Environmental Impact Assessment (EIA)
of
RAJUK Urban Resilience Unit (URU) Building Project

Vol. 1 - Executive Summary (Draft)

Bangladesh University of Engineering and Technology (BUET)
Dhaka-1000, Bangladesh

September 2019

EXECUTIVE SUMMARY

INTRODUCTION

The Government envisaged establishing a trained, competent and well-equipped unit to respond to the critical gap in the management of disaster risk in Bangladesh. The Bangladesh Urban Resilience Project (URP) represents the second phase of a multi-phase national Disaster and Risk Management (DRM) program to build institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh.

Construction of the RAJUK's Urban Resilience Unit (URU) building is a bold and timely initiative for Dhaka and the rapidly expanding urban center of Dhaka. Seismic assessment and resilience must be incorporated into urban development, authority, and accountability, and leadership is needed to facilitate private investments and consider risk and resilience within development of the Dhaka City area.

The objective of the overall engagement is to develop a comprehensive approach to managing earthquake risk through a structured process of knowledge development, education, and planning that involves a wide range of stakeholders to increase engagement and ownership.

It has been anticipated that the "Component C: Improved Construction, Urban Planning and Development" of the Bangladesh Urban Resilience Project (URP) would be successful through institutional strengthening by the creation of a new organizational unit in RAJUK. It has been named as the Urban Resilience Unit (URU) to encompass the development of competencies related to urban resilience such as risk assessment, earthquake engineering, construction standards, in-situ and laboratory construction material testing, specialized construction training, and risk-sensitive land use planning.

Objective of the EIA and Scoping

In order to get environmental clearancefrom the Department of Environment, GoB and to secure funding from the World Bank the RAJUK decided to conduct an Environmental Impact Assessment (EIA). The main objective of the EIA of the proposed Urban Resilience Unit (URU) Building is to conduct a baseline survey, identify potential negative impacts, provide a complete environmental management plan (EMP) to minimize or mitigate negative impacts and enhance positive impacts.

As the first step of the EIA scoping was performed through categorization of the project according to the ECR '97 and the World Bank Guidelines. This also included identification and collection of institutional information, discussion with World Bank, RAJUK and DoE to define scope of impact assessment, planning of and designing implementation schemes for mitigation measures and monitoring, selection of type of documentation required, and identifying the need for RAP.Screening for the EIA study was performed review of available documents, reconnaissance survey, discussion with the client and stakeholders. This also included identification of the World Bank Operational triggered by the different aspects of projects, namely, location, characteristics of the populace, presence / absence of cultural heritage in the area, and need for land acquisition, etc.

PROJECT DESCRIPTION AND ACTIVITIES

The URU would be equipped with a specialized training facility geared toward competency building of construction activities. A testing facility for in-situ and laboratory of construction materials and structural components has also been proposed for this unit. The area/site for the proposed Urban Resilience Unit (URU) Building area (presently, RAJUK zonal office at Mohakhali) is located under

Gulshan Thana of Dhaka North City Corporation, Dhaka. The latitude and longitude of the proposed site are 23° 46' 56.3304'' N and 90° 24' 8.0856'' E, respectively. The boundaries of the proposed Urban Resilience Unit (URU) Building area are: Govt. Titumir College, college Mosque are on the eastern side, Titumir College hostel is at the Northern side, part of Western side is occupied by the BSTI residential area (quarter); and the rest of the surrounding establishments are private residential or commercial buildings. Mohakhali-Gulshan road constitutes the key and ease of access to the project site and an alley connects the road directly to the site. Starting from Mohakhali- Amtoli juncture, the nearby point on the main road to the site, is located 350.2 m distance and from that point (Amtoli More). A 30 m well paved connects the project site to the Gulshan-Mohakhali Road.

In August, 2018 it was decided that a single 30 storied building including four levels of basement and 30 additional floors all of which would have a floor area of 4,050m^2 will be constructed at the project site as a URU Building. However, buoyancy effect over 4,050 m^2 for required significant resistance against uplift for the basement 4 slab as well as uplift resistance from the pile support in the design making it an extremely expensive proposition. After a series of discussion meetings with the World Bank, RAJUK and its Consultant the following plan was suggested for Phase I:

- A two level Basement,
- A small tower of 10 storied and approximate typical floor area of about 900 m^2 each,
- A layout providing for an eccentric building core located at the north face of the building.

The proposed shake table and laboratory with all equipment to be located within the basement and ground floor areas of the Building.

The final architectural design provided by RAJUK's Design Consultant was approved by RAJUK on 2 July 2019 and included another building change such that the shake table and laboratory were to be located in a separate and distinct building located to the west of the 10 storied building. It has been planned that another building will be constructed in the Phase II of the project with 22-storied tower with 4 basements (Figure E-2).

The total site area is 7117.89 m^2 which will primarily be used as office of RAJUK with a small portion will accommodate the laboratory. The three main components of the buildings will be the Basement, Podium and Tower. The site coverage for these components will be about 4,932.58, 3998.31 and 3558.54 m^2, respectively. As mentioned earlier the Phase I will be a 10 storied building with 2 basements and an exterior Shake Table room and the Phase II will be a 22 storied building with 4 basements. Phase-wise distribution of gross floor areas for these three components include 3,502, 1,745 and 7,449m^2 totaling 12,746m^2 for Phase I, whereas, 12,458, 3,529 and 48,500m^2 totaling 64,486m^2 for Phase II. The basement will be of reinforced cement concrete with steel frame and glass curtain walls. The two basements of Phase I Tower will accommodate 63 cars in the parking spaces, whereas, the four basements of Phase II Tower will accommodate 300 cars in the parking spaces.

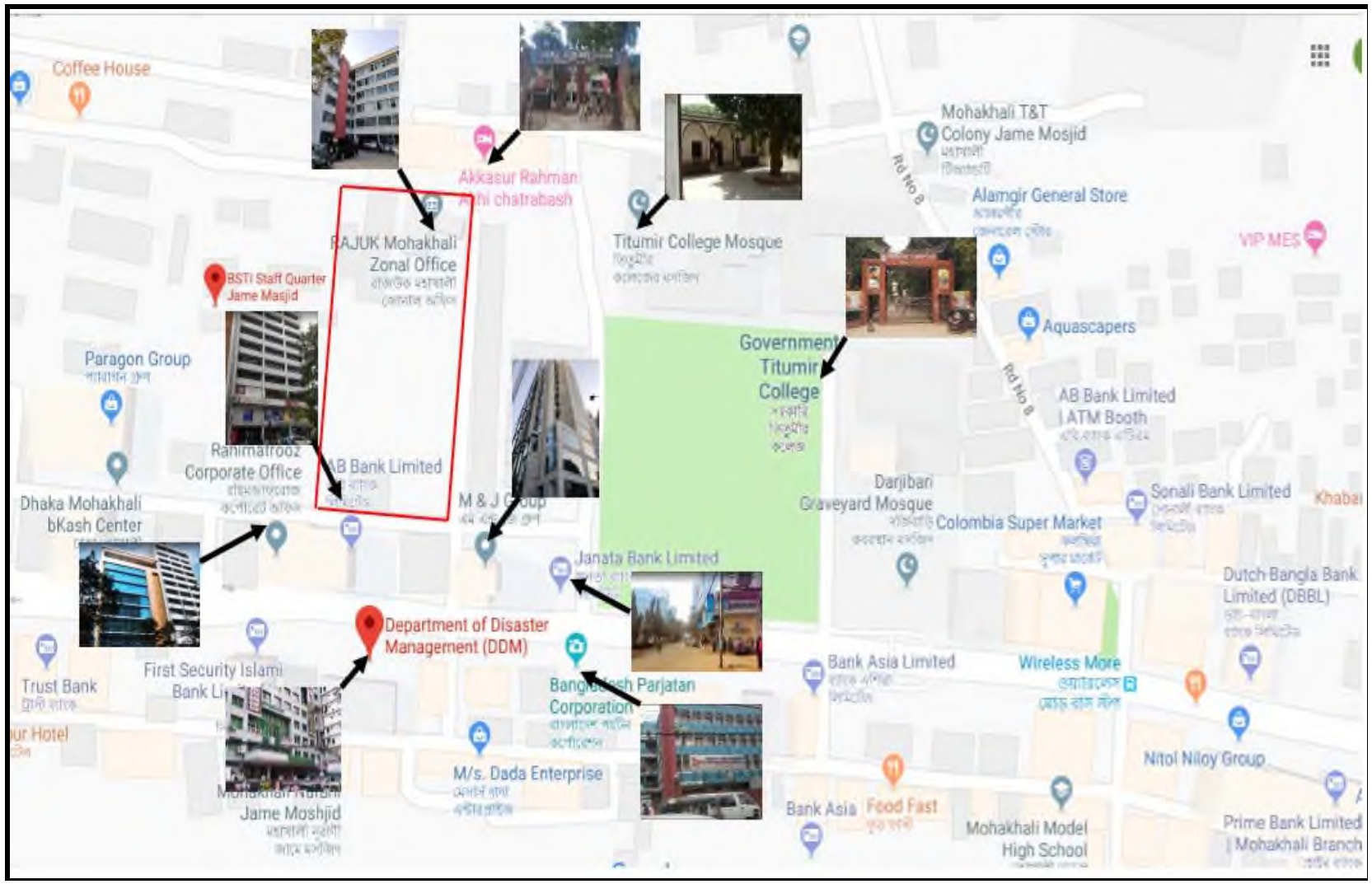


Figure E-1: Important establishments and features around the proposed RAJUK-URU Building Site

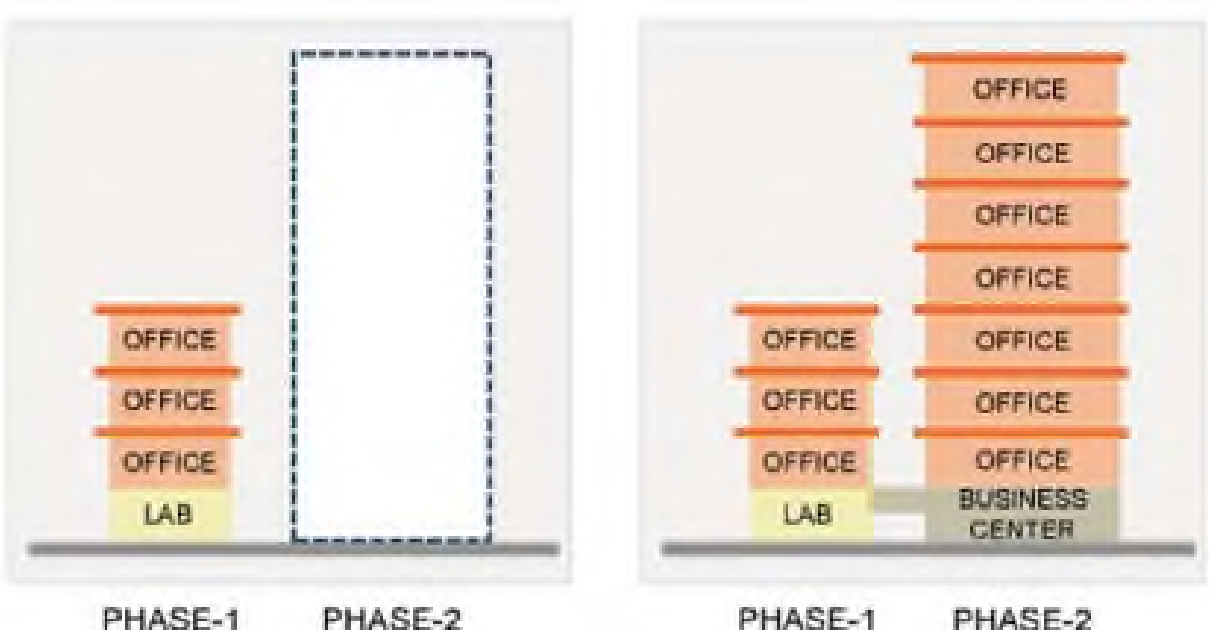


Figure E-2: Tentative Plan for Phase I and Phase II

Project Activities during Construction Phase

The major activities carried out during construction phase of the proposed project will commence with mobilization of personnel, material and equipment; followed by topographical survey; laying out each buildings and ancillary facilities; dismantling and demolishing of existing semi-pucca sheds and one story building within the project site; earth excavation works with shore protection measures for the basement construction; construction of basements with ramps; construction of the foundation followed by steel-framed superstructure; electro-mechanical equipment installation; interior design and furnishing works; internal road construction; security system, traffic and pedestrian management system; and landscaping/tree plantation.

General Structural Design Features:

As the proposed building site is located in the heart of Dhaka thus supply concreter from ready mix plant cannot be delivered with predictable regularity. In addition, activities required for the structural configuration chosen by the design consultants of RAJUK are open cut excavation, foundation pile driving, construction of RCC basements and perimeter wall, elevator core construction, and steel frame typical floors consisting of Hollow Structural Steel Columns with supporting steel beams and girders supporting 75mm steel deck of thickness 0.81mm and filled with 75mm of concrete. Steel frame structures are lighter than RCC, thus, would better withstand impact of earthquake forces. It would also construction process faster as no formwork would be required.

Excavation and Sub Structure Design:

Two alternative options in respect of the excavation, foundations and structures connected with the two basement floors have been contemplated for the Phase I building, namely Open Cut Method and Shore Pile Method.

Open Cut Method: Two basements will be excavated to a depth of 9m below grade by an open cut method where the slopes of the excavation will be sloped at 1:1 or 45 degree. The Construction Contractor must protect the slope during construction to the approval of the Consultant and the Client and take appropriate measures to protect the open cut slope. The process must keep the provision for pumping water out of the excavation such that the base of the excavation can support truck traffic and construction activity until the reinforced concrete basement structure and ground floor is complete.

Shore Pile Method: Alternative of providing for protective shore piles around the entire perimeter of the Phase I Building from Level B2 to the Ground Floor. This method requires the placement of 162 permanent 600mm diameter piles placed outside the basement perimeter walls. It has been estimated that the expected length of the bored concrete piles will be 25m below ground level.

Project Activities during Operational Phase

The major activities during operational phase include: regular operation and maintenance of RAJUK-Urban Resilience Unit; Regular operation and maintenance of the testing facilities at the Laboratory and Internal traffic management.

POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The national environmental policies and laws and legal framework applicable to the proposed project have been identified. An overview of a few of the major national environmental laws and regulations that are relevant and may apply to the activities supported by the proposed project, and World Bank safeguard policies are given below.

National Environmental Policy 2018

It is essential that proper environmental management and appropriate use of different components of environment are practiced in every region of the country and in every development project. Therefore, the National Environmental Policy 2018 has been developed addressing the sector-wise environmental policy among 24 sectors/fields.

Environment Conservation Rules (ECR) 1997, amended 2003 and 2010

These are the first set of rules, promulgated under the Environment Conservation Act 1995. Among other things, these rules set: (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust, etc., (ii) Categorization of industries, development projects and other activities on the basis of actual (for existing industries/development projects/activities) and anticipated (for proposed industries/development projects/activities) pollution load, iii) requirement for and procedures to obtain Environmental Clearance, and (iv) requirements for IEE/EIA according to categories of industrial and other development interventions, v) Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civil life.

Bangladesh National Building Code (BNBC), 2017 (Draft)

The basic purpose of this code is to establish minimum standards for design, construction, quality of materials, use and occupancy, location and maintenance of all buildings within Bangladesh in order to safeguard, within achievable limits, life, limb, health, property and public welfare. For example, Part-7, Chapter-3 of the BNBC has clarified the issue of safety of workmen during construction and with relation

to this, set out the details about the different safety tools of specified standard. In relation with the health hazards of the workers during construction, this chapter describes the nature of the different health hazards that normally occur in the sites during construction and at the same time specifies the specific measures to be taken to prevent such health hazards.

WBG Environmental, Health and Safety Guidelines

Depending on the specific characteristics of the project, World Bank Environmental and Social Safeguard Policies provide ten potential issues that may need to be considered in an EIA.

Environmental policies:

OP/BP 4.01 Environmental Assessment
OP/BP 4.03Performance Standards for Private Sector Projects
OP/BP 4.04 Natural Habitats
OP/BP 4.09 Pest Management
OP/BP 4.11 Physical Cultural Resources
OP/BP 4.36 Forests
OP/BP 4.37 Safety of Dams

Social Policies

OP/BP 4.10 Indigenous Peoples
OP/BP 4.12 Involuntary Resettlement

Legal Policies

OP/BP 7.50 International Waterways
OP/BP 7.60 Disputed Areas

Operational Policies (OP) are the statement of policy objectives and operational principles including the roles and obligations of the Borrower and the Bank, whereas Bank Procedures (BP) is the mandatory procedures to be followed by the Borrower and the Bank. Apart from these, the WB guidelines for Environmental Health and safety have been adopted by the World Bank Group which is also relevant for environmental protection and monitoring. In addition to that the Policy on Access to Information of World Bank also relates to environmental safeguard. The expected applicability of the potential safeguard policies for the proposed URU project has been summarized in the following Table E-1:

Table E-1: World Bank Environmental Safeguard Policies and its Applicability to the Project

Safeguard Policy	***Requirement***	***Policy Triggered***	***Applicability/Compliance***
Environment Assessment (EA) (OP 4.01)	The Bank requires EA of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making.	Yes	The proposed project involves construction of a 10 storied + 2 basement building on 1.77 acres of land owned by RAJUK at Mohakhali, Dhaka. All environmental and social aspects included in the proposed project will be adequately examined. The project is likely to have some risks and potential adverse environmental impacts during the construction and operational phases regarding the natural environment, water, human health, and safety.
Performance Standards for Private Sector	This policy is aimed at facilitating World Bank financing for private sector led economic development projects by applying	No	Since it is a Govt. project, therefore, OP 4.03 is not applicable.

Safeguard Policy	*Requirement*	*Policy Triggered*	*Applicability/Compliance*
Activities (OP 4.03)	environmental and social policy standards that are better suited to the private sector, while enhancing greater policy coherence and cooperation across the World Bank Group		
Natural Habitats (OP 4.04)	The Bank requires borrowers to incorporate into their development and environmental strategies analyses of any major natural habitat issues, including identification of important natural habitat sites, the ecological functions they perform, the degree of threat to the sites, priorities for conservation, and associated recurrent-funding and capacity-building needs.	No	The project site is at the prime location of the commercial area of Mohakhali, Dhaka The land is owned by the client RAJUK. There exists only a number of fruit trees within the project boundary. Therefore, the impacts on natural habitat may not be significant due to the project.
Pest Management (OP 4.09)	In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management. As necessary, the Bank and the borrower incorporate in the project components to strengthen such capacity	No	The proposed project involves the construction of a 10 storied building in an urban setting. The project activity would not require the use of pesticides in any way.
Involuntary Resettlement (OP 4.12)	World Bank recognizes that Involuntary resettlement may cause severe long-term hardship, impoverishment, and environmental damage unless appropriate measures are carefully planned and carried out.	No	The project will be built in RAJUK own land and no human resettlement or land acquisition/requisition will be required.
Indigenous People (OP 4.10)	The Bank recognizes that the identities and cultures of Indigenous Peoples are inextricably linked to the lands on which they live and the natural resources on which they depend. Hence, A the project proposed for Bank financing must be screened for the presence of indigenous people.	No	This policy does not get triggered as there are no indigenous people inside and within the project influence area.
Forests (OP 4.36)	If a project involves significant conversion or degradation of natural forests or related natural habitats that the Bank determines are not critical, and the Bank determines that there are no feasible alternatives to the project and its siting, and comprehensive analysis demonstrates that overall benefits from the project substantially outweigh the environmental costs; the Bank may finance the project provided that it incorporates appropriate mitigation measures.	No	The proposed project and the project influence area do not have of any kind of forest land.
Physical Cultural Resources (OP 4.11)	The proponent needs to addresses impacts on physical cultural resources in projects proposed for Bank financing, as an integral part of the environmental assessment (EA) process.	No	No tangible forms of cultural, archaeological, paleontological, historical, and religious significance exist in the vicinity of the project area.
Safety of Dams (OP 4.37)	When the Bank finances a project that includes the construction of a new dam, it requires that the dam be designed and its construction supervised by experienced and competent professionals.	No	Not applicable. No Dams in the project area.
Project in Disputed Areas	Projects in Disputed Areas may affect the relations between the Bank and its borrowers,	No	The proposed project is not in a disputed area.

Safeguard Policy	*Requirement*	*Policy Triggered*	*Applicability/Compliance*
(OP 7.60)	and between the claimants to the disputed area. Therefore, the Bank will only finance projects in disputed areas when either there is no objection from the other claimant to the disputed area, or when the special circumstances of the case support Bank financing, notwithstanding the objection.		
Project on International Waterways (OP 7.50)	The Bank recognizes that the cooperation and goodwill of riparian's is essential for the efficient use and protection of the waterway. Therefore, it attaches great importance to riparian's making appropriate agreements or arrangements for these purposes for the entire waterway or any part thereof.	No	Not applicable

In addition to Table E-1, the WBG guidelines provides guidance on certain EHS issues which include standards for environmental parameters (ambient air quality, water and wastewater quality, noise level, waste management), hazard and accident prevention, occupational and community health and safety (during construction and operation), etc. These guidelines will be directly applicable to the proposed project. As a general rule, the WBG guidelines should complement the existing Bangladesh guidelines or standards. In case the Bangladesh guidelines or standards differ from the WBG guidelines, project is expected to follow the more stringent ones. Moreover, relevant Fire Safety Rules will also be applicable to the proposed project.

National Legal Instruments Applicable to the Project

Relevant laws, Act, Rules and Ordinances which will be applicable to the proposed project are summarized and presented in the Table E-2.

Table E-2: Relevant Law, Rules, Ordinances to the Project

Act/Rule/Law/Ordinance	Key Features	Applicability
The Environment Conservation Act, 1995 and subsequent amendments in 2000 2002 and 2010	• Define Applicability of environmental clearance • Regulation of development activities from environmental perspective • Framing applicable limits for emissions and effluents • Framing of standards for air, water, and noise quality • Formulation of guidelines relating to control and mitigation of environmental pollution, conservation, and improvement of Environment Declaration of Ecologically critical areas	Applicable as the proposed project activity associated with environmental issues
Environmental conservation Rules, 1997 and subsequent amendments in 2002, 2003 and 2010	• Declaration of Ecologically critical areas • Requirement of environmental clearance certificate for various categories of projects • Requirement of IEE/EIA as per category • Renewal of the environmental clearance certificate within 30 days after the expiry • Provides standards for quality of air, water and sound and acceptable limits for emissions/discharges from vehicles and other sources	Applicable. Projects falls under Orange-B Category and require EIA approval prior to start construction and environmental Clearance Certificate prior to start of operation

Act/Rule/Law/Ordinance	Key Features	Applicability
Environment Court Act, 2000 and subsequent amendments in 2002	• GoB has given highest priority to environment pollution • Provides the Jurisdictions of environment court, the penalty for violating court's order, trial procedure in special magistrate's court, the power of entry and search, the procedure for investigation, procedure and power of environment court, the authority of environment court to inspect, appeal procedure and formation of environment appeal court.	Applicable
Water Supply and Sanitation Act, 1996	Management and control of water supply and sanitation in urban areas.	Not directly applicable, however, indirectly applicable when considering water usage management and sanitation facilities for the project
National Biodiversity Strategy and Action Plan (2004)	Maintain and improve environmental stability for ecosystems and restore the biodiversity of the country for wellbeing of the present and future generations	Not/marginally applicable
The Acquisition and Requisition of Immovable Property ordinance 1982 and subsequent amendments in 1994, 1995 and 2004	Current GOB Act and Guidelines, relating to acquisition and requisition of land	Not Applicable since project will be constructed on RAJUK's own land
The Building construction Act 1952 and subsequent amendments	This act provides for prevention of haphazard construction of building and excavation of tanks which are likely to interfere with the planning of certain areas in Bangladesh	Applicable due to structure will be constructed in the project area
Noise Pollution (Control) Rules 2006	• Prevention of Noise pollution • Standards for noise levels	Applicable. Noise will be generated due to the construction activity
Bangladesh Labor Law, 2006, Bangladesh Labor Act, 2013 and Bangladesh Labor Rules, 2015	Provides health, safety, and well-being of workforce during project life cycle. In addition, it also stipulated that children under 18 years are not allowed to be employed during project life cycle and therefore, this law requires to be complied with	Applicable as skill, semiskilled and day labor will be worked in the project
The Electricity Act, 1910 and Amendment and The Electricity Rules, 1937	Law relating to the supply and use of electrical energy	Not directly applicable, however, indirectly applicable when considering electricity use during construction and operation phase of the project
The Vehicle Act, 1927; The Motor Vehicles Ordinance, 1983; and The Bengal Motor Vehicle Rules, 1940	• Exhaust emissions • Vehicular air and noise pollution • Road/traffic safety • Vehicle Licensing and Registration • Fitness of Motor Vehicles • Parking by-laws	Applicable for proposed Project in relation to road transport

BASELINE: ENVIRONMENTAL, ECOLOGICAL AND SOCIAL

As a part of the environmental assessment of the propose RAJUK-URU Building Project, an environmental baseline survey was carried out in areas surrounding the proposed location from July – August, 2019. The specific objectives of the baseline study were: documentation of the existing condition of physical and biological environment and prevailing socio-economic condition of the project areas; identification of the significant environmental and social aspects that are likely to be affected by

the proposed project activities; and setting of baseline parameters in order to identify possible adverse and beneficial impacts due to the proposed project activities.

Physical Features of the Study Area

As mentioned earlier, the RAJUK-URU project site has been selected at RAJUK Mohakhali Zonal Office comprising of 1.77 acre rectangular-shaped land owned by RAJUK. Presently there is a relatively new 8 storied Building at the north end of the plot. This recently constructed L-shaped building is used as the Zonal Office of RAJUK. Besides, there exists an incomplete unused concrete structure within the site. The existing 4.50m wide service road within the site is located at the east side of the plot. Other than this, there exist a number of trees, mainly fruit trees within the plot. The physical location of the URU building project of RAJUK is at Mohakhali, besides the Bir Uttam AK Khandakar Road which is the main road connection between Mohakhali to Gulshan -1. The notable establishments around the project site have been summarized in Figure E-1 as well as below:

North side: Government Titumir College academic building and its student's hostel (Akkasur Rahman Akhi Chatrabas) are on the north of the project site.

South side: Two-high-rising commercial buildings containing different offices, e.g. AB Bank, M & J Group, and Green Delta Insurance are on the south of the project site. At present construction work of another high-rising building is going on.

East side:The eastern side covers almost all the area that belongs to RAJUK. Now a day, the area is being used by RAJUK authority as a parking place for their Staff buses, excavators, road rollers and Dump trucks.

West side: BSTI officers' quarters and BSTI staff quarters Masjid are on the west side of the project site.

There are no archaeological sites within the project influence area. The nearest remarkable and nationally important establishment to the proposed project site is the Jatiya Sangsad Bhaban, which is more than 5.0 km away.

Physico-Chemical Environment

Air Quality: The air quality data has been collected from CAMS Station 2 and 3 of the CASE Project of the DoE. Also, some data have also been collected from the US Embassy in Dhaka which has installed continuous monitoring equipment and have published the data on itswebpage. PM10 and PM2.5 concentrations in air remain higher than the standards of Bangladesh during November to April, and from May to October the PM levels satisfy the limit values. The month of January is found to be the most polluted month, followed by December and February. Winter season (December – January) is also characterized with higher fraction of fine particles to PM10 mass concentrations and the summer time (February – April) is typified with coarse particles in air. It is important to note that hundreds of brick kilns around the city operate during the dry season only (Figure E-3).

The US Embassy in Dhaka has also installed a continuous air quality monitoring station at Baridhara which records $PM_{2.5}$ and provides Air Quality Index (AQI) of the area. These data are available in the US Embassy website. The US Embassy installed air quality monitoring station records show that the average and maximum PM2.5 levels in the year 2018 were 111.7 and 985 $\mu g/m^3$, respectively. The average AQI for the year 2018 was 164, while an AQI index greater than 150 indicates unhealthy condition.

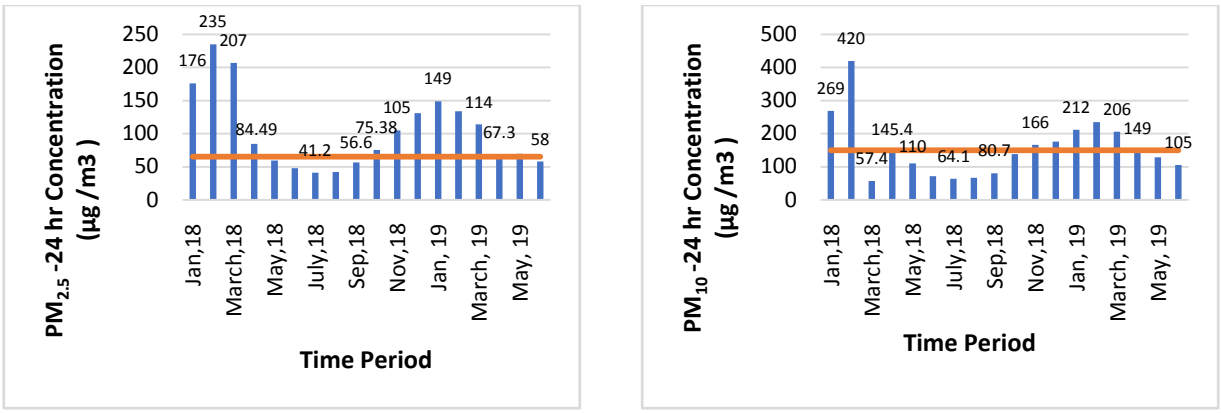


Figure E-3: Monthly average PM10 and PM2.5 data recorded by CAMS 2 in year 2018

Climate, Solar Radiation, Precipitation, Temperature, Rainfall and Relative Humidity: Although there are six seasons in Bengali year, three seasons are generally recognized: a hot, muggy summer from March to June; a hot, humid and rainy monsoon season from June to November during which more than 85% of the total annual rainfall occurs; and a moderately cold, dry winter from December to February. The beginning of the rainy season vary from year to year; heavy rains may commence anywhere between mid-April and early June and may end anywhere between the end of September and mid-November. Usually winter season is dry with occasional rains. The early summer season is considered from March-April. During summer, the air becomes hot with very low humidity. Early summer is also dominated by Baishakhi cyclone and rains.

Solar radiation directly affects air quality contributory pollutants and their dispersion through the area. CAMS-2 (Darus Salam) data shows an average monthly solar radiation data of year 2018. The spatial and temporal variation of Relative Humidity throughout the year is very low in Bangladesh. Around the project area, the relative humidity varies from 10.6% to 98.7% with an annual average of 61.2%. The general pattern of precipitation (which consists entirely of rain) follows the monsoon pattern with the cooler, drier months of November to March, increasing rains in April and May, and highest rainfall in the summer months of September and October when the prevailing wind direction from the southwest brings moisture-laden air from the Bay of Bengal. The winter period (November to February) is dry with very little rainfall. The temperature of the country is related to the period of rainfall. In general, cool seasons coincide with the period of lowest rainfall. Maximum average temperature over the year is usually observed in March - September and minimum average temperature in January.

Geology, Seismicity and Soil Characteristics: The subsurface sedimentary sequence of Dhaka, up to the explored depth of 300m, shows three distinct entities: one is the Madhupur Clay of the Pleistocene age, characterized by reddish plastic clay with silt and very fine sand particles. This Madhupur Clay un-conformably overlies the DupiTila Formation of the Plio-Pleistocene age, composed of medium to coarse yellowish brown sand and occasional gravel. The incised channels and depressions within the city are floored by recent alluvial floodplain deposits and are further subdivided into Lowland Alluvium and Highland Alluvium.

Based on the logs of the boreholes drilled at the different locations of the project site, done under a separate study conducted by BUET in February and March of 2019 (BRTC, 2019) as per the request of the RAJUK, soil profiles up to 30m below the EGL are:

- Up to a depth of 6m blow the EGL, read and reddish brown to light brown medium-stiff to very stiff silty clay layers exist.
- Below the medium-stiff to very stiff silty clay layer, brown medium-dense to dense silty fine sand (trace mica) layers were encountered up to a depth of 18m to 25.5m below the EGL. However, a thin pocket of brown medium-stiff to stiff clayey silt was encountered below the medium-stiff to very stiff silty clay layer.

Bangladesh is divided into three seismic zones. The Zone-II includes the greater districts of Dinajpur, Bogra, Dhaka and Chittagong and the shocks of intensity of VIII are possible. The experts suggest not to construct normal buildings with more than 60m height. Project site falls under Zone II. The Basic Seismic Coefficient in this Zone is considered to be 0.05g (G 0.2 – 0.6).

The land average elevation of Urban Resilience Unit (URU) Building area is about 10.5m PWD. The only nearest large water body is the Banani and Gulshan lakes located around at a distance of 4 km in the east. Two more water bodies are located on the north side of the site, at a distance of 1.6 km, closer to the T&T playground. Moreover, the Turag and Buriganga Rivers are constituting a circular water system along the boundary of the city of Dhaka.

To assess the heavy metal contents of the natural soil in the study area 5 soil samples were collected from the proposed Project site. Soil samples were collected from about 0.15m below the top of the original soil layer, using a split spoon. The inorganic parameters, organic contents and heavy metal contents determined through total extraction, following the USEPA guidelines have been performed. In order to assess the suitability of disposal of excavated soil in a landfill site, if required, the soil samples were assessed through Toxicity Characteristics Leaching Procedure(TCLP) following the USEPA Method 1311. Results of the analyses are presented in Table E-3.

Table E-3: Inorganic, Organic and Heavy Metal Concentrations of Soil at Site

Analysis	**Parameter**	**L -1**	**L -2**	**L -3**	**L -4**	**L -5**
Inorganic	pH	6	6	6	7	7
	EC (µS/cm)	284	100	183	278	165
	Cl^- (g/kg)	7.6	5.6	5.6	4.8	4.8
	SO_4 (g/kg)	16.4	6.4	5.6	3.6	4
TCLP	Cr (mg/L)	2.604	0.355	0.464	0.053	0.04
	Cd (mg/L)	0.032	0.016	0.016	0.43	0.024
	Pb (mg/L)	0.338	0.124	0.104	<MDL	<MDL
	Hg (µg/L)	<MDL	<MDL	<MDL	<MDL	<MDL
Total Extraction	Cr (mg/kg)	25.4	19	22.9	56	32
	Cd (mg/kg)	2.7	0.8	8.3	33	28
	Pb (mg/kg)	13	5.2	<MDL	<MDL	<MDL
	Hg (µg/L)	<MDL	500	110	<MDL	260
Organic	Organic Content %	4.3636	4.2122	3.5353	3.1095	2.8660

Natural Disaster

Floods: Flooding normally occurs during the monsoon season from June to September during the monsoon. Although the project site and its surroundings are not susceptible to seasonal flooding, water-logging from sustained rainfall in the monsoon may pose problem.

Cyclone and Tidal Surge: A cyclone risk map, prepared by the Management Information & Monitoring (MIM) Division of the Disaster Management Bureau (DMB) in 2001, distinguishes between the risk zones of no risk, wind risk, risk (low risk as mentioned in 2003) and high risk. It shows that the proposed project site does not fall under cyclone risk zone or high wind area.

Water Quality

In order to assess the groundwater quality, two representative groundwater samples were collected from the study area on 13th July, 2019. Since there is no surface water body at the site no surface water sample was collected.

Groundwater Quality: Groundwater samples were tested for selected water quality parameters at the Environmental Engineering Laboratory of Department of Civil Engineering, BUET. Table E-4 shows the characteristics of the groundwater. All the parameters analyzed for both the groundwater samples were found to be within the corresponding drinking water limits set in the ECR, '97 and WHO guidelines.

Groundwater Table: Groundwater in Dhaka city is declining at an alarming rate. The continuous over withdrawal of ground water and irregular and insufficient recharge causes depletion of groundwater. Rapid urbanization during the past 30 years also contributed to the present condition of Dhaka City. DWASA supplies drinking water to the residents of Dhaka City by extracting groundwater through about 870 deep tubewells and by treating surface water from the Sitalakhhya and Buriganga Rivers. Every year about 10% of these DTWs become non-operational due to groundwater depletion. A historical data records compiled by the BWDB in 2014 show the selected piezometers in Dhaka City (Table E-5).

A study conducted by BRTC, BUET following the request of RAJUK which included monitoring the water table through installation of multiple piezometers at the proposed site. Position of the groundwater table within 24 hours of drilling the boreholes were found to vary between 12.2m to 13.77m. However, the position varies significantly over prolonged period of monitoring. The groundwater table recorded in five boreholes at the project site was found to vary between 8.53m to 20.88m from the EGL (BRTC, BUET, 2019).

Table E-4: Summary of groundwater quality in the study area

Water Quality Parameters	Unit	Concentrations		WHO Guide line values 2004	Bangladesh Standard for Drinking Water (ECR'97)
		GW- 1	GW-2		
pH	-	7.35	7.18	6.5 - 8.5	6.5 - 8.5
Turbidity	NTU	0.68	0.56	5	10
Color	Pt. Co Unit	7	4	15	15
Total Hardness as $CaCO_3$	mg/L	96	88	500	200 - 500
Iron, Fe	mg/L	<0.02	<0.02	0.3	0.3 - 1.0
Manganese, Mn	mg/L	0.006	0.008	0.5	0.1
Arsenic, As	µg/L	<0.001	<0.001	10	50
Chloride, Cl^-	mg/L	14	13	250	150 - 600

Water Quality Parameters	Unit	Concentrations		WHO Guide line values 2004	Bangladesh Standard for Drinking Water (ECR'97)
		GW- 1	GW-2		
Lead, Pb	mg/L	<0.001	<0.001	0.01	0.05
Cadmium, Cd	mg/L	<0.001	<0.001	0.003	0.005
Chromium, Cr	mg/L	0.01	0.01	0.05	0.05
Nickle, Ni	mg/L	<0.01	<0.01	0.02(p)	0.1
Mercury, Hg	µg/l	<0.001	<0.001		
Total Dissolved Solids, TDS	mg/L	161	213	1000	1000
Total Suspended Solids, TDS	mg/L	7	3	10	-
Total Coliform, TC	# / 100 ml	Nil	Nil	00 TC / 100 ml	00 TC / 100 ml
Fecal Coliform, FC	# / 100 ml	Nil	Nil	00 FC / 100 ml	00 FC / 100 ml
Electrical Conductivity, EC	µS/cm	228	286	-	-
Ammonia-Nitrogen (NH_3-N)	mg/l	009	0.09	0.5	1.5
Nitrate-Nitrogen (NO_3-N)	mg/l	0.4	0.3	10	50
Sulfate, SO_4	mg/l	0.13	3	400	250
Orthophosphate, PO_4	mg/l	12	13	6	-
Total Alkalinity as $CaCO_3$	mg/l	102	148	-	-

Table E-5: Location and recorded groundwater level of selected piezometers in Dhaka City

Well ID	Location	Thana	Latitude	Longitude	Groundwater Level in meters (2010)
GT2608001	Joar Shahara	Cantonment	23.83	90.42	27.81
GT2668019	Khilgaon	Sabujbag	23.75	90.42	54.4
GT2642900	Palashi	Lalbagh	23.72	90.41	44.77
GT2648010	Monipur	Mirpur	23.79	90.37	65.97
GT2650011	PC Culture	Mohammadpur	23.75	90.37	31.24
GT2616012	Sultangonj	Dhanmondi	23.74	90.37	66.32
GT2988021	Gandaria	Sutrapur	23.70	90.42	21.1

Source: Bangladesh Water Development Board (BWDB), 2014

Ambient Noise Level

As a part of the baseline study, noise level measurements were made at different locations in and around the project area. Noise measurements were performed during both daytime and night time with a calibrated noise level meter (Extech HD-600). 10-minute continuous noise level measurements were carried out at the selected locations in 'A' Weighting and slow response mode with 1 sec interval, and the equivalent noise levels (Leq) as well as the maximum and minimum noise levels (Lmax) were determined. Table E-6 shows the summary of noise level measurements carried out in different locations in and around the study area. It appears that the project site is a very quiet area both during day and night time. The maximum and Leq recorded daytime noise level at the site was 79.3 dB with Leq of 68.3 dB, respectively. In the evening hours the noise level at the proposed site remains in the similar range as those of the daytime noise. However, the effect of traffic noise do not seem to have much influence on the noise level at the proposed site as it is located a bit away from the main road and is surrounded by boundary wall.

Ecological Environment

A rapid ecological baseline study has been carried out for the proposed project RAJUK-URU Building project. Objectives of this ecological baseline study were to gather information on the existing ecological

environment that present within and outside areas of the proposed high-rise building construction project site. The ecologist of the EIA team visited the proposed high-rise URU building construction project site and adjacent areas in July 2019 to collect first hand data on the existing faunal and floral diversity. The study was conducted primarily in day time, however, a part of the study was also conducted at night. Bio-ecologically the proposed RAJUK URU building construction project site and adjacent area remains under the Brahmaputra - Jamuna Floodplain (IUCN - BD, 2002). Agro-ecologically, the project site and adjacent areas are not classified, but mentioned as Urban (BARC/UNDP/FAO, 1995).

Table E-6: Summary of noise level measurements carried out in and around the study area.

Location	Coordinates	Day Time		Evening Time	
		Time	Leq (dBA)	Time	Leq (dBA)
Location 1	23° 46' 53.46"N 90° 24' 8.22"E	11:14-11:23AM	65.2	05:23-05:32PM	69.1
Location 2	23° 46' 54.72"N 90° 24' 7.53"E	12:17-12:27PM	68.1	06:23-06:32PM	67.0
Location 3	23° 46' 54.72"N 90° 24' 8.04"E	01:07-01:16PM	68.3	07:26-07:35PM	61.3

Faunal Diversity

On the basis of habitats, the faunal species found within and outside of the proposed RAJUK URU project site has been divided into two major categories viz. (a) terrestrial fauna and (b) aquatic fauna. Brief description of faunal diversity is given below:

Terrestrial Fauna: Terrestrial habitat dependent faunal species are the main components of terrestrial fauna which includes amphibia, reptile, birds and mammal species. The identified terrestrial fauna is divided into 4 major group viz. amphibian, reptile, bird, and mammal. A total of 18 terrestrial faunal species have been identified from the proposed RAJUK URU project site and adjacent areas, and most of them are avian species. A sample of all terrestrial faunal species habit is shown in Figure E-4 (details provided in main report), which indicates that the project study site is low to moderately rich with the adaptive urban avian species.

Aquatic Fauna: The proposed RAJUK-URU building construction project site and adjacent areas have no wetland or water-bodies that could support habitat for various types of aquatic faunal species including fish diversity; hence, no aquatic faunal and fish species have been identified for the proposed project.

Figure E-4: Sample pictures of Terrestrial Fauna at the project site

Floral Diversity

On the basis of habitats, the floral species found within and outside of the proposed RAJUK-URU building construction project site have been divided into two major categories viz. (a) terrestrial flora, and (b) aquatic flora. Brief descriptions of these floras are given below:

*Terrestrial Flora:*The proposed RAJUK URU project site and adjacent areas have significant number of mixed natural and planted terrestrial native and exotic floras. Common terrestrial floras are Coconut - *Coccosnucifera*, Tal -*Borassusfiabellifer*, Banana - *Musa paradisiacal,* etc. A large number of herb and shrub species also have grown naturally in the proposed project site (Figure E-5). These terrestrial floral species have grown in a scattered way. Most of these floras have economic and aesthetic value.Common terrestrial flora are Coconut (*Cocos nucifera)*, Fig (*Ficusbenghalensis),* Kanthal (*Artocarpusheterophyllus)*, Kola (*Musa spp)*, Mango (*Mangifera indica)*, etc. However, the identified terrestrial floras have been divided into three terrestrial floral habit viz. tree, herb and shrub. A total of 34 terrestrial floral species have been identified at the proposed RAJUK-URU project site and adjacent areas, and most of them are trees with a few herbs.

Figure E-5: Sample pictures of Terrestrial Flora at the project site

Aquatic Flora: The proposed RAJUK-URU building construction project site and adjacent areas have no wetland or water-bodies that could support habitat for various types of aquatic floral species; hence no aquatic floral species have been identified for the proposed RAJUK-URU project.

Threatened Fauna and Flora

Some specific scientific category and criteria are followed to declare a species as threatened. It is generally declared by the World Conservation Union (IUCN), an international Inter Governmental Organization (IGO), for each country. No threatened faunal and floral species have been identified from the proposed RAJUK-URU building construction project site or its adjacent areas.

Ecological Important Site

*Ecologically Critical Area (ECA):*It is an environmental protection zone, defined by the Government of Bangladesh under the Bangladesh Environment Conservation Act, 1995, where ecosystem is considered to be threatened to reach a critical state. No ECA exists at or near the proposed RAJUK-URU building project site.

*Protected Area (PA):*Such an area is predominantly a natural area established and managed in perpetuity, through legal or customary regimes, primarily to conserve their natural resources. No PA exists at or near the proposed RAJUK-URU building project site.

National Park (NP): A National Park (NP) is a reserve land, usually declared and owned by a national government, protected from most human development activities and pollution. No NP exists at or near the proposed RAJUK-URU building project site.

*Game Reserve (GR):*A Game Reserve (GR) is an area of land set aside for maintenance of wildlife for tourism or hunting purposes. No GR exists at or near the proposed RAJUK-URU building project site.

*Wildlife Sanctuary (WS):*A Wildlife Sanctuary (WS) is an area that assures the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment where these require specific human manipulation for their perpetuation. No WS exists at or near the proposed RAJUK-URU building project site.

Socio-Economic Condition around Project Area

Objectives of social baseline study were to gather information on the existing socio-economic aspects that exist within and outside of the proposed RAJUK-URU building construction project site. The social assessment primarily focused on identifying the status of important economic and social conditions within the project areas.

Present uses of Proposed RAJUK- URU Project Site

The project site has a single eight storied building which act as zonal office under zonal director of RAJUK, and provide various type of services to the people of RAJUK zone 3 and zone 4 areas. One semi-pucca guard house exists beside the main gate of this plot and some security guards provide security service, both for office and land. A single tin-shade house with four to five rooms also exists, and a few RAJUK office lower grade staff family stay there. Seasonal gardening inside the land was also observed, though most of the land remains as fallow land and no cultivation is being done at present. Peripheral side of the proposed land has some timber yielding and fruit bearing trees, and all of these floral resources have aesthetic and economic value to the present human society. The proposed project site has a peripheral pave road used by the zonal office personnel and service seekers. All sorts of basic utility services (e.g. electricity by DPDC, natural piped gas by Titas Gas T&D, supplied piped water by DWASA) are available in the proposed land.

Present Status of Areas Adjacent to Proposed RAJUK-URU Project Site

According to the Dhaka North City Corporation (DNCC) webpage the total service area of DNCC is 82.638 km^2 with 36 Wards in 5 Zones (http://www.dncc.gov.bd).The project site is in the Zone 3 which has a total area of coverage of 18.987km^2 in 10 Wards. The Ward no. 20, where the project site is located, has a total area of coverage of1.729 $km^2$with households 4,062. Considering the service area of 18.987km^2 in Zone the proportionate population in Ward 20 in 2011 would be 84,394. With a growth rate of 2.83%, the projected population of Ward 20 for 2019 would be 1,05,505 resulting in a population density of 61,020 per km^2. It should be noted that the floating population in the Dhaka City is generally very high. This is because a large number of people travel to Dhaka for various services and/or business related issues. According to BBS, 2015 (Community Report – Dhaka City) the average family size is 4.14 persons. Distribution of households by type of population are 91.66% general, 0.30% institutional and 8.04%

other units. Structure of these houses are 47.7% pucca house, 25.1% semi-pucca house, 24.5% kutcha house and remaining 2.7% are Shanty (slum) and Literacy rate is 74.8%.

Economic condition of the project study areas seems to be relatively good compared to other regions of the country. Local economy is vibrant and thriving through various businesses operating in this locality. Some governmental offices as well as financial institutions exist there and provide services to the local, city and entire Bangladeshi peoples. People's occupation varies in the project study areas. Private services in the market, shop, bank and transport related occupation (e.g. bus, car, rickshaws, three wheeler CNG taxi, truck etc.) are available that play an import economic role among the people of present society. Some small to medium factory observed in the study site, of which garment related factory is remarkable. All sorts of income group (low, middle & high) people live there, whose income range is from BDT 10,000 to more than BDT 1,00,000. All the roads are paved and are in good condition, and play an important role for intra-city road communications. Utility services including piped supplied natural gas for cooking, piped water for drinking, sanitation and waste dumping issues, electricity, etc. seems to be moderate to good and almost all people have access to those services.

IDENTIFICATION AND ASSESSMENT OF POTENTIAL IMPACTS

An evaluation of the impacts of project activities on the physico-chemical, ecological and socio-economic parameters, both during construction and operation phases of the project has been carried out for the proposed RAJUK URU Project. The impacts have been categorized as "positive impact", "no impact", and "negative impact". Again the intensity of positive and negative impacts have been classified (qualitatively) into "low", "moderate" and "high" categories. Short-term (Sh) and long-term (Lo) nature of impacts have also been identified.Environmental impacts can be broadly categorized into 2 groups – construction phase and operation phase. Major physicochemical parameters considered for assessment of environmental impacts of project activities during construction phase include water pollution, drainage congestion, noise pollution, air pollution, and generation and disposal of solid wastes.

Impacts during Pre-Construction Phase

Before the actual construction can progress, dismantling and removal of infrastructures (semi pucca shed, one storied building etc.) those exist within the project site, would be needed. The dismantling process would generate concrete debris and dust that could affect the air quality in the project area. The existing utility lines (electricity, gas, water supply and telephone) mainly run through the boundary of the project area and apparently it seems that no shifting or disconnecting of those lines would be required. If any such lines need to be disconnected or shifted for the preparation of construction or during construction, relevant authorities should be contacted and act accordingly.

Impacts during Construction Phase

*Impacts from Excavation for Basement:*The proposed RAJUK URU Building Project Phase-I involves construction of a 10 storied building with 2 basements for parking facility. For basements, a deep excavation over a large area within the project site would be needed in open cut method. During this process, there exists a concern of soil collapse as well as the safety of the workers. This process will require constant pumping of water out of the excavation trench for supporting the truck traffic. Moreover, the deep excavation will generate a huge volume of earth material, which need to be properly disposed of. There should be a good drainage system and cover so that no water logging could happen during rains within the area. The foundation work of the project requires the placement of 162 permanent 600mm diameter shore piles placed outside the basement perimeter walls. This piling

activity may cause collapse of the soil or may affect the surrounding structures. Extra precautions should be taken care of during this activity. For the Phase II the 22 storied building with 4 basements the excavation work may have to be done using shore pile method requiring significant protection measures against slope failure.

*Impacts from Wastewater and Solid Waste:*Waste and wastewater that would generate during the construction phase of the project include construction debris and wastes, and some other solid wastes (e.g., from labor sheds), human wastes from people working at the project site (e.g., from labor sheds), and some liquid waste from construction processes. These wastes and wastewater could lead to pollution of water and general environment, if not properly disposed of.

Wastewater, in the form of human wastes, will be generated mainly in the temporary labor sheds. Use of unsanitary latrines and improper disposal of human waste would create environmental pollution and adversely affect human health at the construction site by increasing the risk of disease transmission. Proper disposal of wastewater should, therefore, be ensured.

Construction debris and wastes to be generated during the construction phase would include scrap iron, steel, wooden frames, piping, and other solid wastes. Most of it will be generated toward the end of the construction phase during carrying out of the finishing works, while the site will be cleared of waste materials. The volume of such construction wastes is likely to be significant. Indiscriminate storage and disposal of construction debris and wastes could create local waterlogging and ponding by blocking drainage lines and would be aesthetically displeasing. Solid waste of domestic nature that would be generated in the temporary labor sheds at the construction site is not likely to be significant in volume. But indiscriminate disposal of such solid waste would create environmental pollution and unhealthy situation at the project site.

Impacts on Water Resource: The proposed project will use the DWASA Supply source for their water requirement during construction and operation phase of the project and will not install any tube wells within the project site. Therefore, there will not be any effects on ground water resource. However, there will be some indirect negative impact on the amount of supply water of WASA.

Noise Pollution: Noise pollution is likely to result from a wide range of construction activities at the project site, including the movement of vehicles carrying construction materials, equipment to and from the site, and different construction activities. The main sources of noise during construction period will be site preparation works, excavating, piling, transportation and handling of materials and equipment, other engineering works like riveting, hammering, cutting, welding, etc. Operation of concrete mixers, excavator, construction vehicles, fabrication, handling of equipment and materials, etc. would generate a considerable amount of noise. The noise levels of most of the construction machineries (80~95 dBA) are approximately 10 to 35dBA higher than the base noise level (50~80dBA). The noise from these activities and machines/equipment is likely to cause an increase in noise over the “low” base noise level. This high level of noise would have a significant impact on the population residing nearby. The project site is close to a major educational institution ‘Titumir College’ and its student hostel – with a large number of students and BSTI residential quarter. Proper mitigation measures have to be incorporated to reduce the impact of noise upon health.

Department of Environment (DoE) in Bangladesh does not provide any guideline for noise control in construction sites. So, standards as indicated in Noise Limits for Construction Sites and Standard of

Noise at boundary of Industrial Enterprises (GB12348-90) may be applied for evaluation of noise pollution during construction period, and the said noise limits are listed in Table E-7.

Table E-7: Noise Limits for Construction Sites (GB12523-90)

Construction Phase	Leading Noise Source	Noise Limit, dB(A)	
		Daytime	Night time
Earthwork	Bulldozers, excavators, loaders, backhoes and etc.	75	55
Piling	Various piling machines	85	Construction prohibited
Structure engineering	Concrete mixers, vibrators, electric saws and etc.	70	55
Fit-out work	Cranes, lifters and etc.	65	55

It is seen from Figure E-6 that the noise level of typical construction machineries (85-90 dBA) drops to an acceptable limit (70 dBA) within 30 m from the source. The effect of a noise source as well as of simultaneous operation of more than one noise sources is shown in Figure E-7. In reality, the noise level of most of the construction machineries (80~90 dBA) are on an average 35 dBA higher than the base noise level (50~80 dBA) and it is seen that in case of such a big difference in noise level the combined level is determined by the noise level of the machine. However, the impact of the machine-generated noise will subside within 30 m from the location of the machine.

*Air Pollution:*During the construction phase of the proposed project, the important sources of emissions would include those from the operations of construction equipment and machineries, vehicles carrying construction materials to the site and taking construction debris out of the site. The air pollution generated from these activities is likely to be localized (affecting immediate surroundings of the emission source/ project site).If construction equipment, such as stone (aggregate) crusher, is used at the site, this may result in significant emission of particulate matter during its operation. Since construction of the proposed project would most likely involve significant earthworks, increase in particulate matter in the air from wind-blown dust is also a concern, especially considering the close proximity of a college and residential complex to the project site.

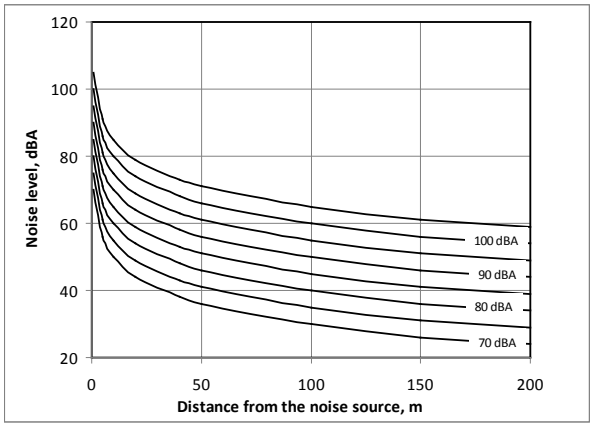


Figure E-6: Attenuation of noise level with distance from the source.

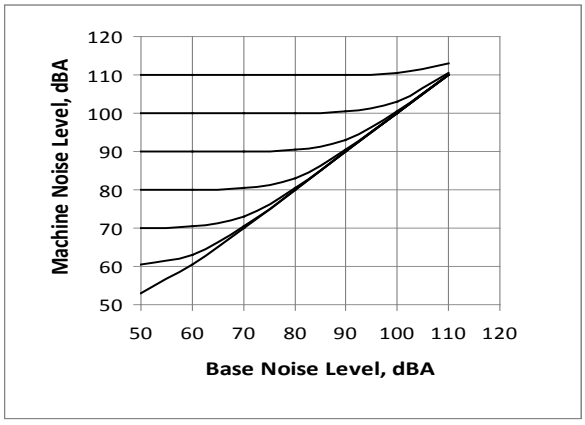


Figure E-7: Combined noise level due to the operation of noise generating machines

Drainage Congestion: Since the construction phase involves significant earthwork (e.g., excavating/ back-filling for the foundation of the building) there are chances of stagnation and ponding of storm water if care is not taken for proper drainage of storm water. Additional drainage congestion may result from possible obstruction to the natural flow of drainage water due to construction activities as well as storage of construction materials. Care should be taken to make sure that natural drainage paths are not obstructed, or alternate drainage paths are provided, especially during the monsoon season.

Generation and Disposal of Human/Solid Wastes: During construction phase, problems related to sanitation and solid waste may result from improper/ inappropriate facilities at the labor sheds. At the peak of construction period, large number of workers are likely to be involved in different construction activities. Lack of proper sanitation facilities for project people, including the labor/ construction worker and absence of proper solid waste (e.g., food waste, construction debris) facilities may create an unhealthy environment (including water pollution) within and around the project site.

The effect of project activities on physico-chemical environmental parameters during construction phase of the project is listed in Table E-8. The physico-chemical environmental parameters that could be affected by the project activities include water and soil quality, air quality and noise level.

Table E-8: Effect of project activities on physico-chemical parameters during construction

Physico-chemical parameters	Environmental examination						
	Positive impact			No impact	Negative impact		
	Low	Moderate	High		Low	Moderate	High
Water and soil quality					X (Sh)		
Air quality						X (Sh)	
Noise level						X (Sh)	

Sh=Short-term; Lo=Long-term

Environmental Impacts during the Operation Stages

Typical environmental impacts resulted during the operational phase may include: Wastewater and waste management; Noise pollution and Air pollution

Impacts from Wastewater and Solid Waste: During the operation phase of the URU Building project, the occupants of the buildings would generate wastewater. Municipal sewage generated from the project are can cause unhygienic condition and environmental pollution, if proper sewer system is not implemented.

The occupants of the building would generate solid wastes including organic waste such as waste foods, fruits and inorganic waste such as waste papers, damaged electronic goods, containers and liquid waste such as wastewater, oil, paint. The point of generation of the solid wastes could be the cafeterias, office rooms, IT section, conference room, business center, and laboratory facilities. Improper disposal of the solid wastes such as through open drains or sewer pipe could result in congestion in the drainage system. This could also lead to soil and groundwater contamination through the generation of leachate. If the solid waste is not removed from inside the project area regularly, it could result in unhealthy conditions in the premises and surrounding area including attracting nuisance insects such as flies and mosquitoes.

Noise Pollution and Vibration: Prolonged exposure to a high level of noise may cause significant damage to human hearing organ and may cause neurological damage. OSHA noise exposure limits for the work environment provides a guideline for the time of noise exposure at the work environment which may be adopted to prepare an environmental management plan. Therefore, noise assessment during the operational phase of different project components is particularly important.

During the operation phase of the RAJUK URU project, the main source of noise would be the vehicles carrying the staffs and visitors to the project area. The vehicle operation and honking of these vehicles could result in noise, which could have increased impacts in case of traffic jam. Office activities in the project area would contribute to low frequency noise that could have effect on the office staff and personnel working there for a significant amount of time of the day. The operation of the lab equipment may also add to the noise level depending on the type of equipment and their operating modes. Another source of the noise could be generators installed as a backup power source if these are not installed in covered places properly.

Air Pollution: After commencement of the URU project, the number of traffic occupying the local road connecting the main road and the project compound will increase. Emission from the increased number of vehicles would impact the air quality in the project area. The impact on air pollution is particularly critical in the dry season, since even at present PM_{10} and $PM_{2.5}$ concentration levels exceed the National Ambient Air Quality Standards in Bangladesh set by the DoE. Depending on the fuel type used, the generator could be an additional source that might add up to the existing air pollution level.

The effect of project activities on physico-chemical environmental parameters during operation phase of the project is listed in Table E-9. The physico-chemical environmental parameters that could be affected by the project activities include water and soil quality, air quality and noise level.

Table E-9: Effect of project activities on physico-chemical parameters during operational phase

Physico-chemical parameters	Environmental examination						
	Positive impact			No impact	Negative impact		
	Low	Moderate	High		Low	Moderate	High
Water and soil quality					X (Sh)		
Air quality						X (Sh)	
Noise level					X (Lo)		

Sh=Short-term; Lo=Long-term

ECOLOGICAL IMPACTS

The project activities of the proposed RAJUK URU project have some potential impacts (direct and indirect) on the existing ecological environment. Important project activities include land clearing and alteration, movement of people and vehicle, materials placement, excavation, construction work, accident (e.g. spills, leaks of chemicals) etc. During construction phase, land related activities are likely to have some adverse impact on its existing ecological environment. During operation, ecological impacts may result from improper disposal of wastes in the existing eco-environment. For the proposed high-rise building construction project, potential ecological impacts could be divided into two broad categories viz. (a) direct impact and (b) indirect impact. Details of these impacts on the existing floral and faunal community are described below.

Potential Impacts on Fauna

The proposed project site has a various assemblage of floras that are used by specific type of local fauna as their permanent / temporary / foraging / resting habitat. Uprooting of flora will destroy the faunal habitat. Land excavation and construction related activities for the proposed project could have some potential impacts (direct and indirect) on the existing faunal environment due to their highly sensitive and reactive behavior in response to disturbance that may occur at or near their habitat. Faunal species that are sensitive to direct (human activity and traffic) or indirect disturbance (noise) would be impacted most. Habitat disturbance would reduce habitat availability and effectiveness for a certain period for mammals, reptiles, amphibians, birds and their predators. There are also some possibilities of direct mortality and displacement of amphibians, reptiles and mammals from the use of vehicles or machineries over the terrestrial faunal habitat or deposition of excavated soil on faunal habitat.

Potential Impacts on Flora

As noted earlier, the proposed high-rise building construction project site and adjacent areas have various types of terrestrial floras that are used by certain types of fauna. None of these floras are threatened in Bangladesh. The proposed high-rise building construction project site have few floras, and almost all of these floras might be needed to uproot forever for building construction and ancillary works, hence, adverse impacts are expected. Some terrestrial undergrowth also exists within the project site and adjacent areas, and this under growth contributes to maintaining the balance of existing eco-environment. Clearing or removal of that undergrowth would also have some adverse impacts on the existing eco-environment.

Evaluation of Ecological Impact

To evaluate the ecological impact of the proposed RAJUK URU project, a simple semi-quantitative descriptive checklist method has been applied. Assessments have been made as to whether the impacts were positive (beneficial) or negative (harmful), short-term (short recovery time) or long-term (extended recovery time); and of high or low / moderate intensity. The results of the assessment are summarized in Table E-10, which indicates that most of the evaluated ecological impacts are low and short-term in nature. No long-term adverse impacts on the floral and faunal species including fish diversity are expected.

Table E-10: Impacts on Ecology due to the proposed RAJUK URU project

Source of Potential Impacts	Ecological Aspects				
	Flora	Fauna			
		Amphibia	Reptile	Bird	Mammal
	TR	TR	TR	TR	TR
During Construction Phase					
Camp setting	-1S	-1S	-1S	-1S	-1S
Material storage on land	-1S	-1S	-1S	0	-1S
Land clearing & / alteration	-1L	-1L	-1L	-1L	-1L
Soil excavation	-1L	-1L	-1L	-1L	-1L
Floral removal	-1L	-1L	-1L	-1L	-1L
Machinery use(noise generation)	0	-1S	-1S	-1S	-1S
Sewage discharge on soil	0	0	0	-1S	0
High-rise building construction	-1L	-1L	-1L	-1L	-1L

Source of Potential Impacts	Ecological Aspects				
	Flora	Fauna			
		Amphibia	Reptile	Bird	Mammal
	TR	TR	TR	TR	TR
During Operation Phase					
General waste / sludge disposal on land	-1S	-1S	-1S	-1S	-1S
Spills (oil) on land	-1S	-1S	-1S	-1S	-1S

[Legend: TR = Terrestrial; 3 = High impact, 2 = Moderate impact, 1 = Low impact, 0 = No impact (negligible impact), S = Short term impact, L = Long term impact, +/- = positive/negative impact]

Risk Assessment

A typical eco-environmental risk assessment matrix has been developed on the ecological aspects of the proposed high-rise building construction project (*please refer to main report)*. The consequence severity ranking (from low to critical) and the likelihood ranking (from "almost certain" to "rare"), along with frequency level for each ranking have been shown in Tables. The ecological impact significance rankings; and the risk assessment matrix have been developed, which is based on consequence severity and likelihood/frequency of occurrence of an event; risk has been classified from "low" to "extreme" for the proposed high-rise building construction project. In Table E-11, the potential impacts of the proposed high-rise building construction project activities on the existing ecological aspects (e.g. flora& fauna) have been ranked on the basis of consequence severity ranking, likelihood/ frequency ranking, and risk rating. Both the "consequence severity" and "risk" of the possible impacts have been categorized as "low", while likelihood/ frequency" has been categorized as "very unlikely". Thus, the proposed high-rise building construction project is likely to have some low significant adverse impact on the existing ecological environment. However, the identified impacts could be resolved to some extent by adopting appropriate mitigation measures in the course of time.

