net ultimate bearing capacity, kPa	Net allowable bearing capacity, kPa (F.S=3)	Net allowable bearing capacity (tsf)
BH-2	1.5 x 1.5	1.5	1.50	7.20	67.5	22.50	0.23
	2.0 x 2.0	2.0	1.50	7.20	67.5	22.50	0.23
	2.5 x 2.5	2.5	2.25	7.20	101.3	33.75	0.35

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Hatkhola, Tikatuli, Dhaka

Shallow Foundation: Isolated Spread Footing

Allowable Bearing Capacity from N-Value for Cohesionless soil

There is no particular incorporate in BNBC 2015 to calculate the bearing capacity of shallow foundation. According to BNBC 2015, any established method to calculate bearig capacity is applicable.

Meyerhof (1956), Allowable bearing capacity equation is given below.

qa (kPa) = 8*N*(3.28*B+1/3.28*B)^2* Fd*(s) / (25.4) for B > 1.2 m

Fd = Depth factor =1+0.33*Df/B ≤ 1.33
s = Tolerable settlement (mm)
B = Width of foundation (m)
Df = Depth of foundation, (m)
N = Average uncorrected N-value from depth of footing to Df+B, only water table correction suggested

Square footing

Bore Hole #	Footing Size (m)	Depth of footing, Df (m)	Depth factor, (Fd)	Average N-value, (Df+B)	Tolerable Settlement (s)	Allowable bearing capacity (kPa)	Net allowable bearing capacity (kPa)	Net allowable bearing capacity (tsf)
BH-1	1.5 x 1.5	1.5	1.330	16	25.4	138.64	138.64	1.45
	2.0 x 2.0	2.0	1.330	19	25.4	268.49	263.59	2.75
	2.5 x 2.5	2.5	1.330	19	25.4	397.62	387.81	4.05
BH-3	1.5 x 1.5	1.5	1.330	5	25.4	43.33	43.33	0.45
	2.0 x 2.0	2.0	1.330	8	25.4	113.05	108.14	1.13
	2.5 x 2.5	2.5	1.330	8	25.4	167.42	157.61	1.65
BH-4	1.5 x 1.5	1.5	1.330	4	25.4	34.66	34.66	0.36
	2.0 x 2.0	2.0	1.330	5	25.4	70.66	65.75	0.69
	2.5 x 2.5	2.5	1.330	5	25.4	104.64	94.83	0.99
BH-5	1.5 x 1.5	1.5	1.330	35	25.4	303.28	303.28	3.17
	2.0 x 2.0	2.0	1.330	42	25.4	593.51	588.60	6.15
	2.5 x 2.5	2.5	1.330	42	25.4	878.94	869.13	9.08
BH-6	1.5 x 1.5	1.5	1.330	31	25.4	268.62	268.62	2.81
	2.0 x 2.0	2.0	1.330	37	25.4	522.85	517.95	5.41
	2.5 x 2.5	2.5	1.330	37	25.4	774.30	764.49	7.98

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Shallow Foundation: Mat

Using Bowles's Equation for Cohesionless soil

qa = 11.98*(N1)55 * Fd*(s/25.4), Bowles (1997)
Fd = Depth factor = 1+0.33*Df/B ≤ 1.33
CN = 0.77 log (2000/σ')
N1(55) = CN*N55
Maximum allowable settlement for sand =50mm (Tomlinson), 45-65mm Skepton and MacDonald)

Mat Foundation

Bore Hole #	Mat size (m)	Depth of Mat, Df (m)	(N1)55	Fd	Allowable settlement (s)	Allowable bearing capacity (kPa)	Net allowable bearing capacity (kPa)	Net allowable bearing capacity (tsf)
BH-1	30 x 20	3.00	27.09	1.05	50	670.58	660.77	6.90
	30 x 20	4.50	27.95	1.07	50	708.19	688.57	7.19
BH-3	30 x 20	3.00	2.36	1.05	50	58.36	48.55	0.51
	30 x 20	4.50	15.69	1.07	50	397.51	377.89	3.95
BH-4	30 x 20	3.00	5.86	1.05	50	144.99	135.18	1.41
	30 x 20	4.50	9.83	1.07	50	248.99	229.37	2.40
BH-5	30 x 20	3.00	29.24	1.05	50	723.81	714.00	7.46
	30 x 20	4.50	48.47	1.07	50	1227.88	1208.26	12.62
BH-6	30 x 20	3.00	24.93	1.05	50	616.98	607.17	6.34
	30 x 20	4.50	44.52	1.07	50	1127.94	1108.32	11.57

Using Skemption's Equation for Cohesive soil

q(net) = 5[1+0.2D/B][1+0.2B/L]c

Mat foundation

Bore Hole #	Mat size (m)	Depth of Mat (m)	Cohesion, c kPa	Net Allowable bearing capacity, kPa,	Net Allowable bearing capacity (tsf)
2	30 x 20	3.00	25.8	145.52	1.52
	30 x 20	4.50	25.8	147.64	1.54

Deep Foundation

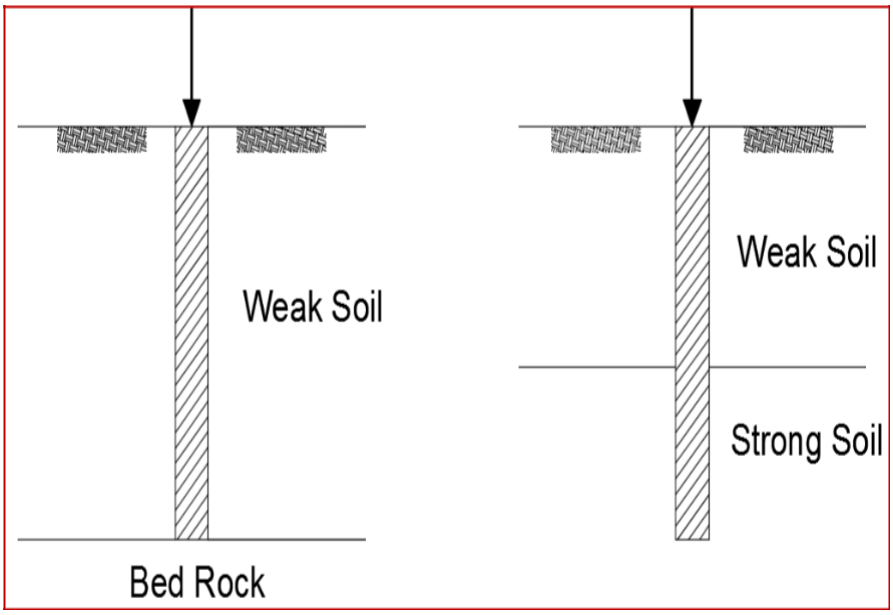
Introduction

Piles are structural members that are made of steel, concrete or timber. They are used to build pile foundations (classified as deep foundations) which cost more than shallow foundations. Despite the cost, the use of piles often is necessary to ensure structural safety. The most case in which pile foundations are required, is when the soil supporting the structure is weak soil (expansive soil, or collapsible soil, etc.) we use piles to transmit the foundation load to the nearest bed rock layer, and if bed rock is not encountered, we use piles to transmit the load to the nearest stronger soil layer to ensure the safety for the structure.

Use of Pile

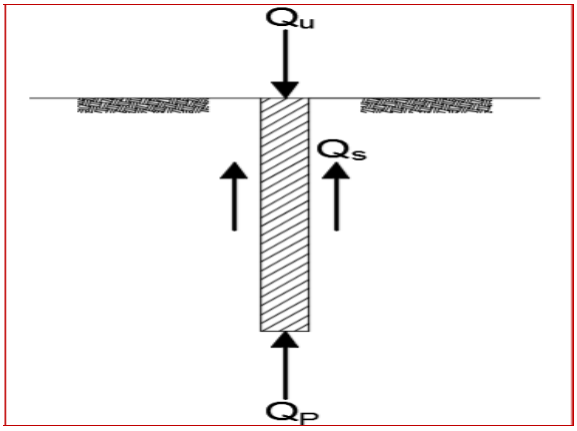
Pile shall be considered when footing cannot be founded on reliable soil stratum within a reasonable depth. Pile may also be used where an unacceptable amount of settlement of spread footing may occur, or where there is possibility of scouring of erosion near the foundation. Considering the low bearing capacity and the possibility of scour and erosion, either pre-cast or cast in situ concrete piles have been recommended.

The following figure clarifies the function of pile foundation (which mentioned above):



Capacity of Pile

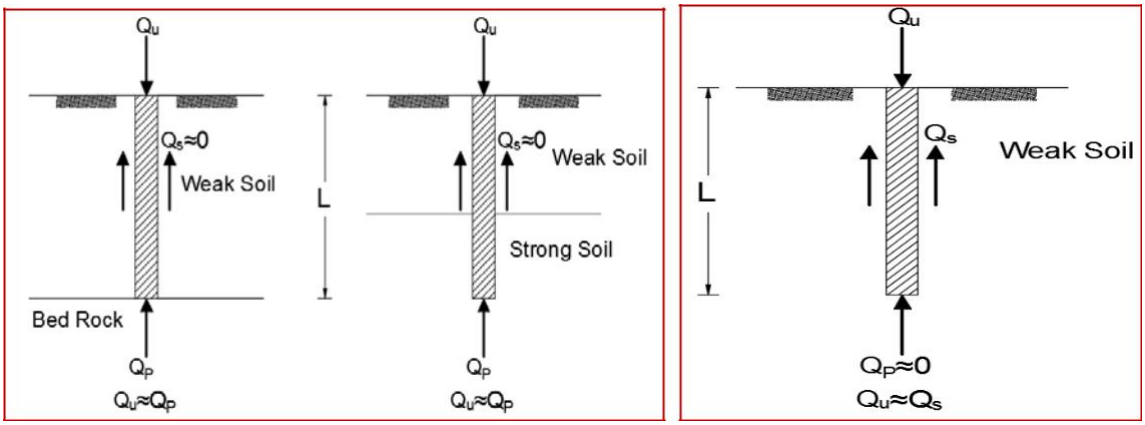
The ultimate load capacity of the pile may be expressed as: Qu=Qp+Qs. When the pile penetrates weak soil to rest on strong soil or bed rock, the pile will be supported by the bed rock or the strong soil from at the pile end (end point of pile), So: Qp=Load carried at the pile end point In addition, when the pile penetrates the soil, the shearing resistance between the soil and the pile should be considered in Qs where: Qs=Load carried by the skin friction developed at the sides of the pile (caused by shearing resistance between the soil and the pile)



Types of Pile

1. Point Bearing Piles

If the soil supporting the structure is weak soil, pile foundation will used to transmit the load to the strong soil layer or to the bed rock (if encountered), here the pile will resist the entire load depending on its end point load Qp and the value of Qs (frictional resistance) is very small in this case, so: Qu=Qp+Qs, Qs≈0.0→ Qu=Qp (Point Bearing Piles)



2. Friction Piles

When no strong layer or rock is present at reasonable depth at a site, point bearing piles becomes very long (to reach strong layer) and uneconomical. In these type of soil profiles, piles are driven through the softer (weaker) soil to specified depth, and here the point bearing load (Qp) is very small and can be considered zero, however the load on the pile will resisted mainly by the frictional resistance between soil and pile (Qs) so: Qu=Qp+Qs, Qp≈0.0→ Qu=Qs (Friction Piles)

In practice, we assume the pile resist the applied loads by its point bearing load and its frictional resistance to estimate the ultimate load the pile can carry. Qu=Qp+Qs

In the following sections, we will learn how to calculate the value of Qp and Qs and thereby Qu for sand and clay and c–ϕ soil.

AXIAL PILE CAPACITY FROM SHEAR STRENGTH PARAMETERS

Axial pile capacity can be calculated from shear strength parameters [cohesion (c) and the angle of internet friction (Ø)] of soil which are inherent properties of soil. There are many methods suggested by different authors (Alpha Method, Beta Method, Lambda method, etc.). In this article α –method for cohesive soil and β –method for cohesionless soil is discussed as BNBC (2015) incorporates both of them.

Unit Skin friction by α method for cohesive soil

The unit ultimate skin friction (fs) in clay can be expressed by following equation

fs = αc_u

Where,

α= adhesion factor

c_u= undrained shear strength = cohesion, c = q_u/2

There are several methods proposed empirically from test data by different authors to estimate the adhesion factor. American Petroleum Institute, API (1984) is based on total stress analysis. It neglects the effective stress effects in soil but widely used. There is also a new method proposed by Kolk and Velde (1996) which considers both cohesion and effective stress. BNBC (2015) integrates the API (1984) method to estimate adhesion factor for driven pile given as follows

α = 1.0 for cu ≤ 25kPa

α = 0.5 for cu ≥kPa

α = 1-(cu-25)/90 for 25 kPa <cu <70kPa

For bored pile, adhesion factor is chosen to be 0.7 times the value for driven piles by Fleming et al. (1985) and can be expressed as follows

α = 0.7for cu ≤25kPa

α = 0.35for cu ≥kPa

α = 0.7-(cu-25)/90 for 25 kPa <cu <70kPa

BNBC (2015) suggests in art 3.10.4.6 that the skin friction, fs may be taken as 2/3rd (0.67 times) the value of driven pile.

Unit Skin friction by β method for cohesionless soil

Numerous techniques have been proposed to compute the skin friction in pile in sandy soil and still it is not completely understand,

The unit ultimate skin friction (fs) in sandy can be expressed by following equation

$Fs = \beta \sigma'z$

Where,

β= friction factor due to over burden pressure, (Difference researchers (I.e, McClelland (1974) Meyerhof (1976) Kraft Lyons (1974) suggested different value of β)

σ´z = effective stress, kPa

BNBC (2015) integrates the Mayerhof (1976) method to estimate friction factor. B for driven pile and bored pile are given below

Driven Pile:

β = 0.44 for ϕ´ = 28°

β = 0.75 for ϕ´ = 35°

β = 1.2 for ϕ´ =

37° Bored Pile:

β = 0.10 for ϕ´ = 33°

β = 0.20 for ϕ´= 35°

β = 0.35 for ϕ´ = 37°

Equations of Unit End Bearing, fb

BNBC (2015) suggested to use Skempton (1959) equation to find out the unit end bearing in cohesive soil.

$ƒb = (cu)b\ Nc \leq 4000kPa$

Where

(cu)b = undrained shear strength at the base of pile (kPa)

Nc = Bearing capacity factor for deep foundation,

usually 9 =6(1+0.2L/B) ≤ 9.

L = Length of pile, m

B = width for square pile or diameter for circular pile at the tip of pile, m

BNBC (2015) adopted API (1984) method to find out the unit end bearing in granular soil as follows. $ƒb = (\sigma'z)bNq$

Where

σ'z = effective stress at pile tip ≤ 240kpa

Nq = bearing capacity factor

= 8 to 12 for loose sand

= 12 to 40 for medium sand

= 40 for dense sand

Table 1.2 can be used to find the compactness of sand. BNBC (2015) suggests in Art 3.10.4.6 that the end bearing, fb may taken as 1/3rd (0.33 times) the value of driven pile.

AXIAL PILE CAPACITY FROM N-VALUE

The ultimate load bearing capacity (Qult) of a pile consists of two parts. One part is due to friction or shaft friction or side shear (Qs) and the other is due to end bearing at the base or tip of the pile (Qb). The ultimate axial capacity of a pile shall be determined in accordance with the following for compression loading as suggested by BNBC, 2015 in art 3.10.

Qult = Qs + Qb - w, [Qs= As*fs, Qb=Ab*fb]

A) Cohesive soil:

Ultimate Skin Friction

fs (kPa) = 1.8 N60 ≤ 70 for driven pile, fs (kPa) = 1.2 N60 ≤ 70 for bored pile

Ultimate End Bearing Capacities

fb (kPa) = 45 N60 ≤ 4000 for driven pile, fb (kPa) = 25 N60 ≤ 4000 for bored pile

B. Cohesionless soil:

Ultimate Skin Friction

fb (kPa) = 2 N60 ≤ 60 for driven pile, fb (kPa) = 1 N60 ≤ 60 for bored pile

Ultimate End Bearing Capacities

fb (kPa) = 40 N60(L/D) ≤ 400N60 ≤ 11000 for

driven pile, fb (kPa) = 15 N60(L/D) ≤ 150N60 ≤

4000 for bored pile Total ultimate load capacity, Qu

= Qs+Qb

Allowable load capacity, Qallow = (Qs + Qb - w) / F.S

F.S = 4.00 for driven & 2.50 for bored pile. w= weight of pile, which is neglected.

Selection of Factor of Safety

Factor of safety is a very important issue in design. Project cost directly depends on the proper use of factor of safety. The recommended values of overall factor of safety on ultimate axial load capacity of driven bored pile and drilled shaft on specified construction control is presented in table 6.3.10b in BNBC (2015).

Factor of safety for Deep Foundation (Cduto, 1994; BNBC, 2015), Table: 3.2

Structure	Design Life (yrs)	Probability of Failure	Design Factor of Safety			
			Good Control	Normal Control	Poor Control	Very Poor Control
Monument	>100	10-5	2.30	3.00	3.50	4.00
Permanent	25-100	10-4	2.00	2.50	2.80	3.40
Temporary	<25	10-3	1.40	2.00	2.30	2.80

Proper Sub-soil Investigation	Yes	Yes	Yes	Yes
Proper Review of Sub-soil Report	Yes	Yes	Yes	Yes
Supervision by competent Geotechnical/Foundation Engineer	Yes	Yes	Yes	No
Load test data	Yes	Yes	Yes	No
Qualification of Contractor	Yes	Yes	No	No
Proper Construction Equipment/s	Yes	No	No	No
Maintaining proper construction Log	Yes	No	No	No

As a general guideline, it also states that a pile shall be designed for a minimum overall factor of safety of 2.0 against bearing capacity failure (end bearing, side resistance or combined) when the design is based on the results of a load test conducted at the side. Otherwise, it shall be designed for minimum overall factor of safety of 3.0. If normal level of field quality control cannot be assured, higher minimum factors of safety shall be used. Factor of safety chart is given in the table 3.2.

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Determination of Pile Bearing Capacity

Bore Hole # 1				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				450mm diameter cast in situ Pile								FS = 2.50		450mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	8	7	S		0.08	10	1.06	3.0	43.9	7.0	9.99	3.99	0.40	6.80	14.4	1020.0	162.1	176.6	70.62	7.09
3.00	24	20	S		0.15	20	4.05	14.5	178.3	28.3	42.80	17.12	1.72	20.40	57.7	3060.0	486.4	544.1	217.63	21.84
4.50	24	20	S		0.15	20	6.08	31.6	267.4	42.5	74.14	29.66	2.98	20.40	100.9	3060.0	486.4	587.3	234.93	23.58
6.00	29	25	S		0.15	20	8.14	54.6	358.2	56.9	111.59	44.64	4.48	24.65	205.4	3697.5	587.8	793.1	317.26	31.84
9.00	7	6	C	1.00			24.92	195.5	334.7	53.2	248.67	99.47	9.98	7.14	235.6	148.8	23.6	259.3	103.72	10.41
12.00	7	6	C	1.00			24.92	336.3	334.7	53.2	389.49	155.80	15.64	7.14	265.9	148.8	23.6	289.6	115.82	11.62
15.00	14	12	S		0.12	15	16.05	427.0	662.2	105.3	532.30	212.92	21.37	14.28	326.4	1785.0	283.7	610.2	244.08	24.50
18.00	18	15	S		0.12	15	19.34	536.3	797.7	126.8	663.13	265.25	26.62	18.36	404.3	2295.0	364.8	769.1	307.64	30.87
21.00	14	12	S		0.12	15	22.48	663.4	927.1	147.4	810.74	324.30	32.55	14.28	464.8	1785.0	283.7	748.6	299.42	30.05
24.00	16	14	S		0.12	15	25.74	808.8	1061.6	168.8	977.57	391.03	39.24	16.32	534.0	2040.0	324.3	858.3	343.31	34.45
27.00	31	26	S		0.20	25	48.94	1085.4	1980.0	314.7	1400.19	560.08	56.21	31.62	668.0	3952.5	628.3	1296.3	518.53	52.04
30.00	36	31	S		0.25	30	68.30	1471.4	2376.0	377.7	1849.14	739.66	74.23	36.72	823.7	4000.0	635.9	1459.5	583.81	58.59

C= Cohesive soil & S= Non cohesive soil

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Determination of Pile Bearing Capacity

Bore Hole # 1				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				500mm diameter cast in situ Pile								FS = 2.50		500mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	8	7	S		0.08	10	1.06	3.0	43.9	8.6	11.62	4.65	0.47	8.16	19.2	1020.0	200.2	219.4	87.76	8.81
3.00	24	20	S		0.15	20	4.05	14.5	178.3	35.0	49.44	19.78	1.98	24.48	76.9	3060.0	600.5	677.4	270.96	27.19
4.50	24	20	S		0.15	20	6.08	31.6	267.4	52.5	84.11	33.65	3.38	24.48	134.5	3060.0	600.5	735.0	294.02	29.51
6.00	29	25	S		0.15	20	8.14	54.6	358.2	70.3	124.95	49.98	5.02	29.58	204.2	3697.5	725.6	929.8	371.93	37.33
9.00	7	6	C	1.00			24.92	195.5	334.7	65.7	261.15	104.46	10.48	7.14	237.8	148.8	29.2	267.0	106.80	10.72
12.00	7	6	C	1.00			24.92	336.3	334.7	65.7	401.97	160.79	16.14	7.14	271.4	148.8	29.2	300.6	120.25	12.07
15.00	14	12	S		0.12	15	16.05	427.0	662.2	130.0	556.99	222.80	22.36	14.28	338.7	1785.0	350.3	689.0	275.60	27.66
18.00	18	15	S		0.12	15	19.34	536.3	797.7	156.6	692.88	277.15	27.82	18.36	425.2	2295.0	450.4	875.6	350.23	35.15
21.00	14	12	S		0.12	15	22.48	663.4	927.1	181.9	845.31	338.12	33.93	14.28	492.4	1785.0	350.3	842.7	337.09	33.83
24.00	16	14	S		0.12	15	25.74	808.8	1061.6	208.3	1017.16	406.86	40.83	16.32	569.3	2040.0	400.4	969.6	387.86	38.93
27.00	31	26	S		0.20	25	48.94	1085.4	1980.0	388.6	1474.02	589.61	59.17	31.62	718.2	3952.5	775.7	1493.9	597.56	59.97
30.00	36	31	S		0.25	30	68.30	1471.4	2376.0	466.3	1937.74	775.10	77.79	36.72	891.2	4000.0	785.0	1676.2	670.47	67.29

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Determination of Pile Bearing Capacity

Bore Hole # 1				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				600mm diameter cast in situ Pile								FS = 2.50		600mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	8	7	S		0.08	10	1.06	3.0	43.9	12.4	15.41	6.16	0.62	6.80	19.2	1020.0	288.3	307.5	122.99	12.34
3.00	24	20	S		0.15	20	4.05	14.5	178.3	50.4	64.84	25.94	2.60	20.40	76.9	3060.0	864.8	941.6	376.65	37.80
4.50	24	20	S		0.15	20	6.08	31.6	267.4	75.6	107.21	42.88	4.30	20.40	134.5	3060.0	864.8	999.3	399.71	40.12
6.00	29	25	S		0.15	20	8.14	54.6	358.2	101.2	155.88	62.35	6.26	24.65	204.2	3697.5	1044.9	1249.1	499.64	50.14
9.00	7	6	C	1.00			24.92	195.5	334.7	94.6	290.05	116.02	11.64	7.14	244.5	148.8	42.0	286.6	114.63	11.50
12.00	7	6	C	1.00			24.92	336.3	334.7	94.6	430.87	172.35	17.30	7.14	284.9	148.8	42.0	326.9	130.77	13.12
15.00	14	12	S		0.12	15	16.05	427.0	662.2	187.1	614.17	245.67	24.66	11.90	352.1	1785.0	504.4	856.6	342.64	34.39
18.00	18	15	S		0.12	15	19.34	536.3	797.7	225.4	761.76	304.70	30.58	15.30	438.6	2295.0	648.6	1087.2	434.88	43.64
21.00	14	12	S		0.12	15	22.48	663.4	927.1	262.0	925.37	370.15	37.15	11.90	505.9	1785.0	504.4	1010.3	404.13	40.56
24.00	16	14	S		0.12	15	25.74	808.8	1061.6	300.0	1108.83	443.53	44.51	13.60	582.7	2040.0	576.5	1159.3	463.70	46.54
27.00	31	26	S		0.20	25	48.94	1085.4	1980.0	559.5	1644.99	658.00	66.04	26.35	731.7	3952.5	1117.0	1848.7	739.46	74.21
30.00	36	31	S		0.25	30	68.30	1471.4	2376.0	671.5	2142.91	857.16	86.03	30.60	904.6	4000.0	1130.4	2035.0	814.01	81.70

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Graphical Representation of Pile's load bearing capacity

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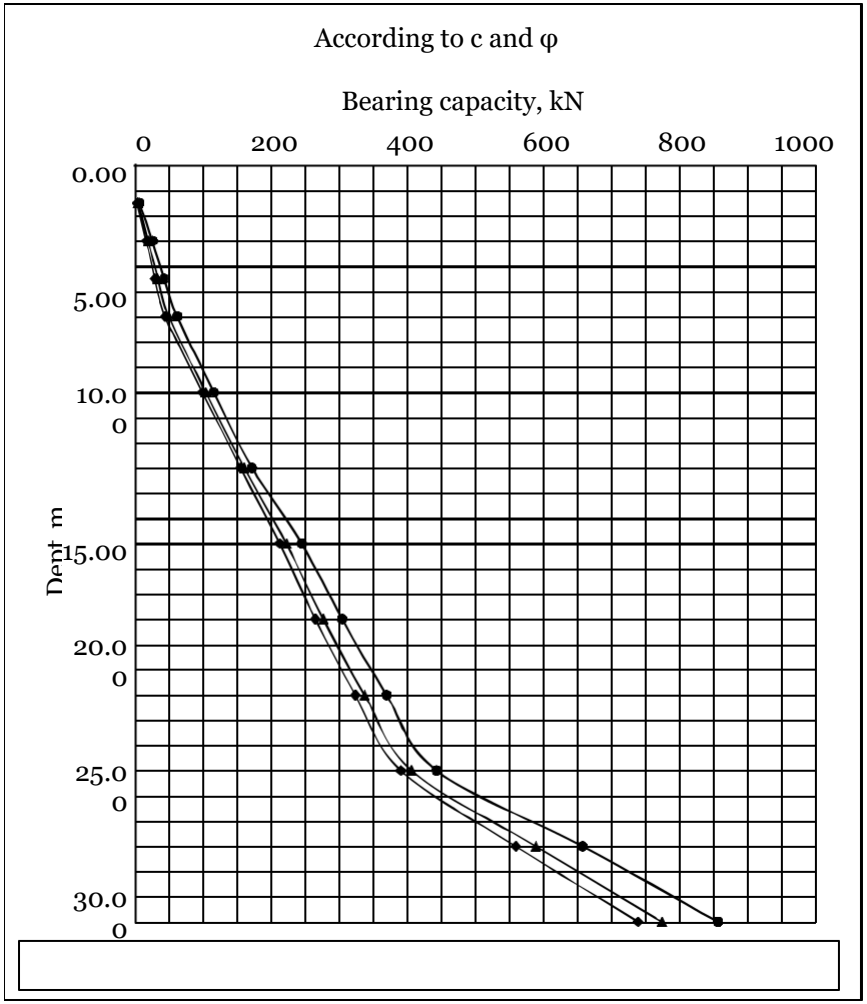

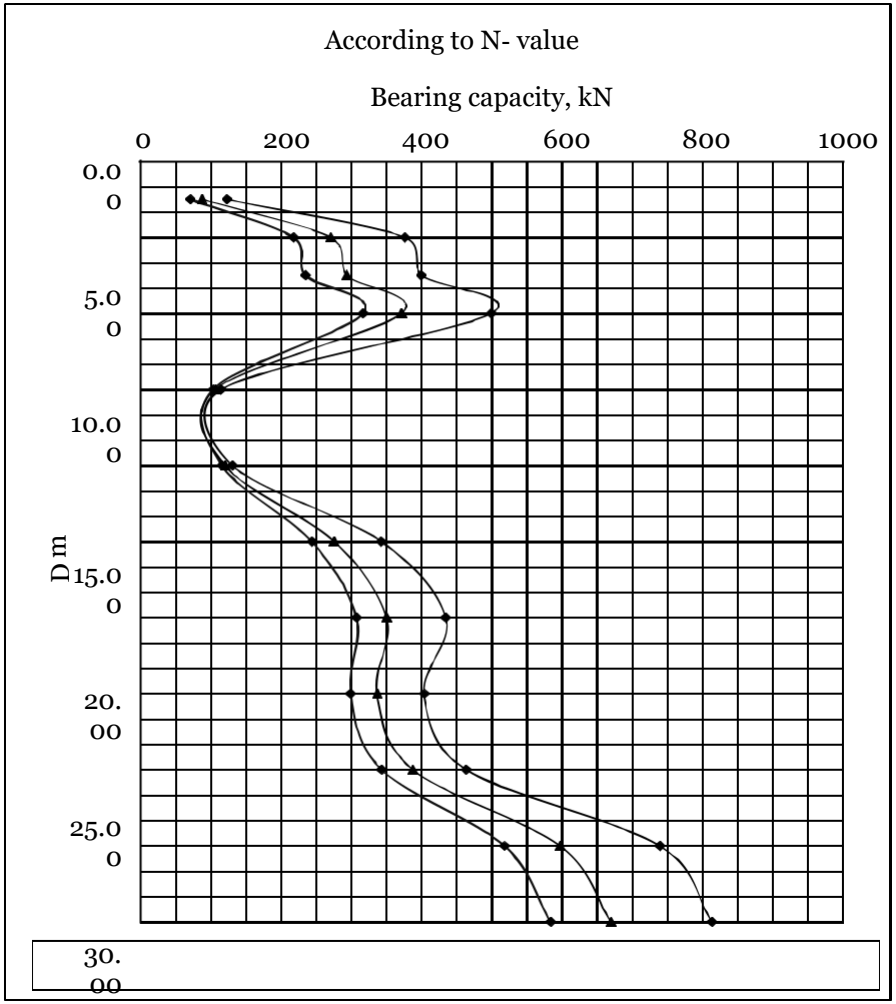

BANGLADESH ENVIRONMENTAL ENGINEERING
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Mamun Plaza (First Floor), 31, ShahidNazrul Islam Sharak,
Hatkhola, Tikatuli, Dhaka