SOCIO-ECONOMIC IMPACTS

Socio-Economic Impacts during the Construction Phase

Employment and Economy: During the construction phase of the project, there will be possibility of generating more than 100 jobs. The job opportunities would be created for labors as well as skilled manpower such as engineers. Additionally, additional employment gain would result from the supply-chain system for the construction materials and transportation of the debris from the dismantling of the existing building in the project area. Requirements of construction materials would also positively impact the job growth in the manufacturing sector that generates various construction materials including steels and cement.

Traffic Condition: During the construction stage, transportation of construction materials would increase traffic flow in the project area. The increased traffic could create traffic congestion in the access road, especially in peak hours. The large trucks carrying the materials could worsen the traffic jam even on the BirUttam A K Khandokar Road (Mohakhali-Gulshan road), especially during peak hours. Traffic congestion may get worse if the construction materials are stored on the street instead of secured shed inside the project area.

Table E-11: Summary of potential Ecological Impact Assessment of the project

Potential Impacts Source / Project Activities	Impact	Ecological Receptor Type	Description	Likelihood	Consequence	Risk Rating
Land utilization for base camp	Reduction of access to the utilized land and its resources.	Flora and Fauna	Direct Negative Short term Local Reversible	Likely	Low	Low
Site preparation /clearing for base camp and associated activities	Floral destruction. Loss to utilize the flora as faunal habitat.	Flora	As above	Unlikely	Low	Low
	Loss / alteration of faunal habitat.	Fauna	As above	Unlikely	Low	Low
	Increased access for exposed faunal harassment or killing (e.g. rat).	Fauna	As above	Unlikely	Minor	Low
Construction of base camp and related activities	Disturbance of soil dwelling fauna (e.g. rat).	Fauna	As above	Unlikely	Minor	Low
High-rise building construction (e.g. concrete structure, rod binding, welding etc.).	Generation of high intensity welding flash and noise.	Fauna	As above	Unlikely	Minor	Low
	Contamination of surface soil with used lubricant, if any.	Flora and Fauna	As above	Unlikely	Minor	Low
Material storage or placement	Habitat destruction of terrestrial flora (herb, shrub) and borrowing faunal habitat and Movement disturbance of terrestrial fauna (amphibia, reptile & mammal).	Flora and Fauna	As above	Unlikely	Minor	Low
Vehicle movement	Impairment of terrestrial flora (herb & shrub), terrestrial fauna (amphibia, reptile & mammal).	Flora and Fauna	As above	Likely	Minor	Low
Equipment installation on land	Habitat destruction of terrestrial flora (herb, shrub) and Movement disturbance of terrestrial fauna (amphibia, reptile & mammal).	Flora and Fauna	As above	Unlikely	Low	Low
Soil excavation	Habitat destruction of terrestrial flora (herb, shrub) and Movement disturbance / habitat destruction of	Flora and Fauna	As above	Unlikely	Minor	Low

Potential Impacts Source / Project Activities	Impact	Ecological Receptor Type	Description	Likelihood	Consequence	Risk Rating
	terrestrial (burrow) fauna (amphibia, reptile, bird & mammal).					
Noise disturbance	Disturbance of terrestrial faunal livelihood [movement, foraging, breeding) (amphibia, reptile, bird & mammal).	Fauna	As above	Unlikely	Minor	Low
Exhaust from generators	Movement disturbance of terrestrial fauna (e.g. aves).	Fauna	As above	Unlikely	Minor	Low
Spills (oil / chemical) on land	Habitat destruction of flora and fauna	Flora and Fauna	As above	Very Unlikely	Minor	Low
Waste generation: (Solids/liquid/gaseous) (e.g. cement bags, exhaust from cranes/ heavy equipment, domestic waste)	Impairment of the health of terrestrial flora and fauna	Flora and Fauna	As above	Unlikely	Minor	Low
	Nuisance noise, dust, emissions, lighting etc.	Flora and Fauna	As above	Unlikely	Minor	Low

Community Health and Safety: Improper health and safety policy maintained at the project area during the construction phase may lead to outbreak of different diseases to the surrounding communities through the sick workers working at the project. Vehicles carrying construction materials would increase traffic and would lead to an increased noise level due to vehicle operation and honking. Noise and vibration from the construction machines and equipment may also affect the health of the surrounding community. Emission from the vehicles would increase air pollution level especially in the dry season. Construction activities would also generate dust increasing the particulate matter in the air, especially in the dry season.

Occupational Health and Safety: Construction workers may face occupational health hazards such as minor or major injuries due to lack of general safety requirements and precautions applicable for such sites, malfunctioning equipment, careless use of equipment and vehicles. Poorly designed temporary accommodation and sanitation facilities may pose a health threat and nuisance to the workers. Uncontrolled vending of food and drinking water on the work site may also pose a risk with respect to the transmission of contagious diseases like Typhoid, Diarrhea, Malaria, Dengue, etc. Construction workers will be required to handle hazardous materials such as cement, paints, chemicals, fuels, etc., therefore increasing health risks of workers. High noise from the heavy construction machines would also pose a threat to the construction workers. Accident during construction phase is also an important issue. Proper measures including regular maintenance of equipment and use of protective gear are needed to reduce the risk of such accidents during the construction phase. A complete plan on Occupational Safety and Health to mitigate the impacts has been provided in the main report.

Socio-Economic Impacts during the Operational Phase

Employment and Economy: During the operational phase of the project, there will be possibility of generating more than 500 jobs. The RAJUK-URU center will house a state-of-the-art laboratory, training, and research facilities that would create employment for the laboratory attendants and training and research personnel. Additionally, there will be conference rooms, business center, and office spaces, which would also create employment opportunities.

The research facility in the RAJUK-URU aims to enhance the urban resilience and institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh. Capacity building through the URU project would facilitate the development of resilient infrastructure in the country, which would contribute to the overall economy.

Traffic Condition: During the operational stage, traffic flow would be increased in the project area. The increased traffic could be generated by considerable number of RAJUK vehicles, and vehicles carrying the staffs and visitors to the project area. The increased traffic could create traffic congestion in the access road, especially in peak hours. Traffic jam occurs, often, on the main road (Mohakhali-Gulshan road) during peak hours. With increased traffic during the operational phase of the project, the traffic jam scenario may get worse, especially during the peak hours.

Community Health and Safety: Improper health and safety policy maintained at the project area during the operational phase may lead to outbreak of different diseases to the surrounding communities through the sick staffs and personnel working in the project area as well as from visitors visiting the center. Increased traffic, which adds to already existing traffic jam on the BirUttam A K Khandokar Road (Mohakhali-Gulshan Road), would lead to the increase in noise pollution from the operation of vehicles and their honking. Emission from the vehicles would also increase air pollution level especially in the dry season. If not housed properly, noise and vibration from the generators may affect the health of the surrounding community which includes educational institutions and residential area.

*Occupational Health and Safety:*During the operational phase more than 500 staffs and personnel would stay and work in the RAJUK complex area during office hours. There could be health and safety risks that may occur during their stay in the office. These impacts may include:

- Accidents due to move/ fall down from the roof/ balcony and using the stairs;
- Fire hazards from short circuits/cooking stoves/careless handling of materials that can generate fire;
- Inadequate lighting and ventilation in and outside the building complex;
- Noise and vibration from generator and other equipment;
- Accidents in the elevators in case of inadequate power supply and lack of generators;
- Inadequate quantities and/or poor-quality water supply and sanitation facilities;
- Poor cleanliness of the building occupants;
- Lack of daily cleaning and regular maintenance of inside and outer side of the complex;
- Safety of the security guards who would work in the night shift.

Table E-12 lists the impacts on socio-economic parameters during operation phase of the project. National economy will be benefited as the URU would build capacity to promote design and implementation earthquake resilient infrastructure. The resilient infrastructures would be able to help

to reduce the cost for disaster management activities marking a positive impact with low priority on national economy.

Table E-12: Effect of project activities on socio-economic parameters during operation phase

Socio-economic parameters	Environmental examination						
	Positive impact			No impact	Negative impact		
	Low	Moderate	High		Low	Moderate	High
Health and well being					X (Lo)		
Traffic condition					X (Lo)		
Employment		X (Lo)					
National economy	X(Lo)						

Risk Assessment for Socio-Economic Impacts

A typical risk assessment matrix has been developed for major socio-economic aspects within the RAJUK URU project areas and presented in the main report. Itindicates that most of the socio-economic impacts are rated as negatively low impacts. Therefore, it can be said that the social environment is expected to be adversely impacted by low intensity with short term effect.

Assessment and Management of Traffic Impacts

Baseline Traffic Condition

A study was conducted to assess the environmental impact of the proposed development project including the traffic impact and to recommend mitigation strategies, as necessary. Figure E-8 (a-b) presents the survey locations along with the extent of study area for the traffic impact assessment.At present, no traffic congestion and conflict within the project site were found for the internal traffic.

It was observed that during the peak hour, flow rate per lane in most of the intersection approaches exceeded their capacity. Private cars and motorcycles, which are not authorized to park, can be seen parked in the access road of the proposed RAJUK-URU building. In most cases, it reduces the two-lane road into 1.5 or 1 lane creating hindrance in passing even two vehicles side by side. Mass transits and para-transits approaching the critical intersections on the link road were found forming platoon due to boarding and alighting of passengers. These vehicles make their stop right at the intersection, often side by side when other vehicles are present. The continuous divider along the link road facilitates an opening in front of the Titumir College for U-turning maneuver. This reduces speed and mobility of the artery: Gulshan-Mohakhali Link Road. A large number of street shops and construction materials were found on both sides of the link road. There was practically very little space left for pedestrian use. On the link road, Amtoli and Gulshan-1intersections have 3-leg and4-leg configurations, respectively. Although both have signal heads,vehiclemovements are controlled by the hand-gestures of traffic police creating an imbalanced allocation of green time for different phases.

Figure E-8a: Traffic survey locations surrounding the URU building project site

Figure E-8b: Existingroads for traffic circulation within the project area

Geometric, Traffic Demand Survey and Demand Forecasting

Five different types of surveys were adopted as follows: (1) Traffic count survey; (2) Vehicle speed study; (3) Travel time survey; (4) Questionnaire survey; and (5) Geometric survey from 9th – 18th July, 2019 at different times of the day. The maximum vehicle flow rates along the roads in the project influence area were found to range between 367 – 5,935 vehicles per hour.

Similarly, other four survey approaches have been performed and is provided in the main report. These data were used for demand forecasting in the project influence area. It applies the traditional four step model, namely, Trip Generation (method: cross classification), Trip Distribution (method: gravity model), Modal Split (method: multinomial logit model) and Traffic Assignment (stochastic user equilibrium) for both the two phases.

Figure E-9 indicate that due to the said project traffic will be increased significantly in the link road affecting both the critical intersections. Proper traffic circulation is needed to accommodate this induced traffic. While analyzing performance of network for different traffic circulation proposed by the RAJUK's consultants, these demands were utilized within the traffic operational model.

Impacts of Traffic Circulation

External Traffic Circulation: The proposed RAJUK-URU building will attract a substantial number of trips through private vehicles, public transport and para-transit coming from both directions of the link road. As designed by the RAJUK's Consultant, westbound vehicles will take a right turn and eastbound traffic will take a left turn to access the RAJUK-URU building. When all the facilities will come under the umbrella of the new RAJUK-URU buildings (Phase I and Phase II), which will attract extra traffic from 77232.21m^2 of interactive space, right turning maneuver will not be a docile movement as it will cause queuing of vehicles right in front of the access road. Hence, external traffic circulation plan should be modified.

Pedestrian facilities: At present, the pedestrian access is kept adjacent to the link road. Most of the people who will be accessing the RAJUK-URU building on foot will be public transport or transit users or people working in nearby offices and facilities of RAJUK which will not be shifting to the RAJUK-URU building. This is considered as a substantial safety hazard. Moreover, the layout also does not provide details on how it will take care of the pedestrians who will be accessing the RAJUK-URU facilities from the entry/exit gate. Moreover, the concern of drop-off passengers directly coming in contact with the exit vehicles in front of the Phase I building entrance shouldbe modified.

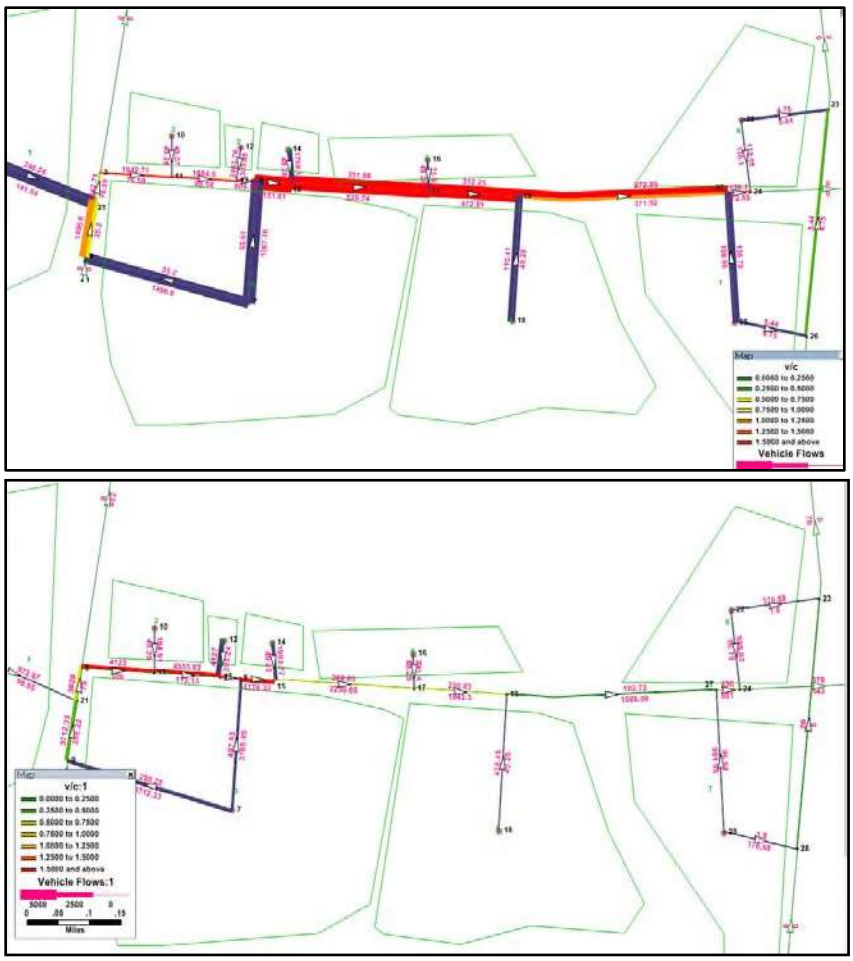


Figure E-9: Traffic flow diagram for (a) Phase I; and (b) Phase II

Conflicting Movements during Traffic Circulation: This study found four conflicting movements in the internal traffic circulation plan for RAJUK-URU building project. Entry vehicles will be in conflicting situation with the exit vehicles in front of the entry-exit gate. The secondis a merging conflict between the vehicles leaving the basement of Phase I building with the vehicles leaving the same building after dropping off passengers and taking U-turn rather than going to the basement. There will be a similar merging conflict in front of Phase II building. The last one is also a merging conflict between the vehicles leaving the basement of Phase II building with the vehicles taking a U-turn in front of the parking exit.

Mitigation Measures (Considering both Phase I and Phase II)

A number modifications have been suggested for the internal traffic circulation taking into account both Phase I and Phase II buildings.

Modification suggested for Exit Vehicle Circulation: As suggested in the proposed design, both entry and exit movements will use a common access road. However, this road will not have adequate capacity to handle the total generated traffic after completion of Phase II since it is not possible to widen the road due to nearby permanent structures and developments. Therefore, itis recommended that the entry and exit movements should be addressed using two separate roads (Figure E-10) to augment the capacity.Thiscirculation could avoid blocking both the access roads and thus could avoid hindrance of traffic mobility on the arterial road.

Figure E-10: Proposed internaltraffic circulationwithin theproject site (Phase I and Phase II buildings)

Modification in Access Road of Resident Students of Titumir College: In order to ensure the above circulation, it is suggested that the resident students of Titumir College Hostel would use a different access road (Figure E-10). For this circulation, RAJUK need to endure the loss of approximately 230, 110 and 600 m^2 of land in the north, south and east sides, respectively. However, RAJUK would take over about 840 m^2 of land on the east side of the project area (owned by RAJUK) that is currently being used as an access road by the resident students of Titumir College Hostel. It will ensure uninterrupted flow surrounding this RAJUK site due to the one-way traffic circulation. Beside the increase of roadway capacity, one-way circulation will also ensure safety for all the users due to the elimination of conflicts that arise from the both way traffic movement.

Pedestrian Movement Facilities: In the current proposal, there is no planned walking facilities within the project site for the pedestrians who will access the project site using para-transit or public transport. For these pedestrians, a footpath is recommended within the project site. Safe crossing can be ensured by providing yield sign to access Phase I building from the footpath. Alternatively, a pedestrian underpass can be designed to eliminate the at-grade crossing, however, it requires a separate feasibility study for the expected pedestrians. In addition, another yield sign need to be installed in front of the parking exit of Phase II building to ensure a safe crossing for the pedestrians.

Parking Requirements

Table E-13 presents the number of required parking spaces along with occupancy breakdown following the Bangladesh National Building Code (BNBC) guidelines. This study finds that the proposed parking spaces are adequate for both the URU buildings. Hence, based on the BNBC parking guidelines, no additional parking spaces are required.

Table E-13: Parking space requirement as perBNBC guidelines

#	Item	Area (m^2)	Occupancy	Calculated Parking Space	Adjusted Parking Space	Given Parking Space
1	Phase-1 Building	9244.54	Office	46.22	50	63
2	Phase-2 Building	52028.47	Office	260.14	265	300

ANALYSIS OF ALTERNATIVES

In order to assess the acceptability of the proposed project it is imperative that alternative options are analyzed and ensure that the proposed option is the best possible option offering least impact on environment. As a part of this analysis two options were considered: (i) Location, and (ii) Design and Construction Method & Material.

Alternative Location

In order to reduce project cost as well as to avoid complicated issue of land acquisition RAJUK has decided to construct the facility at its own land located at the RAJUK Zonal Office near the Mohakhali – Gulshan road (Bir Uttam A K Khandaker Road). There exists an 8 storied building serving as the RAJUK Zonal Office. The Southern part of the 1.77 acre land will be used to construct both the phases of the RAJUK-URU complex keeping the existing building intact, at least for the time being). RAJUK also has another piece of land, slightly bigger in size, on the Eastern side of the project area separated by a local road (also owned by RAJUK) primarily used by the resident students of the Akkasur Rahman Akhi dormitory of the Government Titumir College.

The land on the Eastern side of the proposed project site is currently being used by the RAUJK to store its equipment, service vehicles and heavy rollers under temporary sheds. This land could have been used as the project side. However, RAJUK has plans to construct a park on this land for local people as a part of their social responsibility. Therefore, RAJUK decided to use the proposed location as the project site.

Design Alternatives

In August 2018 it was decided that a single 30 storied building including four levels of basement and 30 additional floors all of which would have a floor area of 4,050m^2 on each floor. However, buoyancy effect over 4,050 m^2 for required significant resistance against uplift for the basement 4 slab as well as uplift resistance from the pile support in the design making it an extremely expensive proposition. It posed a serious concern on funding for this proposed design.

After a series of discussion meetings between the RAJUK and its Consultant the original plan was modified where two buildings would be constructed in two phases and the Phase I would be as follows: (i) A two level Basement, (ii) a small tower of 10 storied and approximate typical floor area of about 900 m^2 each, (iii) a layout providing for an eccentric building core located at the north face of the building, and (iv) the proposed shake table and laboratory with all equipment to be located within the basement and ground floor areas of the Building.

Phase II will include a 22 storied building with 4 basements. The two buildings will be inter-connected through a walkway. In this proposed design the Shake Table would be placed in the basement of the 10 storied building of the Phase I. However, in order to avoid the impact of vibration generated during the operation of the Shake Table this design was further modified, namely the "3rd Alternative Design". To

avoid the possible negative impact of vibration on the superstructure it has been decided to move the Shake Table room with its pit out from underneath to the vacant space between the 10 storied building and boundary wall of the site on the Western side without encroaching into Set-back zone.

Alternative Construction Methods and Materials

The design consultant of RAJUK-URU suggested the Phase I 10 storied tower building will have Steel-frame typical floors consisting of Hollow Structural Steel Columns with supporting steel beams and girders supporting 75mm steel deck of thickness 0.81mm and filled with 75mm of concrete adequately jointed with control joints to mitigate slab surface cracking.As earthquake forces are inertia forces, use of a steel supporting frame with steel deck is lighter than a reinforced concrete solution and thus impact of earthquake forces will be mitigated to some extent due to the lighter structure.Steel erection will speed the construction process as opposed to forming, reinforcing and placing reinforced concrete elements at typical floors.

As mentioned earlier, one of the crucial issues that prompted a change in the proposed design was the depth of excavation for the construction of 4 basements. Position of the groundwater table poses a grave concern by having the potential to induce enormous uplift pressure requiring a large number of piles for stabilization. This would make the cost of construction prohibitively high. Once the design was finalized as two phase construction the next anticipated challenge was the method of construction. Two alternatives have been proposed, namely, (i) Open Cut Method and (ii) Shore Pile Method.

Open Cut Method: the two basements will be excavated to a depth of 9m below grade by an open cut method where the slopes of the excavation will be sloped at 1:1 or 45^0. The Construction Contractor must protect the slope during construction to the approval of the Consultant and the Client and take appropriate measures to protect the open cut slope. The process must keep the provision for pumping water out of the excavation such that the base of the excavation can support truck traffic and construction activity until the reinforced concrete basement structure and ground floor is complete

Shore Pile Method: the alternative of providing for protective shore piles around the entire perimeter of the Phase 1 Building from Level B2 to the Ground Floor. This method requires the placement of 162 permanent 600mm diameter piles placed outside the basement perimeter walls. It has been estimated that the expected length of the bored concrete piles will be 25m below ground level. The length of the shore piles will have to be determined by testing 5 piles to determine the depth at which “FIXITY” of the base of the bored pile is achieved. That is, the pile will be considered to have a FIXED end at its base allowing for no structural rotation under load when it is driven to a depth such that the deflection of the pile when loaded horizontally.

It has been estimated that the cost of construction of the 10 storied building with 2 basements of Phase I would be about USD 13.347 million for Open Cut Method, whereas, the same for the Shore Pile Method the estimated cost would be USD 14.110 million. Considering the limitation of fund, the design consultant has selected the Open Cut Method for earth excavation for construction of the basements of Phase I Tower building. It should be noted that the Phase II may require Shore Pile Method due to the presence of tower buildings on both North and South sides.

No Project Scenario

The construction of the RAJUK’s Urban Resilience Unit (URU) building is timely initiative for Dhaka and the rapidly expanding urban center of Dhaka. Seismic assessment and resilience must be incorporated into urban development, authority, and accountability, and leadership is needed to facilitate private investments and consider risk and resilience within development of the DhakaCity area.

The broad objective of the engagement is to put in place the institutional infrastructure and competency to reduce long-term disaster vulnerability in Dhaka. It will address both the existing built in environment as well as future development. The specific objective of the assignment is to design and supervise a high rise building that will accommodate the URU. Since the land/site is owned by RAJUK at Mohakhali, the prime location of DhakaCity, maximum space utilization is of paramount importance and that led to the construction of this high rise building.

Thus, if the implementation of the proposed project is not done, the need for application of knowledge on earthquake and disaster resilient building construction methods in a planned and centralized way would remain unfinished. Absence of such a centralized service-oriented institution would also enhance the dearth of trained personnel in combating the need for resilient high-rise buildings in this highly congested Dhaka City.

INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

The approach undertaken for information disclosure and consultation involved the following key processes: (i) Identification of Stakeholders, (ii) Undertaking public consultations (FGDs) and interviews with key stakeholders (KII), and (iii) Summarizing the observations and key findings from the consultations.

Participatory approach has been followed to keep the relevancy in group discussion on the environmental (social, ecological and physical) issues as well as to identify the potential impacts and their mitigation measures for the proposed URU project. Two FGD sessions were organized in a place, adjacent to the proposed URU project site, in September 2019. The location was selected to represent the viewpoints of the general people residing near the proposed URU project site. In the FGD sessions, an effort was made to invite a wide range of stakeholders including Ward Councilor and Members, Religious leaders, Local leaders, Businessmen, Traders, Land owners, House owners, Laborers, Teachers, Students, Doctors, Private service holders, Government service holders, Women, etc. More than two dozen of people have been participated in the FGD sessions (see details in Table E-14, main report Figure 8.1 and Annex D). In addition to the FGDs, a number of informal meetings with local stakeholders / peoples were carried out in the project study areas and thus, the study team interacted with more than 30 people during the meetings. Moreover, four key informant interview (KII) sessions have also been conducted with high officials of the relevant Governmental institutions who might be an important stakeholder, during construction and operation phases of the proposed RAJUK URU project.

Table E-14: Details of Focus Group Discussion (FGD) sessions for the proposed 'RAJUK URU Building' project at Mohakhali, Dhaka, Bangladesh.

FGD	Venue	Date & Time	Participants Number
1	Conference Room, Hotel Sarina, Plot # 27, Road # 17, Banani C/A, Dhaka, Bangladesh.	05 – 09 – 2019 04.30 pm – 05.30 pm	12
2	Conference Room, Hotel Sarina, Plot # 27, Road # 17, Banani C/A, Dhaka, Bangladesh.	05 – 09 – 2019 06.00 pm – 07.00 pm	14
		Total	**26**

FGD OUTCOMES:

General Opinion of the Participants regarding the proposed RAJUK URU project:

- Before interacting with the EIA team in the field, most participants have not heard about the proposed RAJUK URU project at their locality which indicates that proper information has not yet been disseminated to them by RAJUK.
- After hearing about the URU project details most participants expressed their supportive attitude for the proposed URU project at Mohakhali RAJUK Plot with minor concerns such as road traffic congestion issues, disposal of excavated soil on road during transportation, etc.
- Most participants opined that the proposed RAJUK URU project will be increase institutional strength by the creation of a new organizational unit within RAJUK, develop competency related to urban resilience such as risk assessment, earthquake engineering, construction standards at in-situ and laboratory construction material testing, specialized construction training, and risk-sensitive land use planning, etc.
- Some participants suggested that the proposed URU building related activities should be completed on time to get relief of multi-dimensional problems that might be arise for construction of URU high rise building at their localities.
- Some participants recommended to carry out cost-benefit analysis before starting this project.
- Some participants opined that big initiative (e.g. URU project) could impact few PAPs for short or long term, but entire community at Dhaka City will get more benefits for long time.
- Most participants opined that URU building will be a Model Building in Dhaka city which will influence / enhance interest to other proponents to build up similar types of buildings.
- Most participants commented that relevant authority should immediately start action for completion of URU project in time.

Opinion of the participants on Potential Impacts for the proposed RAJUK URU Project

- All participants were happy to know that one fourth of the entire land will be used for the proposed URU building and remaining land will be kept as open space that will create healthy environment for the local community - a positive environmental impact.
- The narrow road that exists in the eastern side the proposed plot will be widen enough for vehicle movement which could also be used by the Titumir College student to enter into their hostel that exist behind this plot.
- Participants expressed their concern regarding the excavated soil management during construction and transportation; in most cases, disposal of soil on the paved road creates problems (e.g. accidents, dirty cloths, etc.) to the people who use the roads. Moreover, soil excavation through heavy equipment may create land slide in the adjacent plots if proper initiatives have not taken.
- Participants expressed their concern regarding the sound pollution that might be created for use of heavy construction equipment. Nearby educational institutions, commercial institutions, residential buildings, etc. might be affected most.
- Stockpile of construction materials on the road will create adverse impacts to the local people (e.g. road traffic, hinder of free movement & food / commodity supply to shops, etc.).
- During rush hours, vehicles with heavy machinery for URU project may enhance the existing road traffic.

- During construction, dust might be created due to various types of project activities, and air pollution might be occurred that will create health problems to the people especially the children and aged people.
- Existing flora, inside the proposed plot / land, already created an urban ecosystem where some fauna stay, may need to uproot; cutting of these floras will destroy that ecosystem forever.
- Participants expressed their concern regarding the waste management and labor sanitation issues; in most cases, the project proponent manage it unprofessional way that create multiple problems, and local community suffer a lot for such type of poor management action.
- Participants expressed their concern regarding the use of poor-quality materials and other items (e.g. electric wire, switch, etc.) in the building that may create fire hazard and also short- lasting building and / or its components (e.g. glass, window, etc.).
- Participants expressed their concern regarding the use of jute cover during high rise building construction; spark during welding might fire the jute cover which will invite fire hazard.

Participants' Expectation from the RAJUK URU Project

- Participants suggested that RAJUK should ensure that all criteria for a Green Building or LEED Certified Building should be satisfied, so that, it could be an iconic building / project in the city / country.
- RAJUK should use sustainable materials in the URU building project.
- Ensure proper ventilation for air flow; otherwise, it will create problem to the hostel students.
- Ensure implementation of modern technique to prevent dust / air pollution that might be occurs for high rise building construction activities; also ensure safety measures to prevent health hazard by air pollution.
- Ensure proper management of excavated soil as well as monitoring of it during transportation through paved road.
- Ensure use of modern techniques to prevent adjacent land slide during high rise building construction.
- Ensure enough space inside the URU project site for vehicle movement easily, and also allocate space for more car parking.
- Ensure basement work of high- rise building construction during non-rainy season to avoid land slide and also complete the work within the short time frame.
- Ensure no noise pollution from the testing equipment during operation phase of this project.
- Ensure non-use of jute cover in the outer side of the under-construction building which will help to prevent fire hazard during welding activities.
- Ensure use of earthquake resistance materials as well as technique during design and implementation of the project.
- Ensure use of fire proof materials for safety of URU building,
- Ensure use of modern equipment and materials for electric system of the URU building.
- Ensure use of solar panel & light, and also keep space to enter enough light in the URU building, naturally.
- Ensure enough water in the water reservoir or other places which could be use as water source during fire hazard.
- Ensure wide road for easy movement of large fire service vehicle in the URU premises during fire hazard. Also arrange fire drill program twice a year.
- Ensure plantation of native tree to enhance the esthetic value and balance of existing urban ecosystem.

- Ensure muster point that could use for head count during fire hazard; also keep the roof open always (no lock) as well as lift that could use to enter into the roof during fire hazard.
- Ensure a fire safety team in the URU building who will work to prevent fire.
- Ensure proper waste management that will occur during construction and operation phases of URU building.
- Ensure use of appropriate sign in different places for various purposes during construction and operation periods.

OUTCOMES OF KII

Four Key Informant Interview (KII) sessions have been organized for the proposed RAJUK URU construction project by involving officials of some relevant Governmental institutions.

(i) Dhaka Water Supply and Sewerage Authority (DWASA): **Engr. Mohammad Akhtaruzzaman**, Additional Chief Engineer, Project Director, Dhaka Water Supply Network Improvement Project, Dhaka Water Supply and Sewerage Authority (DWASA), WASA Bhaban (8th Floor), 98 Kazi Nazrul Islam Avenue, Kawran Bazar, Dhaka 1215, Bangladesh,

- Already aware of the URU project implemented by RAJUK.
- DWASA could be a co-partner for this URU building construction project.
- DWASA could play an active role during fire hazard as well as supply of water for various purposes.
- Traffic management, during construction and operation phases, will be a big challenge. Project related vehicles, especially the material carrying vehicles during construction, may create problem in the road where heavy traffic exist almost the whole day.
- Management of Stockpile of materials on road, if needed, will be a challenge, because, it will create problems to the local community with many dimensions (e.g. hinder of free movement, accident, traffic, etc.).
- Delay of planned work will also be a matter of annoyance of local community, because, more delay of work means more sufferings of local community with various dimensions.
- Use of modern techniques with modern equipment and active supervision & monitoring could help to resolve the challenges.
- Ensure enforcement of proper traffic management on the site / adjacent areas; involve local traffic police for such type of activities.
- Avoid stockpile of materials on road, use mid-night to morning period for vehicle that will carry materials to the project site.
- Ensure timely completion of the project activities.

(ii) Dhaka North City Corporation (DNCC): **Engr. Khondoker Mahbub Alam**, Superintending Engineer (Civil Circle), Dhaka North City Corporation (DNCC), House No # 23 – 26 Gulshan Center Point (Level 9), Road No # 46, Gulshan 2, Dhaka 1212

- Well informed of the URU project including RAJUK URU part.
- DNCC have a partnership of the URU project.
- Challenges are:
    - Narrow roads in the project area may be a challenge for transportation vehicles during construction & operation of the URU buildings.

- Road divider on the main road may need to open temporarily for vehicle movement freely; need early communication with traffic police department, ward councilor and local community.
- Lack of disaster shed during natural calamities (e.g. earth quack) as well as access to the URU building (narrow road).

- Mitigation measures are:
  - Ensure widening of road to enter URU building for various purposes.
  - Ensure disaster shed for all victims.
  - Ensure the URU building entrance road free always.

(iii) Department of Disaster Management (DDM): **Md. Abdul Mannan**, Deputy Secretary and Project Director, Urban Resilience Project (DDM Part), Department of Disaster Management, Ministry of Disaster Management and Relief, GoB, House No # 121, Road No # 21, DOHS, Mohakhali, Dhaka 1212

- Already heard about the RAJUK URU building construction project
- DDM have a component on the URU project.
- Challenges are:
  - Dead lock zone due to heavy road traffic. RAJUK URU building construction will face some challenges during construction (e.g. road traffic) and also can't provide proper service during operation due to access to the URU building via existing narrow road.
  - Poor plan for construction of two buildings (10+2 storied and 22+4 storied). Can't provide full service during disaster due to shortage of manpower, access to enter into the URU building through narrow road, etc.
- Mitigation measures are:
  - Ensure widening of existing narrow road
  - Ensure permission from civil aviation for construction of high rise building.
  - Ensure proper traffic management for free movement into the URU building, especially during disaster time.
  - Ensure enough manpower to combat with the disaster.
  - Ensure RAJUK URU building as a single command center for disaster and other calamities management.
  - Illegal approach by nearby community for RAJUK URU building project should resolve immediately; otherwise, engage engineering & management sections of Bangladesh Army.

(iv) Dhaka Metropolitan Police (DMP):**B. M. Forman Ali**, Office in Charge, Banani Police Station, Dhaka Metropolitan Police

- Have not yet heard about the entire component of URU project or RAJUK URU building construction project at Mohakhali.
- Can provide support during construction and operation phases, if RAJUK need any help
- Challenges are:
  - Involvement of local people for smooth construction and operation of RAJUK URU building.
  - Material transportation via main road at day time will delay the work and may causes traffic congestion.
- Mitigation measures are:
  - Ensure road traffic management via police traffic department.
  - Ensure engagement of police for security and safety.
  - Ensure night shift movement for material and equipment carrying vehicles through main road.

GRIEVANCE REDRESS MECHANISM

A Grievance Redress Mechanism (GRM) is a salient feature of a project to receive and facilitate resolution of complainants (project affected people, local community and workers) concerns and grievances regarding the project's performance in the constructional and operational phases. There can be a range of issues arising during a project phase. Such as, Compensation payment, or Failure to fulfill commitments, Poor management of construction activities, Accidents during construction or due to inappropriate planning of vehicle movement, Cultural and social conflicts between workers and local communities, Disturbance due to excessive noise or other nuisance during construction or operation and unfair treatment to workers or unsafe working conditions, etc.

*Procedure for GRM:*The project proponent should ensure that procedures for lodging and registering of grievances are in place. The procedures for GRM should comprise of identifying the personnel (Grievance officer) who will be responsible for receiving and addressing the grievances and handle the cases at the escalation level.

Publicizing GRM: Once the procedures for Grievance Mechanism have been developed, it should be publicized through various stakeholder engagement activities. Various communicative methods can be adopted in disseminating the information like printed materials, displays, face to face meetings, etc. The grievance redress mechanism (GRM) shall be documented in English and Bangla and copies shall be kept at the project site office and the Head Office.

*Recording of Grievances:*There should be arrangement for collecting complaints in a grievance box. A Grievance Log or database emphasizing the records and status of the grievance is to be maintained by the identified Grievance Officer and track them throughout the redress process to reflect on their status and important details.

Appeal and Follow-up: If the solution is not acceptable or agreed by the complainant, the complainant should be offered to an appeal process. The accountability and transparency should be maintained in every step of the process.

Proposed GRM for the Project

The proposed GRM for the RAJUK-URU project is presented below with time bound schedules and specific persons to address grievances.

Grievance Redress Committee (GRC)

There should be a Grievance Redress Committee (GRC) comprising of:

- Site Supervisor
- EHS Manager
- Admin Officer (Grievance Officer) and
- Safety Officer

Functions of GRC:

- To provide support to affected communities/persons on problems arising from environmental or social impacts;
- To record grievances of the affected community by categorizing and prioritizing them
- To provide solutions within a stipulated time period; and
- To report to the aggrieved parties, developments regarding their grievances and decisions of the GRC.

After receiving a complaint it has to be registered by the GRC and addressed following the flowchart below (Figure E-11).

Figure E-11: Flow chart of Grievance Redress Mechanism Process

ENVIRONMENTAL MANAGEMENT PLAN

Mitigation Measures

Construction Phase

The mitigation measures corresponding to specific adverse impacts during construction phase, along with assignment of responsibilities for their implementation has been detailed out in Table E-15. The measures proposed are aimed at minimizing the effects of the possible adverse impacts and enhancing the positive impacts. It is evident that most of the adverse impacts could be minimized or even removed if appropriate mitigation measures are taken. Besides this, construction of a high-rise building entails a requirement for providing uttermost safety for workers involved. Worker health can also be adversely affected at various stages of the construction due to challenging working conditions. In addition, during the Phase I and II construction process. This may require deep excavation over a large area of the project site. Shore protection using shore-piles or open cut methodor any other method approved by the BNBC should be appropriately followed. It is imperative that the contractor follows the workers safety protocol during entire construction phase including deep excavation as well as superstructure construction.

For this an occupational health and safety guideline has been developed and incorporated in the main report. The project director and contractor are advised to consult relevant sections of the occupational health and safety guideline as applicable for a certain situation.

Operational Phase

At the operational phase, RAJUK will be responsible for the operation and maintenance of the URU building and ancillary facilities. No significant air and noise pollution is expected from during the operation phase. The important issues to be addressed during the operational phase include: (i) impact of additional volume of traffic to be generated during office hours, (ii) generation of solid waste and their disposal, (iii) generation of domestic wastewater from the building, (iv) power generation using a generator and (v) fire safety, natural disaster and risk management (Table E-16).

Table E-15: Potentially significant environmental impacts during construction phase and mitigation measures

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Removal of Existing structures/equipment	• Impediment to proposed construction work	• All concrete structures/ equipment in the proposed area to be dismantled as per BNBC guideline and sold before construction starts.	Contractor (Monitoring by RAJUK)
Removal of utilities such as electricity line, gas connection, telephone connection, water supply and sewerage pipelines in the existing one-storied Tin-shed building	• Impediment to proposed construction work	• Necessary planning and coordination with concerned authorities (DPDC, Titas Gas, DWASA, DNCC). Prior to start of construction, all utilities should be shifted with the consultation of relevant authorities. Proper health and safety measures for the workers should be taken during shifting of the utilities to avoid any accidents.	Contractor will implement (RAJUK will coordinate with relevant authorities)
Cutting down of 33 nos. of trees, Clearing of vegetation	• Loss of local flora and fauna	• Re-plantation of trees (66 nos, as same species as fallen down and other species i.e. wooden, fruit, herbal) in and around the building premises. • Ensure re-vegetation and/ or grass turf when soil is exposed/ disturbed.	Contractor (Monitoring by RAJUK)
Influx of workers	• Generation of sewage waste; • Generation of solid waste; • Water, soil, air & dust pollution/ environmental pollution	• Construction camp should be located at the site proposed by the contractor & approved by the Environmental Specialist of DSC. • Construction of sanitary latrine/ Pit latrine with septic tank/ Ring slab system, (separate latrines for male and female workers) • Erection of “no litter” sign, • Open areas/ surrounding bushes are not being used as toilet facility. • Provision of waste bins/ cans, where appropriate, • Litter is to be collected daily. • Bins and/or skips should be emptied regularly and waste/ debris should be disposed of at waste disposal areas and/ or at the site pre-approved by Environmental Specialist of DSC. • Camp and working areas are kept clean and tidy at all times. • Camp is to be checked for spills of substances i.e. chemical, oil, paint, etc.	Contractor (Monitoring by RAJUK)
	• Possible spread of disease from workers	• Clean bill of health a condition for employment • Regular medical monitoring of workers • Raising awareness about hygiene practices among workers • Provision of safe water for all workers	
	• Outside labor force causing negative impact on social well-being of local people.	• Contractor to employ local work force, where appropriate;	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Transportation of equipment, materials and personnel; storage of materials	• Increased traffic • Generation of noise, especially affecting the nearby offices and residential areas	• Scheduling of deliveries after regular office or school working hours • Installation of proper traffic sign and warnings for pedestrians • Depute flagman for traffic control • Arrange for signal light at night	Contractor (Monitoring by RAJUK)
	• Deterioration of air quality from increased vehicular movement, construction activities	• Ensure that all project vehicles are in good operating condition • Spray water on dry surfaces/ unpaved roads regularly reduce dust generation • Maintain adequate moisture content of soil during transportation, compaction and handling • Not using equipment such as stone crushers at site, which produce significant amount of particulate matter	
	• Wind-blown dust from material (e.g., fine aggregate) storage areas	• Watering unpaved/dusty roads (at least twice a day; cost estimate provided) • Sprinkle and cover stockpiles of loose materials (e.g., fine aggregates). • Covering top of trucks carrying materials to the site and carrying construction debris away from the site • Materials storage area must be cleaned after completion of construction.	
	• Security of machine and materials, crime and vandalism	• Proper fencing around the storage area in order to be secure, to minimize the risk of crime and to be safe from access by passersby, animals, etc.	
	• Spillage of liquid/ hazardous substances i.e. oil, paint, chemicals, bitumen etc.	• spills/ hazardous substances should be disposed of at the site proposed by the contractor & approved by the Environmental Specialist of DSC to avoid soil/ water contamination.	
Construction activities, including excavation, operation of construction equipment etc.	• Generation of noise from construction activities (general plant and access road construction), especially affecting the nearby school and residential areas	• Maintain all vehicles in order to keep them in good working order in accordance with manufacturers maintenance procedures. • Make sure all drivers will comply with the traffic codes concerning maximum speed limit, driving hours, etc. (20 km/hr during night time). • Organize the loading and unloading of trucks, and handling operations for the purpose of minimizing construction noise on the work site. • Modify equipment to reduce noise (for example, noise control kits, lining of truck trays or pipelines, silencers). • Maintain all equipment in order to keep it in good working	Contractor (Monitoring by RAJUK)

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		conditions in accordance with manufacturers‟ maintenance procedures. Equipment suppliers and contractors shall present proof of maintenance register of their equipment. • Install acoustic enclosures around generators to reduce noise levels. • Fit high efficiency mufflers to appropriate construction equipment. • Avoid the unnecessary use of alarms, horns and sirens. • Notify adjacent landholders prior of any typical noise events outside of daylight hours. • Plan activities on site and deliveries to and from site to minimize impact. • Monitor and analyze noise and vibration results and adjust construction practices as required. • Avoid undertaking the noisiest activities, where possible, when working at night near the residential areas.	Contractor (Monitoring by RAJUK)
	• Air/Dust pollution	• Maintain construction vehicles and equipment in good working condition including regular servicing. • Operate the construction vehicles in a fuel-efficient manner. • Cover hauls vehicles carrying dusty materials moving outside the construction site. • Impose speed limits (maximum 10 km/hr) on all vehicle movement at the worksite and through access roads to reduce dust emissions. • Control the movement of construction vehicles in the access road (during night from 22:00 to 6:00). • Water spray to the construction materials or cover (especially sand and boulders/brick chips) prior to loading and transport. • Focus special attention on containing the emissions from generators. • Equipment/vehicles causing excess pollution (e.g. visible smoke) should be banned from construction sites or fixed immediately prior to further usage. • Provide filtering systems, dust collectors or humidification or other techniques (as applicable) to the concrete mixing plant to control the particle emissions at all its stages, including unloading, collection, aggregate handling, cement dumping, circulation of trucks and machinery inside the installations. • Water spray to the material stockpiles as and when required to minimize the potential environmental nuisance due to dust.	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		• Increase the watering frequency during periods of high risk (e.g. high winds and dry periods). Stored materials such as boulders and sand should be covered and confined to avoid them being wind-drifted. • Erect dust barriers along the boundary of the construction area to reduce dust movement to the surrounding areas. • Reschedule earthwork activities when practical, if necessary to avoid during periods of high wind and if visible dust is blowing off-site. • Restore disturbed areas as soon as possible by vegetation/grass-turfing. • Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust dispersion is prevented because of such operations. • Using equipment, especially generators with high levels of emission control (e.g., TIER-4). • Immediate disposal/sale of excavated materials	
	• Generation of construction waste	• Organize disposal of all wastes generated during construction in an environmentally acceptable manner. This will include consideration of the nature and location of disposal site, so as to cause less offsite environmental impacts. The disposal site should be approved by RAJUK prior to usage and should be rehabilitated after usage to ensure the land is not exposed to soil erosion, wind and water stagnation. • Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach. • Segregate and reuse or recycle all the wastes, wherever practical. • Train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process. • Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal by Dhaka North City Corporation (DNCC). • Ensure proper collection and disposal of all wastes within the construction camps from where DNCC will take by their truck and dispose of at their dumping area at Aminbazar. • Insist on waste separation and store by source; organic wastes, inorganic wastes and recyclables in separate containers.	Contractor (Monitoring by RAJUK)

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		• Clear wastes on daily basis to waste collectors. Establish waste collection, transportation and disposal at the dumping site in adequate sizes of concrete chambers/boxes. • Dispose organic wastes in a designated safe place and should be kept covered so that flies, mosquitoes, dogs, cats, rats, etc. are not attracted. Encourage composting of organic waste that can be used for tree planting purposes. • Locate the garbage pit/waste disposal site away from the residence so that peoples are not disturbed with the odor likely to be produced from anaerobic decomposition of wastes at the waste dumping places. Encompass the waste dumping place by fencing and tree plantation to prevent children from entering and playing. • Do not establish site specific dumpsites. All solid waste will be collected and removed from the work camps and disposed in approved waste disposal sites.	
	• Occupational health and safety risk	• Provide the workers a safe and healthy work environment, taking into account inherent risks of this particular construction activity and specific classes of hazards in the work areas, provide necessary trainings. Special attention to be given during deep excavation of a large part of the project site for two basements. Adequate shore protection measures to be ensured according to BNBC to ensure workers safety. • Provide personal protection equipment (PPE) for workers, such as safety shoes, helmets, masks, gloves, protective clothing, goggles, safety belt for working at height and ear protection. Maintain the PPE properly by cleaning dirty ones and replacing them with the damaged ones. • Safety procedures include provision of information, training and protective clothing to workers involved in hazardous operations and proper performance of their job. • Appoint an environment, health and safety manager to look after the health and safety of the workers. • Not hire children of less than 14 years of age and pregnant women or women who delivered a child within 8 preceding weeks, in accordance with the Bangladesh Labor Code, 2006 • Provide health care facilities and first aid facilities are readily available. Appropriately equipped first-aid stations shall be easily accessible throughout the place of work • Document and report occupational accidents, diseases, and	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		incidents and actions taken. • Prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards in a manner consistent with good international industry practice. • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. • Provide awareness to the construction drivers to strictly follow the driving rules. • Provide adequate lighting in the construction area and along the roads. • Adequate ventilation in all facilities. • Provide plastic net and others appropriate H&S measures surrounding the buildings to avoid accidents. • Provide safe and reliable water for drinking • Hygienic sanitary facilities and sewerage system. • Carry out regular mosquito repellant spraying during monsoon periods. • Provide ambulance facility for the laborers to be transported to nearest hospitals during an emergency. Train all construction workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work. • Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. • Provide appropriate security personnel (home guard/private security guards) and enclosures to prevent unauthorized entry into the camp area.	
	• Spills and leaks leading to soil and water contamination	• Train the relevant construction personnel in handling of fuels and spill control procedures. • Refueling shall occur only within enclosed areas. • Provide PPE such as protective clothing, safety shoes, helmets, masks and hand gloves to the construction personnel, to handle construction materials. • Make sure all containers and drums that are used for storage are in good condition and are labeled with expiry date. Any container, drum that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur.	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		• Put containers and drums in permanent storage areas on an impermeable floor. • Ensure basic firefighting equipment is in place outside these storage areas in case of a fire.	
	• Employment of work/labor force	• Local people should be employed in the project activities as much as possible. • Employ people living in slums for excavation-related works which does not require skilled manpower • Promote supply from local suppliers	
	• If cultural resources or archeological resources are found during excavation (buried Physical Cultural Resources)	• Inform the department of archeology and other concerned authorities and take steps to secure and preserve the artifact as per their instructions (follow the World Bank guidelines for handling buried PCR as detailed in Annex E)	
	• Drainage congestion, water logging and flooding	• Temporary drainage congestion (TDC) in the foundation trench due to rainwater to be removed by pumping. Avoid monsoon period for foundation works. • TDC in construction yard and camp of the proposed building area to be removed by temporary earth or RCC drains. • All rainwater, storm water waste water etc. should be drain out via sewerage pipelines of DWASA.	
	• Water and Soil Pollution	• Forbid discharge of fuel, lubricants, chemicals, and wastes into surface waters or on land. • Adopt proper disposal techniques for any hazardous waste Install sediment basins to trap sediments in storm water prior to discharge to surface water. • Replant vegetation when soils have been exposed or disturbed.	
	• Traffic Congestion	• Prepare and submit a traffic management plan to the PIU for approval at least 30 days before commencing work on project component involving traffic diversion and management. • Include measures in the traffic management plan to ensure uninterrupted traffic movement during construction: access roads, necessary barricades, warning signs / lights, road signs, etc. • Provide signs at strategic locations of the roads complying with the schedules of signs contained in the Bangladesh Road Traffic Regulations of BRTA. • Restrict truck deliveries to day time working hours (as common practice in Dhaka) to avoid road accidents and to reduce inconveniences to the road users. • Operate construction vehicles to non-peak periods (night) to	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		minimize traffic disruptions. • Enforce on-site and access road speed limits.	
Activities related to RAJUK tower entry road construction, setting up asphalt plant and bitumen preparation area	• Air and noise pollution affecting nearby settlements and office areas	• Locate plant away from office area. • Consider the use of emulsified bitumen	Contractor (monitoring by RAJUK)
	• Possible water pollution by bitumen solvents	• Avoid spills; surround plant area with a ditch with a settling pond/oil trap at the outlet	
	• Cutting down trees to use it as a fuel wood for heating bitumen	• Strictly prohibit the use of wood as fuel for heating the bitumen	
	• Effect of traffic and pedestrian movement	• Employ traffic control measures and limit possible disruption to non-construction traffic • Contractors and workers should wear high visibility safety apparel while working in public right of way. • Signposts and directional signs should be provided at appropriate locations for pedestrians and traffic at construction site.	

Table E-16: Potentially significant impacts during operation phase and mitigation measures

Activity/ Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Operation of road	• Increased traffic congestion due to increased number of vehicles	• Better traffic management following the recommendations of the traffic impact assessment	RAJUK to coordinate with local traffic police
Waste generation from building	• Generation of sewage, if untreated can cause environmental pollution • Generation of solid waste • Blockage of drain due to disposal of solid waste • Possible water pollution of downstream water body due to disposal of polluted water from drain	• Ensuring proper storage, treatment, and disposal of all solid waste • Prohibit direct connection of any sanitation facilities to the stormwater drains. Septic tank needs to be installed in the establishment which will be connected to the local sewage network. Construction of septic tank will lower the pollution load to local sewage system. Septic tank should be desludged regularly. • Designing and sizing the drains appropriately to convey the estimated quantity of stormwater and/or treated sewage • Regular maintenance and cleaning of the drain	RAJUK
Power generation (generator)	• Generation of noise and associated health hazard	• Generator should be located in an area in the building which is isolated by noise-proof barriers • Ensure wearing of personal protective equipment for staff working in the generator area	RAJUK
	• Hazards associated with handling of fuel (for diesel generators), spills and leaks	• Good house keeping • Proper handling of lubricating oil and fuel • Collection, proper treatment, and disposal of spills	
	• GHG gas emission from diesel generators	• Use the latest model of generator having the best technology for GHG emission reduction • Regularly monitoring GHG from the exhaust of generators to detect any faulty operation	

Environmental Management Plan

The EMP should clearly lay out: (a) the measures to be taken during both construction and operation phases of the project to eliminate or offset adverse environmental impacts, or reduce them to acceptable levels; (b) the actions needed to implement these measures; and (c) a monitoring plan to assess the effectiveness of the mitigation measures employed. Environmental management and monitoring activities for the proposed RAJUK tower project could be divided into management and monitoring: (a) during construction phase, and (b) during operation phase.

The environmental management program should be carried out as an integrated part of the project planning and execution.For this purpose, it is recommended that the Project Director (PD) of the Project Management Unit (PMU) for this specific project takes the overall responsibility of environmental management and monitoring. The PD will form an Environmental Management Unit (EMU) with required manpower and expertise to ensure proper environmental monitoring, and to take appropriate

measures (as outlined in the above Tables) to mitigate any adverse impact and to enhance beneficial impacts, resulting from the project activities. The PD through its team will make sure that the Contractor undertake and implement appropriate measures as stipulated in the contract document, or as directed by the PD to ensure proper environmental management of the project activities.

Environmental Monitoring Plan

The primary objective of the environmental monitoring is to record environmental impacts resulting from the project activities and to ensure implementation of the "mitigation measures" identified earlier in order to reduce adverse impacts and reduce negative impacts from specific project activities. In addition, monitoring plan should also include regular reviews of the impacts that cannot be adequately assessed before the start of the works, or which arise unexpectedly, along with appropriate measures to mitigate any negative impacts and/or enhancing beneficial impacts.

The monitoring plan for the construction and operational phases of the project have been detailed out in Tables E-17 and E-18. It should be noted that in addition to the parameters depicted in the tables the measured noise levels should conform to the national ambient noise level standards for different areas (residential, silent zone etc.) as applicable. Noise level during construction activities should be within the limits of exposure prescribed in the OSHA guidelines. The measured air quality should be within the limits of the national ambient air quality standards for particulate matters in the air.

Cost of Environmental Monitoring

Table E-19 shows the preliminary cost estimates for monitoring activities during construction assuming the duration of construction to be 18-month. The responsibility of monitoring is by the contractor and the contractor has to bear the cost. The Contractor will appoint a dedicated environmental health and safety (EHS) officer in order to oversee the mitigation activities carried out during construction and prepare/compile quarterly monitoring reports.

Table E-17: Monitoring plan during construction phase of the proposed RAJUK tower project

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
Noise Level (ambient)	Baseline One set of measurements at property boundaries of selected locations (offices, residential areas.) prior to commencing construction activities Several set of measurements at the same locations during construction activities	Equivalent Noise level (Leq) with GPS location, wind speed and direction	Monthly and as directed by the Project Director; Contractor's Responsibility	Noise level meter, GPS;
Noise Level (personal exposure)	Workers working area (near equipment)	Equivalent Noise level (Leq) calculated over extended period monitoring	Monthly and as directed by the Project Director; Contractor's Responsibility	Noise level meter
Air Quality (dust particles/ particulate matter)	Baseline One set of measurements at selected locations downwind of site activities (prior to commencement of work) and in close proximity to human receptors One set of measurements at selected locations downwind of site activities (during construction activities) and in close proximity to human receptors	SPM, PM_{10} with GPS location, wind speed and direction	Monthly and as directed by the Project Director; Contractor's responsibility	Particulate matter sampling device, GPS Wind speed/direction data to be collected from local BMD station
Surface Water Quality	Baseline: One measurement from the nearest surface water body (Banani Lake) One measurement from the nearest surface water body (Banani Lake) during construction activities	Turbidity, Total Suspended Solids, BOD_5, Dissolved Oxygen	Monthly or as directed by the Project Director; Contractor's responsibility	Laboratory facilities for water/ wastewater analysis
General site condition	Baseline: Visual survey (once) of proposed RAJUK tower site prior to commencement of construction Visual survey of the construction site during the entire period of construction	General site condition, traffic condition, pedestrian movement, vegetation clearance etc. by visual survey (photographs)	Weekly and as directed by the Project team leader; Contractor's responsibility	Digital camera
House-keeping activities	Visual survey of the construction site during the entire period of construction	Construction debris management, traffic management, management of flammable materials (if any), use of PPE by workers, all parameters related occupational health and safety etc.	Weekly and as directed by the Project Director; Contractor's responsibility	Digital camera

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
Drinking water quality for workers	DWASA supplied water and/or bottled water supplied to workers for drinking should be tested	pH, color, turbidity, total hardness, chloride, Total and Fecal coliform, Total Dissolved Solids, Arsenic, Iron, Manganese, Electrical Conductivity (salinity), Free Chlorine	Monthly and as directed by the Project Director; Contractor's responsibility	Laboratory facilities for water/ wastewater analysis

Note: Actual monitoring time and location will be decided by the Project Director

Table E-18: Monitoring plan during operational phase of proposed RAJUK tower project

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
Air Quality (dust particles and gaseous compounds)	Stack of power generator	CO, SO_X, NO_X, PM_{10}, SPM	Monthly or as directed by the Project Director; RAJUK's responsibility	Portable gas analyzer
Noise level	Sensitive receptors within and around the building to monitor noise due to generator emissions	Equivalent Noise level (Leq)	Monthly or as directed by the Project Director; RAJUK's responsibility	Noise level meter
Water Quality for drinking purpose	Should be measured each month after treating DWASA-supplied water or Rainwater for water supply purpose	pH, color, turbidity, total hardness, chloride, Total and Fecal coliform, Total Dissolved Solids, Arsenic, Iron, Manganese, Electrical Conductivity (salinity), Free Chlorine	Monthly or as directed by the Project Director; RAJUK's responsibility	Laboratory facilities for water/ wastewater analysis
Visual and aesthetics	Visual survey (through photographs) of the construction site over a period of one year after the tower has become operational for its intended purpose	Growth of vegetation or planted trees in the previously cleared area, presence of redundant construction materials in and around the site	Monthly and as directed by the Project Director; RAJUK's responsibility	Digital camera
Sanitary inspection and Septic tank desludging	Sanitary inspection and maintenance of all manholes, septic tank desludging	Routine maintenance	Once a year, RAJUK's responsibility to contract the relevant personnel	-

Note: Actual monitoring time and location will be decided by the Project Director

Table E-19: Preliminary cost estimates for monitoring and mitigation activities during construction phase

Parameter/Activity	Frequency of activity	Cost in BDT (per month)	Cost in BDT (18 months)
Particulate Matter (PM_{10}, $PM_{2.5}$)	Once every month	40,000/- per each set of PM_{10} and $PM_{2.5}$ measurement	7,20,000/-
Noise Level (ambient and personal exposure)	Once every month (day and night)	40,000/- (per set of measurement)	7,20,000/-
Surface water quality (parameters: Turbidity, Total Suspended Solids, BOD_5, Dissolved Oxygen)	1 measurement before starting construction, then in each subsequent month	Tk. 10,000/- (per set of measurement)	1,90,000/-
Drinking water quality testing: pH, color, turbidity, total hardness, chloride, Total and Fecal coliform, Total Dissolved Solids, Arsenic, Iron, Manganese, Electrical Conductivity (salinity), Free Chlorine	Monthly	Tk. 20,000/- per set of measurement	3,60,000/-
Site Cleaning and preparation including dismantling of structures, removal and safe disposal of debris, providing necessary protective fencing and safety measures with sign boards.	Periodic	Lump sum	8,00,000/-
Vegetation & Tree plantation around the site including fencing/ conservation/ maintenance for 2 years Total 30 nos. of trees need to be replanted around the periphery of the proposed site at an interval of 10 feet @ Tk. 1500 for each tree.	Periodic	Lump sum	45,000/-
Providing safety gear package like hand gloves, eye protection glasses, helmets, rubber shoes, light reflecting dress etc. for 40 sets @ Tk. 10,000 for each set	-	Lump sum	4,00,000/-
Drinking water container for workers including necessary ceramic filters for providing drinkable water	-	Lump sum	1,00,000/-
Temporary Sanitary Latrine/ Septic Tank/ Portable Toilet: 2 nos. (1 no of Toilet for female and 1 no of Toilet for male) @Tk. 50,000	-	Lump sum	1,00,000/-
Waste disposal charge from site by outsourced cleaners	Daily or weekly collection of solidwaste	20,000/-	3,60,000/-
Dust suppression measures like water sprinkling on aggregates/ unpaved roads, in and around the work site (Lump Sum). For road construction works cost of this item has been mentioned in road section.	Daily or weekly activities	Lump sum	3,60,000/-
Health and safety warning sign	-	Lump sum	20,000/-
Appointment of an Environmental Health and Safety officer for Environmental and Social Management and Monitoring during construction (salaried position)	-	50,000/-	9,00,000/-
Total			47,15,000/-

Notes: (1) The estimated costs for particular matter (PM) and noise level measurements as well as laboratory analysis for water samples are based on current rates charged by BRTC, BUET and the rates may vary. (2) During the construction phase, some monitoring may be carried out by the PMU through its own staff and equipment, if available, or can be out-sourced to a competent Contractor. Equipment for monitoring such as digital camera, sound level meter, GPS etc. may be purchased by RAJUK.

Table E-20 shows the preliminary cost estimates for monitoring activities during operation phase of the project. This shows the cost estimate per month which will continue throughout the life-cycle of the building. The responsibility of this monitoring lies on RAJUK and this cost should be budgeted in the annual maintenance budget of RAJUK.

Table E-20: Preliminary cost estimates for monitoring and mitigation activities during operational phase

Parameter/Activity	Frequency of activity	Cost estimate (per month)
CO, SO_X, NO_X, PM_{10}, SPM for generator stack emission	Monthly	Tk. 40,000/-
Treated water for drinking: pH, color, turbidity, total hardness, chloride, Total and Fecal coliform, Total Dissolved Solids, Arsenic, Iron, Manganese, Electrical Conductivity (salinity), Free Chlorine	Monthly	Tk. 20,000/-
Noise level monitoring at surrounding areas (nearby residential and college areas). Noise emissions from generator.	As and when required	RAJUK conducts monitoring and records positions by RAJUK-owned noise level meter and GPS (cost of standard noise level meter 50,000/- and GPS is 10,000/-)
Building solid waste management, recycling of wastes	Monthly	Tk. 10,000/-
Fire drills	Monthly	Contracted out to Fire Department or other competent contractors

Notes: The estimated costs for air emission and water quality analysis are based on current rates charged by BRTC, BUET for analysis of the parameters and the rates may vary. The monitoring may be out-sourced to a competent Contractor. Equipment for monitoring such as digital camera, sound level meter, GPS etc. may be purchased by RAJUK.

OCCUPATIONAL HEALTH AND SAFETY PLAN

An overview of the potential occupational health and safety risks due to the proposed project has been presented. It defines the various risks involved during both the construction and operation phase of the project and develops an Occupational Health and Safety plan (OHSP). The objectives of OHS Plan are:

- To develop, in the workplace, a collaborative approach to managing Occupational Health and Safety between management and workers
- To identify work associated risk and hazard
- To provide and maintain safe working procedures and operations
- To ensure awareness of all potential work-related risks and hazards and to develop preventive strategies against these risks and hazard
- To define responsibilities to ensure effective implementation of health and safety
- To provide appropriate training to all concerned to work safely and effectively

To maintain a constant and continuing interest in the improvement of occupational health and safety performance and to provide the required resources necessary for the implementation and maintenance of the OHS plan. This OHSP is provided as a guidance document for identifying the potential risks involved during construction and operation phase of the project and reducing workplace injury and damage to property and environment in case of accidents and emergency.A brief list of work equipment safety issues during construction phase of the project is given in the main report.

Personal Protective Equipment (PPE) must be used by the workers and even by the visitors at the construction site to minimize the risk. A partial list of protective gears to be worn by the workers at designated work areas is given in the main report. The gears are for Head Protection, Hearing Protection, Eye and Face Protection, Respiratory Protection, Hand and Arm Protection, Foot Protection and Trunk, Abdomen and Body Protection.