Determination of Pile Bearing Capacity

Bore Hole # 2				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				450mm diameter cast in situ Pile								FS = 2.50		450mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	2	2	C	1.00			7.12	15.1	95.6	15.2	30.29	12.12	1.22	2.04	4.3	42.5	6.8	11.1	4.43	0.44
3.00	3	3	C	1.00			10.68	37.7	143.4	22.8	60.52	24.21	2.43	3.06	10.8	63.8	10.1	20.9	8.38	0.84
4.50	6	5	C	1.00			21.36	83.0	286.9	45.6	128.59	51.43	5.16	6.12	23.8	127.5	20.3	44.0	17.62	1.77
6.00	44	37	S		0.25	30	13.76	112.2	544.9	86.6	198.78	79.51	7.98	37.40	103.1	4000.0	635.9	738.9	295.56	29.66
9.00	14	12	S		0.12	15	9.63	153.0	397.3	63.2	216.15	86.46	8.68	11.90	153.5	1785.0	283.7	437.2	174.90	17.55
12.00	13	11	S		0.12	15	12.83	207.4	529.3	84.1	291.51	116.60	11.70	11.05	200.3	1657.5	263.5	463.8	185.53	18.62
15.00	25	21	S		0.15	20	20.28	293.3	892.2	141.8	435.17	174.07	17.47	21.25	290.4	3187.5	506.7	797.1	318.84	32.00
18.00	34	29	S		0.20	25	32.72	432.0	1349.7	214.6	646.59	258.64	25.96	28.90	412.9	4000.0	635.9	1048.8	419.51	42.10
21.00	50	43	S		0.30	35	58.12	678.4	2237.5	355.7	1034.08	413.63	41.51	42.50	593.1	4000.0	635.9	1228.9	491.57	49.33
24.00	50	43	S		0.30	35	66.42	960.0	2557.2	406.5	1366.44	546.58	54.86	42.50	773.2	4000.0	635.9	1409.1	563.63	56.57
27.00	50	43	S		0.30	35	74.72	1276.7	2772.0	440.6	1717.34	686.94	68.94	42.50	953.4	4000.0	635.9	1589.2	635.70	63.80
30.00	50	43	S		0.30	35	83.03	1628.6	2772.0	440.6	2069.29	827.71	83.07	42.50	1133.6	4000.0	635.9	1769.4	707.76	71.03

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Determination of Pile Bearing Capacity

Bore Hole # 2				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				500mm diameter cast in situ Pile								FS = 2.50		500mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	2	2	C	1.00			7.12	16.8	95.6	18.8	35.53	14.21	1.43	2.04	4.8	42.5	8.3	13.1	5.26	0.53
3.00	3	3	C	1.00			10.68	41.9	143.4	28.1	70.06	28.02	2.81	3.06	12.0	63.8	12.5	24.5	9.81	0.98
4.50	6	5	C	1.00			21.36	92.2	286.9	56.3	148.50	59.40	5.96	6.12	26.4	127.5	25.0	51.4	20.58	2.07
6.00	44	37	S		0.25	30	13.76	124.6	544.9	106.9	231.56	92.62	9.30	37.40	114.5	4000.0	785.0	899.5	359.80	36.11
9.00	14	12	S		0.12	15	9.63	170.0	397.3	78.0	247.96	99.18	9.95	11.90	170.5	1785.0	350.3	520.9	208.34	20.91
12.00	13	11	S		0.12	15	12.83	230.4	529.3	103.9	334.29	133.72	13.42	11.05	222.6	1657.5	325.3	547.9	219.15	21.99
15.00	25	21	S		0.15	20	20.28	325.9	892.2	175.1	501.03	200.41	20.11	21.25	322.7	3187.5	625.5	948.2	379.29	38.07
18.00	34	29	S		0.20	25	32.72	480.0	1349.7	264.9	744.92	297.97	29.90	28.90	458.8	4000.0	785.0	1243.8	497.52	49.93
21.00	50	43	S		0.30	35	58.12	753.8	2237.5	439.1	1192.89	477.15	47.89	42.50	659.0	4000.0	785.0	1444.0	577.59	57.97
24.00	50	43	S		0.30	35	66.42	1066.6	2557.2	501.8	1568.46	627.38	62.96	42.50	859.2	4000.0	785.0	1644.2	657.66	66.00
27.00	50	43	S		0.30	35	74.72	1418.6	2772.0	544.0	1962.56	785.02	78.79	42.50	1059.3	4000.0	785.0	1844.3	737.73	74.04
30.00	50	43	S		0.30	35	83.03	1809.6	2772.0	544.0	2353.61	941.44	94.48	42.50	1259.5	4000.0	785.0	2044.5	817.80	82.08

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Determination of Pile Bearing Capacity

Bore Hole # 2				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				600mm diameter cast in situ Pile								FS = 2.50		600mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	2	2	C	1.00			7.12	20.1	95.6	27.0	47.14	18.86	1.89	2.04	3.8	42.5	12.0	15.9	6.34	0.64
3.00	3	3	C	1.00			10.68	50.3	143.4	40.5	90.83	36.33	3.65	3.06	9.6	63.8	18.0	27.6	11.05	1.11
4.50	6	5	C	1.00			21.36	110.6	286.9	81.1	191.72	76.69	7.70	6.12	26.9	127.5	36.0	62.9	25.17	2.53
6.00	44	37	S		0.25	30	13.76	149.5	544.9	154.0	303.53	121.41	12.19	37.40	132.6	4000.0	1130.4	1263.0	505.20	50.70
9.00	14	12	S		0.12	15	9.63	204.0	397.3	112.3	316.27	126.51	12.70	11.90	199.9	1785.0	504.4	704.3	281.72	28.27
12.00	13	11	S		0.12	15	12.83	276.5	529.3	149.6	426.08	170.43	17.10	11.05	262.3	1657.5	468.4	730.7	292.29	29.33
15.00	25	21	S		0.15	20	20.28	391.1	892.2	252.1	643.26	257.30	25.82	21.25	382.4	3187.5	900.8	1283.2	513.28	51.51
18.00	34	29	S		0.20	25	32.72	576.0	1349.7	381.4	957.48	382.99	38.44	28.90	545.8	4000.0	1130.4	1676.2	670.46	67.29
21.00	50	43	S		0.30	35	58.12	904.5	2237.5	632.3	1536.85	614.74	61.70	42.50	786.0	4000.0	1130.4	1916.4	766.55	76.93
24.00	50	43	S		0.30	35	66.42	1279.9	2557.2	722.7	2002.59	801.04	80.39	42.50	1026.2	4000.0	1130.4	2156.6	862.63	86.57
27.00	50	43	S		0.30	35	74.72	1702.3	2772.0	783.4	2485.63	994.25	99.78	42.50	1266.4	4000.0	1130.4	2396.8	958.71	96.22
30.00	50	43	S		0.30	35	83.03	2171.5	2772.0	783.4	2954.89	1181.96	118.62	42.50	1506.6	4000.0	1130.4	2637.0	1054.80	105.86

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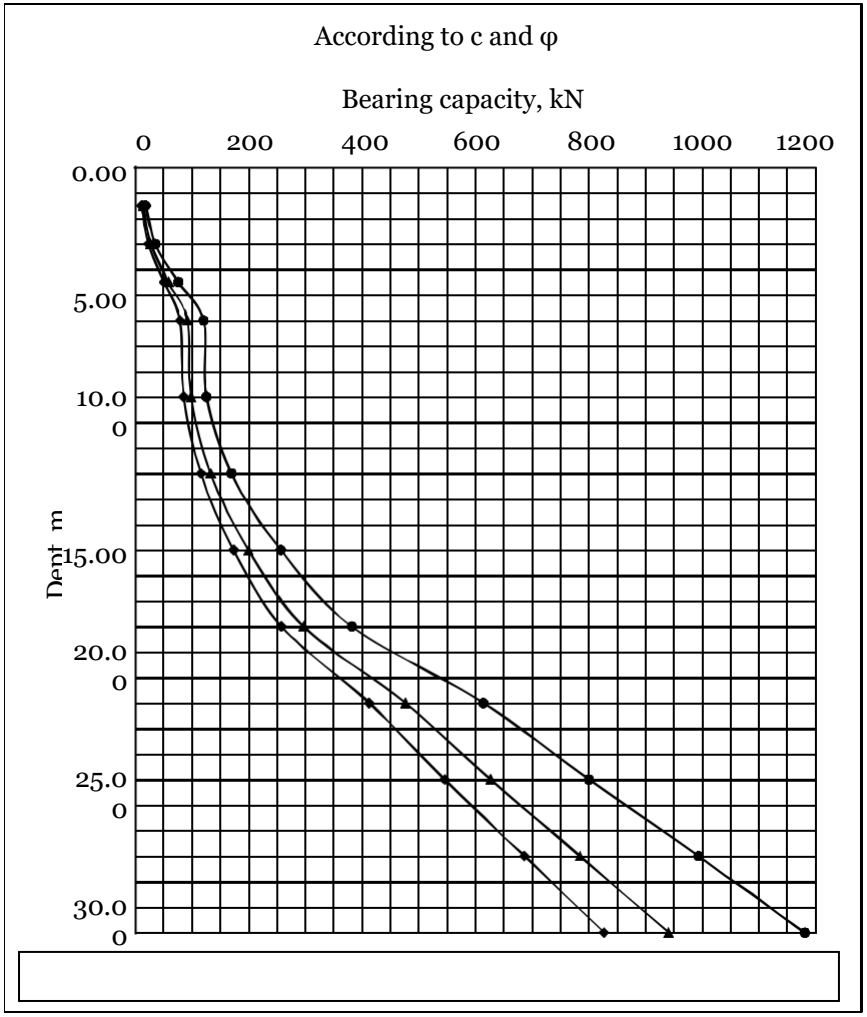
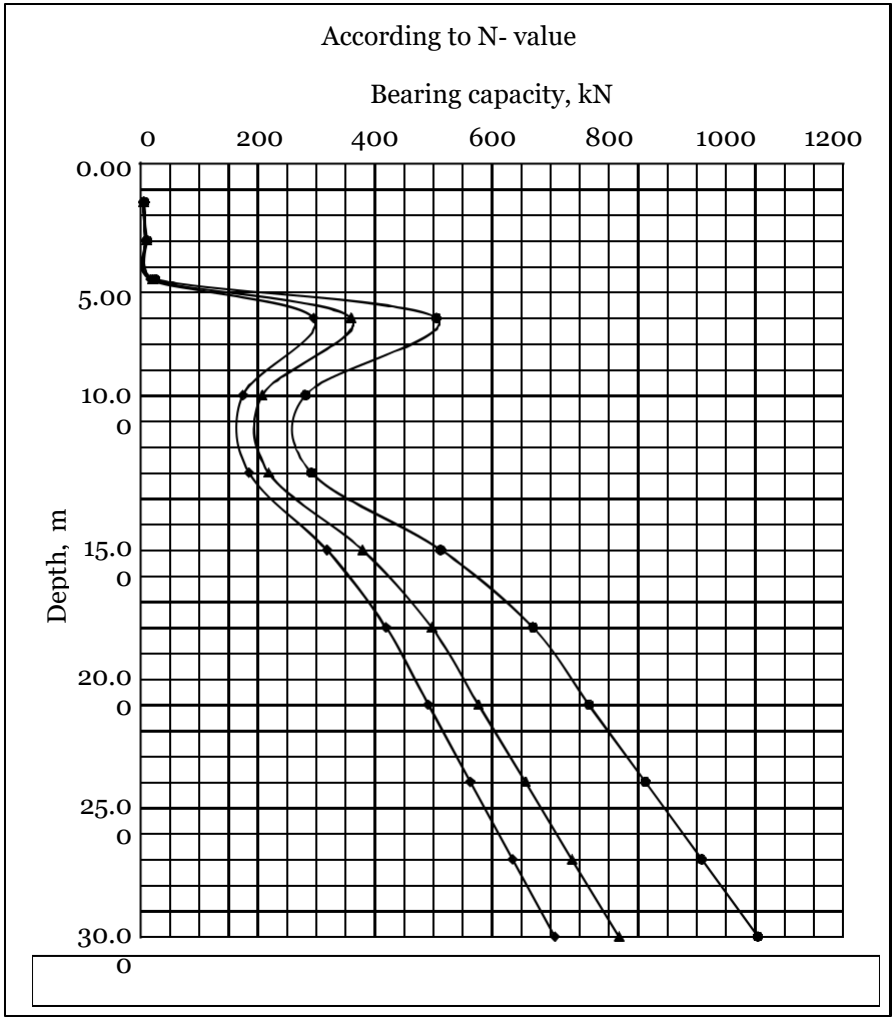
Graphical Representation of Pile's load bearing capacity

BH#02





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Hatkhola, Tikatuli, Dhaka

Determination of Pile Bearing Capacity

Bore Hole # 3				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				450mm diameter cast in situ Pile								FS = 2.50		450mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	8	7	S		0.08	12	1.06	2.3	52.7	8.4	10.63	4.25	0.43	6.80	14.4	1020.0	162.1	176.6	70.62	7.09
3.00	2	2	S		0.08	12	2.12	6.7	104.7	16.7	23.39	9.36	0.94	1.70	18.0	255.0	40.5	58.6	23.42	2.35
6.00	13	11	S		0.10	15	5.35	18.1	264.6	42.1	60.14	24.06	2.41	11.05	41.4	1657.5	263.5	304.9	121.97	12.24
9.00	7	6	S		0.08	12	6.38	45.1	315.8	50.2	95.30	38.12	3.83	5.95	66.7	892.5	141.9	208.5	83.41	8.37
12.00	26	22	S		0.15	20	16.24	113.9	714.5	113.6	227.52	91.01	9.13	22.10	160.3	3315.0	527.0	687.3	274.92	27.59
15.00	34	29	S		0.20	25	27.27	229.5	1124.8	178.8	408.32	163.33	16.39	28.90	282.8	4000.0	635.9	918.7	367.48	36.88
18.00	37	31	S		0.20	25	32.81	368.6	1353.5	215.2	583.78	233.51	23.44	31.45	416.2	4000.0	635.9	1052.0	420.81	42.23
21.00	47	40	S		0.30	35	57.96	614.3	2231.3	354.7	969.00	387.60	38.90	39.95	585.5	4000.0	635.9	1221.4	488.54	49.03
24.00	50	43	S		0.30	35	66.42	895.9	2557.2	406.5	1302.35	520.94	52.28	42.50	765.7	4000.0	635.9	1401.5	560.61	56.26
27.00	50	43	S		0.30	35	74.72	1212.6	2772.0	440.6	1653.25	661.30	66.37	42.50	945.8	4000.0	635.9	1581.7	632.67	63.50
30.00	50	43	S		0.30	35	83.03	1564.5	2772.0	440.6	2005.19	802.08	80.50	42.50	1126.0	4000.0	635.9	1761.8	704.73	70.73

BANGLADESH ENVIRONMENTAL ENGINEERING
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Determination of Pile Bearing Capacity

Bore Hole # 3				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				500mm diameter cast in situ Pile								FS = 2.50		500mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	8	7	S		0.08	12	1.06	2.5	52.7	10.3	12.84	5.14	0.52	6.80	16.0	1020.0	200.2	216.2	86.48	8.68
3.00	2	2	S		0.08	12	2.12	7.5	104.7	20.6	28.05	11.22	1.13	1.70	20.0	255.0	50.0	70.1	28.02	2.81
6.00	13	11	S		0.10	15	5.35	20.1	264.6	51.9	72.02	28.81	2.89	11.05	46.0	1657.5	325.3	371.3	148.53	14.91
9.00	7	6	S		0.08	12	6.38	50.1	315.8	62.0	112.09	44.84	4.50	5.95	74.1	892.5	175.2	249.2	99.69	10.00
12.00	26	22	S		0.15	20	16.24	126.6	714.5	140.2	266.82	106.73	10.71	22.10	178.2	3315.0	650.6	828.7	331.49	33.27
15.00	34	29	S		0.20	25	27.27	255.0	1124.8	220.7	475.77	190.31	19.10	28.90	314.3	4000.0	785.0	1099.3	439.71	44.13
18.00	37	31	S		0.20	25	32.81	409.6	1353.5	265.6	675.20	270.08	27.11	31.45	462.4	4000.0	785.0	1247.4	498.96	50.08
21.00	47	40	S		0.30	35	57.96	682.6	2231.3	437.9	1120.45	448.18	44.98	39.95	650.6	4000.0	785.0	1435.6	574.23	57.63
24.00	50	43	S		0.30	35	66.42	995.4	2557.2	501.8	1497.24	598.89	60.11	42.50	850.7	4000.0	785.0	1635.7	654.30	65.67
27.00	50	43	S		0.30	35	74.72	1347.3	2772.0	544.0	1891.34	756.54	75.93	42.50	1050.9	4000.0	785.0	1835.9	734.37	73.70
30.00	50	43	S		0.30	35	83.03	1738.4	2772.0	544.0	2282.39	912.96	91.63	42.50	1251.1	4000.0	785.0	2036.1	814.44	81.74

BANGLADESH ENVIRONMENTAL ENGINEERING
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Determination of Pile Bearing Capacity

Bore Hole # 3				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				600mm diameter cast in situ Pile								FS = 2.50		600mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	8	7	S		0.08	12	1.06	3.0	52.7	14.9	17.89	7.16	0.72	6.80	19.2	1020.0	288.3	307.5	122.99	12.34
3.00	2	2	S		0.08	12	2.12	9.0	104.7	29.6	38.59	15.44	1.55	1.70	24.0	255.0	72.1	96.1	38.43	3.86
6.00	13	11	S		0.10	15	5.35	24.1	264.6	74.8	98.88	39.55	3.97	11.05	55.2	1657.5	468.4	523.7	209.46	21.02
9.00	7	6	S		0.08	12	6.38	60.1	315.8	89.2	149.38	59.75	6.00	5.95	88.9	892.5	252.2	341.1	136.44	13.69
12.00	26	22	S		0.15	20	16.24	151.9	714.5	201.9	353.83	141.53	14.20	22.10	213.8	3315.0	936.8	1150.6	460.24	46.19
15.00	34	29	S		0.20	25	27.27	306.0	1124.8	317.9	623.90	249.56	25.05	28.90	377.1	4000.0	1130.4	1507.5	603.01	60.52
18.00	37	31	S		0.20	25	32.81	491.5	1353.5	382.5	873.99	349.60	35.09	31.45	554.9	4000.0	1130.4	1685.3	674.11	67.65
21.00	47	40	S		0.30	35	57.96	819.1	2231.3	630.6	1449.64	579.86	58.20	39.95	780.7	4000.0	1130.4	1911.1	764.43	76.72
24.00	50	43	S		0.30	35	66.42	1194.5	2557.2	722.7	1917.13	766.85	76.96	42.50	1020.9	4000.0	1130.4	2151.3	860.52	86.36
27.00	50	43	S		0.30	35	74.72	1616.8	2772.0	783.4	2400.17	960.07	96.35	42.50	1261.1	4000.0	1130.4	2391.5	956.60	96.01
30.00	50	43	S		0.30	35	83.03	2086.1	2772.0	783.4	2869.43	1147.77	115.19	42.50	1501.3	4000.0	1130.4	2631.7	1052.69	105.65

BANGLADESH ENVIRONMENTAL ENGINEERING
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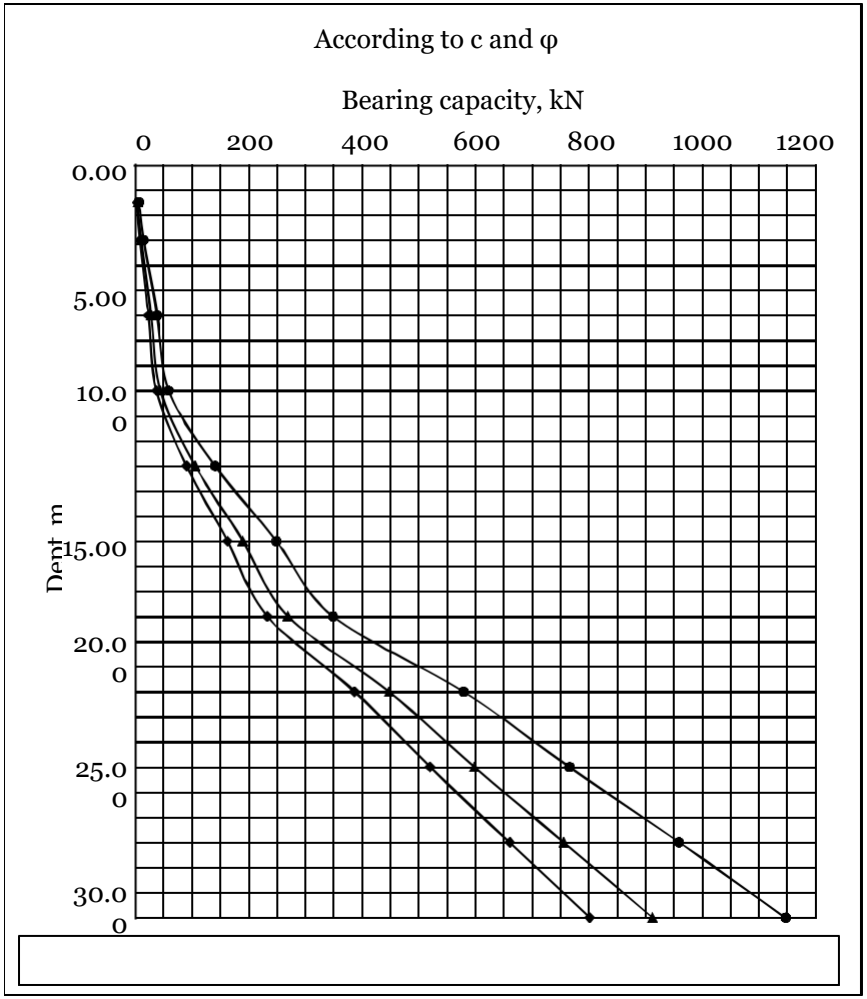
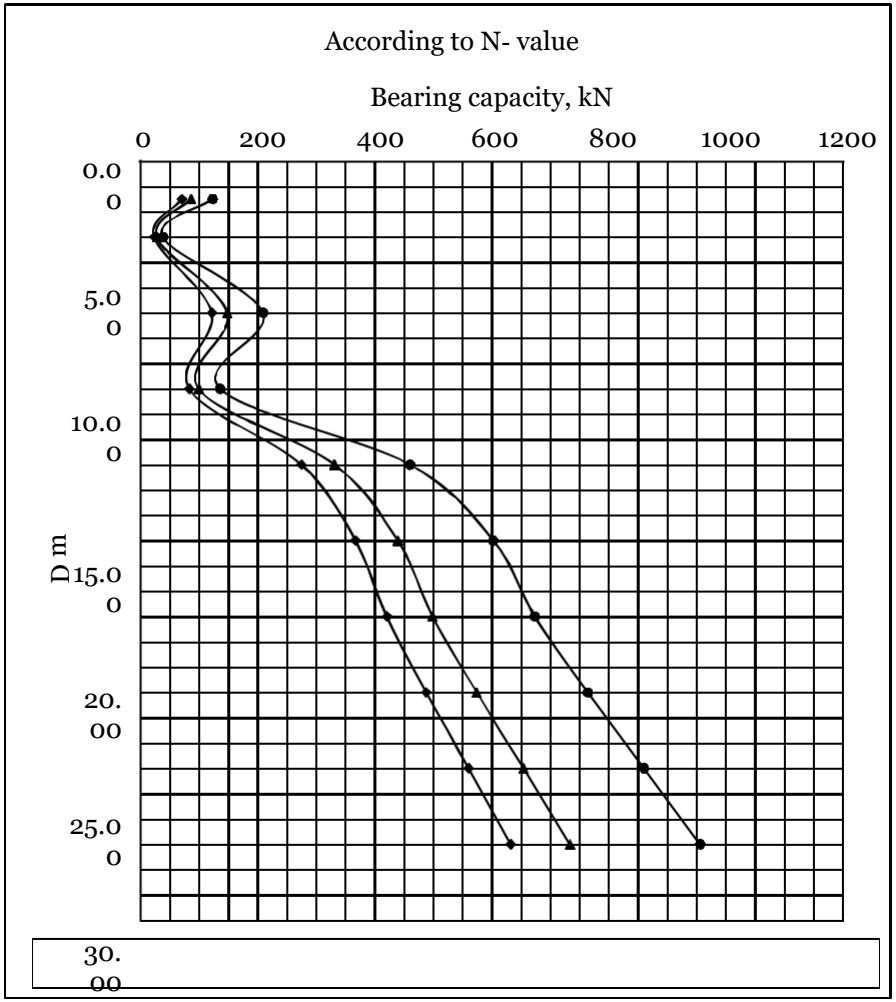
Graphical Representation of Pile's load bearing capacity

BH#03





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Determination of Pile Bearing Capacity

Bore Hole # 4				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				450mm diameter cast in situ Pile								FS = 2.50		450mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	2	2	S		0.08	10	1.06	2.2	95.6	15.2	17.44	6.98	0.70	1.70	3.6	255.0	40.5	44.1	17.66	1.77
3.00	5	4	S		0.08	10	2.12	6.7	239.1	38.0	44.74	17.90	1.80	4.25	12.6	637.5	101.3	113.9	45.58	4.57
6.00	8	7	S		0.10	12	5.32	18.0	382.5	60.8	78.82	31.53	3.16	6.80	27.0	1020.0	162.1	189.2	75.67	7.59
9.00	9	8	S		0.10	12	7.99	51.9	316.4	50.3	102.17	40.87	4.10	7.65	59.5	1147.5	182.4	241.9	96.74	9.71
12.00	13	11	S		0.10	12	10.69	97.2	423.4	67.3	164.52	65.81	6.60	11.05	106.3	1657.5	263.5	369.8	147.91	14.84
15.00	18	15	S		0.10	12	13.43	154.1	531.8	84.5	238.67	95.47	9.58	15.30	171.1	2295.0	364.8	536.0	214.39	21.52
18.00	32	27	S		0.20	25	32.66	292.6	1347.2	214.2	506.73	202.69	20.34	27.20	286.5	4000.0	635.9	922.3	368.92	37.03
21.00	36	31	S		0.25	30	47.81	495.2	1893.1	300.9	796.17	318.47	31.96	30.60	416.2	4000.0	635.9	1052.0	420.81	42.23
24.00	44	37	S		0.30	35	66.05	775.2	2543.0	404.2	1179.48	471.79	47.35	37.40	574.7	4000.0	635.9	1210.6	484.22	48.60
27.00	50	43	S		0.30	35	74.72	1092.0	2772.0	440.6	1532.62	613.05	61.53	42.50	754.9	4000.0	635.9	1390.7	556.28	55.83
30.00	50	43	S		0.30	35	83.03	1443.9	2772.0	440.6	1884.56	753.83	75.65	42.50	935.0	4000.0	635.9	1570.9	628.35	63.06

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Determination of Pile Bearing Capacity

Bore Hole # 4				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				500mm diameter cast in situ Pile								FS = 2.50		500mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	2	2	S		0.08	10	1.06	2.5	43.6	8.6	11.06	4.42	0.44	1.70	4.0	255.0	50.0	54.0	21.62	2.17
3.00	5	4	S		0.08	10	2.12	7.5	87.5	17.2	24.67	9.87	0.99	4.25	14.0	637.5	125.1	139.1	55.65	5.58
6.00	8	7	S		0.10	12	5.32	20.0	210.7	41.4	61.37	24.55	2.46	6.80	30.0	1020.0	200.2	230.2	92.08	9.24
9.00	9	8	S		0.10	12	7.99	57.6	316.4	62.1	119.73	47.89	4.81	7.65	66.1	1147.5	225.2	291.3	116.50	11.69
12.00	13	11	S		0.10	12	10.69	108.0	423.4	83.1	191.11	76.44	7.67	11.05	118.1	1657.5	325.3	443.4	177.36	17.80
15.00	18	15	S		0.10	12	13.43	171.3	531.8	104.4	275.63	110.25	11.07	15.30	190.2	2295.0	450.4	640.6	256.22	25.71
18.00	32	27	S		0.20	25	32.66	325.1	1347.2	264.4	589.47	235.79	23.66	27.20	318.3	4000.0	785.0	1103.3	441.31	44.29
21.00	36	31	S		0.25	30	47.81	550.3	1893.1	371.5	921.78	368.71	37.00	30.60	462.4	4000.0	785.0	1247.4	498.96	50.08
24.00	44	37	S		0.30	35	66.05	861.4	2543.0	499.1	1360.43	544.17	54.61	37.40	638.6	4000.0	785.0	1423.6	569.42	57.15
27.00	50	43	S		0.30	35	74.72	1213.3	2772.0	544.0	1757.31	702.93	70.55	42.50	838.7	4000.0	785.0	1623.7	649.49	65.18
30.00	50	43	S		0.30	35	83.03	1604.4	2772.0	544.0	2148.36	859.34	86.24	42.50	1038.9	4000.0	785.0	1823.9	729.56	73.22

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Determination of Pile Bearing Capacity

Bore Hole # 4				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				600mm diameter cast in situ Pile								FS = 2.50		600mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	2	2	S		0.08	10	1.06	3.0	43.6	12.3	15.32	6.13	0.62	1.70	4.8	255.0	72.1	76.9	30.75	3.09
3.00	5	4	S		0.08	10	2.12	9.0	87.5	24.7	33.73	13.49	1.35	4.25	16.8	637.5	180.2	197.0	78.79	7.91
6.00	8	7	S		0.10	12	5.32	24.0	210.7	59.5	83.57	33.43	3.35	6.80	36.0	1020.0	288.3	324.3	129.71	13.02
9.00	9	8	S		0.10	12	7.99	69.2	316.4	89.4	158.58	63.43	6.37	7.65	79.3	1147.5	324.3	403.6	161.42	16.20
12.00	13	11	S		0.10	12	10.69	129.6	423.4	119.7	249.27	99.71	10.01	11.05	141.7	1657.5	468.4	610.1	244.05	24.49
15.00	18	15	S		0.10	12	13.43	205.5	531.8	150.3	355.80	142.32	14.28	15.30	228.2	2295.0	648.6	876.8	350.71	35.20
18.00	32	27	S		0.20	25	32.66	390.1	1347.2	380.7	770.82	308.33	30.94	27.20	381.9	4000.0	1130.4	1512.3	604.93	60.71
21.00	36	31	S		0.25	30	47.81	660.3	1893.1	535.0	1195.31	478.12	47.99	30.60	554.9	4000.0	1130.4	1685.3	674.11	67.65
24.00	44	37	S		0.30	35	66.05	1033.6	2543.0	718.7	1752.30	700.92	70.35	37.40	766.3	4000.0	1130.4	1896.7	758.67	76.14
27.00	50	43	S		0.30	35	74.72	1456.0	2772.0	783.4	2239.34	895.73	89.90	42.50	1006.5	4000.0	1130.4	2136.9	854.75	85.78
30.00	50	43	S		0.30	35	83.03	1925.2	2772.0	783.4	2708.59	1083.44	108.74	42.50	1246.7	4000.0	1130.4	2377.1	950.84	95.43

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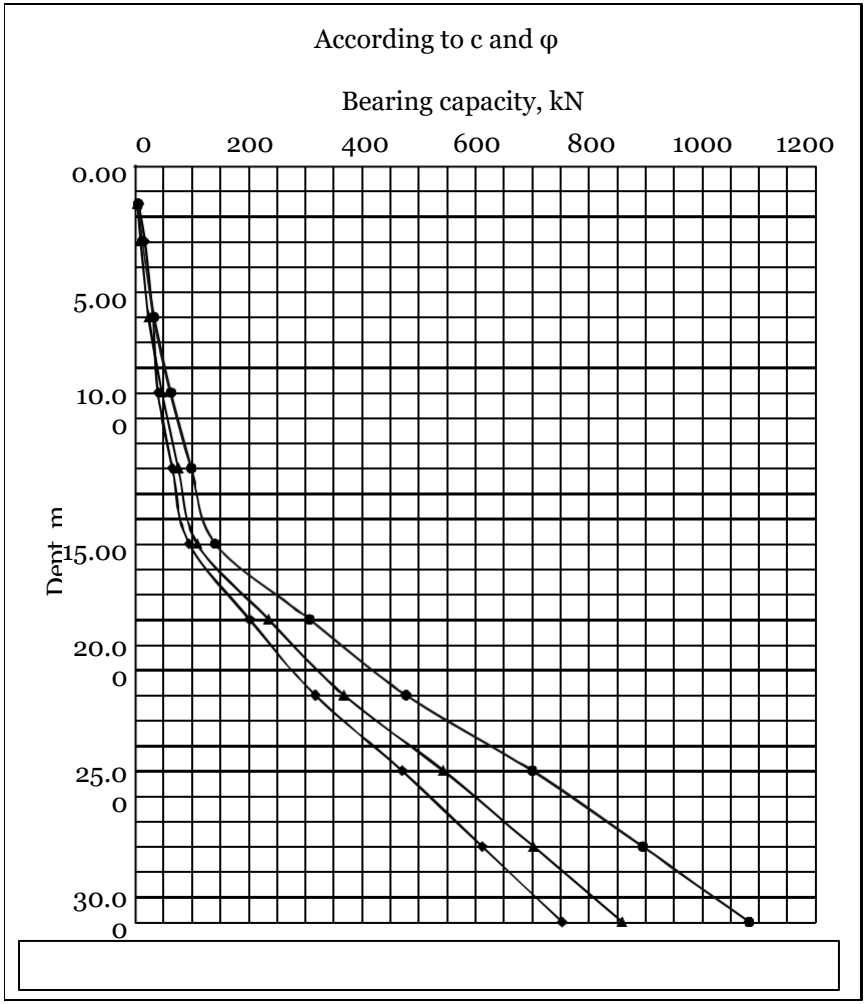
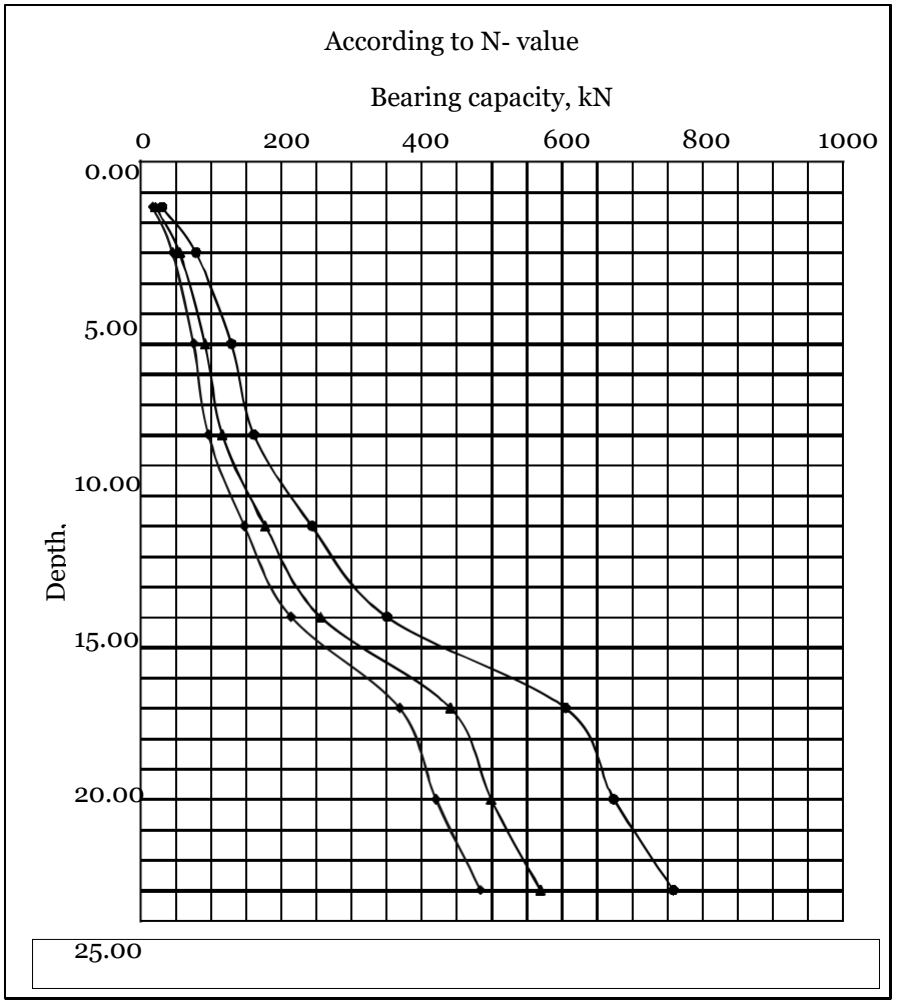
Graphical Representation of Pile's load bearing capacity

BH#04





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Determination of Pile Bearing Capacity

Bore Hole # 5				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				450mm diameter cast in situ Pile								FS = 2.50		450mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	26	22	S		0.20	25	2.71	5.7	111.6	17.7	23.48	9.39	0.94	22.10	46.8	3315.0	527.0	573.8	229.52	23.03
3.00	44	37	S		0.30	35	8.26	23.2	317.9	50.5	73.77	29.51	2.96	37.40	126.1	4000.0	635.9	762.0	304.78	30.59
6.00	50	43	S		0.30	35	16.61	93.6	639.3	101.6	195.25	78.10	7.84	42.50	306.3	4000.0	635.9	942.1	376.85	37.82
9.00	50	43	S		0.30	35	24.91	199.2	958.9	152.4	351.64	140.66	14.12	42.50	486.4	4000.0	635.9	1122.3	448.91	45.05
12.00	50	43	S		0.30	35	33.21	340.0	1278.6	203.2	543.23	217.29	21.81	42.50	666.6	4000.0	635.9	1302.4	520.97	52.29
15.00	50	43	S		0.30	35	41.51	516.0	1598.2	254.1	770.01	308.01	30.91	42.50	846.7	4000.0	635.9	1482.6	593.04	59.52
18.00	50	43	S		0.30	35	49.82	727.1	1917.9	304.9	1031.99	412.80	41.43	42.50	1026.9	4000.0	635.9	1662.7	665.10	66.75
21.00	50	43	S		0.30	35	58.12	973.5	2237.5	355.7	1329.16	531.67	53.36	42.50	1207.1	4000.0	635.9	1842.9	737.16	73.98
24.00	50	43	S		0.30	35	66.42	1255.0	2557.2	406.5	1661.53	664.61	66.70	42.50	1387.2	4000.0	635.9	2023.1	809.23	81.21
27.00	50	43	S		0.30	35	74.72	1571.8	2772.0	440.6	2012.43	804.97	80.79	42.50	1567.4	4000.0	635.9	2203.2	881.29	88.45
30.00	50	43	S		0.30	35	83.03	1923.7	2772.0	440.6	2364.37	945.75	94.92	42.50	1747.5	4000.0	635.9	2383.4	953.35	95.68

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Determination of Pile Bearing Capacity

Bore Hole # 5				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				500mm diameter cast in situ Pile								FS = 2.50		500mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	26	22	S		0.20	25	2.71	6.4	111.6	21.9	28.28	11.31	1.14	22.10	52.0	3315.0	650.6	702.6	281.05	28.21
3.00	44	37	S		0.30	35	8.26	25.8	317.9	62.4	88.20	35.28	3.54	37.40	140.1	4000.0	785.0	925.1	370.05	37.14
6.00	50	43	S		0.30	35	16.61	104.0	639.3	125.5	229.49	91.80	9.21	42.50	340.3	4000.0	785.0	1125.3	450.12	45.17
9.00	50	43	S		0.30	35	24.91	221.3	958.9	188.2	409.53	163.81	16.44	42.50	540.5	4000.0	785.0	1325.5	530.19	53.21
12.00	50	43	S		0.30	35	33.21	377.8	1278.6	250.9	628.68	251.47	25.24	42.50	740.6	4000.0	785.0	1525.6	610.26	61.25
15.00	50	43	S		0.30	35	41.51	573.3	1598.2	313.7	886.94	354.77	35.61	42.50	940.8	4000.0	785.0	1725.8	690.33	69.28
18.00	50	43	S		0.30	35	49.82	807.9	1917.9	376.4	1184.30	473.72	47.54	42.50	1141.0	4000.0	785.0	1926.0	770.40	77.32
21.00	50	43	S		0.30	35	58.12	1081.6	2237.5	439.1	1520.76	608.30	61.05	42.50	1341.2	4000.0	785.0	2126.2	850.47	85.35
24.00	50	43	S		0.30	35	66.42	1394.5	2557.2	501.8	1896.33	758.53	76.13	42.50	1541.3	4000.0	785.0	2326.3	930.54	93.39
27.00	50	43	S		0.30	35	74.72	1746.4	2772.0	544.0	2290.43	916.17	91.95	42.50	1741.5	4000.0	785.0	2526.5	1010.61	101.43
30.00	50	43	S		0.30	35	83.03	2137.5	2772.0	544.0	2681.48	1072.59	107.65	42.50	1941.7	4000.0	785.0	2726.7	1090.68	109.46

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Determination of Pile Bearing Capacity

Bore Hole # 5				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				600mm diameter cast in situ Pile								FS = 2.50		600mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.50	26	22	S		0.20	25	2.71	7.6	111.6	31.5	39.20	15.68	1.57	22.10	62.5	3315.0	936.8	999.3	399.71	40.12
3.00	44	37	S		0.30	35	8.26	31.0	317.9	89.8	120.81	48.33	4.85	37.40	168.1	4000.0	1130.4	1298.5	519.42	52.13
6.00	50	43	S		0.30	35	16.61	124.8	639.3	180.7	305.50	122.20	12.26	42.50	408.4	4000.0	1130.4	1538.8	615.50	61.77
9.00	50	43	S		0.30	35	24.91	265.6	958.9	271.0	536.61	214.64	21.54	42.50	648.6	4000.0	1130.4	1779.0	711.59	71.42
12.00	50	43	S		0.30	35	33.21	453.3	1278.6	361.3	814.64	325.86	32.70	42.50	888.8	4000.0	1130.4	2019.2	807.67	81.06
15.00	50	43	S		0.30	35	41.51	687.9	1598.2	451.7	1139.60	455.84	45.75	42.50	1129.0	4000.0	1130.4	2259.4	903.75	90.70
18.00	50	43	S		0.30	35	49.82	969.5	1917.9	542.0	1511.49	604.60	60.68	42.50	1369.2	4000.0	1130.4	2499.6	999.84	100.35
21.00	50	43	S		0.30	35	58.12	1298.0	2237.5	632.3	1930.30	772.12	77.49	42.50	1609.4	4000.0	1130.4	2739.8	1095.92	109.99
24.00	50	43	S		0.30	35	66.42	1673.4	2557.2	722.7	2396.04	958.42	96.19	42.50	1849.6	4000.0	1130.4	2980.0	1192.01	119.63
27.00	50	43	S		0.30	35	74.72	2095.7	2772.0	783.4	2879.08	1151.63	115.58	42.50	2089.8	4000.0	1130.4	3220.2	1288.09	129.27
30.00	50	43	S		0.30	35	83.03	2565.0	2772.0	783.4	3348.34	1339.34	134.42	42.50	2330.0	4000.0	1130.4	3460.4	1384.17	138.92

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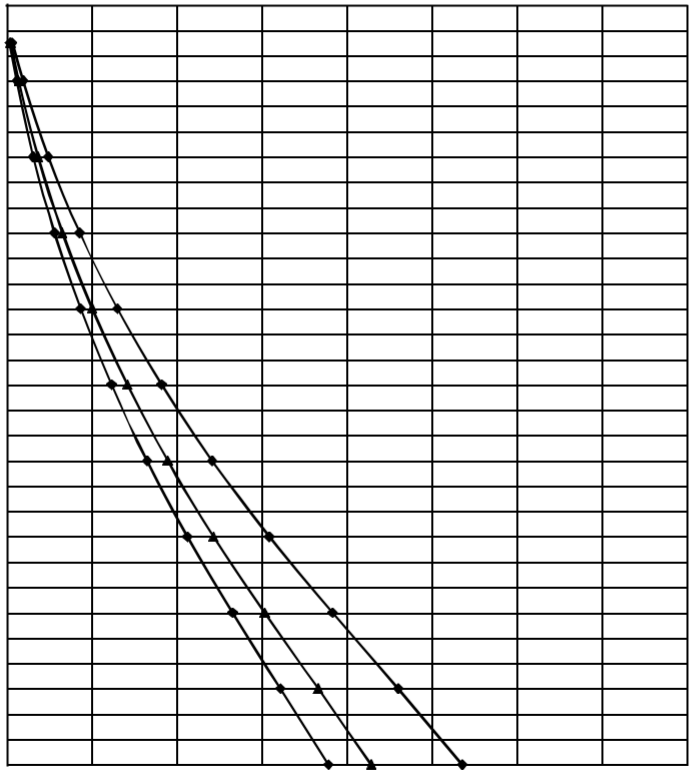
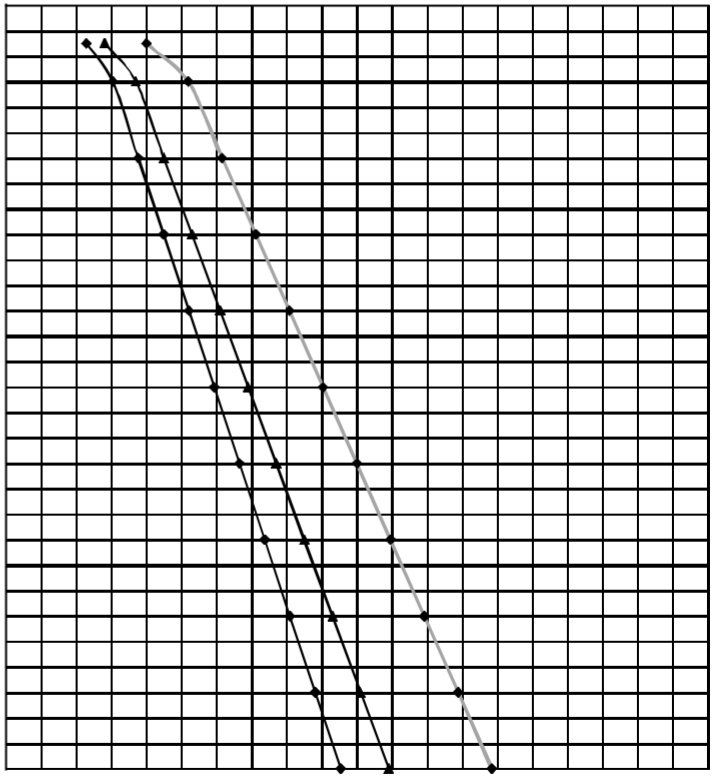
Graphical Representation of Pile's load bearing capacity

BH#05

According to c and φ



According to N- value



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Determination of Pile Bearing Capacity

Bore Hole # 6				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				450mm diameter cast in situ Pile								FS = 2.50		450mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.5	22	19	S		0.15	20	2.02	4.3	89.0	14.1	18.43	7.37	0.74	18.70	39.6	2805.0	445.9	485.5	194.21	19.49
3	40	34	S		0.20	25	5.48	15.9	226.2	36.0	51.87	20.75	2.08	34.00	111.7	4000.0	635.9	747.5	299.02	30.01
6	50	43	S		0.30	35	16.61	51.1	639.3	101.6	152.73	61.09	6.13	42.50	201.8	4000.0	635.9	837.6	335.05	33.63
9	50	43	S		0.30	35	24.91	103.9	958.9	152.4	256.33	102.53	10.29	42.50	291.9	4000.0	635.9	927.7	371.08	37.24
12	50	43	S		0.30	35	33.21	174.3	1278.6	203.2	377.53	151.01	15.16	42.50	381.9	4000.0	635.9	1017.8	407.11	40.86
15	50	43	S		0.30	35	41.51	262.3	1598.2	254.1	516.33	206.53	20.73	42.50	472.0	4000.0	635.9	1107.9	443.15	44.47
18	50	43	S		0.30	35	49.82	367.9	1917.9	304.9	672.72	269.09	27.01	42.50	562.1	4000.0	635.9	1197.9	479.18	48.09
21	50	43	S		0.30	35	58.12	491.0	2237.5	355.7	846.71	338.69	33.99	42.50	652.2	4000.0	635.9	1288.0	515.21	51.71
24	50	43	S		0.30	35	66.42	631.8	2557.2	406.5	1038.30	415.32	41.68	42.50	742.2	4000.0	635.9	1378.1	551.24	55.32
27	50	43	S		0.30	35	74.72	790.2	2772.0	440.6	1230.83	492.33	49.41	42.50	832.3	4000.0	635.9	1468.2	587.27	58.94
30	50	43	S		0.30	35	83.03	966.2	2772.0	440.6	1406.80	562.72	56.48	42.50	922.4	4000.0	635.9	1558.3	623.30	62.56

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Determination of Pile Bearing Capacity

Bore Hole # 6				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				500mm diameter cast in situ Pile								FS = 2.50		500mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.5	22	19	S		0.15	20	2.02	4.8	89.0	17.5	22.22	8.89	0.89	18.70	44.0	2805.0	550.5	594.5	237.81	23.87
3	40	34	S		0.20	25	5.48	17.7	226.2	44.4	62.07	24.83	2.49	34.00	124.1	4000.0	785.0	909.1	363.64	36.50
6	50	43	S		0.30	35	16.61	56.8	639.3	125.5	182.24	72.90	7.32	42.50	224.2	4000.0	785.0	1009.2	403.68	40.51
9	50	43	S		0.30	35	24.91	115.4	958.9	188.2	303.63	121.45	12.19	42.50	324.3	4000.0	785.0	1109.3	443.71	44.53
12	50	43	S		0.30	35	33.21	193.6	1278.6	250.9	444.57	177.83	17.85	42.50	424.4	4000.0	785.0	1209.4	483.75	48.55
15	50	43	S		0.30	35	41.51	291.4	1598.2	313.7	605.06	242.03	24.29	42.50	524.5	4000.0	785.0	1309.5	523.78	52.57
18	50	43	S		0.30	35	49.82	408.7	1917.9	376.4	785.11	314.04	31.52	42.50	624.5	4000.0	785.0	1409.5	563.82	56.59
21	50	43	S		0.30	35	58.12	545.6	2237.5	439.1	984.71	393.88	39.53	42.50	724.6	4000.0	785.0	1509.6	603.85	60.60
24	50	43	S		0.30	35	66.42	702.0	2557.2	501.8	1203.85	481.54	48.33	42.50	824.7	4000.0	785.0	1609.7	643.89	64.62
27	50	43	S		0.30	35	74.72	878.0	2772.0	544.0	1421.99	568.79	57.08	42.50	924.8	4000.0	785.0	1709.8	683.92	68.64
30	50	43	S		0.30	35	83.03	1073.5	2772.0	544.0	1617.51	647.00	64.93	42.50	1024.9	4000.0	785.0	1809.9	723.96	72.66

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Hatkhola, Tikatuli, Dhaka

Determination of Pile Bearing Capacity

Bore Hole # 6				According to shear strength parameter, BNBC, 2015										According to N-value, BNBC, 2015						
Detail Pile Data				600mm diameter cast in situ Pile								FS = 2.50		600mm diameter cast in situ Pile					FS = 2.50	
Depth, m	N	N60	Sample type	α	β	Nq	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton	fs,kPa	Qs, kN	fb,kPa	Qb, kN	Qu, kN	Qa, kN	Qa, ton
1.5	22	19	S		0.15	20	2.02	5.7	89.0	14.1	19.86	7.94	0.80	18.70	52.8	2805.0	792.7	845.5	338.22	33.94
3	40	34	S		0.20	25	5.48	21.2	226.2	63.9	85.14	34.06	3.42	34.00	148.9	4000.0	1130.4	1279.3	511.73	51.36
6	50	43	S		0.30	35	16.61	68.1	639.3	180.7	248.80	99.52	9.99	42.50	269.0	4000.0	1130.4	1399.4	559.77	56.18
9	50	43	S		0.30	35	24.91	138.5	958.9	271.0	409.52	163.81	16.44	42.50	389.1	4000.0	1130.4	1519.5	607.82	61.00
12	50	43	S		0.30	35	33.21	232.4	1278.6	361.3	593.71	237.48	23.83	42.50	509.2	4000.0	1130.4	1639.6	655.86	65.82
15	50	43	S		0.30	35	41.51	349.7	1598.2	451.7	801.35	320.54	32.17	42.50	629.4	4000.0	1130.4	1759.8	703.90	70.64
18	50	43	S		0.30	35	49.82	490.5	1917.9	542.0	1032.46	412.98	41.45	42.50	749.5	4000.0	1130.4	1879.9	751.94	75.47
21	50	43	S		0.30	35	58.12	654.7	2237.5	632.3	1287.03	514.81	51.67	42.50	869.6	4000.0	1130.4	2000.0	799.98	80.29
24	50	43	S		0.30	35	66.42	842.4	2557.2	722.7	1565.07	626.03	62.83	42.50	989.7	4000.0	1130.4	2120.1	848.03	85.11
27	50	43	S		0.30	35	74.72	1053.6	2772.0	783.4	1836.95	734.78	73.74	42.50	1109.8	4000.0	1130.4	2240.2	896.07	89.93
30	50	43	S		0.30	35	83.03	1288.2	2772.0	783.4	2071.57	828.63	83.16	42.50	1229.9	4000.0	1130.4	2360.3	944.11	94.75

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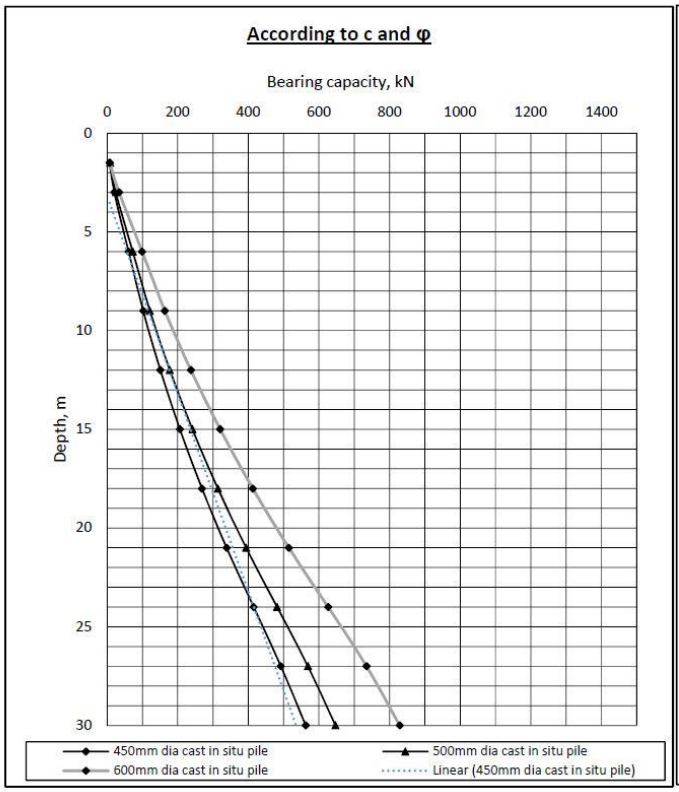
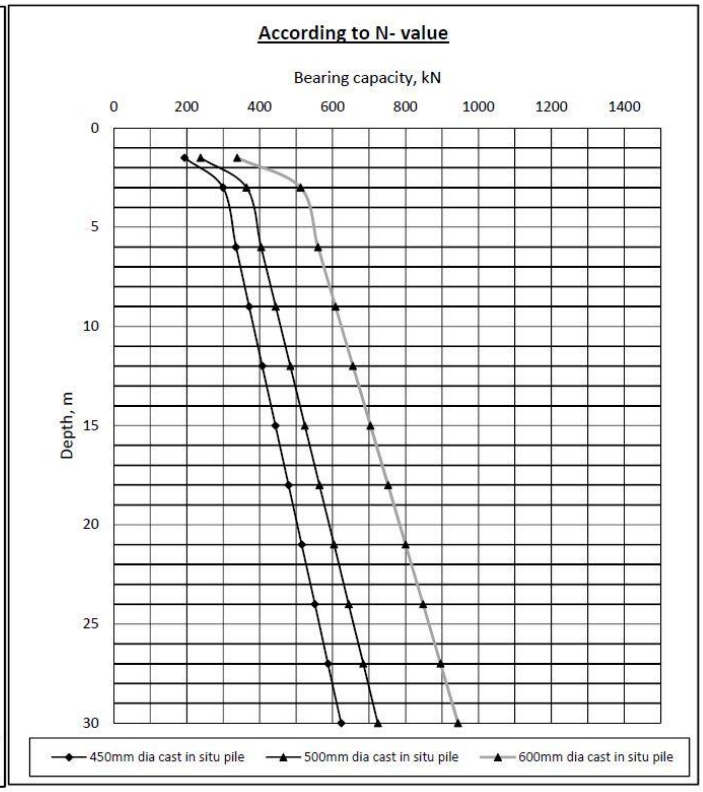
Mamun Plaza (First Floor), 31, ShahidNazrul Islam Sharak,
Hatkhola, Tikatuli, Dhaka

Graphical Representation of Pile's load bearing capacity

BH # 06





CHAPTER-7
Monitoring Ambient Air & Noise

CHAPTER-7 Monitoring Ambient Air & Noise

7.1 PROJECT SUMMARY

1.7

Sonadia Eco-Tourism Park is located at Sonadia Island at Maheshkhali Upazila. Sonadia Island is about 9 square kilometers (3.5 square miles), offshore of the Cox's Bazaar coast in Chittagong Division, Bangladesh. It is only 3 kilometer from Cox's Bazar via Maheshkhali channel. The western side of the island is sandy and northern part of the island is green. BEZA will develop this zone as environment friendly Eco-Tourism Park, where maximum 30% of land may use as a part of truism attraction.

Fig. 7.1 Sample Location Map

Sampling Location ID with GPS Coordinate

Location ID	Tested Parameters	Latitude	Longitude
Location 1 or L1	Air, Noise	21'30"5.57" N	91'52"7.52" E
Location 2 or L2	Air, Noise	21'28"43.60" N	91'55"18.72" E

Sampling Details

Sampling locations for air quality are identical to noise monitoring locations. Noise level monitoring at these two locations were done during these time period. Both day & night value of sound level has been measured accurately.

Air Quality Sampling Time schedule

Location	Date	Time started	Time ended	Duration
L1	25-26 Feb 2020	11.40 pm	11.20 pm	23 hrs 40 mins
L2	26-27 Feb 2020	11.50 pm	11.45 pm	23 hrs 55 mins

Noise Monitoring Time schedule

Location	Date	Day		Night	
		Start	End	Start	End
L1	25-26 Feb 2020	10.35 am	11.00 pm	9.10 pm	9.30 pm
L2	26-27 Feb 2020	10.05 pm	10.30 pm	8.50 pm	9.15 m

7.2 AIR QUALITY MONITORING

7.2.1 Introduction

Air pollution is the change in the natural composition of the air we breathe, beyond some defined limits. This change is induced by releasing harmful substances into the atmosphere and it causes damage to our health and environment. Natural sources of air pollution include sea spray, volcanic activity, forest fire, and dust storms. Anthropogenic sources include motor vehicles, industrial production processes, and power generation.

7.2.2 Basic of Different parameters:

The main pollutants that can affect human health are often known as “criteria” pollutants and these include:

a. Particulate matter

Particulate matter is the general term used to describe a mixture of solid and liquid particles in air including dust, soot, smoke, and dirt. PM10 is particulate matter less than 10 microns in aerodynamic diameter and is often called the coarse fraction. PM2.5 is particulate matter less than 2.5 microns (about 0.0001 inch) in aerodynamic diameter and is often called the fine fraction.

PM10 and PM2.5 particles are small enough to penetrate into and accumulate in the respiratory system. Exposure can cause respiratory morbidity, impaired lung function and irritation. It is also carcinogenic. This pollution is sometimes referred to as “black carbon pollution”.

Suspended particulate matter (SPM) are finely divided solids or liquids that may be dispersed through the air from combustion processes, industrial activities or natural sources.

b. Oxides of Nitrogen

Nitrogen dioxide (NOx) is a noxious gas, highly reactive and it is formed when fuel is burned at high temperature. The main sources are motor vehicles, power plants and industrial boilers. Nitrogen dioxide can cause respiratory problems. It can also take part in the chemical reactions in the atmosphere to form corrosive nitric acid and can also react with sunlight to form ground level ozone.

Long term exposure can decrease lung function, increase the risk of respiratory conditions and increases the response to allergens. NOx also contributes to the formation of fine particles (PM) and ground level ozone, both of which are associated with adverse health effects.

c. Carbon monoxide

Carbon monoxide (CO) is a gas that is slightly lighter than air and is formed when carbon in fuel is not burned completely. In urban areas, almost all CO is produced by motor vehicles. Exposure to CO can disrupt the supply of oxygen to the body tissue, cause neurobehavioral effects and cardiovascular problems.

d. Sulfur dioxide

Sulfur dioxide (SOx) is a gas that is often produced in the burning of fossil fuels containing Sulphur. It can cause respiratory problems and damage vegetation. Sulfur dioxide dissolves easily in water and therefore can contribute to acid rain, once it released into the atmosphere.

e. Carbon Dioxide

Most of the air pollution we cause results from the burning of fossil fuels, such as coal, oil, natural gas, and gasoline to produce electricity and power our vehicles. Carbon dioxide (CO_2) is a good indicator of how much fossil fuel is burned and how much of other pollutants are emitted as a result.

Fresh-air contains about 400 ppm CO_2. The exhaust gas of combustion engine contains about 140,000 ppm CO_2. Human breath contains about 50,000 ppm CO_2. Indoor ventilation is well-balanced at a level of 1,000 ppm CO_2.

7.2.3 Methodology

Particulate monitoring is accomplished with Respirable Dust sampler, which is a vacuum type device that draws air with particulate matter through a filter paper. Particles within the range of 100 to 0.1 microns diameter are ordinarily collected on glass fiber filter. The instrument sucks the ambient air with a blower at a flow rate that allows suspended particles to pass to the filter surface. This sampling filter paper is dried up in the laboratory and the weight difference is the amount of PM10 or PM2. 5, content measured in micro grams per cubic meter of air collected over a period of 24 hours.

Principle of West Gaeke Method: This method is based on the absorption and stabilization of SO_2 from air by a solution of Sodium tetrachloromercurate II to form the dichlorosulfitomercurate II complex. Quantitative determination is accomplished by adding acid bleached parasonaline HCl and formaldehyde to the sulfite complex and measuring the color intensity by a UV Spectrophotometer.

Principle of Jacobs-Hochheiser Method: Ambient NO_2 is collected by bubbling Air through a solution of Sodium Hydroxide and Sodium Arsenite. The concentration of Nitrite ion produce during sampling is determined colorimetrically by reacting the Nitrite ion with Hydrogen Peroxide, Sulphanilamide, NEDA (N-(1-Naphthyl) Ethylenediamine di-hydrochoride) and measuring the Absorbance of highly colored azo dye at 540 nm.

7.2.4 Equipment Used

The APM 460 sampler uses an improved cyclone with sharper cutoff (D50 at 10 microns) to separate the coarser particulates from the air stream before filtering it on the glass microfibre filter. By using the APM 460, measurement of Respirable Particulate Matter can be done accurately and TSPM can also be assessed by collection of dust retained in the cyclone cup.