Roles and Responsibilities

Site Supervisor

The Site Supervisor is responsible for overall management of the project and EMP implementation. The following tasks will fall within his/her responsibilities:

- Supervise the performance of the work being carried out within the project
- Monitor site activities on weekly basis for compliance
- Conduct internal audits of the construction site against the EMP
- Keeping a check on operation and maintenance services of solar project components
- Confine the construction site to the demarcated area

EHS Manager

The duties of an EHS Manager shall include the following:

- Ensure that the operations at the facility are in compliance with EHS requirements at all times
- Conducting Health and Safety Audits on a regular basis and advice management for necessary action
- Providing first aid facilities and personal protective equipment as required
- Recording all type of accidents and Reporting to Site Supervisor
- Training of workers and ensuring that they are issued with adequate instructions and creating awareness of safe work practice among them
- Carrying out Job Safety Analysis to determine“ Hazards of the operations/activity and facilitating suitable solutions
- Participate in the preparation of, all Safety instructions, procedures and activities

Safety Officer

The contractor will employ safety officer to maintain EHS at the project site. His roles are:

- identify potential hazards and potential major incidents
- review the effectiveness of health and safety measures
- inspect the site with a view to the health and safety of employees, at regular intervals
- participate in any internal health or safety audit
- ensure that the operations at the facility are in compliance with EHS requirements at all times

The client shall ensure the provision of necessary assistance, facilities and training to carry out the functions of a health and safety representatives established above

Employees/Workers

- Use the correct tools and equipment for the job
- use Safety equipment and protective equipment/clothing supplied, e.g. Safety helmets, shoes, harness, goggles, etc.
- Report all defects in plant or equipment to health and safety representatives

Training

The contractor should establish procedures to identify training needs and provide adequate safety training for all levels of employees. The safety training should provide staff with the knowledge and skills necessary for organizing and managing occupational safety and health programs; management should implement and apply occupational safety and health activities; and workers with the knowledge, skills and right attitudes to enable them to work safely (Table E-21).

Table E-21: Proposed Training Programs

Training	Frequency	Description	Responsibility
Induction Training on Health and Safety, covering • HSE Policy • Hazard and Risk associated with activities at work place • Control measures • Emergency response procedures such as fire-fighting, evacuation procedure, artificial resuscitation	Once in every three months	All staff and contractor workers at the time of joining/engagement	EHS Manager
Tool Box Training or pre-task briefings, highlighting hazards and the method of dealing with them	Once in every three months	Held at each work location by head of the contractor to discuss day's activities and specific hazards	Supervisor
Workers Safety Training	Once in every three months	Review safety performance for week Discuss safety for upcoming operations	Supervisor
Fire Safety and Fire Drill	Once in every month	Fire Safety measure and Fire Drill	EHS Manager
Emergency Response	Once in every two months	For emergency preparedness	EHS Manager
First Aid	Once in every three months	First Aid	EHS Manager

EMERGENCY PREPAREDNESS AND RESPONSE PLAN

The primary objective of developing an Emergency Preparedness and Response Plan is to undertake immediate rescue and necessary measures as quickly as possible. The response plan should include:

- Identification and declaration of potential emergencies
- Signal/warning mechanism
- Activities and their Levels
- Command and control structure
- Individual roles and responsibilities of each specified authority to achieve the activation as per response time
- Emergency procedures
- Alternate plans and contingency measures
- Coordination with External parties

Identification of Emergency

Identification of all the hazards and risks associated with each activity which may lead to an emergency and anticipate the actions to be taken before or after the emergency arises. This section identifies the hazardous areas and activities in both construction and operation phases. Probable emergencies that might arise due to these hazards for the duration of the project have been listed below:

Hazardous Area:The primary hazardous areas usually are Fuel storage areas, Kitchen premises in labor camps, Electrical installations - improper laying of cables, Scaffolds. The potentially hazardous areas and activities during project operations will be a storage area of broken panels, hazardous waste such as used oil, oily rags etc.

Emergency Situations:The possible emergency situations identified for the construction and operation phases of the Project areas are Fire and Explosion, Leakage of fuel from storage areas and Short-circuit at campsite/project site

Mechanical and Electrical Hazards: These type of hazards include Structural Collapse, Accidentally dropped object, Loss of stability andElectrocution.

Occupational Hazards: These include Outbreak of Disease / Illness, Handling of chemicals, Accidents due to vehicle movement andVandalism.

Emergency Equipment

To tackle the emergency situation, onsite emergency equipment such as first aid box, fire-fighting equipment and personal protective equipment shall be available at the project site. The adequacy and condition of these items should be assessment at periodic intervals. Inventory and locations of respective emergency equipment's shall be displayed at project office building, construction areas and other work areas; It is to be ensured that the staff of developer is trained on the usage of each type of emergency equipment First aid boxes shall be provided at identified locations throughout the plant premises. During the construction phase, fire extinguishers and sand buckets will be provided at critical areas such as fuel storage area, waste storage area, labor camps, kitchens, first aid center, areas with electrical installations and project office.

Emergency Response Team (ERT)

The Emergency Response Team (ERT) will be set up at the beginning of the construction phase and the same will be revised for the operation phase. Each personnel identified as part of the ERT shall be designated roles and responsibilities for handling emergency situations. The ERT will comprise of the Site Supervisor, EHS Manager, Safety Officer, Evacuation Officer and representative from workers/employees. The priority in managing emergency situation will be: Preservation of Life (self, team, community), Protection of the Environment, Protection or Property/assets, and Preservation of Evidence.

The Emergency Response Team should coordinate with external agencies such as Fire brigade, Police Department, Hospitals/Ambulance Services, Utility departments (electricity, gas and water) and local authorities.

Response Process

During the emergency situation such as fire, collapse of scaffolding, cave- in during excavation, etc., all personnel at site including the designated Evacuation officer must be immediately notified. The procedures to be followed during an emergency are provided in the main report. The task of the professional Emergency Services must not be obstructed.

Training, Reporting and Documentation

All site personnel, including contractors, are to be trained in the appropriate responses to possible emergencies and disasters. Training is to include, but not limited to Firefighting, First Aid, and Emergency Evacuation. Information on all emergency situation should be documented and reported to the proper authority.

CONCLUSIONS AND RECOMMENDATIONS

Construction of the RAJUK's Urban Resilience Unit (URU) building is a bold and timely initiative for Dhaka and the rapidly expanding urban center of Dhaka. Seismic assessment and resilience must be incorporated into urban development, especially of Dhaka City.The objective of the overall engagement is to develop a comprehensive approach to managing earthquake risk through a structured process of knowledge development, education, and planning that involves a wide range of stakeholders to increase engagement and ownership.

The building design, finalized on 02 July, 2019, includes Phase I: construction of a 10-storied building with 2 basements on the southern side of the project site and Phase II: construction of a 22-storied building with 4 basements. It has also been planned that URU would be equipped with a specialized training facility geared toward competency building of construction activities. A testing facility for in-situ and laboratory of construction materials and structural components has also been proposed for this unit. The URU will be accommodated into new premises to be built in RAJUK's own land. The building will be constructed at Mohakhali in the heart of Dhaka; by the side of Gulshan-Mohakhali Road (Bir Uttam A K Khandakar Avenue), which will be the administrative headquarters of URU, RAJUK.

During the process of conducting the EIA possible impacts of the project have been identified for both the construction and operational phases. The possible effects of project activities on ecological, physic-chemical and socio-economic parameters have been evaluated. The ecological impacts of the project activities appear to be minor in nature.

The physico-chemical environmental parameters, those would be affected by the project activities during construction phase include earth excavation, drainage congestion, water pollution, noise pollution and air pollution have been identified. Traffic congestion and obstruction to pedestrian movement due to vehicular movement and other project activities (e.g., storage of excavated soils/ delivery of construction material, hospital equipment, etc.) are important concerns.

Proper mitigation measures, as suggested in the EMP, should be followed to reduce such adverse impacts to the extent possible. The project activities are likely to generate opportunity for significant employment. During the operational phase, the project is likely to bring about significant benefit through development of competencies related to urban resilience: risk assessment, earthquake engineering, construction standards, in-situ and laboratory construction material testing, specialized construction training, and risk-sensitive land use planning addressing the need of the nation.

An Environmental Management Plan (EMP), including monitoring requirements, has been developed to ensure implementation of the "mitigation measures" identified in the environmental assessment. A Grievance Redress Committee has been suggested where aggrieved parties may launch complaint during the operational phase, which will be addressed by the committee upon formal hearing and investigation.

It has been found that most of the adverse impacts resulting from the proposed project during construction phase would be minimal. However, these impacts could further be minimized if appropriate mitigation measures are taken. The project would bring about socio-economic benefits during its operational phase through improvement of resilient building construction, risk reduction, disaster preparedness and trained personnel in the entire country.

Mitigation and abatement measures to reduce or eliminate the identified potential adverse impacts and to enhance beneficial impacts have been suggested. It is important that the RAJUK administration sets up a designated team with specific responsibilities to ensure proper adherence to the suggested EMP. The EIA report may now be submitted to the Department of Environment (DoE) for obtaining necessary environmental clearance.

Environmental Impact Assessment (EIA)
of
RAJUK Urban Resilience Unit (URU) Building Project

Vol. 2 - Draft Final Report

Bangladesh University of Engineering and Technology (BUET)
Dhaka-1000, Bangladesh

September 2019

TABLE OF CONTENTS

Abbreviations

		Page
1.	**Introduction**	**1-1**
1.1.	Background	1-1
1.2.	Objectives of the RAJUK-URU Project	1-2
1.3.	Objective of the EIA Study	1-2
1.4.	Scoping and Screening	1-2
1.5.	Outline of Methodology	1-4
1.6.	The EIA Report	1-4
2.	**Project Description**	**2-1**
2.1.	Background	2-1
2.2.	Project Description	2-1
2.3.	Project Activities of Urban Resilience Unit (URU) Building	2-12
	2.3.1. Project Activities during Construction Phase	2-12
	2.3.2. Project Activities during Operational Phase	2-13
3.	**Policy, Legal and Administrative Framework**	**3-1**
3.1.	Introduction	3-1
3.2.	National Environmental Policy, Laws and Regulations	3-1
3.3.	Relevant Fire Safety Rules for Buildings	3-5
3.4.	National Social Policies, Laws and Regulations	3-7
3.5.	Institutional Framework Related to Environment in Bangladesh	3-9
3.6.	World Bank Environmental and Safeguard Policies	3-11
3.7.	Applicability to the Project	3-12
	3.7.1. Applicable World Bank Policies	3-12
	3.7.2. Applicable Environmental Standards	3-15
	3.7.3. Applicable National Laws, Rules, Acts	3-15
4.	**Baseline: Environmental, Ecological and Social**	**4-1**
4.1.	Introduction	4-1
4.2.	Physical Environment	4-1
	4.2.1. Physical Features of the Study Area	4-1
	4.2.2. Archaeological Sites	4-5
4.3.	Physico-chemical Environment	4-5
	4.3.1. Air Quality	4-5
	4.3.2. Climate	4-9
	4.3.3. Geology and Seismicity	4-10
	4.3.4. Natural Disasters	4-13
	4.3.5. Water Quality	4-15
	4.3.6. Ambient Noise Level	4-19
4.4.	Ecological Environment	4-23
	4.4.1. Approach and Methodology	4-24
	4.4.2. Ecological Perspective	4-24

4.4.3. Ecological Aspects 4-27
4.4.4. Threatened Fauna and Flora 4-35
4.4.5. Ecological Important Site 4-36
4.5. Baseline Socio-Economic Condition around Project Area 4-36
4.5.1. Approach and Methodology 4-37
4.5.2. Socio-economic Perspective of the Project Areas 4-37
4.5.3. Present Status of Areas adjacent to Proposed RAJUK- URU Project Site 4-39
5. Identification and Assessment of Potential Impacts 5-1
5.1. Introduction 5-1
5.2. Methodology 5-1
5.3. Environmental Impacts 5-1
5.3.1. Impacts during Pre-Construction Phase 5-2
5.3.2. Impacts during Construction Phase 5-2
5.3.3. Impacts during Operation Phase 5-8
5.4. Ecological Impacts 5-10
5.4.1. Potential Impacts on Fauna 5-10
5.4.2. Potential Impacts on Flora 5-11
5.4.3. Evaluation of Ecological Impacts 5-11
5.4.4. Risk Assessment 5-12
5.5. Socio-Economic Impacts 5-18
5.5.1. Socio-economic Impacts during Construction Phase 5-18
5.5.2. Socio-economic Impacts during Operational Phase 5-19
5.5.3. Risk assessment for Socio-Economic Impacts 5-21
6. Assessment and Management of Traffic Impacts 6-1
6.1. Background 6-1
6.1.1. Traffic within the Project Site 6-1
6.1.2. Traffic in the Surrounding Area 6-2
6.2. Existing Traffic Condition of the Study Area 6-3
6.3. Geometric and Traffic Demand Survey 6-3
6.3.1. Count Survey 6-4
6.3.2. Speed Survey 6-7
6.3.3. Travel Time Survey 6-7
6.3.4. Questionnaire Survey 6-8
6.3.5. Geometric Survey 6-10
6.4. Demand Forecasting for the Project 6-10
6.5. Traffic Circulation Plan and Parking Requirements 6-14
6.5.1. Impacts of Traffic Circulation 6-14
6.5.2. Mitigation Measures (Considering Phase I) 6-16
6.5.3. Mitigation Measures (Considering both Phase I and Phase II) 6-18
6.5.4. Parking Requirements 6-19
6.6. Scenario Design 6-20
6.7. Performance Evaluation 6-21
6.7.1. Nodal Evaluation 6-22
6.7.2. Network Evaluation 6-23

7. Analysis of Alternatives **7-1**
7.1. Introduction 7-1
7.2. Alternative Project Location 7-1
7.3. Alternative Design and Construction Method 7-2
7.4. No Project Scenario 7-5
8. Information Disclosure, Consultation and Participation **8-1**
8.1. Introduction 8-1
8.2. Approach and Methodology 8-1
8.3. Key Findings from FGD and KII 8-2
8.3.1. Outcomes of FGDs 8-3
8.3.2. Outcomes of KIIs 8-5
9. Grievance Redress Mechanism **9-1**
9.1. Introduction 9-1
9.2. Development of GRM 9-1
9.2.1. Procedure for GRM 9-1
9.2.2. Publicize GRM 9-1
9.2.3. Recording of GRM 9-2
9.2.4. Appeal and Follow-up 9-2
9.3. Proposed GRM for the Project 9-2
10. Environmental Management Plan **10-1**
10.1. Introduction 10-1
10.2. Mitigation Measures 10-1
10.2.1. Construction Phase 10-1
10.2.2. Operational Phase 10-12
10.3. Environmental Management Plan 10-14
10.3.1. Scope of EMP 10-14
10.3.2. Work Plan and Schedules 10-14
10.4. Environmental Monitoring Plan 10-15
10.4.1. Monitoring during Construction Phase 10-15
10.4.2. Monitoring during Operational Phase 10-18
10.4.3. Cost of Environmental Monitoring 10-19
10.5. Implementation Arrangements 10-21
10.6. Occupational Health and Safety Plan 10-22
10.6.1. Suggested Safety Directives for Work Equipment 10-23
10.6.2. Suggested Safety Directives for Protective Gears 10-24
10.6.3. Safety and Health Signs 10-25
10.6.4. Roles and Responsibilities 10-26
10.6.5. Training 10-27
10.6.6. Documentation, Record Keeping and Reporting 10-27
10.6.7. General Working Condition 10-28
10.7. Emergency Preparedness and Response Plan 10-29
10.7.1. Identification of Emergency 10-29
10.7.2. Emergency Equipment 10-30
10.7.3. Emergency Response Team (ERT) 10-30

10.7.4. Response Process 10-30
10.7.5. Training, Reporting and Documentation 10-31
11. Conclusions and Recommendations **11-1**
11.1. Introduction 11-1
11.2. Conclusions 11-2
11.3. Recommendations 11-3

References

Annexure

Annex A: Terms of Reference (ToR)

Annex B: Recommendations for LEED Certification

Annex C: Environmental Standards

Annex D: FGD Participants List

Annex E: Chance Find Procedures: World Bank OP 4.11

Acronyms and Abbreviations

BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BNBC	Bangladesh National Building Code
BRTC	Bureau of Research Testing and Consultation
BUET	Bangladesh University of Engineering and Technology
DCSC	Design and Construction Supervision Consultant
DMB	Division of the Disaster Management Bureau
DNCC	Dhaka North City Corporation
DoE	Department of Environment
DRM	Disaster Risk Management
DWASA	Dhaka Water Supply and Sewerage Authority
ECA	Environmental Conservation Act
ECR	Environmental Conservation Rule
EIA	Environmental Impact Assessment
EHS	Environment, Health and Safety
EMP	Environmental Management Plan
EMU	Environmental Management Unit
ERT	Emergency Response Team
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GoB	Government of Bangladesh
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
IEE	Initial Environmental Examination
IGO	Inter Governmental Organization
IUCN	International Union for Conservation of Nature
KII	Key Informant Interview
LEED	Leadership in Energy and Environmental Design
MDL	Minimum Detection Limit
MIM	Management Information & Monitoring
O-D	Origin and Destination
OP	Operational Policy
OSHA	Occupational Health and Safety Assessment
PAP	Project Affected Person
PCR	Physical Cultural Resources
PD	Project Director
PMU	Project Management Unit
RAJUK	Rajdhani Unnayan Kartipakhya
RAP	Resettlement Action Plan

TDC	Temporary Drainage Congestion
ToR	Terms of Reference
UNDP	United Nations Development Program
URP	Urban Resilience Project
URU	Urban Resilience Unit
WB	World Bank
WHO	World Health Organization

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Bangladesh is highly vulnerable to earthquake due to its geological location and given the lack of recent earthquake events, an understanding of earthquake risk and corresponding strategies to mitigate the impact of such events is lacking. Bangladesh National Plan on Disaster Management (2010-2015) includes an Earthquake Management Plan and a National Earthquake Contingency Plan, which have been developed under the Ministry of Food and Disaster Management. These plans identify response and risk reduction activities with corresponding lead and support agencies. However, the plans lack the comprehensive vision of a national earthquake strategy, and a convincing demonstration of benefits, implementation, and controls. Furthermore, the institutional structure for multi-stakeholder engagement to deal with a problem as complex as urban earthquake risk is also lacking and the existing plans do not engage agencies and organizations in a sustainable way.

The Government envisaged establishing a trained, competent and well-equipped unit to respond to this critical gap in the management of disaster risk in Bangladesh. The Bangladesh Urban Resilience Project (URP) represents the second phase of a multi-phase national Disaster and Risk Management (DRM) program to build institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh.

The construction of the RAJUK's Urban Resilience Unit (URU) building is a bold and timely initiative for Dhaka and the rapidly expanding urban center of Dhaka. Seismic assessment and resilience must be incorporated into urban development, authority, and accountability, and leadership is needed to facilitate private investments and consider risk and resilience within development of the Dhaka City area.

Mega-City Dhaka, the seventh largest populous city in the world, with an estimated population of 20,283,552 in 2019. In 1950, the population of Dhaka was 335,760 that had grown to 2,686,375 since 2015, which represents a 3.62% annual change. These population estimates and projections have been collected from the latest revision of the UN World Urbanization Prospects. These estimates represent the Urban agglomeration of Dhaka, which typically includes Dhaka's population in addition to adjacent suburban areas. Areas of Dhaka City are getting overcrowded and are creating unwholesome environment and spoiling the beauty of the City. These are primarily due to lack of planned urbanization. To offer better and quick services to the city dwellers, the GOB has divided the Dhaka City Corporation into two parts: Dhaka South City Corporation and Dhaka North City Corporation. Unfortunately, these two City Corporations are proving to be inadequate to provide the desired services due to the rapid rate

of urbanization. It is possible to reduce the pressure of population of Dhaka City in a planned way of establishing permanent commercial and residential areas for this vast population and to manage seismic preparedness and resilience for the Dhaka City.

1.2 OBJECTIVES OF THE RAJUK-URU PROJECT

The objective of the overall engagement is to develop a comprehensive approach to managing earthquake risk through a structured process of knowledge development, education, and planning that involves a wide range of stakeholders to increase engagement and ownership.

The Project comprises five components, namely:

Component A: Reinforcing the Country's Emergency Management Response Capacity
Component B: Vulnerability Assessment of Critical and Essential Facilities
Component C: Improved Construction, Urban Planning and Development
Component D: Project Coordination, Monitoring and Evaluation
Component E: Contingent Emergency Response

It has been anticipated that the component C of the Bangladesh Urban Resilience Project (URP) would be successful through institutional strengthening by the creation of a new organizational unit in RAJUK. It has been named as the Urban Resilience Unit (URU) to encompass the development of competencies related to urban resilience such as risk assessment, earthquake engineering, construction standards, in-situ and laboratory construction material testing, specialized construction training, and risk-sensitive land use planning. It has been planned that URU would be equipped with a specialized training facility geared toward competency building of construction activities. A testing facility for in-situ and laboratory of construction materials and structural components has also been proposed for this unit. The URU will be accommodated into new premises to be built in RAJUK's own land. The Building will be constructed at Mohakhali in the heart of Dhaka; by the side of Gulshan-Banani, which will be the administrative headquarters of URU, RAJUK.

1.3 OBJECTIVE OF THE EIA STUDY

The main objective of the EIA of the proposed Urban Resilience Unit (URU) Building is to conduct an environmental assessment, identify potential negative impacts, provide a complete environmental management plan (EMP) to minimize or mitigate negative impacts and enhance positive impacts.

1.4 SCOPING AND SCREENING

As the first step, the Terms of Reference (ToR) provided by the Client RAJUK (Annex A) was reviewed and project screening and scoping exercise have been undertaken to categorize the project according to the Department of Environment, GoB and the World Bank. According to the Environmental Conservation Rules (ECR), 1997 of the Department of Environment (DoE), Bangladesh, construction of multi-storied building is considered under the "Orange B" category

and therefore environmental clearance certificate will not be applicable rather than site clearance. According to World Bank, this project is considered as “Category B”. Therefore the IDA requires EIA for the project to ensure that the project is environmentally sound and sustainable.

The next step of the scoping exercise the Team of Consultants set-out to identify the parameters needed to be considered for the study and to outline the activities for collecting and analyzing data on each parameter of physical, ecological, environmental and socio-economic aspects. Geographical area to be covered has been identified in consultation with the client.

Scoping was done for:

- Categorization of the project according to ECR ’97 and the World Bank.
- Identifying and procuring institutional information.
- Information collection through discussions/meetings with WB, RAJUK, etc. to define scope for the impact assessment,
- Planning and implementation of mitigation and monitoring,
- Confirmation of the environmental categorization of the project along with selecting the type of EIA documents to be prepared (Full EIA, IEE, EMP, etc.) as required under the Environment Conservation Rules, 1997.
- Confirmation whether Resettlement Action Plan (RAP) or voluntary dispossession or negotiated settlement is required.

The steps followed in screening include:

- Desk review of the relevant documents and available imagery of the project site and its surroundings,
- Reconnaissance survey of the site, surrounding areas, approach road and informal discussions with local stakeholders,
- Discussions with World Bank, RAJUK, Design Consultants of the Client and Department of Environment (DOE) to update the regulatory requirements and formats/ methods, etc.,
- A preliminary stakeholder mapping exercise to identify key stakeholders from the relevant Governmental Agencies, Non-Governmental Organizations (NGOs), Local Community Representatives. This information has been used for consultation during different stages of the project.
- Categorization of subproject for the purpose of EIA.
- Preliminary identification of the World Bank Operational Policies triggered by the project, e.g.,
    - Location of the project – in eco-sensitive area or not
    - Presence of indigenous peoples in the impact area or not
    - Cultural heritage sites affected or not
    - Land acquisition and/or Involuntary resettlement involved or not

1.5 OUTLINE OF METHODOLOGY

This study used multiple data collection technique to collect various primary as well as secondary information for conducting the EIA. Relevant information about the project area were gathered through detailed physical survey. Additional information was collected from published literature. In addition, data and information were also collected from different government and non-government organizations.

Field visits were carried out by the study team to obtain firsthand information on environmental conditions around the project site. During these field visits, informal discussions were carried out with people living in and around the project area. A detailed reconnaissance survey was conducted to gather specific information. In addition, a detailed survey around the proposed site was also carried out for documenting specific details. In the field surveys, GPS has been extensively used for geo-referencing the site specific structures.

An environmental baseline survey has been carried out to gather information on the existing physicochemical, biological, and socio-economic environment of areas surrounding the proposed area. Subsequently, the possible environmental impacts of the project activities have been evaluated against these baseline environmental conditions. For identification of potential environmental impacts, the major project activities during both construction and operational phases have been identified. Impacts of these activities on the existing baseline environment have been assessed both for construction and operation phases of the proposed project. This exercise has been followed by prediction and evaluation of the most significant impacts.

After evaluation of impacts, mitigation measures have been devised for all potential adverse impacts that could result from the proposed project activities. Mitigation measures have been developed separately for adverse impacts during construction and operation phases. Finally, an environmental management plan (EMP), including monitoring requirements, has been developed.

1.6 THE EIA REPORT

The EIA report has been prepared and presented in Eleven Chapters. The first Chapter (Chapter 1)of this EIA report describes the background and objectives of the project. It also presents an outline of the methodology followed for carrying out EIA. Chapter 2 presents a detail description of the project including the major activities to be carried out during both construction and operation phases of the project. Chapter 3 presents an overview of policy, legal and administrative framework relevant to the project. Chapter 4 presents a description of the environmental, ecological and social baseline including detail description of physical features around the project site. Chapter 5 presents identification and assessment of the potential environmental, ecological and socio-economic impacts of the proposed project, both during construction and operation phases. Chapter 6 provides the assessment and

management of traffic impacts. Chapter 7 presents the alternative options for the proposed project. Chapter 8 presents the Information Disclosure along with outcome of public consultations and communications carried out as a part of the environmental assessment. Chapter 9 presents the Grievance Redress Mechanism for the proposed project. Chapter 10 presents the mitigation measures for enhancement of positive impact and reduction or elimination of negative impacts. It also presents the Environmental Management Plan (EMP), including Monitoring Plans for both construction and operational phases, Occupational Health and Safety Plan and Emergency Preparedness Plan. The final Chapter (Chapter 11) of the EIA report presents the conclusions of the environmental assessment of the proposed project.

In addition to these chapters, it is worthwhile to mention here that RAJUK has requested in their ToR to provide recommendations for 'LEED Certification' process for the proposed project. Although review of LEED Certification is not a requirement of the EIA process, as per the Client's requirement mentioned in the ToR, the criteria for LEED Certification has been reviewed with respect to the features included in the proposed project and the necessary recommendations have been provided in Annex B of this report.

CHAPTER 2
PROJECT DESCRIPTION

2.1 BACKGROUND

To respond to the critical gap in the management of disaster risk in Bangladesh, Bangladesh Urban Resilience Project (URP) represents the second phase of a multi-phase national DRM program to build institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh. As mentioned earlier in Chapter 1, the Government of Bangladesh has decided to set up the Urban Resilience Unit (URU) to develop the competence and capability to handle the needs for earthquake resilient infrastructure development. It has been planned that URU would be equipped with a specialized training facility geared toward competency building of construction activities. A testing facility for in-situ and laboratory of construction materials and structural components has also been proposed for this unit. The URU will be accommodated into new premises to be built in RAJUK's own land and will be the administrative headquarters of URU, RAJUK.

2.2 PROJECT DESCRIPTION

The area/site for the proposed Urban Resilience Unit (URU) Building area (presently, RAJUK zonal office at Mohakhali) is located under Gulshan Thana of Dhaka North City Corporation, Dhaka. The latitude and longitude of the proposed site are 23° 46' 56.3304'' N and 90° 24' 8.0856'' E, respectively. The boundaries of the proposed Urban Resilience Unit (URU) Building area are: Govt. Titumir College, college Mosque are on the eastern side, Titumir College hostel is at the Northern side, part of Western side is occupied by the BSTI residential area (quarter); and the rest of the surrounding establishments are private residential or commercial buildings. Mohakhali-Gulshan road constitutes the key and ease of access to the project site and an alley connects the road directly to the site. Starting from Mohakhali- Amtoli juncture, the nearby point on the main road to the site, is located 350.2 m distance and from that point (Amtoli More). A 30 m well paved connects the project site to the Gulshan-Mohakhali Road.

The physical location of the URU building project of RAJUK is at Mohakhali, besides the BirUttam AK Khandakar Road which is the main road connection between Mohakhali to Gulshan -1. The notable establishments around the project site have been summarized in Figure 2.1 (a-d) as well as below:

North side: Government Titumir College academic building and its student's hostel (Akkasur Rahman Akhi Chatrabas) are on the north of the project site.

South side: Two-high-rising commercial buildings containing different offices, e.g. AB Bank, M & J Group, and Green Delta Insurance are on the south of the project site. At present construction work of another high-rising building is going on.

East side: The eastern side covers almost all the area that belongs to RAJUK. Now a day, the area is being used by RAJUK authority as a parking place for their Staff buses, excavators, road rollers and Dump trucks.

West side: BSTI officers' residents' quarters and BSTI staff quarter's Masjid are on the west side of the project site.

In August 2018 it was decided that a single 30 storied building including four levels of basement and30 additional floors all of which would have a floor area of 4,050m^2 will be constructed at the project site as a URU Building. However, buoyancy effect over 4,050 m^2 for required significant resistance against uplift for the basement 4 slab as well as uplift resistance from the pile support in the design making it an extremely expensive proposition. After a series of discussion meetings with the World Bank, RAJUK and its Consultant the following plan was suggested for Phase I:

- A two level Basement
- A small tower of 10 storied and approximate typical floor area of about 900 m^2 each
- A layout providing for an eccentric building core located at the north face of the building
- The proposed shake table and laboratory with all equipment to be located within the basement and ground floor areas of the Building (Figure 2.2).

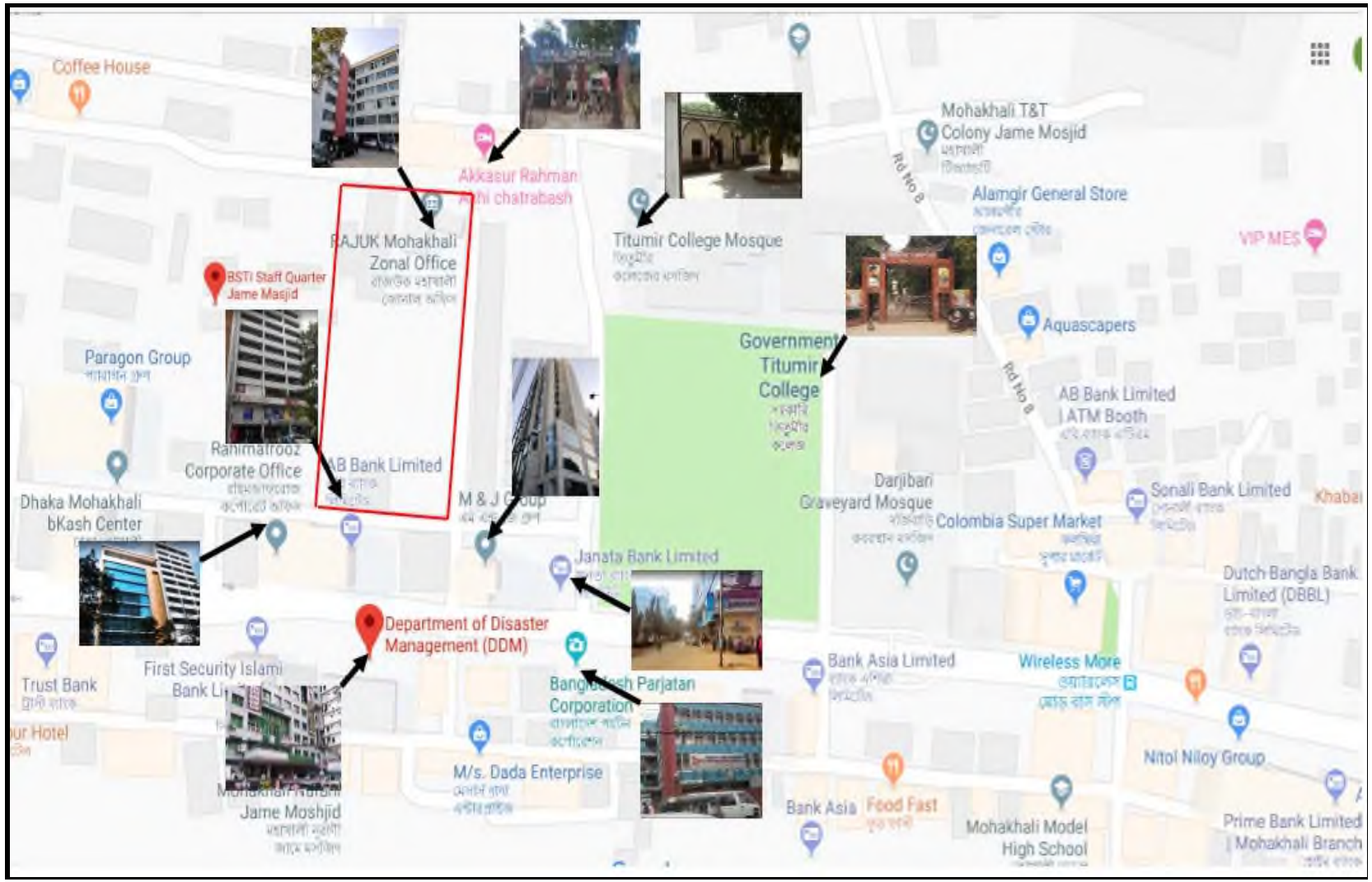


Figure 2.1(a): Important establishments and features around the proposed RAJUK-URU Building Site

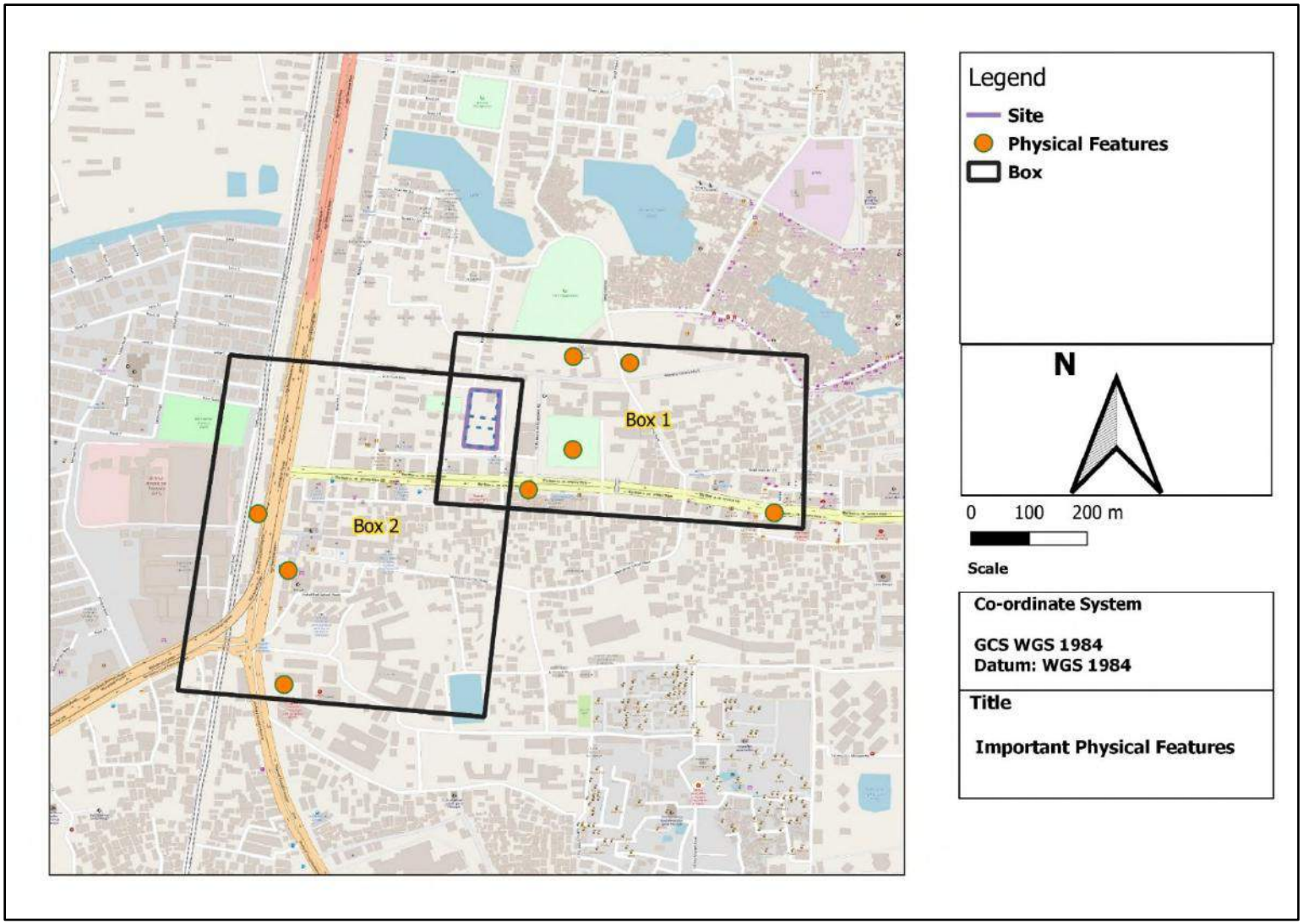


Figure 2.1 (b): Important physical features around the proposed project site, divided into 2 Boxes

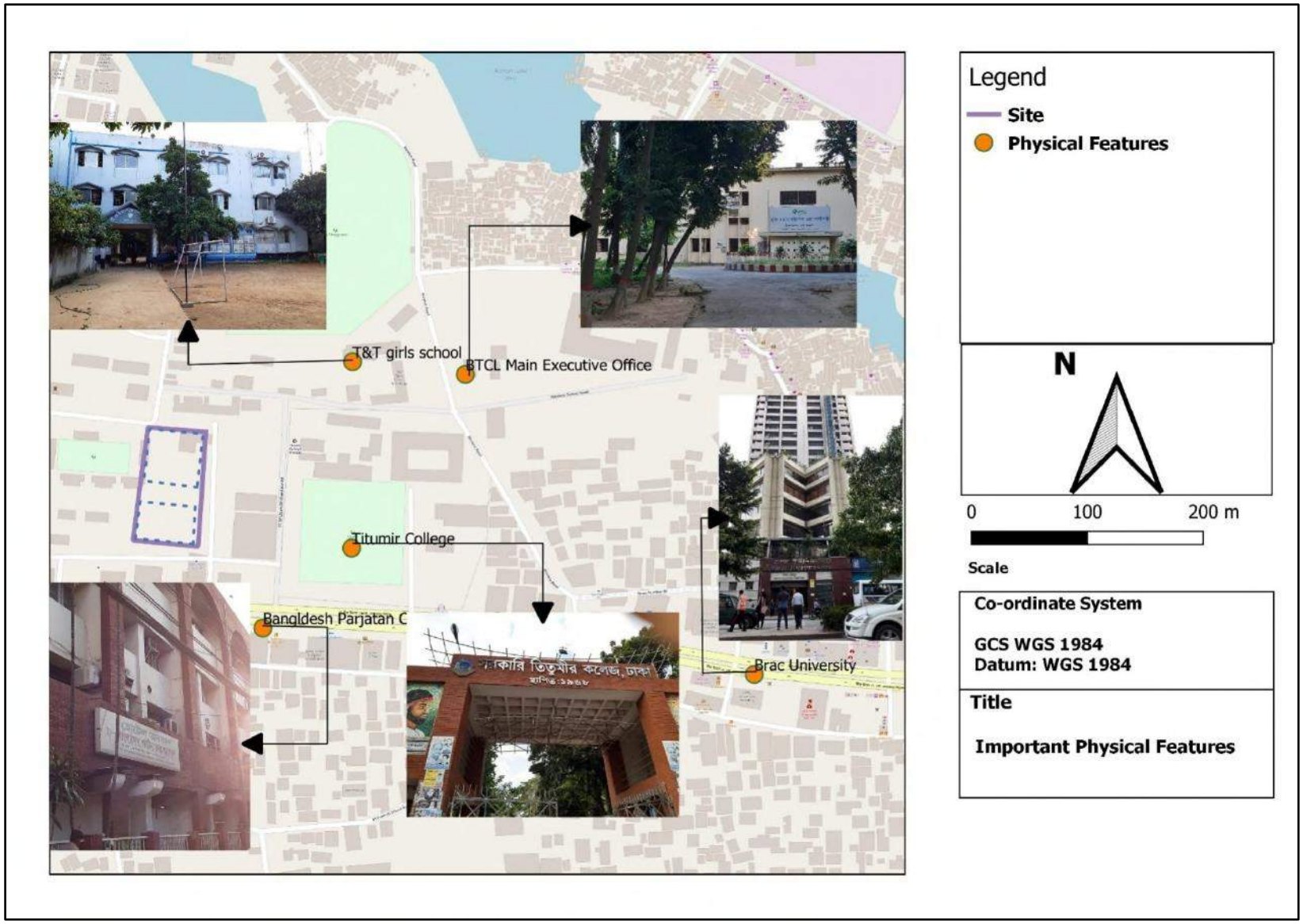


Figure 2.3(c): Important physical features around the proposed project site within Box 1

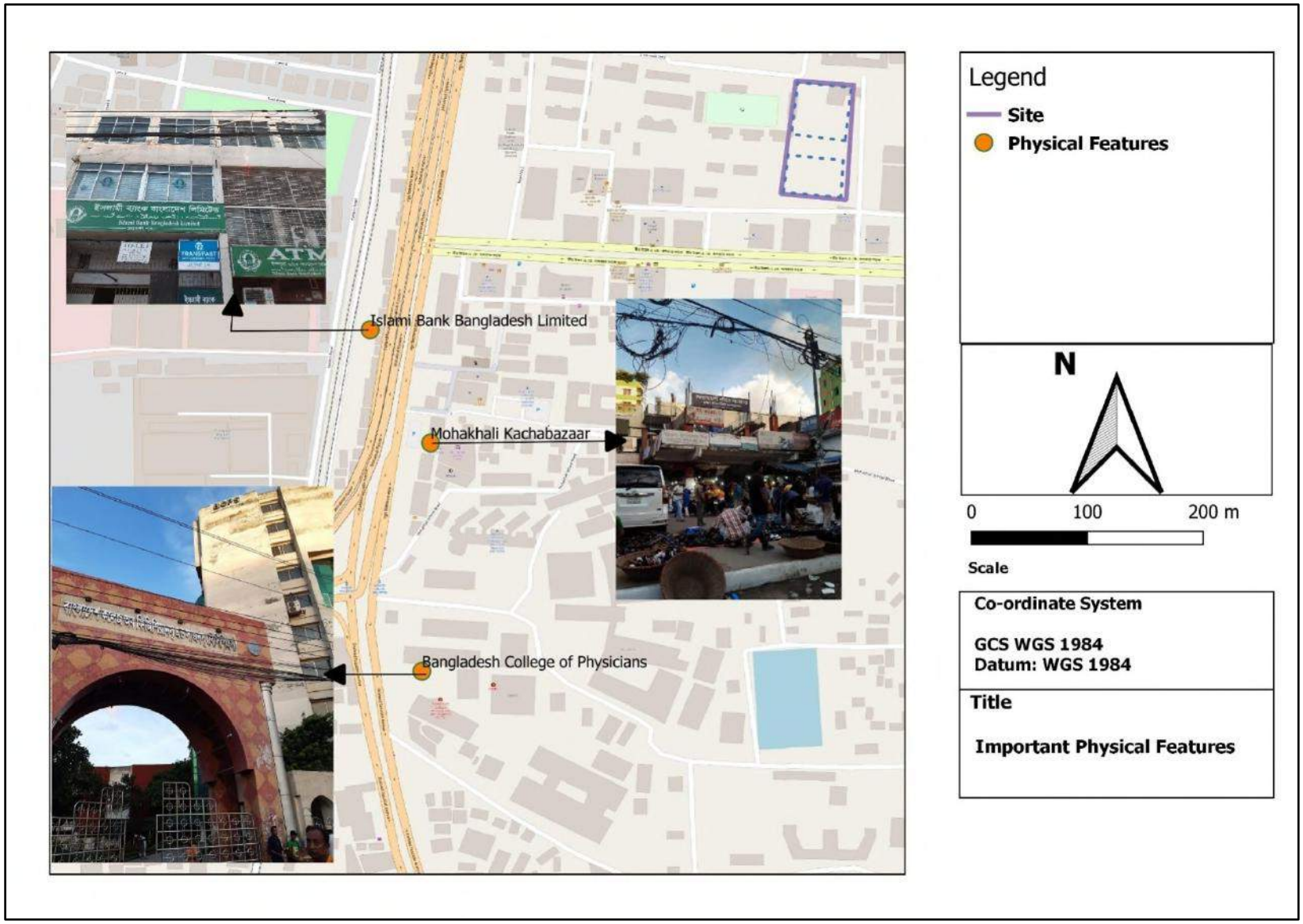


Figure 2.1 (d): Important physical features around the proposed project site within Box 2

The Final Architectural Design was approved on 2 July 2019 and included another building change such that the shake table and laboratory were to be located in a separate and distinct building located to the west of the 10 storied building.

It has been planned that another building will be constructed in the Phase II of the project with 22 storied tower with 4 basements. Project summary mentioning each component of both the Phases has been provided in Table 2.1.

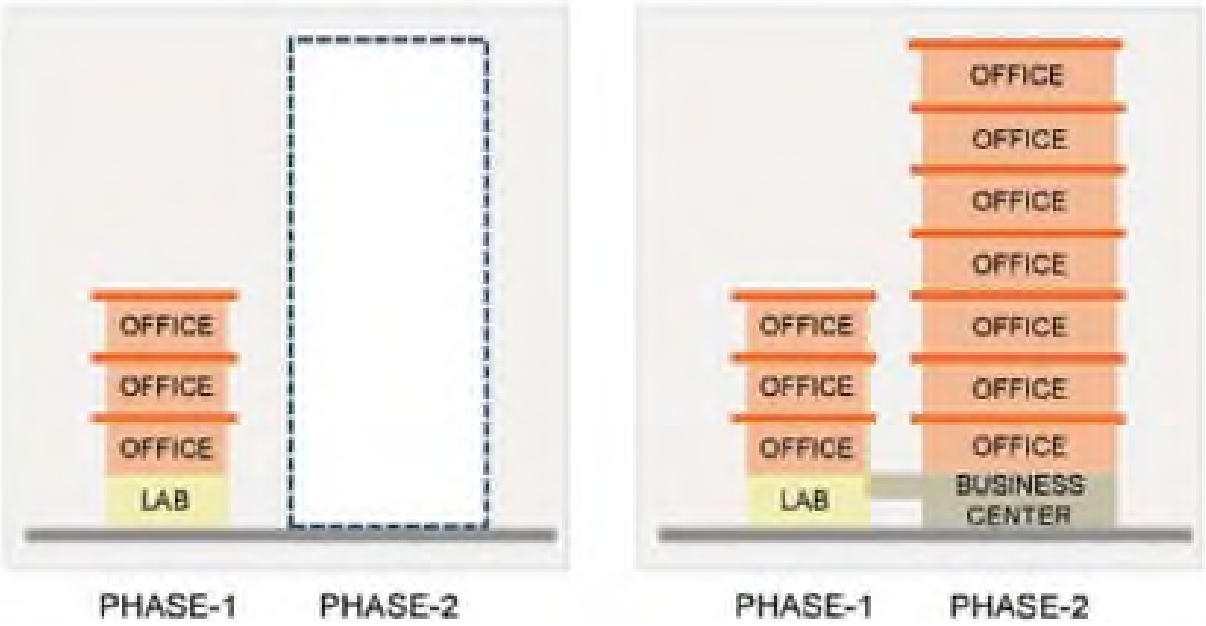


Figure 2.2: Tentative Plan for Phase I and Phase II

Table 2.1: Project Summary

TOTAL SITE AREA		**7,117.89㎡**	
USE OF BUILDING		**LABORATORY, OFFICE**	
SITE COVERAGE	TOWER	**49.99%**	**3,558.54㎡**
	PODIUM	**56.17%**	**3,998.31㎡**
	BASEMENT	**69.30%**	**4,932.58㎡**
GROSS FLOOR AREA		**PHASE 1**	**PHASE 2**
	TOWER	**7,449.33㎡**	**48,499.69㎡**
	PODIUM	**1745.21㎡**	**3,528.78㎡**
	BASEMENT	**3,501.64㎡**	**12,457.56㎡**
	TOTAL	**12,746.18㎡**	**64,486.03㎡**
FLOOR AREA RATIO		**129.88%**	**730.95%**
FLOOR AREA RATIO (PHASE 1+2)		**860.83%**	
STRUCTURE		**RC + STEEL**	
NUMBER OF FLOORS		**Phase -1**	**10 STORIES / 2 BASEMENT**
		Phase -2	**22 STORIES / 4 BASEMENT**

PARKING CARS		PHASE 1	PHASE 2
	GF	-	6
	B1	30	73
	B2	33	72
	B3	-	72
	B4	-	77
	TOTAL	63	300
EXTERIOR FEATURE		**GLASS CURTAIN WALL, EXPOSED CONCRETE**	
LANDSCAPE AREA		**21.17%**	**1,933.91㎡**

The total site area is 7117.89 m^2 which will primarily be used as office of RAJUK with a small portion will accommodate the laboratory. The three main components of the buildings will be the Basement, Podium and Tower. The site coverage for these components will be about 4,932.58, 3998.31 and 3558.54 m^2, respectively. As mentioned earlier the Phase I will be a 10 storied building with 2 basements and an exterior Shake Table room and the Phase II will be a 22 storied building with 4 basements. Phase-wise distribution of gross floor areas for these three components include 3,502, 1,745 and 7,449m^2 totaling 12,746m^2 for Phase I, whereas,

12,458, 3,529 and 48,500m^2 totaling 64,486m^2 for Phase II. The basement will be of reinforced cement concrete with steel frame and glass curtain walls. The two basements of Phase I Tower will accommodate 63 cars in the parking spaces, whereas, the four basements of Phase II Tower will accommodate 300 cars in the parking spaces (Table 2.1). Figure 2.3 provides a schematic representation of Phase I and II arrangements for work spaces along with parking areas.

The finalized ground and 1st floor plans for the proposed Phase I and Phase II are shown in Figure 2.4. The Tower Building of Phase I will have a lobby with reception center on the ground floor along with a laboratory for testing building materials, safety equipment, etc. The 2nd – 5th floors will provide office space for the URU personnel of RAJUK. The Shake Table pit will be constructed outside this Tower on the western side of the plot. This 10 storied building will be connected with the 22 storied Tower Building to be constructed in the Phase II. This tower will also have a reception, lobby and number of meeting room with a business center. Rest of the floors will have training rooms and office space for the employees of RAJUK as it has future plan to shift the its office from Motijheel to this RAJUK-URU center. The fire control room, generator room and substation will be housed on the ground floor of Phase II Tower. A birds-eye-view of the proposed project buildings is shown in Figure 2.5.

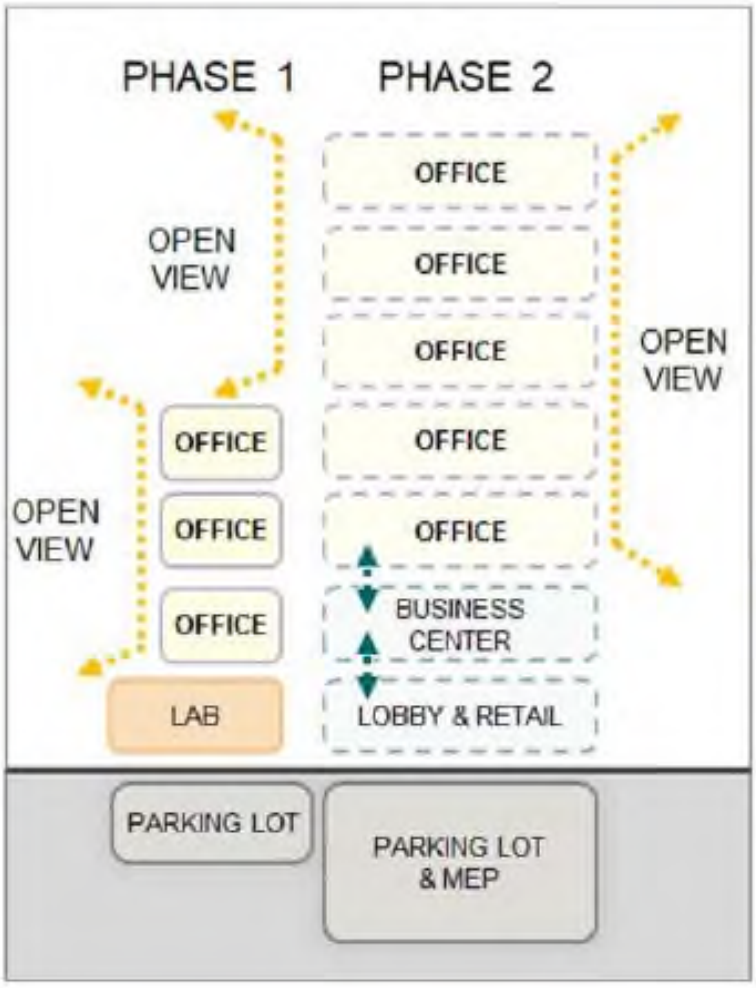


Figure 2.3: Schematic diagram of Phase I and II arrangements work spaces with parking areas

Figure 2.4: Proposed Ground and 1st floor plans for Phase I and Phase II of RAJUK-URU project

Figure 2.5: Birds-eye-view of the proposed Phase I and Phase II Towers and Shake Table Room

Additional architectural design features include:

- Landscape: It has been decided that based on the maximum area development, landscape area will be adjusted during layout. However, the area of 8m setback for the front main road (to the public and proposed site) shall be considered as landscape area.

- Setback: A total of 12m front main road with 8m setback will be ensured in the design. Phase 1 and Phase 2 buildings will have 3m setback by considering excavation work and in accordance with the BNBC.

- Access Roads: With 8m setback for the main front road, a total of 4 lanes has been planned, which will ensure 2 lanes per each traffic way.
- Suspended ceiling at the living space based on the international standard will be provided as below:
    - at the typical ground floor level (2F/3F ~): 4m Floor to floor / 2.6 ~2.7mceiling height with suspended ceiling;
    - at the typical basement parking floor level: 3.6m Floor to floor / 2.3m or more ceiling height without suspended ceiling.

2.3 PROJECT ACTIVITIES OF URBAN RESILIENCE UNIT (URU) BUILDING

2.3.1 Project Activities during Construction Phase

The major activities carried out during construction phase of the proposed project include the following:

(1) Mobilization of personnel, material and equipment (including establishment of project office and labor shed, etc.)
(2) Conducting topographical survey to identify the dips, notches and undulations in the hilly terrain.
(3) Providing layout of each buildings and ancillary facilities based on the topographical survey.
(4) Ground preparation according to the topographical survey.
(5) Dismantle and demolishing of existing semi-pucca sheds and one story building within the project site.
(6) Earth excavation works with shore protection measures for the basement construction.
(7) Construction of basements with ramps.
(8) Construction of the building starting with the construction of the foundation followed by steel-framed superstructure.
(9) Installation of the electro-mechanical equipment including, generators, transformers, elevators, and central air-conditioning system.
(10) Interior design including furniture and furnishing works;
(11) Internal road construction;
(12) Security system, traffic and pedestrian management system;
(13) Landscaping/tree plantation, etc.

General Structural Design Features:

The proposed building site is located in the heart of Dhaka and thus endures very heavy traffic such that supply of ready mix plant produced concrete cannot be delivered with predictable regularity. For the aforementioned reason and for the following additional reasons the structural configuration chosen by the design consultants of RAJUK are as follows:

- Open cut excavation (a shore pile alternative may be adopted if funds are available)
- Pile supported foundation
- Reinforced Concrete Basement 2, Basement 1 and Ground Level
- Reinforced concrete perimeter wall
- Reinforced concrete elevator and service core to resist 100% of applied lateral loads from wind and/or earthquake to extend to the roof penthouse
- Steel frame typical floors consisting of Hollow Structural Steel Columns will be provided with supporting steel beams and girders supporting 75mm steel deck of thickness 0.81mm and filled with 75mm of concrete adequately jointed with control joints to mitigate slab surface cracking.

The design consultant of the RAJUK has suggested steel frame structure for the following reasons:

- As earthquake forces are inertia forces, use of a steel supporting frame with steel deck is lighter than a reinforced concrete solution and thus impact of earthquake forces will be mitigated to some extent due to the lighter structure.
- Steel erection will speed the construction process as opposed to forming, reinforcing and placing reinforced concrete elements at typical floors.
- Ease and speed of inspecting and approving the General Contractor work as typical floor slab forming and reinforcement inspection will largely be eliminated. The typical floor design as proposed will reduce the possibility of errors or omission on the part of the Construction Contractor as well as the inspection authorities.

Excavation and Sub Structure Design:
Two alternative options in respect of the excavation, foundations and structures connected with the two basement floors have been contemplated for the Phase I building, namely Open Cut Method and Shore Pile Method.

Open Cut Method: Two basements will be excavated to a depth of 9m below grade by an open cut method where the slopes of the excavation will be sloped at 1:1 or 45^{o}. The Construction Contractor must protect the slope during construction to the approval of the Consultant and the Client and take appropriate measures to protect the open cut slope. The process must keep the provision for pumping water out of the excavation such that the base of the excavation can support truck traffic and construction activity until the reinforced concrete basement structure and ground floor is complete.

Shore Pile Method: Alternative of providing for protective shore piles around the entire perimeter of the Phase 1 Building from Level B2 to the Ground Floor. This method requires the placement of 162 permanent 600mm diameter piles placed outside the basement perimeter walls. It has been estimated that the expected length of the bored concrete piles will be 25m below ground level. The length of the shore piles will have to be determined by testing 5 piles to determine the depth at which "FIXITY" of the base of the bored pile is achieved. That is, the pile will be considered to have a FIXED end at its base allowing for no structural rotation under load when it is driven to a depth such that the deflection of the pile when loaded horizontally.

2.3.2 Project Activities during Operational Phase

The major activities during operational phase include:

(1) Regular operation and maintenance of RAJUK-Urban Resilience Unit; and
(2) Regular operation and maintenance of the testing facilities at the Laboratory.
(3) Internal traffic management.

CHAPTER 3
POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1 INTRODUCTION

This Chapter focuses on the national environmental policies and laws and legal framework applicable to the proposed project. In addition, a wide range of laws and regulations related to environmental and social issues are in place in Bangladesh. Many of these are cross-sectoral and partially related to environmental issues. This Section presents an overview of the major national environmental laws and regulations that are relevant and may apply to the activities supported by the proposed project, and World Bank safeguard policies.

3.2 NATIONAL ENVIRONMENTAL POLICY, LAWS AND REGULATIONS

National Environmental Policy 2018

The concept of environmental protection through national efforts was first recognized and declared in Bangladesh with the adoption of the Environment Policy, 1992 and the Environment Action Plan, 1992. In 2018 the National Environmental Policy has been rewritten with a vision to ensure sustainable development through environmental conservation, pollution control, conservation of biodiversity and by combating the negative impacts of climate change. The Policy has been set with 16 specific objectives include: i) maintaining natural balance and ensuring overall development of the country through conservation of environment and sustainable management, ii) expansion of climate change adaptation programs to reduce its negative impacts; iii) introduce and encourage wide-spread use of low-carbon emitting technology; iv) identification control of all types of pollution and degradation of environment; v) ensuring environment friendly development in all sectors; vi) introduction and extension of cooperation in the national and international sectors for betterment of the global environment; vii) introducing environmental education, increasing ability, public awareness and develop public opinion in conservation of environment; viii) undertaking Public-Private Partnership in the betterment of environment; ix) ensuring sustainable, long-term and environment-friendly use of all natural resources; x) including environmental policy and strategy into the mainstream of other policies and strategies in order to ensure sustainable development; xi) developing population trained in combating any type of environmental and ecological problems including climate change; xii) ensuring that EIA and EA have been performed in all necessary cases; xiii) discouraging artificial introduction of alien and invasive animals and plants, if required, decide through appropriate research; xiv) maintaining active participation with international initiatives as much as possible and taking necessary programs in local and national platforms; xv) taking initiatives in eradicating poverty through conservation of environment; and xvi) strengthening monitoring to ensure that the environmental conservation laws and acts are being followed properly.

It is essential that proper environmental management and appropriate use of different components of environment are practiced in every region of the country and in every development project. Therefore, the National Environmental Policy 2018 has been developed addressing the sector-wise environmental policy among 24 sectors/fields.

National Environmental Policy 1992

The concept of environmental protection through national efforts was first recognized and declared in Bangladesh with the adoption of the Environment Policy, 1992 and the Environment Action Plan, 1992. The major objectives of Environmental policy are to i) maintain ecological balance and overall development through protection and improvement of the environment; ii) protect country against natural disaster; iii) identify and regulate activities, which pollute and degrade the environment; iv) ensure environmentally sound development in all sectors; v) ensure sustainable, long term and environmentally sound base of natural resources; and vi) actively remain associate with all international environmental initiatives to the maximum possible extent.

Bangladesh Environmental Conservation Act (ECA), 1995 amended 2002 and 2010

This umbrella Act includes laws for conservation of the environment, improvement of environmental standards, and control and mitigation of environmental pollution. It is currently the main legislative framework document relating to environmental protection in Bangladesh, which repealed the earlier Environment Pollution Control ordinance of 1977.

The main provisions of the Act can be summarized as:

- Declaration of ecologically critical areas, and restrictions on the operations and processes, which can be carried or cannot be initiated in the ecologically critical area;
- Regulation in respect of vehicles emitting smoke harmful for the environment.
- Environmental Clearance;
- Regulation of industries and other development activities with regards to discharge permits;
- Promulgation of standards for quality of air, water, noises and soils for different areas for different purposes;
- Promulgation of standard limits for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines;

The first sets of rules to implement the provisions of the Act were promulgated in 1997 (see below: “Environmental Conservation Rules 1997”).

The Environmental Conservation Act has been further amended in 2010 where the “Wetland” has been defined to include any marshy land, flood plain land, land of which contain water and rain water; “Hill and Tilla” have been identified as those naturally created earth surface which are above the ground from adjacent plain land, or ground and stone or stone or ground and gravel or mound or place formed any other hard substances and, noted as “Hill and Till” land in government record; and “ Hazardous waste” has been defined as any kinds of waste, due to its physical or chemical properties or contraction with other waste or substances create toxicity, infection, oxidation, exploration, radioactivity, decay or other harmful effect to environment.

In the 2010 amendment it is prohibited to cutting and/ or razing of hill and tilla by person or institution of government or semi-government or personal or autonomous organization or occupied or personal acquisition: provided that such direction, it will be possible to cut or raze hill or tilla with respect to clearance certificate from the Department in case of necessity of national interest. Furthermore, to protect the environmental damage, government with respect to provision of other law can control by means of provision production, processing, contain, storage, loading, supply, transportation, import, export, disposal, dumping, etc. of hazardous waste. In this amendment the penalties for various violation have been modified in a tabular form.

Environment Conservation Rules (ECR) 1997, amended 2003 and 2010

These are the first set of rules, promulgated under the Environment Conservation Act 1995. Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) Categorization of industries, development projects and other activities on the basis of actual (for existing industries/development projects/activities) and anticipated (for proposed industries/development projects/activities) pollution load iii) requirement for and procedures to obtain Environmental Clearance, and (iv) requirements for IEE/EIA according to categories of industrial and other development interventions v) Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civil life.

Depending on the location, size and severity of pollution loads, projects/activities have been classified in ECR, 1997 into four categories: Green, Orange A, Orange B and Red respectively as nil, minor, medium and severe impacts on important environmental components (IECs).

National Land-use Policy, 2001

The Government of Bangladesh has adopted national Land use Policy, 2001. The salient features of the policy objectives relevant to the proposed policy are as follows:

- To prevent the current tendency of gradual and consistent decrease of cultivable land for the production of food to meet the demand of expanding population;
- To ensure that land use is in harmony with natural environment;
- To use land resources in the best possible way and to play supplementary role in controlling the consistent increase in the number of land less people towards the elimination of poverty and the increase of employment;
- To protect natural forest areas, prevent river erosion and destruction of hills;
- To prevent land pollution; and
- To ensure the minimal use of land for construction of both government and nongovernment buildings.

Environment Court Act, 2000, amended 2010

The aim and objective of the Act is to materialize the Environmental Conservation Act, 1995 through judicial activities. This Act includes establishment of Environmental Courts (one or more in every division), set the jurisdiction of the courts, and outlined the procedure of activities and power of the courts, right of entry for judicial inspection and for appeal as well as the constitution of Appeal Court.

Bangladesh Labor Act, 2006, amended 2013

This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions. In the chapter VI of this law, safety precaution regarding explosive or inflammable dust/ gas, protection of eyes, protection against fire, works with cranes and other lifting machinery, lifting of excessive weights are described. Also in the Chapter VIII provision of safety measures such as appliances of first aid, maintenance of safety record book, rooms for children, housing facilities, medical care, group insurance etc. are illustrated.