Fig 7.2: APM 460 sampler

APM 460 BL comes with an in-built voltage stabilizer to compensate for voltage fluctuations. This model has been made more user-friendly by providing a lighting arrangement for night operation, tool box within the instrument, softer handles, lockable top-cover and wheels foreasy transportation. The cabinet design has also been improved to prevent entry of rain water and dust into the machine. Owing to its modular design, APM 460 BL can be easily paired with a gaseous sampling attachment (for monitoring SO2, NOx, NH3, Ozone etc.) as gaseous sampling requires only a few LPM of air flow.

Fig 7.3: AAS 127 Mini

The AAS 127 system is a manual method for sampling fine particles (PM2.5 fraction) and is based on impactor designs standardized by USEPA for ambient air quality monitoring. Ambient air enters the sampler system through an omni-directional inlet designed to provide a clean aerodynamic cut-point for particles greater than 10 microns. Particles in the air stream finer than 10 microns proceed to a second impactor that has an aerodynamic cut-point at 2.5 microns. The air sample and fine particulates exiting from the PM 2.5 impactor are passed through a 47 mm diameter Teflon filter membrane that retains the fine particulate matter. The sampling rate of the system is held constant at 1 m3/hr by a suitable critical orifice. The standard system is supplied with a Dry Gas Meter to provide a direct measure of the total air volume sampled. Owing to its modular design, APM 550 can be easily paired with a gaseous sampling attachment (for monitoring SO2, NOx, NH3, Ozone etc) as gaseous sampling requires only a few LPM of air flow.

Ambient Air Sampling Photographs (L1)

Ambient Air Sampling Photographs (L2)

Table 7.1: Ambient Air Quality Analysis Result

SN	Parameters	Methodology	Test Duration (Min)	Unit	L1	L2	Bangladesh (DoE) Standard	IFC /World Bank Standard
1	PM2.5	Gravimetric	480	µg/m3	21.16	13.62	65	75
2	PM10	Gravimetric	480	µg/m3	63.15	81.23	150	150
3	SPM	Gravimetric	480	µg/m3	90.72	100.27	200	NF
4	SO2	West-Geake	480	µg/m3	7.83	7.61	365	125
5	NOx	Jacob and Hochheiser	480	µg/m3	10.31	9.44	NF*	200
6	CO	CO Meter	60	ppm	0	0	NF	NF

Terminology:

1. Fine Particulate Matter (PM2.5).
2. Respirable Dust Content (PM10).

c Suspended Particulate Matter (SPM).

4. DoE- Department of Environment
5. NF- Not Found

Comment: - The above result for ambient air quality monitoring shows the PM2.5, PM10 & SPM concentrations of the ambient air. From the above results it is discernible that all the parameters are within the allowable limits.

Test Performed & Lab Report Prepared by:

Mousumi Bepari

Mousumi Rani Bepari
Executive (Lab & Environment)

Test Supervised by:

Dr. Fatima Akter
Director, BEETLSL

7.3 NOISE QUALITY MONITORING

7.3.1 Methodology of Noise Level Analysis

Noise quality will measured instantly on the site by Wensn WS 1361C Digital Sound Level Meter. At each location minimum 20 minutes with 2 minutes interval reading were taken. At the time of measurement, whenever there is an interfering effect like mike noise, human voice from house and bazaar, vehicular sound, sound of machine and tool from workshop etc. are also recorded.

7.3.2 Monitoring of Noise Level

Noise is an important environmental pollutant. A survey by the U S. Federal Council of Science and Technology has revealed that noise is a technology generated problem and that the overall loudness of environmental noise doubles every ten years in pace with our social and industrial progress. This geometric progression wise growth of noise could be mind-boggling in view of the ever-increasing pace of technological growth.

Measurement of noise—Noise is a combination of intensity and frequency and can be measured in decibels. Decibel is a unit of sound, named after Alexander Graham Bell.

The level of sound is usually expressed in terms of the Sound Pressure Level (SPL) in decibels, which is defined as:

$$SPL = 20 \log_{10} P/ P_0 \text{ dB}$$

Where P is the pressure variation measured in N/ m2 and P0 is the standard reference pressure taken as 2x 10 – 5 N /m2

7.3.3 Monitoring procedure of noise level

Noise quality has been measured instantly on the site by Noise level meter. At each location 10 to 12 times reading were taken over a short period of time. Three measurements such as maximum, minimum and mode were recorded. At the time of measurement, whenever there was an interfering effect like mike noise, human voice from house and bazaar, vehicular sound, sound of machine and tool from workshop etc., was also recorded.

Fig 7.6: Wensn WS 1361C

Table 7.2: Instrument Specification (Noise Meter)

Design Standards	IEC651 TYPE 2; ANSI S1.4 TYPE 2
Measuring Range	30~130 dBA or 35~130 dBC
Frequency Weighting	A and C
Time Weighting	Fast & Slow
Linearity Weighting	50 dB
Resolution	0.1 dB
Sample rate	2 times/second

Noise Monitoring Photographs (L1)

Noise Monitoring Photograph (L2)

Table 7.3: Noise Level Analysis Result

SN.	Site Location ID	Site Condition	Concentrations present (LAeq) dBA.	
			Day	Night
01	L1	Pre-construction Stage	53.84	47.14
02	L2	Pre-construction Stage	48.23	48.64
DoE (Bangladesh) Standard for Industrial area			75	70
IFC/International Standard for Industrial/Commercial Zone			70	70

All units are in (LAeq) dBA.

Comment: According to the Department of Environment (ECR-1997), the standard for ambient noise level in the industrial zone is 75 decibels at day & 70 decibels at night. In that case all the results were found within the limit as per DoE Standards.

Test Performed & Lab Report Prepared by:

Mousumi Bepari

Mousumi Rani Bepari
Executive (Lab & Environment)

Test Supervised by:

Dr. Fatima Akter
Director, BEETLSL

Attachment

Monitoring SURFACE & GROUND WATER

8.1 Monitoring of Water Quality Status:

Water quality is one of the important indicators of the environment. As such water samples from the surface and groundwater sources were collected from upstream and downstream area to understand the baseline condition of both the sources. Some parameters such as pH, DO, TDS, EC of the surface water quality were measured in-situ during the field visit while the rests were measured in the lab. For the groundwater, water samples were collected from the tube-wells at two points at the upstream and downstream area of Paschimpara and Purbapara respectively of Sonadia Island and tested in BEETLSL Environmental Laboratory.

8.1.1 Surface Water Quality:

Twelve different surface water quality parameters such as, BOD, COD, Total Suspended Solids (TDS), Total Dissolved Solids (TSS), Turbidity, Electrical Conductivity (EC), Dissolved Oxygen (DO), Total Coliform (TC), Phospahte (PO4), Total Iron, Oil & Grease and Temperature were measure among which major physicochemical properties such as pH, DO, EC, TDS were measure in-situ during the field visit while the rests were measured in the laboratory. Table 8.1 and 8.2 presents the values of different parameters of the surface water quality with reference to the DoE standard. It shows that all values are within the standard limit except EC and oil and grease where the former one is related to high salinity and the later one may arise from navigational activities in the surface water. The surface water quality of the study area is found satisfactory for fisheries and not satisfactory for irrigation due to salinity. Thus comprehensive environmental implication of these identified surface water qualities on the eco-tourism development interventions along with their cumulative impacts on the downstream water quality need to be explored.

8.1.2 Ground Water Quality:

Groundwater samples have been collected from the tube wells of the nearby community in the upstream and downstream of the study area to understand the groundwater quality. The sample has been investigated from laboratory test. Table 8.3 and 8.4 show the test result. The tube-wells at Paschimpara was 20ft depth and Purbapara was 30ft depth. All the parameters were found within the limit except lead in the downstream sample which might be distinctive to this sample only and attributed to natural origin as there are no industrial activities in the study area. However, detailed investigations on ground water availability, quality and composition will help to identify the viable sources of domestic/industrial water for the project.

Fig. 8.1 Ground water sample collection-01

Ground water sample collection-02

Surface water sample collection-01

Surface water sample collection-02

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.
Mamun Plaza (First Floor) 31, Shahid Nazrul Islam sharak, Hatkhola, Tikatuli, Dhaka - 1203, Bangladesh, Phone: +88-02-7175845, 7118094, Mobile: +8801729269355,+88 01712009373,
Email: info.beetlsl@gmail.com

Sample Ref. No : 2020.02.05-SW- U -009	Delivery Date : 22.02.2020
Name of Company/Organization : Dev Consultants Ltd.	Location : Sonadia Eco-Tourism Park at Maheshkhali Upazila (Paschimpara, Sonadia) GPS Location: 21°30´ 5.57 ″N 91°52´ 7.52 ″E
Sample Collected by : BEETLSL Personnel.	Sampling Date: 25.01.20
Name of Test :	Physical/ Chemical/ Biological Analysis of Surface Water/ Ground Water
Service Duration:	General: 5 or 7 working days; Emergency: 3 or 4 working days; Urgent: 2 or 3 working days;

Table 8.1: Test Report: Surface Water-Upstream

SL No.	Surface Water Upstream	Concentration Present	Unit	ECR 1997 Standard for Drinking Water	Methods of Analysis
1.	BOD	10	mg/L	50	APHA22ndEDN.2012 (5210 B)
2.	COD	26	mg/L	200	APHA22ndEDN.2012 (5220 B)
3.	Total Suspended Solids (TSS)	24	mg/L	150-650	APHA22ndEDN.2012 (2540 D)
4.	Total Dissolved Solids (TDS)	280	mg/L	2100	APHA22ndEDN.2012 (2540C)
5.	Turbidity	2.62	NTU	10	APHA22ndEDN.2012 (2130 B)
6.	Electrical Conductivity (EC)	42.69	mS/cm	1200	APHA22ndEDN.2012 (2510 B)
7.	Dissolved Oxygen (DO)	8.43	mg/L	5 or more	APHA22ndEDN.2012 (4500 O)
8.	Total Coliform(TC)	40	CFU/100 ml	200	APHA22ndEDN.2012 (9222H)
9.	Phospahte (PO4)	0.05	mg/L	8	APHA22ndEDN.2012 (4500 P)
10.	Total Iron	0.28	mg/L	0.3-1.0	APHA22ndEDN.2012 (3500- Fe)
11.	Oil & Grease	10	mg/L	0.01	APHA22ndEDN.2012 (5520 B)
12.	Temperature	20	o C	(20-30) oC	APHA22ndEDN.2012 (2550 B)

Test Performed & Lab Report Prepared by:

Mousumi Rani Bepari
Executive (Lab & Environment)

Test Supervised by:

Dr. Fatima Akter
Director, BEETLSL

BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.
Mamun Plaza (First Floor) 31, Shahid Nazrul Islam sharak, Hatkhola, Tikatuli, Dhaka - 1203, Bangladesh, Phone: +88-02-7175845, 7118094, Mobile: +8801729269355,+88 01712009373,
Email: info.beetlsl@gmail.com

Sample Ref. No : 2020.02.05-SW- D -009	Delivery Date : 22.02.2020
Name of Company/Organization : Dev Consultants Ltd.	Location : Sonadia Eco-Tourism Park at Maheshkhali Upazila (Purbapara, Sonadia) GPS Location: 21°28´ 43.60˝ N 91°55´ 18.72 ˝E
Sample Collected by : BEETLSL Personnel.	Sampling Date: 25.01.20
Name of Test :	Physical/ Chemical/ Biological Analysis of Surface Water/ Ground Water
Service Duration:	General: 5 or 7 working days; Emergency: 3 or 4 working days; Urgent: 2 or 3 working days;

Table 8.2: Test Report: Surface Water Downstream

SL No.	Surface Water Downstream	Concentration Present	Unit	ECR 1997 Standard for Drinking Water	Methods of Analysis
1.	BOD	8	mg/L	50	APHA22ndEDN.2012 (5210 B)
2.	COD	18	mg/L	200	APHA22ndEDN.2012 (5220 B)
3.	Total Suspended Solids (TSS)	20	mg/L	150-650	APHA22ndEDN.2012 (2540 D)
4.	Total Dissolved Solids (TDS)	115	mg/L	2100	APHA22ndEDN.2012 (2540C)
5.	Turbidity	0.14	NTU	10	APHA22ndEDN.2012 (2130 B)
6.	Electrical Conductivity (EC)	16.34	mS/cm	1200	APHA22ndEDN.2012 (2510 B)
7.	Dissolved Oxygen (DO)	8.28	mg/L	5 or more	APHA22ndEDN.2012 (4500 O)
8.	Total Coliform(TC)	45	CFU/100 ml	200	APHA22ndEDN.2012 (9222H)
9.	Phospahte (PO4)	0.05	mg/L	8	APHA22ndEDN.2012 (4500 P)
10.	Total Iron	0.56	mg/L	0.3-1.0	APHA22ndEDN.2012 (3500- Fe)
11.	Oil & Grease	11	mg/L	0.01	APHA22ndEDN.2012 (5520 B)
12.	Temperature	21	o C	(20-30) oC	APHA22ndEDN.2012 (2550 B)

Test Performed & Lab Report Prepared by:

Mousumi Bepari

Mousumi Rani Bepari
Executive (Lab & Environment)

Test Supervised by:

Dr. Fatima Akter
Director, BEETLSL

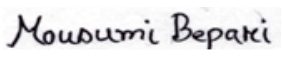
BANGLADESH ENVIRONMENTAL ENGINEERING TRAINING & LAB SERVICES LTD.
Mamun Plaza (First Floor) 31, Shahid Nazrul Islam sharak, Hatkhola, Tikatuli, Dhaka - 1203, Bangladesh, Phone: +88-02-7175845, 7118094, Mobile: +8801729269355,+88 01712009373,
Email: info.beetlsl@gmail.com

Sample Ref. No : 2020.02.05-GW- 01 -009	Delivery Date : 22.02.2020
Name of Company/Organization : Dev Consultants Ltd.	Location : Sonadia Eco-Tourism Park at Maheshkhali Upazila (Paschimpara, Sonadia) GPS Location: 21°30´ 5.57 ˝N 91°52´ 7.52 ˝E
Sample Collected by : BEETLSL Personnel.	Sampling Date: 25.01.20
Name of Test :	Physical/ Chemical/ Biological Analysis of Surface Water/ Ground Water
Service Duration:	General: 5 or 7 working days; Emergency: 3 or 4 working days; Urgent: 2 or 3 working days;

Table 8.3: Test Report: Ground Water Upstream

SL No.	Ground Water	Concentration Present	Unit	ECR 1997 Standard for Drinking Water	Methods of Analysis
1	COD	4	mg/L	4	APHA22ndEDN.2012 (5220 B)
2	Total Dissolved Solids (TDS)	142.5	mg/L	1000	APHA22ndEDN.2012 (2540C)
3	Electrical Conductivity (EC)	220.69	µS/cm	-	APHA22ndEDN.2012 (2510 B)
4	Chloride(Cl-)	73	mg/L	150-600	APHA22ndEDN.2012 (4500-Cl-)
5	Temperature	21	oC	20-30	APHA22ndEDN.2012 (2550 B)
6	Dissolved Oxygen (DO)	7.78	mg/L	6	APHA22ndEDN.2012 (4500 O)
7	Total Coliform(TC)	0	CFU/100ml	0	APHA22ndEDN.2012 (9222H)
8	Fecal Coliform(FC)	0	CFU/100ml	0	-
9	Arsenic	0.01	mg/L	0.05	APHA22ndEDN.2012 (3500-As)
10	Mangnesse	0.04	mg/L	0.1	APHA22ndEDN.2012 (3500- Mn)
11	Lead	0.01	mg/L	0.05	-
12	Iron	0.33	mg/L	0.3-1.0	APHA22ndEDN.2012 (3500- Fe)
13	Alkalinity	220	mg/L	-	APHA22ndEDN.2012 (2320-B)

Test Performed & Lab Report Prepared by:



Mousumi Rani Bepari
Executive (Lab & Environment)

Test Supervised by:

Dr. Fatima Akter
Director, BEETLSL

BANGLADESH ENVIRONMENTAL ENGINEERING
TRAINING & LAB SERVICES LTD.
Mamun Plaza (First Floor) 31, Shahid Nazrul Islam sharak, Hatkhola, Tikatuli, Dhaka - 1203, Bangladesh, Phone: +88-02-7175845, 7118094, Mobile: +8801729269355,+88 01712009373,Email: info.beetlsl@gmail.com

Sample Ref. No : 2020.02.05-GW- 02 -009	Delivery Date : 22.02.2020
Name of Company/Organization : Dev Consultants Ltd.	Location : Sonadia Eco-Tourism Park at Maheshkhali Upazila (Purbapara, Sonadia) GPS Location: 21°28´ 43.60˝ N 91°55´ 18.72 ˝E
Sample Collected by : BEETLSL Personnel.	Sampling Date: 25.01.20
Name of Test :	Physical/ Chemical/ Biological Analysis of Surface Water/ Ground Water
Service Duration:	General: 5 or 7 working days; Emergency: 3 or 4 working days; Urgent: 2 or 3 working days;

Table 8.4: Test Report: Ground Water Downstream

SL No.	Ground Water	Concentration Present	Unit	ECR 1997 Standard for Drinking Water	Methods of Analysis
1	COD	3.0	mg/L	4	APHA22ndEDN.2012 (5220 B)
2	Total Dissolved Solids (TDS)	137.2	mg/L	1000	APHA22ndEDN.2012 (2540C)
3	Electrical Conductivity (EC)	200.9	µS/cm	-	APHA22ndEDN.2012 (2510 B)
4	Chloride (Cl-)	95	mg/L	150-600	APHA22ndEDN.2012 (4500-Cl-)
5	Temperature	22	oC	20-30	APHA22ndEDN.2012 (2550 B)
6	Dissolved Oxygen (DO)	7.62	mg/L	6	APHA22ndEDN.2012 (4500 O)
7	Total Coliform(TC)	0	CFU/100ml	0	APHA22ndEDN.2012 (9222H)
8	Fecal Coliform(FC)	0	CFU/100ml	0	-
9	Arsenic	0.01	mg/L	0.05	APHA22ndEDN.2012 (3500-As)
10	Manganesse	0.05	mg/L	0.1	APHA22ndEDN.2012 (3500- Mn)
11	Lead	0.46	mg/L	0.05	-
12	Iron	0.27	mg/L	0.3-1.0	APHA22ndEDN.2012 (3500- Fe)
13	Alkalinity	225	mg/L	-	APHA22ndEDN.2012 (2320-B)

Test Performed & Lab Report Prepared by:

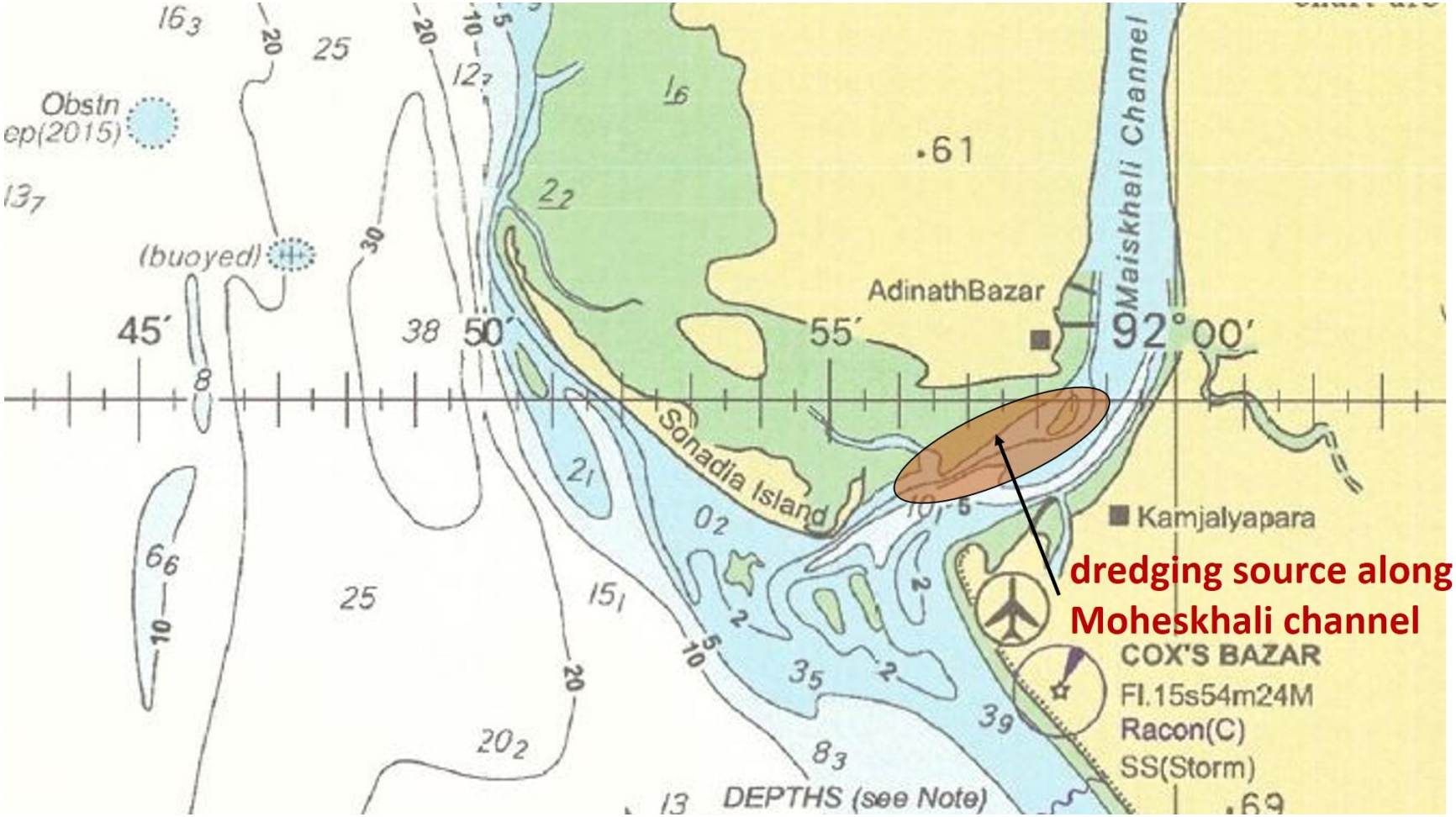
Mousumi Bepari

Mousumi Rani Bepari
Executive (Lab & Environment)

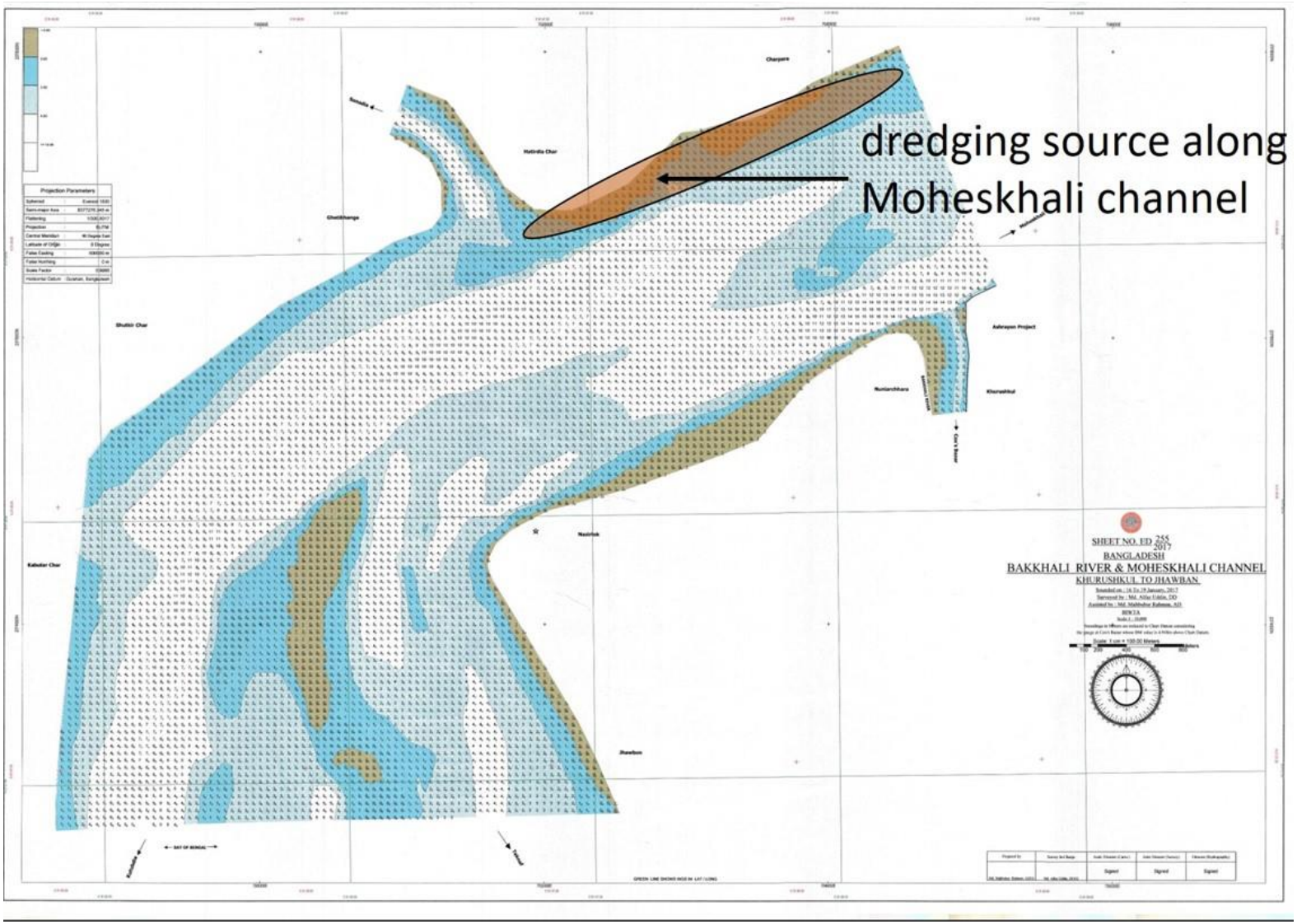
Test Supervised by:

Dr. Fatima Akter
Director, BEETLSL

14.12. Annexure 12: Location map for dredging



Note: Detailed hydrostatic study has to be carried out for identifying the suitable point of dredging and necessary permission has to be obtained from Bangladesh Inland Water Transport Authority (BIWTA) authorities for dredging of sand



Note: Detailed hydrostatic study has to be carried out for identifying the suitable point of dredging and necessary permission has to be obtained from Bangladesh Inland Water Transport Authority (BIWTA) authorities for dredging of sand

14.13. Annexure 13: Infrastructure cost estimates

Infrastructure (Onsite + Offsite) cost breakdown

Sl No.	Component	Quantity	Unit	Amount in Taka
I	**Sonadia Island tourism facilitation development**			
a	Embankment - 7.5 m top width	17.94	Km	3599135820
b	Land filling	437057	Cum	82166735
c	Road connecting zones - 7.5 m top width	4.6	Km	91445015
	Sub total I			**3772747570**
II) 1	**Entrance zone**			
a	Internal road / path - 5.5 m top width	0.8	Km	11455119
b	E-car and cycle parking	686	Sqm	1566273
c	Information kiosk/globe	415	Sqm	1330952
d	Helipad	2000	Sqm	5995500
e	Viewing deck	1146	Sqm	7117061
f	Water pool with musical fountains	13956	Sqm	1350000
g	Green / landscape	5712	Sqm	2856000
h	Jetty	1067	Sqm	106662900
	Sub total - Entrance zone			**138333805**
2	**Heritage and hospitality zone**			

a	Pavilion	19024.2	Sqm	9512100
Sl No.	**Component**	**Quantity**	**Unit**	**Amount in Taka**
b	**Arts & craft village**			
i	Themed pavilion	2000	Sqm	108395118
ii	Internal road / path - 5.5 m top width	0.4	Km	3963681
iii	Green / landscape	2943	Sqm	1471675
	Sub total - Arts & craft village			**113830474**
c	**Star hotel**			
i	Building	2000	Sqm	830271648
ii	Internal road / path - 5.5 m top width	0.7	Km	6015565
iii	Green / landscape	4020	Sqm	2010150
	Sub total - Star hotel			**838297363**
d	**Business & relaxation**			
i	Statue deck	4000	Sqm	5535000
ii	Heritage pavilion	600	Sqm	33726706
iii	Convention centre and MICE	2000	Sqm	252695177
iv	Budget hotel	1200	Sqm	124769789
v	Yoga centre and meditation hall	530	Sqm	28657365
vi	Resorts and multi-cuisine restaurant	360	Sqm	32844113
vii	Water pool	1500	Sqm	5704332
viii	Green / landscape	4000	Sqm	2000000

Sl No.	Component	Quantity	Unit	Amount in Taka
ix	Internal road / path - 5.5 m top width	0.8	Km	6592400
	Sub-total - Business & relaxation			**492524882**
	Sub-total - Heritage and hospitality zone			**1454164819**
3	**Knowledge centre zone**			
a	IRC-CoE&IDC	2500	Sqm	467398677
b	Internal road / path - 5.5 m top width	0.7	Km	2518950
c	Green / landscape	2037	Sqm	1018251
d	Golf course	145395	Sqm	84553838
e	Club house	800	Sqm	24064000
f	Kiosk	294	Sqm	8762238
g	Cottages	715	Sqm	21492160
	Sub total - Knowledge centre zone			**609808114**
4	**Family entertainment zone**			
a	**Botanical Garden**			
i	Green houses and agro tourism	20619	Sqm	12134516
ii	Butterfly park	1000	Sqm	10593952
iii	Public Square	5000	Sqm	37980000
iv	Internal road / path - 5.5 m top width	2.3	Km	18953150
Sl No.	**Component**	**Quantity**	**Unit**	**Amount in Taka**

v	Green sculptures and eco bridge	1000	Sqm	2941180
vi	Green / landscape	9854	Sqm	4926877
vii	Multi-cuisine restaurant	500	Sqm	19387150
	Sub total - Botanical Garden			**106916825**
b	**Villas - 8 nos**	400	**Sqm**	**36236989**
c	**Open garden**	4000	**Sqm**	**3129412**
	Sub total - Family entertainment zone			**146283226**
5	**Adventure zone**			
a	Dry rides and other adventure activity	360667		165556477
b	Wet rides and other adventure activity	327783		84524710
	Sub total - Adventure zone			**250081187**
6	**Eco science zone**			
a	Oceanarium	9231	Sqm	3530000000
b	Marine biology research centre	2000	Sqm	1200000000
c	Internal road / path - 5.5 m top width	0.5	Km	4120250
d	Wooden deck	2610	Sqm	44589310
Sl No.	**Component**	**Quantity**	**Unit**	**Amount in Taka**
e	Water pool	2500	Sqm	9507220

f	Amphitheatre	1000	Sqm	31648000
g	Green and organic cultivation	3000	Sqm	1500000
h	Wooden walkway	3600	Sqm	59294118
i	Eco-tents - 25 nos	575	Sqm	18197600
j	Sky bridge	600	Sqm	26583600
k	Green / landscape	1233	Sqm	616305
	Sub total - Eco science zone			**4926056403**
III	**Amenity buildings**			
	Administration building	1000	Sqm	51987412
	Training /skill development centre	1000	Sqm	51987412
	Primary health centre	1000	Sqm	51987412
	Disaster management centre	500	Sqm	25993706
	Fire station	500	Sqm	25993706
	Police station	300	Sqm	15596224
	Sub total - Amenity buildings			**223545872**
IV	**Utility structures**			
	Internal water distribution network -Potable	16.60	Km	126650414.6
	Internal water distribution network - Non potable	13.28	Km	30560000
	Water treatment plant including utility structures	2.00	MLD	70000000
	Water utility structures (GLSR, ELSR & pump house)	1.00	LS	67294118
	Internal power distribution line (OHT)	14.6	Km	58588235
Sl No.	**Component**	**Quantity**	**Unit**	**Amount in Taka**
	Street light	22.47	Km	57433412
	Distribution transformers	225.00	Nos	86150118

	Internal sewerage network	16.60	Km	180163329
	Sewerage treatment plant	0.60	MLD	21176471
	Internal drain network and rainwater harvesting	18.00	Km	158823529
	Internal telecom network	16.60	km	87364941
	Solid waste management plant	2.86	TPD	28904941
	Sub total - Utility structures			**967881494**
	Total onsite project cost			**12488902489**
V	**Off-site infrastructures**			
	Access road (10 m wide)	3.5	Km	192500000
	Power supply external line	13.23	Km	52941176
	Sub-station 33/11 kV	8	mVA	100000000
	Water supply	12	Km	120000000
	Total offsite infrastructure cost			**465441176**
	Overall Infrastructure cost			**12954343666**

Cost abstract for embankment

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
1	2.1	Earth work in excavation in all kinds of soil for foundation trenches including. layout, providing center lines, local bench-mark pillars, leveling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer, subject to submit method statement of carrying out excavation work to the Engineer for approval. However, Engineer's approval shall not relieve the contractor of his responsibilities and obligations under the contract.				
	2.1.1	Layout and marking for earthwork in excavation in foundation accepted by the Engineer. [Plinth area of the structure shall be considered for measurement]				
		Formation for road embankment				
			Sqm	487860.00	21.77	10,620,712.20
2	LGED - 2.02.2	EFW(AE): Earth filling work with specified soil in any type of embankment including cutting, carrying, filling by throwing earth in layers not more than 150mm in each layer in proper alignment, grade, camber and side slope in all types of soil except rocky, gravelly and slushy including benching not more than 30cm in vertical and 60cm in horizontal steps along the sides while widening any embankment, etc. all complete as per the direction of E-I-C. Earth shall be arranged by the contractor at his own cost and it will include all necessary lead & lift. Payment will be made on the basis of compacted volume. Note: This item shall be used when the work will be done by contractor	Cum	1090320.00	165	179,902,800.00

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
3	LGED - 2.03.2	Mechanical compaction of earthworks in 150mm thick compacted layers by breaking clods to a maximum size of 25mm using wooden drag or ladder and compacting using mechanical equipment, watering or drying to obtain optimum moisture content watering if necessary including the equipment and other tools required to work site, etc. all complete as per direction of the E-I-C. 98% compaction of the maximum dry density is to be obtained by the standard compaction test (Rate is for each layer of 150mm thick).				
		same as filling Qty	Cum	1090320.00	77.25	84,227,220.00
4	31.31	Compaction test				
	31.31.1	Modified proctor	Per test	183.00	1800	329,400.00
5	2.1	Earth work excavation for Hard stones	Sqm	251160.00	257.50	64673700
6	2.10.1	Sand filling (For cement concrete block) in foundation trenches and plinth with sand having F.M. 0.5 to 0.8 in 150mm layers including leveling, watering and compaction to achieve minimum dry density of 90% with optimum moisture content (Modified proctor test) by ramming each layer up to finished level as per design supplied by the design office only etc. all complete and accepted by the Engineer.	Sqm	22694.10	2860.11	64907622.35

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
7	2.11	50 mm downgraded picked jhama Khoa consolidation in foundation trenches by mixing the same with best quality local sand (F.M. 1.2) in (2:1) (khoa : sand) proportion to achieve minimum dry density of 90% with optimum moisture content (Modified proctor test) including breaking and screening chips, laying and spreading in100mm layers uniformly etc. all complete and accepted by the Engineer.	Sqm	22694.10	5999.40	136150983.5
8	40-280-30	Supply of stone boulders at site: 30cm to 45cm size	Sqm	102123.45	5649.80	576977067.8
9	3385	Labour charge in laying stone boulders	Sqm	102123.45	257.5	26296788.38
10	2.8	Supply and laying 3 mm thick geo-textile of approved quality and origin /manufacturer as per manufacturer's instructions approved and accepted by the Engineer. Before commencing lying of geo-textile, the contractor must submit the method statement for carrying out this work including sample with evidence of origin and compliance certificate from independent testing laboratory for approval.	Sqm	226941.00	146.06	33147002.46
11	40-140	Manufacturing and supplying C.C. blocks (Block size 50cmx50cmx40cm) in leanest mix. 1:3:6, with cement, sand (FM>=1.5) and Stone Chips (40mm downgraded), to attain a minimum 28 days cylinder strength 'of 25 Mpa including grading, washing stone chips, mixing, laying in forms; consolidation, curing for at least 21 days, including preparation of platform, shuttering and stacking in measurable stacks etc complete- including · supply of all materials (steel shutter to be Used) as per direction of Engineer in charge.	Sqm	907764.00	1547.72	1404964498
12	40-220	Labour charge for protective works in laying CC blocks of different sizes including preparation of base, watering and ramming of base etc. complete as per direction of Engineer in charge.	Sqm	102123.45	257.5	26296788.38
13	15.7	Flush pointing to CC blocks with cement sand (F.M. 1.2), mortar (1:2) with cement including raking out the joints, and necessary scaffolding curing af least for 7 days,cost of water, electricity and other charges etc. all complete in all respect as per drawing and accepted by the Engineer. (Cement: CEM-11/A-M). Ground floor.	Sqm	226941.00	429.16	97393999.56

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
14	40-280-40	Supplying of local hard rock (Madhyapara) at site: 60cm and above size	Sqm	125580.00	429.16	53893912.8
15	NTI	Manufacturing and supplying C.C. blocks in leanest mix. 1 :3:6, with cement, sand (FM>=1.5) and Stone Chips (40mm down graded), to attain a minimum 28 days cylinder strength 'of 9.0 · N/mm2 including grading, washing stone chips, mixing, laying in forms; consolidation, curing for at least 21 days, including preparation of platform, shutteting and stacking in measurable stacks etc complete- including · supply of all materials (steel shutter to be Used) as per direction ofEngineer in charge.	Cum	261625.00	2220.49	580935696.3
		block size 100cmx80cmx60cm				
16		Labour charge for protective works in laying CC blocks of different sizes including preparation of base, watering and ramming of base etc. complete as per direction of Engineer in charge.	Cum	125580.00	257.9	32387082
		Roads				
17	03.02.01/ R&HD	Sub base	Cum	9867.00	4,575.00	45141526.00
18	03.03.01/RHD	Aggregate base type I	Cum	9867.00	6,570.00	64826190.00
19	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	98670.00	1,155.00	113963850.00
20	30.22	Kerb wall	Sqm	10764.00	195.00	2098980.00
		Total Cost in Tk			**3,599,135,820**	
		Total Cost in Million			**3,599**	

Cost abstract for landfilling

Item. No	BPWD Item. Code	Description	Unit	Total Qty	Rate in Tk	Amount in Tk
1	2.16	Site development/improvement by carted earth or dredged sand, sandy silt (free from any organic, foreign, environmental hazardous substances) carried by head or truck or any other meansl in/c cost of cutting or by dredging of sand, sandy silt, all; in/c local carrying, placing the earth/sand, sandy silt in the designated area, maintaining slopes, breaking lumps, levelling and dressing in layers up to finished level etc. all complete as per direction and accepted by the engineer in charge.	Cum			
	02.16.2.2	By Dredgeing	Cum	437057.1	188.00	82,166,735
		Total for Site Development in Tk				**82,166,735**
		Total for Site Development in Million lakh Tk				**82.17**

Cost abstract for road connecting zones

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
1	2.1	Earth work in excavation in all kinds of soil for foundation trenches including. layout, providing center lines, local bench-mark pillars, leveling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer, subject to submit method statement of carrying out excavation work to the Engineer for approval. However, Engineer's approval shall not relieve the contractor of his responsibilities and obligations under the contract.				
	2.1.1	Layout and marking for earthwork in excavation in foundation accepted by the Engineer. [Plinth area of the structure shall be considered for measurement]				
		Formation for road embankment	Sqm	91104.00	21.77	1,983,334.08
2	LGED - 2.02.2	EFW(AE): Earth filling work with specified soil in any type of embankment including cutting, carrying, filling by throwing earth in layers not more than 150mm in each layer in proper alignment, grade, camber and side slope in all types of soil except rocky, gravelly and slushy including benching not more than 30cm in vertical and 60cm in horizontal steps along the sides while widening any embankment, etc. all complete as per the direction of E-I-C. Earth shall be arranged by the contractor at his own cost and it will include all necessary lead & lift. Payment will be made on the basis of compacted volume. Note: This item shall be used when the work will be done by contractor	Cum	126144.00	165	20,813,760.00

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
3	LGED - 2.03.2	Mechanical compaction of earthworks in 150mm thick compacted layers by breaking clods to a maximum size of 25mm using wooden drag or ladder and compacting using mechanical equipment, watering or drying to obtain optimum moisture content watering if necessary including the equipment and other tools required to work site, etc. all complete as per direction of the E-I-C. 98% compaction of the maximum dry density is to be obtained by the standard compaction test (Rate is for each layer of 150mm thick).				
		same as filling Qty	Cum	126144.00	77.25	9,744,624.00
4	31.31	Compaction test				
	31.31.1	Modified proctor	Per test	22.00	1800	39,600.00
Roads						
5	03.02.01/ R&HD	Sub base	Cum	2,569.60	4575	11755920
6	03.03.01/RHD	Aggregate base type I	Cum	2,569.60	6570	16882272
7	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	25,696.00	1155	29678880
8	30.22	Kerb wall	Sqm	2,803.20	195	546624
		Total Cost in Tk				**91,445,015**
		Total Cost in Million				**91.45**

Cost abstract - Entrance zone

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
a. Internal road						
1	03.02.01/ R&HD	Sub base	Cum	489.06	4,575.00	2237449.50
2	03.03.01/RHD	Aggregate base type I	Cum	489.06	6,570.00	3213124.20
3	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	4,890.60	1,155.00	5648643.00
4	30.22	Kerb wall	Sqm	533.52	195.00	104036.40
5	2.1	Earth work excavation	Sqm	978.12	257.5	251865.90
					Total Cost in Tk	**11,455,119.00**
b. E-car and cycle parking						
1	03.02.01/ R&HD	Sub base	Cum	68.55	4575.00	313616.25
2	03.03.01/RHD	Aggregate base type I	Cum	68.55	6570.00	450373.50
3	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	685.50	1155.00	791752.50
4	30.22	Kerb wall	Sqm	54.00	195	10530.00
		Total Cost in Tk				**1,566,273.00**
c. Information kiosk/Globe						
1	Market rate	Water fall area	Sqm	415.48	2000.00	830951.25
2	LS	Globe & information arrangements	Nos	1.00	500000.00	500000.00
		Total Cost in Tk				**1,330,952.00**
d. Helipad						
1	03.02.01/ R&HD	Sub base	Cum	400.00	4575.00	1830000.00
2	03.03.01/RHD	Aggregate base type I	Cum	300.00	6570.00	1971000.00
3	07.2.2.1	Cement concrete pavement	Sqm	300.00	7315.00	2194500.00
		Total Cost in Tk				**5,995,500.00**
e. Viewing deck						

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
1	Market rate	Pile work	Sqm	270.00	3000	810000.00
2	Market rate	Steel	Sqm	13,500.00	80	1080000.00
3	30.22	Retaining wall	Sqm	121.50	10000	1215000.00
4	30.22	Step's area	Sqm	1,146.30	3500	4012060.33
		Total Cost in Tk				**7,117,061.00**
f. Water pool with musical fountains						
1	Market Rate	Water fountain	Sqm	2.70	500000	1350000.00
		Total Cost in Tk				**1,350,000.00**
g. Green / Landscape						
1	25.2,25.5&25.8	Green / Landscape	Sqm	5,712.00	500	2856000.00
		Total Cost in Tk				**2,856,000.00**
8. Jetty area						

Cost abstract for jetty

i. No	Item. Code	Description of items	Unit	Qty	Rate in Tk	Amount in Tk
1	4.05.04	Making earthen ring/ cross bundh of required height and width to prevent water from entering in the working area for any type of foundation with earth arranged and carried by the contractor including bullah/bamboo palisading and double tarja mat/drum sheets wailing as and where necessary, maintaining the some throughout the working period, filling by throwing earth in layers, removal of structure totally on completion of the bridge, etc. all complete as per requirement and instruction of the E-I-C.	Ls	1.00	1500000.00	1,500,000.00

i. No	Item. Code	Description of items	Unit	Qty	Rate in Tk	Amount in Tk
2	LGED 4.07.01.04	Boring / drilling for cast in situ piles up to the required depth and diameter with minimum 6m long temporary steel casing, true to vertical, providing bentonite slurry and maintaing water level in the hole, washing the hole for atleast 30 minutes, clean the bore-hole and make the bore-hole ready for placing steel cage and concreting including hire charge of rig set with winch machine, tripod stand, trimie pipe, cost of fule, lubricant, mobilization, demobilization, maintenance, spares, stand-byes, insurance coverage, water, electricity and other charges all compete approved and accepted by the Engineer. Before commencing boring operation contractor shall submit the method statement of cast-in-situ pile work including sequence of boring and casting, disposal of spoils, test result of materials to the Engineer for approval. However, Engineer's approval shall not relieve the contractor of his responsibilities and obligations under contract.				
		500mm dia pile	rm	3060.00	5540.00	16952400.00
3	9.2	Removing of spoils / mud accumulated during boring for cast in situ pile by wash boring from working site to a safe distance by contractors own arrangement i.e. with container set in truck or on cart including loading, unloading everything complete as per standard practice. (Quantity should be given three times of solid volume of boring)	Cum	1803.00	378.00	681534.00
		Permanent steel casing				
4	04.01.05f	500mm dia	rm	1200.00	24578.00	29493600.00

i. No	Item. Code	Description of items	Unit	Qty	Rate in Tk	Amount in Tk
5	4.07.04	Cast in situ pile with reinforced cement concrete works of high slump by adding high range water reducing admixture (ASTM C494 Type A or F complying item 7.20.1 or 7.20.6) with minimum cement content relates to mix ratio 1:1:2 having minimum **f'cr = 32 Mpa,** and satisfying a specified compressive strength **f'c = 28 Mpa at 28 days** on standard cylinders as per standard practice of code ACI / BNBC / ASTM & cement conforming to BDS EN-197-1-CEM1, 52.5N (52.5MPa) / ASTM - C 150 Type - I, best quality coarse sand [Sylhet sand or coarse sand of equivalent F. M. 2.2], 20mm down well graded crushed stone chips conforming to ASTM c-33, including breaking chips, screening through proper sieves, making, placing re-bar cage in position, placing and removing tri-pod as per requirement, pouring the concrete in bore-hole with the help of a trimie pipe, maintaining the trimie pipe immersed in concrete by atleast 1 meter throughout the period of concreting, maintaining required slump, etc. mixing the aggregates with standard mixer machine with hoper, casting in forms, all complete including water, electricity, testing of materials and concrete etc and other charges as per design, drawing, etc all complete approved and accepted by the Engineer. (Rate is excluding the cost of reinforcement and its fabrication, binding, welding, placing and admixture (approx. does 150 to 250 ltr per bag of cement which to fix by mix design)	Cum	601.00	12838.97	7716221.00
6	9.4	Providing and making point welding at contact points of the spiral binders at reasonable intervals with the main reinforcements by electric arc welding for construction of cast in situ bored piles carefully with highly oxidized electrodes making the points prominent and accepted by the Engineer (rates inclusive of all materials, labour, tools and plants, electicity and all equipment).	point	326400.00	3.90	1272960.00

i. No	Item. Code	Description of items	Unit	Qty	Rate in Tk	Amount in Tk
7	9.5	Providing and welded splice over two sides of contact by welding of minimum 300 mm length at the lap of main reinforcement in re-bars cage to be placed in the Bore-hole where necessary by arc welding with highly oxidized electrodes making the points prominent and accepted by the Engineer (rates inclusive of all materials, labour, tools and plants, electicity and all equipment).	rm of weld	4080.00	472.83	1929146.00
8	4.07.08	Labour for breaking head of hardened cast in situ bored pile/pre-cast pile up to a required length by any means but without damaging the rest and removing the dismantled materials such as concrete to a safe distance including scraps and cleaning concrete from steel/M.S. rods, straightening and bending of pile bars, preparation and making platform where necessary, carrying, all sorts of handling, stacking the same properly after cleaning, levelling and dressing the situ and clearing the bed etc., complete in all respects and accepted by the Engineer. (Measurement will be given for the pile head volume to be broken)	Cum	18.00	4101.68	73830.00
9	9.7	Conducting static load test as per ASTM D1143 or equivalent standard for the cast - in - situ / pre - cast pile providing required scaffolding, bracing, jacks, pressure test gauge, loading, unloading, Kentledge and other plants and equipment including staging, mobilization, demobilization, hire charge, gunny bags, sand and filling sacs / gunny bags for loading, record readings and preparation of results in standard forms and other incidental charges per standard practice and procedures including submission of load test report, furnishing all graph and chart, etc., complete in all respects approved and accepted by the Engineer (minimum two cyclic loading, one at service load and another cycle at double the load of service load then to continue loading till failure of the pile). Before commencing load test, contractor shall submit method statement for conducting load test to the Engineer for approval. However, Engineer's approval shall not relieve the contractor of his responsibilities and obligations under contract.				

i. No	Item. Code	Description of items	Unit	Qty	Rate in Tk	Amount in Tk
		Load test and report shall be conducted under the supervision of a professional Geotechnical Engineer registered in BPERB or Geotechnical Firm registered in PWD. Boring and pouring logs / driving logs of piles and method statemetn shall be the part of load test report. (Rates on load test under the supervision of experts in the laboratory of universities and HBRI can be found in Chapter - 32)				
		Initial Load	Per test	1.00	245302.00	245302.00
		Routine Load	Per test	1.00	198458.00	198458.00
	2.1	Earth work in excavation in all kinds of soil for foundation trenches including. layout, providing center lines, local bench-mark pillars, leveling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer, subject to submit method statement of carrying out excavation work to the Engineer for approval. However, Engineer's approval shall not relieve the contractor of his responsibilities and obligations under the contract.				
10	02/01/01	Clearing, grubbing, Layout and marking for earthwork in excavation in foundation accepted by the Engineer. [Plinth area of the structure shall be considered for measurement]	Sqm	800.00	56.00	44800.00

i. No	Item. Code	Description of items	Unit	Qty	Rate in Tk	Amount in Tk
11	4.05.01.01.01	Earth work in excavation of foundation of structures by mechanical (Hydraulic'excavator - Long Boom)/ manual means in all sorts of soil up to specified depth in accordance with requirements of lines, grades, cross sections and elevation as shown in the drawing including setting out, removal of stumps, logs, boulders and other deletertious materials, providing necessary tools and plants, construction of shoring and bracing, cleaning the excavated materials to a safe distance out of the site premises, cut to a firm surface including pumping/ bailing out water, removal of spoils to a safe distance, dressing of sides and bottom and backfilling of trenches up to original level with approved material etc. all complete as per approval of E-I-C. Contractor shall get acquainted with site conditions, nature of soil and adopt suitable adequate dewatering system as deemed fit for the nature of soil and prevailing water table to get the surface reasonably dry for laying PCC at the time of execution so that execution will not be hampered or delayed. Back filled materials shall be compacted to a density comparable with the adjacent undisturbed material.	Cum	499.00	125.53	62639.00
12	04/07/05	Sand filling in foundation trenches and plinth with sand having F.M. 0.5 to 0.8 in 150mm layers including leveling, watering and compaction to achieve minimum dry density of 90% with optimum moisture content (Modified proctor test) by ramming each layer up to finished level as per design supplied by the design office only etc. all complete and accepted by the Engineer.	Cum	12.00	1175.00	14100.00
	3.4	Mass concrete (1:3:6) in foundation with cement, sand (F.M. 1.2) and picked jhama chips including breaking chips, screening, mixing, laying, compacting to levels and curing for at least 7 days including the supply of water, electricity and other charges and				

i. No	Item. Code	Description of items	Unit	Qty	Rate in Tk	Amount in Tk
		costs of tools and plants etc. all complete and accepted by the Engineer.(Cement: CEM-II/A-M)				
13	3.4.1	Mass concrete in foundation (1:3:6) with cement, brick chips and sand of F.M.1.2	cum	12.00	6319.00	75828.00
	7.8	Reinforced cement concrete works using steel shutter with minimum cement content relates to mix ratio 1:1.25:2.5 having minimum **f'cr = 40 Mpa,** and satisfying a specified compressive strength **f'c = 32 Mpa at 28 days** on standard cylinders as per standard practice of code ACI/BNBC/ASTM & cement conforming to BDS EN-197-1-CEM1, 52.5N 952.5Mpa)/ ASTM-C 150 type -I, and adding approved high range water reducing admixture of complying specific type (generally be type-G) under ASTM-C 494, best quality coarse sand (shlhet sand or coarse sand of equivalent F.M. 2.2), 20mm down well graded crushed stone chips conforming to ASTM C-33, including breaking chips and screening through proper sieves, making and placing shutter in positon and mainting true to plumb, making shutter water-tight properly, placing reinforcement in position, mixing with standard mixer machine with hoper and fed by standard measuring boxes, casting in forms, compacting by vibrator machine and curing at least for 28 days, rmoving centering-shuttering after specified time approved, including cost of water, electricity, additional testing charges of materials and cylinders required by engineer, other charges etc. all complete approved and accepted by the engineer. (Doses of admixture in the mix to be fixed by mix design)(rate is excluding the cost of reinforcement and its fabrication, placing and binding etc)				
	7.8.4	Padestals, column, column capitals, lift walls and walls up to Ground Floor				

i. No	Item. Code	Description of items	Unit	Qty	Rate in Tk	Amount in Tk
14	05/01/02 k	Concrete M30	cum	94.00	15526.00	1459444.00
15	07.8.4.2	Formwork/shuttering, prop and necessary supports etc. (steel)	sqm	417.00	373.00	155541.00
	7.8.6	**Tee beams, Ell beams and Rectangular beams etc,**				
16	05/01/02 k	Concrete M30	cum	252.00	15526.00	3912552.00
17	07.8.6.2	Formwork/shuttering, prop and necessary supports etc. (steel)	sqm	2124.00	498.00	1057752.00
	07.8.7	**Floor / Floor slab**				
18	05/01/02 k	Concrete M30	cum	398.00	15526.00	6179348.00
19	07.8.7.2	Formwork / shuttering, prop and necessary supports etc. (steel)	sqm	2431.00	403.00	979693.00
20	8.1	Supplying, fabrication and fixing to details as per design deformed bar reinforcement in concrete in accordance with BDS 1313 : 1991 standard including straightening and cleaning rust, if any, bending and binding in position including supply of G.I. wires etc. complete in all respects and accepted by the Engineer.				

i. No	Item. Code	Description of items	Unit	Qty	Rate in Tk	Amount in Tk
	8.1.2	Grade 400 (RB 400 / 400W: complying BDS ISO 6935-2:2006) ribbed or deformed bar produced and marked according to Bangladesh Standard, with minimum yield strength fy (ReH) = 400 Mpa but fy not exceeding 418MPa and what ever is the Yield strength within allowable limit as per BNBC sec 8.3.3.5 / ACI 318-11 sec 21.1.5.2, the ratio ultimate tensile strength fu to yield strength fy, shall be at least 1,25 and minimum elongation after fracture and minimum total elongation at maximum force is 16% and 8% respectively : up to ground floor.	Kg	288178.00	85.00	24495130.00
21	MR	Anti Corrosive paint / Treatment for the reinforcements applying as per the manufacturer instruction of approved quality delivered from authorized local agent of the manufacturer in a sealed container etc. complete in all respect accepted by the Engineer.	Kg	288179.00	12.00	3458148.00
23		Cassion Pipe for Concreting in river	LS	1.00	1941574.00	1941574.00
24		Temporary supporting structure for pile works	LS	1.00	3000000.00	3000000.00
25		Dewatering	LS	1.00	100000.00	100000.00
		Total Cost in Tk				**106662900**

Cost abstract – Heritage and hospitality zone

Item. No	BPWD Item. Code/Market rate	Description	Unit	Qty	Total Qty	Rate in Tk	Amount
a. Pavilion							
1	25.2,25.5&25.8	Green/ Landscape	Sqm	19,024.20	19,024.20	500	9512100.00
		Total Cost in Tk					**9,512,100.00**

Cost estimates for Arts & craft village

i. Arts and crafts village						
1	MR	Pavilion	Sqm	2,000.00	54197.56	108395118.00
		Total Cost in Tk				**108,395,118.00**
ii. Internal road & Path						

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
1	03.02.01/ R&HD	Sub base	Cum	168.35	4,575.00	770201.25
2	03.03.01/RHD	Aggregate base type I	Cum	168.35	6,570.00	1106059.50
3	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	1,683.50	1,155.00	1944442.50
4	30.22	Kerb wall	Sqm	288.60	195.00	56277.00
5	2.1	Earth work excavation	Sqm	**336.70**	257.5	86700.25

		Total Cost in Tk				**3,963,681.00**
iii. Green / Landscape						
1	25.2,25.5&25.8	Green / Landscape	Sqm	2,943.35	500	1471675.00
		Total Cost in Tk				**1,471,675.00**

Cost abstract – Star hotel

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
i. Building						
1	Plinth area Rate	Built up area – G+4 floors	Sqm	8,000.00	103783.96	830271648.00
		Total Cost in Tk				**830,271,648.00**
ii. Internal road / Path						
1	03.02.01/ R&HD	Sub base	Cum	255.50	4,575.00	1168912.50
2	03.03.01/RHD	Aggregate base type I	Cum	255.50	6,570.00	1678635.00
3	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	2,555.00	1,155.00	2951025.00
4	30.22	Kerb wall	Sqm	438.00	195.00	85410.00
5	2.1	Earth work excavation	Sqm	**511.00**	257.5	131582.50
		Total Cost in Tk				**6,015,565.00**
iii. Green / Landscape						
1	25.2,25.5&25.8	Green / Landscape	Sqm	4,020.30	500	2010150.00
		Total Cost in Tk				**2,010,150.00**

Cost abstract – Business & relaxation

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
i. Statue deck						
1	03.02.01/ R&HD	Sub base	Cum	200.00	4575	915000.00
2	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	4,000.00	1155	4620000.00
		Total Cost in Tk				**5,535,000.00**
ii. Heritage Pavilion						
1	Plinth area Rate	Themed Pavilion	Sqm	600.00	56211.18	33726706.00
		Total Cost in Tk				**33,726,706.00**
iii. Convention centre and MICE						
1	Plinth area Rate	Convention Centre	Sqm	4,000.00	63,173.79	252695177.00
		Total Cost in Tk				**252,695,177.00**
iv. Budget hotel						
1	Plinth area Rate	Budget Hotel – G+2 floors	Sqm	2,400.00	51987.41	124769789.00
		Total Cost in Tk				**124,769,789.00**
v. Yoga & meditation hall						
1	Plinth area Rates	Yoga & meditation hall	Sqm	530.00	54070.50	28657365.00
		Total Cost in Tk				**28,657,365.00**
vi. Resorts and multi cusine restaurant						

1	Plinth area rate	Resorts – 12 nos	Sqm	720.00	45616.82	32844113.00
		Total Cost in Tk				**32,844,113.00**
vii. Water Pool						
1	Market rate	Tile area	Sqm	1,800.00	2,000.00	3600000.00
2	Market rate	Concrete	Sqm	1,500.00	1,177.00	1765500.00
3	Market rate	Wall	Cum	36.00	9,412.00	338832.00
		Total Cost in Tk				**5,704,332.00**
viii. Green / Landscape						
1	25.2,25.5&25.8	Green / Landscape	Sqm	4,000.00	500	2000000.00
		Total Cost in Tk				**2,000,000.00**
ix. Internal road / Path						
1	03.02.01/ R&HD	Sub base	Cum	280.00	4,575.00	1281000.00
2	03.03.01/RHD	Aggregate base type I	Cum	280.00	6,570.00	1839600.00
3	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	2,800.00	1,155.00	3234000.00
4	30.22	Kerb wall	Sqm	480.00	195.00	93600.00
5	2.1	Earth work excavation	Sqm	**560.00**	257.5	144200.00
		Total Cost in Tk				**6,592,400.00**

Cost abstract – Knowledge centre zone

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
a. IRC-CoE&IDC						
1	Market rate	R&D Centre		2,500.00	86959.47	217398677.00
2	Market rate	Specialised infrastructure	LS	**1**	250000000.00	250000000.00
		Total Cost in Tk				**467,398,677.00**
b. Internal road / Path						
1	03.02.01/ R&HD	Sub base	Cum	105.00	4,575.00	480375.00
2	03.03.01/RHD	Aggregate base type I	Cum	105.00	6,570.00	689850.00
3	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	1,050.00	1,155.00	1212750.00
4	30.22	Kerb wall	Sqm	420.00	195.00	81900.00
5	2.1	Earth work excavation	Sqm	**210.00**	257.5	54075.00
		Total Cost in Tk				**2,518,950.00**
c. Green / Landscape						
1	25.2,25.5&25.8	Green / Landscape		2,036.50	500	1018250.25
		Total Cost in Tk				**1,018,250.25**

d. Golf Course						
1	Market rate	Golf area	Acre	35.94	2352942.00	84553837.28
		Total Cost in Tk				**84,553,838.00**
e. Club house						
1	Market rate	Club House	Sqm	800.00	30080.00	24064000.00
		Total Cost in Tk				**24,064,000.00**
f. Kiosk						
1	Market rate	Kiosk	Sqm	294.00	29803.53	8762238.00
		Total Cost in Tk				**8,762,238.00**
g. Cottages						
1	Market rate	Cottages – G+1 – 8 nos	Sqm	714.50	30080.00	21492160.00
		Total Cost in Tk				**21,492,160.00**

Cost abstract – Family entertainment zone

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
a. Botanical garden						
i. Green houses and agro tourism						
1	Market rate	Green houses	Sqm	10,309.70	1177.00	12134515.63
		Total Cost in Tk				**12,134,515.63**
ii. Butterfy Park						
1	25.2,25.5&25.8	Landscape area	Sqm	1,000.00	500	500000.00
2	Market rate	Domes	Sqm	8,576.00	1177.00	10093952.00
		Total Cost in Tk				**10,593,952.00**
iii. Public Square						
1	Market Rate	Public Square	Sqm	5,000.00	7596.00	37980000.00
		Total Cost in Tk				**37,980,000.00**
iv. Internal road / Path						
1	03.02.01/ R&HD	Sub base	Cum	805.00	4,575.00	3682875.00