Public Procurement Rule (PPR), 2008

This is the public procurement rules of Bangladesh and this rule shall apply to the Procurement of Goods, Works or Services by any government, semi-government or any statutory body established under any law. The PPR Rule includes Principles of Public Procurement, Preparation of Tender or Proposal, Methods of Procurement for goods and related services, works, physical services and their use, Preparation of Specification, Processing of Procurement, Contract Administration and Management, Procurement of Intellectual and Professional services and e-Government Procurement etc.

Bangladesh National Building Code (BNBC), 2017 (Draft)

The basic purpose of this code is to establish minimum standards for design, construction, quality of materials, use and occupancy, location and maintenance of all buildings within Bangladesh in order to safeguard, within achievable limits, life, limb, health, property and public welfare. The installation and use of certain equipment, services and appurtenances related, connected or attached to such buildings are also regulated herein to achieve the same purpose.

Part-7, Chapter-3 of the BNBC has clarified the issue of safety of workmen during construction and with relation to this, set out the details about the different safety tools of specified standard. In relation with the health hazards of the workers during construction, this chapter describes the nature of the different health hazards that normally occur in the sites during construction and at the same time specifies the specific measures to be taken to prevent such health hazards. According to this chapter, exhaust ventilation, use of protective devices, medical checkups etc. are the measures to be taken by the particular employer to ensure a healthy workplace for the workers.

Chapter-1, Part-7 of the Bangladesh National Building Code (BNBC), states the general duties of the employer to the public as well as workers - “All equipment and safeguards required for the construction work such as temporary stair, ladder, ramp, scaffold, hoist, run way, barricade, chute, lift etc. shall be substantially constructed and erected so as not to create any unsafe situation for the workmen using them or the workmen and general public passing under, on or near them”.

Chapter -1, Part-7 of the BNBC clearly sets out the constructional responsibilities according to which the relevant authority of a particular construction site shall adopt some precautionary measures to ensure the safety of the workmen. According to section 1.2.1 of chapter 1 of part 7, “in a construction or demolition work, the terms of contract between the owner and the contractor and between a consultant and the owner shall be clearly defined and put in writing. These however will not absolve the owner from any of his responsibilities under the various provisions of this Code and other applicable regulations and bye-laws. The terms of contract between the owner and the contractor will determine the responsibilities and liabilities of either party in the concerned matters, within the provisions of the relevant Acts and Codes (e.g.) the Employers' Liability Act, 1938, the Factories Act 1965, the Fatal Accident Act, 1955 and Workmen's Compensation Act 1923”. (After the introduction of the Bangladesh Labor Act, 2006, these Acts have been repealed).

To prevent workers falling from heights, the Code in Chapter 3 of Part 7 sets out the detailed requirements on the formation and use of scaffolding. According to section 11.2 of the same chapter, “every temporary floor opening shall either have railing of at least 900 mm height or shall be constantly attended. Every floor hole shall be guarded by either a railing with toe board or a hinged cover. Alternatively, the hole may be constantly attended or protected by a removable railing. Every stairway floor opening shall be guarded by railing at least 900 mm high on the exposed sides except at entrance to stairway. Every ladder way floor opening or platform shall be guarded by a guard railing with toe board except at entrance to opening. Every open sided floor or platform 1.2 meters or more above adjacent ground level shall be guarded by a railing on all open sides except where there is entrance to ramp, stairway or fixed ladder. The precautions shall also be taken near the open edges of the floors and the roofs”.

3.3 RELEVANT FIRE SAFETY RULES FOR BUILDINGS

According to Bangladesh National Building Code (BNBC), any building over six storeys is by definition a high-rise building. In any such buildings, building owners must follow fire safety rules and install fire-fighting equipment. Before completing construction work, building owners have to obtain Fire Service Approval. Fire service will check the building and if the building complies with all fire safety design requirements and has adequate fire-fighting equipment, then only the Fire Service will issue a No Objection Certificate (NOC).
According to the BNBC's ‘Fire Drill and Evacuation Procedure’ section, every building must have an emergency evacuation protocol, a first aid and firefighting plan, training and responsibilities

for occupants, compliant with the requirements provided therein. All occupants of buildings must be trained in first aid and firefighting.

According to BNBC, high rise buildings have to be equipped with hydrant and sprinkler systems so water is sprayed automatically if room temperature goes above 62 degree Celsius. High rise buildings must be equipped with heat detectors, flame detectors, rate-of-rise heat detectors, and smoke detectors, including ionization chamber, smoke detectors and chemically sensitive smoke detectors. BNBC requires Fire Service and Civil Defense to check high rise buildings for sprinklers installed every 10 feet. The law requires buildings to set up smoke detectors in each and every room. Smoke venting devices are required to be designed and installed so they operate automatically at the earliest sign of fire or smoke.

The building code says the maximum height for an apartment building should be six stories. On the other hand, the Dhaka Metropolis Building Construction Rules 2008 allows 10-storied residential buildings with one staircase and exit. However, buildings with over 500 occupants must have at least two staircases, and fire exits need to have doors that block out fire and smoke. Escape staircases must be protected against fire. Such staircases must have positive air pressure, connected through a pressurized lobby. Alternate routes must be available in a fire to the extent that every home in a building must have an escape plan. Staircases and alternate exits should be as far apart as possible from each other.

Rule 17(1) of the Building Construction Rules 1996 requires establishment of the emergency exit gate in every floor connected to its lower floors. It further provides installation of fire extinguisher machine or any other alternative arrangement as much as necessary in a conspicuous place of the building along with fire alarms as an indication to leave the building.

Bangladesh National Building Code (2006), Chapter 4 presents the design, construction and arrangement of building components to provide a reasonably safe means of escape therefrom. Buildings shall be evacuated during any repair or alteration works unless the existing means of escape and fire protection system are continuously maintained or other exit and protection measures are taken to provide an equivalent degree of safety. All buildings constructed for human occupancy or storage shall be provided with adequate exit facilities to permit safe and quick unaided escape of the occupants in the event of fire or other emergency. Paragraph 3.3.5 of BNBC provides that the owner of the building shall be responsible for the safety of all occupants. Usually used stairways or lifts cannot be regarded as emergency exit. This code also enunciates some exit requirements for different occupancies such as health care, educational, institutional, dwelling houses, industries, etc.

Section 4 of the Fire Prevention and Extinction Act 2003 provides that if any person wants to use any building as warehouse or workshop, he shall have to take license from the Directorate General of Fire Service and Civil Defense. Contravention of this section will cause imprisonment for 3 years or fine and the building along with goods kept in it shall be forfeited. Section 7

depicts, notwithstanding anything contained in any other law, without approval of the Directorate General of Fire Service and Civil Defense regarding fire prevention or extinction, no structural design or layout of multi-storied commercial building shall be approved or amended. Section 18 connotes that contravention of section 7 shall be dealt with imprisonment for 6 months or fine. Section 8 (3) directs every owner of the building to take precautions and other measures necessary for public safety. The Fire Prevention and Extinction Act 2003 is supplemented by the Fire Prevention and Extinction Rules 2014 which enumerates that owner of the building shall have to apply for occupancy certificate of the building at the end of the construction (Rule 22). These enable the authority to inspect the building, to examine whether the owner met all the requirements of the building code for the public safety or not.

3.4 NATIONAL SOCIAL POLICIES, LAWS AND REGULATIONS

Infrastructure development projects using lands in Bangladesh is designed and implemented under the legislative and regulatory framework to compensate the affected persons due to land acquisition using the power of eminent domain. Whenever it appears to the Government that any property in any locality is needed or is likely to be needed for any public purpose or in the public interest, the property is acquired using existing laws and regulations. Land acquisition is governed by the Acquisition and Requisition of Immovable Property Ordinance, 1982 (Ordinance II of 1982). The ordinance supersedes earlier laws including the Land Acquisition Law of 1894 and others that have been in force between 1947 and 1982. In addition to the Ordinance, acquisition of any land or forest area in Chittagong Hill-Tracts (CHT) districts requires consent under the Chittagong Hill-Tracts (Land Acquisition) Regulation 1958, the CHT Regional Council Act 1998 and the Forest Act (1927). There is no national policy in Bangladesh governing social effects of infrastructure development projects on the project area communities. However, the Constitution of Bangladesh provides some rights to the affected persons, communities and groups those are not upheld in the Ordinance II of 1982 which is the instrument followed for land acquisition. The active instruments under the legislative and regulatory framework in Bangladesh are discussed below:

Constitution of Bangladesh

The fundamental rights under the Constitution indicate the general guidelines for a policy on resettlement/rehabilitation of citizens adversely affected (whatever be the mechanism) due to any activity of the State. Article 40 of the constitution states categorically that every citizen has the right to practice any lawful occupation which implies that anything impeding such right (a) should not be done or (b) there should be supplementary measures to make good the losses incurred by the citizen. Resettlement and rehabilitation of adversely affected people due to infrastructure projects very clearly falls within this requirement for supplementary measures. However, as per Article 42, sub-clause 2, no law with provision of compensation for acquisition of land can be challenged in a court on the ground that such compensation has been inadequate. However, under World Bank OP 4.12 Involuntary Resettlement, every affected person will have access to a project specific Grievance Redress Mechanism for dispute

resolution before the matter is moved to the courts. Complaints, the resolution process and the outcome will be reviewed by the project proponent as well as the Bank.

The Acquisition and Requisition of Immovable Property Ordinance, 1982

The principal legal instrument governing land acquisition in Bangladesh is the Acquisition and Requisition of Immovable Property Ordinance, 1982 (Ordinance II of 1982 with amendments up to 1994) and other land laws and administrative manuals relevant to land administration in Bangladesh. According to the Ordinance, whenever it appears to the Government of Bangladesh that any property in any locality is needed or is likely to be needed for any public purpose or in the public interest, the Government can acquire the land provided that no property used by the public for the purpose of religious worship, graveyard and cremation ground. The 1982 Ordinance requires that compensation be paid for (i) land and assets permanently acquired (including standing crops, trees, houses); and (ii) any other damages caused by such acquisition. The Deputy Commissioner (DC) determines (a) market value of acquired assets on the date of notice of acquisition (based on the registered value of similar property bought and/or sold in the area over the preceding 12 months), and (b) 50% premium on the assessed value (other than crops) due to compulsory acquisition. The 1994 amendment made provisions for payment of crop compensation to tenant cultivators. The law specifies methods for calculation of market value of property based on recorded prices obtained from relevant Government departments such as Registrar (land), Public Works Department (structures), Department of Forest (trees), Department of Agriculture (crops) and Department of Fisheries (fish stock). Given that people devalue land during title transfer to minimize tax payment, compensation for land paid by DC including premium largely remains less than the actual market price.

The Ministry of Land (MOL) is authorized to deal with land acquisition. The MOL delegates some of its authority to the Commissioner at Divisional level and to the Deputy Commissioner at the District level. The Deputy Commissioners (DCs) are empowered by the MOL to process land acquisition under the Ordinance and pay compensation to the legal owners of the acquired property. Khas (government owned land) lands should be acquired first when a project requires both khas and private land. If a project requires only khas land, the land will be transferred through an inter-ministerial meeting following the acquisition proposal submitted to DC or MOL as the case may be. The DC is empowered to acquire a maximum of 50 standard bigha (6.75 ha) of land without any litigation where the Divisional Commissioner is involved for approval. Acquisition of land more than 50 standard bigha is approved from the central land allocation committee (CLAC) headed by the chief executive of the Government of Bangladesh proposed by the MOL.

The land owner needs to establish ownership by producing record-of-rights in order to be eligible for compensation under the law. The record of rights prepared under 4. 143 or 144 of the State Acquisition and Tenancy Act 1950 (revised 1994) are not always updated and as a

result legal land owners have faced difficulties trying to “prove” ownership. The affected person (AP) has also to produce rent receipt or receipt of land development tax, but this does not assist in some situations as a person is exempted from payment of rent if the area of land is less than 25 bighas (3.37 ha).

3.5 INSTITUTIONAL FRAMEWORK RELATED TO ENVIRONMENT IN BANGLADESH

As outlined in the National Environment Policy (1992) and National Forest Policy (1994), the Ministry of Environment, Forests and Climate Change acts as the guide and custodian for the conservation and development of the environment and, in the pursuit of that goal, to ensure through appropriate laws and regulations that natural resources, including land, air, water and forests, are exploited and managed in an environmentally sustainable manner. The Department of Environment (DoE), formed in 1989 with a mandate for environmental management later formalized under the Environment Conservation Act, 1995 (ECA’95), acts as the technical arm of the Ministry and is responsible for environmental planning, management, monitoring and enforcement. The mandate of the Department has expanded over time, evolving from an exclusive focus on pollution control to include natural resources and environmental management, now covering:

- monitoring environmental quality;
- promoting environmental awareness through public information programs;
- controlling and monitoring industrial pollution;
- reviewing environmental impact assessments and managing the environmental clearance process; and,
- establishing regulations and guidelines for activities affecting the environment

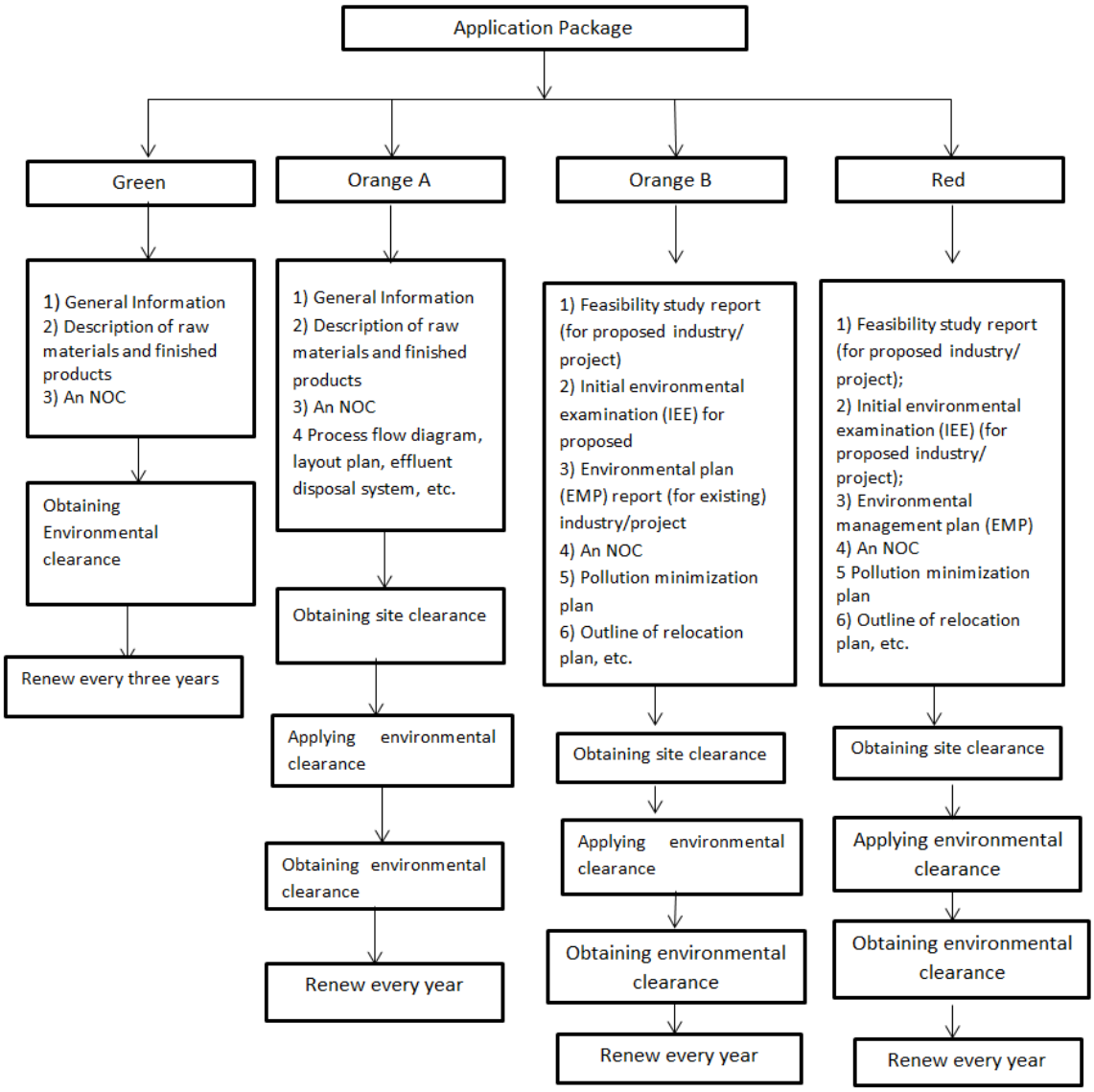
DoE is headed by a Director General (DG). The DG has complete control over the DoE and the main power of DG, as given in the Act, may be outlined as follows:

- Identification of different types and causes of environmental degradation and pollution;
- Instigating investigation and research regarding environmental conservation, development and pollution.
- Power to close down the activities considered harmful to human life or the environment.
- Power to declare an area affected by pollution as an Ecologically Critical Area. Under the Act, operators of industries/projects must inform the Director General of any pollution incident. In the event of an accidental pollution, the Director General may take control of an operation and the respective operator is bound to help. The operator is responsible for the costs incurred and possible payments for compensation.

The Environment Conservation Rules (1997) provide the Director General a discretionary authority to grant ‘Environmental Clearance' to an applicant, exempting the requirement of site/location clearance, provided the DG considers it to be appropriate.

Rule 7 of Environment Conservation Rules (ECR) has classified the projects into following four categories based on their site conditions and the impacts on the environment; (a) Green, (b) Orange A, (c) Orange B and (d) Red. Various industries and projects falling under each category

have been listed in Schedule 1 of ECR 1997. According to the Rules, Environmental Clearance Certificate is issued to all existing and proposed industrial units and projects, falling in the Green Category without undergoing EIA. However, for category Orange A and B and for Red projects, require location clearance certificate and followed by issuing of Environmental Clearance upon the satisfactory submission of the required documents. Green listed industries are considered relatively pollution-free, and therefore do not require site clearance from the DoE. On the other hand, Red listed industries are those that can cause 'significant adverse' environmental impacts and are, therefore, required to submit an EIA report. These industrial projects may obtain an initial Site Clearance on the basis of an IEE based on the DoE's prescribed format, and subsequently submit an EIA report for obtaining Environmental Clearance. Figure 3.1 shows the process of application leading to environmental clearance for all four categories of projects.



NOC = No Objection Certificate, usually obtained from local government.

Figure 3.1: Environmental Clearance Procedure in Bangladesh (ECR, 1997)

3.6 WORLD BANK ENVIRONMENTAL AND SOCIAL SAFEGUARD POLICIES

The objective of World Bank environmental and social safeguard policies is to prevent and mitigate undue harm to people and the environment due to the development process. Safeguard policies provide a platform for the participation of stakeholders in project design, and act as an important instrument for building ownership among local populations.

The World Bank sets out its procedures and policies with regard to conducting environmental assessments in different policies and other pertinent Guidelines. World Bank Environmental and Social Safeguard Policies provide ten potential issues that may need to be considered in an EIA. These are:

Environmental policies:

OP/BP 4.01 Environmental Assessment
OP/BP 4.03Performance Standards for Private Sector Projects
OP/BP 4.04 Natural Habitats
OP/BP 4.09 Pest Management
OP/BP 4.11 Physical Cultural Resources
OP/BP 4.36 Forests
OP/BP 4.37 Safety of Dams

Social Policies

OP/BP 4.10 Indigenous Peoples
OP/BP 4.12 Involuntary Resettlement

Legal Policies

OP/BP 7.50 International Waterways
OP/BP 7.60 Disputed Areas

Operational Policies (OP) are the statement of policy objectives and operational principles including the roles and obligations of the Borrower and the Bank, whereas Bank Procedures (BP) is the mandatory procedures to be followed by the Borrower and the Bank. Apart from these, the WB guidelines for Environmental Health and safety have been adopted by the World Bank Group which is also relevant for environmental protection and monitoring. In addition to that the Policy on Access to Information of World Bank also relates to environmental safeguard.

WBG Environmental, Health and Safety Guidelines

The Environmental, Health and Safety (EHS) Guidelines of the World Bank Group (WBG)/International Finance Corporation (WBG), 2008 is the safeguard guidelines for environment, health and safety for the development of the industrial and other projects. They contain performance levels and measures that are considered to be achievable in new facilities at reasonable costs using existing technologies. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed

justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment. The section 4 of EHS Guidelines for "Construction and Decommissioning" provides additional, specific guidance on prevention and control of community health and safety impacts that may occur during new project development, at the end of the project life-cycle, or due to expansion or modification of existing project facilities.

World Bank Policy on Access to Information

In addition to the safeguard policies, the Access to Information Policy also relates to safeguards. To promote transparency and facilitate accountability, Bank Access to Information Policy supports decision making by the Borrower and Bank by allowing the public access to information on environmental and social aspects of projects in an accessible place and understandable form and language to key stakeholders. The Bank ensures that relevant project-related environmental and social safeguard documents, including the procedures prepared for projects involving subprojects, are disclosed in a timely manner before project appraisal formally begins. The policy requires disclosure in both English and Local language and must meet the World Bank standards.

3.7 APPLICABILITY TO THE PROJECT

Depending on the specific characteristics of the project, both World Bank and Bangladesh's National policies, laws, rules, acts which will be applicable to the project are presented in the following sub sections.

3.7.1 Applicable World Bank Policies

The expected applicability of the potential World Bank safeguard policies for the proposed URU project has been summarized in the following Table 3.1:

Table 3.1: World Bank Environmental Safeguard Policies and its Applicability to the Project

Safeguard Policy	Requirement	Policy Triggered	Applicability/Compliance
Environment Assessment (EA) (OP 4.01)	The Bank requires EA of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making.	Yes	The proposed project involves construction of a 10 storied + 2 basement building on 1.77 acres of land owned by RAJUK at Mohakhali, Dhaka. All environmental and social aspects included in the proposed project will be adequately examined. The project is likely to have some risks and potential adverse environmental impacts during the construction and operational phases regarding the natural environment, water, human health, and safety.

Safeguard Policy	Requirement	Policy Triggered	Applicability/Compliance
Performance Standards for Private Sector Activities (OP 4.03)	This policy is aimed at facilitating World Bank financing for private sector led economic development projects by applying environmental and social policy standards that are better suited to the private sector, while enhancing greater policy coherence and cooperation across the World Bank Group	No	Since it is a Govt. project, therefore, OP 4.03 is not applicable.
Natural Habitats (OP 4.04)	The Bank requires borrowers to incorporate into their development and environmental strategies analyses of any major natural habitat issues, including identification of important natural habitat sites, the ecological functions they perform, the degree of threat to the sites, priorities for conservation, and associated recurrent-funding and capacity-building needs.	No	The project site is at the prime location of the commercial area of Mohakhali, Dhaka The land is owned by the client RAJUK. There exists only a number of fruit trees within the project boundary. Therefore, the impacts on natural habitat may not be significant due to the project.
Pest Management (OP 4.09)	In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management. As necessary, the Bank and the borrower incorporate in the project components to strengthen such capacity	No	The proposed project involves the construction of a 10 storied building in an urban setting. The project activity would not require the use of pesticides in any way.
Involuntary Resettlement (OP 4.12)	World Bank recognizes that Involuntary resettlement may cause severe long-term hardship, impoverishment, and environmental damage unless appropriate measures are carefully planned and carried out.	No	The project will be built in RAJUK own land and no human resettlement or land acquisition/requisition will be required.
Indigenous People (OP 4.10)	The Bank recognizes that the identities and cultures of Indigenous Peoples are inextricably linked to the lands on which they live and the natural resources on which they depend. Hence, A the project proposed for Bank financing must be screened for the presence of indigenous people.	No	This policy does not get triggered as there are no indigenous people inside and within the project influence area.

Safeguard Policy	Requirement	Policy Triggered	Applicability/Compliance
Forests (OP 4.36)	If a project involves significant conversion or degradation of natural forests or related natural habitats that the Bank determines are not critical, and the Bank determines that there are no feasible alternatives to the project and its siting, and comprehensive analysis demonstrates that overall benefits from the project substantially outweigh the environmental costs; the Bank may finance the project provided that it incorporates appropriate mitigation measures.	No	The proposed project and the project influence area do not have of any kind of forest land.
Physical Cultural Resources (OP 4.11)	The proponent needs to addresses impacts on physical cultural resources in projects proposed for Bank financing, as an integral part of the environmental assessment (EA) process.	No	No tangible forms of cultural, archaeological, paleontological, historical, and religious significance exist in the vicinity of the project area.
Safety of Dams (OP 4.37)	When the Bank finances a project that includes the construction of a new dam, it requires that the dam be designed and its construction supervised by experienced and competent professionals.	No	Not applicable. No Dams in the project area.
Project in Disputed Areas (OP 7.60)	Projects in Disputed Areas may affect the relations between the Bank and its borrowers, and between the claimants to the disputed area. Therefore, the Bank will only finance projects in disputed areas when either there is no objection from the other claimant to the disputed area, or when the special circumstances of the case support Bank financing, notwithstanding the objection.	No	The proposed project is not in a disputed area.
Project on International Waterways (OP 7.50)	The Bank recognizes that the cooperation and goodwill of riparian's is essential for the efficient use and protection of the waterway. Therefore, it attaches great importance to riparian's making appropriate agreements or arrangements for these purposes for the entire waterway or any part thereof.	No	Not applicable

In addition to Table 3.1, the WBG guidelines provides guidance on certain EHS issues which include standards for environmental parameters (ambient air quality, water and wastewater quality, noise level, waste management), hazard and accident prevention, occupational and community health and safety (during construction and operation) etc. These guidelines will be directly applicable to the proposed project. As a general rule, the WBG guidelines should complement the existing Bangladesh guidelines or standards. In case the Bangladesh guidelines or standards differ from the WBG guidelines, project is expected to follow the more stringent ones. Moreover, relevant Fire Safety Rules will be applicable to the proposed project.

3.7.2 Applicable Environmental Standards

The applicable environmental standards for the proposed project have been presented in Annex C. The ambient air quality and noise standards will be applicable during the construction phase of the project and the wastewater discharges from the project during both construction and operation phases shall be applicable as per the general discharge standards of Bangladesh.

3.7.3 Applicable National Laws, Rules, Acts

Relevant National laws, Act, Rules and Ordinances which will be applicable to the proposed project are summarized and presented in the Table 3.2.

Table 3.2: Relevant Law, Rules, Ordinances to the Project

Act/Rule/Law/Ordinance	Key Features	Applicability
The Environment Conservation Act, 1995 and subsequent amendments in 2000 2002 and 2010	• Define Applicability of environmental clearance • Regulation of development activities from environmental perspective • Framing applicable limits for emissions and effluents • Framing of standards for air, water, and noise quality • Formulation of guidelines relating to control and mitigation of environmental pollution, conservation, and improvement of Environment Declaration of Ecologically critical areas	Applicable as the proposed project activity associated with environmental issues
Environmental conservation Rules, 1997 and subsequent amendments in 2002, 2003 and 2010	• Declaration of Ecologically critical areas • Requirement of environmental clearance certificate for various categories of projects • Requirement of IEE/EIA as per category • Renewal of the environmental clearance certificate within 30 days after the expiry • Provides standards for quality of air, water and sound and acceptable limits for emissions/discharges from vehicles and other sources	Applicable. Projects falls under Orange-B Category and require EIA approval prior to start construction and environmental Clearance Certificate prior to start of operation
Environment Court Act, 2000 and subsequent amendments in 2002	• GoB has given highest priority to environment pollution • Provides the Jurisdictions of	Applicable

Act/Rule/Law/Ordinance	Key Features	Applicability
	environment court, the penalty for violating court's order, trial procedure in special magistrate's court, the power of entry and search, the procedure for investigation, procedure and power of environment court, the authority of environment court to inspect, appeal procedure and formation of environment appeal court.	
Water Supply and Sanitation Act, 1996	Management and control of water supply and sanitation in urban areas.	Not directly applicable, however, indirectly applicable when considering water usage management and sanitation facilities for the project
National Biodiversity Strategy and Action Plan (2004)	Maintain and improve environmental stability for ecosystems and restore the biodiversity of the country for wellbeing of the present and future generations	Not/marginally applicable
The Acquisition and Requisition of Immovable Property ordinance 1982 and subsequent amendments in 1994, 1995 and 2004	Current GOB Act and Guidelines, relating to acquisition and requisition of land	Not Applicable since project will be constructed on RAJUK's own land
The Building construction Act 1952 and subsequent amendments	This act provides for prevention of haphazard construction of building and excavation of tanks which are likely to interfere with the planning of certain areas in Bangladesh	Applicable due to structure will be constructed in the project area
Noise Pollution (Control) Rules 2006	• Prevention of Noise pollution • Standards for noise levels	Applicable. Noise will be generated due to the construction activity
Bangladesh Labor Law, 2006, Bangladesh Labor Act, 2013 and Bangladesh Labor Rules, 2015	Provides health, safety, and well-being of workforce during project life cycle. In addition, it also stipulated that children under 18 years are not allowed to be employed during project life cycle and therefore, this law requires to be complied with	Applicable as skill, semiskilled and day labor will be worked in the project
The Electricity Act, 1910 and Amendment and The Electricity Rules, 1937	Law relating to the supply and use of electrical energy	Not directly applicable, however, indirectly applicable when considering electricity use during construction and operation phase of the project
The Vehicle Act, 1927; The Motor Vehicles Ordinance, 1983; and The Bengal Motor Vehicle Rules, 1940	• Exhaust emissions • Vehicular air and noise pollution • Road/traffic safety • Vehicle Licensing and Registration • Fitness of Motor Vehicles • Parking by-laws	Applicable for proposed Project in relation to road transport

CHAPTER 4
BASELINE: ENVIRONMENTAL, ECOLOGICAL AND SOCIAL

4.1 INTRODUCTION

As a part of the environmental assessment of the propose RAJUK-URU Building Project, an environmental baseline survey was carried out in areas surrounding the proposed location from July – August, 2019. The specific objectives of the baseline study were:

- To document the existing condition of physical and biological environment and prevailing socio-economic condition of the project areas;
- To identify the significant environmental and social aspects that are likely to be affected by the proposed project activities; and
- Setting of baseline parameters in order to identify possible adverse and beneficial impacts due to the proposed project activities.

This Chapter describes the baseline physical, biological and social environment of project areas based on the findings of the baseline surveys.

4.2 PHYSICAL ENVIRONMENT

4.2.1 Physical Features of the Study Area

The major objective of this project is to construct a 10-storied + 2-basement Urban Resilience Unit (URU) Building (Phase I) including Research, Training, and Testing Laboratory facilities under RAJUK in Mohakhali, Dhaka, Bangladesh for maximum utilization of land to construct commercial and office spaces and to manage seismic preparedness and resilience for the Dhaka City. The RAJUK-URU project site has been selected at RAJUK Mohakhali Zonal Office comprising of 1.77 acre land owned by RAJUK.

As a part of the reconnaissance survey, the EIA Team of BRTC, BUET visited the project site on June 18, 2019 to get a first-hand idea of the project area (Figure 4.1). The proposed project site is located on the north side of the Mohakhali Road, Dhaka. The area is a commercial one housed with many High-Rise Buildings of Government Offices, Commercial Banks, Business entities, etc. The project site is located near the Government Titumir College, Dhaka.

The plot for the proposed project is a rectangular in shape. Presently there is a relatively new 5 storied Building at the north end of the plot. This recently constructed L-shaped building is used as the Zonal Office of RAJUK. Besides, there exists an incomplete unused concrete structure within the site. The existing 4.50m wide service road within the site is located at the east side of the plot. Other than this, there exists a number of trees, mainly fruit trees within the plot. Outside the project boundary area, a residential Hall named 'Akkasur Rahman Akhi Hall' of the Government Titumir College is located at the back side (on the North) of the project

area (Figure 4.2). RAJUK has two adjacent plots in this area separated by a narrow road which gives access to the students of the Government Titumir College to their Hall (Photo 5). One plot is the proposed project site and the other plot is presently used as a storage shed for machinery storage and car sheds. The EIA team visited the two plots and had informal talks with the RAJUK Officials during the visit. The EIA Team also observed that the road in front of the other plot of RAJUK connecting the arterial Mohakhali road is much wider than that of the site.

Figure. 4.1: Photographs of reconnaissance survey of the project site

Figure 4.2: Important physical features around the proposed project site

4.2.2 Archaeological Sites

Bangladesh is considerably rich in archaeological wealth, especially of the medieval period both during the Muslim and pre-Muslim rules, though most of it is still unexplored and unknown. There are no archaeological sites within the project influence area. The nearest remarkable and nationally important establishment to the proposed project site is the Jatiya Sangsad Bhaban, which is more than 5.0 km away.

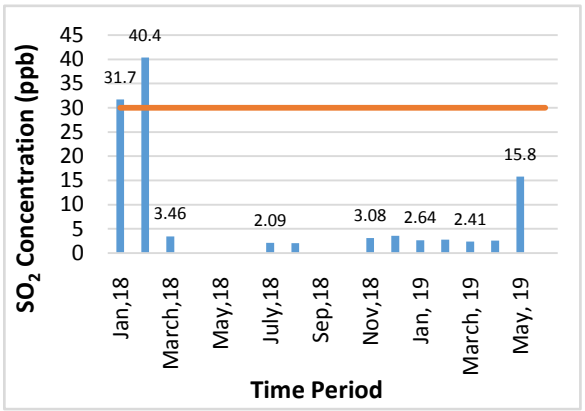
4.3 PHYSICO- CHEMICAL ENVIRONMENT

4.3.1 Air Quality

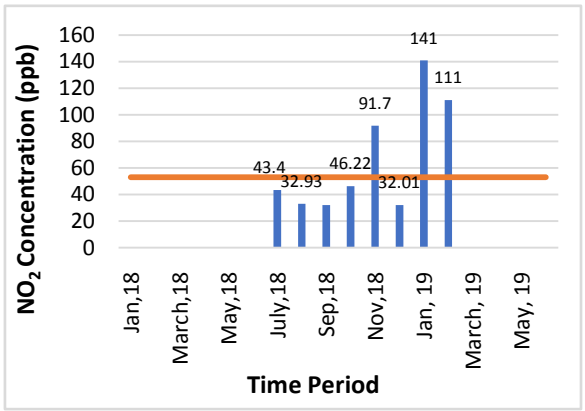
The Clean Air and Sustainable Environment (CASE) Project, under the Ministry of Environment and Forest, Government of the People's Republic of Bangladesh, monitors different ambient air quality parameters from 11 fixed continuous air monitoring stations (CAMS) located in different parts of the country. Among these CAMS, the stations nearest to the proposed project site are CAMS-2 and CAMS-3, hence, the data well represent the proposed project site ambient air quality (Table 4.1). Different ambient air quality data like PM_{10}, $PM_{2.5}$, SO_2, NOx, O_3 measured monthly in these CAMS during the Months of 2018 and 2019 are summarized in Figure 4.3 (a) to (f), which are compared with the Bangladesh Ambient Air Quality Standards and WHO Ambient Air Quality Guidelines for assessing the overall situation of the ambient air quality. The $PM_{2.5}$ and AQI of the year 2018.Table 4.2 outlines the National Ambient Air Quality Standards for Bangladesh.

Table 4.1: The continuous air monitoring stations (CAMS) nearest to the project site

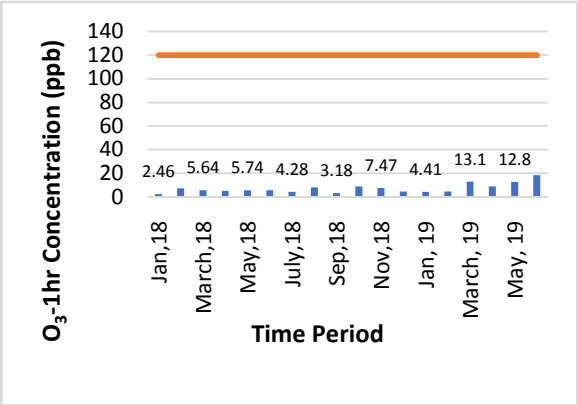
CAMS					
City	ID	Location	Latitude	Longitude	Monitoring Capacity
Dhaka	CAMS-2	Farmgate	23.76N	90.39E	PM_{10}, $PM_{2.5}$, SO_2, NO_2, O_3, and Rainfall
Dhaka	CAMS-3	Darus-Salam	23.78N	90.36E	Solar Radiation, Relative Humidity, Ambient Temperature



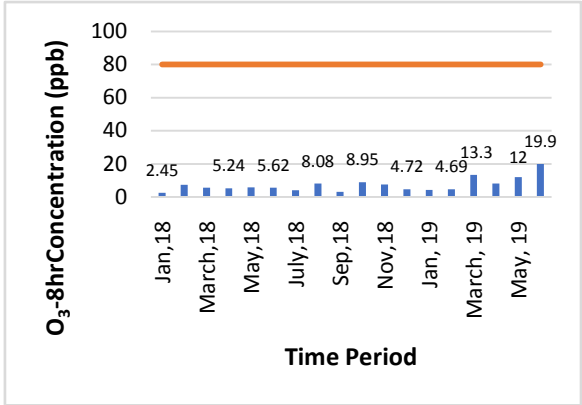
(a)



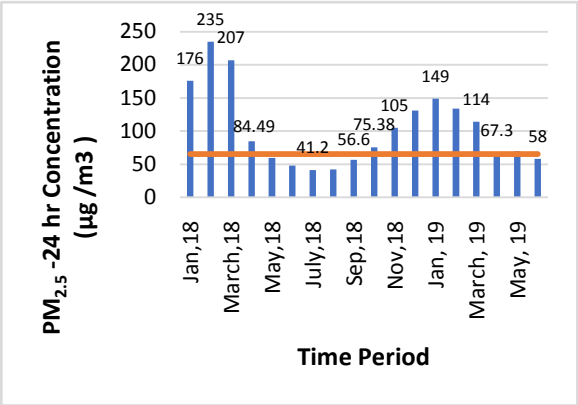
(b)


O3-1hr Concentration (ppb)
140
120
100
80
60
40
20
0
2.46 5.64 5.74 4.28 3.18 7.47 4.41 13.1 12.8
Jan,18
March,18
May,18
July,18
Sep,18
Nov,18
Jan, 19
March, 19
May, 19
Time Period

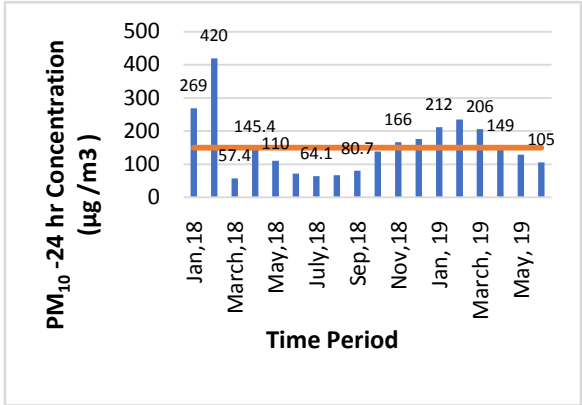
(c)


O3-8hrConcentration (ppb)
100
80
60
40
20
0
2.45 5.24 5.62 8.08 8.95 4.72 4.69 13.3 12 19.9
Jan,18
March,18
May,18
July,18
Sep,18
Nov,18
Jan, 19
March, 19
May, 19
Time Period

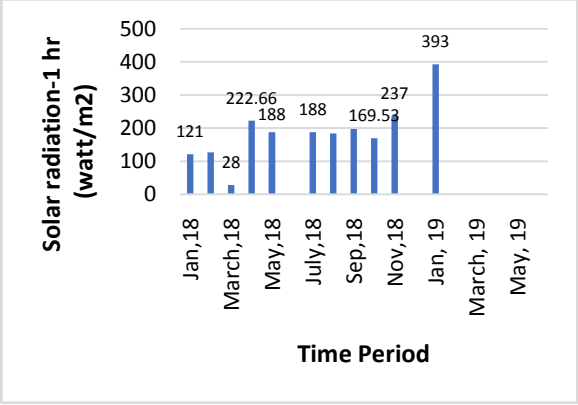
(d)


PM2.5 -24 hr Concentration (µg /m3)
250
200
150
100
50
0
176 235 207 84.49 41.2 56.6 75.38 105 149 114 67.3 58
Jan,18
March,18
May,18
July,18
Sep,18
Nov,18
Jan, 19
March, 19
May, 19
Time Period

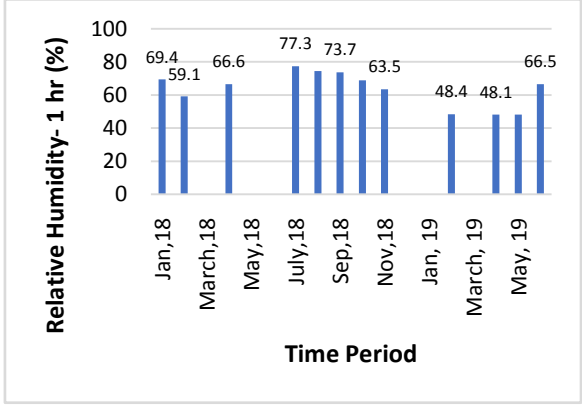
(e)


PM10 -24 hr Concentration (µg /m3)
500
400
300
200
100
0
269 420 57.4 145.4 110 64.1 80.7 166 212 206 149 105
Jan,18
March,18
May,18
July,18
Sep,18
Nov,18
Jan, 19
March, 19
May, 19
Time Period

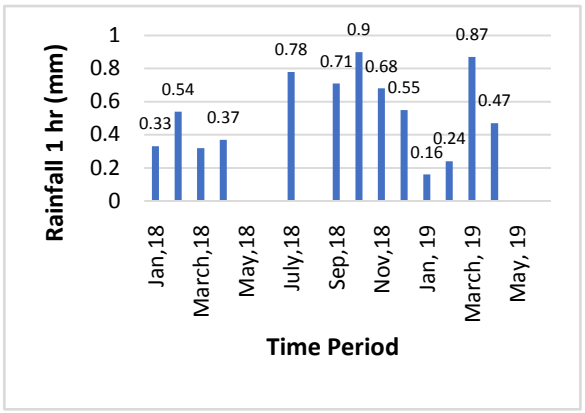
(f)


Solar radiation-1 hr (watt/m2)
500
400
300
200
100
0
121 28 222.66 188 188 169.53 237 393
Jan,18
March,18
May,18
July,18
Sep,18
Nov,18
Jan, 19
March, 19
May, 19
Time Period

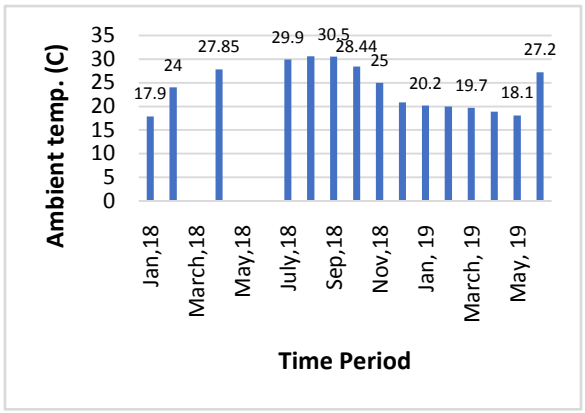
(g)


Relative Humidity- 1 hr (%)
100
80
60
40
20
0
69.4 59.1 66.6 77.3 73.7 63.5 48.4 48.1 66.5
Jan,18
March,18
May,18
July,18
Sep,18
Nov,18
Jan, 19
March, 19
May, 19
Time Period

(h)



(i)



(j)

Figure 4.3: Monthly air quality and Meteorological monitoring data from the CAMS-2 located at Firm Gateand CAMS-3 at Darus Salam for the monthly period of year 2018 and 2019. The air quality parameters monitored are: (a) SO_2, (b) NO_x, (c) O_3-1hr, (d) O_3-8hr, (e) $PM_{2.5}$, (f) PM_{10}, and Meteorological parameters are: (g) Solar radiation, (h) Relative Humidity, (i) Rainfall (j) Temperature

Table 4.2: National Ambient Air Quality Standards for Bangladesh (ECR, 1997)

Pollutant	Objective	Average
CO	10 mg/m^3 (9 ppm)	8 hours [(a)]
	40 mg/m^3 (35 ppm)	1 hour [(a)]
NO_x	100 µg/m^3 (0.053 ppm)	Annual
SO_2	80 µg/m^3 (0.03 ppm)	Annual
	365 µg/m^3 (0.14 ppm)	24 hours [(a)]
O_3	235 µg/m^3 (0.12 ppm)	1 hour [(b)]
	157 µg/m^3 (0.08 ppm)	8 hours
$PM_{2.5}$	15 µg/m^3	Annual
	65 µg/m^3	24 hours
PM_{10}	50 µg/m^3	Annual [(c)]
	150 µg/m^3	24 hours [(d)]

Notes:

Not to be exceeded more than once per year.

The objective is attained when the expected number of days per calendar year with the maximum hourly average of 0.12 ppm is equal to or less than 1 (Source: AQMP, DoE)

The objective is attained when the annual arithmetic mean is less than or equal to 50 µg/m^3

The objective is attained when the expected number of days per calendar year with a 24-hour average of 150 µg/m^3 is equal to or less than 1

Main sources of air pollution of the project sites are brick kiln and vehicular emissions from the daily traffic. The quality of air in the area is also affected by the numerous building construction activities in the Gulshan-Banani-Mohakhali area as well as mega-projects such as the on-going

Elevated Expressway and Metrorail projects. The 24-hr average PM2.5 and PM10 levels recorded at CAMS-2 (at BARC) in 2018 were 103 and 167μg/m^3, respectively. The maximum and minimum levels at the same location are 393 and 8.2 μg /m^3 for PM2.5 and 666 and 29.5 μg /m^3 for PM10, respectively. The maximum concentrations were recorded in the month of February, 2018.

Temporal trends in PM concentrations for 2013 – 2017 demonstrate sharp seasonal variations (Table 4.3). PM10 and PM2.5 concentrations in air remain higher than the standards of Bangladesh during November to April, and from May to October the PM levels satisfy the limit values. The month of January is found to be the most polluted month, followed by December and February. Winter season (December – January) is also characterized with higher fraction of fine particles to PM10 mass concentrations and the summer time (February – April) is typified with coarse particles in air. It is important to note that hundreds of brick kilns around the city operate during the dry season only.

The US Embassy in Dhaka has also installed a continuous air quality monitoring station at Baridhara which records $PM_{2.5}$ and provides Air Quality Index (AQI) of the area. These data are available in the US Embassy website. The US Embassy installed air quality monitoring station records show that the average and maximum PM2.5 levels in the year 2018 were 111.7 and 985 μg /m^3, respectively. The average AQI for the year 2018 was 164, while an AQI index greater than 150 indicates unhealthy condition.
(https://www.airnow.gov/index.cfm?action=airnow.global_summary#Bangladesh$Dhaka).

Table 4.3: Overview of daily PM concentrations in Dhaka in recent years; daily concentrations are determined when minimum 80% valid hourly data is available in a day

Year	PM_{10} Conc. (μg m^{-3})						$PM_{2.5}$ Conc. (μg m^{-3})					
	Data capture rate %	percentile				mean	Data capture rate %	percentile				mean
		25	50	75	95			25	50	75	95	
2013	90.7	66	122	221	394	161.4	87.6	32	57	127	259	92.0
2014	82.2	66	120	237	393	159.4	86.5	34	70	145	236	95.0
2015	62.7	80	160	254	349	172.8	90.0	35	62	143	222	90.0
2016	69.3	58	98	214	395	145.1	64.0	28	44	92	211	68.0
2017	85.7	65	103	207	362	142.6	85.5	34	53	118	200	80.5

Ref.: Sources of air pollution in Bangladesh, CASE Project

4.3.2 Climate

Bangladesh is located at the central part within the Asiatic monsoon region where the climate is tropical. Relatively small size of the country and generally low-lying area cause moderate spatial variation of temperature, precipitation, relative humidity, wind speeds and other climatic variables. However, the climate of Bangladesh exhibits pronounced temporal variability. This is because of the moisture-laden monsoon winds flowing predominantly from the south-west during summer and the comparatively dry and colder north-western winds during winter.

Three seasons are generally recognized: a hot, muggy summer from March to June; a hot, humid and rainy monsoon season from June to November during which more than 85% of the total annual rainfall occurs; and a moderately cold, dry winter from December to February. The beginning of the rainy season vary from year to year; heavy rains may commence anywhere between mid-April and early June and may end anywhere between the end of September and mid-November. Usually winter season is dry with occasional rains. The early summer season is considered from March-April. During summer, the air becomes hot with very low humidity. Early summer is also dominated by Baishakhi cyclone and rains. Figure 4.4 represents the climatic conditions of proposed project site location on Bangladesh Climate Elements map.

Solar Radiation

Solar radiation directly affects air quality contributory pollutants and their dispersion through the area. Figure 4.3(g) shows CAMS-2 (Darus Salam) average monthly solar radiation data of year 2018.

Precipitation

Figure 4.3(i) shows CAMS-2 average monthly rainfall data of year 2018 at the study area. The general pattern of precipitation (which consists entirely of rain) follows the monsoon pattern with the cooler, drier months of November to March, increasing rains in April and May, and highest rainfall in the summer months of September and October when the prevailing wind direction from the southwest brings moisture-laden air from the Bay of Bengal. The winter period (November to February) is dry with very little rainfall. However, the temporal pattern of rainfall is pretty much similar throughout the country.

Relative Humidity

The spatial and temporal variation of Relative Humidity throughout the year is very low in Bangladesh. In the project area, the relative humidity varies from 10.6% to 98.7% with an annual average of 61.2%(Figure 4.3(h)).

Ambient Air Temperature

The temperature of the country is related to the period of rainfall. In general, cool seasons coincide with the period of lowest rainfall. Figures4.3(j) and 4.4 shows the monthly average temperature of the study area. Maximum average temperature over the year is usually observed in March - September and minimum average temperature in January.

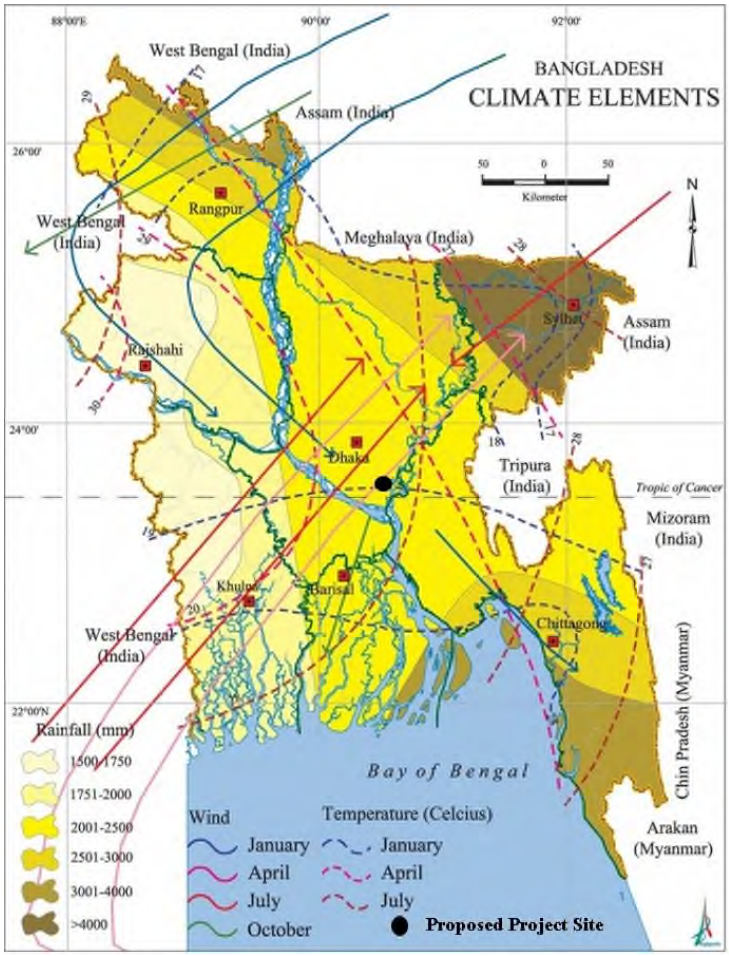


Figure 4.4: The proposed project location on Bangladesh Climate Elements map.

4.3.3 Geology and Seismicity

Geology of Bangladesh is generally dominated by poorly consolidated sediments deposit over the past 10,000 to 15,000 years (Holocene age). It is mostly characterized by the rapid subsidence and filling of a basin in which a huge thickness of deltaic sediments were deposited gradually from the north to south. The delta building is still continuing in the present Bay of Bengal and a broad fluvial front of the Ganges-Brahmaputra-Meghna river system gradually follows it from behind.

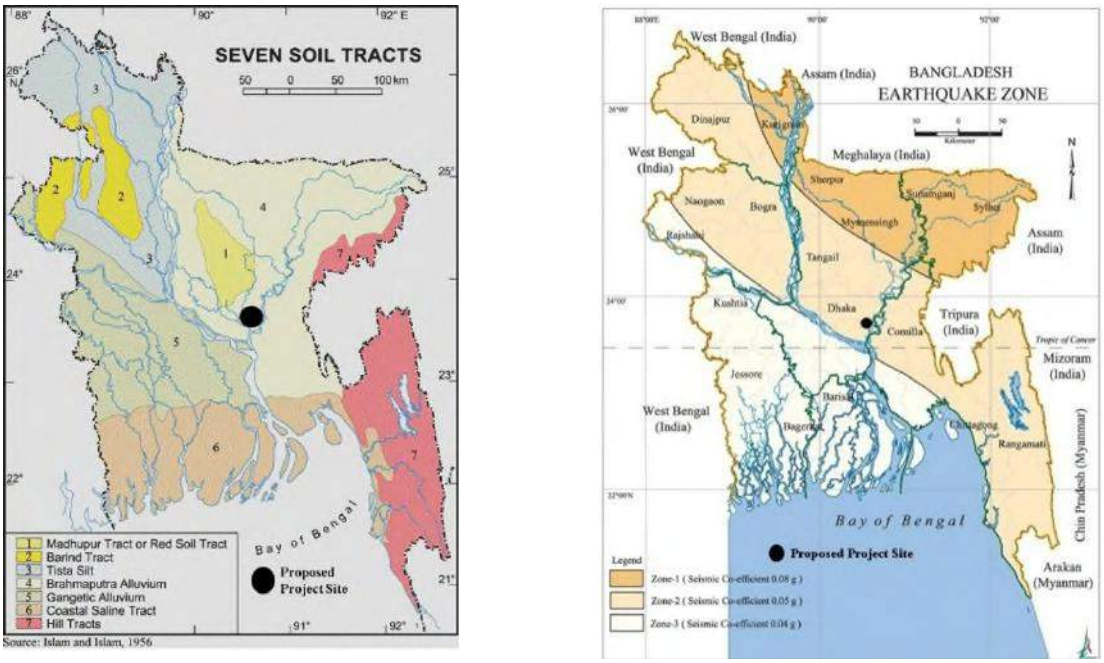
The elevation of Greater Dhaka district is 2 to 13 m above the mean sea level, and most of the urbanized areas are at elevation of 6 to 8 m above the mean sea level. The land area (above 8m) above mean sea level covers about 20 square kilometers. The land ranging from 6 to 8 m above mean sea level covers 75 sq. km, while 170 sq. km of Greater Dhaka district is less than 6 m above mean sea level (JICA 1987).

The land average elevation of Urban Resilience Unit (URU) Building area is about 10.5m PWD. The only nearest large water body is the Banani and Gulshan lakes located around at a distance of 4 km in the east. Two more water bodies are located on the north side of the site, at a distance of 1.6 km, closer to the T&T playground. Moreover, the Turag and Buriganga Rivers are constituting a circular water system along the boundary of the city of Dhaka.

Soil Characteristics

The soil formation in Bangladesh is remarkably homogeneous in appearance, both vertically and laterally. It comprises layer of unconsolidated clay, about 10m thick near Dhaka, but apparently thinner to the east and possibly much thicker in the west of the Rajshahi district. The sand mineralogy in this area is broadly similar to that of the tertiary hill sediments. Mineral contents of the soil are high in quartz, relatively low in feldspar and mica, and with zircon, tourmaline, kyanite, staurolite, sillimanite, and epidote dominating the heavy mineral fractions. The content of easily weatherable minerals ranges from 4 to 9%. The soil of Bangladesh can broadly be classified into seven tracts: (1) Madhupur Tract or Red Soil Tract, (2) Barind Tract, (3) Tista Silt, (4) Brahmaputra Alluvium, (5) Gangetic Alluvium, (6) Coastal Saline Tract, and (7) Hill Tracts. Figure 4.5 (a) shows the position of the project site area on the soil tract map of Bangladesh.

The subsurface sedimentary sequence of Dhaka, up to the explored depth of 300m, shows three distinct entities: one is the Madhupur Clay of the Pleistocene age, characterized by reddish plastic clay with silt and very fine sand particles. This Madhupur Clay un-conformably overlies the DupiTila Formation of the Plio-Pleistocene age, composed of medium to coarse yellowish brown sand and occasional gravel. The incised channels and depressions within the city are floored by recent alluvial floodplain deposits and are further subdivided into Lowland Alluvium and Highland Alluvium.



(a) (b)

Figure 4.5: Location of the proposed site on the (a) seven soil tract map and (b) earthquake zone map of Bangladesh.

Based on the logs of the boreholes drilled at the different locations of the project site, done under a separate study conducted by BUET in February and March of 2019 (BRTC, 2019) as per the request of the RAJUK, soil profiles up to 30m below the EGL are:

- Up to a depth of 6m blow the EGL, read and reddish brown to light brown medium-stiff to very stiff silty clay layers exist.
- Below the medium-stiff to very stiff silty clay layer, brown medium-dense to dense silty fine sand (trace mica) layers were encountered up to a depth of 18m to 25.5m below the EGL. However, a thin pocket of brown medium-stiff to stiff clayey silt was encountered below the medium-stiff to very stiff silty clay layer.

To assess the heavy metal contents of the natural soil in the study area 5 soil samples were collected from the proposed Project site. Figure 4.6 shows the soil and groundwater sampling locations at the project site. The coordinates of each sampling locations are given in Table 4.4. Soil samples were collected from about 0.15m below the top of the original soil layer, using a split spoon. The inorganic parameters, organic contents and heavy metal contents determined through total extraction, following the USEPA guidelines have been performed. In order to assess the suitability of disposal of excavated soil in a landfill site, if required, the soil samples were assessed through Toxicity Characteristics Leaching Procedure(TCLP) following the USEPA Method 1311. Results of the analyses are presented in Table 4.5. Typical levels of heavy metals in natural soils are given in Table 4.6.

Table 4.4: GPS Coordinates of Soil Sampling Locations at the Site

Location	**Sample ID**	**Latitude**	**Longitude**
Location 1	S - 1	23° 46' 53.46"	90° 24' 8.22"
Location 2	S - 2	23° 46' 54.72"	90° 24' 7.53"
Location 3	S - 3	23° 46' 54.72"	90° 24' 8.04"
Location 4	S - 4	23° 46' 55.80"	90° 24' 7.80"
Location 5	S - 5	23° 46' 55.20"	90° 24' 7.32"

Table 4.5: Inorganic, Organic and Heavy Metal Concentrations of Soil at Site

Analysis	**Parameter**	**L -1**	**L -2**	**L -3**	**L -4**	**L -5**
Inorganic	pH	6	6	6	7	7
	EC (µS/cm)	284	100	183	278	165
	Cl^- (g/kg)	7.6	5.6	5.6	4.8	4.8
	SO_4 (g/kg)	16.4	6.4	5.6	3.6	4
TCLP	Cr (mg/L)	2.604	0.355	0.464	0.053	0.04
	Cd (mg/L)	0.032	0.016	0.016	0.43	0.024
	Pb (mg/L)	0.338	0.124	0.104	<MDL	<MDL
	Hg (µg/L)	<MDL	<MDL	<MDL	<MDL	<MDL
Total Extraction	Cr (mg/kg)	25.4	19	22.9	56	32
	Cd (mg/kg)	2.7	0.8	8.3	33	28

Analysis	Parameter	L -1	L -2	L -3	L -4	L -5
	Pb (mg/kg)	13	5.2	<MDL	<MDL	<MDL
	Hg (µg/L)	<MDL	500	110	<MDL	260
Organic	Organic Content %	4.3636	4.2122	3.5353	3.1095	2.8660

Table 4.6: Typical contents of heavy metals in natural soil

Parameters	**Unit**	**Typical content in natural soil [(a)]**
Chloride, Cl-	mg/kg	20-900 (avg 100)
Chromium, Cr	mg/kg	1 – 1000 (avg 100)
Cadmium, Cd	mg/kg	0.1 – 0.7 (avg 0.6)
Lead, Pb	mg/kg	2 – 200 (avg 10)
Nickel, Ni	mg/kg	5 – 200 (avg 20)
Sulfate, SO4	mg/kg	--

[(a)] USEPA Office of Solid Waste & Emergency Response, Hazardous Waste Treatment, SW-874 (April 1983, Page 273)

Seismicity

In the north and northeast of Bangladesh, there are areas of high seismic activity and some of the major earthquakes originating in these areas have affected the adjacent regions of the country. The whole of Bangladesh is divided into three seismic zones. The northern part of the country that includes the greater districts of Rangpur, Mymensingh, and Sylhet are in the Zone-I where earthquake shock of maximum intensity of IX of the Modified Mercalli Scale is possible. The Zone-II includes the greater districts of Dinajpur, Bogra, Dhaka and Chittagong and the shocks of intensity of VIII are possible. The southern part of the country, the least active region, where the maximum intensity is not likely to exceed VII, is in the Zone-III. The experts suggest not to construct normal buildings with more than 60m height. Project site falls under Zone II(Figure 4.5 (b)). The Basic Seismic Coefficient in this Zone is considered to be 0.05g (G 0.2 – 0.6).

4.3.4 Natural Disasters

Floods

Bangladesh is prone to flooding; the coastal flooding as well as the bursting of Bangladesh's riverbanks is common and severely affects the landscape of the country. 75% of Bangladesh is less than 10m above sea level and 80% is flood plain, therefore rendering Bangladesh as a nation very much at risk of further widespread damage. Flooding normally occurs during the monsoon season from June to September during the monsoon. The convectional rainfall ofthe monsoon is added to by relief rainfall caused by the Himalayas. Melt-water from the Himalayas is also a significant input and flood every year. Figure 4.7 (a) shows the position of the project site over the flood risk map of Bangladesh. Although the project site and its surroundings are not susceptible to seasonal flooding, water-logging from sustained rainfall in the monsoon may pose problem.