2	03.03.01/RHD	Aggregate base type I	Cum	805.00	6,570.00	5288850.00
3	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	8,050.00	1,155.00	9297750.00
4	30.22	Kerb wall	Sqm	1,380.00	195.00	269100.00
5	2.1	Earth work excavation	Sqm	**1610.00**	257.5	414575.00
		Total Cost in Tk				**18,953,150.00**
v. Green Sculptures and eco bridge						
1	Market Rate	Green Sculptures	Nos	5.00	588236.00	2941180.00
		Total Cost in Tk				**2,941,180.00**
vi. Green / Landscape						
1	25.2,25.5&25.8	Green / Landscape	Sqm	9,853.75	500	4926877.00
		Total Cost in Tk				**4,926,877.00**
vii.Multi cusine restaurant						
1	Market Rate	Restaurant	Sqm	500	38774	19387150.00
		Total Cost in Tk				**19387150.00**

b. villas						
1	Market rate	Sea view villa – 8 nos – G+1 floor	Sqm	800	45,296.24	36236989.00
		Total Cost in Tk				**36236989.00**

c. Open garden						
1	25.2,25.5&25.8	Lawn area	Sqm	4,000.00	500.00	2000000.00
2	25.2,25.5&25.8	shrubs - 2m heigh	Sqm	800.00	1411.76	1129411.76
		Total Cost in Tk				**3129412.00**

Cost abstract – Adventures zone

Item. No	Description	Unit	Total Qty	Rate in Tk	Amount
a. Dry rides					
	Dry Rides				
1	Disco Ride	Each	1.00	7017648.00	7017648.00
2	Bike Coaster	Each	1.00	14862353.00	14862353.00
3	Giant Ferris Wheel	Each	1.00	17041177.00	17041177.00
4	Roller coaster	Each	1.00	30750589.00	30750589.00
5	Flying Boat (Pirate Ship)	Each	1.00	9224706.00	9224706.00
6	Mirror Maze	Each	1.00	3376471.00	3376471.00
7	Carousel	Each	1.00	6754118.00	6754118.00
8	Freaky Jungle	Each	1.00	3617648.00	3617648.00
9	Hanging Vortex	Each	1.00	1504706.00	1504706.00
10	Crazy Cup (9 cups)	Each	1.00	12630589.00	12630589.00
11	Sky Swinger	Each	1.00	41350589.00	41350589.00

12	Rainbow Ride (Hammer Ride)	Each	1.00	17425883.00	17425883.00
	Total Cost in Tk				**165,556,477.00**
b. Wet rides					
	Wet Rides				
1	Thunderstorm	Each	1.00	20198824.00	20198824.00
2	Lazy River	Each	1.00	3787059.00	3787059.00
3	Wave Pool	Each	1.00	8837648.00	8837648.00
4	Kiddies Pool (All in One)	Each	1.00	3029412.00	3029412.00
5	Tube Slides	Each	1.00	5655295.00	5655295.00
6	Multilane Slides	Each	1.00	6767059.00	6767059.00
7	Log Flume Ride	Each	1.00	11109412.00	11109412.00
8	Pirate Play Pan	Each	1.00	3914118.00	3914118.00
9	Gaming Zone - 4D Theatre	Each	1.00	21225883.00	21225883.00
	Total Cost in Tk				**84,524,710.00**

Cost abstract – Eco science zone

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
a. Oceanarium						
1	Market Rate	Construction of Oceanarium	Sqm	9231	3,530,000,000.00	3530000000.00
		Total Cost in Tk				**3,530,000,000.00**
b. Marine biology research centre						
1	Market Rate	Construction of Oceanarium	Sqm	2000	1200000000	1200000000
		Total Cost in Tk				**1200000000.00**
c. Internal road / Path						
1	03.02.01/ R&HD	Sub base	Cum	175.00	4,575.00	800625.00
2	03.03.01/RHD	Aggregate base type I	Cum	175.00	6,570.00	1149750.00
3	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	1,750.00	1,155.00	2021250.00
4	30.22	Kerb wall	Sqm	300.00	195.00	58500.00
5	2.1	Earth work excavation	Sqm	**350.00**	257.5	90125.00
		Total Cost in Tk				**4,120,250.00**
d. Wooden Deck						
1	Market Rate	Wooden deck	Sqm	2,610.00	16,471.00	42989310.00

2	Market Rate	Arch way - Steel element	LS	2.00	800,000.00	1600000.00
		Total Cost in Tk				**44,589,310.00**
e. Water Pool						
1	Market rate	Tile area	Sqm	3,000.00	2,000.00	6000000.00
2	Market rate	Concrete	Sqm	2,500.00	1,177.00	2942500.00
3	Market rate	Wall	Cum	60.00	9,412.00	564720.00
		Total Cost in Tk				**9,507,220.00**
f. Amphitheatre						
1	Market rate	Built up area	Sqm	1,000.00	31648	31648000.00
		Total Cost in Tk				**31,648,000.00**
g. Green and organic cultivation						
1	25.2,25.5&25.8	Green / Landscape	Sqm	3,000.00	500	1500000.00
		Total Cost in Tk				**1,500,000.00**

Item. No	BPWD Item. Code/Market rate	Description	Unit	Total Qty	Rate in Tk	Amount
h. wooden walkway						
1	03.02.01/ R&HD	Sub base	Cum	126.00	4,575.00	576450.00
2	03.03.01/RHD	Aggregate base type I	Cum	126.00	6,570.00	827820.00
3	30.15.2	60 mm thick coloured Uni-Biock for paving foot-path,major walk way, car. porch	Sqm	1,260.00	1,155.00	1455300.00
4	30.22	Kerb wall	Sqm	216.00	195.00	42120.00
5	2.1	Earth work excavation	Sqm	**252.00**	257.5	64890.00
		Total Cost in Tk				**59294118.00**

i. Eco cottages						
1	Market rate	Eco cottages – 25 nos	Sqm	575.00	31,648.00	18197600.00
		Total Cost in Tk				**18,197,600.00**
j. Sky bridge						
1	Market Rate	Sky Bridge	Sqm	600.00	44,306.00	26583600.00
		Total Cost in Tk				**26,583,600.00**
k. Green / Landscape						
1	25.2,25.5&25.8	Green / Landscape	Sqm	1,232.61	500	616304.50
		Total Cost in Tk				**616,304.50**

Cost abstract – Amenity buildings
Cost abstract for Administration building

Plint area	Unit	Qty		
Ground floor	Sqm	500		
1st floor	Sqm	500		
Total built up area	Sqm	1000		
A. Foundation cost	Unit	Qty	rate	Total in Taka
Pile foundation	Sqm	500	23389	11694500
B. Superstruture cost				
Ground floor	Sqm	500	25303	12651500
1st floor	Sqm	500	25303	12651500
C. Other building cost				
Internal sanitary & water supply				
Ground floor	Sqm	500	1250	625000
1st floor	Sqm	500	1250	625000
Internal electrification				
Ground floor	Sqm	500	1570	785000
1st floor	Sqm	500	1570	785000
D.Additional superstructure cost				
Porch,water tank,parapet wall,compound wall,landscape & etc	LS	1		12169912
Total cost in Taka (A+B+C+D)				**51987412**

Cost abstract for Training/ skill development centre

Plint area	Unit	Qty		
Ground floor	Sqm	500		
1st floor	Sqm	500		
Total built up area	Sqm	1000		
A. Foundation cost	Unit	Qty	rate	Total in Taka
Pile foundation	Sqm	500	23389	11694500
B. Superstruture cost				
Ground floor	Sqm	500	25303	12651500
1st floor	Sqm	500	25303	12651500
C. Other building cost				
Internal sanitary & water supply				
Ground floor	Sqm	500	1250	625000
1st floor	Sqm	500	1250	625000
Internal electrification				
Ground floor	Sqm	500	1570	785000
1st floor	Sqm	500	1570	785000
D.Additional superstructure cost				
Porch,water tank,parapet wall,compound wall,landscape & etc	LS	1		12169912
Total cost in Taka (A+B+C+D)				**51987412**

Cost abstract for primary health centre

Plint area	Unit	Qty		
Ground floor	Sqm	500		
1st floor	Sqm	500		
Total built up area	Sqm	1000		
A. Foundation cost	Unit	Qty	rate	Total in Taka
Pile foundation	Sqm	500	23389	11694500
B. Superstruture cost				
Ground floor	Sqm	500	25303	12651500
1st floor	Sqm	500	25303	12651500
C. Other building cost				
Internal sanitary & water supply				
Ground floor	Sqm	500	1250	625000
1st floor	Sqm	500	1250	625000
Internal electrification				
Ground floor	Sqm	500	1570	785000
1st floor	Sqm	500	1570	785000
D.Additional superstructure cost				
Porch,water tank,parapet wall,compound wall,landscape & etc	LS	1		12169912
Total cost in Taka (A+B+C+D)				**51987412**

Cost abstract for diaster management centre

Plint area	Unit	Qty		
Ground floor	Sqm	500		
Total built up area	Sqm	500		
A. Foundation cost	Unit	Qty	rate	Total in Taka
Pile foundation	Sqm	500	23389	11694500
B. Superstruture cost				
Ground floor	Sqm	500	25303	12651500
C. Other building cost				
Internal sanitary & water supply				
Ground floor	Sqm	500	1250	625000
Internal electrification				
Ground floor	Sqm	500	1570	785000
D.Additional superstructure cost				
landscape & etc	LS	1		237706
Total cost in Taka (A+B+C+D)				**25993706**

Cost abstract for police station

Plinth area	Unit	Qty		
Ground floor	Sqm	300		
Total built up area	Sqm	300		
A. Foundation cost	Unit	Qty	rate	Total in Taka
Pile foundation	Sqm	300	23389	7016700
B. Superstructure cost				
Ground floor	Sqm	300	25303	7590900
C. Other building cost				
Internal sanitary & water supply				
Ground floor	Sqm	300	1250	375000
Internal electrification				
Ground floor	Sqm	300	1570	471000
D.Additional superstructure cost				
landscape & etc	LS	1		142624
Total cost in Taka (A+B+C+D)				**15596224**

Cost abstract – Fire station – B catogery

Sl. No	Description	Amount (Lac)	Remarks
A	**Construction works**		As per Fire Service & Civil Defence Department requirement (as per **BNBC-2006**)
1	Construction of Fire Station	98.304	
2	Others Costruction Works	25.00	
Sub-Total (A)		**123.304**	
B	**Equipment & Others**		
3	Equipment	100.00	
4	Furniture	11.9722	
Sub-Total (B)		**111.9722**	
Total (A+B)		**235.2762**	

Consider **Safety factor 1.20** (only construction work) for BNBC-2020 aplication

So Total Construction Cost (lac)	147.96
Total Equipement Cost	111.9722
Grand Total	**259.94**

Cost abstract - Internal water distribution network (Potable)

BPWD Item Code	Sl.No	Description	Unit	Quantity	Rate in Taka	Amount	Amount in Million Taka
02.1.5	1	Earth work in excavation in all kinds of soil for foundation trenches including layout, providing center lines, local bench-mark pillars, levelling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer-in-charge, subject to submit method statement of carrying out excavation work to the Engineer-in-charge for approval. However, engineer"s approval shall not relieve the contractor of his responsibilities and obligations under the contract. Extra rate for each additional 0.5 meter depth exceeding 1.5 meter.	Cum	31246	237.00	7405226.63	**7.41**
02.16.1.2	2	Site development/improvement by carted earth or dredged sand, sandy silt (free from any organic, foreign, environmental hazardous substances) carried by head or truck or any other meansl in/c cost of cutting or by dredging of sand, sandy silt, all; in/c local carrying, placing the earth/sand, sandy silt in the designated area, maintaining slopes, breaking lumps, levelling and dressing in layers up to finished level etc. all complete as per direction and accepted by the engineer in charge.	Cum	2611	449.00	1172419.82	**1.17**
	3	Providing and fixing 3 layer PPR pipes UV stabilised & anti - micro bial fusion welded, having thermal stability for hot & cold water supply, excludingtrenching, refilling cost ..etc - External work					
MR	e)	PN - 10 110mm dia pipe	Rm	13280	582.94	7741475.07	**8.29**
MR	f)	PN - 10 140mm dia pipe	Rm	3320	1004.90	3336260.70	**3.34**
MR	g)	PN - 10 160mm dia pipe	Rm	3320	1224.35	4064837.02	**4.06**
MR	h)	PN - 10 200mm dia pipe	Rm	3320	1999.63	6638764.96	**6.64**
MR	i)	Providing and laying S& Scentrifugally cast (spun) / Ductile iron 250mm dia pipes (classK7)	0	3320	5304.00	17609280.00	**17.61**

MR	j)	Providing and laying S& Scentrifugally cast (spun)/ Ductile iron 300mm dia pipes (classK7)	Rm	3320	10123.00	33608360.00	**33.61**
MR	k)	Providing and laying S& Scentrifugally cast (spun)/ Ductile iron 350mm dia pipes (classK7)	Rm	1660	11736.00	19481760.00	**19.48**
MR	l)	Providing and laying S& Scentrifugally (spun) / Dutile iron 400mm dia pipes (classK7)	Rm	1660	13818.00	22937880.00	**22.94**
	4	Providing and fixing Butterfly valve					
MR	f)	PN - 16 110mm Butterfly valve	Each	5	17074.80	85374.00	**0.09**
MR	g)	PN - 16 160mm Butterfly valve	Each	2	21513.60	43027.20	**0.04**
MR	h)	PN - 16 200mm Butterfly valve	Each	2	44820.00	89640.00	**0.09**
MR	i)	250mmdia Butterfly valve - Ductile iron	Each	2	57967.20	115934.40	**0.12**
MR	o)	PN - 16 110mm Air valve	Each	7	40338.00	282366.00	**0.28**
MR	p)	PN - 16 160mm Air valve	Each	2	40836.00	81672.00	**0.08**
MR	q)	PN - 16 200mm Air valve	Each	2	41035.20	82070.40	**0.08**
MR	r)	250mm dia Air valve - Ductile iron	Each	2	42240.00	84480.00	**0.08**
MR	s)	300mm dia Air valve - Ductile iron	Each	2	42480.00	84960.00	**0.08**
MR	t)	350mm dia Air valve - Ductile iron	Each	1	43320.00	43320.00	**0.04**
MR	u)	400mm dia Air valve - Ductile iron	Each	1	45240.00	45240.00	**0.05**

MR	x)	PN - 16 110mm Gate valve	Each	14	8605.20	120472.80	**0.12**
MR	y)	PN - 16 160mm Gate valve	Each	4	9852.00	39408.00	**0.04**
MR	z)	PN - 16 200mm Gate valve		4	10806.00	43224.00	**0.04**
MR	aa)	250mm dia Gate valve - Ductile iron	Each	4	14760.00	59040.00	**0.06**
MR	ab)	300mm dia Gate valve - Ductile iron	Each	4	17400.00	69600.00	**0.07**
MR	ac)	350mm dia Gate valve - Ductile iron	Each	2	18000.00	36000.00	**0.04**
MR	ad)	400mm dia Gate valve - Ductile iron	Each	2	24000.00	48000.00	**0.05**
MR	7	Constructing masonry chamber 120x120x100cm inside,in brickwork in cement mortar 1:4 for sluice valve with CI surface box 100mmm top diameter, 160mm bottom diameter and 180mm deep inside with chain lid and RCC top slab 1:2:4 mix including necessary excavation, foundation .. etc	Each	17	2000.00	34000.00	**0.03**
MR	8	Constructing masonry chamber 90x90x100cm inside,in brickwork in cement mortar 1:4 for sluice valve with CI surface box 100mmm top diameter, 160mm bottom diameter and 180mm deep inside with chain lid and RCC top slab 1:2:4 mix including necessary excavation, foundation .. etc	Each	38	1800.00	68400.00	**0.07**
MR	9	Constructing masonry chamber 60x60x75cm inside,in brickwork in cement mortar 1:4 for sluice valve with CI surface box 100mmm top diameter, 160mm bottom diameter and 180mm deep inside with chain lid and RCC top slab 1:2:4 mix including necessary excavation, foundation .. etc	Each	19	1600.00	30400.00	**0.03**
		Total Cost in Taka					126650414.6
		Total Cost in Million Taka					**126.65**

Cost abstract - Internal water distribution network (Non potable)

BPWD Item Code	Sl.No	Description	Unit	Quantity	Rate in Taka	Amount	Amount in Million Taka
02.1.5	1	Earth work in excavation in all kinds of soil for foundation trenches including layout, providing center lines, local bench-mark pillars, levelling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer-in-charge, subject to submit method statement of carrying out excavation work to the Engineer-in-charge for approval. However, engineer"s approval shall not relieve the contractor of his responsibilities and obligations under the contract. Extra rate for each additional 0.5 meter depth exceeding 1.5 meter.	Cum	26165	237.00	6201086.04	**6.20**
02.16.1.2	2	Site development/improvement by carted earth or dredged sand, sandy silt (free from any organic, foreign, environmental hazardous substances) carried by head or truck or any other meansl in/c cost of cutting or by dredging of sand, sandy silt, all; in/c local carrying, placing the earth/sand, sandy silt in the designated area, maintaining slopes, breaking lumps, levelling and dressing in layers up to finished level etc. all complete as per direction and accepted by the engineer in charge.	Cum	2357	449.00	1058382.80	**1.06**
	3	Providing and fixing 3 layer PPR pipes UV stabilised & anti - micro bial fusion welded, having thermal stability for hot & cold water supply, excludingtrenching, refilling cost ..etc - External work					
MR	e)	PN - 10 110mm dia pipe	Rm	33200	582.94	19353687.68	**19.90**
	4	Providing and fixing Butterfly valve					

MR	f)	PN - 16 110mm Butterfly valve	Each	12	17074.80	204897.60	**0.20**
MR	o)	PN - 16 110mm Air valve	Each	67	40338.00	2702646.00	**2.70**
MR	x)	PN - 16 110mm Gate valve	Each	34	8605.20	292576.80	**0.29**
MR	7	Constructing masonry chamber 120x120x100cm inside,in brickwork in cement mortar 1:4 for sluice valve with CI surface box 100mmm top diameter, 160mm bottom diameter and 180mm deep inside with chain lid and RCC top slab 1:2:4 mix including necessary excavation, foundation .. etc	Each	12	2000.00	24000.00	**0.02**
MR	8	Constructing masonry chamber 90x90x100cm inside,in brickwork in cement mortar 1:4 for sluice valve with CI surface box 100mmm top diameter, 160mm bottom diameter and 180mm deep inside with chain lid and RCC top slab 1:2:4 mix including necessary excavation, foundation .. etc	Each	34	1800.00	61200.00	**0.06**
MR	9	Constructing masonry chamber 60x60x75cm inside,in brickwork in cement mortar 1:4 for sluice valve with CI surface box 100mmm top diameter, 160mm bottom diameter and 180mm deep inside with chain lid and RCC top slab 1:2:4 mix including necessary excavation, foundation .. etc	Each	67	1600.00	107200.00	**0.11**
		Total Cost in Taka					30560000
		Total Cost in Million Taka					**30.56**

Cost abstract - Water treatment plant including utility structures

Cost abstract for water treatment plant

S. No.	Reference - BPWD 2018	Description of work	Rate	Unit	Collection sump		Aeration tank		Flash mixer		Filter Press feed & Back wash return pump		Clariflocculator	
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount
1	02.1.5	Earthwork excavation in all stiff clay, stiff back cotton, hard red earth, shales, murum, gravel, stoney earth and earth mixed with small size boulders and to the required depth including surveying wherever necessary with all leads and lifts for the materials as may be directed except in hard rock requiring blasting but inclusive of shoring strutting and baling out water wherever necessary, depositing the surplus earth in places shown clearing and levelling the site all complete in all respects complying with relevant standard specification and including the cost of removing shrubs, logs, roots, jungles if any, providing barricading arrangements and adequate safety measures (including refilling) 0 to 2m depth	237.00	Cum	610.40	144664.80	55.50	13153.50	27.20	6446.40	11.00	2607.00	626.66	148517.47
		Below 2m depth	155.25	Cum										
6	02.15.2	Refilling in foundation and basement and other similar works with excavated earth in layers of 150mm thickness well-watered rammed and consolidated complying with relevant standard specifications as directed by the Departmental officers.	497.00	Cum							4.00	1988.00		
2	02.16.1.2	Supplying and filling in foundation and basement with sand in layers of 150 mm thickness well-watered rammed and consolidated complying with relevant standard specifications including cost of sand and as directed by the Engineer in charge.	449.00	Cum	29.20	13110.80	2.70	1212.30	1.10	493.90	2.52	1132.83	23.58	10586.19
8	2.11	50 mm downgraded picked jhama khoa consolidation in foundation trenches by mixing the same with best quality local sand (F.M. 1.2) in 2:1 (khoa: sand) proportion to achieve minimum dry density of 95% with optimum moisture content (Modified proctor test) including breaking and screening chips, laying and spreading in 150 mm layers uniformly and compacting etc. all complete and accepted by the Engineer-in-charge.	4239.00	Cum										
3	03.4.1	Mass concrete in foundation (1:3:6) with cement, brick chips and sand of F.M. 1.2	6647.00	Cum	29.20	194092.40	2.70	17946.90	1.10	7311.70	2.00	13294.00	23.58	156718.05
10	4.1	Brick works with first class bricks with cement sand (F.M. 1.2) mortar (1:6) in foundation and plinth, filling the joints/interstices fully with mortar, racking out the joints, cleaning and soaking the bricks at least for 24 hours before use and curing at least for 7 days etc. all complete including cost of water, electricity and other charges and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M)	6040.00	Cum										
12		Brick partition wall in cement mortar 1:4 (One of cement and six of sand) 115 mm thick for superstructure In Following Floors using chamber burnt second class stock bricks of size 9"X41/2"X.3" having minimum average crushing strength of 50Kg/sqcm. including labour for fixing the doors, windows and ventilator frames in position fixing of hold fasts scaffolding, curing etc. complete in all respects complying with relevant standard specifications and drawings and as directed by the Departmental Officers.												
a		Ground floor	598.32	Sqm										
#REF!		In First floor	607.32	Sqm										
4	07.4.1	Reinforced cement concrete works with minimum cement content relates to mix ratio1:1.25:2.5 having minimum f'cr = 40 MPa, satisfying a specified compressive strength f'c =32 MPa at 28 days on standard cylinders as per standard practice of CodeACI/BNBC/ASTM, Cement conforming to BDS EN-197-1-CEM-I, 52.5N (52.5 MPa)/ASTM-C 150 Type – I, and adding approved high range water reducing admixture ofcomplying specific type (generally be Type-G) under ASTM-C 494, best quality coarsesand [Sylhet sand or coarse sand of equivalent F.M. 2.2], 20 mm down well gradedcrushed stone chips conforming to ASTM C-33, including screening sand through propersieves, making and placing shutter in position and												

S. No.	Reference - BPWD 2018	Description of work	Rate	Unit	Collection sump		Aeration tank		Flash mixer		Filter Press feed & Back wash return pump		Clariflocculator	
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount
		maintaining true to plumb, makingshutter water-tight properly, placing reinforcement in position; mixing with standard mixermachine with hopper and fed by standard measuring boxes or mixing in batching plant,casting in forms, compacting by vibrator machine and curing at least for 28 days, removingcentering-shuttering after specified time approved; including cost of water, electricity,testing charges of materials and cylinders as required, other charges etc. all complete,approved and accepted by the Engineer-in-charge. (Doses of admixture to be fixed inconsultation with design office) (Rate is excluding the cost of reinforcement and itsfabrication, placing, binding etc, admixture and the cost of shuttering & centering)												
a		In foundation and basement upto 1.50 Mt from Ground Level.	12451.00	Cum	341.30	4249526.30	8.80	109568.80	2.40	29882.40	3.00	37353.00	93.05	1158517.25
b		In Stilt floor	6062.82	Cum	304.56	1846493.74	10.49	63613.53	14.23	86244.82			165.85	1005513.49
5	07.2.1	Reinforced cement concrete works with minimum cement content relates to mix ratio 1:2:4 having minimum f'cr = 27 MPa, satisfying a specified compressive strength f'c = 22 MPa at 28 days on standard cylinders as per standard practice of Code ACI/BNBC/ASTM, cement conforming to BDS EN-197-1-CEM-I, 52.5N (52.5 MPa) / ASTM-C 150 Type – I, best quality Sylhet sand or coarse sand of equivalent F.M. 2.2 and 20 mm down well graded stone chips conforming to ASTM C-33, making and placing shutter in position maintaining true to plumb, making shutter water-tight properly, placing reinforcement in position; mixing in standard mixer machine with hopper fed by standard measuring boxes or mixing in batching plant, casting in forms, compacting by vibrator machine and curing at least for 28 days, removing centering-shuttering after specified time approved; including cost of water, electricity, testing charges of materials and cylinders as required, other charges etc. all complete, approved and accepted by the Engineer-in-charge. (Rate is excluding the cost of reinforcement and its fabrication, placing, binding etc. and the cost of shuttering & centering)	11817.00	Cum										
6		Providing formwork for reinforced cement concrete works using M.S. or plywood shuttering of size 90x60cm and MS 10 gauge stiffened with M.S. angle of size 25mm x 25mm x 3mm for boarding laid over silver oak (C.W.) joist of size 10cm x 6.50cm (spaced about 90cm c/c) and supported by MS pipe supports/wooden props of 10cm to 13 cm dia. (spaced about 75 cm c/c) etc., including strutting up to 3 m height and removing the same after a specified period without damaging the CC works complying with relevant standard specification and as directed by the Engineer in charge												
		a) For R.C.C. works in foundation and basement such as grid beam, plinth beam, raft beam, raft slab, column base, column footings, other similar nature of works etc all complete	450.00	Sqm	71.70	32265.00	6.30	2835.00	6.80	3060.00	8.00	3600.00	39.08	17586.64
		b) For reinforced cement concrete works such as floor and roof slab, lintels, beams staircase waist and landing slab and plane surfaces and other similar works. (0-3 m)	500.00	Sqm	984.95	492473.02	38.30	19149.81	42.21	21105.00			54.82	27411.24
		c) For RCC surface of columns and in small quantities such as sunshades, parapet cum drops, window boxing in projections and other similar works.	550.00	Sqm	624.50	343475.00	41.60	22880.00	82.80	45540.00			1021.95	562072.66
23		Supplying, fitting and fixing of aluminium sliding window as per the U.S. Architectural Aluminium Manufacturer"s Association (AAMA) standard specification and BDS 1879:2014 having 1.2 mm thick outer bottom (size 75.50 mm, 32mm), 1.2 mm thick outer top (size 75.50 mm, 16.80 mm), 1.2 mm thick shutter top (size 33 mm.26.80, 22 mm), 1.2 mm thick shutter bottom (size 60mm, 24.40 mm), 1.2 mm thick outer side (size 75.50 mm,19.90 mm), 1.2 mm thick shutter lock (size 49.20 mm 26.20 mm) and 1.2 mm thick inter lock (size 34.40 mm, 32.10 mm) sections all aluminium members (total weight kg/sqm) will be anodized to aluminium bronze/silver/ss/black colour with a coat not less than 15 microns in thickness or powder coated to any colour with a coat not less than 25 microns in thickness and density of 4 mg per square cm etc. including all accessories like sliding door key lock, sliding door wheel, sliding door mohair, sliding door neoprene, bolts and nuts including sealants, keeping provision for fitting 5 mm thick glass including labour charge for fitting of accessories, making grooves and mending good damages, carriage, and electricity complete in all respect as per drawing and accepted by the Engineer-in-charge.												

S. No.	Reference - BPWD 2018	Description of work	Rate	Unit	Collection sump		Aeration tank		Flash mixer		Filter Press feed & Back wash return pump		Clarifloculator	
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount
		Aluminum clips, handle stoppers and fixing 4mm thick plain glass lock L angles, screws including, conveyance scaffolding if any etc complete. necessary dismantling makes holes in RCC columns, beams, masonry wherever necessary power drill to extent required and made good the original condition after fixing as directed by the departmental officers and complying with relevant standard specification. The alu. surface is to be anodized with matt finish under electrically controlled condition in accordance with ISI specification 1868/1962 for an average anodic film thickness of not less than 15 (fifteen) microns. All the materials should be got approved by the SE before fixing in position.												
	14.6	a) Window	4146.00	Sqm										
8	4.25	75 mm thick cement concrete (1:3:6) flooring with cement, best quality coarse sand and 19 mm downgraded picked jhama brick chips including breaking of chips, screening, mixing, laying, compacting, washing and screening of sand (F.M 1.2) and curing at least for 7 days etc. including cost of water, electricity and other charges etc. all complete and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M)	507.00	Sqm									214.94	108976.53
#REF!														
37	6.11	Supplying, fitting and fixing country made rustic or matt finished stair tiles complying BDS ISO 13006: 2015, water absorption ≤ 0.5%, modulus of rupture (MOR) ≥ 27 N/mm2, irrespective of color &/or design, with 20 mm thick cement sand (F.M. 1.2) mortar (1:3) base and raking out the joints with white cement including cutting, laying and hire charge of machine and finishing with care etc. including water, electricity and other charges complete in all respect and accepted by the Engineer-in-charge. (Cement: CEMII/ A-M). In ground floor	1935.00	Sqm										
#REF!	6.14	Supplying, fitting and fixing country made floor tiles complying BDS ISO 13006: 2015, water absorption ≤ 0.5%, modulus of rupture (MOR) ≥ 27 N/mm2, irrespective of color &/or design, with adhesives in full thickness of tiles, filler/tiles grout including cutting, shaping, placing in proper level etc. all complete and accepted by the Engineer-in-charge. In ground floor GP mirror polished floor tiles (600 mm x 900 mm)	2256.00	Sqm										
39	6.16	Supplying, fitting and fixing 20mm to 25mm thick machine made cement pavement tiles having minimum compressive strength of 27 MPa, irrespective of color &/or design, with 20 mm thick cement sand (F.M. 1.2) mortar (1:4) base and making the joints carefully in true straight line including cutting, laying and hire charge of machine and finishing with care etc. including water, electricity and other charges complete in all respect and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M). In ground floor Pavement tiles of size 300 mm x 300 mm	2481.00	Cum										
43	07.17.3	Water-proofing membrane on the floor or on the horizontal surfaces with permanent protective cover & wearing coarse. (Rate is excluding the cost of protective cover and wearing coarse which to be paid as per corresponding items in this schedule)	908.00	Sqm										
9	4.3	Brick works with first class bricks with cement sand (F.M. 1.2) mortar (1:4) in exterior walls including filling the interstices with mortar, raking out joints, cleaning and socking the bricks at least for 24 hours before use and washing of sand, necessary scaffolding, curing at least for 7 days etc. all complete including cost of water, electricity and other charges (measurement to given as 250 mm width for one brick length and 375 mm for one brick and a half brick length) accepted by the Engineer-in-charge. (Cement: CEM-II/A-M) In ground floor	6769.00	Cum			6.00	40614.00						
10	06.6.3	Supplying, fitting and fixing country made glazed wall tiles complying BDS ISO 13006: 2015, irrespective of color &/or design, with 20 mm thick cement sand (F.M. 1.2) mortar (1:3) base and raking out the joints with white cement including cutting, laying and hire charge of machine and finishing with care etc. including cost of water, electricity and other charges complete in all	1817.00	Sqm			27.32	49633.44						

S. No.	Reference - BPWD 2018	Description of work	Rate	Unit	Collection sump		Aeration tank		Flash mixer		Filter Press feed & Back wash return pump		Clariflocculator	
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount
		respect and accepted by the Engineer-in-charge. (Cement: CEMII/ A-M). In ground floor Wall tiles more than 250 mm x 400 mm & less than or equal to 300 mm x 600 mm in sizes												
11	15.1	Minimum 12 mm thick cement sand (F.M. 1.2) plaster (1:4) with fresh cement to both inner-and outer surface of wall, finishing the corner and edges including washing of sand, cleaning the surface, curing at least for 7 days, cost of water, electricity, scaffolding and other charges etc. all complete in all respect as per drawing and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M) ground floor.	243.00	Sqm	310.90	75548.70	7.50	1822.50	36.80	8942.40			673.21	163590.21
12		Plastering in C.M 1:3 (one of cement OPC 53 grade (Considered 35% of fly ash in replacement of cement) and three of sand) 10 mm thick for bottom of sunshade, ceiling in all floors, including scaffolding, curing, finishing, etc complete in all respects complying with relevant standard specification and as directed by the Engineer in charge (Cement will be supplied free of cost by the Employer at project site; The contractor is to take delivery of the cement from the site. The quote should not include the cost of cement but should include all other items including fly ash)	197.80	Sqm	1014.90	200747.22	64.90	12837.22	32.10	6349.38				
13	08.1.2	Grade 400 (RB 400 /RB 400W: complying BDS ISO 6935-2:2006) ribbed or deformed bar produced and marked according to Bangladesh standard, with minimum yield strength, fy (ReH)= 400 MPa but fy not exceeding 450 MPa and whatever is the yield strength within allowable limit as per BNBC/ ACI 318, the ratio of ultimate tensile strength fu to yield strength fy, shall be at least 1.25 and minimum elongation after fracture and minimum total elongation at maximum force is 16% and 8% respectively : up to ground floor.												
		Mild steel bars/RTS bars	82000.00	MT	50.26	4121635.28	1.70	139400.00	1.800	147600.00	0.417	34194.00	18.452	1513095.83
75	30.15.2	Supplying and placing of approx. 60 mm thick coloured uni-block for paving walk way having compressive strength of 15 N/mm2 on compacted sand bed of 50 mm on stabilized soil base, and filling all interstices with sand, cleaning etc. accepted by the Engineer-incharge.	1276.00	Sqm										
76	30.3	Supplying, carrying, placing, providing of concrete Kerb stone size 600 mm x 300 mm x 100 mm approved and accepted by the Engineer-in-charge.	238.00	Sqm										
		.												
#REF!	26.82.1	950 mm x 950 mm x 75 mm R.C.C. pit cover with 450 mm dia C.I. manhole cover.	2280.00	Nos	3.00	6840.00			16.00	36480.00				
#REF!		Providing and fixing hand rail of approved size by welding etc. to steel ladder railing, balcony railing and staircase railing including applying a priming coat of approved steel primer.	316.70	Rmt	40.53	12835.22							51.00	16151.70
		Total				117337.00		494667.00		399456.00		94169.00		4888738.00
		Total amount in lakhs				117.337		4.947		3.995		0.942		48.887

Cost abstract for water treatment plant (Continuation)

No.	Reference - BPWD 2018	Description of work	Rate	Unit	Filter feed tank		Valve sump		Sludge & Valve sump		Filter platform		Back wash sump		Total Qty	Amount
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount		
1	02.1.5	Earthwork excavation in all stiff clay, stiff back cotton, hard red earth, shales, murum, gravel, stoney earth and earth mixed with small size boulders and to the required depth including surveying wherever necessary with all leads and lifts for the materials as may be directed except in hard rock requiring blasting but inclusive of shoring strutting and baling out water wherever necessary, depositing the surplus earth in places shown clearing and levelling the site all complete in all respects complying with relevant standard specification and including the cost of removing shrubs, logs, roots, jungles if any, providing barricading arrangements and adequate safety measures (including refilling) 0 to 2m depth	237.00	Cum	282.89	67046.06			66.90	15855.30	90.50	21448.50	63.00	14931.00	1834.05	434670.03
		Below 2m depth	155.25	Cum	77.80	12077.84			49.50	7684.88			50.00	7762.50	177.30	27525.21
6	02.15.2	Refilling in foundation and basement and other similar works with excavated earth in layers of 150mm thickness well-watered rammed and consolidated complying with relevant standard specifications as directed by the Departmental officers.	497.00	Cum									52.00	25844.00	56.00	27832.00
2	02.16.1.2	Supplying and filling in foundation and basement with sand in layers of 150 mm thickness well-watered rammed and consolidated complying with relevant standard specifications including cost of sand and as directed by the Engineer in charge.	449.00	Cum	10.06	4518.86			2.20	987.80	18.10	8126.90	5.00	2245.00	94.46	42414.58
8	2.11	50 mm downgraded picked jhama khoa consolidation in foundation trenches by mixing the same with best quality local sand (F.M. 1.2) in 2:1 (khoa: sand) proportion to achieve minimum dry density of 95% with optimum moisture content (Modified proctor test) including breaking and screening chips, laying and spreading in 150 mm layers uniformly and compacting etc. all complete and accepted by the Engineer-in-charge.	4239.00	Cum												
3	03.4.1	Mass concrete in foundation (1:3:6) with cement, brick chips and sand of F.M. 1.2	6647.00	Cum	10.06	66897.27			2.20	14623.40	18.10	120310.70	4.00	26588.00	92.94	617782.42
10	4.1	Brick works with first class bricks with cement sand (F.M. 1.2) mortar (1:6) in foundation and plinth, filling the joints/interstices fully with mortar, racking out the joints, cleaning and soaking the bricks at least for 24 hours before use and curing at least for 7 days etc. all complete including cost of water, electricity and other charges and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M)	6040.00	Cum												
12		Brick partition wall in cement mortar 1:4 (One of cement and six of sand) 115 mm thick for superstructure In Following Floors using chamber burnt second class stock bricks of size														

No.	Reference - BPWD 2018	Description of work	Rate	Unit	Filter feed tank		Valve sump		Sludge & Valve sump		Filter platform		Back wash sump		Total Qty	Amount
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount		
		9"X41/2"X.3" having minimum average crushing strength of 50Kg/sqcm. including labour for fixing the doors, windows and ventilator frames in position fixing of hold fasts scaffolding, curing etc. complete in all respects complying with relevant standard specifications and drawings and as directed by the Departmental Officers.														
a		Ground floor	598.32	Sqm												
#REF!		In First floor	607.32	Sqm												
4	07.4.1	Reinforced cement concrete works with minimum cement content relates to mix ratio1:1.25:2.5 having minimum f'cr = 40 MPa, satisfying a specified compressive strength f'c =32 MPa at 28 days on standard cylinders as per standard practice of CodeACI/BNBC/ASTM, Cement conforming to BDS EN-197-1-CEM-I, 52.5N (52.5 MPa)/ASTM-C 150 Type – I, and adding approved high range water reducing admixture ofcomplying specific type (generally be Type-G) under ASTM-C 494, best quality coarsesand [Sylhet sand or coarse sand of equivalent F.M. 2.2], 20 mm down well gradedcrushed stone chips conforming to ASTM C-33, including screening sand through propersieves, making and placing shutter in position and maintaining true to plumb, makingshutter water-tight properly, placing reinforcement in position; mixing with standard mixermachine with hopper and fed by standard measuring boxes or mixing in batching plant,casting in forms, compacting by vibrator machine and curing at least for 28 days, removingcentering-shuttering after specified time approved; including cost of water, electricity,testing charges of materials and cylinders as required, other charges etc. all complete,approved and accepted by the Engineer-in-charge. (Doses of admixture to be fixed inconsultation with design office) (Rate is excluding the cost of reinforcement and itsfabrication, placing, binding etc, admixture and the cost of shuttering & centering)														
a		In foundation and basement upto 1.50 Mt from Ground Level.	12451.00	Cum	125.13				6.70	83421.70			16.00	199216.00	596.38	7425472.42
b		In Stilt floor	6062.82	Cum					15.00	90942.29					510.13	3092807.87
5	07.2.1	Reinforced cement concrete works with minimum cement content relates to mix ratio 1:2:4 having minimum f'cr = 27 MPa, satisfying a specified compressive strength f'c = 22 MPa at 28 days on standard cylinders as per standard practice of Code ACI/BNBC/ASTM, cement conforming to BDS EN-197-1-CEM-I, 52.5N (52.5 MPa) / ASTM-C 150 Type – I, best quality Sylhet sand or coarse sand of equivalent F.M. 2.2 and 20 mm down well graded stone chips conforming to ASTM C-33, making and placing shutter in position maintaining true to plumb, making shutter water-tight properly, placing reinforcement in position; mixing in standard mixer machine with hopper fed by standard measuring boxes or mixing in batching plant, casting in forms, compacting by vibrator machine and curing at least for 28 days, removing centering-shuttering after specified time approved; including cost of	11817.00	Cum							70.20	829553.40			70.20	829553.40

No.	Reference - BPWD 2018	Description of work	Rate	Unit	Filter feed tank		Valve sump		Sludge & Valve sump		Filter platform		Back wash sump		Total Qty	Amount
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount		
		water, electricity, testing charges of materials and cylinders as required, other charges etc. all complete, approved and accepted by the Engineer-in-charge. (Rate is excluding the cost of reinforcement and its fabrication, placing, binding etc. and the cost of shuttering & centering)														
			.													
6		Providing formwork for reinforced cement concrete works using M.S. or plywood shuttering of size 90x60cm and MS 10 gauge stiffened with M.S. angle of size 25mm x 25mm x 3mm for boarding laid over silver oak (C.W.) joist of size 10cm x 6.50cm (spaced about 90cm c/c) and supported by MS pipe supports/wooden props of 10cm to 13 cm dia. (spaced about 75 cm c/c) etc., including strutting up to 3 m height and removing the same after a specified period without damaging the CC works complying with relevant standard specification and as directed by the Engineer in charge														
		a) For R.C.C. works in foundation and basement such as grid beam, plinth beam, raft beam, raft slab, column base, column footings, other similar nature of works etc all complete	450.00	Sqm	16.99	7646.79			6.40	2880.00	21.20	9540.00	95.00	42750.00	271.47	122163.43
		b) For reinforced cement concrete works such as floor and roof slab, lintels, beams staircase waist and landing slab and plane surfaces and other similar works. (0-3 m)	500.00	Sqm											1120.28	560139.07
		c) For RCC surface of columns and in small quantities such as sunshades, parapet cum drops, window boxing in projections and other similar works.	550.00	Sqm	222.27	122250.68			126.90	69795.00					2120.02	1166013.34
23		Supplying, fitting and fixing of aluminium sliding window as per the U.S. Architectural Aluminium Manufacturer˝s Association (AAMA) standard specification and BDS 1879:2014 having 1.2 mm thick outer bottom (size 75.50 mm, 32mm), 1.2 mm thick outer top (size 75.50 mm, 16.80 mm), 1.2 mm thick shutter top (size 33 mm.26.80, 22 mm), 1.2 mm thick shutter bottom (size 60mm, 24.40 mm), 1.2 mm thick outer side (size 75.50 mm,19.90 mm), 1.2 mm thick shutter lock (size 49.20 mm 26.20 mm) and 1.2 mm thick inter lock (size 34.40 mm, 32.10 mm) sections all aluminium members (total weight kg/sqm) will be anodized to aluminium bronze/silver/ss/black colour with a coat not less than 15 microns in thickness or powder coated to any colour with a coat not less than 25 microns in thickness and density of 4 mg per square cm etc. including all accessories like sliding door key lock, sliding door wheel, sliding door mohair, sliding door neoprene, bolts and nuts including sealants, keeping provision for fitting 5 mm thick glass including labour charge for fitting of accessories, making grooves and mending good damages, carriage, and electricity complete in all respect as per drawing and accepted by the Engineer-in-charge.														
		Aluminum clips, handle stoppers and fixing 4mm thick plain glass lock L angles, screws including, conveyance scaffolding if any etc complete. necessary dismantling makes holes in RCC columns, beams, masonry wherever necessary power drill to extent required and made good the														

No.	Reference - BPWD 2018	Description of work	Rate	Unit	Filter feed tank		Valve sump		Sludge & Valve sump		Filter platform		Back wash sump		Total Qty	Amount
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount		
		original condition after fixing as directed by the departmental officers and complying with relevant standard specification. The alu. surface is to be anodized with matt finish under electrically controlled condition in accordance with ISI specification 1868/1962 for an average anodic film thickness of not less than 15 (fifteen) microns. All the materials should be got approved by the SE before fixing in position.														
	14.6	a) Window	4146.00	Sqm												
8	4.25	75 mm thick cement concrete (1:3:6) flooring with cement, best quality coarse sand and 19 mm downgraded picked jhama brick chips including breaking of chips, screening, mixing, laying, compacting, washing and screening of sand (F.M 1.2) and curing at least for 7 days etc. including cost of water, electricity and other charges etc. all complete and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M)	507.00	Sqm	83.65	42408.92			8.00	4056.00			13.00	6591.00	319.59	162032.45
#REF!																
37	6.11	Supplying, fitting and fixing country made rustic or matt finished stair tiles complying BDS ISO 13006: 2015, water absorption ≤ 0.5%, modulus of rupture (MOR) ≥ 27 N/mm2, irrespective of color &/or design, with 20 mm thick cement sand (F.M. 1.2) mortar (1:3) base and raking out the joints with white cement including cutting, laying and hire charge of machine and finishing with care etc. including water, electricity and other charges complete in all respect and accepted by the Engineer-in-charge. (Cement: CEMII/ A-M). In ground floor	1935.00	Sqm												
#REF!	6.14	Supplying, fitting and fixing country made floor tiles complying BDS ISO 13006: 2015, water absorption ≤ 0.5%, modulus of rupture (MOR) ≥ 27 N/mm2, irrespective of color &/or design, with adhesives in full thickness of tiles, filler/tiles grout including cutting, shaping, placing in proper level etc. all complete and accepted by the Engineer-in-charge. In ground floor GP mirror polished floor tiles (600 mm x 900 mm)	2256.00	Sqm												
39	6.16	Supplying, fitting and fixing 20mm to 25mm thick machine made cement pavement tiles having minimum compressive strength of 27 MPa, irrespective of color &/or design, with 20 mm thick cement sand (F.M. 1.2) mortar (1:4) base and making the joints carefully in true straight line including cutting, laying and hire charge of machine and finishing with care etc. including water, electricity and other charges complete in all respect and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M). In ground floor Pavement tiles of size 300 mm x 300 mm	2481.00	Cum												
43	07.17.3	Water-proofing membrane on the floor or on the horizontal surfaces with permanent protective cover & wearing coarse. (Rate is excluding the cost of protective cover and wearing coarse which to be paid as per corresponding items in this schedule)	908.00	Sqm												

No.	Reference - BPWD 2018	Description of work	Rate	Unit	Filter feed tank		Valve sump		Sludge & Valve sump		Filter platform		Back wash sump		Total Qty	Amount
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount		
9	4.3	Brick works with first class bricks with cement sand (F.M. 1.2) mortar (1:4) in exterior walls including filling the interstices with mortar, raking out joints, cleaning and socking the bricks at least for 24 hours before use and washing of sand, necessary scaffolding, curing at least for 7 days etc. all complete including cost of water, electricity and other charges (measurement to given as 250 mm width for one brick length and 375 mm for one brick and a half brick length) accepted by the Engineer-in-charge. (Cement: CEM-II/A-M) In ground floor	6769.00	Cum											6.00	40614.00
10	06.6.3	Supplying, fitting and fixing country made glazed wall tiles complying BDS ISO 13006: 2015, irrespective of color &/or design, with 20 mm thick cement sand (F.M. 1.2) mortar (1:3) base and raking out the joints with white cement including cutting, laying and hire charge of machine and finishing with care etc. including cost of water, electricity and other charges complete in all respect and accepted by the Engineer-in-charge. (Cement: CEMII/ A-M). In ground floor Wall tiles more than 250 mm x 400 mm & less than or equal to 300 mm x 600 mm in sizes	1817.00	Sqm											27.32	49633.44
11	15.1	Minimum 12 mm thick cement sand (F.M. 1.2) plaster (1:4) with fresh cement to both inner-and outer surface of wall, finishing the corner and edges including washing of sand, cleaning the surface, curing at least for 7 days, cost of water, electricity, scaffolding and other charges etc. all complete in all respect as per drawing and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M) ground floor.	243.00	Sqm	194.78	47332.46			134.90	32780.70			90.00	21870.00	1448.09	351886.96
12		Plastering in C.M 1:3 (one of cement OPC 53 grade (Considered 35% of fly ash in replacement of cement) and three of sand) 10 mm thick for bottom of sunshade, ceiling in all floors, including scaffolding, curing, finishing, etc complete in all respects complying with relevant standard specification and as directed by the Engineer in charge (Cement will be supplied free of cost by the Employer at project site; The contractor is to take delivery of the cement from the site. The quote should not include the cost of cement but should include all other items including fly ash)	197.80	Sqm											1111.90	219933.82
13	08.1.2	Grade 400 (RB 400 /RB 400W: complying BDS ISO 6935-2:2006) ribbed or deformed bar produced and marked according to Bangladesh standard, with minimum yield strength, fy (ReH)= 400 MPa but fy not exceeding 450 MPa and whatever is the yield strength within allowable limit as per BNBC/ ACI 318, the ratio of ultimate tensile strength fu to yield strength fy, shall be at least 1.25 and minimum elongation after fracture and minimum total elongation at maximum force is 16% and 8% respectively : up to ground floor.														
		Mild steel bars/RTS bars	82000.00	MT	12.177	998487.24			1.400	114800.00			3.00	246000.00	89.21	7315212.34

No.	Reference - BPWD 2018	Description of work	Rate	Unit	Filter feed tank		Valve sump		Sludge & Valve sump		Filter platform		Back wash sump		Total Qty	Amount
					Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount		
75	30.15.2	Supplying and placing of approx. 60 mm thick coloured uni-block for paving walk way having compressive strength of 15 N/mm2 on compacted sand bed of 50 mm on stabilized soil base, and filling all interstices with sand, cleaning etc. accepted by the Engineer-incharge.	1276.00	Sqm												
76	30.3	Supplying, carrying, placing, providing of concrete Kerb stone size 600 mm x 300 mm x 100 mm approved and accepted by the Engineer-in-charge.	238.00	Sqm												
		.														
	26.82.1	950 mm x 950 mm x 75 mm R.C.C. pit cover with 450 mm dia C.I. manhole cover.	2280.00	Nos	3.00	6840.00									22.00	50160.00
		Providing and fixing hand rail of approved size by welding etc. to steel ladder railing, balcony railing and staircase railing including applying a priming coat of approved steel primer.	316.70	Rmt											91.53	28986.92
		Total				**293350.0**				**437828.00**		**988980.00**		**593798.00**		**22564834.00**
		Total amount in lakhs				**29.335**				**4.378**		**9.890**		**5.938**		**225.648**

Cost abstract for water treatment plant (Continuation)

S.No	Description	Amount	Amount in Million Taka
	WTP		
1	Collection sump	11,733,708	11.73
2	Aeration tank	494,667	0.49
3	Flash mixer & Spillter Box	399,456	0.40
4	Clariflocculator	4,888,738	4.89
5	Filter feed tank	2,933,494	2.93
6	Sludge sump	437,828	0.44
7	Filter platform	988,980	0.99
8	Air blower /MCC contol room	4,884,836	4.88
9	Chemical storage house	900,749	0.90
10	Filter Press house	2,962,088	2.96
11	Building-Internal electrification	614,910	0.61

S.No	Description	Amount	Amount in Million Taka
12	Elctro mechanical cost	12,744,354	12.50
13	Back wash drain collection sump	593,798	0.59
14	Filter press drain water return pump platform	94,169	0.09
15	Desalination	40,000,000	40.00
Total		**44,671,775**	**84.43**
Total cost in Lakhs			**84.43**
	WTP capacity	2.5	MLD
		Cost per MLD	33.63
		Cost excalation	4%
	Total cost per MLD in Million Taka		35.122
Cost for 2 MLD			**70.00**

Cost abstract - Water utility structures (GLSR, ELSR & pump house)

BPWD SOR/2018	Cost Abstract	Unit	Qty.	Rate in Taka	Amount in Taka	Amount in Million Taka
BPWD rates 2018, Annex - A	Sump - Potable - Processing	Lit	2040000	20.34	41,496,275.16	41.50
BPWD rates 2018, Annex - A	OHT - Potable - Processing	Lit	400000	40.95	16,378,718.23	16.38
MR	Potable water pump - Processing	nos	2.00	490910.00	981,820.00	0.98
MR	Construction of pump house with hand operated crane for lifting the pump as per the specification and design in drawing for potable water - Processing area	Sqm	128	70313.00	9,000,064.00	8.43

Cost abstract for electrical works

Remarks/PWD SCHDULE 2018 Item no	Item name	Description of Items	Unit	Quantity	Rate (BDT)	Total Amount (BDT)	Total Amount in Million BDT
Cost abstract for Power supply Internal line							
BPDB	**33 kV Line contruction**	Supply,installation/construction and testing & commissioning work of double circuit 33 kV line.	km	14.6	4000000.00	58,400,000.00	58.40
Cost abstract for Power supply External line and substation							
BPDB	33 kV & 132 kV Line contruction	Supply,installation/construction and testing & commissioning work of double circuit 33 kV line.	km	13.2	4000000.00	52,940,000.00	52.94
PBS	**33/11kV Sub-station**	Supply,installation and testing & commissioning workof a complete 33/11 kV substation.including construction of control room for 33/11 kV voltage level.	numbers	1	100,000,000.00	100,000,000.00	100

Cost abstract for electrical network

SL	Major Items	Unit	Unit system Cost	Demand milage (km)	Total System Cost
A)	**Material's Estimated Cost:**				
1	33 kV Line material (New)	Tk./ km	2542000	2.5	6355000.00
2	11 kV Line material (New)	Tk./ km	1235000	6.8	8398000.00
B)	**Installation/ Construction Cost:**				
1	Construction of 33kV Line	Tk./ km	260000	2.5	650000
2	Construction of 11kV Line	Tk./ km	180000	6.8	1224000
C)	**Electrical Works Design, Implementation & Supervision Consultant Cost:**				
1	33kV Line Works Design, Implementation & Supervision Consultant (New)	Tk./ km	30000	1	30000
2	11kV Line Works Design, Implementation & Supervision Consultant (New)	Tk./ km	25000	1	25000
D)	**Civil & other Cost:**				

1	33kV Line Works Design, Implementation & Supervision Consultant (New)	Tk./ km	1168000	1	1168000
2	11kV Line Works Design, Implementation & Supervision Consultant (New)	Tk./ km	25000	1	25000
Total					
1	Design, supply, installation, testing & commissioning etc all complete as required of 33kV new Line	Tk./ km	4000000	1	4000000
2	Design, supply, installation, testing & commissioning etc all complete as required of 11kV new Line	Tk./ km	1400000	1	1400000
	Cost abstract for Power supply internal network - 33 kV	Tk./ km	4000000	14.6	58400000
	Cost abstract for Power supply external network - 33kV	Tk./ km	4000000	13.235	52940000

Cost abstract for 33/kV Sub- station

Item No	Description	Quantity	Unit	Price in Taka (Source REB)
	PART-A: SUBSTATION EQUIPMENT			
1	33 KV ACR (AUTO CIRCUIT RECLOSER)	1	Set	27,00,000
2	33 KV ISOLATOR	1	Set	2,40,000
3	33 KV ABS (AIR BREAK SWITCH)	1	Set	2,40,000

Item No	Description	Quantity	Unit	Price in Taka (Source REB)
4	33 KV LIGHTNING ARRESTOR	2	Set	4,20,000
5	33 KV HT SWITCHGEAR (VCB) INDOOR TYPE	1	Set	60,00,000
6	33/11 KV, 8000 KVA TRANSFORMER WITH OLTC	1	Set	1,80,00,000
7	110V DC BATTERY & 3 PHASE BATTERY CHARGER	1	Job	13,50,000
8	AC/DC PANEL	1	No	3,00,000
	Sub Total -A			2,92,50,000
	PART-B: INSTALLATION			
9	INSTALLATION OF 33 KV SUB-STATION EQUIPMENT	1	Job	6,00,000
10	EARTHING MATERIALS FOR SUB-STATION MEASH EARTHING	1	Job	13,50,000
11	2 NOS. POLE WITH STRUCTURE	1	Job	4,50,000
12	LOADING, UNLOADING & TRANSPORTATION COST	1	Job	3,00,000
	Sub Total -B			27,00,000
	PART-C: (11 KV SUBSTATION)			
13	11 KV HT SWITCHGEAR PANEL (VCB) INCOMING FEEDER	1	Set	7,00,000
14	11 KV HT SWITCHGEAR PANEL (VCB) OUTGOING FEEDER	1	Set	14,00,000
15	11 KV HT SWITCHGEAR PANEL (VCB) OUTGOING FEEDER	2	Set	7,00,000
16	11/0.415 KV, 3000 KVA DRY TYPE TRANSFORMER	1	Set	84,00,000
17	11/0.415 KV, 2500 KVA DRY TYPE TRANSFORMER	1	Set	30,00,000
18	HEAT SHRINK KIT	12	Set	36,000
19	INSTALLATION OF SUB-STATION EQUIPMEN	1	Job	5,00,000
20	EARTHING FOR SUBSTATION	10	Set	4,00,000
	Sub Total -C			1,51,36,000
	PART-C: Building			
21	Control room & other civil works	2400	Sqm	5,29,14,000
	Total cost (A+B+C+D)			**10,00,00,000**

Cost abstract for streetlight network

Item no.	Remarks/PWD SCHDULE 2018 Item no	Item name	Description of Items	Unit	Quantity	Rate	Total Amount
				a	b	c	d=bxc
1		Cable work (through PVC pipe)	Underground wiring: Providing & laying of the following XLPE insulated & PVC sheathed cable (N2XY) with PVC insulated green/white coloured ECC wire (BYA) connecting at both ends, through PVC pipe & accessories in the following manner: All electrical contacts shall be of brass/copper connected through connector or soldering (no twisting shall be allowed) and cables shall be manufactured and tested according to relevant IEC/BDS/ BS/ VDE standards and as per detailed specification mentioned in Annexure-A. The work shall be carried out as per direction/approval/acceptance of the Engineer. *With cable manufactured by M/S BRB/Paradise/Poly/Citizen/BBS/Super sign cables Ltd.*				
			i) In kutcha ground by cutting 45.70 cm width x 91.40 cm depth trench with necessary brick or tile protection and mending the damages good by refilling trench with proper compaction.				
			ii) In pucca floor through PVC pipe by cutting trench of necessary size and mending the damages good by brick soling, 75 mm (1:2:4) CC work with neat cement finishing etc.				
			1C-2 x 16 sq.mm (N2XY) with 35 sq.mm (BYA) ECC wire through PVC pipe of minimum inner dia 40 mm having wall thickness of 1.9 mm.				
			In katcha ground	meter	12750.00	480.00	6120000.00
			In pucca floor	meter	5400.00	520.00	2808000.00
2		Concealed wiring (BYM)	1C-4 x 25 sq.mm (N2XY) with 35 sq.mm (BYA) ECC wire through PVC pipe of minimum inner dia 50 mm having wall thickness of 2.59 mm. The work shall be carried out as per direction & approval of the Engineer.				
			In katcha ground	meter	6,780.00	760.00	5,152,800.00
			In pucca floor	meter	1,350.00	800.00	1,080,000.00
3		STREET LIGHT FITTINGS (LED)	Supply & fixing of LED street light fitting of the following features and model with all necessary elements such as driver, chips etc. complete. Model & sample shall be approved by the Engineer.				
			(i)GLORIA cat No- GLST. 1205 or equivalent product of ENERGY +, SUNKO, etc. (ii) Rated life : 50,000 hr (minimum) (iii) Luminux flux : 100 + 1m/w (iv) LED chips: EDISON/EPISTOR/OSRAM/PHILIPS/CREE/BRIDGELUX. (v) Driver: MEANWELL / OSRAM / PHILIPS / IEC standard. (vi) Body: Tempered glass pure Aluminium.				
	6.A.8.(iii).(a).1		100 W	each	1,610.00	9,358.00	15,066,380.00
	6.A.8.(iii).(a).2		150 W	each	-	11,773.00	
4		GI POLE	Providing following seamless hot dip galvanized GI pole fabricated with GI pipe complete with GI sockets, MS. base plate, top cover, necessary welding as required:-The length of the bracket shall be such that the end of light fixture will be 1.5meter (approx.) from the light column. A junction box to be installed at bottom level of the pole fabricated from 2.0mm (min.) mild steel sheet and hot deep galvanized complete with cover including termination unit, circuit breaker and earthing terminal etc. The work shall be completed as per drawing and direction of the Engineer.				
	3.2.3		Total length-30'(9m),Bottom-150mm,Top-100mm, Thikness-4.0mm, Base plate-300mmx300mm with 12mm th.	each	925	24149	22337825
	3.2.4		Total length-25'(8m),Bottom-150mm,Top-100mm, Thikness-4.0mm, Base plate-300mmx300mm with 12mm th.	each	0	19319	0
5	10.1(Civil)	Anchor Bolt	Supply and fixing of galvanized anchor bolts of variable dia for rigid frame conforming to ASTM F1554 Grade 55, Galvanized to A153, Class C or equivalent with minimum yield strength of 380 MPa, as per manual of steel construction by American Institute of Steel Construction (AISC) etc. including the cost of washer & bolts, material testing etc. all complete as per drawing, specification and direction of the Engineer-in-charge. Length-400mm,Dia -20mm,Bend length-100mm ,Thred length-75mm with Nut ,Washer .	kg	5155	180	927900
6		FORMWORK (Wooden)	Centering and shuttering, including strutting, propping etc. and removal of form after hardening of the concrete for:				
	07.15.3(Civil)		Padestals, column, wall	sqm	2,964.38	429.00	1,271,716.88
7	08.1.2(Civil)	Re-Bar work	Grade 400 (RB 400 /RB 400W: complying BDS ISO 6935-2:2006) ribbed or deformed bar produced and marked according to Bangladesh standard, with minimum yield strength, fy (ReH)= 400 MPa but fy not exceeding 450 MPa and whatever is the yield strength within allowable limit as per BNBC/ ACI 318, the ratio of ultimate tensile strength fu to yield strength fy, shall be at least 1.25 and minimum elongation after fracture and minimum total elongation at maximum force is 16% and 8% respectively : up to ground floor.	kg	14920.00	82.00	1223440
8	02.1.5 (Civil)	Earth work	Earth work in excavation in all kinds of soil for foundation trenches including layout, providing center lines, local bench-mark pillars, levelling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer-in-charge, subject to submit method statement of carrying out excavation work to the Engineer-in-charge for approval. However, engineer's approval shall not relieve the contractor of his responsibilities and obligations	Cum	2241.88	217.00	486486.875