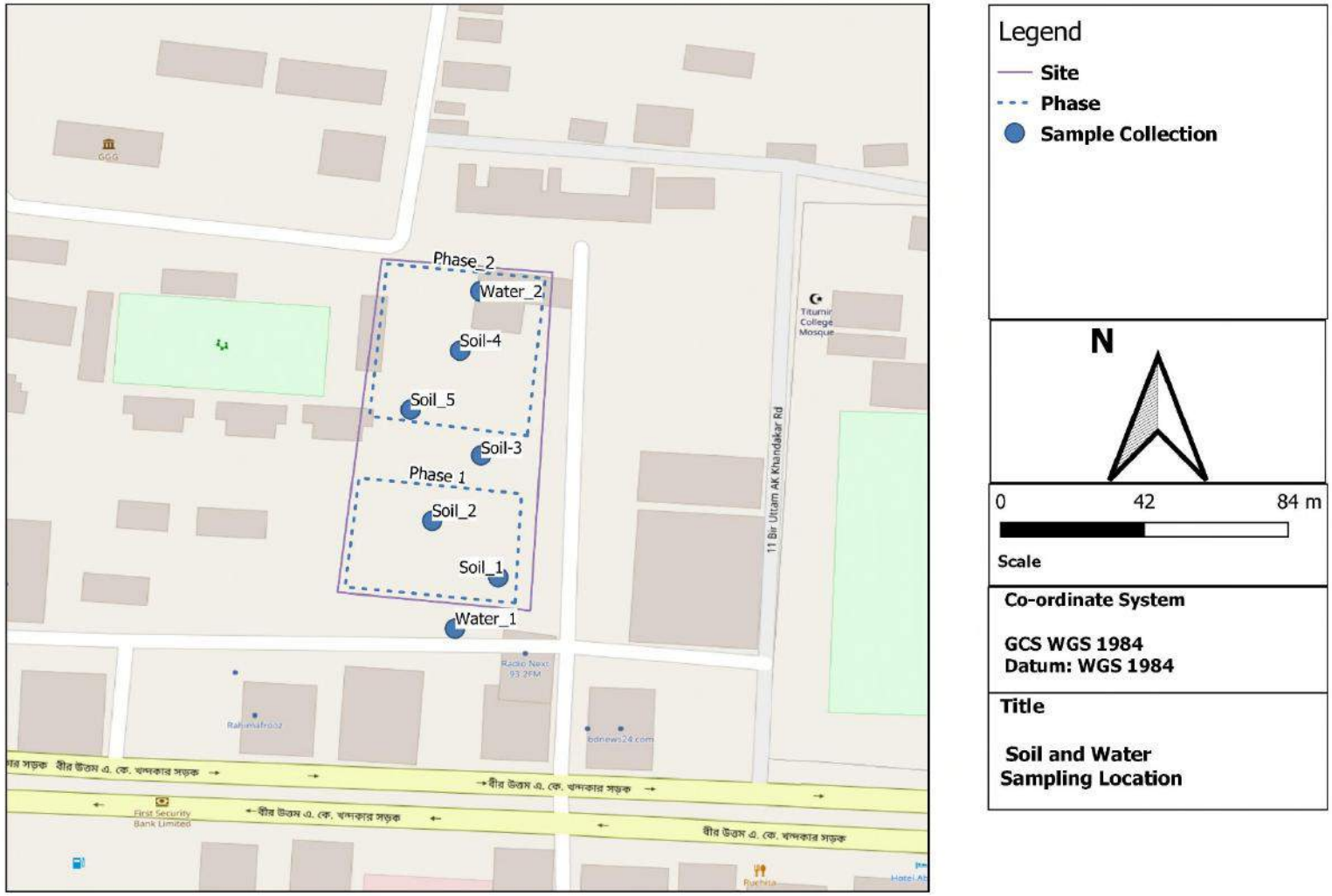


Figure 4.6: Soil and groundwater sampling locations at the proposed project site

Earthquake

Bangladesh is possibly one of the most vulnerable to potential earthquake threat and damage. Earthquake vulnerability of any place largely depends on its geology and topography, population density, building density and quality, and finally the coping strategy of its people and it shows clear spatial variations. Most of the parts of Chittagong, the port city of Bangladesh consisting of fine sand and silt deposits are susceptible to liquefaction. Chittagong City is mostly a hilly region, but it also consists of alluvial flood plain and sandy sea-shore area. Although the hilly region is less susceptible to liquefaction, it is formed by sandy and clayey soil and the area bottom of the hill also liquefy if the intensity of shaking is high, which may cause landslide in the hilly region. On the other hand, flood plains and sea shore areas consisting of fine sand and silt deposit with shallow water table in most of the places, which may liquefy during a strong earthquake. In the north and northeast of Bangladesh, there are areas of high seismic activity and some of the major earthquakes originating in these areas have affected the adjacent regions of the country. The whole of Bangladesh is divided into three seismic zones. The northern part of the country that includes the greater districts of Rangpur, Mymensingh, and Sylhet are in the Zone-I where earthquake shock of maximum intensity of IX of the Modified Mercalli Scale is possible. The Zone-II includes the greater districts of Dinajpur, Bogra, Dhaka and Chittagong and the shocks of intensity of VIII are possible. The southern part of the country, the least active region, where the maximum intensity is not likely to exceed VII, is in the Zone-III. The project area falls under Zone II on the earthquake zone map (Figure 4.5(b)), which implies that earthquakes of moderate intensities are expected here.

Cyclone and Tidal Surge

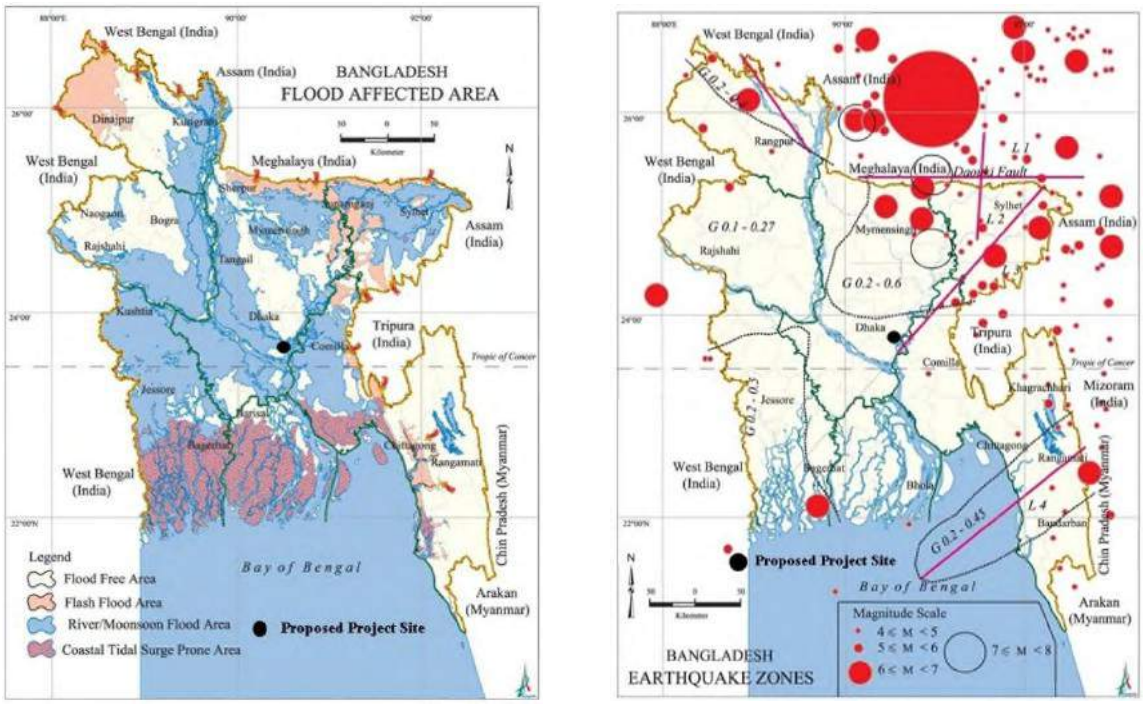
Bangladesh very often becomes the landing ground of cyclones formed in the Bay of Bengal. A cyclone risk map, prepared by the Management Information & Monitoring (MIM) Division of the Disaster Management Bureau (DMB) in 2001 (Figure 4.8), distinguishes between the risk zones of no risk, wind risk, risk (low risk as mentioned in 2003) and high risk. Figure 4.7 shows the proposed project site does not fall under cyclone risk zone or high wind area.

4.3.5 Water Quality

In order to assess the groundwater quality, two representative groundwater samples were collected from the study area on 13th July, 2019. Since there is no surface water body at the site no surface water sample was collected.

Groundwater quality

Groundwater samples were tested for selected water quality parameters at the Environmental Engineering Laboratory of Department of Civil Engineering, BUET. Table 4.7 shows the characteristics of the groundwater. All the parameters analyzed for both the groundwater samples were found to be within the corresponding drinking water limits set in the ECR, ’97 and WHO guidelines.



(a) (b)

Figure 4.7: Location of the proposed site: (a) Flood Affected Area map and (b) earthquake map

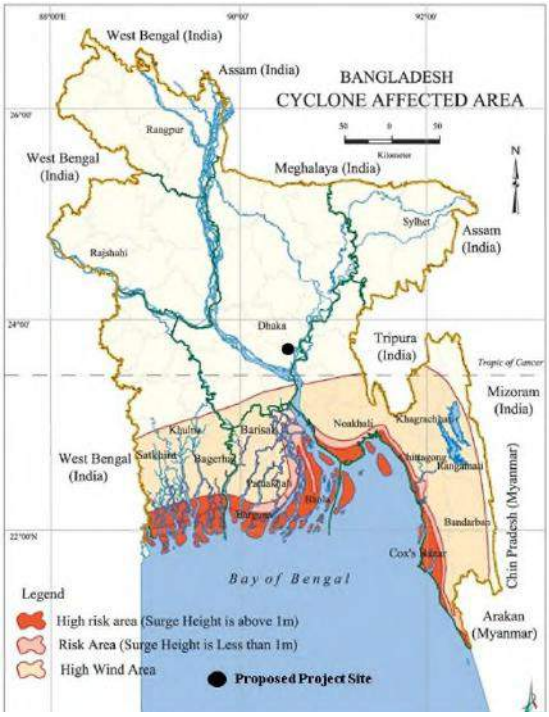


Figure 4.8: Proposed project site on Cyclone affected area map of Bangladesh

Table 4.7: Summary of groundwater quality in the study area

Water Quality Parameters	Unit	Concentrations		WHO Guide line values 2004	Bangladesh Standard for Drinking Water (ECR'97)
		GW- 1	GW-2		
pH	-	7.35	7.18	6.5 - 8.5	6.5 - 8.5
Turbidity	NTU	0.68	0.56	5	10
Color	Pt. Co Unit	7	4	15	15
Total Hardness as $CaCO_3$	mg/L	96	88	500	200 - 500
Iron, Fe	mg/L	<0.02	<0.02	0.3	0.3 - 1.0
Manganese, Mn	mg/L	0.006	0.008	0.5	0.1
Arsenic, As	µg/L	<0.001	<0.001	10	50
Chloride, Cl^-	mg/L	14	13	250	150 - 600
Lead, Pb	mg/L	<0.001	<0.001	0.01	0.05
Cadmium, Cd	mg/L	<0.001	<0.001	0.003	0.005
Chromium, Cr	mg/L	0.01	0.01	0.05	0.05
Nickle, Ni	mg/L	<0.01	<0.01	0.02(p)	0.1
Mercury, Hg	□g/l	<0.001	<0.001		
Total Dissolved Solids, TDS	mg/L	161	213	1000	1000
Total Suspended Solids, TDS	mg/L	7	3	10	-
Total Coliform, TC	# / 100 ml	Nil	Nil	00 TC / 100 ml	00 TC / 100 ml
Fecal Coliform, FC	# / 100 ml	Nil	Nil	00 FC / 100 ml	00 FC / 100 ml
Electrical Conductivity, EC	µs/cm	228	286	-	-
Ammonia-Nitrogen (NH_3-N)	mg/l	009	0.09	0.5	1.5
Nitrate-Nitrogen (NO_3-N)	mg/l	0.4	0.3	10	50
Sulfate, SO_4	mg/l	0.13	3	400	250
Orthophosphate, PO_4	mg/l	12	13	6	-
Total Alkalinity as $CaCO_3$	mg/l	102	148	-	-

Groundwater Table

Water aquifers are present beneath the vast majority of Bangladesh, which are being recharged by the major river systems and by infiltration of rainwater. The groundwater level fluctuates seasonally, approaching the ground surface at some places of the country during the months July to September (Figure 4.9). Groundwater is replenished each year during the monsoon season when rain and flood water finds its way into the aquifer slowly percolating down through overlying soils and sediments. The rate of recharge varies depending on the property of soil and geology of the area.

Groundwater in Dhaka city is declining at an alarming rate. The continuous over withdrawal of ground water and irregular and insufficient recharge causes depletion of groundwater. Rapid urbanization during the past 30 years also contributed to the present condition of Dhaka City. DWASA supplies drinking water to the residents of Dhaka City by extracting groundwater through about 870 deep tubewells and by treating surface water from the Sitalakhhya and Buriganga Rivers. Every year about 10% of these DTWs become non-operational due to groundwater depletion. A historical data records compiled by the BWDB in 2014 show the selected piezometers in Dhaka City (Table 4.8).

Table 4.8: Location and recorded groundwater level of selected piezometers in Dhaka City

Well ID	Location	Thana	Latitude	Longitude	Groundwater Level in meters (2010)
GT2608001	Jour Shahara	Cantonment	23.83	90.42	27.81
GT2668019	Khilgaon	Sabujbag	23.75	90.42	54.4
GT2642900	Palashi	Lalbagh	23.72	90.41	44.77
GT2648010	Monipur	Mirpur	23.79	90.37	65.97
GT2650011	PC Culture	Mohammadpur	23.75	90.37	31.24
GT2616012	Sultanganj	Dhanmondi	23.74	90.37	66.32
GT2988021	Gandaria	Sutrapur	23.70	90.42	21.1

Source: Bangladesh Water Development Board (BWDB), 2014

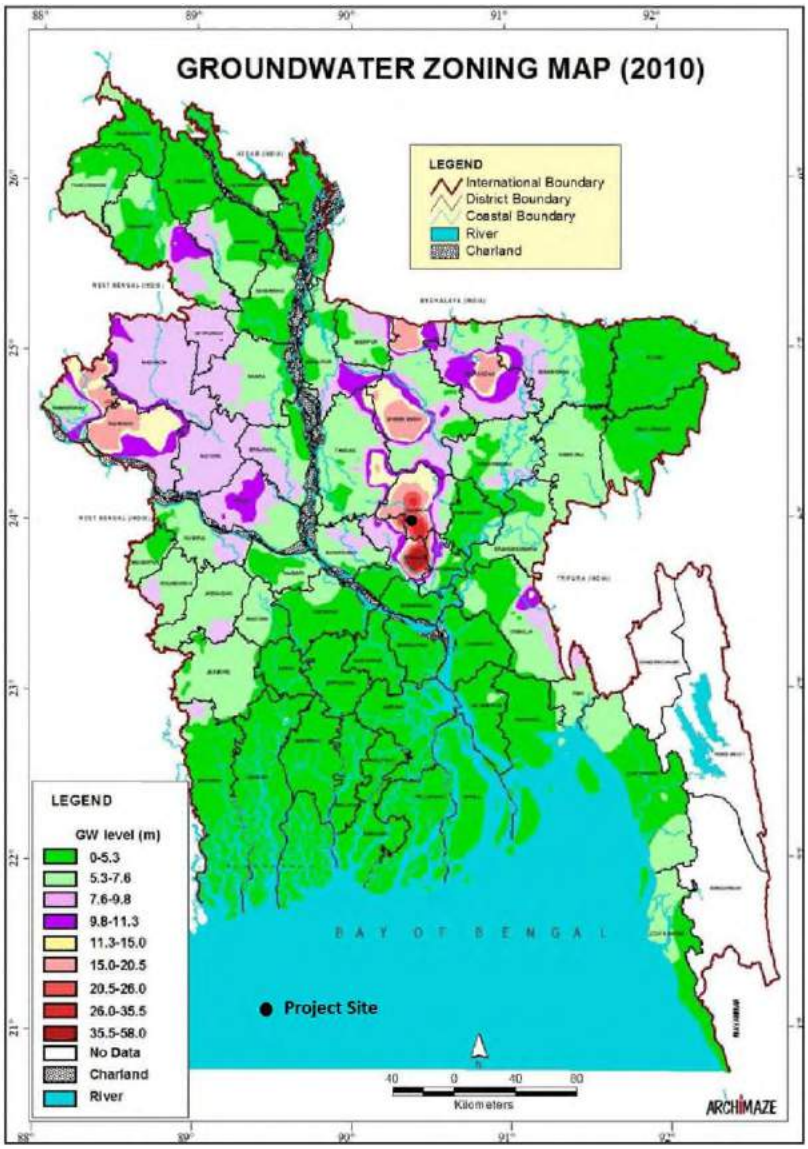


Figure 4.9: Location of the RAJUK-URU project site on the Groundwater Zoning Map 2010 of Bangladesh (map source: Bangladesh Agricultural Development Corporation)

A simulation based on piezometer records of BDWB to map the groundwater conditions was done by Arfanuzzaman and Rahman (2017) which shows alarming extent of lowering of groundwater table in the central part of Dhaka City at the upper DupiTila aquifer system (Figure 4.10).

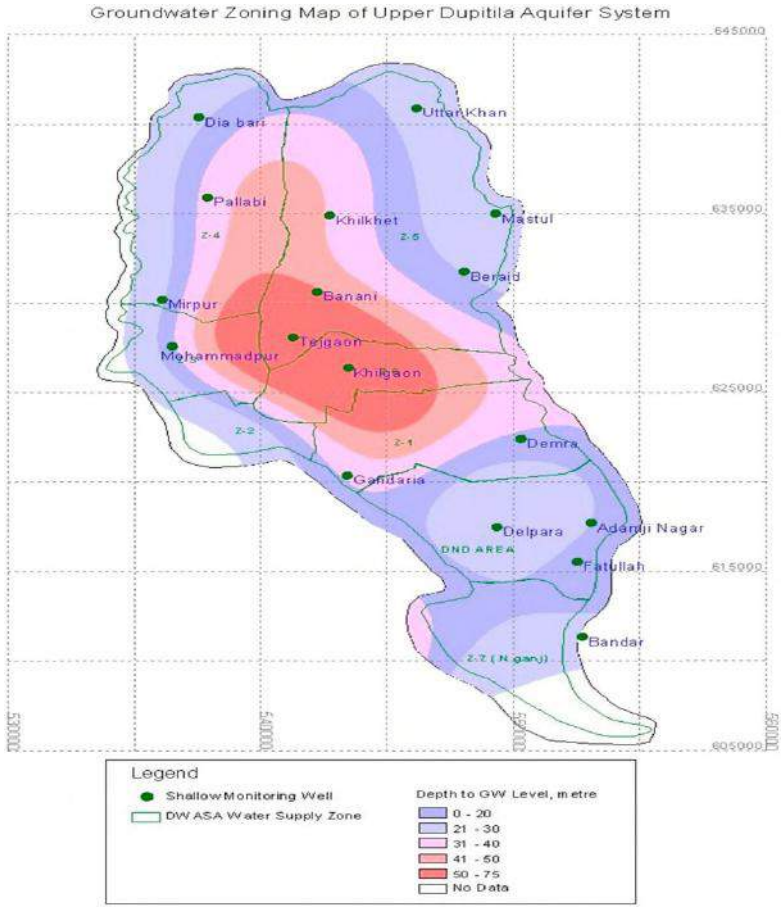


Figure 4.10: Simulation of Upper DupiTila aquifer system in Dhaka City (Arfanuzzaman and Rahman, 2017)

Position of the water table will play an important role during the excavation works of the multi-level basements. Thus, a study conducted by BRTC, BUET following the request of RAJUK which included monitoring the water table through installation of multiple piezometers at the proposed site. Position of the groundwater table within 24 hours of drilling the boreholes were found to vary between 12.2m to 13.77m. However, the position varies significantly over prolonged period of monitoring. The groundwater table recorded in five boreholes at the project site was found to vary between 8.53m to 20.88m from the EGL (BRTC, BUET, 2019).

4.3.6 Ambient Noise Level

As a part of the baseline study, noise level measurements were made at different locations (Figures 4.11-4.12) in and around the project area. Noise measurements were performed during both daytime and night time with a calibrated noise level meter (Extech HD-600). 10-minute continuous noise level measurements were carried out at the selected locations in 'A' Weighting and slow Response mode with 1 sec interval, and the equivalent noise levels (Leq) as well as the maximum and minimum noise levels (Lmax) were determined. Table 4.9 shows the summary of noise level measurements carried out in different locations in and

around the study area. It appears that the project site is a very quiet area both during day and night time. The maximum recorded daytime noise level at the site was 79.3 dB with Leq of 68.3 dB. In the evening hours the noise level at the proposed site remains in the similar range as that of the daytime noise. However, the effect of traffic noise do not seem to have much influence on the noise level at the proposed site as it is located a bit away from the main road and is surrounded by boundary wall. Table 4.10 and Table 4.11 shows the Bangladesh noise level standards and the World Health Organization noise level guidelines for community noise (Environmental, Health, and Safety General Guidelines, 2007), respectively, during daytime and nighttime for various types of areas. The recorded noise levels and Leq at the project site are below the Commercial Zone allowable levels set in the ECR '97 and the WHO Guideline values. Table 4.12 and 4.13 shows the noise limits for various working environments according to Environmental, Health, and Safety General Guidelines and OSHA, respectively.

Figure 4.11: Noise data collection at the RAJUK Zonal Office at daytime

Figure 4.12: Noise data collection campaign near project site at evening hours

Table 4.9: Noise level measurements during daytime and night time at selected locations

Location	Date	Coordinates	Day Time				Evening Time			
			Time	Leq (dB)	Max	Min	Time	Leq (dB)	Max	Min
Location 1	22/08/2019	23° 46' 53.46"N 90° 24' 8.22"E	11:14-11:23AM	65.2	74.7	53.0	05:23-05:32PM	69.1	78.8	54.4
Location 2	22/08/2019	23° 46' 54.72"N 90° 24' 7.53"E	12:17-12:27PM	68.1	74.2	64.5	06:23-06:32PM	67.0	80.8	53.4
Location 3	22/08/2019	23° 46' 54.72"N 90° 24' 8.04"E	01:07-01:16PM	68.3	79.3	63.4	07:26-07:35PM	61.3	75.7	49.3

[Note: The equivalent level is the level (L_{eq}) of a hypothetical steady sound that would have the same energy (i.e., the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level represents the time average of the fluctuating sound pressure and is close to the maximum level observed during the measurement period. For the fluctuating noise scenario the equivalent noise level (L_{eq}) is generally used for more complete noise sample and is calculated as follows:

$$L_{eq} = 10\log_{10}\left[\sum_{i=1}^{n} P_i 10^{L_i/10}\right]$$

Where, P_i is the probability of the noise level lying in the i-th measurement interval and L_i is the mid-point of that interval.]

Table 4.10: Bangladesh standards for sound level (GoB, 2006)

Locations	Noise level (dBA) at day	Noise level (dBA) at night
Silent zone	50	40
Residential area	55	45
Mixed area	60	50
Commercial area	70	60
Industrial area	75	70

(Ref: Noise Pollution Control Rules, 2006)

Table 4.11: Noise Level Guidelines (Guidelines for Community Noise, WHO, 1999)

Receptor	One Hour L_{Aeq} (dBA)	
	Daytime 07:00 – 22:00	Nighttime 22:00 – 7:00
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Note: For acceptable indoor noise levels for residential, institutional, and education settings refer to WHO (1999)

Table 4.12: Noise Limits for Various Working Environments.

Location/ activity	Equivalent Level L_{Aeq}, 8h	Maximum L_{Amax}, fast
Heavy Industry (no demand for oral communication)	85 dB(A)	110 dB(A)
Light Industry (decreasing demand for oral communication)	50 – 65 dB(A)	110 dB(A)
Open offices, control rooms, service counters or similar	45 – 50 dB(A)	--
Individual offices (no disturbing noises)	40 – 45 dB(A)	--
Classrooms, lecture halls	35 – 40 dB(A)	--
Hospitals	30 – 35 dB(A)	40 dB(A)

Note: For acceptable indoor noise levels for residential, institutional, and education settings refer to WHO (1999)

Table 4.13: OSHA Noise Exposure Limits for the Work Environment (Noise Exposure in dBA)

Noise Levels (dBA)	Permissible Exposure (hours and minutes)
85	16 hrs
87	12 hrs 6 min.
90	8 hrs
93	5 hrs 18 min
96	3 hrs 30 min
99	2 hrs 13 min
102	1 hr 30 min
105	1 hr
108	40 min
111	26 min
114	17 min
115	15 min
118	10 min
121	6.6 min
124	4 min
127	3 min
130	1 min

Note: Exposure above or below the 90 dBA limit have been time weighted to give what OSHA believes are equivalent risks to a 90 dBA 8 hr. exposure (Marsh, 1991, p.322).

4.4 ECOIGICAL ENVIRONMENT

A rapid ecological baseline study has been carried out for the proposed project RAJUK URU Building project. As noted earlier, the proposed high-rise building will be constructed on a brick-wall bounded RAJUK owned land, approx. 1.77 Acres, at Mohakhali, Dhaka. The proposed URU building will be constructed in two phases. Phase-I will be construction of 10 storied + 2 basement building (approximately 915 sq. m per floor) and Phase-II will be construction of a separate 22 storied + 2 basement building (approximately 2402 sq. m area/floor). Most part of the proposed project land is now vacant, though the 5-storied directorate of RAJUK Zonal Office (Zone 3 and Zone 4) building exists on the northern side of the proposed land. The proposed project land exists near to BirUttamA K Khandakar Road (Mohakhali to Gulshan Circle No 1 Road) and western side of Government Titumir College at Mohakhali, Dhaka, Bangladesh. However, the objectives of this ecological baseline study were to gather information on the existing ecological environment that present within and outside areas of the proposed high-rise building construction project site.

This section describes the baseline ecological environment which primarily focused on identifying the faunal and floral diversity and their abundance and distribution within and outside areas of the proposed RAJUK URU building construction project' site as well as their

ecological status in Bangladesh. Potential impacts for the proposed RAJUK URU building construction project activities have been identified, evaluated and described against these baseline situations in the relevant section of this EIA report.

4.4.1 Approach and Methodology

The baseline ecological study was conducted within and outside areas of the proposed RAJUK URU building construction project site

(i) to enlist the faunal and floral species with their national and / or international status,
(ii) to enlist keystone, rare and threatened faunal and floral species,
(iii) to investigate the distribution & abundance of faunal & floral species, and

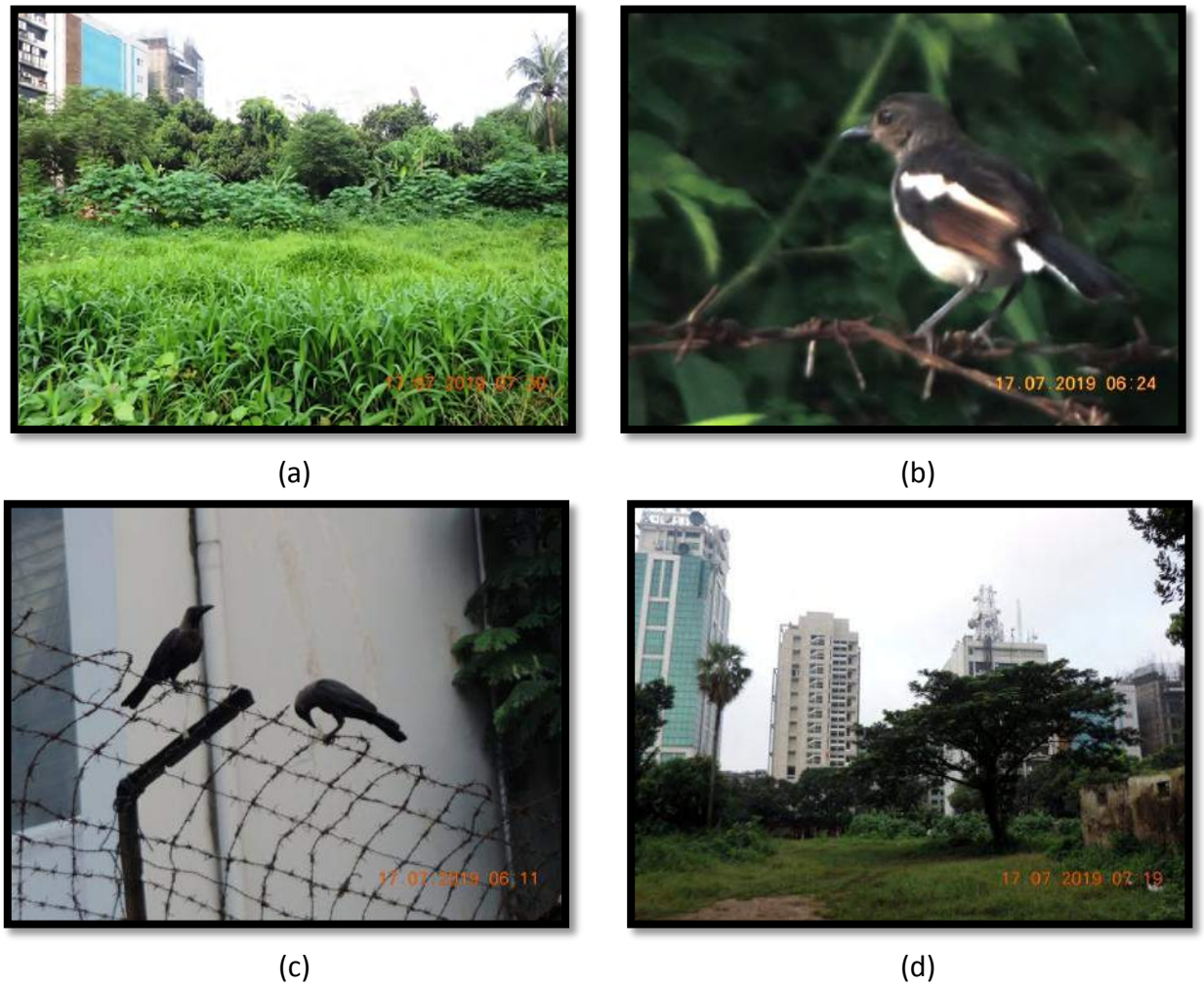
Generally, floral and faunal diversity fluctuates seasonally due to the environmental reasons. Seasonal survey, spanning over a year, could provide detailed information on the existing ecological aspects of the proposed RAJUK URU building project site and adjacent areas. The ecologist of the EIA team visited the proposed high-rise URU building construction project site and adjacent areas in July 2019 to collect first hand data on the existing faunal and floral diversity. The study was conducted primarily in day time, however, a part of the study was also conducted at night. Aural and visual search was the main survey method for ornithological study. Herpeto-faunal and mammalian study was done through visual search and also through discussion with local people and literature review. Rapid field survey and discussion with local people was the main method for floral survey. Informal interviews with local people were also conducted as a part of this baseline study to learn about seasonal ecological aspects of the proposed URU building construction project site and adjacent areas. The collected data were cross-checked through literature review.

4.4.2 Ecological Perspective

Bio-ecologically the proposed RAJUK URU building construction project site & adjacent area remains under the Brahmaputra - Jamuna Floodplain (IUCN - BD, 2002). Agro-ecologically, the project site and adjacent areas are not classified, but mentioned as Urban (BARC/UNDP/FAO, 1995). The existing ecological aspects within and surrounding the proposed RAJUK URU project site differs from each other and are described below:

(a) Project site: The proposed RAJUK URU project site has 1.77 acre land, most of which are unused & undisturbed, and plenty of undergrowth grows there, naturally. The entire land is bounded by concrete wall and has an active five storied building – used as RAJUK Zonal office (zone 3 and zone 4) in the northern side, one storied semi-pucca security house in the southern side and a couple of tin-shade small rooms on the western side. A few planted terrestrial floras exist adjacent to those houses or building. Most of the floras are planted in scattered-way

except along the eastern and western boundary wall sides where a row of fruit bearing trees. Tiny section of proposed land is also used for vegetable cultivation. However, most of the land at the site is unused and undisturbed. Therefore, a remarkable number of herb and shrub has naturally grown creating a semi-urban-like ecosystem. Local adaptive urban fauna get advantage (e.g. food, shelter, nest build, etc.) by using that ecosystem (Figure 4.13 (a-d)).



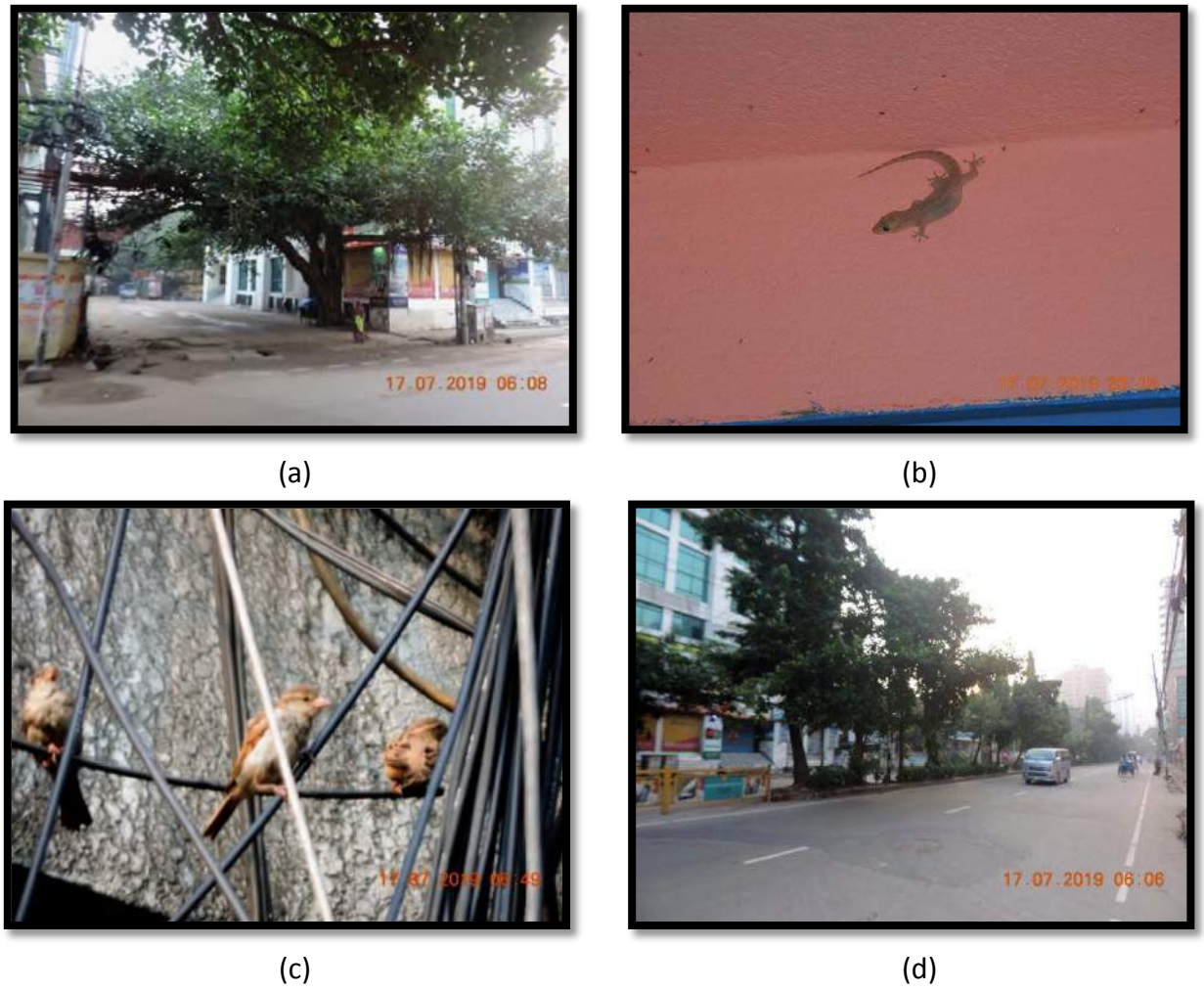
(a) (b)

(c) (d)

Figure 4.13: Ecological aspects observed within the proposed RAJUK-URU project site: (a) mixed terrestrial flora (tree, herb & shrub) exist within the URU project site, (b) Oriental Magpie Robin - *Copsychussaularis*, an avian species, perched on the boundary wall wire of URU project site, (c) House Crow - *Corvussplendens*, an avian species, stand on the boundary wall wire of URU project site, and (d) a few planted terrestrial flora exist within the URU project site.

(b) Project adjacent areas: Project adjacent areas have remarkable number of firm urban structures (i.e. road, building, shop, settlement, educational institution, etc.) in full operational mode and with all urban facilities. There are little to moderate number of adaptive ecological aspects on (a) road divider & footpath, (b) along the boundary of the Govt. Titumir College, (c)

along boundary wall on the BSTI quarter side, and (d) boundary wall side along governmental, semi-governmental, commercial, residential plots. The areas provide low to moderate habitat for diversified adaptive floral and faunal species. Most floras are planted for economical and aesthetical purposes. Some flora produce bio-products (e.g. fruits) naturally that attract associated insects. The bio-products and associated insects are consumed by certain type of faunal species for their livelihood. Ventilator or hole or cable wire, etc. of some buildings also are used as habitat for certain types of urban adaptive fauna (Figure 4.14 (a-d)).



(a) (b)

(c) (d)

Figure 4.14: Ecological aspects observed outside of the proposed RAJUK URU building construction project site: (a) mature terrestrial tree, Bot - *Ficusbenghalensis*, exist in the peripheral side of a side road, outside of URU project site, (b) Common House Lizard - *Hemidactylusflaviviridis*, a reptilian species, perched on a concrete wall, outside of URU project site, (c) House Sparrow - *Passer domisticus*, an avian species, stand on cable wires of a high-rise concrete building, outside of URU project site, and (d) mixed terrestrial flora, dominated by Debdaru - *Polyalthialongifolia*, exist on the divider of main road, outside of URU project site.

4.4.3 Ecological Aspects

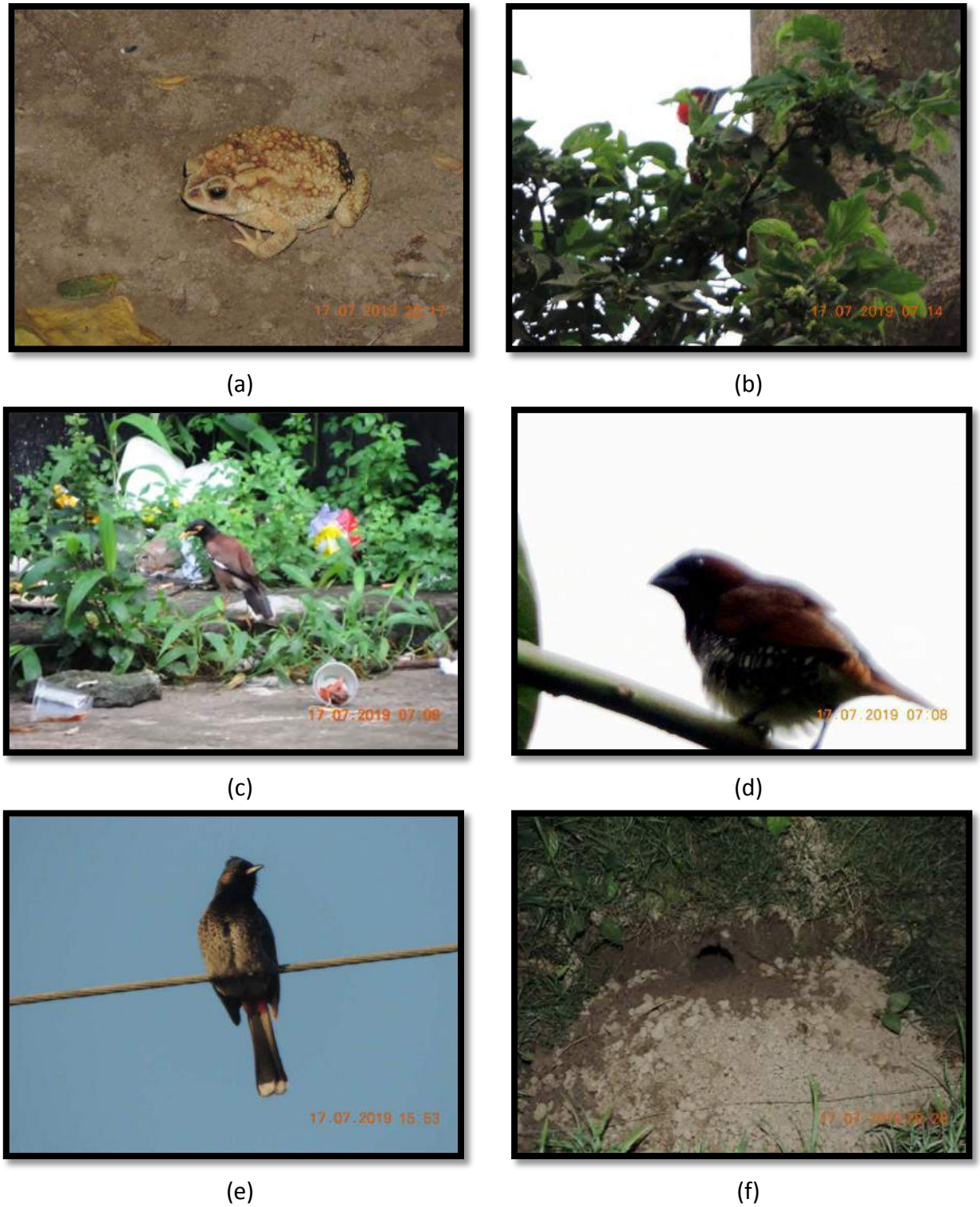
This baseline ecological study considered the macro-ecological aspects of the proposed RAJUK URU building construction project site as well as its adjacent areas. Macro-ecological aspects primarily consist of floral and faunal diversity including all sorts of fish species. However, the macro-ecological aspects of the proposed RAJUK URU building construction project site and adjacent areas are described below:

Faunal Diversity

Few types of faunal species exist within and outside areas of the proposed RAJUK URU building construction project site. All identified faunal species play a vital role for balancing the existing urban ecosystem. Some species use the areas as their permanent habitat, while others use as temporary habitat. On the basis of habitats, the faunal species found within and outside of the proposed RAJUK URU project site has been divided into two major categories viz. (a) terrestrial fauna and (b) aquatic fauna. Brief description of faunal diversity is given below:

Terrestrial Fauna

Terrestrial habitat dependent faunal species are the main components of terrestrial fauna which includes amphibia, reptile, bird and mammal species (Figure 4.15). These faunal species depend (partially or fully) on the terrestrial environment to live or to get food, shelter, nest, breed, and produce offspring. The study areas have full urban type of lands and structures, and have few diversified planted and natural floras which provide low to moderate eco-environment for the existing terrestrial urban adaptive fauna. The proposed project site has undisturbed and unused land which provide suitable environment for the local fauna. On the other hand, most of the adjacent areas (e.g. commercial, residential, educational, other types of institutions, etc.) of the proposed RAJUK URU project site supports low to moderate habitat for certain types of terrestrial adaptive urban fauna. However, the identified terrestrial fauna is divided into 4 major group viz. amphibian, reptile, bird, and mammal. A total of 18 terrestrial faunal species have been identified from the proposed RAJUK URU project site and adjacent areas, and most of them are avian species. A breakdown of all terrestrial faunal species habit is shown in Figure 4.16, which indicates that the project study site is low to moderately rich with the adaptive urban avian species. A complete list of terrestrial faunal species is given in Table 4.14.



(a) (b)

(c) (d)

(e) (f)

Figure 4.15: Terrestrial fauna observed within and outside of the proposed RAJUK URU building construction project site: (a) Common Toad - *Duttaphrynusmelanostictus*, an amphibian species, waiting to catch insect, within the URU project site, (b) Rufous-bellied Woodpecker - *Dendrocoposhyperythrus,* an avian species, stand on a coconut tree, within the URU project

site, (c) Common Myna - *Acridotherestristis*, an avian species, searching food on the ground, within the URU project site, (d) Scaly-breasted Munia - *Lonchurapunctulata,*an avian species, stand on a tree trunk, within the URU project site, (e) Red-vented Bulbul - *Pycnonotuscafer,* an avian species, stand on a live electric wire, outside of the URU project site, and (f) hole of Rat - *Rattusrattus*, indicates its presence outside of the URU project site.

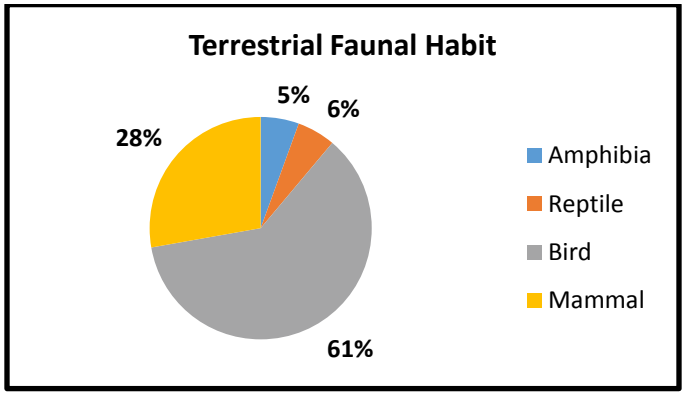


Figure 4.16: Distribution of terrestrial faunal habit (%) within and outside of the proposed RAJUK URU building construction project site.

Table 4.14: Identified terrestrial fauna within & outside of the proposed RAJUK URU building construction project site.

NAME			O	PR	LI	Status			Distribution	
CLASS	**ENGLISH**	**SCIENTIFIC**				**C**	**R**	**T**	**1**	**2**
Amphibia	Common toad	*Duttaphrynusmelanostictus*	Y	N	N	Y	N	N	Y	Y
Reptilia	Common House Lizard	*Hemidactylusflaviviridis*	N	N	N	Y	N	N	N	Y
Aves	Asian Palm Swift	*Cypriirusparvus*	Y	N	N	Y	N	N	Y	Y
	Asian Pied Starling	*Sturnus contra*	Y	N	N	N	N	N	N	Y
	Black Drongo	*Dicrurusmacrocercus*	N	N	N	N	N	N	N	Y
	Common Myna	*Acridotherestristis*	Y	N	N	Y	N	N	Y	Y
	Common Tailorbird	*Orthotomussutorius*	Y	N	N	Y	N	N	Y	Y
	Scaly-breasted Munia	*Lonchurapunctulata*	Y	N	N	N	N	N	Y	Y
	House Crow	*Corvussplendens*	Y	N	N	Y	N	N	Y	Y
	House Sparrow	*Passer domisticus*	Y	N	N	Y	N	N	Y	Y
	Oriental Magpie Robin	*Copsychussaularis*	Y	N	N	N	N	N	Y	Y
	Red-vented Bulbul	*Pycnonotuscafer*	Y	N	N	N	N	N	N	Y
	Rufous-bellied woodpecker	*Dendrocoposhyperythrus*	Y	N	N	N	N	N	Y	Y
Mammalia	Common House Rat	*Rattusrattus*	Y	N	Y	N	N	N	Y	Y
	Grey Musk Shrew	*Suncusmurinus*	N	N	Y	N	N	N	Y	Y
	House Mouse	*Musmusculus*	N	N	Y	N	N	N	Y	Y
	Indian Pipistrelle	*Pipistrelluscoromandra*	Y	N	Y	N	N	N	Y	Y
	Small Indian Mongoose	*Herpestesauropunctatus*	N	N	N	N	N	N	Y	Y

1.0

[Legend: O = Observed, PR = Previous Record, LI = Local Information, C = Common, R = Rare, T = Threatened, Y = Yes, N = No, 1 = within the proposed RAJUK URU project site, 2 = Adjacent areas of the proposed RAJUK URU project site.]

Aquatic Fauna

Aquatic habitat dependent faunal species are the main components of aquatic fauna which includes amphibia, reptile, bird, mammal and fish species. The reproduction, breeding and multiplication of aquatic fauna is finely tuned and adjusted to the rhythm and amplitude of monsoon flooding. Unfortunately, the proposed RAJUK-URU building construction project site and adjacent areas have no wetland or water-bodies that could support habitat for various types of aquatic faunal species including fish diversity; hence, no aquatic faunal and fish species have been identified for the proposed RAJUK-URU project.

Floral Diversity

Various types of flora exist within and outside of the proposed RAJUK URU building construction project site, and these floras play a vital role to maintain the balance of the existing eco-environment. Generally, flora plays vital socio-economic and ecological role in a particular habitat or ecosystem. Some flora develops adaptive aspects to survive in particular types of habitats. Other floras are habituated with soil, whereas, some are habituated with water and rest with both soil and water for their normal growth and development. On the basis of habitats, the floral species found within and outside of the proposed RAJUK-URU building construction project site have been divided into two major categories viz. (a) terrestrial flora, and (b) aquatic flora. Brief descriptions of these floras are given below:

Terrestrial Flora

The proposed RAJUK URU project site and adjacent areas have significant number of mixed natural and planted terrestrial native and exotic floras. Most of the floras are planted and have economic value. Generally, the terrestrial floral make a complex ecosystem in which local fauna has direct relationship through their ecological niche. As noted earlier, the proposed RAJUK-URU project site remains in an urban environment with altered land, and have few number of matured terrestrial floral diversity. Common terrestrial floras are Coconut - *Coccosnucifera*, Tal - *Borassusfiabellifer*, Banana - *Musa paradisiacal* etc. Remarkable number of herb and shrub species also have grown naturally in the proposed project site (Figure 4.17 – 4.18). These terrestrial floral species have grown in a scattered way. On the other hand, most of the adjacent areas (e.g. commercial, residential, educational, other types of institutions, road, etc.) of the proposed RAJUK-URU project site have varieties of planted terrestrial flora. Most of these floras have economic and aesthetic value.Common terrestrial flora are Coconut (*Cocos nucifera)*, Fig (*Ficusbenghalensis),*Kanthal (*Artocarpusheterophyllus)*, Kola (*Musa spp)*, Mango (*Mangifera indica)*, etc. (Figure 4.19). However, the identified terrestrial floras have been divided into three terrestrial floral habit viz. tree, herb and shrub. A total of 34 terrestrial floral species have been identified at the proposed RAJUK-URU project site and adjacent areas, and most of them are trees with a few herbs. A breakdown of all terrestrial floral species is shown in

Figure 4.20, which indicates that the areas are moderately rich in planted terrestrial floral diversity. A complete list of terrestrial floral species is given in Table 4.15.

(a) **(b)**

(c) **(d)**

(e) **(f)**

Figure 4.17: Diversified terrestrial flora observed within the proposed RAJUK-URU building construction project site: (a) planted mixed terrestrial flora observed, adjacent to main gate of URU project site, (b) planted mixed terrestrial flora observed in front of RAJUK zonal office, within the project site, (c) mixed terrestrial flora (tree) observed in front of guard room, (d)

mixed terrestrial flora (herb) observed in front of temporary room of RAJUK staffs, (e) flower of Lozzaboti - *Mimosa pudica*, a herb species, grown naturally in middle part of URU project site, and (f) planted Pui-shak - *Basellarubra*, a terrestrial shrub species, cultivated for human consumption, in the middle part of URU project site.

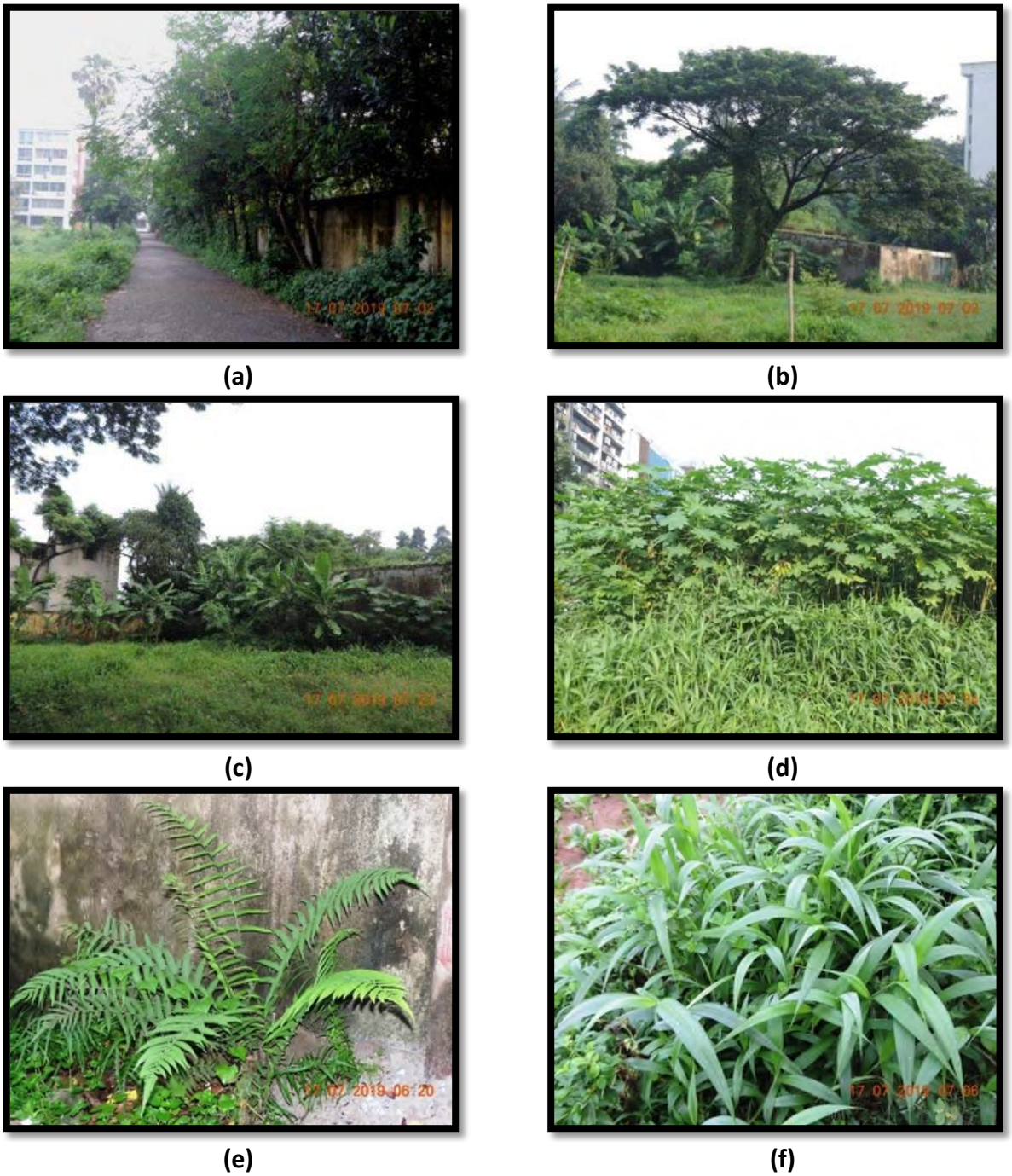


Figure 4.18: Diversified terrestrial flora observed within the proposed RAJUK-URU building construction project site: (a) planted mixed terrestrial flora observed in the peripheral eastern side of the project site, (b) planted matured terrestrial flora was observed, adjacent to the

abandoned concrete building of RAJUK zonal office, within the project site, (c) banana plantation observed in the peripheral western side of the project site, (d) Reri / Venna - *Ricinuscommunis*, a terrestrial herbal flora observed in the middle of RAJUK-URU project site, (e) Fern - *Pterisvittata*, a herb species, grown naturally beside a wall within the RAJUK-URU project site, and (f) Grass - *Cynodondactylon*, a terrestrial herb species, grown naturally, in the middle part of the project site.

Figure 4.19: Diversified terrestrial flora observed outside of the proposed RAJUK URU building construction project site: (a) Bot - *Ficusbenghalensis*. a matured terrestrial flora, observed in

the middle of main road, adjacent to the project site, (b) Bot - *Ficusbenghalensis*. a semi-matured terrestrial flora, observed, in a footpath, adjacent to the project site, (c) mixed matured terrestrial flora observed in the peripheral back side of Govt. Titumir College, adjacent to the URU project site, (d) mixed matured terrestrial flora observed in front of residential hostel of Govt. Titumir college, adjacent to the RAJUK-URU project site, (e) planted mixed terrestrial floral species observed in the peripheral eastern side of BSTI staff colony, very adjacent to the URU project site, and (f) planted mixed terrestrial flora observed in the outer side of western part of the URU project site

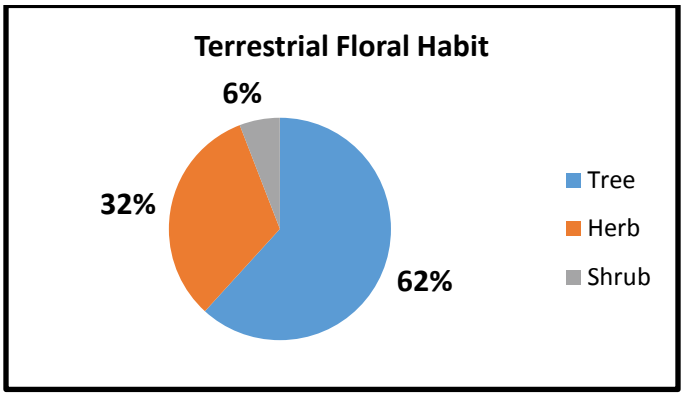


Figure 4.20: Distribution of terrestrial floral habit (%) within and outside of the proposed RAJUK URU building construction project site.

Table 4.15: Identified terrestrial flora within & outside of the proposed RAJUK-URU building project site.

Name			Habit	O	P R	LI	Status			Distribution	
Family	**Native/English**	**Scientific**					**C**	**R**	**T**	**1**	**2**
Annonaceae	Ata	*Annonasquamosa*	Tree	Y	N	N	N	N	N	Y	Y
	Debdaru	*Polyalthialongifolia*	Tree	Y	N	N	N	N	N	N	Y
Anacardiaceae	Am	*Mangiferaindica*	Tree	Y	N	N	N	N	N	Y	Y
Apocynaceae	Chatim	*Alstoniascholaris*	Tree	Y	N	N	N	N	N	Y	N
Araceae	Katchu	*Colocasiaesculenta*	Herb	Y	N	N	N	N	N	N	Y
Arecaceae	Oil Palm	*Elaeisguineensis*	Herb	Y	N	N	N	N	N	N	Y
Basellaceae	PuiShak	*Basellarubra*	Shrub	Y	N	N	N	N	N	Y	N
Cucurbitaceae	Telakucha	*Cocciniaindica*	Shrub	Y	N	N	N	N	N	Y	Y
Caricaceae	Papaya /pepe	*Carica papaya*	Herb	Y	N	N	N	N	N	Y	N
Euphorbiaceae	Reri, venna	*Ricinuscommunis*	Herb	Y	N	N	N	N	N	Y	N
Gramineae	Durbaghas	*Cynodondactylon*	Herb	Y	N	N	Y	N	N	Y	Y
	Shon grass/Patila	*Phragmites sp.*	Herb	Y	N	N	N	N	N	Y	N
Leguminosae	Koroi	*Albiziaprocera*	Tree	Y	N	N	N	N	N	N	Y
	Rendi	*Samaneasaman*	Tree	Y	N	N	N	N	N	Y	Y
	Krishnachura	*Delomixregia*	Tree	Y	N	N	N	N	N	N	Y
Malvaceae	Derosh	*Abelmoschusesculentus*	Herb	Y	N	N	N	N	N	Y	N
Musaceae	Banana / Kola	*Musa paradisiacal*	Herb	Y	N	N	Y	N	N	Y	Y
Mimosoidae	Lazzaboti	*Mimosa pudica*	Herb	Y	N	N	N	N	N	Y	N

Name			Habit	O	P R	LI	Status			Distribution	
Family	**Native/English**	**Scientific**					**C**	**R**	**T**	**1**	**2**
Meliaceae	MehagonI	*Swieteniamahagoni*	Tree	Y	N	N	Y	N	N	Y	N
Moraceae	Kathal	*Artocarpusheterophyllus*	Tree	Y	N	N	Y	N	N	Y	Y
	Jagadumur	*Ficusglomoreta*	Tree	Y	N	N	N	N	N	Y	Y
	Kakdumur	*Ficushispida*	Tree	Y	N	N	N	N	N	N	Y
	Sheora	*Sireblusasper*	Tree	Y	N	N	N	N	N	Y	N
	Fig /Bot	*Ficusbenghalensis*	Tree	Y	N	N	Y	N	N	N	Y
Moringaceae	Sajna	*Moringaoleifera*	Tree	Y	N	N	N	N	N	Y	N
Myrtaceae	Guava/Payara	*Psidiumguayava*	Tree	Y	N	N	N	N	N	Y	Y
Palmae	Tal	*Borassusfiabellifer*	Tree	Y	N	N	Y	N	N	Y	Y
	Narikel	*Coccosnucifera*	Tree	Y	N	N	Y	N	N	Y	Y
Pteridophytes	Fern	*Pterisvittatai*	Herb	Y	N	N	N	N	N	Y	Y
Rhamnaceae	Boroi, Kul	*Zizyphusmauritiana*	Tree	Y	N	N	N	N	N	Y	N
Rubiaceae	Kadam	*Neolamarckiacadamba*	Tree	Y	N	N	N	N	N	N	Y
Sapotaceae	Sofeda	*Manilkarazapota*	Tree	Y	N	N	N	N	N	Y	N
Verbinaceae	Mehedi	*Durantarepens*	Herb	Y	N	N	N	N	N	Y	N
	Segun	*Tectonagrandis*	Tree	Y	N	N	N	N	N	N	Y

[Legend: O = Observed, PR = Previous Record, LI = Local Information, C = Common, R = Rare, T = Threatened, Y = Yes, N = No, 1 = within the proposed RAJUK project site, 2 = Adjacent areas of the proposed RAJUK project site.]

Aquatic Flora

Aquatic habitat dependent floral species are the main components of aquatic flora which includes tree, herb and shrub species. Unfortunately, the proposed RAJUK-URU building construction project site and adjacent areas have no wetland or water-bodies that could support habitat for various types of aquatic floral species; hence no aquatic floral species have been identified for the proposed RAJUK-URU project.

4.4.4 Threatened Fauna and Flora

Some specific scientific category and criteria are followed to declare a species as threatened (critically endangered, endangered, etc.). It is generally declared by the World Conservation Union (IUCN), an international Inter Governmental Organization (IGO), for each country. Any species, under flora and fauna that exist in threatened condition are generally known as threatened species. Currently 115 wildlife species (e.g. 38 Reptile, 10 Amphibia, 39 Bird and 28 Mammal) and 64 freshwater fish species are threatened in Bangladesh (IUCN-BD 2015). On the other hand, 486 floras are threatened [e.g. 36 Pteridophytes (V) and 293 Angiosperm (V), 1 Gymnosperm (EN) and 126 Angiosperm (EN), and 30 Angiosperm (CR)] in Bangladesh (Hasib, M.I. 2011).

However, no threatened faunal and floral species have been identified from the proposed RAJUK-URU building construction project site or its adjacent areas.

4.4.5 Ecological Important Site

Ecologically Critical Area (ECA)

It is an environmental protection zone, defined by the Government of Bangladesh under the Bangladesh Environment Conservation Act, 1995, where ecosystem is considered to be threatened to reach a critical state. The declaration states restrictions on hunting, fishing, all activities that could result in the destruction of floral or faunal habitats, activities that could destroy natural characteristics of water and soil, activities detrimental to fishery, installation of polluting industrial units, and discharge of domestic/ industrial liquid waste into the river. No ECA exists at or near the proposed RAJUK-URU building project site.

Protected Area (PA)

An area of land and/or ocean especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means is referred to as "Protected Area (PA)". Such an area is predominantly a natural area established and managed in perpetuity, through legal or customary regimes, primarily to conserve their natural resources. No PA exists at or near the proposed RAJUK-URU building project site.

National Park (NP)

A National Park (NP) is a reserve land, usually declared and owned by a national government, protected from most human development activities and pollution. No NP exists at or near the proposed RAJUK-URU building project site.

Game Reserve (GR)

A Game Reserve (GR) is an area of land set aside for maintenance of wildlife for tourism or hunting purposes. No GR exists at or near the proposed RAJUK-URU building project site.

Wildlife Sanctuary (WS)

A Wildlife Sanctuary (WS) is an area that assures the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment where these require specific human manipulation for their perpetuation. No WS exists at or near the proposed RAJUK-URU building project site.

4.5 BASELINE SOCO-ECONOMIC CODITION AROUND PROJECT AREA

Objectives of social baseline study were to gather information on the existing socio-economic aspects that exist within and outside of the proposed RAJUK-URU building construction project site. The social assessment primarily focused on identifying the status of important economic and social conditions within the project areas. Potential impacts of the proposed project activities have been evaluated against these baseline socio-economic aspects, and later, mitigation measures have been suggested to reduce / eliminate the significant adverse impacts.

4.5.1 Approach and Methodology

An assessment has been carried out to evaluate the current baseline socio-economic aspects of the proposed RAJUK-URU building construction project study areas. The social assessment covered an area of about 5 km radius surrounding the proposed project site. Efforts were made to identify the socio-economic aspects that may be impacted due to the proposed project activities. The main purposes of the baseline socio-economic assessment were to understand:

(a) people's socio-economic condition;
(b) extent of people's access to basic services; and
(c) people's perception regarding the proposed URU project.

To collect information on socio-economic aspects of the proposed URU project site and adjacent areas, the sociologist of the EIA team has conducted a rapid field assessment and arranges meetings, Focus Group Discussion (FGD) and Key Informant Interview (KII) sessions. More than 70 people have been directly interacted during the study; 26 people participated in the FGD sessions, and others participated in the meetings (informal) and KIIs. However, this section describes the baseline socio-economic aspects of the proposed URU project study areas, based on field assessment and literature reviews. Findings of the FGD & KII sessions and also meeting (informal) are presented in the relevant Chapter of this EIA report.

4.5.2 Socio-economic perspective of the project study areas

The socio-economic perspective of the proposed RAJUK URU project site and adjacent areas are described below in brief.

Present uses of proposed RAJUK- URU project site

As noted earlier, the proposed RAJUK URU building construction project site has a single six storied building which act as zonal office under zonal director of RAJUK, and provide various type of services to the people of RAJUK zone 3 and zone 4 areas. One semi-pucca guard house exists beside the main gate of this plot and some security guards provide security service, both for office and land. A single tin-shade house with four to five rooms also exists, and a few RAJUK office lower grade staff family stay there. Seasonal gardening inside the land was also observed, though most of the land remains as fallow land and no cultivation is being done at present. Peripheral side of the proposed land has some timber yielding and fruit bearing trees, and all of these floral resources have aesthetic and economic value to the present human society. The proposed project site has a peripheral pave road usedby the zonal office personnel and service seekers. All sorts of basic utility services (e.g. electricity by DPDC, natural piped gas by Titas Gas T&D, supplied piped water by DWASA) are available in the proposed land. However, some socio-economic aspects inside the proposed RAJUK URU building construction project site have been shown in below in Figure 4.21.

(a) (b)

(c) (d)

(e) (f)

Figure 4.21: Some socio-economic aspects observed, inside of the proposed RAJUK-URU building construction project site: (a) RAJUK Zonal Office (Zone 3 & 4) with full operational mode, (b) narrow pave road to enter in the RAJUK zonal office, (c) security guard house exist beside the main gate, (d) tin made structure exist, few RAJUK lower staff live there, (e) seasonal gardening inside the proposed project land, and (f) fallow land with peripheral floras – provide some economic benefit.

4.5.3 Present status of areas adjacent to proposed RAJUK-URU project site

As noted earlier, the project study area is situated at Mohakhali area in Dhaka City which is primarily a fully developed full urban social environment. According to the Dhaka North City Corporation (DNCC) webpage the total service area of DNCC is 82.638 km^2 with 36 Wards in 5 Zones (http://www.dncc.gov.bd).The project site is in the Zone 3 which has a total area of coverage of 18.987km^2 in 10 Wards. The Ward no. 20,where the project site is located, has a total area of coverage of1.729 $km^2$with households4,062. Table 4.16 provides a detailed break-up of the different entities within the service area of the DNCC. The BBS (2011) shows that the population of Zone 3 of DNCC is 9,26,769. Considering the service area of 18.987km^2 in Zone the proportionate population in Ward 20 in 2011 would be 84,394. With a growth rate of 2.83%, the projected population of Ward 20 for 2019 would be 1,05,505 resulting in a population density of 61,020 per km^2. It should be noted that the floating population in the Dhaka City is generally very high. This is because a large number of people travel to Dhaka for various services and/or business related issues. According to BBS, 2015 (Community Report – Dhaka City) the average family size is 4.14 persons. Distribution of households by type of population are 91.66% general, 0.30% institutional and 8.04% other units. Structure of these houses are 47.7% pucca house, 25.1% semi-pucca house, 24.5% kutcha house and remaining 2.7% are Shanty (slum) and Literacy rate is 74.8%.

Table 4.16: Basic information of Dhaka North City Corporation

Description	Zone-1	Zone-2	Zone-3	Zone-4	Zone-5	Total
Area (sqkm)	11.570	21.317	18.987	11.962	18.802	82.638
Nos. of Ward	02 nos.	08 nos.	10 nos.	07 nos.	09 nos.	36 nos
Population (BBS, 2011)	379777	1002501	926769	836132	812123	3957302
Nos. of Holdings (Feb,2014)	23120	30307	46428	32214	40185	1,72,254
Nos. of Trade License (Feb,2014)	14335	15382	64611	32948	20876	1,48,152
Market's (Feb, 2014)	—	4	13	2	24	43
Road Length (KM)	260.31	283.48	367.55	218.03	208.268	1337.913
Footpath Lenght (KM)	18.186	39.80	95.72	25.48	46.463	223.049
Lenght of Drain (KM)	199.95	233.964	325.581	191.71	250.36	1201.565
Lenght of Mediam (KM)	4.67	13.035	15.891	9.573	14.941	58.11
Foot over bridge/Underpass	01	–	16	16	12	45 nos.
Community Centre	01	03	04	01	04	13 nos.
Graveyard	02	—	02	01	01	06 (5+1)nos.
Park	02	—	13	—	13	28 nos.
Play Ground	—	03	02	01	09	15 nos.
Bus / Truck Terminal	—	—	01	02	—	3 nos.
Underpass	—	—	—	01	01	2 nos.
Newspaper Booth (Feb, 2014)	—	05	05	05	05	20 nos.
Cinema Hall (Feb, 2014)	1	02	02	02	05	12 nos.
Public Toilet	06	03	07	07	14	37 nos.
Other	—	—	—	—	—	60,023

Table 4.17 shows the detailed list of different institutional entities in the different Zones of DNCC. There are 147 mosques, 24 temples, 138 schools, 8 universities, 53 clinics and hospitals, and 14 parks and playground in the Zone 3 of the DNCC.

Table 4.17: Detailed list of different institutional entities in the DNCC

Description	Zone-1	Zone-2	Zone-3	Zone-4	Zone-5	Total
Hospital	13	17	19	18	51	118
Clinic	09	29	34	18	31	121
School (All Kinds)	114	208	138	82	179	721
Collage	28	54	32	28	49	191
University	08	03	08	05	13	37
Madrasha	24	97	65	36	80	302
Masjid	72	194	147	124	136	673
Mandir	01	05	24	08	04	42
Park	02	02	06	01	03	14
Play Ground	03	05	08	04	20	40

Both governmental and private residential building exists near to the project site, and several thousand people live in those buildings with or without family. The BSTI officers and staffs quarter is one of the remarkable residential areas that exist very close to the proposed RAJUK-URU project site. A significant numbers of people live around the project study area permanently, while there are also temporary residents. Together they have woven a strong social relationship among themselves. Socio-culture is mixed and dynamic. A few social clubs exist, adjacent to the RAJUK-URU project site, of which, Gulshan club is the most notable one. All social clubs regularly perform socio-cultural activities through-out the year. No historical and archeological establishment identified from the project study areas.

Economic condition of the project study areas seems to be relatively good compared to other regions of the country. Local economy is vibrant and thriving through various businesses operating in this locality. Some governmental offices as well as financial institutions exist there and provide services to the local, city and entire Bangladeshi peoples. People's occupation varies in the project study areas. Private services in the market, shop, bank and transport related occupation (e.g. bus, car, rickshaws, three wheeler CNG taxi, truck etc.) are available that play an import economic role among the people of present society. Many small shops exist beside the roads from where people buy their necessary foods and commodities. Many private employed people do job in the high rise buildings, markets & shops, and most of them stay in other areas of the city. Some small to medium factory observed in the study site, of which garment related factory is remarkable. All sorts of income group (low, middle & high) people live there, whose income range is from BDT 10000 to more than BDT 100000. All the roads are

paved and in good condition, and play an important role for intra-city road communications. All sorts of vehicles are available, and people have easy access to them. Road accident sometime occurs, and people get treatment both in the nearby private clinics and governmental hospitals. Utility services including piped supplied natural gas for cooking, piped water for drinking, sanitation and waste damping issues, electricity, etc. seems to be moderate to good and almost all people have access to those services. Some of the socio-economic aspects of the adjacent areas of the proposed RAJUK URU building construction project are shown in Figure 4.22 and Figure 4.23.

Figure 4.22: Socio-economic aspects depicted around the proposed project site: (a) government office, (b) high rise buildings with different types of private business, (c) government owned bank, (d) private bank inside a high rise building, (e) entrance of a

modern restaurant, and (f) various types of shops.

Figure 4.23: Socio-economic aspects depicted around of the proposed project site: (a) various modes of transportation on the road (b) Mohakhali overpass, (c) main gate of Titumir college, (d) a private car workshop (e) BSTI staff quarter, and (f) high rise building for business.

CHAPTER 5
IDENTIFICATION AND ASSESSMENT OF POTENTIAL IMPACTS

5.1 INTRODUCTION

This chapter summarizes the impacts associated with the implementation of the project. The impacts would result from project related activities during the whole life-cycle of the project including the design, construction and operation phase. The potential impacts could cover a wide range of environmental, social, and ecological aspects. The objective of this chapter is to identify and evaluate the extent of probable impacts associated with the project, which would be useful in developing mitigation measures to avoid or minimize the adverse effects.

5.2 METHODOLOGY

An environmental impact is defined as any change to an existing condition of the environment. Identification of potential impacts has been done on the basis of baseline data collected from secondary and primary sources. The potential impacts have also been identified based on experts' opinions and inputs received from public consultation events. The impacts can be broadly classified as those taking place during construction and operational stages. The impacts of environmental components that are identified in this chapter include physiochemical environmental impacts, ecological impacts, and socio-economic impacts. Potential Impacts associated with the proposed development are identified from their sources that include project's activities; equipment; processes; materials against their main receptors that include the baseline environmental and social condition. Information collected from public consultation, literature review, and professional knowledge were used to inform the baseline characteristics of the project site.

An evaluation of the impacts of project activities on the physico-chemical, ecological and socio-economic parameters, both during construction and operation phases of the project has been carried out for the proposed RAJUK URU Project. For convenience, the impacts have been categorized as "positive impact", "no impact", and "negative impact". Again the intensity of positive and negative impacts have been classified (qualitatively) into "low", "moderate" and "high" categories. Short-term (Sh) and long-term (Lo) nature of impacts have also been identified.

5.3 ENVIRONMENTAL IMPACTS

Environmental impacts can be broadly categorized into 2 groups – construction phase and operation phase. Major physicochemical parameters considered for assessment of environmental impacts of project activities during construction phase include water pollution, drainage congestion, noise pollution, air pollution, and generation and disposal of solid wastes.

5.3.1 Impacts during Pre-Construction Phase

Before the actual construction can progress, dismantling and removal of infrastructures (semi pucca shed, one storied building etc.) those exist within the project site, would be needed. The dismantling process would generate concrete debris and dust that could affect the air quality in the project area. In addition, if there are abandoned old and damaged vehicles, old and damaged equipment, and damaged furniture (steel and wooden chair, table, almirah, iron scrape/plate), needs to be removed along with the construction materials such as broken concretes, brick before starting the construction. These processes could lead to the pollution of soils, air, and groundwater.

The existing utility lines (electricity, gas, water supply and telephone) mainly run through the boundary of the project area and apparently it seems that no shifting or disconnecting of those lines would be required. If any such lines need to be disconnected or shifted for the preparation of construction or during construction, relevant authorities should be contacted and act accordingly.

5.3.2 Impacts during Construction Phase

Impacts from Excavation for Basement

The proposed RAJUK URU Building Project Phase-I involves construction of a 10 storied building with 2 basements for parking facility. For basements, a deep excavation over a large area within the project site would be needed in open cut method. During this process, there exists a concern of soil collapse as well as the safety of the workers. This process will require constant pumping of water out of the excavation trench for supporting the truck traffic. Moreover, the deep excavation will generate a huge volume of earth material, which need to be properly disposed of. There should be a good drainage system and cover so that no water logging could happen during rains within the area.

The foundation work of the project requires the placement of 162 permanent 600mm diameter shore piles placed outside the basement perimeter walls. This piling activity may cause collapse of the soil or may affect the surrounding structures. Extra precautions should be taken care of during this activity.

Impacts from Wastewater and Solid Waste

Waste and wastewater that would generate during the construction phase of the project include construction debris and wastes, and some other solid wastes (e.g., from labor sheds), human wastes from people working at the project site (e.g., from labor sheds), and some liquid waste from construction processes. These waste and wastewater could lead to pollution of water and general environment, if not properly disposed of.

Wastewater

Wastewater, in the form of human wastes, will be generated mainly in the temporary labor sheds. This could be a major source of pollution (including water pollution) if not properly managed. Use of unsanitary latrines and improper disposal of human waste would create environmental pollution and adversely affect human health at the construction site by increasing the risk of disease transmission. Proper disposal of wastewater should, therefore, be ensured as suggested in Chapter 10. There is also a risk of disease transmission from workers from outside who would come to work in the RAJUK URU construction site.

Solid Waste

Construction debris and wastes to be generated during the construction phase would include scrap iron, steel, wooden frames, piping, and other solid wastes. Most of it will be generated toward the end of the construction phase during carrying out of the finishing works, while the site will be cleared of waste materials. The volume of such construction wastes is likely to be significant. Indiscriminate storage and disposal of construction debris and wastes could create local water logging and ponding by blocking drainage lines and would be aesthetically displeasing. Solid waste of domestic nature that would be generated in the temporary labor sheds at the construction site is not likely to be significant in volume. But indiscriminate disposal of such solid waste would create environmental pollution and unhealthy situation at the project site. Proper disposal of these solid wastes, as described in Chapter 10, is therefore necessary.

Impacts on Water Resource

The proposed project will use the DWASA Supply source for their water requirement during construction and operation phase of the project and will not install any tube wells within the project site. Therefore, there will not be any effects on ground water resource. However, there will be some indirect negative impact on the amount of supply water of WASA.

Noise Pollution

Noise pollution is likely to result from a wide range of construction activities at the project site, including the movement of vehicles carrying construction materials, equipment to and from the site, and different construction activities. The main sources of noise during construction period will be site preparation works, excavating, piling, transportation and handling of materials and equipment, other engineering works like riveting, hammering, cutting, welding, etc. Operation of concrete mixers, excavator, construction vehicles, fabrication, handling of equipment and materials, etc. would generate a considerable amount of noise. The noise levels of most of the construction machineries (80~95 dBA) are approximately 10 to 35dBA higher than the base noise level (50~80dBA). The noise from these activities and machine/equipment is likely to cause an increase in noise over the “low” base noise level. This high level of noise would have a significant impact on the population residing nearby. The project site is close to a

major educational institute 'Titumir College' and its student hostel – with a large number of students and BSTI residential quarter. Proper mitigation measures have to be incorporated to reduce the impact of noise upon health. Detail mitigation measures are summarized in Chapter 10.

Department of Environment (DoE) in Bangladesh does not provide any guideline for noise control in construction sites. So, standards as indicated in Noise Limits for Construction Sites (GB12523-90) and Standard of Noise at boundary of Industrial Enterprises (GB12348-90) may be applied for evaluation of noise pollution during construction period, and the said noise limits are listed in Table 5.1.

Table 5.1: Noise Limits for Construction Sites (GB12523-90)

Construction Phase	Leading Noise Source	Noise Limit, dB(A)	
		Daytime	Night time
Earthwork	Bulldozers, excavators, loaders, backhoes and etc.	75	55
Piling	Various piling machines	85	Construction prohibited
Structure engineering	Concrete mixers, vibrators, electric saws and etc.	70	55
Fit-out work	Cranes, lifters and etc.	65	55

Table 5.2 shows the typical noise levels generated by some of the construction equipment expected to be used during the construction phase. As seen from the table, the local peak noise level for non-continuous construction activity may reach as high as 90 dB(A), depending on the type of equipment.

Table 5.2: Noise Levels Generated by Construction Equipment (measured at 1 m distance)

Equipment	Noise Level (dB(A)
Earth Movers	
Front Loaders	72-84
Backhoes	72-93
Tractors	76-96
Scrapers, Graders	80-93
Pavers	86-88
Bull dozer	86-88
Excavator	84-86
Trucks	82-94
Material Handlers	
Concrete Mixers	75-88
Concrete Pumps	81-83
Cranes	75-86
Winch	85-88
Stationary	
Generators (in canopy)	71-82

Equipment	Noise Level (dB(A)
Electric Saw	81-85
Wood Planer	81-85

The noise levels of the engineering machinery and vehicles used during the construction period are featured by their intermittent nature with mobility and high noise level (which is 80~90 dB(A) at a distance of 1 m). Through applying the attenuation of point source method (without taking into account of such attenuation by sound barriers or atmospheric absorptions), the geometric divergence of sound attenuation has been calculated using the following formula:

$$L_r = L_{r\,0} - 20\,log(^{r}/_{r_0}) \quad (8.1)$$

Here,

L_r = A-weighted sound pressure level in dB(A) at place r away from the noise source;

$L_{r\,0}$ = A-weighted sound pressure level in dB(A) at place r_0 away from the noise source;

r = distance between the point of estimation and noise source (in meters); and

r_0 = distance between the reference point and noise source (in meters)

Estimated noise levels at different distances from the noise source at the construction site are shown in Fig. 5.1. It is seen from the figure that the noise level of typical construction machineries (85-90 dBA) drops to an acceptable limit (70 dBA) within 30 m from the source. However, at the locations of the noise sources (construction machinery/ activities), the noise level will increase over the base level noise at that location and the extent of increase is estimated as follows.

The cumulative or combined sound level due to n number of different sources is given by the following equation.

$$L_t = 10\log\left(\sum_{i=1}^{n} 10^{^{L_i}/_{10}}\right) \quad (8.2)$$

Here, L_i = A-weighted sound pressure level in dB(A) of individual noise source; and

L_t = Combined A-weighted sound pressure level in dB(A) of all noise sources;

The effect of a noise source as well as of simultaneous operation of more than one noise sources is shown in Fig. 5.2. In reality, the noise level of most of the construction machineries (80~90 dBA) are on an average 35 dBA higher than the base noise level (50~80 dBA) and it is seen that in case of such a big difference in noise level the combined level is determined by the noise level of the machine. However, the impact of the machine-generated noise will subside within 30 m from the location of the machine.

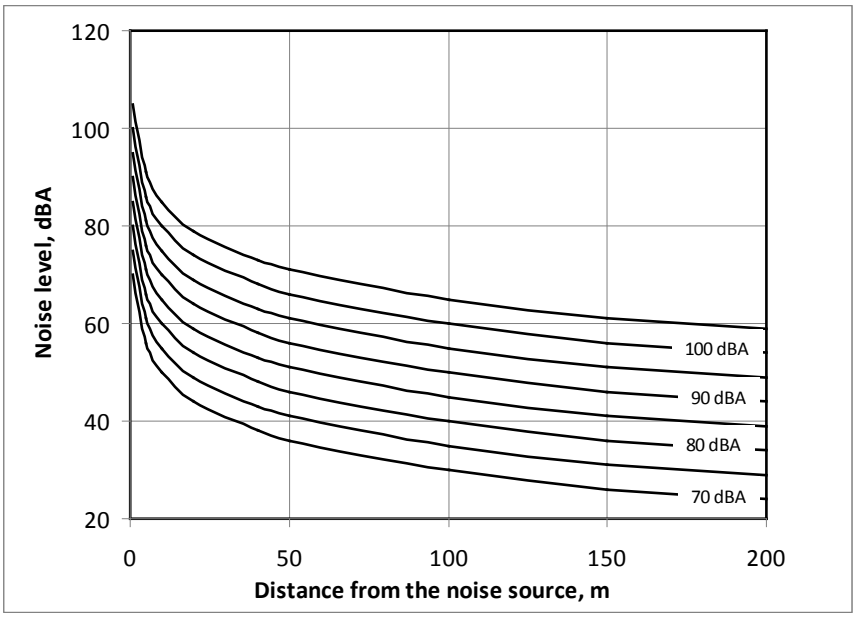


Figure 5.1: Attenuation of noise level with distance from the source.

Table 5.2 demonstrates that noise levels of engineering machinery are high, and the place where noise at daytime exceeds those as indicated in Noise Limits for Construction Sites (GB12523-90) are within a radius of 30 m to the noise source. Such noise from project activities may cause discomfort to the people living/working in the surrounding areas at close proximity of the project site, especially if such activities are continued during the night. However, such noise impacts will be temporary in nature and will cease as soon as the construction work is over.

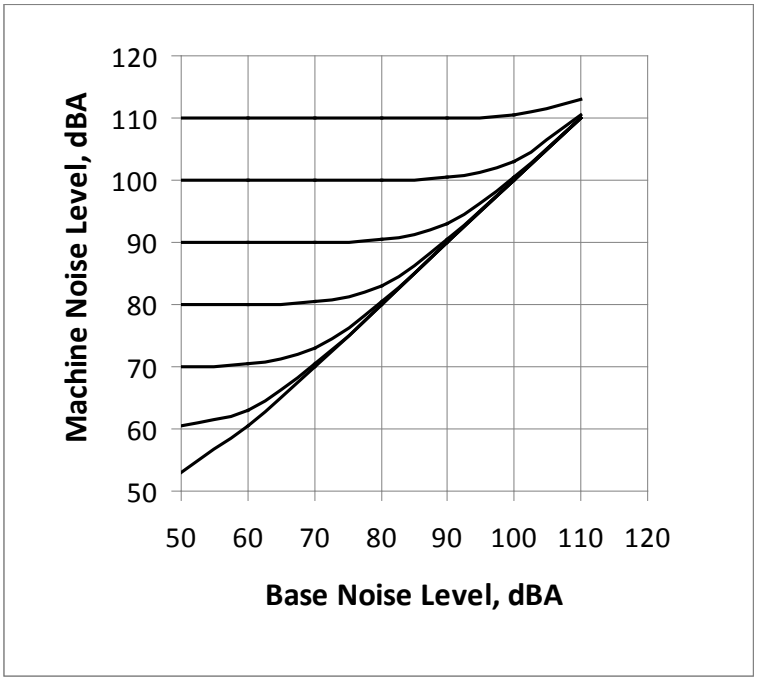


Figure 5.2: Combined noise level due to the operation of noise generating machines.

Air Pollution

Localized and temporary air pollution may generate from earthworks (e.g., excavation, filling) during site preparation, movement of vehicles, and operation of machines and equipment. During the construction phase of the proposed project, the important sources of emissions would include those from the operations of construction equipment and machineries, vehicles carrying construction materials to the site and taking construction debris out of the site. The air pollution generated from these activities is likely to be localized (affecting immediate surroundings of the emission source/ project site).If construction equipment, such as stone (aggregate) crusher, is used at the site, this may result in significant emission of particulate matter during its operation. Since construction of the proposed project would most likely involve significant earthworks, increase in particulate matter in the air from wind-blown dust is also a concern, especially considering the close proximity of a college and residential complex to the project site. Mitigation measures as outlined in Chapter 10 should be adopted to minimize the possible adverse impacts of project activities on air quality.

Drainage Congestion

Since the construction phase involves significant earthwork(e.g., excavating/ back-filling for the foundation of the building) there are chances of stagnation and ponding of stormwater if care is not taken for proper drainage of stormwater. Additional drainage congestion may result from possible obstruction to the natural flow of drainage water due to construction activities as well as storage of construction materials. Care should be taken to make sure that natural drainage paths are not obstructed, or alternate drainage paths are provided, especially during the monsoon season.

Generation and Disposal of Human/Solid Wastes

During construction phase, problems related to sanitation and solid waste may result from improper/ inappropriate facilities at the labor sheds. At the peak of construction period, large numbers of workers are likely to be involved in different construction activities. Lack of proper sanitation facilities for project people, including the labor/ construction worker and absence of proper solid waste (e.g., food waste, construction debris) facilities may create an unhealthy environment (including water pollution) within and around the project site.

The effect of project activities on physico-chemical environmental parameters during construction phase of the project is listed in Table 5.3. The physico-chemical environmental parameters that could be affected by the project activities include water and soil quality, air quality and noise level.

Table 5.3: Effect of project activities on physico-chemical parameters during construction

Physico-chemical parameters	Environmental examination						
	Positive impact			No impact	Negative impact		
	Low	Moder-ate	High		Low	Moder-ate	High
Water and soil quality					X (Sh)		
Air quality						X (Sh)	
Noise level						X (Sh)	

Sh=Short-term; Lo=Long-term

5.3.3 Impacts during the Operation Phase

Typical environmental impacts resulted during the operational phase may include:

- Wastewater and waste management;
- Noise pollution
- Air pollution

Impacts from Wastewater and Solid Waste

During the operation phase of the URU Building project, the occupants of the buildings would generate wastewater. Municipal sewage generated from the project are can cause unhygienic condition and environmental pollution, if proper sewer system is not implemented. If untreated sewage is disposed of to a surface water body, it could pollute the water body that receives the wastewater.

The occupants of the building would generate solid wastes including organic waste such as waste foods, fruits and inorganic waste such as waste papers, damaged electronic goods, containers and liquid waste such as wastewater, oil, paint. The point of generation of the solid wastes could be the cafeterias, office rooms, IT section, conference room, business center, and laboratory facilities. The solid waste needs to be collected and disposed of properly. Improper disposal of the solid wastes such as through open drains or sewer pipe could result in congestion in the drainage system. This could also lead to soil and groundwater contamination through the generation of leachate. If the solid waste is not removed from inside the project area regularly, it could result in unhealthy conditions in the premises and surrounding area including attracting nuisance insects such as flies and mosquitoes.

Noise Pollution and Vibration

Prolonged exposure to a high level of noise may cause significant damage to human hearing organ and may cause neurological damage. OSHA noise exposure limits for the work environment provides a guideline for the time of noise exposure at the work environment which may be adopted to prepare an environmental management plan (Table 5.4). Therefore, noise assessment during the operational phase of different project components is particularly important.

Table 5.4: OSHA noise exposure limits for the work environment

Noise (dBA)	Permissible Exposure (Hours and minutes)
85	16 hrs
87	12hrs 6 min
90	8 hrs
93	5 hrs 18 min
96	3 hrs 30 min
99	2 hrs 18 min
102	1 hr 30 min
105	1 hr
108	40 min
111	26 min
114	17 min
115	15 min
118	10 min
121	6.6 min
124	4 min
127	3 min
130	1 min

Note: Exposure above or below the 90dB limit have been "time weighted" to give what OSHA believes are equivalent risks to a 90 dB eight-hour exposure. Source: Marsh, 1991, p. 322.

During the operation phase of the RAJUK URU project, the main source of noise would be the vehicles carrying the staffs and visitors to the project area. The vehicle operation and honking of these vehicles could result in noise, which could have increased impacts in case of traffic jam. Office activities in the project area would contribute to low frequency noise that could have effect on the office staff and personnel working there for a significant amount of time of the day. The operation of the lab equipment may also add to the noise level depending on the type of equipment and their operating modes. Another source of the noise could be generators installed as a backup power source if these are not installed in covered places properly.

Air Pollution

After commencement of the URU project, the number of traffic occupying the local road connecting the main road and the project compound will increase. Emission from the increased number of vehicles would impact the air quality in the project area. The impact on air pollution is particularly critical in the dry season, since even at present PM_{10} and $PM_{2.5}$ concentration levels exceed the National Ambient Air Quality Standards in Bangladesh set by the DoE. Depending on the fuel type used, the generator could be an additional source that might add up to the existing air pollution level.

The effect of project activities on physico-chemical environmental parameters during operation phase of the project is listed in Table 5.5. The physico-chemical environmental parameters that could be affected by the project activities include water and soil quality, air quality and noise level.

Table 5.5: Effect of project activities on physico-chemical parameters during operational phase

Physico-chemical parameters	Environmental examination						
	Positive impact			No impact	Negative impact		
	Low	Moder-ate	High		Low	Moder-ate	High
Water and soil quality					X (Sh)		
Air quality						X (Sh)	
Noise level					X (Lo)		

Sh=Short-term; Lo=Long-term

5.4 ECOLOGICAL IMPACTS

The project activities of the proposed RAJUK URU project have some potential impacts (direct and indirect) on the existing ecological environment. Important project activities include land clearing and alteration, movement of people and vehicle, materials placement, excavation, construction work, accident (e.g. spills, leaks of chemicals) etc. During construction phase, land related activities are likely to have some adverse impact on its existing ecological environment. During operation, ecological impacts may result from improper disposal of wastes in the existing eco-environment. For the proposed 10 storied high-rise building construction project, potential ecological impacts could be divided into two broad categories viz. (a) direct impact and (b) indirect impact. Details of these impacts on the existing floral and faunal community are described below

5.4.1 Potential Impacts on Fauna

The proposed project site has a various assemblage of floras that are used by specific type of local fauna as their permanent / temporary / foraging / resting habitat. Generally, flora provides habitat for insects as well as their food. The proposed high-rise building construction project site and adjacent areas have mainly various type of native floras that are used by certain types of adaptive native fauna. Uprooting of flora will destroy the faunal habitat forever. Land excavation and construction related activities for the proposed project could have some potential impacts (direct and indirect) on the existing faunal environment due to their highly sensitive and reactive behavior in response to disturbance that may occur at or near their habitat. Faunal species that are sensitive to direct (human activity and traffic) or indirect disturbance (noise) would be impacted most. Habitat disturbance would reduce habitat availability and effectiveness for a certain period for mammals, reptiles, amphibians, birds and their predators. There are also some possibilities of direct mortality and displacement of amphibians, reptiles and mammals from the use of vehicles or machineries over the terrestrial faunal habitat or deposition of excavated soil on faunal habitat. Quantification of these losses is difficult; however, the impact is expected to be low intensity and also short term in nature.

5.4.2 Potential Impacts on Flora

As noted earlier, the proposed high-rise building construction project site and adjacent areas have various types of terrestrial floras that are used by certain types of fauna. None of these floras are threatened in Bangladesh. The proposed high-rise building construction project site have few floras, and almost all of these floras might be needed to uproot forever for building construction and ancillary works (Box 5.1), hence, adverse impacts are expected. Some terrestrial undergrowth also exists within the project site and adjacent areas, and this undergrowth contributes to maintaining the balance of existing eco-environment. Clearing or removal of that undergrowth would also have some adverse impacts on the existing eco-environment. Quantification of these losses is difficult; however, the impact is expected to be low intensity and also short to long term in nature.

Box 5.1: Number of terrestrial flora (Trees) within the project site that may likely to be felled of for the proposed project implementation

Name		Habit	Total Number
Native/English	Scientific		
Ata	Annona squamosa	Tree	1
Am	Mangiferaindica	Tree	7
Chatim	Alstoniascholaris	Tree	1
Rendi	Samaneasaman	Tree	1
MehagonI	Swieteniamahagoni	Tree	3
Kathal	Artocarpusheterophyllus	Tree	5
Jagadumur	Ficusglomoreta	Tree	2
Sheora	Sireblus asper	Tree	1
Sajna	Moringa oleifera	Tree	1
Peyara	Psidium guayava	Tree	5
Tal	Borassusfiabellifer	Tree	2
Narikel	Coccos nucifera	Tree	1
Boroi, Kul	Zizyphusmauritiana	Tree	2
Sofeda	Manilkarazapota	Tree	1
Total:			33

5.4.3 Evaluation of Ecological Impact

To evaluate the ecological impact of the proposed RAJUK URU project, a simple semi-quantitative descriptive checklist method has been applied. Assessments have been made as to whether the impacts were positive (beneficial) or negative (harmful), short-term (short recovery time) or long-term (extended recovery time); and of high or low / moderate intensity. The results of the assessment are summarized in Table 5.6, which indicates that most of the evaluated ecological impacts are low and short-term in nature. No long-term adverse impacts on the floral and faunal species including fish diversity are expected.

Table 5.6: Impacts on Ecology due to the proposed RAJUK URU project.

Source of Potential Impacts	Ecological Aspects				
	Flora	Fauna			
		Amphibia	Reptile	Bird	Mammal
	TR	TR	TR	TR	TR
During Construction Phase					
Camp setting	-1S	-1S	-1S	-1S	-1S
Material storage on land	-1S	-1S	-1S	0	-1S
Land clearing & / alteration	-1L	-1L	-1L	-1L	-1L
Soil excavation	-1L	-1L	-1L	-1L	-1L
Floral removal	-1L	-1L	-1L	-1L	-1L
Machinery use(noise generation)	0	-1S	-1S	-1S	-1S
Sewage discharge on soil	0	0	0	-1S	0
High-rise building construction	-1L	-1L	-1L	-1L	-1L
During Operation Phase					
General waste / sludge disposal on land	-1S	-1S	-1S	-1S	-1S
Spills (oil) on land	-1S	-1S	-1S	-1S	-1S

[Legend: TR = Terrestrial; 3 = High impact, 2 = Moderate impact, 1 = Low impact, 0 = No impact (negligible impact), S = Short term impact, L = Long term impact, +/- = positive/negative impact]

5.4.4 Risk Assessment

A typical eco-environmental risk assessment matrix has been developed on the ecological aspects of the proposed high-rise building construction project. Table 5.7 shows the consequence severity ranking (from low to critical); Table 5.8 shows the likelihood ranking (from “almost certain” to “rare”), along with frequency level for each ranking. Table 5.9 shows the ecological impact significance rankings; and Table 5.10 shows the risk assessment matrix, which is based on consequence severity and likelihood/frequency of occurrence of an event; risk has been classified from “low” to “extreme” for the proposed high-rise building construction project.

Table 5.7: Categories and Definition of Consequence Levels

Category	Ranking	Definition
Critical	5	Very serious environmental effects with impairment of ecosystem function. Long-term, widespread effects on significant environment (e.g. unique habitat, national park) Habitat restitution time >100 years and requiring extreme substantial intervention.
Major	4	Serious environmental effects with some impairment of ecosystem function (e.g. displacement of species). Relative widespread medium–long term impacts.

Category	Ranking	Definition
		Habitat restitution time >10 years and requiring substantial intervention. Potential for continuous non-compliance with environmental regulations and/or company policy.
Moderate	3	Moderate effects on biological environment but not affecting ecosystem function. Moderate short-medium term widespread impacts Habitat restitution time 1-5 years (possible limited and local areas up to 10 years) with potential for full recovery and limited or no intervention required. Potential for short to medium term noncompliance with environmental regulations and/or company policy.
Minor	2	Minor effects on biological environment. Minor short-medium term damage to small area of limited significant Full recovery in < 1 year without intervention required. Any potential non-compliance with environmental regulations and/or company policy would be minor and short-term.
Low	1	No lasting effect. Low-level impacts on biological environment. Limited damage to minimal area of low significant. Compliance with environmental regulations and/or company policy at all times. Possible beneficial effect or ecosystem improvement.
None	0	No impact on ecosystem damage. No compliance required for environmental regulations and/or company policy at all times. Possible beneficial effect or ecosystem improvement.
Limited Positive	+	Some beneficial improvement to ecosystem. Benefits to specific flora and / or fauna.
Modest Positive	++	Moderate beneficial improvement to ecosystem. Medium benefits to specific flora and / or fauna.
Significant Positive	+++	Major beneficial improvement to ecosystem. Large scale benefits to specific flora and / fauna.

Table 5.8: Ecological Likelihood of Occurrence and Rankings in Impact Evaluation

Impact Likelihood	Ranking	Definition	Impact Frequency
Almost Certain (80 – 100%)	5	The activity will occur under normal operating conditions.	Very Frequent (High frequency of occurrence – occur > one per month)
Very Likely (60 - 80%)	4	The activity is very likely to occur under normal operational conditions.	Frequent (Regular frequency. Event likely to occur at least once per year)

Impact Likelihood	Ranking	Definition	Impact Frequency
Likely (40 - 60%)	3	The activity is likely to occur at some time under normal operating conditions.	Occasional (Occurs once every 1 – 10 years)
Unlikely (20 - 40%	2	The activity is unlikely to but may occur at some time under normal operating conditions.	Few (Unlikely to occur during life of operations – occurs once every 10 – 100 years)
Very Unlikely (0 - 20%)	1	The activity is very unlikely to occur under normal operating conditions but may occur in exceptional circumstances.	Rare (Highly unlikely to occur during life of the operation. Occurs less than once every 100 years).

Impact Significance

The significance of ecological impact for the proposed high-rise building construction project has been determined by calculating the consequence and likelihood of occurrence of the activity, expressed as follows

Significance = Consequence X Likelihood

The above Tables illustrate all possible consequence X likelihood product results for the five consequences and likelihood categories. The possible significance rankings are presented in the following Table 5.9.

Table 5.9: Ecological impact significance rankings

Ranking (Consequence x Likelihood)	Significance
>16	Critical
9-16	High
6-8	Medium
2-5	Low
<2	Negligible

Table 5.10: Risk Assessment Matrix

Likelihood/ Frequency	Consequence Severity				
	Low	Minor	Moderate	Major	Critical
Almost Certain	High	High	Extreme	Extreme	Extreme
Very Likely	Moderate	High	High	Extreme	Extreme
Likely	Low	Moderate	High	Extreme	Extreme
Unlikely	Low	Low	Moderate	High	Extreme
Very Unlikely	Low	Low	Moderate	High	High

In Table 5.11, the potential impacts of the proposed high-rise building construction project activities on the existing ecological aspects (e.g. flora and fauna) have been ranked on the basis of consequence severity ranking (Table 5.7), likelihood/ frequency ranking (Table 5.8), and risk rating (Table 5.9). Both the “consequence severity” and “risk” of the possible impacts have been categorized as “low”, while likelihood/ frequency” has been categorized as “very unlikely”. Thus, the proposed high-rise building construction project is likely to have some low significant adverse impact on the existing ecological environment. However, the identified impacts could be resolved to some extent by adopting appropriate mitigation measures in the course of time.

Table 5.11: Summary of Potential Ecological Impact Assessment for the proposed RAJUK URU Building Project

Potential Impacts Source / Project Activities	Impact	Ecological Receptor Type	Description	Likelihood	Consequence	Risk Rating
Land utilization for base camp	Reduction of access to the utilized land and its resources.	Flora and Fauna	Direct Negative Short term Local Reversible	Likely	Low	Low
Site preparation /clearing for base camp and associated activities	Floral destruction. Loss to utilize the flora as faunal habitat.	Flora	As above	Unlikely	Low	Low
	Loss / alteration of faunal habitat.	Fauna	As above	Unlikely	Low	Low
	Increased access for exposed faunal harassment or killing (e.g. rat).	Fauna	As above	Unlikely	Minor	Low
Construction of base camp and related activities	Disturbance of soil dwelling fauna (e.g. rat).	Fauna	As above	Unlikely	Minor	Low
High-rise building construction (e.g. concrete structure, rod binding, welding etc.).	Generation of high intensity welding flash and noise.	Fauna	As above	Unlikely	Minor	Low
	Contamination of surface soil with used lubricant, if any.	Flora and Fauna	As above	Unlikely	Minor	Low
Material storage or placement	Habitat destruction of terrestrial flora (herb, shrub) and borrowing faunal habitat and Movement disturbance of terrestrial fauna (amphibia, reptile & mammal).	Flora and Fauna	As above	Unlikely	Minor	Low
Vehicle movement	Impairment of terrestrial flora (herb & shrub), terrestrial fauna (amphibia, reptile & mammal).	Flora and Fauna	As above	Likely	Minor	Low
Equipment installation on land	Habitat destruction of terrestrial flora (herb, shrub) and Movement disturbance of terrestrial fauna (amphibia, reptile & mammal).	Flora and Fauna	As above	Unlikely	Low	Low
Soil excavation	Habitat destruction of terrestrial flora (herb, shrub) and Movement disturbance / habitat	Flora and Fauna	As above	Unlikely	Minor	Low

Potential Impacts Source / Project Activities	Impact	Ecological Receptor Type	Description	Likelihood	Consequence	Risk Rating
	destruction of terrestrial (burrow) fauna (amphibia, reptile, bird & mammal).					
Noise disturbance	Disturbance of terrestrial faunal livelihood [movement, foraging, breeding) (amphibia, reptile, bird & mammal).	Fauna	As above	Unlikely	Minor	Low
Exhaust from generators	Movement disturbance of terrestrial fauna (e.g. aves).	Fauna	As above	Unlikely	Minor	Low
Spills (oil / chemical) on land	Habitat destruction of flora and fauna	Flora and Fauna	As above	Very Unlikely	Minor	Low
Waste generation: (Solids/liquid/gaseous) (e.g. cement bags, exhaust from cranes/ heavy equipment, domestic waste)	Impairment of the health of terrestrial flora and fauna	Flora and Fauna	As above	Unlikely	Minor	Low
	Nuisance noise, dust, emissions, lighting etc.	Flora and Fauna	As above	Unlikely	Minor	Low
	Increased level of disease vectors (mosquitoes, rats, flies, etc)	Flora and Fauna	As above	Unlikely	Minor	Low
	Soil contamination due to sewage discharge (e.g. increase in diseases)	Fauna	As above	Unlikely	Minor	Low
Decommissioning Repair of damaged roads Removal of structures Restoration of site etc.	Nuisance (e.g. noise, emission, vibration etc.) from heavy machinery.	Fauna	As above	Likely	Minor	Low

.

5.5 SOCIO-ECONOMIC IMPACTS

5.5.1 Socio-Economic Impacts during Construction Phase

Employment and Economy

During the construction phase of the project, there will be possibility of generating more than 100 jobs. The job opportunities would be created for labors as well as skilled manpower such as engineers. Additionally, additional employment gain would result from the supply-chain system for the construction materials and transportation of the debris from the dismantling of the existing building in the project area. Requirements of construction materials would also positively impact the job growth in the manufacturing sector that generates various construction materials including steels and cement.

Traffic Condition

During the construction stage, transportation of construction materials would increase traffic flow in the project area. The increased traffic could create traffic congestion in the access road, especially in peak hours. The large trucks carrying the materials could worsen the traffic jam even on the Bir Uttam A K Khandokar Road (Mohakhali-Gulshan road), especially during peak hours. Traffic congestion may get worse if the construction materials are stored on the street instead of secured shed inside the project area.

Community Health and Safety

Improper health and safety policy maintained at the project area during the construction phase may lead to outbreak of different diseases to the surrounding communities through the sick workers working at the project. Vehicles carrying construction materials would increase traffic and would lead to an increased noise level due to vehicle operation and honking. Noise and vibration from the construction machines and equipment may also affect the health of the surrounding community. Emission from the vehicles would increase air pollution level especially in the dry season. Construction activities would also generate dust increasing the particulate matter in the air, especially in the dry season.

Occupational Health and Safety

Construction workers may face occupational health hazards such as minor or major injuries due to lack of general safety requirements and precautions applicable for such sites, malfunctioning equipment, careless use of equipment and vehicles. Poorly designed temporary accommodation and sanitation facilities may pose a health threat and nuisance to the workers. Uncontrolled vending of food and drinking water on the work site may also pose a risk with respect to the transmission of contagious diseases like Typhoid, Diarrhea, Malaria, Dengue, etc. Construction workers will be required to handle hazardous materials such as cement, paints, chemicals, fuels, etc., therefore increasing health risks of workers. High noise from the heavy construction machines would also pose a threat to the construction workers. Accident during

construction phase is also an important issue. Proper measures including regular maintenance of equipment and use of protective gear are needed to reduce the risk of such accidents during the construction phase. A complete plan on Occupational Safety and Health to mitigate the impacts has been provided in Chapter 10. Table 5.12 listed the effects of project activities during the construction phase.

Table 5.12: Effect of project activities on socio-economic parameters during construction phase

Socio-economic parameters	Environmental examination						
	Positive impact			No impact	Negative impact		
	Low	Moder-ate	High		Low	Moder-ate	High
Health and well being						X (Sh)	
Traffic condition						X (Sh)	
Employment	X (Sh)						

Sh=Short-term; Lo=Long-term

5.5.2 Socio-Economic Impacts during Operational Phase

Employment and Economy

During the operational phase of the project, there will be possibility of generating more than 500 jobs. The RAJUK-URU center will house a state-of-the-art laboratory, training, and research facilities that would create employment for the laboratory attendants and training and research personnel. Additionally, there will be conference rooms, business center, and office spaces, which would also create employment opportunities.

The research facility in the RAJUK-URU aims to enhance the urban resilience and institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh. The objective of the overall engagement is to develop a comprehensive approach to managing earthquake risk through a structured process of knowledge development, education, and planning for risk assessment, earthquake engineering, construction standards, in-situ and laboratory construction material testing, specialized construction training, and risk-sensitive land use planning. Capacity building through the URU project would facilitate the development of resilient infrastructure in the country, which would contribute to the overall economy.

Traffic Condition

During the operational stage, traffic flow would be increased in the project area. The increased traffic could be generated by considerable number of RAJUK vehicles, and vehicles carrying the staffs and visitors to the project area. The increased traffic could create traffic congestion in the access road, especially in peak hours. Traffic jam occurs, often, on the main road (Mohakhali-Gulshan road) during peak hours. With increased traffic during the operational phase of the project, the traffic jam scenario may get worse, especially during the peak hours.

Community Health and Safety

Improper health and safety policy maintained at the project area during the operational phase may lead to outbreak of different diseases to the surrounding communities through the sick staffs and personnel working in the project area as well as from visitors visiting the center. Increased traffic, which adds to already existing traffic jam on the Bir Uttam A K Khandokar Road (Mohakhali-Gulshan Road), would lead to the increase in noise pollution from the operation of vehicles and their honking. Emission from the vehicles would also increase air pollution level especially in the dry season. If not housed properly, noise and vibration from the generators may affect the health of the surrounding community which includes educational institutions and residential area.

Occupational Health and Safety

During the operational phase more than 500 staffs and personnel would stay and work in the RAJUK complex area during office hours. There could be health and safety risks that may occur during their stay in the office. These impacts may include:

- Accidents due to move/ fall down from the roof/ balcony and using the stairs;
- Fire hazards from short circuits/cooking stoves/careless handling of materials that can generate fire;
- Inadequate lighting and ventilation in and outside the building complex;
- Noise and vibration from generator and other equipment;
- Accidents in the elevators in case of inadequate power supply and lack of generators;
- Inadequate quantities and/or poor-quality water supply and sanitation facilities;
- Poor cleanliness of the building occupants;
- Lack of daily cleaning and regular maintenance of inside and outer side of the complex;
- Safety of the security guards who would work in the night shift.

Table 5.13 lists the impacts on socio-economic parameters during operation phase of the project. National economy will be benefited as the URU would build capacity to promote design and implementation earthquake resilient infrastructure. The resilient infrastructures would be able to help to reduce the cost for disaster management activities marking a positive impact with low priority on national economy.

Table 5.13: Effect of project activities on socio-economic parameters during operation phase

Socio-economic parameters	Environmental examination						
	Positive impact			No impact	Negative impact		
	Low	Moderate	High		Low	Moderate	High
Health and well being					X (Lo)		
Traffic condition					X (Lo)		
Employment		X (Lo)					
National economy	X(Lo)						

5.5.3 Risk Assessment for Socio-Economic Impacts

A typical risk assessment matrix has been developed for major socio-economic aspects within the RAJUK URU project areas and presented in Table 5.14. Table 5.14 indicates that most of the socio-economic impacts are rated as negatively low impacts. Therefore, it can be said that the social environment is expected to be adversely impacted by low intensity with short term effect.

Table 5.14: Risk Assessment for Potential Socio-Economic Impacts of the proposed RAJUK URU Building Project

Socio-economic Aspects	Potential Impact (Consequence)	Socio-economic Receptor Type	Description	Consequence Severity Ranking	Impact Likelihood Rating	Risk Rating
Permitting	Acceptance of URU project and cooperation / participation from communities and government.	• Social • Economic	• Direct • Positive • Long term • Local • Reversible	Low	Likely	Low
Land (utilization, clearing, alteration etc.)	Local community and their life & livelihood affected	• Social • Economic	• Direct • Negative • Short term • Local • Reversible	Low	Likely	Low
	Destruction of vegetation	As above	As above	Low	Likely	Low
Structure (demolition & debris removal to other places, etc.)	Debris removal through roads with possibilities of accident	As above	As above	Low	Likely	Low
Mobilization to site	Increase in usage of roads with possibilities of accidents	As above	As above	Low	Unlikely	Low
	Increase in usage and resultant damage to existing roads	As above	As above	Low	Likely	Low
Accommodation of workers	Local contractors shall be used	As above	As above	Low	Likely	Low
Business	Shutdown or relocation of current business with economic loss and mental disturbances	As above	As above	Low	Likely	Low
Income	Loss of current Income from various sources (business, structure rent, job etc.)	As above	As above	Low	Unlikely	Low
Roads & utilities	Pressure on use of existing roads, & available utilities for the types of uses	As above	As above	Low	Likely	Low

Socio-economic Aspects	Potential Impact (Consequence)	Socio-economic Receptor Type	Description	Consequence Severity Ranking	Impact Likelihood Rating	Risk Rating
Recruitment of workers and / or local contractors	Creation of opportunities for employment	As above	As above	Low	Likely	Low
	Third party agitation over contracts, employment issues, community benefits, waste disposal, degradation of water, pressure on water and food.	As above	As above	Minor	Unlikely	Low
Building construction (e.g. structure, rod binding, welding) &repairs & maintenance	Generation of high intensity welding flash and noise.	As above	As above	Minor	Unlikely	Low
	Burns and injuries from welding sparks / injuries from other maintenance activities	As above	• Direct • Positive • Long term • Local • Reversible	Low	Unlikely	Low
	Contamination of surface soil with used lubricant, if any	As above	• Direct • Negative • Short term • Local • Reversible	Low	Unlikely	Low
Vehicle movement	Probability of accident during transportation of goods through road	As above	As above	Minor	Likely	Low
	Nuisance noise, dust, emissions, lighting etc	As above	As above	Minor	Likely	Low
Noise disturbance	Disturbance to local community and educational institutions.	As above	As above	Minor	Unlikely	Low
Exhaust from generators	Disturbance to local community especially to the nearby educational institutions, residential & commercial community and road side moving people.	As above	As above	Minor	Unlikely	Low
Spills (oil / Chemical) on land	Soil contamination / disturbance to local community	As above	As above	Minor	Very Unlikely	Low
Waste generation: (Solids/liquid/gaseou	Impairment of health of local community.	As above	As above	Minor	Unlikely	Low

Socio-economic Aspects	Potential Impact (Consequence)	Socio-economic Receptor Type	Description	Consequence Severity Ranking	Impact Likelihood Rating	Risk Rating
s) (e.g. cement bags, exhaust from cranes/ heavy equipment, domestic waste)	Increase in disease conditions like diarrhea / respiratory tract diseases.	As above	As above	Minor	Unlikely	Low
	Increased level of disease vectors (mosquitoes, rats, flies, etc)	As above	As above	Minor	Unlikely	Low
	Soil contamination due to sewage discharge (e.g. increase diseases)	As above	As above	Minor	Unlikely	Low
Testing inside the URU building	Noise or sound pollution to the nearby education, residential and commercial institutions.	As above	As above	Minor	Unlikely	Low
Decommissioning • Repair of damaged roads • Removal of structures • Restoration of site	Increased opportunity for employment and contracting resulting in increased income level.	As above	As above	Minor	Likely	Low

CHAPTER 6
ASSESSMENT AND MANAGEMENT OF TRAFFIC IMPACTS

6.1 BACKGROUND

The new RAJUK Urban Resilience Unit (URU) building is envisaged as a service oriented building. Therefore, once built, it is likely to attract a substantial amount of traffic to its office facilities. This initiates the need to carefully investigate the existing access facilities to and from the adjacent arterial road: Gulshan-Mohakhali Link Road (Figure 6.1). Evaluation of any future traffic impacts on this link must be carefully reviewed and if necessary, mitigation strategies must be implemented to ensure trouble free traffic operations. Hence, a study was conducted to assess the environmental impact of the proposed development project including the traffic impact and to recommend mitigation strategies, as necessary. This chapter presents detail assessment of the traffic impact the project will likely to have on the surrounding areas. The following sections of this chapter describes the existing traffic condition, relevant data collection and analysis, estimation of the vehicle trips that are likely to be generated once the project is in operation, their distribution, and possible improvements and/or modifications of the surrounding street network to accommodate the additional traffic.

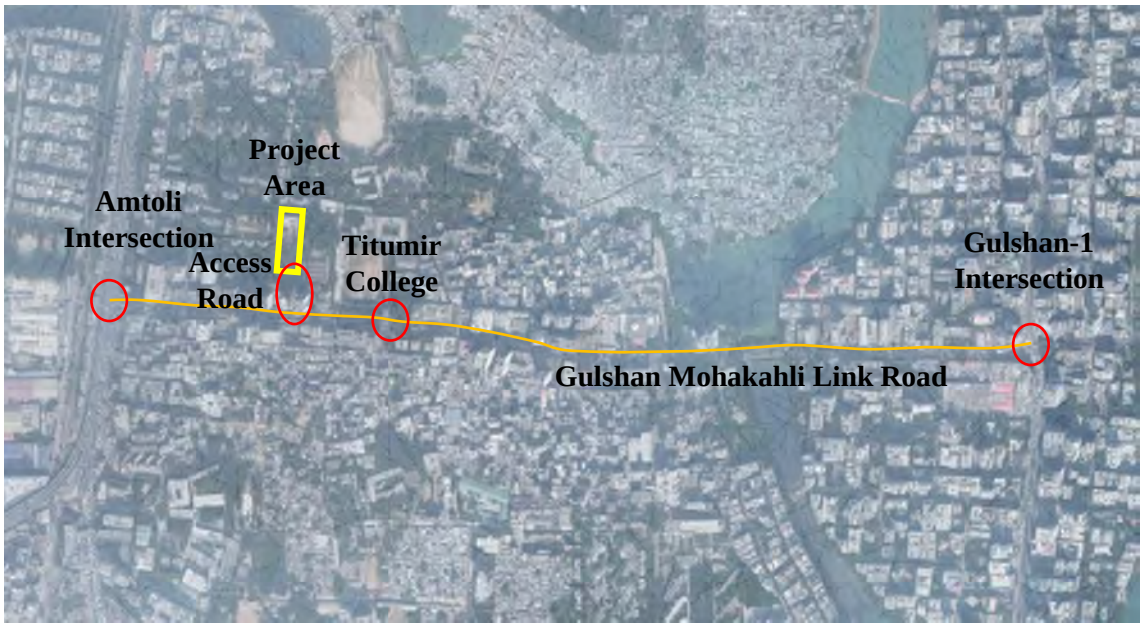


Figure 6.1: Traffic survey locations surrounding the URU building project site

6.1.1 Traffic within the Project Site

At present, the RAJUK zonal office at Mohakhali situated within the project area provides service primarily to Gulshan-Banani-Mohakhali areas. The existing traffic uses an internal road (Figure 6.2) adjacent to the link road to access this office. From field observation, no traffic congestion and conflict within the project site were found for the internal traffic.

Figure 6.2: Existing roads for traffic circulation within the project influence area

6.1.2 Traffic in the Surrounding Area

Field survey around the project influence area specifies external traffic conditions. The key findings from the survey are described below:

I. **Existing flow rate and available capacity:** The volume count study at the critical intersections used a 15-minute data aggregation time. It was observed that during the peak hour, flow rate per lane in most of the intersection approaches exceeded their capacity. So, formation of queue was noticed frequently.

II. **Illegally parked vehicles:** Private cars and motorcycles, which are not authorized to park, can be seen parked in the access road of the proposed RAJUK-URU building. In most cases, it reduces the two-lane road into 1.5 or 1 lane creating hindrance in passing even two vehicles side by side. However, significance of this is lower as current traffic demand at the access road is lower than the link road.

III. **Unauthorized stop made by mass transits and para-transits:** Mass transits and para-transits approaching the critical intersections on the link road were found forming platoon due to boarding and alighting of passengers. These vehicles make their stop right at the intersection, often side by side when other vehicles are present. Also, these vehicles progress very slowly while leaving the stoppage. This is mainly intended to give a false impression to the potential passengers by giving them an indication that they are leaving and boarding those vehicles will reduce the passengers' in-vehicle waiting time. This is usually one of the major reasons of congestion during the evening peak hour (05:30 PM – 06:30 PM). These vehicles tend to wait a bit longer during this time to ensure that they leave the place with its full capacity. It was also observed that para-transit drops and waits for

passengers on the link road closed to the critical intersections creating a flock and causing serious safety hazard.

IV. **Vehicles driving through wrong direction:** The continuous divider along the link road facilitates an opening in front of the Titumir College for U-turning maneuver. Often many vehicles, especially non-motorized para-transit e.g., rickshaws who are in the link road coming from Gulshan-1 use this opening and travel in the wrong direction in order to access their destination. This reduces speed and mobility of the artery: Gulshan-Mohakhali Link Road.

V. **Unauthorized street side shops blocking pedestrian walkway:** A large number of street shops and construction materials were found on both sides of the link road. There was practically very little space left for pedestrian use which forces them to shift to the carriage way hindering smooth flow on the link road as well as making them vulnerable to road crashes.

VI. **Imbalanced allocation of green time:** On the link road, Amtoli and Gulshan-1intersections have 3-leg and4-leg configurations, respectively. Although both have signal heads, vehicle movements are controlled by the hand-gestures of traffic police creating an imbalanced allocation of green time for different phases.

6.2 EXISTING TRAFFIC CONDITION OF THE STUDY AREA

Before assessing the impacts of the project on traffic operating conditions, it is necessary to know the existing traffic situation at the two critical intersections (i.e., Amtoli and Gulshan-1) within the project influence area (Figure 6.1). The qualitative information regarding traffic situations can be found in the earlier sections, however, the quantification of traffic parameters gathered from a series of field survey are presented in the following sections.

6.3 GEOMETRIC AND TRAFFIC DEMAND SURVEY

A comprehensive traffic survey was conducted to build / calibrate / validate a base micro-simulation model that was used to evaluate the existing traffic condition in the link road and expected changes in the traffic situation caused by the RAJUK-URU Building. Particularly, five different types of survey were adopted as follows:(1) Traffic count survey;(2) Vehicle speed study; (3) Travel time survey; (4) Questionnaire survey; and (5) Geometric survey, as depicted in Table 6.1.Methodologies of these survey types are described as follows:

Table 6.1: Study locations, survey types and methods

Sr. No.	Location name	Type	Method	Date	Time
1	Gulshan-1 Intersection	Volume Count	Manual	9 & 10 July, 2019	08:00-12:00 & 15:00-19:00
2	Amtoli Intersection	Volume Count	Manual	9 & 10 July, 2019	08:00-12:00 & 15:00-19:00
3	Access Road	Volume Count	Manual	9 & 10 July, 2019	08:00-12:00 & 15:00-19:00
4	Titumir College	Volume Count	Manual	9 & 10 July, 2019	08:00-12:00 & 15:00-19:00
5	Gulshan Mohakhalilink road	Speed Study	Automatic (Radar Gun)	9 & 10 July, 2019	15:00-16:15
6	Gulshan Mohakhali link road	Travel Time Survey	Automatic (GPS)	9 & 10 July, 2019	15:00-19:00
7	RAJUK Bhaban	Questionnaire survey	Manual	14-18 July, 2019	08:00-15:00

6.3.1 Count Survey

Traffic counting was performed at four strategic locations to cover the project influence area (Figure 6.1). These four locations include even approaches of two critical intersections, two U-turn movements and entry movement to the proposed RAJUK-URU building. Manual counting was adopted to accumulate data of different categories of vehicles. A data collection form was designed to collect directional classified traffic counts. Traffic counting was conducted at those locations by assigning 30 experienced surveyors. At least two surveyors recorded traffic count for each approach to overcome the limitations of counting error and to accommodate nearly accurate classified count.

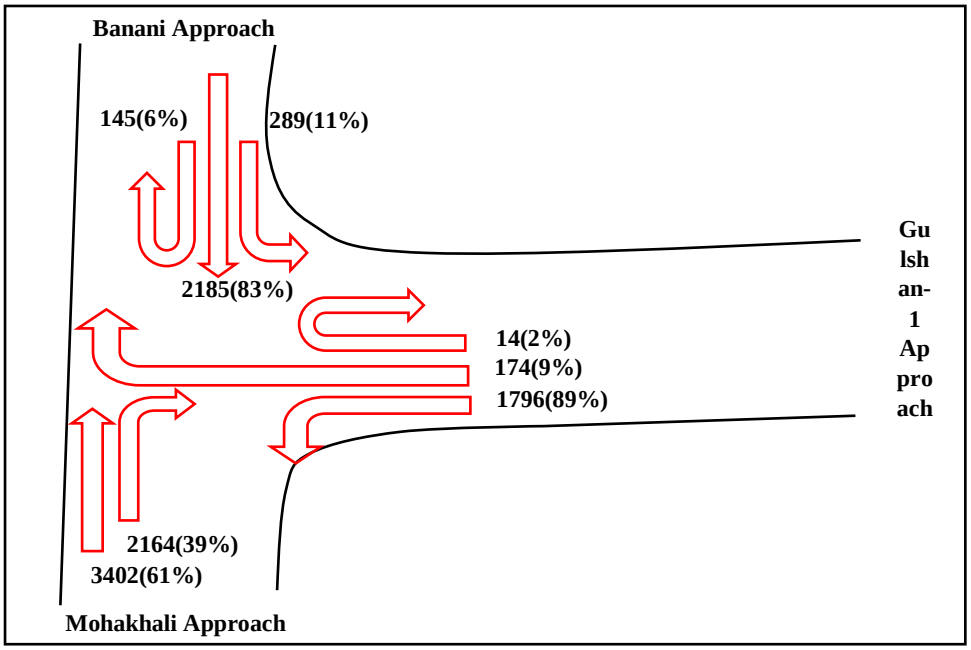
Eight hours (08:00 am-12:00 pm and 3:00 pm-7:00 pm) manual traffic count covering both peak and off-peak periods of two weekdays (9^{th} and 10^{th} July 2019) were conducted. As traffic in weekend is significantly lower, weekdays were chosen for count survey. At each approach, three movements were considered for traffic count. These were left-turn, through and right-turn movements. U-turning movement was also considered for the link road. In each movement, the traffic count was classified into nine categories: (i) motor -cycle; (ii) car/ jeep/ microbus/ taxi/ delivery van; (iii) CNG; (iv) covered van; (v) truck; (vi) bus; (vii) Leguna; (viii) rickshaw/ van and (ix) bi-cycle. Peak period was found to be vary in different approaches as found from the analysis of the survey data. The maximum calculated peak flow rate for each leg along with the number of lanes is presented in Table 6.2.

Table 6.2: Maximum flow rates for different roads in the study area

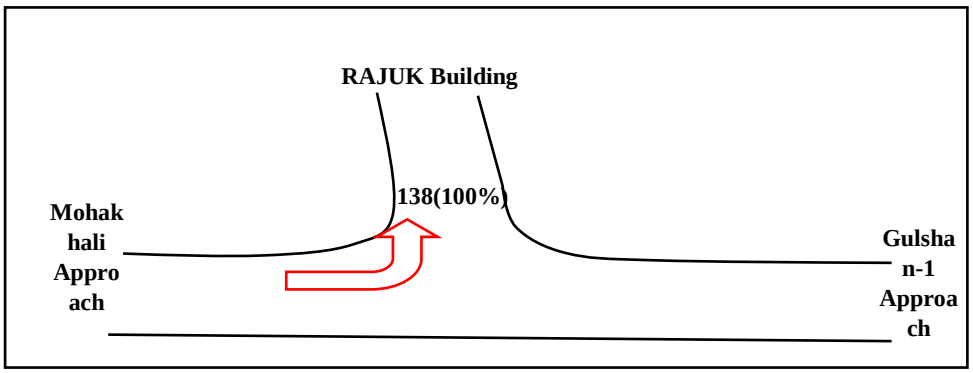
No.	Study Location	Flow Direction	No. of Lanes	Max. Flow Rate (vph)*	Max. Flow Rate (vphpl)*
1	Gulshan-1 Intersection	Police Plaza to Gulshan-1	3	5935	1978
2		Badda to Gulshan-1	2	861	431
3		Gulshan-2 to Gulshan-1	3	3912	1304
4		Mohakhali to Gulshan-1	2	1671	836
5	Amtoli Intersection	Mohakhali to Banani	2	5566	2783
6		Banani to Mohakhali	2	2619	1310
7		Gulshan-1 to Mohakhali	2	1984	992
8	Access Road	Entry	2	733	367
9	Titumir College	Mohakhali to Mohakhali	1	447	447
10		Gulshan-1to Gulshan-1	1	456	456

*Note: vph = vehicles per hour and vphpl = vehicles per hour per lane

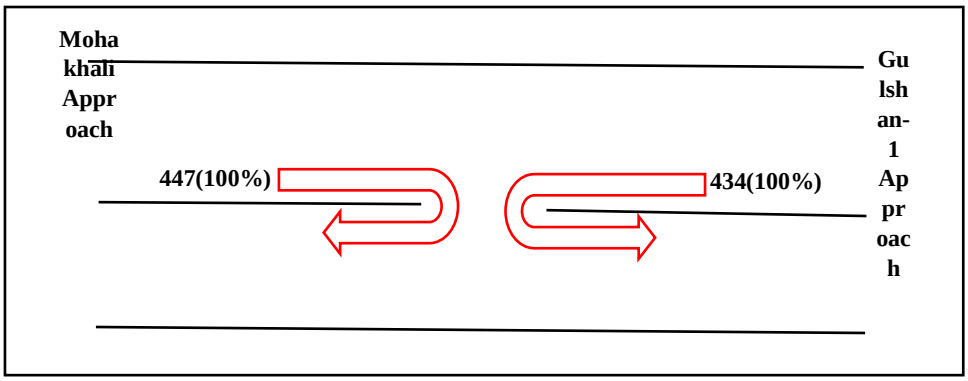
A summary of these data during peak hour are represented in Figure 6.2. It is important to identify the underlying reasons for such flow rates in deciding the impact of the newly proposed RAJUK-URU building. Any traffic solution that can improve the existing capacity will be able to better serve the future traffic accommodating a new project.



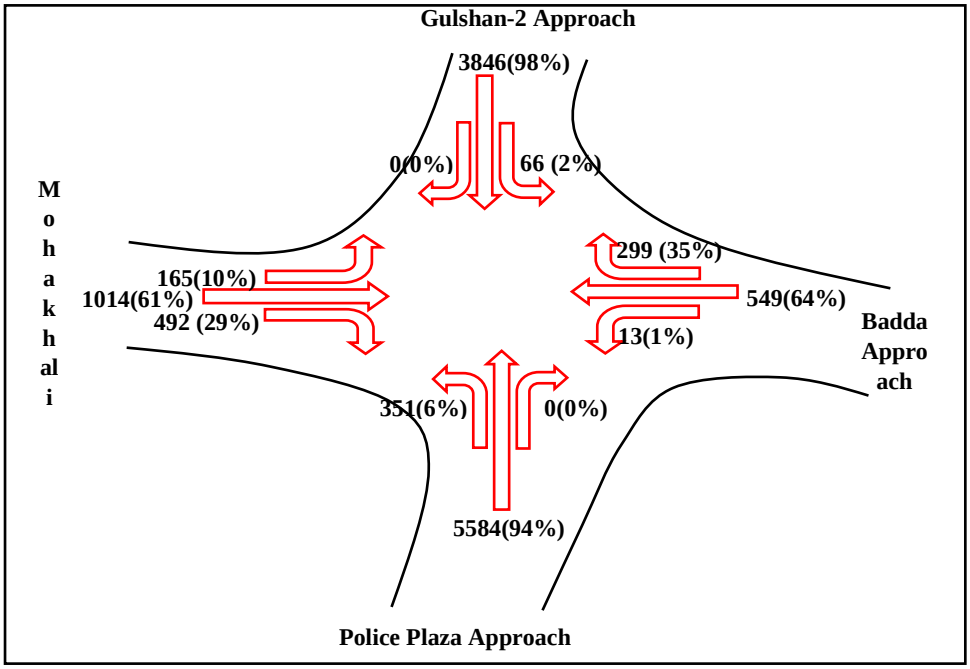
(a)



(b)



(c)



(d)

Figure 6.2: Direction-wise traffic volume during peak hour: (a) Amtoli intersection; (b) Access road; (c) Titumir college; and (d) Gulshan-1 intersection

6.3.2 Speed Survey

Speed studies were adopted to determine the speed distribution of a traffic stream in the link road. Particularly, the data gathered in spot speed studies were used to determine two important parameters, i.e., 50thand 85th speed percentiles. The 50thpercentile corresponds to the average speed of the vehicles traveling on the link road. Whereas, the 85thpercentile is the highest safe speed at or below which 85% of the observed vehicles were traveling. From the speed study, the 50thand 85thpercentile speeds were found to be27.9 kmph and 36.8 kmph, respectively. The speed distribution curve shown in Figure 6.3 was utilized while calibrating the operational model.