Item no.	Remarks/PWD SCHDULE 2018 Item no	Item name	Description of Items	Unit	Quantity	Rate	Total Amount
				a	b	c	d=bxc
			under the contract. Earthwork in excavation in foundation trenches up to 1.5 m depth and maximum 10 m lead: in very soft / saturated / organic clayey soil / soil of semi-liquid state.				
9	2.13 (Civil)	Back filling	Earth filling in foundation trenches and plinth in 150 mm layer with earth available within 90 m of the building site to achive minimum dry density of 95% with optimum moisture content (Modified proctor test) including carrying, watering, levelling, dressing and compacting to a specified percentage each layer up to finished level etc. all complete and accepted by Engineer-in-charge.	Cum	1530.00	149.00	227970
10	03.4.1 (Civil)	C.C. Work	Mass concrete (1:3:6) in foundation or in floor with cement, sand (F.M. 1.2) and picked jhama brick chips including breaking of chips, screening, mixing, laying, compacting to required level and curing for at least 7 days including the supply of water, electricity, costs of tools & plants and other charges etc. all complete and accepted by the Engineer-in-charge.(Cement: CEM-II/A-M) Mass concrete in foundation (1:3:6) with cement, brick chips and sand of F.M. 1.2	Cum	70.13	6,647.00	466120.875
11	07.3.1(Civil)	RCC work	Reinforced cement concrete works with minimum cement content relates to mix ratio 1:1.5:3 having minimum f'cr = 30 MPa, satisfying a specified compressive strength f'c = 25 MPa at 28 days on standard cylinders as per standard practice of Code ACI/BNBC/ASTM, Cement conforming to BDS EN-197-1-CEM-I, 52.5N (52.5 MPa) / ASTM-C 150 Type – I, best quality Sylhet sand or coarse sand of equivalent F.M. 2.2 and 20 mm down well graded stone chips conforming to ASTM C-33, making and placing shutter in position and maintaining true to plumb, making shutter water-tight properly, placing reinforcement in position; mixing with standard mixer machine with hopper, fed by standard measuring boxes or mixing in batching plant, casting in forms, compacting by vibrator machine and curing at least for 28 days, removing centering-shuttering after specified time approved; including cost of water, electricity, testing charges of materials and concrete cylinders as required, cost of all materials and other charges etc. all complete, approved and accepted by the Engineer-in-charge. (Rate is excluding the cost of reinforcement and its fabrication, placing, binding etc. and the cost of shuttering & centering)				
			Individual & combined footing, pile cap, raft/mat, floor slab and foundation beam up to plinth level	cum	500.00	12154.00	6077000.00
12	PWD-EM - ANALYSIS-38	GI Pipe for light bracket	G.I pipe 50mm dia	meter	0.00	410.00	0.00
13		MCB Box	Supplying and fixing of almirah type 18 SWG metal board of depth 228mm (6") duly painted with powder coating with epoxy polyester resin on all surfaces of board (gray / off-white) having built in push type / suitable locking arrangement including metal bridges of suitable size for fixing of all electrical control devices complete with suitable anchoring arrangement in wall / column and keeping provision for cable inlets and exits as required (only front surface of the board will be considered for measurement). (Manufactured by RECO / NASCO / C&S or equivalent product of any other manufacturer)				
	4.9.2		With water tight arrangement.	sqm	5.3200	16240.00	86396.80
		DB	Supply & installation of outdoor type distribution board made of epoxy powder coated 14 SWG sheet steel with hinge type double doors having built in flash type locking arrangement, complete with copper bus bars (phases & nentral), copper earthing bars and indicating lamps in conformity to the distribution boards ratings as detailed below. The box shall be double door type i.e. one cover door inside through which knobs of MCB/MCCB's are accessible and no live part shall be accessible to an operator. The rate shall include supply & installation of MCB/MCCB, magnetic contractor (Siemens/Dorman Smith/Schneider/Eaton), photo cell, timer etc. The work shall be complete in all respect as per specifications, drawing and direction of the Engineer-in-Charge. Sufficient gap must be maintained between bus bars and back side of the box. The item also includes the fixing of the cable lugs for distribution cables as per drawing and direction of the Engineer-in-Charge.				
			Box size : 650mm x 750mm x 150mm, Busbar: 120A SPN & E; Incoming: 63A SP/DP MCB;63A SP/DP Magnetic Contractor; Photo Cell & Timmer; Outgoing: up to 5x 36 A TP MCB (minimum 6 KA)	set	45.00	50000.00	2250000.00
		Auto Controller	Supplying and fixing of almirah type 18 SWG metal board of depth 228mm (6") duly painted with powder coating with epoxy polyester resin on all surfaces of board (gray / off-white) having built in push type / suitable locking arrangement including metal bridges of suitable size for fixing of all electrical control devices complete with suitable anchoring arrangement in wall / column and keeping provision for cable inlets and exits as required. Magnetic contractor -38A (Ith 60A) magnetic contactor -1nos, Tharmal over load Relay-24- 36A ,Photo cell -2 nos, TPMCB-50A-1 Nos, Internal wiring, Phase indicator, all complete, approved and accepted by the Engineer-in-charge. MCB-2499, MC-12225, OLR-2777, Box 1 sqm-16240.	each	2.00	50,000.00	
16		Earthing	Earthing the electrical installation with 40 mm (1.5") dia G.I. pipe (earth electrode) having 6.35 mm. dia hole across the pipe at 305 mm. interval securely bonded by soldering with 2 nos. of No-2 SWG HDBC earth leads (at the top of the electrode) with its protection by 20 mm. (3/4") dia G.I. pipe up-to plinth level run at a depth of 609.6 mm (2 ft.) below G.L up-to main board to be earthed including necessary connecting copper sockets, bolts, nuts, etc. complete for maintaining earth resistance within 1 ohm. [Fig : 4.17]				
	4.17 (vi)		Depth of bottom of main electrode at 37338 mm. (122.5 ft) from GL & length of electrode 36576 mm. (120 ft).	per set	10.00	42,261.00	422,610.00

Item no.	Remarks/PWD SCHDULE 2018 Item no	Item name	Description of Items	Unit	Quantity	Rate	Total Amount
				a	b	c	d=bxc
		Connecting wire	Providing and drawing No.2 SWG HDBC wire through 20mm (3/4") dia G.I. pipe including fitting, fixing the G.I. pipe in wall or column complete as required.	meter	100.00	614.00	61,400.00
17	4.18	Earth Pit	Construction of earthing inspection pit inside measurement 600 mm x 600 mm with 250 mm thick brick in cement mortar (1:4) with 100mm thick RCC top slab (1:2:4) with 1% re-enforcement 450 mm dia water sealed CI man-hole cover with locking arrangement including necessary earth works, site filling and one brick flat soling 75 mm thick (1:3:6) base concrete for making inlet channel & 12mm thick (1:2) cement plaster with neat finishing etc. all complete up to a depth of .75 meter.	each	10.00	6,037.00	60,370.00
				for	18.761	km	66,126,416.43
				for	1.00	km	3,524,674.40
			proportionately for	for	16.3	km	57,381,699.24
						Total Cost in Million Taka	**57.40**

Cost abstract for Distribution transformers

Sl.No	Description	Unit	Qty	Rate in BDT	Amount in BDT	Amount in Million BDT
1	Supply, Erection Testing, Commissioning of 11 kV/415 V, 500kVA outdoor distribution Transformer along with earth pit, hardware accessories of adequate sizes including civil works along with necessary materials as required	Nos	28.00	1488500	41,678,000	41.68
2	Supply, Erection, Commissioning of four pole structure using ISMB 175, 'O' gauge copper conductor along with cross arm, Porcelain disc insulator, Pin insulator, stray set , earth pit & hardware accessories of adequate sizes including civil works along with necessary materials as required	Nos	28.00	200,000	5,600,000	5.60
3	Design, manufacture, testing and inspection at places of manufacturer, and supplying delivery at site, unloading, storing, transporting directly to site or through transit stores as the case may be, laying inclusive of excavation in all types of soil reinstatement and making good the surface to match original, removal of surplus earth including supplying and laying / installation of screened sand, cable protective bricks and cable tags of the following **11 KV grade XLPE insulated aluminium conductor armoured cables.**					
a	3½ x 300 Sq.mm. AYFY	Mtr	7,300.00	2,587	18,885,100	18.89

Sl.No	Description	Unit	Qty	Rate in BDT	Amount in BDT	Amount in Million BDT
4	Design, manufacture, testing and inspection at places of manufacturer, and supplying delivery at site, unloading, storing, transporting directly to site or through transit stores as the case may be, laying inclusive of excavation in all types of soil reinstatement and making good the surface to match original, removal of surplus earth including supplying and laying / installation of screened sand, cable protective bricks and cable tags of the following **1.1 KV grade XLPE insulated aluminium conductor armoured cables.**					
a	3½ x 300 Sq.mm. AYFY	Mtr	4,210.00	1,915	8,062,992	8.06
b	3½ x 185 Sq.mm. AYFY	Mtr	1,265.00	1,231	1,556,709	1.56
	LT transmission transformer				**75,782,801**	**75.78**
			cost per 1 LT transmission transformer			2.71
			cost per 32 LT transmission transformer			86

Cost abstract - Internal sewer network

Sl.No	Description	Unit	Quantity	Rate in Taka	Amount	Amount in Million Taka
1	Excavating trenches of required width for pipes, cables, etc including excavation for sockets and dressing of sides, ramming of bottoms, depth upto 1.5m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20cm in depth, including consolidating..etc : Pipes,cables etc.exceeding 80mm dia but not exceeding 300mm dia	Cum	187248	325.00	60855600.00	60.86

Sl.No	Description	Unit	Quantity	Rate in Taka	Amount	Amount in Million Taka
2	Constructing brickmasonry circular manhole 0.91m internal dia at bottom and 0.56m dia at top in cement mortar 1:4 inside cement plaster 12mm thick in cement mortar 1:3 foundation concrete 1:3:6 mix and making ..etc	Each	1800.00	20571.76	37029176.47	37.03
3	Constructing brickmasonry circular manhole 1.22m internal dia at bottom and 0.56m dia at top in cement mortar 1:4 inside cement plaster 12mm thick in cement mortar 1:3 foundation concrete 1:3:6 mix and making ..etc	Each	250.00	34828.24	8707058.82	8.71
4	Constructing brickmasonry circular manhole 1.52m internal dia at bottom and 0.56m dia at top in cement mortar 1:4 inside cement plaster 12mm thick in cement mortar 1:3 foundation concrete 1:3:6 mix and making ..etc	Each	225.00	51764.71	11647058.82	11.65
5	Providing, laying and jointing of pipe approved material and brand for sewer network including transporting to the spot, handling, lifting, etc all including jointing of pipes as per standard, testing, ancillary materials, labour all complete and as directed by the engineer-in-charge					
a)	Sewer pipe - RCC hume pipe 150mm dia	Rm	53120	795.60	42262272.00	41.76
b)	Sewer pipe - RCC hume pipe 200mm dia	Rm	13280	1216.80	16159104.00	16.16
c)	Sewer pipe - RCC hume pipe 250mm dia	Rm	2800	1456.00	4076800.00	4.08
						180.2

Cost abstract for STP

Description	Price (USD)	Price (in BDT)	Remarks
Electromechanical Equipment of STP (including shipping)	2,860,000	237,380,000	As per quotation
Erection and Commissioning	70,500	5,851,500	As per quotation
Sub total	2,930,500	243,231,500	
Electromechanical cost / MLD	183156.25	15,201,969	
Civil cost / MLD	73262.5	6,080,788	40% considered as per general practice
Total cost / MLD based on SBR technology	**256418.75**	**21,282,756**	
Description	**Price (USD)**	**Price (in BDT)**	
STP capacity	1	MLD	
Total cost / MLD	256418.75	**21176471**	

Cost abstract for storm water drain network and rainwater harvesting

and Sl.No	PWD /SOR 2018	Description	Unit	Quantity	Rate in Taka	Amount	Amount in Million Taka
1	2.1.5	Earth work in excavation in all kinds of soil for foundation trenches including layout, providing center lines, local bench-mark pillars, levelling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer-in-charge, subject to submit method statement of carrying out excavation work to the Engineer-in-charge for approval. However, engineer"s approval shall not relieve the contractor of his responsibilities and obligations under the contract. Earthwork in excavation in foundation trenches up to 1.5 m depth and maximum 10 m lead: in very soft / saturated / organic clayey soil / soil of semi-liquid state.	Cum	21019.11	217.00	4561147.03	4.56
2	3.4.1	Mass concrete (1:3:6) in foundation or in floor with cement, sand (F.M. 1.2) and picked jhama brick chips including breaking of chips, screening, mixing, laying, compacting to required level and curing for at least 7 days including the supply of water, electricity, costs of tools & plants and other charges etc. all complete and accepted by the Engineer-incharge.(Cement: CEM-II/A-M) Mass concrete in foundation (1:3:6) with cement, brick chips and sand of F.M. 1.2	Cum	9379.93	6647.00	62348414.65	62.35
3	7.2.1	Reinforced cement concrete works with minimum cement content relates to mix ratio 1:2:4 having minimum f'cr = 27 MPa, satisfying a specified compressive strength f'c = 22 MPa at 28 days on standard cylinders as per standard practice of Code ACI/BNBC/ASTM, cement conforming to BDS EN-197-1-CEM-I, 52.5N (52.5 MPa) / ASTM-C 150 Type – I, best quality Sylhet sand or coarse sand of equivalent F.M. 2.2 and 20 mm down well graded stone chips conforming to ASTM C-33, making and placing shutter in position maintaining true to plumb, making shutter water-tight properly, placing reinforcement in position; mixing in standard mixer machine with hopper fed by standard measuring boxes or mixing in batching plant, casting in forms, compacting by vibrator machine and curing at least for 28 days, removing centering-shuttering after specified time approved; including cost of water, electricity, testing charges of materials and cylinders as required, other charges etc. all complete, approved and accepted by the Engineer-in-charge. (Rate is excluding the cost of reinforcement and its fabrication, placing, binding etc. and the cost of shuttering & centering) Individual & combined footing, pile cap, raft/mat, floor slab and foundation beam up to plinth level	Cum	134.27	11817.00	1586721.77	1.59
4	8.1.2	Grade 400 (RB 400 /RB 400W: complying BDS ISO 6935-2:2006) ribbed or deformed bar produced and marked according to Bangladesh standard, with minimum yield strength, fy (ReH)= 400 MPa but fy not exceeding 450 MPa and whatever is the yield strength within allowable limit as per BNBC/ ACI 318, the ratio of ultimate tensile strength fu to yield strength fy, shall be at least 1.25 and minimum elongation after fracture and minimum total elongation at maximum force is 16% and 8% respectively : up to ground floor.	Kg	2851.88	82.00	233853.75	0.23
5	4.1	Brick works with first class bricks with cement sand (F.M. 1.2) mortar (1:6) in foundation and plinth, filling the joints/interstices fully with mortar, racking out the joints, cleaning and soaking the bricks at least for 24 hours before use and curing at least for 7 days etc. all complete including cost of water, electricity and other charges and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M)	Cum	11742.12	6040.00	70922404.80	70.32

and Sl.No	PWD /SOR 2018	Description	Unit	Quantity	Rate in Taka	Amount	Amount in Million Taka
6	7.2.1	Providing and laying coping and Screed concrete with 1 :2:4 cement concrete, 40 mm thickSqm 150.09 using broken granite metal of 20mm and down size laid to line and level in one layer and finish with a floating coat of neat cement, including cost of materials, labour, curing, complete as per specifications.	Sqm	13896.00	296.00	4113216.00	4.11
7	15.1	Minimum 12 mm thick cement sand (F.M. 1.2) plaster (1:4) with fresh cement to both inner-and outer surface of wall, finishing the corner and edges including washing of sand, cleaning the surface, curing at least for 7 days, cost of water, electricity, scaffolding and other charges etc. all complete in all respect as per drawing and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M) ground floor.	Sqm	63008.43	243.00	15311049.53	15.31
9		Providing and layiing non pressure NP 2 class (light duty) RCC pipes with collars jointed with stiff mixture of the cement mortor..etc					
	1151	300mm dia RCC pipe	Rm	100.00	1895.00	189500.00	0.19
	MR	500mm dia RCCpipe	Rm	44.00	2954.00	129976.00	0.13
		Total Cost in Million Taka					**158.80**

Cost abstract for internal telecom network

Sl.No	PWD SOR/2018	Description	Unit	Quantity	Rate in Taka	Amount	Amount in Million Taka
1	**2.1.5**	Earth work in excavation in all kinds of soil for foundation trenches including layout, providing center lines, local bench-mark pillars, levelling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer-in-charge, subject to submit method statement of carrying out excavation work to the Engineer-in-charge for approval. However, engineer"s approval shall not relieve the contractor of his responsibilities and obligations under the contract. Earthwork in excavation in foundation trenches up to 1.5 m depth and maximum 10 m lead: in very soft / saturated / organic clayey soil / soil of semi-liquid state.	Cum	12017	217.00	2,607,661.88	**2.66**
2	**3.4.1**	Mass concrete (1:3:6) in foundation or in floor with cement, sand (F.M. 1.2) and picked jhama brick chips including breaking of chips, screening, mixing, laying, compacting to required level and curing for at least 7 days including the supply of water, electricity, costs of tools & plants and other charges etc. all complete and accepted by the Engineer-incharge.(Cement: CEM-II/A-M) Mass concrete in foundation (1:3:6) with cement, brick chips and sand of F.M. 1.2	Cum	924	6647.00	6,144,320.63	**6.14**
3	**7.3.1**	Reinforced cement concrete works with minimum cement content relates to mix ratio 1:1.5:3 having minimum f'cr = 30 MPa, satisfying a specified compressive strength f"c = 25 MPa at 28 days on standard cylinders as per standard practice of Code ACI/BNBC/ASTM, Cement conforming to BDS EN-197-1-CEM-I, 52.5N (52.5 MPa) / ASTM-C 150 Type – I, best quality Sylhet sand or coarse sand of equivalent F.M. 2.2 and 20 mm down well graded stone chips conforming to ASTM C-33, making and placing shutter in position and maintaining true to plumb, making shutter water-tight properly, placing reinforcement in position; mixing with standard mixer machine with hopper, fed by standard measuring boxes or mixing in batching plant, casting in forms, compacting by vibrator machine and curing at least for 28 days, removing centering-shuttering after specified time approved; including cost of water, electricity, testing charges of materials and cylinders as required, other charges etc. all complete, approved and accepted by the Engineer-in-charge. (Rate is excluding the cost of reinforcement and its fabrication, placing, binding etc. and the cost of shuttering & centering) Individual & combined footing, pile cap, raft/mat, floor slab and foundation beam up to plinth level	Cum	3931	12154.00	47,780,412.50	**47.78**
4	**8.1.2**	Grade 400 (RB 400 /RB 400W: complying BDS ISO 6935-2:2006) ribbed or deformed bar produced and marked according to Bangladesh standard, with minimum yield strength, fy (ReH)= 400 MPa but fy not exceeding 450 MPa and whatever is the yield strength within allowable limit as per BNBC/ ACI 318, the ratio of ultimate tensile strength fu to yield strength fy, shall be at least 1.25 and minimum elongation after fracture and minimum total elongation at maximum force is 16% and 8% respectively : up to ground floor.	Kg	353813	82.00	29,012,625.00	**29.01**
5	**7.9.2**	Centering and shuttering, including strutting, propping etc. (The formwork must be rigid enough both in and out of plane, to make the concrete surface true to the designed shape and size by using necessary MS sheets of minimum 16 BWG, angles of minimum size 40 mm x 40 mm x 5 mm, flat bars etc.) and removal of form for:In raft/mat/floor slab up to plinth level	Sqm	1275	434.00	553,350.00	**0.55**
6	**7.9.4**	Centering and shuttering, including strutting, propping etc. (The formwork must be rigid enough both in and out of plane, to make the concrete surface true to the designed shape and size by using necessary MS sheets of minimum 16 BWG, angles of minimum size 40 mm x 40 mm x 5 mm, flat bars etc.) and removal of form for:Pedestal, column, column capital, lift wall and wall up to ground floor	Sqm	1594	408.00	650,250.00	**0.65**
7	**7.9.7**	Centering and shuttering, including strutting, propping etc. (The formwork must be rigid enough both in and out of plane, to make the concrete surface true to the designed shape and size by using necessary MS sheets of minimum 16 BWG, angles of minimum size 40 mm x 40 mm x 5 mm, flat bars etc.) and removal of form for:Floor and roof slab up to ground floor	Sqm	1063	532.00	565,250.00	**0.57**
		Total Cost in Million Taka					**87.36**

Cost abstract for solid waste management

I. SWM plant with a capacity of 1 TPD: Civil works					
Sl. No.	**Description**	**Quantity**	**Unit**	**Rate (in Taka)**	**Amount (in Taka)**
1.	Waste collection platform	1	No	201,600	201,600
2.	Crusher and mixing unit	1	No	40,320	40,320
3.	Primary anaerobic plant digester	1	No	642,600	642,600
4.	Secondary anaerobic plant digester	1	No	642,600	642,600
5.	Slurry pit	1	No	70,560	70,560
6.	Slurry chamber	1	No	131,040	131,040
7.	Purification unit	1	Lot	645,120	645,120
8.	Storage and dispensing unit	1	Lot	403,200	403,200
9.	Non-bio degradable waste storage shed 1 (For storing recyclable waste)	1	No	221,760	221,760
10.	Non-bio degradable waste storage shed 2(For storing inert waste)	1	No	483,840	483,840
11.	Internal electrification for buildings	1	Lot	201,600	201,600
12.	Any other components in civil structures required for the construction of SWM plant missing out in the above	1	Lot	201,600	201,600
	Total - I				**3,885,840**
II. SWM Plant with a capacity of 1 TPD: Electro-mechanical works					
	Description	**Quantity**		**Rate (in Taka)**	**Amount (in Taka)**
1.	Waste collection and segregation unit				
	a) Hopper with weighing arrangement for receiving organic waste of required size	1	No	254,880	254,880
	b) Shaft less screw conveyor for transferring waste from hopper to pulper/grinder of required capacity/size	1	No	191,160	191,160
	c) Suitable crusher / pulper / shredder for crushing the organic waste of required capacity/size	1	No	318,600	318,600
2.	Primary anaerobic plant digester				
	a) Floating FRP hood	1	No	415,800	415,800
3.	Secondary anaerobic plant digester				
	a) Floating FRP hood	1	No	415,800	415,800
4.	Slurry Pit				
	a) FRP cover for slurry pit	1	No	31,860	31,860
5.	Agitator	1	No	84,960	84,960
6.	Pumps				
	a) Digester feed pump	1	No	16,992	16,992
	b) Filtrate recirculation pump	1	No	13,806	13,806
	c) Submersible mixer	1	No	21,240	21,240
7.	Flaring unit – Gas flare system	1	No	21,240	21,240
8.	Bio gas engine	1	No	637,200	637,200
9.	Purification unit				
	a) Hydrogen sulphide remover	1	No	212,400	212,400
	b) Carbon-di-oxide remover	1	No	1,062,000	1,062,000
10.	Piping and valves				

I. SWM plant with a capacity of 1 TPD: Civil works					
Sl. No.	**Description**	**Quantity**	**Unit**	**Rate (in Taka)**	**Amount (in Taka)**
	a) Interconnecting pipes with approved makes and size	1	Lot	148,680	148,680
	b) Valves: Butterfly valves, ball valves, non return valves wherever applicable	1	Lot	63,720	63,720
11.	Storage and dispensing unit				
	a) Suitable compressor along with cylinders for storage of bio gas	1	No	1,189,440	1,189,440
12.	**Electrical works including gas flow meter** - MCC panel, local push buttons stations, power, control cables, cable end terminations, earthing system, electronic type gas flow meter, etc.,	1	Lot	212,400	212,400
13.	**Automation with PLC system -** PLC control panel, SCADA system, input waste weighing monitoring, Field Instruments, power, control, instrumentation cables, cable end terminations, earthing system, field junction box. The system should be suitable for control/monitor from the centralized control station.	1	Lot	424,800	424,800
14.	Any other electromechanical components required for the construction of SWM plant missing out in the above	1	Lot	424,800	424,800
	Total - II				**6,161,778**
	Grand total (I+II)				**10,047,618**
				Cost per TPD in Taka	10,047,618
				in Million BDT	10.04761793
	Total SWM cost for 2.89 TPD in Million Taka				**28.9**

Cost abstract for access road

Description	Unit	Quantity	Rate in Taka as per SoR	Amount	Amount in Million Taka
[RHD-2/1/01] Clearing & grubbing	Sqm	31500	55.00	1,732,500.00	**1.73**
Earth work excavation / by mechanical means (Hydraulic Excavator)/ manual means in trenches and over areas for foundations of columns, walls, rafts, beams, steps etc., in all types of soil except hard rock requiring chiseling, blasting but including Existing building foundation dismantling, shoring, strutting, de-watering, refilling in foundations, plinth etc., wherever necessary in layers not exceeding 15cm with approved excavated soil, including watering and compaction etc., Surplus / rejected excavated material shall be disposed off to the contractor's own dump yard outside the work site or as per the requirements of local authorities or as directed by the Engineer-in-charge. - All kinds of soil	Cum	15362	144.00	2,212,056.00	**2.21**
[RHD-2/7/02] Preparation of Subgrade	Sqm	31500	40.00	1,260,000.00	**1.26**
[RHD-2/8/01] Improved Subgrade (Sand F.M >0.80)	Cum	3675	1099.00	4,038,825.00	**4.04**
Construction of granular sub-base by providing close graded material, spreading in uniform layers with motor grader on prepared surface, mixing by mix in place method with rotavator at OMC, and compacting with vibratory roller to achieve the desired density (Aggregate type 2 as per Bangladesh SoR)	Cum	4410	5363.00	23,650,830.00	**23.65**
Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site, laying in uniform layers with paver in sub- base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density. (Aggregate type base II as per Bangladesh SoR)	Cum	4410	7384.00	32,563,440.00	**32.56**
Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site, laying in uniform layers with paver in sub- base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density. (Aggregate type base I as per Bangladesh SoR)	Cum	8085	8461.00	68,407,185.00	**68.41**
Providing and applying primer coat with bitumen emulsion on prepared surface of granular Base of low porosity such as WBM and WMM including including clearing of road surface and spraying primer at the rate of 1.05 kg/sqm using mechanical means. (Bitumen Emulsion = 1.05 kglsqmt.)	Sqm	14700	113.00	1,661,100.00	**1.66**
Providing and applying tack coat with bitumen emulsion using emulsion pressure distributor at the rate of 0.4 kg per sqm on the prepared on granular surface cleaned with mechanical broom such as WBM and WMM surfaces treated with primer and dry and bituminous surface	Sqm	29400	50.00	1,470,000.00	**1.47**
Providing and laying dense graded bituminous macadam 155 mm thick with 40-60 TPH HMPusing crushed aggregates of specified grading, premixed with bituminous binder @ 4.25 percent by weight of total mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction	Cum	2279	22133.00	50,430,040.50	**52.78**
Providing and fixing Pre cast solid concrete kerb stones made out of CC 1 :1.5:3 of size 450 x 200 x 400 mm and finished with CM 1 :3 plastering and finishing cutting etc., complete.	Rm	7000	317.33	2,221,333.30	**2.22**
Total Cost in Million Taka					**192.50**

Cost abstract for external water supply

Sl. No.	Description	Nos.	Quantity	Unit	Rate (Tk)	Amount (Tk)
1	Earth work in excavation in all kinds of soil for foundation trenches including layout, providing centre lines, local bench mark pillars, levelling , ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc., all complete and accepted by the Engineer, subject to submit method statement of carrying out excavation work to the Engineer for approval. However Engineer's approval shall not relieve the contractor of his responsibilities and obligations under the contract		29748	Cum	100	2,974,800.00
2	Reinstating the road surface to its original WBM condition wherever disturbed.		125256	Sqm	40	5,010,240.00
3	Supplying, Loading & Transporting Ductile Iron pipes (Class K7) and specials, unolading, lowering in trenches, laying (CI as per standards) with ordinary bedding and jointing with tyton joints, with EPDM rubber rings (Type II) flanged joints, with rubber gaskets ,pipes and specials, joints in chambers, including providing all jointing materials as per specifications, testing the pipeline for specified heads and leakages and disinfecting before commissioning complete					
	Spun D.I. pipe 200 mm diameter		19600	Rm	7,800	152,880,000.00
	Spun D.I. pipe 125 mm diameter		430	Rm	4,800	2,064,000.00
4	Providing, installing, jointing to pipelines, testing and commissioning. Butterfly Valves, Sluice Valves, Kinetic Double Air Valves with isolating Sluice Valves, Scour Valves with all jointing materials, gaskets, bolts, nuts, inclusive of dismantling pieces, washers, rubber gaskets as per standards etc. complete as per drawing and specifications provided.					
a	C.I Kinetic Double Air Valves					
	80mm valve on 225-350mm. Dia. Pipe, rating 10kg/cm2		16	Nos.	50,000	800,000.00
b	C.I Sluice Valve					
	200 mm. dia. pipe rating 10 kg/cm2		9	Nos.	30,000	270,000.00
	125 mm. dia. Pipe rating 10 kg/cm2					
c	C.I Scour (Gate) Valve including drain pipe of diameter equivalent to that of Scour valve of about and 6 m. length					
	350 mm. dia. pipe rating 10 kg/cm2		5	Nos.	50,000	250,000.00
d	Pressure reducing valve of diameter equivalent to that of pipe diameter at the entry point of sump		3	Nos.	40,000	120,000.00
5	Providing and constructing rectangle / square valve chambers as per drawing including bed concrete, masonry in C.M. 1:4, plaster in C.M. 1:4 rough finish on external surfaces and smooth cement finish on internal surfaces, pre-cast covers, joint for inlet and outlet in the masonry, providing RCC NP2 drain pipe 150 mm. dia. of about 6 m. length from chamber to nearest storm drain, testing for water tightness etc. complete including de-watering whenever required					
a	For air valves					
	Chamber size (Inner) 2.2 m. x 1.2 m. for air valve on pipe of dia 300 mm to 500 mm.		18	Nos.	20,000	360,000.00
b	For Sluice Valves					
	Chamber size (Inner) 2.2 m. x 1.2 m. for Sluice valve on pipe of dia. 200 to 500 mm.		7	Nos.	20,000	140,000.00
c	For Scour Valves					
	Chamber size (Inner) 2.2 m. x 1.6 m. for scour valve on pipe of dia 300 mm to 350 mm.		7	Nos.	22,000	154,000.00
d	For pressure reducing valve					
	Chamber size (Inner) 2.2 m. x 1.6 m. for pressure reducing valve on pipe of dia 300 mm to 350 mm.		1	Nos.	22,000	22,000.00
6	Providing and placing P.C.C. M-15 for thrust blocks at bends of water mains and junctions including necessary shuttering, curing etc. all complete		45	Nos.	13,000	585,000.00
7	Electromagnetic flow meter of suitable model with hard rubber liner, SS316 electrode, SS 304 Coil Housing, SS 316 Grounding Ring, Flanged connection with IP 68 protection with suitable electronics components for input power supply of 230 V AC and output of 4- 20 MA DC with flow indicator and totaliser of 350 mm DIA		2	Nos.	350,000	700,000.00
	One layer of brick flat soling in foundation or floor with first class brick or picked jhma bricks including preparation of bed and filling the interstices with local sand, levelling, etc., complete and accepted by engineer.		694	sqm	355	246,214.69
	Lime Soil		520	cum	3,484	1,812,310.02
	Anti-Corrosion		2694	sqm	853	2,298,572.88
Total pumping main length			20.03	KM		
Amount in Taka			170,687,137.59	Taka		
Cost per KM			8,521,574.52	Taka		
		In Million	8.52	Taka		
					Unit in Km	Amount in Million Taka
Total cost for external water supply in Million Taka					**14**	**120**