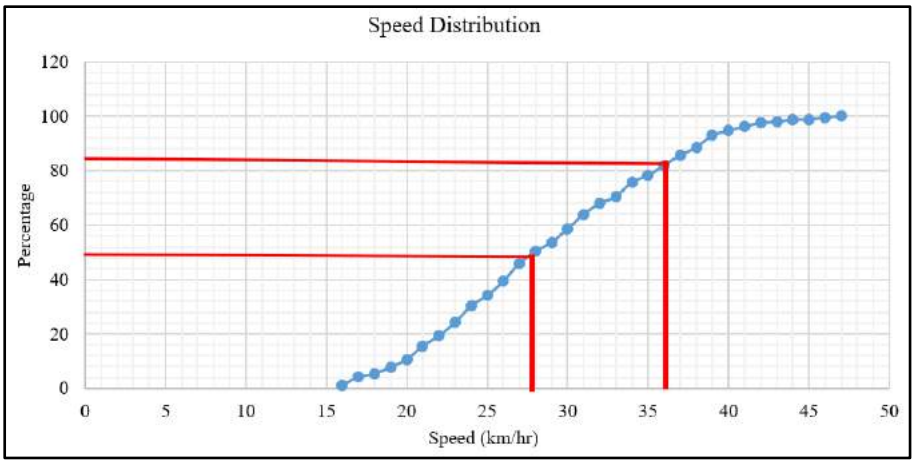


Figure 6.3: Desired speed distribution curve

6.3.3 Travel Time Survey

The travel time survey was conducted on the link road on 9th and 10th July, 2019. It is a probe-vehicle based approach, which travels through the study corridor and determines the real-time traffic condition. This survey incorporates GPS data. Figure 6.4 shows the time-space diagram obtained from this rigorous survey. In this figure, 0km represents the survey starting point, i.e. Amtoli intersection. One bottleneck section at Gulshan-1 end is found from the analysis. Also, the bottleneck speed (0.9 km/h) is obtained from this time-space diagram.

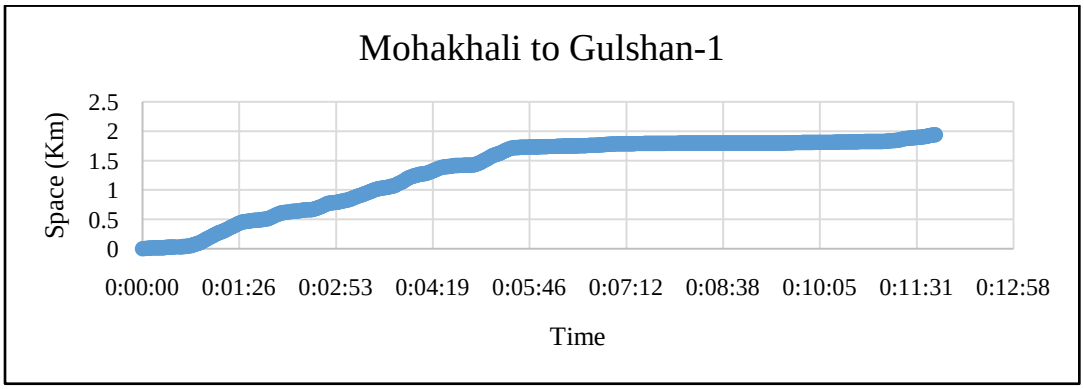


Figure 6.4: Time-space diagram

6.3.4 Questionnaire Survey

A survey on the RAJUK personnel and clients was conducted to understand the future demand and parking requirements of the planned RAJUK-URU building. Specifically, the survey was carried out in the existing RAJUK Bhaban at Motijheel, Dhaka from July 14, 2019 to July 18, 2019. In this survey, about four hundred (400) samples were collected to get five important parameters: (1) residence location; (2) visit purpose; (3) frequency of visit; (4) time required for completing a work; and (5) mode used to arrive at RAJUK building.

The first parameter gives an indication on the Origin-Destination (O-D) pattern of the RAJUK clients that seems to affect the two critical intersections on the link road. Particularly, the sample data shows that about 51.5% of the respondents come from North Dhaka, 41.2% come from South Dhaka and rest 7.4% come from outside of Dhaka city. The second parameter indicates the necessity and duration of parking. Usually, the building/housing developers visit RAJUK Bhaban more frequently compared to individual building owners. Particularly, the survey data shows that about 44.8% of all the clients are developers and the rest 55.2% are individual owners. The third parameter was collected to understand whether there are unnecessary trips made by the clients due to any procedural complexity of RAJUK for completing a work. Particularly, it reveals that about 60.3% of the clients need to come RAJUK building less than 5 (five) times where the other 33.3% need to come 5 (five) to 10 (ten) times to complete a work. The percentages of the clients who need to come from 11 (eleven) times to 20 (twenty) times and more than 20 (twenty) times are 3.2% and 3.2%, respectively. In relation to the fourth parameter, it was found that about 25.8% respondents can get their work done within 1(one) week, whereas 45.6% need to wait about 6 (six) months. About 9.1% clients said that they require 7 (seven) months to 5 (five) years. However, this duration generally depends on the complexity of works. Interestingly, about 19.7% of the clients have no idea about the time required to get their work done. The fifth parameter gives an important indication about the importance of planning internal and external traffic circulation. Particularly, private vehicles, para-transit modes, and public transport will call for off-street parking places, drop off area and nearby bus stops on the link road, respectively. Currently, 40.2% use public transport, 33.7% use private car, 13% use rickshaw, 7.6% use motor cycle, 1.1% use bicycle and 4.3% come to the office on foot. These results are used as important basis for micro-simulation modeling to assess the operational impacts. Figure 6.5 summarizes the questionnaire survey results.

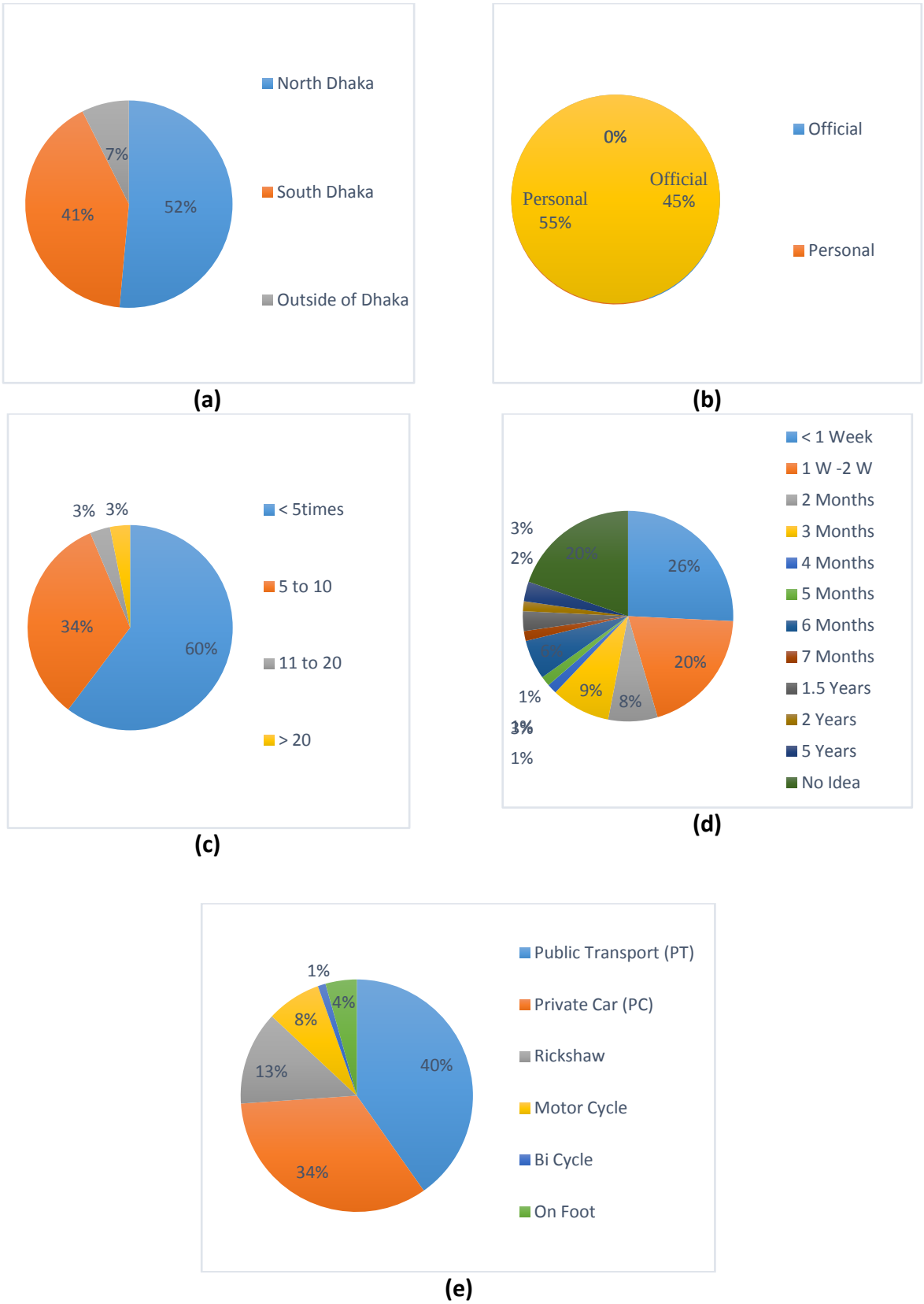


Figure 6.5: Summary of questionnaire survey (a) residence location; (b) visit purpose; (c) frequency of visit; (d) time required for completing a work; and (e) mode used to arrive at RAJUK Bhaban

6.3.5 Geometric Survey

The roadway geometry data of the study area is shown in Figure 6.6. These data were used while coding the links for preparing operational model of the road network surrounding the RAJUK-URU project site and analyzing the performance of network as well as the critical intersections.

Figure 6.6: Geometric Dimensions of the Project Site Area

The road way geometry data along with their lane number and lane separation are summarized in Table 6.3.

Table 6.3: Road geometry data in the study area

Symbol in Figure 6.6	Road Name	No. of Lanes	Lane separation	Width (m)
1	Mohakhali Approach	2	Divided	7.90
2	Gulshan Approach	2	Divided	7.90
3	Access Road	2	Undivided	8.45
4	Parallel Access Road	2	Undivided	7.90
5	Parallel Access Road	2	Undivided	9.10
6	Perpendicular Access Road	1	Undivided	3.50
7	Perpendicular Access Road	1	Undivided	4.00

6.4 DEMAND FORECASTING FOR THE PROJECT

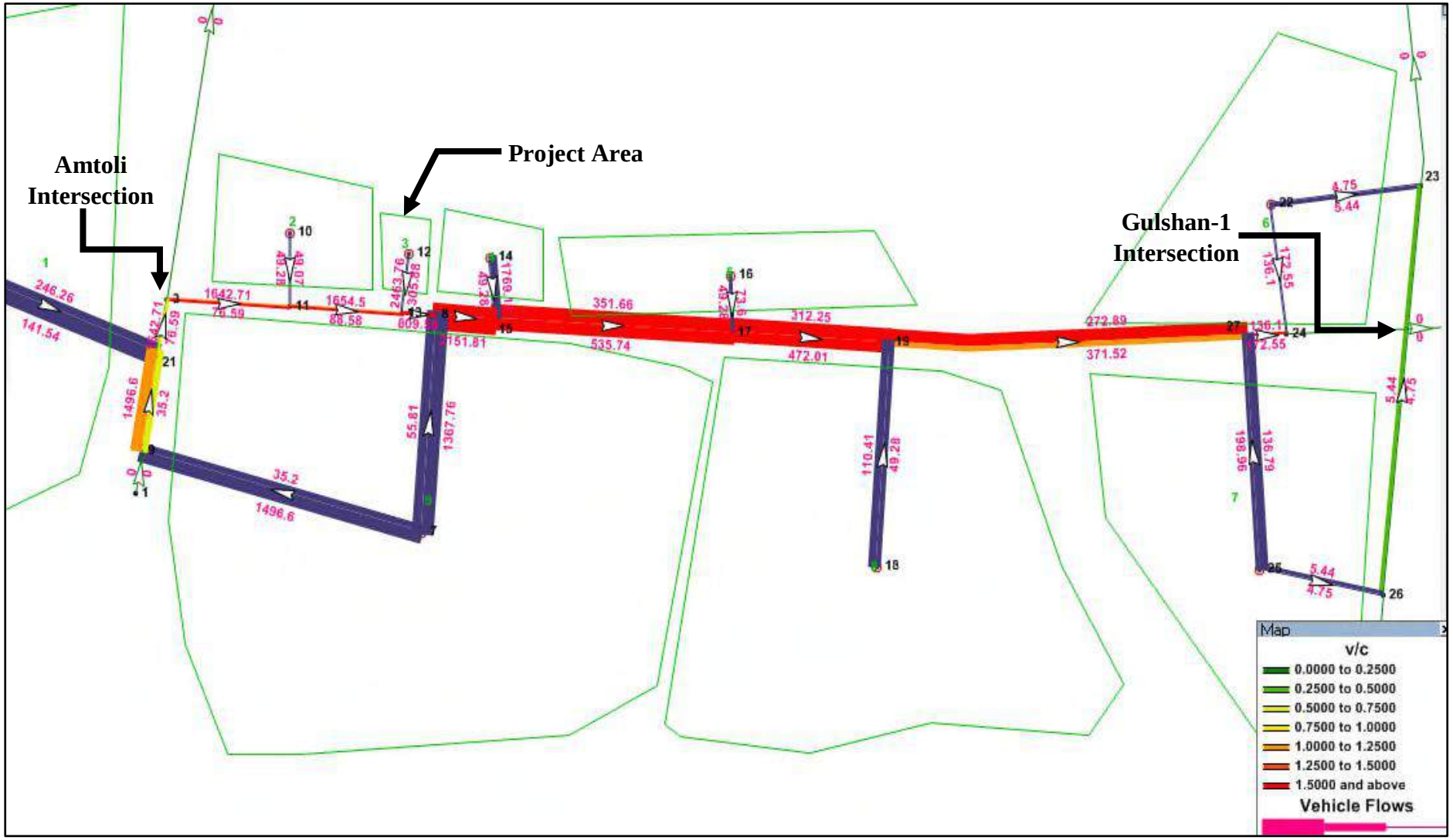
Demand forecasting involved a set of analytical procedures to estimate the induced traffic due to the RAJUK-URU building project. Particularly, the travel demand forecasting is done with a prominent travel demand forecasting software. It applies the traditional four step model, namely, Trip Generation (method: cross classification), Trip Distribution (method:

gravity model), Modal Split (method: multinomial logit model) and Traffic Assignment (stochastic user equilibrium) for both the two phases. Phase I is the 10 storied building with 2 basements. Total travel demands in the road network for Phase I and II are shown in Figures 6.7 (a and b). This demand study includes the traffic of the existing building of RAJUK and RAJUK-URU buildings of Phase I and II with the vehicles owned by the RAJUK employees working at this buildings.

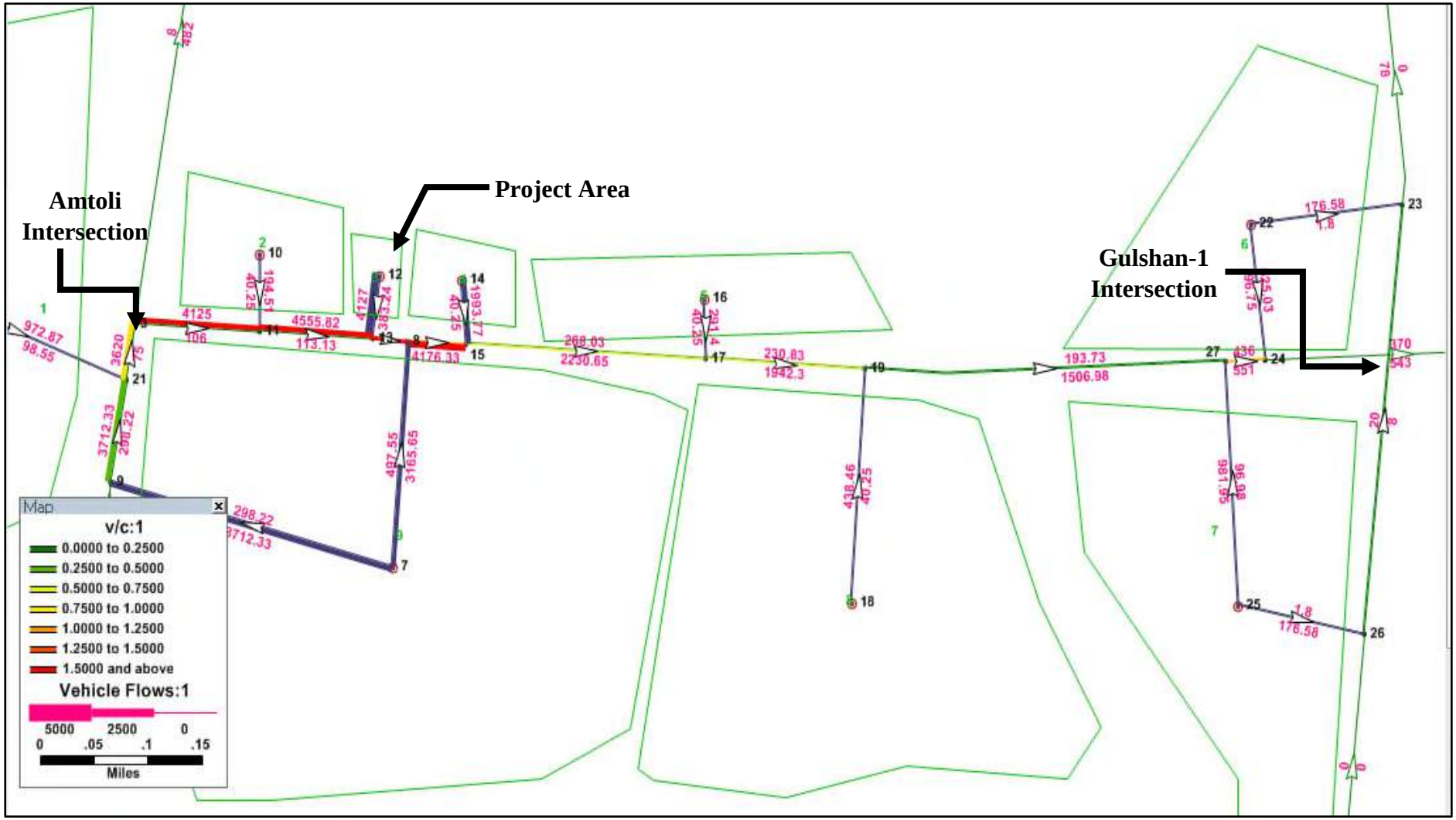
These figures indicate that due to the said project traffic will be increased significantly in the link road affecting both the critical intersections. Proper traffic circulation is needed to accommodate this induced traffic. While analyzing performance of network for different traffic circulation proposed by the RAJUK's consultants, these demands were utilized within the traffic operational model as illustrated in the later sections.

Table 6.4: Induced traffic for RAJUK-URU building project

Sl. No.	Intersection	Approach Name	Movement	Phase I (veh/hr)		Phase II (veh/hr)	
				In	Out	In	Out
1	-	Access Road	Entry	2464	-	4127	-
2			Exit	-	306	-	383
3	Amtoli	Gulshan	U-turn	9	-	23	-
4			Right	-	7	-	8
5			Left	-	70	-	75
6		Mohakhali	Right	1441	-	3620	-
7		Banani	Left	192	-	482	-
8	Gulshan-1	Mohakhali	Left	-	18	-	58
9			Through	-	113	-	370
10			Right	-	5	-	8
11		Police Plaza	Left	6	-	20	-
12		Badda	Through	166	-	543	-


Amtoli Intersection
Project Area
Gulshan-1 Intersection
Map
v/c
0.0000 to 0.2500
0.2500 to 0.5000
0.5000 to 0.7500
0.7500 to 1.0000
1.0000 to 1.2500
1.2500 to 1.5000
1.5000 and above
Vehicle Flows

(a)



(b)

Figure 6.7: Traffic flow diagram for (a) Phase I; and (b) Phase II

6.5 TRAFFIC CIRCULATION PLAN AND PARKING REQUIREMENTS

For external circulation, it is envisaged that the traffic from Gulshan-1willtake aright-turn from the link road (Figure 6.8) to access the project site through a two-lane access road. This will create a T-junction on the link road. Moreover, Figure6.9illustratesthetraffic circulation within the project site for the different facilities (shake table, phase-1 building, phase-2 building) as planned by the RAJUK's Consultant. It is envisioned that there will be different pickup and drop-off areas for Phase I and Phase II buildings. After dropping the passengers off, the vehicle can either enter into the underground parking space or through a circulatory movement exit the building.

Figure 6.8: External traffic circulation around the project site as designed by the RAJUK Consultant

6.5.1 Impacts of Traffic Circulation

Major concerns that were taken into account while proposing a modified traffic circulation plan for the URU building are given below:

External traffic circulation

The proposed RAJUK-URU building will attract a substantial number of trips through private vehicles, public transport and para-transit coming from both directions of the link road. As designed by the RAJUK's Consultant, westbound vehicles will take a right turn and eastbound traffic will take a left turn to access the RAJUK-URU building. When all the facilities will come under the umbrella of the new RAJUK-URU buildings (Phase I and Phase II), which will attract extra traffic from 77232.21 $m^2$of interactive space, right turning maneuver will not be a docile movement as it will cause queuing of vehicles right in front of the access road. Hence, external traffic circulation plan should be modified.

Pedestrian facilities

At present, the pedestrian access is kept adjacent to the link road. Most of the people who will be accessing the RAJUK-URU building on foot will be public transport or transit users or people working in nearby offices and facilities of RAJUK which will not be shifting to the RAJUK-URU building. Figure 6.9 shows that the same access road will be used by the pedestrians as well as the entry/exit vehicles. This is considered as a substantial safety hazard. Moreover, the layout also does not provide details on how it will take care of the pedestrians who will be accessing the RAJUK-URU facilities from the entry/exit gate. Moreover, the concern of drop-off passengers directly coming in contact with the exit vehicles in front of the Phase I building entrance should be modified.

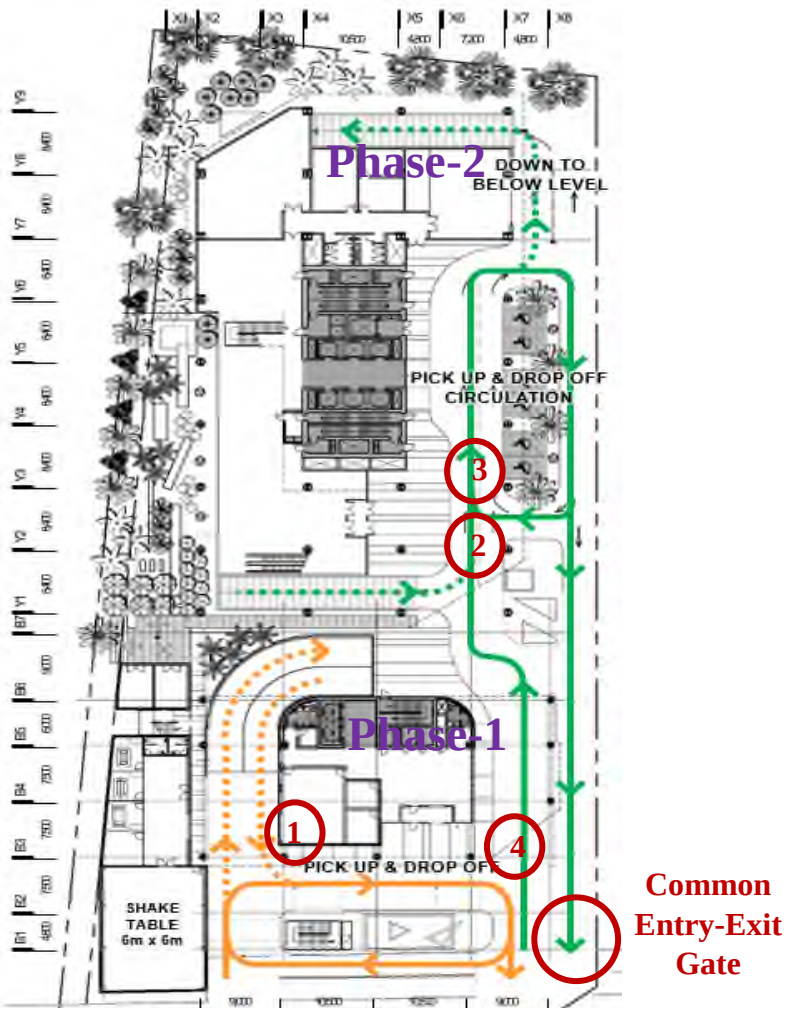


Figure 6.9: Internal traffic circulation within the project site as designed by the RAJUK's Design Consultant

Conflicting movements during traffic circulation

This study found four conflicting movements (see Figure 6.9) in the internal traffic circulation plan for RAJUK-URU building project. Entry vehicles will be in conflicting situation with the exit vehicles in front of the entry-exit gate(conflict 4).The second is a merging conflict between the vehicles leaving the basement of Phase I building with the

vehicles leaving the same building after dropping off passengers and taking U-turn rather than going to the basement (conflict 1). There will be a similar merging conflict in front of Phase II building(conflict 2).The last one is also a merging conflict between the vehicles leaving the basement of Phase II building with the vehicles taking a U-turn in front of the parking exit (conflict 3).

6.5.2 Mitigation Measures (Considering Phase I)

Conducting a detailed layout planning for access and traffic circulation is beyond the scope of this study. Hence, a set of recommendations have been provided in this section which can be used as the basis of detailed layout planning. Figure 6.10 summarizes the recommendations for external traffic circulation plan and Figure 6.11 summarizes the internal traffic circulation plan for Phase I building (10 storied building with 2 basement floors).

Figure 6.10: Traffic circulation on the link and access roads of the project site as proposed in the present study (considering phase-1 only)

Modification in external traffic circulation

As per the RAJUK's Consultant's proposed plan, entry vehicles from Gulshan-1 have to take a right turn to access the URU building (see Figure 6.8). This conflict can be avoided by making these vehicles take a U-turn (see Figure 6.10) about 150m downstream on the link road from Gulshan-1 intersection rather than taking a right-turn to avoid queuing of vehicles in front of the access road.

Adjustment in pickup-drop-off plan

As per the conceptual design, the RAJUK's Consultant showed the drop-off area on the entry driveway in front of Phase I building. Considering the capacity and length of the

access road, it is recommended that the pickup and drop-off is shifted to the basement for the vehicles requiring parking. Whereas, for the vehicles which do not need parking, both the pickup and drop-off should be considered on the exit driveway (in front of the building) after completing the U-turn (see Figure 6.11). This circulation plan could ensure smooth flow for the Phase I traffic. Furthermore, it will improve safety for the pedestrian by avoiding at-grade crossing through the exit driveway as well as could improve comfort by avoiding direct exposure to the bad weather (e.g., rain).

Alteration in exit vehicle circulation

As proposed by the RAJUK's Consultant, exit traffic from Phase I building will have a crossing conflict with the entry traffic of the existing RAJUK building (see Figure 6.9). It is recommended that all the exit traffic from Phase I building complete a U-turn as shown in see Figure 6.11 to avoid this conflict. This will improve both mobility and safety.

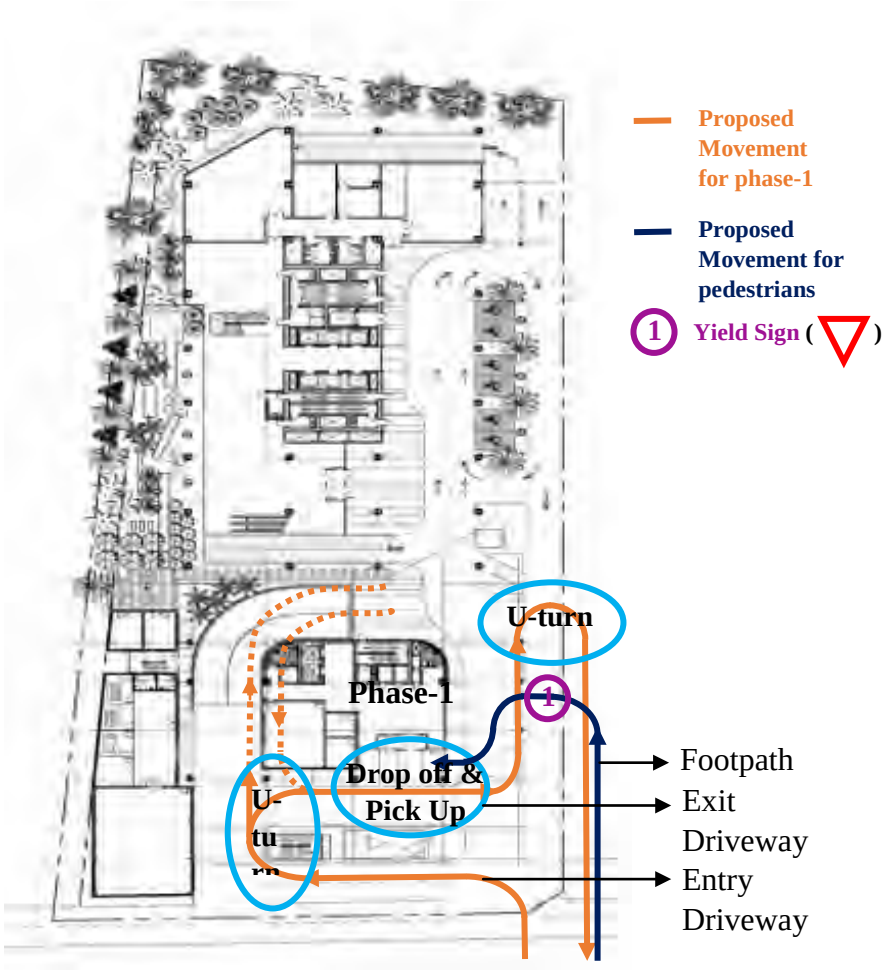


Figure 6.11: Internal traffic circulation within the project site as proposed in the present study (considering phase-1)

Pedestrian movement facilities

In the current proposal, here is no planned walking facilities within the project site for the pedestrians who will access the project site using para-transit or public transport. For these pedestrians, a footpath is recommended within the project site as shown in Figure 6.11. Safe crossing can be ensured by providing yield sign(see Figure 6.11) to access phase-1 building from the footpath. Alternatively, a pedestrian underpass can be designed to eliminate the at-grade crossing, however, it requires a separate feasibility study for the expected pedestrians.

6.5.3 Mitigation Measures (Considering both Phase I and Phase II)

The traffic circulation plan on the link road will be similar to Phase I (see Figure 6.10). However, some modifications are suggested for the internal traffic circulation (Figure 6.12)taking into account both Phase I and Phase II buildings.

Modification suggested for exit vehicle circulation

As suggested in the proposed design, both entry and exit movements will use a common access road (see Figure 6.9). However, this road will not have adequate capacity to handle the total generated traffic after completion of Phase II since it is not possible to widen the road due to nearby permanent structures and developments. Therefore, it is recommended that the entry and exit movements should be addressed using two separate roads (see Figure 6.12) to augment the capacity. This circulation could avoid blocking both the access roads and thus could avoid hindrance of traffic mobility on the arterial road.

Modification in access road of resident students of Titumir College

In order to ensure the above circulation, it is suggested that the resident students of Titumir College Hostel would use a different access road (see Figure 6.12). For this circulation, RAJUK need to endure the loss of approximately 230, 110 and 600 m^2 of land in the north, south and east sides, respectively. However, RAJUK would take over about 840 m^2 of land in the east side of the project area (owned by RAJUK) that is currently being used as an access road by the resident students of Titumir College Hostel. It will ensure uninterrupted flow surrounding this RAJUK site due to the one-way traffic circulation as shown in Figure 6.12. Beside the increase of roadway capacity, one-way circulation will also ensure safety for all the users due to the elimination of conflicts that arise from the both way traffic movement.

Pedestrian movement facilities

In addition to the facilities recommended for Phase I, another yield sign need to be installed in front of the parking exit of Phase II building to ensure a safe crossing for the pedestrians (see Figure 6.12).

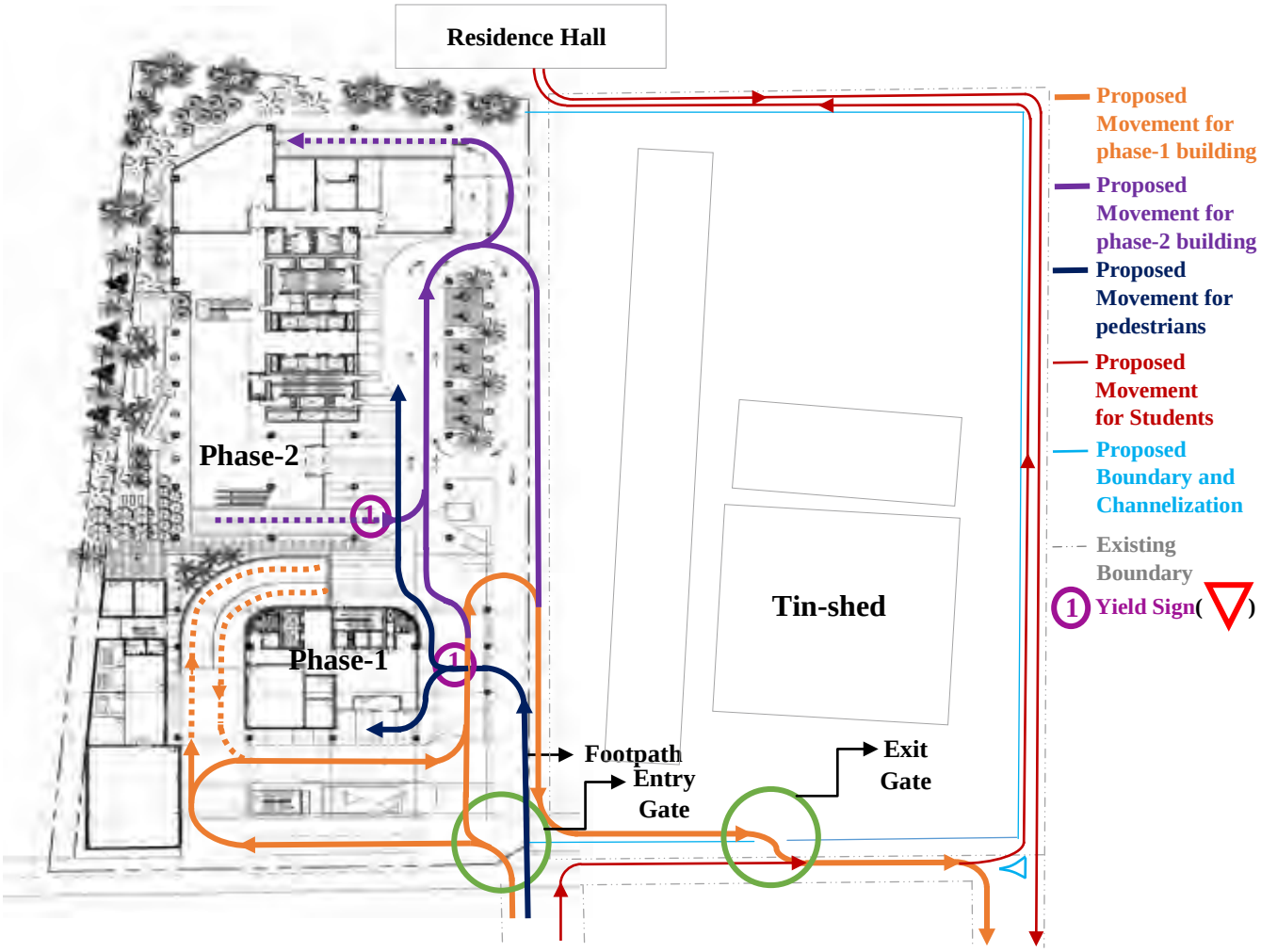


Figure 6.12: Proposed internal traffic circulation within the project site (considering both Phase I and Phase II buildings)

6.5.4 Parking Requirements

Table 6.5 presents the number of required parking spaces along with occupancy breakdown following the Bangladesh National Building Code (BNBC) guidelines. This study finds that the proposed parking spaces are adequate for both the URU buildings. Hence, based on the BNBC parking guidelines, no additional parking spaces are required.

Table 6.5: Parking space requirement as per BNBC guidelines

#	Item	Area (m^2)	Occupancy	Calculated Parking Space	Adjusted Parking Space	Given Parking Space
1	Phase-1 Building	9244.54	Office	46.22	50	63
2	Phase-2 Building	52028.47	Office	260.14	265	300

6.6 SCENARIO DESIGN

The Traffic Impact Analysis (TIA) for the RAJUK-URU buildings was done using a state-of-art micro-simulation model. Specifically, with the calibrated operational model detail analyses were carried out to determine the mobility benefits expected from the different recommendations as proposed above. Considering future traffic (both natural and induced), and other crucial factors, a total of six (6) scenarios have been designed to determine the option that will provide the optimum operational benefits. The details of those scenarios are illustrated below.

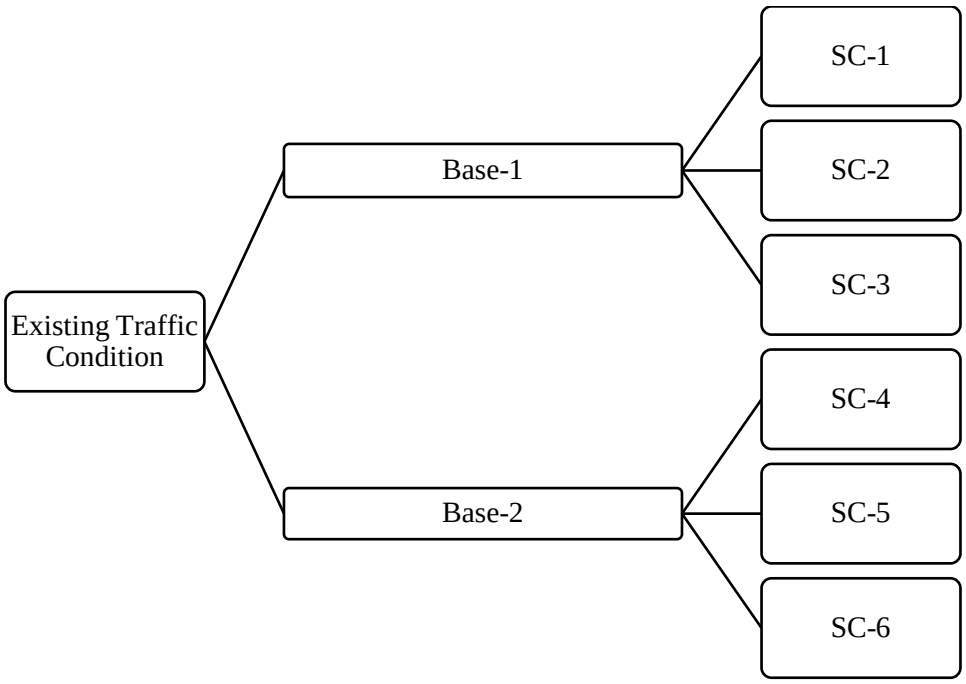


Figure 6.13: Flow chart of different scenarios mode

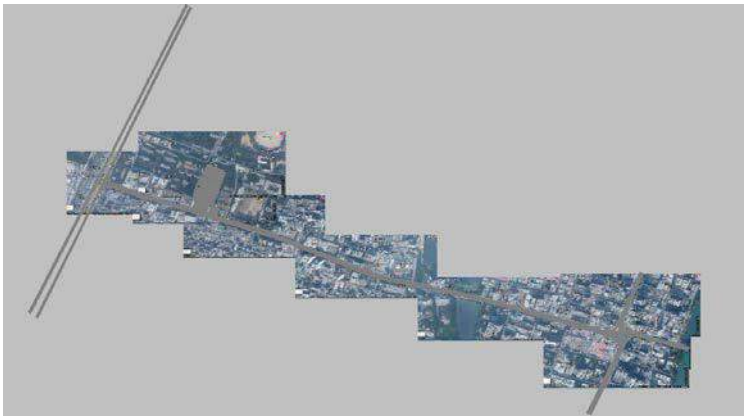
- **Existing Traffic Condition:** This analysis is carried out in two stages. In the first stage, flow parameters for the study area are determined based on a series of field survey. In the second stage, this study utilized well-known micro-simulation software, taking into consideration the local traffic situations including the driver's characteristics and the road circumstances obtained from the first stage. It represents the existing traffic performances along the link road and critical intersections. In this stage, at-grade 4-lane 2-way link road is being shared by local traffic, where, each lane width was kept as per field survey. In addition, speed reduction areas were coded to replicate the bottleneck speed as observed in the field. 3-phase signalized system was coded to replicate vehicular control that prevails in Gulshan-1 and Amtoli intersections.

- **Base-1:** Based on the estimation of the future traffic growth in the study area (growth rate 7%), the future traffic volumes are estimated for the expected operational year of the Phase I building (2022). Specifically, in Base-1, analysis of the future state is carried out to study the traffic condition at link road and intersections without Phase I induced traffic.

- **SC-1:** This scenario represents the traffic conditions along the link road and critical intersections in 2022 due to the implementation of Phase IRAJUK-URU building.
- **SC-2:** This scenario represents the traffic conditions along the link road and critical intersections in 2022 due to the implementation of Phase IRAJUK-URU building with traffic circulation designed by the RAJUK's consultant.
- **SC-3:** This scenario represents the traffic conditions along the link road and critical intersections in 2022 due to the implementation of Phase IRAJUK-URU building with traffic circulation proposed in this study.
- **Base-2:** Based on the estimation of the future traffic growth in the study area (growth rate 7%), the future traffic volumes are estimated for the expected operational year of the Phase II building (2027). Specifically, in Base-2, analysis of the future state is carried out to study the traffic condition at link road and intersections without Phase II induced traffic.
- **SC-4:** This scenario represents the operating traffic conditions along the link road and critical intersections in 2027 due to the implementation of both Phase I and Phase IIRAJUK-URU buildings.
- **SC-5:** This scenario represents the operating traffic conditions along the link road and critical intersections in 2027 due to the implementation of both Phase I and Phase IIRAJUK-URU buildings with traffic circulation designed by the RAJUK's design consultant.
- **SC-6:** This scenario represents the operating traffic conditions along the link road and critical intersections in 2027 due to the implementation of both Phase I and Phase IIRAJUK-URU buildings with traffic circulation proposed in this study.

6.7 PERFORMANCE EVALUATION

The calibrated model (see Figure 6.14) was utilized for performance evaluation at different nodal points as well as for the study network for different scenarios. The quantification of the benefits necessitates the implementation of traffic circulation plan proposed in this study.



(a)

(b)

(c)

Figure 6.14: Traffic model for performance evaluation: (a) Entire network; (b) Gulshan-1 intersection; and (c) Amtoli intersection

6.7.1 Nodal Evaluation

U-turning maneuver of vehicles in Gulshan-1 approach of Amtoli intersection (scenario-1 and 4) is replaced by the right turning maneuver in front of the project site (scenario-2 and 5) for entry vehicles. This offload of vehicles results in decrement of average delay (per vehicle) at Amtoli intersection from 351.8sec to 243.0sec (30.9%) and 444.2sec to 436.7sec (1.7%) in Phase I and Phase II, respectively. On the other hand, by introducing the U-turning maneuver (scenario-3 and 6) instead of the right turning maneuver, the delay can be further

reduced to 199sec (43.4%) and 395.3sec (11%), respectively. Moreover, due to RAJUK's Design Consultant's proposed right turning maneuver (scenario-2 and 5), the average delay for the vehicles crossing the T-junction results in 199.9sec and 291.9sec in Phase I and Phase II, respectively. Whereas, due to the merging with the main stream (scenario-3 and 6) average delay at the U-turn location were found to be 166.9sec and 256.1sec, respectively. Specifically, average vehicle delay decreases by 16.5% and 12.3% due to the U-turn in Phase I and Phase II, respectively.

Table 6.6: Nodal performance evaluation of alternative scenarios at peak hour

Scenarios	Average Delay per Vehicle (sec)				
	Amtoli Intersection	Newly proposed U-turn	T-junction	U-turn near Titumir College	Gulshan-1 Intersection
SC-1	351.8	NA	NA	319.7	413
SC-2	243.1	NA	199.9	187.9	391.4
SC-3	199	166.9	NA	177.4	369.3
SC-4	444.2	NA	NA	350.5	525.4
SC-5	436.7	NA	292	334.9	464.9
SC-6	395.3	256.1	NA	318.1	395.0

NA=Not Applicable

6.7.2 Network Evaluation

Model outputs for network performance for the different scenarios at peak hour are presented in Table 6.7. It summarizes the performance in terms of three important MOEs (Measure-of-Effectiveness): (1) Average delay time per vehicle (s); (2) Total travel time (hr); and (3) Average speed (kmph).

Average delay time per vehicle in SC-2 is 350.2 seconds which decreases from SC-1 (380.7 seconds) by an amount of 8.01%. It reflects the improvement in the network due to the implementation of traffic circulation plan proposed by the RAJUK's Design Consultant for Phase I. From SC-1 to SC-3 (349.5 seconds), it decreases by 9.0% which reflects slight improvement of the network due to the implementation of traffic circulation plan proposed in this study. Average delay time per vehicle in the SC-4 is 437.5 seconds which indicates the increase of delay time due to the natural growth of SC-1 traffic and induced traffic due to implementation of Phase II in 2027. From SC-4 to SC-5 (390.3 seconds), it decreases by 10.6% due to the implementation of traffic circulation plan proposed by the RAJUK's Design Consultant. However, in case of SC-6 (379 seconds), it decreases by 15.5% from SC-4 which reflects significant improvement in the network due to the implementation of traffic circulation plan proposed in this study.

Total travel time in SC-2 is 1280.5 hr which decreases from SC-1 (1236.5 hr) by an amount of 3.6%. It reflects the improvement in the network due to the implementation of traffic

circulation plan proposed by the RAJUK's Design Consultant for Phase I. From SC-1 to SC-3 (1064.4 hr), it decreases by 16.83% which reflects improvement of the network due to the implementation of traffic circulation plan proposed in this study. Total travel time in SC-4 is 1420.7 hr which indicates the increase of total travel time due to natural growth of SC-1 traffic and induced traffic due to implementation of Phase II in 2027. From SC-4 to SC-5 (1291.2 hr), it decreases by 9.11% due to the implementation of traffic circulation plan proposed by the RAJUK's Design Consultant. However, in case of SC-6 (1207.9 hr), it decreases by 15.1% from SC-4 which reflects significant improvement in the traffic network due to the implementation of traffic circulation plan proposed in this study.

Average speed in SC-2 is 8.2 kmph which increases from SC-1 (7.2 kmph) by an amount of 12.5%. It reflects the improvement of the network due to the implementation of traffic circulation plan proposed by the RAJUK's Design Consultant for Phase I. From SC-1 to SC-3 (8.7 kmph), it increases by 20.83% which reflects improvement in the network due to the implementation of traffic circulation plan proposed in this study. Average speed in SC-4 is 6.1 kmph which indicates the decease of average speed due to natural traffic growth of SC-1 traffic and induced traffic for the implementation of Phase IIin 2027. From SC-4 to SC-5 (7.6 kmph), it increases by 19.73% due to the implementation of traffic circulation plan proposed by the RAJUK's Design Consultant. However, in case of SC-6 (8.1 kmph), it increases by 32.78% from SC-4 which reflects significant improvement of the network due to the implementation of traffic circulation plan proposed in this study.

Table 6.6: Network performance evaluation of alternative scenarios at peak hour

Parameters	SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
Average delay time per vehicle [s], All Vehicle Types	380.7	350.2	349.5	437.5	390.3	379
Total travel time [hr], All Vehicle Types	1280.5	1236.5	1064.4	1420.7	1291.2	1207.9
Average speed [kmph], All Vehicle Types	7.2	8.1	8.7	6.1	7.6	8.1

Based on the network impact analysis, the proposed RAJUK-URU buildings in Phase I and Phase II are found to be feasible provided that the traffic management plan (internal and external) and the road infrastructures proposed in this study are properly addressed.

CHAPTER 7
ANALYSIS OF ALTERNATIVES

7.1 INTRODUCTION

This Chapter provides an assessment of alternative to the proposed project location. For completeness, the "no project" scenario has also been discussed in this Chapter.

7.2 ALTERNATIVE PROJECT LOCATION

To respond to the critical gap in the management of disaster risk in Bangladesh, Bangladesh Urban Resilience Project (URP) represents the second phase of a multi-phase national DRM program to build institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh.

The proposed project of RAJUK-URU involves construction of a new building complex in two phases. Phase I involves construction of a 10 storied building with 2 basements and a Shake Table facility along the western boundary. In Phase II a 22 storied building with 4 basements will be constructed having lateral connection at Podium Level. In order to reduce project cost as well as to avoid complicated issue of land acquisition RAJUK has decided to construct the facility at its own land located at the RAJUK Zonal Office near the Mohakhali – Gulshan road (Bir Uttam A K Khandaker Road). There exists an 8 storied building serving as the RAJUK Zonal Office. The Southern part of the 1.77 acre land will be used to construct both the phases of the RAJUK-URU complex keeping the existing building intact, at least for the time being). RAJUK also has another piece of land, slightly bigger in size, on the Eastern side of the project area separated by a local road (also owned by RAJUK) primarily used by the resident students of the Akkasur Rahman Akhi dormitory of the Government Titumir College (Figure 7.1).

(a) (b)

Figure 7.1: RAJUK owned land at an around the proposed project site: (a) proposed site and (b) adjacent RAJUK owned land on the Eastern side used as equipment shed

The land on the Eastern side of the proposed project site is currently being used by the RAUJK to store its equipment, service vehicles and heavy rollers under temporary sheds. This land could have been used as the project side. However, RAJUK has plans to construct a park on this land for local people as a part of their social responsibility. Therefore, RAJUK decided to use the proposed location as the project site.

7.3 ALTERNATIVE DESIGN AND CONSTRUCTION METHOD

Design Alternatives

In August 2018 it was decided that a single 30 storied building including four levels of basement and 30 additional floors all of which would have a floor area of 4,050m^2(Figure 7.2).

(a) (b)

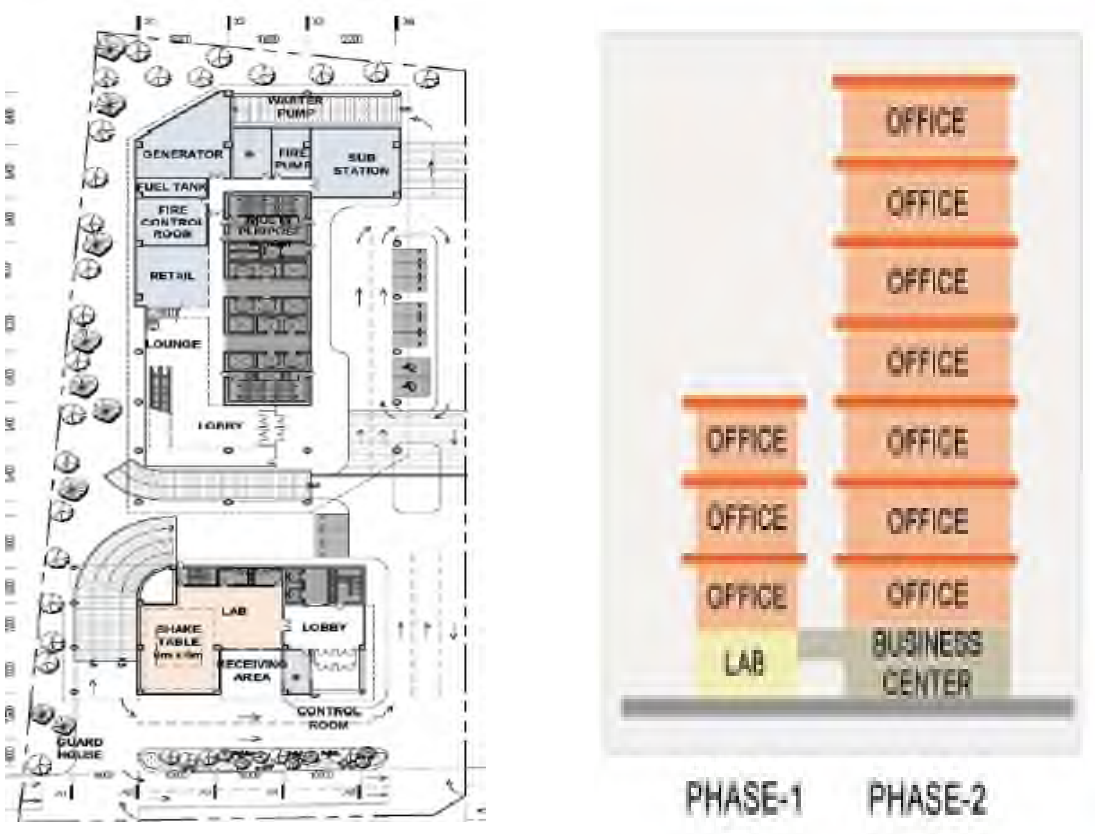
Figure 7.2: (a) Floor plan and (b) Elevation of originally proposed 30 storied dual tower building with 4 basements for RAJUK-URU

However, buoyancy effect over 4,050 m^2 for required significant resistance against uplift for the basement 4 slab as well as uplift resistance from the pile support in the design making it an extremely expensive proposition. It posed a serious concern on funding for this proposed design.

After a series of discussion meetings between the RAJUK and its Consultant the original plan was modified where two buildings would be constructed in two phases and the Phase I would be as follows:

- A two level Basement
- A small tower of 10 storied and approximate typical floor area of about 900 m^2 each
- A layout providing for an eccentric building core located at the north face of the building
- The proposed shake table and laboratory with all equipment to be located within the basement and ground floor areas of the Building.

Phase II will include a 22 storied building with 4 basements. The two buildings will be inter-connected through a walkway. In this proposed design the Shake Table would be placed in the basement of the 10 storied building of the Phase I. However, in order to avoid the impact of vibration generated during the operation of the Shake Table this design was further modified, namely the "3rd Alternative Design". To avoid the possible negative impact of vibration on the superstructure it has been decided to move the Shake Table room with its pit out from underneath to the vacant space between the 10 storied building and boundary wall of the site on the Western side without encroaching into Set-back zones (Figure 7.3).



(a) (b)

Figure 7.3: (a) Schematics of Floor plan and (b) Elevation of finalized RAJUK-URU Building

Alternative Construction Methods and Materials

The design consultant of RAJUK-URU suggested the Phase I 10 storied tower building will have Steel-frame typical floors consisting of Hollow Structural Steel Columns with

supporting steel beams and girders supporting 75mm steel deck of thickness 0.81mm and filled with 75mm of concrete adequately jointed with control joints to mitigate slab surface cracking. As earthquake forces are inertia forces, use of a steel supporting frame with steel deck is lighter than a reinforced concrete solution and thus impact of earthquake forces will be mitigated to some extent due to the lighter structure. Steel erection will speed the construction process as opposed to forming, reinforcing and placing reinforced concrete elements at typical floors.

Ease and speed of inspecting and approving the General Contractor work as typical floor slab forming and reinforcement inspection will largely be eliminated. The typical floor design as proposed will reduce the possibility of errors or omission on the part of the Construction Contractor as well as the inspection authorities.

As mentioned earlier, one of the crucial issues that prompted a change in the proposed design was the depth of excavation for the construction of 4 basements. Position of the groundwater table poses a grave concern by having the potential to induce enormous uplift pressure requiring a large number of piles for stabilization. This would make the cost of construction prohibitively high. Once the design was finalized as two phase construction the next anticipated challenge was the method of construction. Two alternatives have been proposed, namely, (i) Open Cut Method and (ii) Shore Pile Method.

Open Cut Method: the two basements will be excavated to a depth of 9m below grade by an open cut method where the slopes of the excavation will be sloped at 1:1 or 45^0. The Construction Contractor must protect the slope during construction to the approval of the Consultant and the Client and take appropriate measures to protect the open cut slope. The process must keep the provision for pumping water out of the excavation such that the base of the excavation can support truck traffic and construction activity until the reinforced concrete basement structure and ground floor is complete

Shore Pile Method: the alternative of providing for protective shore piles around the entire perimeter of the Phase 1 Building from Level B2 to the Ground Floor. This method requires the placement of 162 permanent 600mm diameter piles placed outside the basement perimeter walls. It has been estimated that the expected length of the bored concrete piles will be 25m below ground level. The length of the shore piles will have to be determined by testing 5 piles to determine the depth at which “FIXITY” of the base of the bored pile is achieved. That is, the pile will be considered to have a FIXED end at its base allowing for no structural rotation under load when it is driven to a depth such that the deflection of the pile when loaded horizontally.

It has been estimated that the cost of construction of the 10 storied building with 2 basements of Phase I would be about USD 13.347 million for Open Cut Method. Whereas, the same for the Shore Pile Method the estimated cost would be USD 14.110 million. Considering the limitation of fund, the design consultant has selected the Open Cut Method for earth excavation for construction of the basements of Phase I Tower building.

7.4 NO PROJECT SCENARIO

Bangladesh is highly vulnerable to earthquake due to its geological location and given the lack of recent earthquake events, an understanding of earthquake risk and corresponding strategies to mitigate the impact of such events is lacking. Bangladesh National Plan on Disaster Management (2010-2015) includes an Earthquake Management Plan and a National Earthquake Contingency Plan, which have been developed under the Ministry of Food and Disaster Management. These plans identify response and risk reduction activities with corresponding lead and support agencies. However, the plans lack the comprehensive vision of a national earthquake strategy, and a convincing demonstration of benefits, implementation, and controls. Furthermore, the institutional structure for multi-stakeholder engagement to deal with a problem as complex as urban earthquake risk is also lacking and the existing plans do not engage agencies and organizations in a sustainable way.

To respond to this critical gap in the management of disaster risk in Bangladesh, Bangladesh Urban Resilience Project (URP) represents the second phase of a multi-phase national DRM program to build institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh. The objective of the overall engagement is to develop a comprehensive approach to managing earthquake risk through a structured process of knowledge development, education, and planning that involves a wide range of stakeholders to increase engagement and ownership.

The construction of the RAJUK's Urban Resilience Unit (URU) building is timely initiative for Dhaka and the rapidly expanding urban center of Dhaka. Seismic assessment and resilience must be incorporated into urban development, authority, and accountability, and leadership is needed to facilitate private investments and consider risk and resilience within development of the Dhaka City area.

The broad objective of the engagement is to put in place the institutional infrastructure and competency to reduce long-term disaster vulnerability in Dhaka. It will address both the existing built in environment as well as future development. The specific objective of the assignment is to design and supervise a high rise building that will accommodate the URU. Since the land/site is owned by RAJUK at Mohakhali, the prime location of Dhaka City, maximum space utilization is of paramount importance and that led to the construction of this high rise building.

Thus, if the implementation of the proposed project is not done, the need for application of knowledge on earthquake and disaster resilient building construction methods in a planned and centralized way would remain unfinished. Absence of such a centralized service-oriented institution would also enhance the dearth of trained personnel in combating the need for resilient high-rise buildings in this highly congested Dhaka City.

CHAPTER 8
INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

8.1 INTRODUCTION

Public consultation is a two-way communication process between the project proponent and the stakeholders and project affected persons (PAP) for a proposed development project. Stakeholders involvement and cooperation help in reducing any dispute among the Project proponent and PAP and increase the chances of successful implementation of the project. Therefore, information dissemination and consultation with the Stakeholders is an integral part of an EIA. This Chapter outlines the information disclosure, consultation and participation activities that have been undertaken as part of EIA process for the proposed project.

Focus Group Discussion (FGD) and Key Informant Interviews (KII) were conducted in the proposed RAJUK URU project influence areas to disclose the project information to the local community as well as to assess the potential impacts from participant's perspectives for the proposed high-rise building construction and operation activities as well as to get suggestions to mitigate the adverse impacts. The following sections present the adopted methodology in carrying out the activities and outcome of the activities.

8.2 APPROACH AND METHODOLOGY

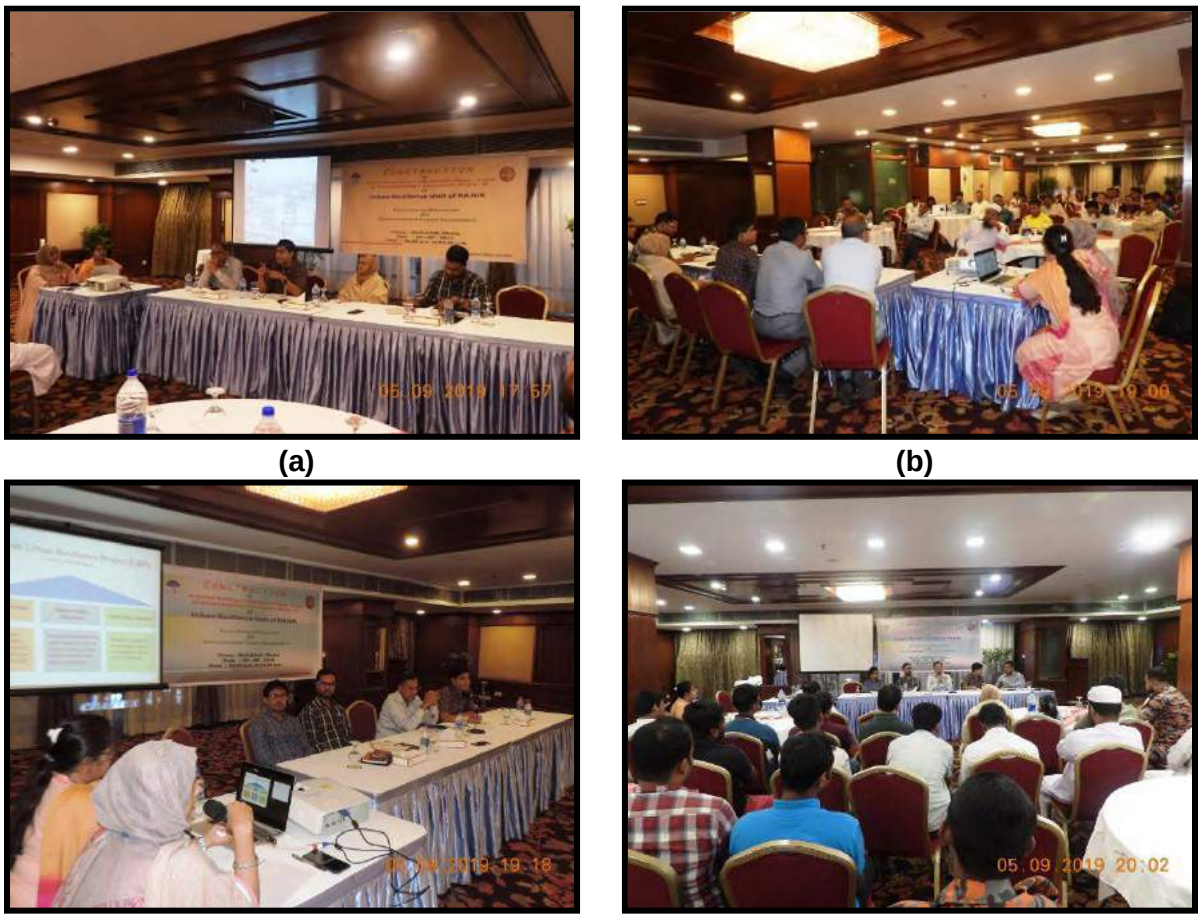
The approach undertaken for information disclosure and consultation involved the following key processes:

- Identification of Stakeholders
- Undertaking public consultations (FGDs) and interviews with key stakeholders (KII)
- Summarizing the observations and key findings from the consultations

Participatory approach has been followed to keep the relevancy in group discussion on the environmental (social, ecological and physical) issues as well as to identify the potential impacts and their mitigation measures for the proposed URU project. Two FGD sessions were organized in a place, adjacent to the proposed URU project site, in September 2019. The location was selected to represent the viewpoints of the general people residing near the proposed URU project site. In the FGD sessions, an effort was made to invite a wide range of stakeholders including Ward Councilor and Members, Religious leaders, Local leaders, Businessmen, Traders, Land owners, House owners, Laborers, Teachers, Students, Doctors, Private service holders, Government service holders, Women, etc. More than two dozen of people have been participated in the FGD sessions (see details in Table 8.1, Figure 8.1 and Annex D). In addition to the FGDs, a number of informal meetings with local stakeholders / peoples were carried out in the project study areas and thus, the study team interacted with more than 30 people during the meetings. Moreover, four key informant interview (KII) sessions have also been conducted with high officials of the relevant Governmental institutions who might be an important stakeholder, during construction and operation phases of the proposed RAJUK URU project.

Table 8.1: Details of Focus Group Discussion (FGD) sessions for the proposed 'RAJUK URU Building' project at Mohakhali, Dhaka, Bangladesh.

FGD	Venue	Date & Time	Participants Number
1	Conference Room, Hotel Sarina, Plot # 27, Road # 17, Banani C/A, Dhaka, Bangladesh.	05 – 09 – 2019 04.30 pm – 05.30 pm	12
2	Conference Room, Hotel Sarina, Plot # 27, Road # 17, Banani C/A, Dhaka, Bangladesh.	05 – 09 – 2019 06.00 pm – 07.00 pm	14
		Total	**26**



(a) **(b)** **(c)** **(d)**

Figure 8.1: Focus Group Discussion (FGD) sessions in present of Rajdhani Unnayan Kartripakkha (RAJUK) officials, respective ward councilor of Dhaka North City Corporation (DNCC), and major stakeholders from various discipline attended in the FGD sessions. Photo (a) & (b) represent the first FGD and Photo (c) & (d) represent the second FGD.

8.3 KEY FINDINGS FROM FGD AND KII

Utmost efforts were made in all FGDs to get feedback from participants on the nature of socio-environmental impacts, and their suggestions about ways to mitigate the adverse impacts, and enhance beneficial impacts for the proposed project. People who participated in the public consultations were found enthusiastic in sharing their views. The participants expressed their

opinions regarding different issues including their knowledge about the proposed RAJUK project, socio-economic condition of people in their localities, possible impact of the proposed project on the existing environment and in their localities, and mitigation measures to address adverse impacts. The major findings of FGDs and public consultation are summarized below:

8.3.1: Outcomes of FGDs

General opinion regarding the proposed RAJUK URU project

- Before interacting with the EIA team in the field, most participants have not heard about the proposed RAJUK URU project at their locality which indicates that proper information has not yet been disseminated to them by RAJUK.
- After hearing about the URU project details through MS Power Point presentation by RAJUK representatives, most participants expressed their supportive attitude for the proposed URU project at Mohakhali RAJUK Plot with minor concerns such as road traffic congestion issues, disposal of excavated soil on road during transportation, etc.
- Most participants opined that the proposed RAJUK URU project will be a great project in compare to other projects in Bangladesh; because it will create institutional strength by the creation of a new organizational unit within RAJUK, that means, it will encompass the development of competencies related to urban resilience such as risk assessment, earthquake engineering, construction standards at in-situ and laboratory construction material testing, specialized construction training, and risk-sensitive land use planning, etc.
- Some participants suggested that the proposed URU building related activities should be completed on time to get relief of multi-dimensional problems that might be arise for construction of URU high rise building at their localities.
- Some participants recommended to carry out cost-benefit analysis before starting this project.
- Some participants opined that big initiative (e.g. URU project) could impact few PAPs for short or long term, but entire community at Dhaka City will get more benefits for long time.
- Most participants opined that URU building will be a Model Building in Dhaka city which will influence / enhance interest to other proponents to build up similar types of buildings.
- Most participants commented that relevant authority should immediately start action for completion of URU project in time.

Potential Impacts for the proposed RAJUK URU Project

- All participants were happy to know that one fourth of the entire land will be used for the proposed URU building and remaining land will be kept as open space that will create healthy environment for the local community - a positive environmental impact.
- The narrow road that exists in the eastern side the proposed plot will be widen enough for vehicle movement which could also be used by the Titumir College student to enter into their hostel that exist behind this plot.

- Participants expressed their concern regarding the excavated soil management during construction and transportation; in most cases, disposal of soil on the paved road creates problems (e.g. accidents, dirty cloths, etc.) to the people who use the roads. Moreover, soil excavation through heavy equipment may create land slide in the adjacent plots if proper initiatives have not taken.
- Participants expressed their concern regarding the sound pollution that might be created for use of heavy construction equipment. Nearby educational institutions, commercial institutions, residential buildings, etc. might be affected most.
- Stockpile of construction materials on the road will create adverse impacts to the local people (e.g. road traffic, hinder of free movement & food / commodity supply to shops, etc.).
- During rush hours, vehicles with heavy machinery for URU project may enhance the existing road traffic.
- During construction, dust might be created due to various types of project activities, and air pollution might be occurred that will create health problems to the people especially the children and aged people.
- Existing flora, inside the proposed plot / land, already created an urban ecosystem where some fauna stay, may need to uproot; cutting of these floras will destroy that ecosystem forever.
- Participants expressed their concern regarding the waste management and labor sanitation issues; in most cases, the project proponent manage it unprofessional way that create multiple problems, and local community suffer a lot for such type of poor management action.
- Participants expressed their concern regarding the use of poor-quality materials and other items (e.g. electric wire, switch, etc.) in the building that may create fire hazard and also short- lasting building and / or its components (e.g. glass, window, etc.).
- Participants expressed their concern regarding the use of jute cover during high rise building construction; spark during welding might fire the jute cover which will invite fire hazard.

Expectation of people from the RAJUK URU Project

- Participants suggested that RAJUK should ensure that all criteria for a Green Building or LEED Certified Building should be satisfied, so that, it could be an iconic building / project in the city / country.
- RAJUK should use sustainable materials in the URU building project.
- Ensure proper ventilation for air flow; otherwise, it will create problem to the hostel students.
- Ensure implementation of modern technique to prevent dust / air pollution that might be occurs for high rise building construction activities; also ensure safety measures to prevent health hazard by air pollution.
- Ensure proper management of excavated soil as well as monitoring of it during transportation through paved road.
- Ensure use of modern techniques to prevent adjacent land slide during high rise building construction.
- Ensure enough space inside the URU project site for vehicle movement easily, and also allocate space for more car parking.

- Ensure basement work of high- rise building construction during non-rainy season to avoid land slide and also complete the work within the short time frame.
- Ensure no noise pollution from the testing equipment during operation phase of this project.
- Ensure non-use of jute cover in the outer side of the under-construction building which will help to prevent fire hazard during welding activities.
- Ensure use of earthquake resistance materials as well as technique during design and implementation of the project.
- Ensure use of fire proof materials for safety of URU building,
- Ensure use of modern equipment and materials for electric system of the URU building.
- Ensure use of solar panel & light, and also keep space to enter enough light in the URU building, naturally.
- Ensure enough water in the water reservoir or other places which could be use as water source during fire hazard.
- Ensure wide road for easy movement of large fire service vehicle in the URU premises during fire hazard. Also arrange fire drill program twice a year.
- Ensure plantation of native tree to enhance the esthetic value and balance of existing urban ecosystem.
- Ensure muster point that could use for head count during fire hazard; also keep the roof open always (no lock) as well as lift that could use to enter into the roof during fire hazard.
- Ensure a fire safety team in the URU building who will work to prevent fire.
- Ensure proper waste management that will occur during construction and operation phases of URU building.
- Ensure use of appropriate sign in different places for various purposes during construction and operation periods.

8.3.2: Outcomes of KII

Four Key Informant Interview (KII) sessions have been organized for the proposed RAJUK URU construction project by involving officials of some relevant Governmental institutions (Figure 8.2 and Figure 8.3). Most participants expressed their opinion regarding the proposed URU project, their involvement, suggestion etc. based on their similar type of project experience. Summary of these interviews is given below.

(a) **(b)**

Figure 8.2: KII with Officials of relevant Govt. offices who / who's office might be involved with this RAJUK URU project during project formulation, construction and / or operation phase: (a) Engr. Mohammad Akhtaruzzaman, Additional Chief Engineer, Project Director, Dhaka Water Supply Network Improvement Project, Dhaka Water Supply and Sewerage Authority (DWASA), WASA Bhaban (8th Floor), 98 Kazi Nazrul Islam Avenue, Kawran Bazar, Dhaka 1215, Bangladesh, participated in the first KII session, and (b) KhondokerMahbub Alam, Superintending Engineer (Civil Circle), Dhaka North City Corporation (DNCC), House No # 23 – 26 Gulshan Center Point (Level 9), Road No # 46, Gulshan 2, Dhaka 1212, Bangladesh, participated in the second KII session.

(i) Dhaka Water Supply and Sewerage Authority (DWASA)

- Already informed about the URU project implementing by RAJUK
- DWASA could be a co-partner for this URU building construction project.
- DWASA could play an active role during fire hazard as well as supply of water for various purposes.
- Traffic management, during construction and operation phases, will be a big challenge. Project related vehicles, especially the material carrying vehicles during construction, will create problem in the road where heavy traffic exist almost the whole day.
- Management of Stockpile of materials on road, if needed, will be a challenge, because, it will create problems to the local community with many dimensions (e.g. hinder of free movement, accident, traffic, etc.).
- Delay of planned work will also be a matter of annoyance of local community, because, more delay of work means more sufferings of local community with various dimensions.
- Use of modern techniques with modern equipment and active supervision & monitoring could help to resolve the challenges.
- Ensure enforcement of proper traffic management on the site / adjacent areas; involve local traffic police for such type of activities.
- Avoid stockpile of materials on road, use mid-night to morning period for vehicle that will carry materials to the project site.
- Ensure timely completion of the project activities.

(ii) Dhaka North City Corporation (DNCC)

- Well informed of the URU project including RAJUK URU part.
- DNCC have a partnership of the URU project.
- Challenges are:
    - Narrow roads in the project area may be a challenge for transportation vehicles during construction & operation of the URU buildings.
    - Road divider on the main road may need to open temporarily for vehicle movement freely; need early communication with traffic police department, ward councilor and local community.
    - Lack of disaster shed during natural calamities (e.g. earth quack) as well as access to the URU building (narrow road).
- Mitigation measures are:
    - Ensure widening of road to enter URU building for various purposes.
    - Ensure disaster shed for all victims.
    - Ensure the URU building entrance road free always.

(a)

(b)

Figure 8.3: Key Informant Interview (KII) with Officials of relevant Governmental offices who / who's office might be involved with this URU project during project formulation, construction and / or operation phase: (a) Md. Abdul Mannan, Deputy Secretary and Project Director, Urban Resilience Project (DDM Part), Department of Disaster Management, Ministry of Disaster Management and Relief, GoB, House No # 121, Road No # 21, DOHS, Mohakhali, Dhaka 1212, Bangladesh, participated in the third KII session, and (b) B. M. Forman Ali, Office in Charge, Banani Police Station, Dhaka Metropolitan Police, participated in the fourth KII session.

(iii) Department of Disaster Management (DDM)

- Already heard about the RAJUK URU building construction project
- DDM have a component on the URU project.
- Challenges are:
    - Dead lock zone due to heavy road traffic. RAJUK URU building construction will face some challenges during construction (e.g. road traffic) and also can't

provide proper service during operation due to access to the URU building via existing narrow road.
    - Poor plan for construction of two buildings (10+2 storied and 22+4 storied). Can't provide full service during disaster due to shortage of manpower, access to enter into the URU building through narrow road, etc.
- Mitigation measures are:
    - Ensure widening of existing narrow road
    - Ensure permission from civil aviation for construction of high rise building.
    - Ensure proper traffic management for free movement into the URU building, especially during disaster time.
    - Ensure enough manpower to combat with the disaster.
    - Ensure RAJUK URU building as a single command center for disaster and other calamities management.
    - Illegal approach by nearby community for RAJUK URU building project should resolve immediately; otherwise, engage engineering & management sections of Bangladesh Army.

(iv) Dhaka Metropolitan Police (DMP)

- Have not heard about the entire component of URU project or RAJUK URU building construction project at Mohakhali.
- Can provide support during construction and operation phases, if RAJUK need any help
- Challenges are:
    - Involvement of local people for smooth construction and operation of RAJUK URU building.
    - Material transportation via main road at day time will delay the work and may causes traffic congestion.
- Mitigation measures are:
    - Ensure road traffic management via police traffic department.
    - Ensure engagement of police for security and safety.
    - Ensure night shift movement for material and equipment carrying vehicles through main road.

CHAPTER 9
GRIEVANCE REDRESS MECHANISM

9.1 INTRODUCTION

This chapter presents the need of establishment of a Grievance Redress Mechanism (GRM) to receive and facilitate resolution of complainants (project affected people, local community and workers) concerns and grievances regarding the project's performance in the constructional and operational phases. The mechanism should be able to address the aggrieved parties concerns and complaints promptly by using an understandable and transparent grievance addressing process which is accessible to all including workers in a workplace environment. The GRM has been developed with an intention of it being an effective tool for early identification, assessment and resolution of complaints during the project life cycle. There can be a range of issues arising during a project phase. Such as:

- Compensation payment, or Failure to fulfill commitments,
- Poor management of construction activities,
- Accidents during construction or due to inappropriate planning of vehicle movement,
- Cultural and social conflicts between workers and local communities
- Disturbance due to excessive noise or other nuisance during construction or operation and
- unfair treatment to workers or unsafe working conditions etc.

Hence, a robust GRM is required that is gender responsive, culturally appropriate and readily accessible to the affected persons at no costs and without retribution.

9.2 DEVELOPMENT OF GRM

9.2.1 Procedure for GRM

The project proponent should ensure that procedures for lodging and registering of grievances are in place. The procedures for GRM should comprise of identifying the personnel (Grievance officer) who will be responsible for receiving and addressing the grievances and handle the cases at the escalation level. Procedures for grievance assessment, appropriate resolution process, making decisions on proposed settlements, time frames for grievance resolution etc. should be developed.

9.2.2 Publicize GRM

Once the procedures for Grievance Mechanism have been developed, it should be publicized through various stakeholder engagement activities. Various communicative methods can be adopted in disseminating the information like printed materials, displays, face to face meetings etc. The grievance redress mechanism (GRM) shall be documented in English and Bangla and copies shall be kept at the project site office and the Head Office. The GRM is also to be displayed at notice board at the project site office and training on the GRM shall also be provided during orientation. The contractor would keep the workers informed about the

grievance mechanism at the time of recruitment and make it easily accessible to them. All the relevant contact numbers to be made available to them.

9.2.3 Recording of Grievances

There should be arrangement for collecting complaints in a grievance box. A Grievance Log or database emphasizing the records and status of the grievance is to be maintained by the identified Grievance Officer and track them throughout the redress process to reflect on their status and important details.

9.2.4 Appeal and Follow Up

If the solution is not acceptable or agreed by the complainant, the complainant should be offered to an appeal process. The accountability and transparency should be maintained in every step of the process.

Once the corrective action has been agreed upon, a good practice is to document the process, , getting confirmation from the complainant and retain evidence. In addition, monitoring and follow up on the resolution agreed upon should be conducted once to close the case accordingly.

9.3 PROPOSED GRM FOR THE PROJECT

The Grievance Redress Mechanism outlines the process for lodging of grievances, steps to be taken for subsequent action and the time limit within which the issue would be resolved to the satisfaction of the complainant (community members, project affected persons and workers). All complaints shall be recorded and addressed in a uniform and consistent manner. The GRM for the proposed project is presented below with time bound schedules and specific persons to address grievances.

Grievance Redress Committee

There should be a Grievance Redress Committee (GRC) comprising of:

- Site Supervisor
- EHS Manager
- Admin Officer (Grievance Officer)and
- Safety Officer

The functions of GRC are as follows:

- To provide support to affected communities/persons on problems arising from environmental or social impacts;
- To record grievances of the affected community by categorizing and prioritizing them
- To provide solutions within a stipulated time period; and
- To report to the aggrieved parties, developments regarding their grievances and decisions of the GRC.

The steps of grievance redressal are provided below:

Receive and Register a Complaint

Any stakeholder such as worker, person from local community or any other stakeholder, with concerns pertaining to onsite work such as health and safety, local employment, community risk, migrant labor or any issues etc., may register their complaint in writing to the nominated person/grievance officer at site level. The contact details of the Grievance Officer shall be maintained, updated and displayed at prominent places available to public and the project area. All grievances will be addressed during the construction and operation phase. Secured grievance boxes shall be placed at the entrance of the site office. Once a complaint has been received it shall be recorded in the grievance log register or data system.

Assessment and Addressal of a Complaint

Figure 9.1 depicts the assessment and adressal procedure of a complaint.

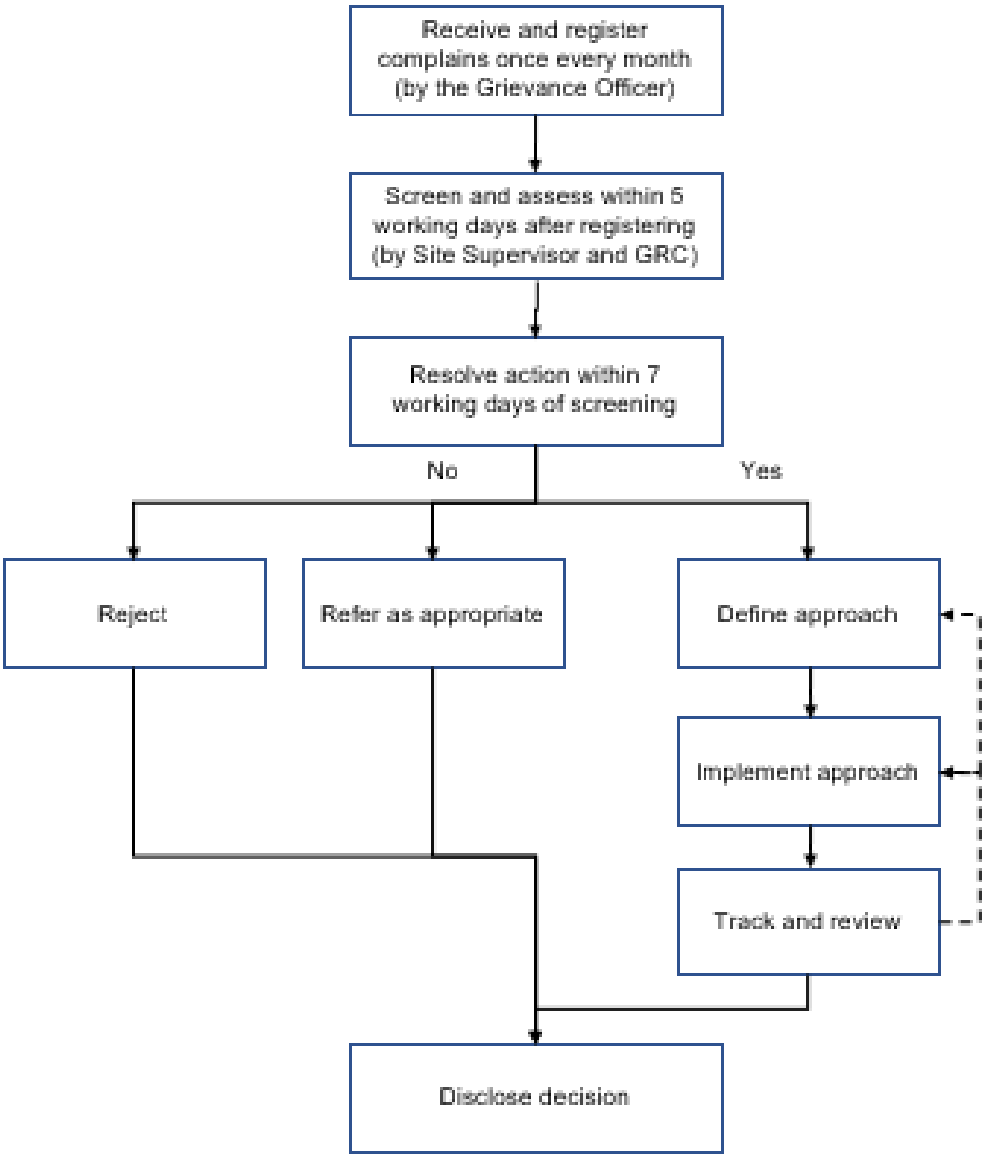


Figure 9.1: Flow chart of Grievnce Redress Mechanism Process

Resources Required for GRM Implementation

Adequate resources should be allocated for an effective implementation of GRM. Adequate resources here refer to people, system, time and associated financial resources. In order to incorporate the responsibility of designing, implementing and monitoring the grievance mechanism, the senior management should be involved in the process. For a grievance mechanism to function effectively, it is important to establish a governance structure and assign responsibilities for the mechanism's implementation.

Monitoring and Reporting

Monitoring and reporting are requisite tools of measuring the effectiveness of the grievance mechanism, the efficient use of resources, determining broad trends and acknowledging recurring problems so that they can be resolved before they reach to a higher level of contention.

All grievances registered have to be recorded, documented and updated regularly. The site management or Grievance Officer is responsible of discharging this responsibility and he should be able to produce this document whenever any audits take place. All minutes of meetings with stakeholders, complainants and Grievance Committee are to be recorded and documented regularly for reference purposes. In addition, through the process of monitoring and the reports produced thereafter, assurance of continual improvement is guaranteed.

CHAPTER 10
ENVIRONMENTAL MANAGEMENT PLAN

10.1 INTRODUCTION

This chapter summarizes the mitigation and abatement measures both during construction and operation phases of the project. It also presents an environment management plan (EMP), including a monitoring program with a preliminary cost estimate. This Chapter also includes Occupational Health and Safety Plan and Emergency Preparedness Plan for the proposed project.

10.2 MITIGATION MEASURES

10.2.1 Construction Phase

The proposed project involves construction of a Urban Resilience Unit (URU) building and ancillary facilities in Mohakhali Dhaka. The project will be implemented by Rajdhani Unnayan Kartripakkha (RAJUK). The significant environmental impacts of project activities during construction and operational phases have been presented in Chapter 5. Table 10.1 shows the mitigation measures corresponding to specific adverse impacts during construction phase, along with assignment of responsibilities for their implementation. The measures presented in Table 10.1 are aimed at minimizing the effects of the possible adverse impacts and enhancing the positive impacts. The table shows that most of the adverse impacts could be minimized or even removed if appropriate mitigation measures are taken. Besides this, construction of a high-rise building entails a requirement for providing uttermost safety for workers involved. Worker health can also be adversely affected at various stages of the construction due to challenging working conditions. In addition, during the Phase I of this project a 10 storied building with 2 basements for parking facility will be constructed. This may require deep excavation over a large area of the project site. Shore protection using shore-piles or open cut method or any other method approved by the BNBC should be appropriately followed. It is imperative that the contractor follows the workers safety protocol during entire construction phase including deep excavation as well as superstructure construction. For this an occupational health and safety guideline has been developed and incorporated in this report. The project director and contractor are advised to consult relevant sections of the occupational health and safety guideline as applicable for a certain situation.

Table 10.1: Potentially significant environmental impacts during construction phase and mitigation measures

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Removal of Existing structures/equipment	• Impediment to proposed construction work	• All concrete structures/equipment in the proposed area to be dismantled as per BNBC guideline and sold before construction starts.	Contractor (Monitoring by RAJUK)
Removal of utilities such as electricity line, gas connection, telephone connection, water supply and sewerage pipelines in the existing one-storied Tin-shed building	• Impediment to proposed construction work	• Necessary planning and coordination with concerned authorities (DPDC, Titas Gas, DWASA, DNCC). Prior to start of construction, all utilities should be shifted with the consultation of relevant authorities. Proper health and safety measures for the workers should be taken during shifting of the utilities to avoid any accidents.	Contractor will implement (RAJUK will coordinate with relevant authorities)
Cutting down of 33 nos. of trees, Clearing of vegetation	• Loss of local flora and fauna	• Re-plantation of trees (66nos, as same species as fallen down and other species i.e. wooden, fruit, herbal) in and around the building premises. • Ensure re-vegetation and/ or grass turf when soil is exposed/ disturbed.	Contractor (Monitoring by RAJUK)
Influx of workers	• Generation of sewage waste; • • Generation of solid waste; • Water, soil, air & dust pollution/ environmental pollution	• Construction camp should be located at the site proposed by the contractor & approved by the Environmental Specialist of DSC. • Construction of sanitary latrine/ Pit latrine with septic tank/ Ring slab system, (separate latrines for male and female workers) • Erection of “no litter” sign, • Open areas/ surrounding bushes are not being used as toilet facility. • Provision of waste bins/ cans, where appropriate, • Litter is to be collected daily. • Bins and/or skips should be emptied regularly and waste/ debris should be disposed of at waste disposal areas and/ or at the site pre-approved by Environmental Specialist of DSC. • Camp and working areas are kept clean and tidy at all times.	Contractor (Monitoring by RAJUK)

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		• Camp is to be checked for spills of substances i.e. chemical, oil, paint, etc.	
	• Possible spread of disease from workers	• Clean bill of health a condition for employment • Regular medical monitoring of workers • Raising awareness about hygiene practices among workers • Provision of safe water for all workers	
	• Outside labor force causing negative impact on social well-being of local people.	• Contractor to employ local work force, where appropriate;	
Transportation of equipment, materials and personnel; storage of materials	• Increased traffic • Generation of noise, especially affecting the nearby offices and residential areas	• Scheduling of deliveries after regular office or school working hours • Installation of proper traffic sign and warnings for pedestrians • Depute flagman for traffic control • Arrange for signal light at night	Contractor (Monitoring by RAJUK)
	• Deterioration of air quality from increased vehicular movement, construction activities	• Ensure that all project vehicles are in good operating condition • Spray water on dry surfaces/ unpaved roads regularly reduce dust generation • Maintain adequate moisture content of soil during transportation, compaction and handling • Not using equipment such as stone crushers at site, which produce significant amount of particulate matter	
	• Wind-blown dust from material (e.g., fine aggregate) storage areas	• Watering unpaved/dusty roads (at least twice a day; cost estimate provided) • Sprinkle and cover stockpiles of loose materials (e.g., fine aggregates). • Covering top of trucks carrying materials to the site and carrying construction debris away from the site • Materials storage area must be cleaned after completion of construction.	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	• Security of machine and materials, crime and vandalism	• Proper fencing around the storage area in order to be secure, to minimize the risk of crime and to be safe from access by passersby, animals, etc.	
	• Spillage of liquid/ hazardous substances i.e. oil, paint, chemicals, bitumen etc.	• spills/ hazardous substances should be disposed of at the site proposed by the contractor & approved by the Environmental Specialist of DSC to avoid soil/ water contamination.	
Construction activities, including excavation, operation of construction equipment etc.	• Generation of noise from construction activities (general plant and access road construction), especially affecting the nearby school and residential areas	• Maintain all vehicles in order to keep them in good working order in accordance with manufacturers maintenance procedures. • Make sure all drivers will comply with the traffic codes concerning maximum speed limit, driving hours, etc. (20 km/hr during night time). • Organize the loading and unloading of trucks, and handling operations for the purpose of minimizing construction noise on the work site. • Modify equipment to reduce noise (for example, noise control kits, lining of truck trays or pipelines, silencers). • Maintain all equipment in order to keep it in good working conditions in accordance with manufacturers‟ maintenance procedures. Equipment suppliers and contractors shall present proof of maintenance register of their equipment. • Install acoustic enclosures around generators to reduce noise levels. • Fit high efficiency mufflers to appropriate construction equipment. • Avoid the unnecessary use of alarms, horns and sirens. • Notify adjacent landholders prior of any typical noise events outside of daylight hours.	Contractor (Monitoring by RAJUK)

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		• Plan activities on site and deliveries to and from site to minimize impact. • Monitor and analyze noise and vibration results and adjust construction practices as required. • Avoid undertaking the noisiest activities, where possible, when working at night near the residential areas.	Contractor (Monitoring by RAJUK)
	• Air/Dust pollution	• Maintain construction vehicles and equipment in good working condition including regular servicing. • Operate the construction vehicles in a fuel-efficient manner. • Cover hauls vehicles carrying dusty materials moving outside the construction site. • Impose speed limits (maximum 10 km/hr) on all vehicle movement at the worksite and through access roads to reduce dust emissions. • Control the movement of construction vehicles in the access road (during night from 22:00 to 6:00). • Water spray to the construction materials or cover (especially sand and boulders/brick chips) prior to loading and transport. • Focus special attention on containing the emissions from generators. • Equipment/vehicles causing excess pollution (e.g. visible smoke) should be banned from construction sites or fixed immediately prior to further usage. • Provide filtering systems, dust collectors or humidification or other techniques (as applicable) to the concrete mixing plant to control the particle emissions at all its stages, including unloading,	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		collection, aggregate handling, cement dumping, circulation of trucks and machinery inside the installations. • Water spray to the material stockpiles as and when required to minimize the potential environmental nuisance due to dust. • Increase the watering frequency during periods of high risk (e.g. high winds and dry periods). Stored materials such as boulders and sand should be covered and confined to avoid them being wind-drifted. • Erect dust barriers along the boundary of the construction area to reduce dust movement to the surrounding areas. • Reschedule earthwork activities when practical, if necessary to avoid during periods of high wind and if visible dust is blowing off-site. • Restore disturbed areas as soon as possible by vegetation/grass-turfing. • Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust dispersion is prevented because of such operations. • Using equipment, especially generators with high levels of emission control (e.g., TIER-4). • Immediate disposal/sale of excavated materials	Contractor (Monitoring by RAJUK)
	• Generation of construction waste	• Organize disposal of all wastes generated during construction in an environmentally acceptable manner. This will include consideration of the nature and location of disposal site, so as to cause less offsite environmental impacts. The disposal site should be approved by RAJUK prior to usage and should be rehabilitated after usage to	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		ensure the land is not exposed to soil erosion, wind and water stagnation. • Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach. • Segregate and reuse or recycle all the wastes, wherever practical. • Train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process. • Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal by Dhaka North City Corporation (DNCC). • Ensure proper collection and disposal of all wastes within the construction camps from where DNCC will take by their truck and dispose of at their dumping area at Aminbazar. • Insist on waste separation and store by source; organic wastes, inorganic wastes and recyclables in separate containers. • Clear wastes on daily basis to waste collectors. Establish waste collection, transportation and disposal at the dumping site in adequate sizes of concrete chambers/boxes. • Dispose organic wastes in a designated safe place and should be kept covered so that flies, mosquitoes, dogs, cats, rats, etc. are not attracted. Encourage composting of organic waste that can be used for tree planting purposes. • Locate the garbage pit/waste disposal site away from the residence so that peoples are not disturbed with the odor likely to	Contractor (Monitoring by RAJUK)

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		be produced from anaerobic decomposition of wastes at the waste dumping places. Encompass the waste dumping place by fencing and tree plantation to prevent children from entering and playing. • Do not establish site specific dumpsites. All solid waste will be collected and removed from the work camps and disposed in approved waste disposal sites.	Contractor (Monitoring by RAJUK)
	• Occupational health and safety risk	• Provide the workers a safe and healthy work environment, taking into account inherent risks of this particular construction activity and specific classes of hazards in the work areas, provide necessary trainings. Special attention to be given during deep excavation of a large part of the project site for two basements. Adequate shore protection measures to be ensured according to BNBC to ensure workers safety. • Provide personal protection equipment (PPE) for workers, such as safety shoes, helmets, masks, gloves, protective clothing, goggles, safety belt for working at height and ear protection. Maintain the PPE properly by cleaning dirty ones and replacing them with the damaged ones. • Safety procedures include provision of information, training and protective clothing to workers involved in hazardous operations and proper performance of their job. • Appoint an environment, health and safety manager to look after the health and safety of the workers. • Not hire children of less than 14 years of age and pregnant women or women who delivered	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		a child within 8 preceding weeks, in accordance with the Bangladesh Labor Code, 2006 • Provide health care facilities and first aid facilities are readily available. Appropriately equipped first-aid stations shall be easily accessible throughout the place of work • Document and report occupational accidents, diseases, and incidents and actions taken. • Prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards in a manner consistent with good international industry practice. • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. • Provide awareness to the construction drivers to strictly follow the driving rules. • Provide adequate lighting in the construction area and along the roads. • Adequate ventilation in all facilities. • Provide plastic net and others appropriate Health and Safety measures surrounding the buildings to avoid accidents. • Provide safe and reliable water for drinking • Hygienic sanitary facilities and sewerage system. • Carry out regular mosquito repellant spraying during monsoon periods. • Provide ambulance facility for the laborers to be transported to nearest hospitals during an emergency. Train all construction workers in basic	Contractor (Monitoring by RAJUK)

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		sanitation and health care issues and safety matters, and on the specific hazards of their work. • Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. • Provide appropriate security personnel (home guard/private security guards) and enclosures to prevent unauthorized entry into the camp area.	Contractor (Monitoring by RAJUK)
	• Spills and leaks leading to soil and water contamination	• Train the relevant construction personnel in handling of fuels and spill control procedures. • Refueling shall occur only within enclosed areas. • Provide PPE such as protective clothing, safety shoes, helmets, masks and hand gloves to the construction personnel, to handle construction materials. • Make sure all containers and drums that are used for storage are in good condition and are labeled with expiry date. Any container, drum that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur. • Put containers and drums in permanent storage areas on an impermeable floor. • Ensure basic firefighting equipment is in place outside these storage areas in case of a fire.	
	• Employment of work/labor force	• Local people should be employed in the project activities as much as possible. • Employ people living in slums for excavation-related works which does not require skilled manpower • Promote supply from local suppliers	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	• If cultural resources or archeological resources are found during excavation (buried Physical Cultural Resources)	• Inform the department of archeology and other concerned authorities and take steps to secure and preserve the artifact as per their instructions (follow the World Bank guidelines for handling buried Physical Cultural Resources (PCR) as detailed in Annex E: Chance Find Procedure)	Contractor (Monitoring by RAJUK)
	• Drainage congestion, water logging and flooding	• Temporary drainage congestion (TDC) in the foundation trench due to rainwater to be removed by pumping. Avoid monsoon period for foundation works. • TDC in construction yard and camp of the proposed building area to be removed by temporary earth or RCC drains. • All rainwater, storm water waste water etc. should be drain out via sewerage pipelines of DWASA.	
	• Water and Soil Pollution	• Forbid discharge of fuel, lubricants, chemicals, and wastes into surface waters or on land. • Adopt proper disposal techniques for any hazardous waste Install sediment basins to trap sediments in storm water prior to discharge to surface water. • Replant vegetation when soils have been exposed or disturbed.	
	• Traffic Congestion	• Prepare and submit a traffic management plan to the PIU for approval at least 30 days before commencing work on project component involving traffic diversion and management. • Include measures in the traffic management plan to ensure uninterrupted traffic movement during construction: access roads, necessary barricades, warning signs/lights, road signs, etc. • Provide signs at strategic locations of the roads complying with the schedules of signs contained in the Bangladesh Road Traffic Regulations of BRTA.	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		• Restrict truck deliveries to day time working hours (as common practice in Dhaka) to avoid road accidents and to reduce inconveniences to the road users. • Operate construction vehicles to non-peak periods (night) to minimize traffic disruptions. • Enforce on-site and access road speed limits.	
Activities related to RAJUK tower entry road construction, setting up asphalt plant and bitumen preparation area	• Air and noise pollution affecting nearby settlements and office areas	• Locate plant away from office area. • Consider the use of emulsified bitumen	Contractor (monitoring by RAJUK)
	• Possible water pollution by bitumen solvents	• Avoid spills; surround plant area with a ditch with a settling pond/oil trap at the outlet	
	• Cutting down trees to use it as a fuel wood for heating bitumen	• Strictly prohibit the use of wood as fuel for heating the bitumen	
	• Effect of traffic and pedestrian movement	• Employ traffic control measures and limit possible disruption to non-construction traffic • Contractors and workers should wear high visibility safety apparel while working in public right of way. • Signposts and directional signs should be provided at appropriate locations for pedestrians and traffic at construction site.	

10.2.2 Operational Phase

At the operational phase, RAJUK will be responsible for the operation and maintenance of the URU building and ancillary facilities. No significant air and noise pollution is expected from during the operation phase. The important issues to be addressed during the operational phase include: (i) impact of additional volume of traffic to be generated during office hours, (ii) generation of solid waste and their disposal, (iii) generation of domestic wastewater from the building, (iv) power generation using a generator and (v) fire safety, natural disaster and risk management. Table 10.2 lists the mitigation and enhancement measures for the operational phase of the project.

Table 10.2: Potentially significant impacts during operation phase and mitigation measures

Activity/ Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Operation of road	• Increased traffic congestion due to increased number of vehicles	• Better traffic management following the recommendations of the traffic impact assessment	RAJUK to coordinate with local traffic police
Waste generation from building	• Generation of sewage, if untreated can cause environmental pollution • Generation of solid waste • Blockage of drain due to disposal of solid waste • Possible water pollution of downstream water body due to disposal of polluted water from drain	• Ensuring proper storage, treatment, and disposal of all solid waste • Prohibit direct connection of any sanitation facilities to the stormwater drains. Septic tank needs to be installed in the establishment which will be connected to the local sewage network. Construction of septic tank will lower the pollution load to local sewage system. Septic tank should be desludged regularly. • Designing and sizing the drains appropriately to convey the estimated quantity of stormwater and/or treated sewage • Regular maintenance and cleaning of the drain	RAJUK
Power generation (generator)	• Generation of noise and associated health hazard	• Generator should be located in an area in the building which is isolated by noise-proof barriers • Ensure wearing of personal protective equipment for staff working in the generator area	RAJUK
	• Hazards associated with handling of fuel (for diesel generators), spills and leaks	• Good house keeping • Proper handling of lubricating oil and fuel • Collection, proper treatment, and disposal of spills	
	• GHG gas emission from diesel generators	• Use the latest model of generator having the best technology for GHG emission reduction • Regularly monitoring GHG from the exhaust of generators to detect any faulty operation	

10.3 ENVIRONMENTAL MANAGEMENT PLAN

10.3.1 Scope of EMP

The primary objective of environmental management and monitoring is to record environmental impacts resulting from the project activities and to ensure implementation of the "mitigation measures" identified earlier (see Tables 10.1 and 10.2) in order to reduce adverse impacts and enhance positive impacts from specific project activities. Besides, it would also address any unexpected or unforeseen environmental impacts that may arise during construction and operation phases of the project.

The EMP should clearly lay out: (a) the measures to be taken during both construction and operation phases of the project to eliminate or offset adverse environmental impacts, or reduce them to acceptable levels; (b) the actions needed to implement these measures; and (c) a monitoring plan to assess the effectiveness of the mitigation measures employed. Environmental management and monitoring activities for the proposed RAJUK tower project could be divided into management and monitoring: (a) during construction phase, and (b) during operation phase.

10.3.2 Work Plans and Schedules

The environmental management program should be carried out as an integrated part of the project planning and execution. It must not be seen merely as an activity limited to monitoring and regulating activities against a pre-determined checklist of required actions. Rather it must interact dynamically as project implementation proceeds, dealing flexibly with environmental impacts, both expected and unexpected.

For this purpose, it is recommended that the Project Director (PD) of the Project Management Unit (PMU) for this specific project takes the overall responsibility of environmental management and monitoring. The PD will form an Environmental Management Unit (EMU) with required manpower and expertise to ensure proper environmental monitoring, and to take appropriate measures (as outlined in Tables 10.1 and 10.2) to mitigate any adverse impact and to enhance beneficial impacts, resulting from the project activities. The PD through its team will make sure that the Contractor undertake and implement appropriate measures as stipulated in the contract document, or as directed by the PD to ensure proper environmental management of the project activities.

It should be emphasized that local communities should be involved in the management of activities that have potential impacts on them (e.g., drainage congestion, employment generation). They should be properly consulted before taking any management decision that may affect them. The viewpoint of the general people as well as some major stakeholders of the project has been presented in Chapter 5. The input from the people can serve as a useful guideline in this regard.

The environmental management during the construction phase should primarily be focused on addressing the possible negative impacts arising from:

(a) Air pollution
(b) Traffic/communication problems
(c) Noise pollution
(d) Drainage congestion
(e) Water and soil pollution
(f) Reduction of damage to plants and floral habitat
(g) Employment of labor force giving priority to local people with required skills
(h) Accidents, spills and leaks
(i) Occupational health and safety

The environmental management during the operation phase should primarily be focused on addressing the possible negative impacts arising from:

(a) Generation of solid waste and wastewater
(b) Accidental spills of oils, leaks etc.
(c) Increased volume of traffic, associated impacts on local traffic congestion
(d) Power generation for the building and associated noise and air pollution
(e) Monitoring of drinking water quality of the building (after treatment)

The mitigation measures for addressing the above issues are listed in Tables10.1 and 10.2. It must be ensured that these measures are implemented in the field under the supervision of the PD of the project. The PD must also ensure the health and safety of the workers for which the occupational health and safety issues and guidelines in Annex A (as well as Table 10.1) may be consulted.

10.4 ENVIRONMENTAL MONITORING PLAN

The primary objective of the environmental monitoring is to record environmental impacts resulting from the project activities and to ensure implementation of the “mitigation measures” identified earlier in order to reduce adverse impacts and reduce negative impacts from specific project activities. In addition, monitoring plan should also include regular reviews of the impacts that cannot be adequately assessed before the start of the works, or which arise unexpectedly, along with appropriate measures to mitigate any negative impacts and/or enhancing beneficial impacts.

10.4.1 Monitoring during Construction Phase

Table 10.3 shows monitoring plan for monitoring environmental parameters during construction phase of the project.

Table 10.3: Monitoring plan during construction phase of the proposed RAJUK URU project

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
Noise Level (ambient)	Baseline One set of measurements at property boundaries of selected locations (offices, residential areas.) prior to commencing construction activities	Equivalent Noise level (Leq) with GPS location, wind speed and direction	Monthly and as directed by the Project Director; Contractor's Responsibility	Noise level meter, GPS;
	Several set of measurements at the same locations during construction activities			
Noise Level (personal exposure)	Workers working area (near equipment)	Equivalent Noise level (Leq) calculated over extended period monitoring	Monthly and as directed by the Project Director; Contractor's Responsibility	Noise level meter
Air Quality (dust particles/ particulate matter)	Baseline One set of measurements at selected locations downwind of site activities (prior to commencement of work) and in close proximity to human receptors	SPM, PM_{10} with GPS location, wind speed and direction	Monthly and as directed by the Project Director; Contractor's responsibility	Particulate matter sampling device, GPS Wind speed/direction data to be collected from local BMD station
	One set of measurements at selected locations downwind of site activities (during construction activities) and in close proximity to human receptors			
Surface Water Quality	Baseline: One measurement from the nearest surface water body (Banani Lake)	Turbidity, Total Suspended Solids, BOD_5, Dissolved Oxygen	Monthly or as directed by the Project Director; Contractor's responsibility	Laboratory facilities for water/ wastewater analysis
	One measurement from the nearest surface water body (Banani Lake) during construction activities			
General site condition	Baseline: Visual survey (once) of	General site condition, traffic	Weekly and as directed by the	Digital camera

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
	proposed RAJUK tower site prior to commencement of construction Visual survey of the construction site during the entire period of construction	condition, pedestrian movement, vegetation clearance etc. by visual survey (photographs)	Project team leader; Contractor's responsibility	
House-keeping activities	Visual survey of the construction site during the entire period of construction	Construction debris management, traffic management, management of flammable materials (if any), use of PPE by workers, all parameters related occupational health and safety etc.	Weekly and as directed by the Project Director; Contractor's responsibility	Digital camera
Drinking water quality for workers	DWASA supplied water and/or bottled water supplied to workers for drinking should be tested	pH, color, turbidity, total hardness, chloride, Total and Fecal coliform, Total Dissolved Solids, Arsenic, Iron, Manganese, Electrical Conductivity (salinity), Free Chlorine	Monthly and as directed by the Project Director; Contractor's responsibility	Laboratory facilities for water/ wastewater analysis

Note: Actual monitoring time and location will be decided by the Project Director

The measured noise levels should conform to the national ambient noise level standards for different areas (residential, silent zone etc.) as applicable. Noise level during construction activities should be within the limits of exposure prescribed in the OSHA guidelines. The measured air quality should be within the limits of the national ambient air quality standards for particulate matters in the air.

10.4.2 Monitoring during Operational Phase

Table 10.4 shows the monitoring plan (parameter and frequency of measurement) for the operational phase of the proposed RAJUK URU Building project.

Table 10.4: Monitoring plan during operational phase of proposed RAJUK URU project

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
Air Quality (dust particles and gaseous compounds)	Stack of power generator	CO, SO_X, NO_X, PM_{10}, SPM	Monthly or as directed by the Project Director; RAJUK's responsibility	Portable gas analyzer
Noise level	Sensitive receptors within and around the building to monitor noise due to generator emissions	Equivalent Noise level (Leq)	Monthly or as directed by the Project Director; RAJUK's responsibility	Noise level meter
Water Quality for drinking purpose	Should be measured each month after treating DWASA-supplied water or Rainwater for water supply purpose	pH, color, turbidity, total hardness, chloride, Total and Fecal coliform, Total Dissolved Solids, Arsenic, Iron, Manganese, Electrical Conductivity (salinity), Free Chlorine	Monthly or as directed by the Project Director; RAJUK's responsibility	Laboratory facilities for water/ wastewater analysis
Visual and aesthetics	Visual survey (through photographs) of the construction site over a period of one year after the tower has become operational for its intended purpose	Growth of vegetation or planted trees in the previously cleared area, presence of redundant construction materials in and around the site	Monthly and as directed by the Project Director; RAJUK's responsibility	Digital camera
Sanitary inspection and Septic tank desludging	Sanitary inspection and maintenance of all manholes, septic tank desludging	Routine maintenance	Once a year, RAJUK's responsibility to contract the relevant personnel	-

Note: Actual monitoring time and location will be decided by the Project Director

10.4.3 Cost of Environmental Monitoring

Table 10.5 shows the preliminary cost estimates for monitoring activities during construction assuming the duration of construction to be 18-month. The responsibility of monitoring is by the contractor and the contractor has to bear the cost. The Contractor will appoint a dedicated environmental health and safety (EHS) officer in order to oversee the mitigation activities carried out during construction and prepare/compile quarterly monitoring reports.

Table 10.5: Preliminary cost estimates for monitoring and other mitigation activities during construction phase

Parameter/Activity	Frequency of activity	Cost in BDT (per month)	Cost in BDT (18 months)
Particulate Matter (PM_{10}, $PM_{2.5}$)	Once every month	40,000/- per each set of PM_{10} and $PM_{2.5}$ measurement	7,20,000/-
Noise Level (ambient and personal exposure)	Once every month (day and night)	40,000/- (per set of measurement) See note (3)	7,20,000/-
Surface water quality (parameters: Turbidity, Total Suspended Solids, BOD_5, Dissolved Oxygen)	One measurement before starting construction, then in each subsequent month	Tk. 10,000/- (per set of measurement)	1,90,000/-
Drinking water quality testing: pH, color, turbidity, total hardness, chloride, Total and Fecal coliform, Total Dissolved Solids, Arsenic, Iron, Manganese, Electrical Conductivity (salinity), Free Chlorine	Monthly	Tk. 20,000/- per set of measurement	3,60,000/-
Site Cleaning and preparation including dismantling of structures, removal and safe disposal of debris, providing necessary protective fencing and safety measures with sign boards.	Periodic	Lump sum	8,00,000/-
Vegetation & Tree plantation around the site including fencing/ conservation/ maintenance for 2 years Total 30 nos. of trees need to be replanted around the periphery	Periodic	Lump sum	45,000/-

Parameter/Activity	Frequency of activity	Cost in BDT (per month)	Cost in BDT (18 months)
of the proposed site at an interval of 10 feet @ Tk. 1500 for each tree.			
Providing safety gear package like hand gloves, eye protection glasses, helmets, rubber shoes, light reflecting dress etc. for 40 sets @ Tk. 10,000 for each set	-	Lump sum	4,00,000/-
Drinking water container for workers including necessary ceramic filters for providing drinkable water	-	Lump sum	1,00,000/-
Temporary Sanitary Latrine/ Septic Tank/ Portable Toilet: 2 nos. (1 no of Toilet for female and 1 no of Toilet for male) @Tk. 50,000	-	Lump sum	1,00,000/-
Waste disposal charge from site by outsourced cleaners	Daily or weekly collection of solid waste	20,000/-	3,60,000/-
Dust suppression measures like water sprinkling on aggregates/ unpaved roads, in and around the work site (Lump Sum). For road construction works cost of this item has been mentioned in road section.	Daily or weekly activities	Lump sum	3,60,000/-
Health and safety warning sign	-	Lump sum	20,000/-
Appointment of an Environmental Health and Safety officer for Environmental and Social Management and Monitoring during construction (salaried position)	-	50,000/-	9,00,000/-
Total			47,15,000/-

Notes: (1) The estimated costs for particular matter (PM) and noise level measurements as well as laboratory analysis for water samples are based on current rates charged by BRTC, BUET and the rates may vary. (2) During the construction phase, some monitoring may be carried out by the PMU through its own staff and equipment, if available, or can be out-sourced to a competent Contractor. Equipment for monitoring such as digital camera, sound level meter, GPS etc. may be purchased by RAJUK.

Table 10.6 shows the preliminary cost estimates for monitoring activities during operation phase of the project. This shows the cost estimate per month which will continue throughout the life-cycle of the building. The responsibility of this monitoring lies on RAJUK and this cost should be budgeted in the annual maintenance budget of RAJUK.

Table 10.6: Preliminary cost estimates for monitoring and other mitigation activities during operational phase

Parameter/Activity	Frequency of activity	Cost estimate (per month)
CO, SO_X, NO_X, PM_{10}, SPM for generator stack emission	Monthly	Tk. 40,000/-
Treated water for drinking: pH, color, turbidity, total hardness, chloride, Total and Fecal coliform, Total Dissolved Solids, Arsenic, Iron, Manganese, Electrical Conductivity (salinity), Free Chlorine	Monthly	Tk. 20,000/-
Noise level monitoring at surrounding areas (nearby residential and college areas). Noise emissions from generator.	As and when required	RAJUK conducts monitoring and records positions by RAJUK-owned noise level meter and GPS (cost of standard noise level meter 50,000/- and GPS is 10,000/-)
Building solid waste management, recycling of wastes	Monthly	Tk. 10,000/-
Fire drills	Monthly	Contracted out to Fire Department or other competent contractors

Notes: The estimated costs for air emission and water quality analysis are based on current rates charged by BRTC, BUET for analysis of the parameters and the rates may vary. The monitoring may be out-sourced to a competent Contractor. Equipment for monitoring such as digital camera, sound level meter, GPS etc. may be purchased by RAJUK.

10.5 Implementation Arrangements

The RAJUK is responsible for ensuring that (i) all required mitigation measures that need to be incorporated into Urban Resilience Unit (URU) Building design are passed on to the engineering consultant, (ii) the bidding document for contractors contains all required mitigation measures to be implemented during the construction period and obligation for contractor to implement EMP at construction period, (iii) the no objection certificate (NOC) is obtained prior to granting any civil works contract, (iv) monitoring of EMP implementation is undertaken on a regular basis as required, and the monthly report on EMP implementation is well documented; (v) remedial actions are undertaken for unpredicted environmental impacts, and (vi) additional

environmental assessment is undertaken if any change in project design takes place. For this purpose, RAJUK has set up a Project Management Unit (PMU) headed by the Project Director (PD). The PMU consists of one Deputy Project Director (DPD) and seven Executive Engineers (EE). EE (Civil) will be in charge of supervising the activities (including EMP implementation) of the contractor during construction.

The Contractor will be responsible for implementation of the EMP during construction works and Design and Construction Supervision Consultant (DCSC) appointed by RAJUK will be primarily responsible for design, supervision, monitoring, and auditing of the implementation of the EMP. Office of the Project Director, for the Urban Resilience Project, RAJUK part, shall have overall responsibility to ensure that environmental management plan is maintained and followed fully with due consideration. The Contractor will appoint an EHS officer who will prepare/compile quarterly environmental safeguard monitoring and compliance reports and send those to the PD. The PD will share the progress report along with he EMP implementation report to the World Bank.

To ensure that contractors will comply with the provisions of the EMP, the following specifications should be incorporated in all construction bidding procedures: (i) a set of environmental prequalification conditions for potential bidders, (ii) a list of environmental items budgeted by the bidders in their proposal, (iii) environmental evaluation factors for bid reviewers, (iv) environmental clauses for contract conditions and specifications, and (v) the full EIA report should be made available for potential bidders.

The implementation schedule for environmental management and monitoring during the construction phase will be prepared by the Contractor as part of construction contract following recommended mitigation measures of potentially significant impacts given in Table 10.1. Resources required for implementation of mitigation and enhancement measures and monitoring during construction will be borne by the Contractor. Therefore, Tables 10.1, 10.3 should therefore be made integral parts of the Contract Document of the proposed project and the budget for EMP should be constructed based on Table 10.5 and Table 10.6. Environmental monitoring obligations during operation phase are the responsibility of the RAJUK.

10.6 OCCUPATIONAL HEALTH AND SAFETY PLAN

This section presents an overview of the potential occupational health and safety risks due to the proposed project. It defines the various risks involved during both the construction and operation phase of the project and develops an Occupational Health and Safety plan (OHSP). The objectives of OHS Plan are:

- To develop, in the workplace, a collaborative approach to managing Occupational Health and Safety between management and workers
- To identify work associated risk and hazard
- To provide and maintain safe working procedures and operations

- To ensure awareness of all potential work-related risks and hazards and to develop preventive strategies against these risks and hazard
- To define responsibilities to ensure effective implementation of health and safety
- To provide appropriate training to all concerned to work safely and effectively
- To maintain a constant and continuing interest in the improvement of occupational health and safety performance and to provide the required resources necessary for the implementation and maintenance of the OHS plan

This OHSP is provided as a guidance document for identifying the potential risks involved during construction and operation phase of the project and reducing workplace injury and damage to property and environment in case of accidents and emergency.
The following sub-sections provide guidelines/ directives for: (a) work equipment, (b) protective gear, and (c) safety and health signs.

10.6.1 Suggested Safety Directives for Work Equipment

It is the contractor's obligation that every possible measure is taken to ensure the safety of the work equipment made available to workers and the project proponent will oversee the situation. During the selection of the work equipment the contractor should pay attention to the specific working conditions which exist at the workplace, especially in relation to safety and health of the workers. A brief list of work equipment safety issues during construction phase of the project is given below:

- Work equipment control devices which affect safety must be clearly visible, identifiable and appropriately marked where necessary.
- All work equipment must be fitted with a control to stop it completely and safely. Where appropriate and depending on the hazards the equipment presents and its normal stopping time, work equipment must be fitted with an emergency stop device
- Work equipment presenting hazards due to emissions of gas, vapor, liquid or dust must be fitted with appropriate containment and/or extraction devices near the sources of the hazard
- Where there is a risk of mechanical contact with moving parts of work equipment which could lead to accidents, those parts must be provided with guards or devices to prevent access to danger zones or to halt movements of dangerous parts before the danger zones are reached
- Work equipment must bear the warnings and markings essential to ensure the safety of workers
- All work equipment must be appropriate for protecting workers against the risk of the work equipment catching fire or overheating, or of discharges of gas, dust, liquid, vapor or other substances produced, used or stored in the work equipment
- All work equipment must be appropriate for protecting exposed workers against the risk of direct or indirect contact with electricity

- Fork-lift trucks carrying one or more workers must be adapted or equipped to limit the risk of the fork-lift truck overturning
- Mobile work equipment such as Bulldozer or Road Rollers with ride-on workers must be designed to restrict, under actual conditions of use, the risks arising from work equipment roll-over
- Machinery for lifting loads, such as Crane, must be clearly marked to indicate its nominal load, and must where appropriate be fitted with a load plate giving the nominal load for each configuration of the machinery
- Work equipment must be erected or dismantled under safe conditions, in particular observing any instructions which may have been furnished by the manufacturer

10.6.2 Suggested Safety Directives for Protective Gears

Personal Protective Equipment (PPE) must be used by the workers and even by the visitors at the construction site to minimize the risk. All personal protective equipment must:

- be appropriate for the risks involved, without itself leading to any increased risk
- correspond to existing conditions at the workplace
- fit the wearer correctly after any necessary adjustment

The Contractor must provide the appropriate equipment to the workers and must ensure that it is in good working order. The Contractor shall organize training and demonstrate the use of personal protective equipment. Workers shall be informed of all measures to be taken. Consultation and participation shall take place on the matters related to the use of these protective equipment. A partial list of protective gears to be worn by the workers at designated work areas is given below:

- Head Protection: Protective helmets must be worn at all times in hard-hat areas, such as the building construction sites, under scaffolds, erection and stripping of formworks, etc., where there are possibilities of head injuries from falling/flying objects.
- Hearing Protection: Ear plugs or ear muffs or full acoustic helmets, whichever is appropriate, should be worn in areas where exposure to high noise level is expected. Examples of such activities include percussion drill, bolt driving, etc.
- Eye and Face Protection: Spectacles, Goggles, Face Shield or Arc-welding Mask with Hand Masks, whichever is appropriate, should be worn at times when percussion drilling, spray painting, welding or similar activities are in progress at the field.
- Respiratory Protection: In work areas such as septic tanks, dump sites, sewers etc., where exposure to harmful or toxic gases is likely the workers should wear gas masks, dust filters, or insulating appliances with air supply, whichever is appropriate.
- Hand and Arm Protection: Gloves must be worn at all times when, machineries are used which involve piercing, cutting or vibration. For protection against toxic chemicals special chemical resistant gloves should be worn. Over sleeves must be worn to protect ones arms.

- Foot Protection: Working on or under scaffolds, roof works, formwork erection at the construction site and dismantling, safety shoes/boots are essential protective measures. When working with chemicals special chemical resistant shoes may be necessary. Electrical works require insulated and antistatic shoes/boots.
- Trunk, Abdomen and Body Protection: Where heavy loads need to be lifted and/or physical force becomes necessary body belts are the appropriate protective measure. Safety aprons are essential when welding works are in progress or when handling chemicals. Body harness along with safety ropes and nets are required when working at higher elevation or where possibilities of accidental falls exist.

Table 10.7: List of protective gear to be worn at the construction site

Works/ Equipment Use	**Safety Measures for Workers and/or Work Areas**
Common Construction Works	HH, STB, HG
Earth-works	HH, STB, HG
Electric works	RSB, HG
Wood works	HH, STB, HG
Road paving	HH, STB, HG, BP, FM
Cranes	HH, STB, HG, WB
Pile Driver	HH, STB, HG, EP, WB
Arc Welder	HH, WV, HG
Bull Dozer	HH, STB, WB
Heavy Roller	HH, STB, HG, WB
Concrete Mixer	HH, STB, HG, WB
Fork Lift	HH, HG, STB, WB
Percussion Drill	HH, STB, HG, WB, EG, EP, WB
Sledge/Pick Hammer	HH, STB, HG, WB
Vibrator	HH, STB, HG, WB
Working on Scaffolds	HH, STB, HG, WB

Note: HH = Hard Hat, STB = Steel-tipped Boot, HG = Hand Gloves, BH = Body Harness WB = Waist Belt, EM = Ear Muff, EP = Ear Plug, WV = Welding Visor, FM = Face Mask, BP = Body Protective Apron, RSB = Rubber Soled Boot, EG = Eye protection Glasses

10.6.3 Safety and Health Signs

Safety signs, health signs, prohibition sign, warning sign, mandatory sign, emergency escape sign, first-aid sign, information sign, signboard, supplementary signboard, safety color, symbol, pictogram, illuminated sign, acoustic signal, verbal communication and hand signal are essential tools for preventing accidents by providing information in advance.

The Contractor must provide or ensure that appropriate safety and/or health signs are in place at their work sites where hazards cannot be avoided or reduced. Workers and their representatives must be informed of all the measures taken concerning health and safety signs at work and must be given suitable instruction about these signs.

10.6.4 Roles and Responsibilities

Site Supervisor

The Site Supervisor is responsible for overall management of the project and EMP implementation. The following tasks will fall within his/her responsibilities:

- Supervise the performance of the work being carried out within the project
- Monitor site activities on weekly basis for compliance
- Conduct internal audits of the construction site against the EMP
- Keeping a check on operation and maintenance services of solar project components
- Confine the construction site to the demarcated area

EHS Manager

The duties of an EHS Manager shall include the following:

- Ensure that the operations at the facility are in compliance with EHS requirements at all times
- Conducting Health and Safety Audits on a regular basis and advice management for necessary action
- Providing first aid facilities and personal protective equipment as required
- Recording all type of accidents and Reporting to Site Supervisor
- Training of workers and ensuring that they are issued with adequate instructions and creating awareness of safe work practice among them
- Carrying out Job Safety Analysis to determine“ Hazards of the operations/activity and facilitating suitable solutions
- Participate in the preparation of, all Safety instructions, procedures and activities

Safety Officer

The contractor will employ safety officer to maintain EHS at the project site. His roles are:

- identify potential hazards and potential major incidents
- review the effectiveness of health and safety measures
- inspect the site with a view to the health and safety of employees, at regular intervals
- participate in any internal health or safety audit
- ensure that the operations at the facility are in compliance with EHS requirements at all times

The client shall ensure the provision of necessary assistance, facilities and training to carry out the functions of a health and safety representatives established above

Employees/Workers

- Use the correct tools and equipment for the job
- use Safety equipment and protective equipment/clothing supplied, e.g. Safety helmets, shoes, harness, goggles, etc
- Report all defects in plant or equipment to health and safety representatives

10.6.5 Training

The contractor should establish procedures to identify training needs and provide adequate safety training for all levels of employees. The safety training should provide staff with the knowledge and skills necessary for organizing and managing occupational safety and health programs; management should implement and apply occupational safety and health activities; and workers with the knowledge, skills and right attitudes to enable them to work safely.

Table 10.8: Proposed Training Programs

Training	Frequency	Description	Responsibility
Induction Training on Health and Safety, covering • HSE Policy • Hazard and Risk associated with activities at work place • Control measures • Emergency response procedures such as fire-fighting, evacuation procedure, artificial resuscitation	Once in every three months	All staff and contractor workers at the time of joining/engagement	EHS Manager
Tool Box Training or pre-task briefings, highlighting hazards and the method of dealing with them	Once in every three months	Held at each work location by head of the contractor to discuss day's activities and specific hazards	Supervisor
Workers Safety Training	Once in every three months	Review safety performance for week Discuss safety for upcoming operations	Supervisor
Fire Safety and Fire Drill	Once in every month	Fire Safety measure and Fire Drill	EHS Manager
Emergency Response	Once in every two months	For emergency preparedness	EHS Manager
First Aid	Once in every three months	First Aid	EHS Manager

10.6.6 Documentation, Record Keeping and Reporting

Site Supervisor should maintain data and records concerning the identification of hazards, assessment, and control of risks of the ongoing activities. The document should establish and maintain procedures for controlling all relevant EHS documents and data. Such documents should include but not limited to EHS Policy, Hazard Identification Records, Incident-Accident Records, Control Methods including process control and machine design, Safe work

procedures, In-house work rules, Meeting Records, Training and Drill Reports, Inspection and Audit Records etc. All the incidents and accidents should be reported to the higher relevant authority.

The risk assessment should be reviewed and revised upon the occurrence of any injuries to any person as a result of exposure to a hazard in the workplace; or where there is a significant change in work practices or procedures.

10.6.7 General Working Condition

Housekeeping

- Work areas should be maintained in a neat and orderly condition
- Scrap material, such as rags, bolts, and wedges should not be allowed to accumulate in the site area
- Spills of oil, grease, paint and other slippery substances should be cleaned up immediately
- Walkways should be kept clear of tripping hazards at all times
- All personal protective equipment required for a procedure or production area must be properly fitted and worn
- Maintain a free access to all safety equipment including firefighting equipment, electrical panels, and boxes, etc.
- Scaffolding and ladders must be secured
- Proper barricades, safety rings, and safety wires should be used for openings, manholes, etc.
- Barricades must be properly lighted for visibility
- Operating equipment, tools or machinery without proper guards and/or signaling devices is prohibited
- Observe all warning signs in the yard and
- Before leaving the job, always check the area for any sparks or smoldering materials

Ventilation

- Adequate local ventilation is to be arranged in connection with all types of works involving injurious or irritating gases/smoke/ fumes, which may occur or may form while the work is going on
- Ventilation is to start up before work commences and a check is to be made by the EHS Manager

First Aid

- All work areas must be provided with adequate first aid facilities with a trained first aider during working hours
- The contractor must provide or ensure that there is the provision of adequate and appropriate facilities for enabling first aid to be rendered to their employees if they are injured or become ill at work

10.7 EMERGENCY PREPAREDNESS AND RESPONSE PLAN

The primary objective of developing an Emergency Preparedness and Response Plan is to undertake immediate rescue and necessary measures as quickly as possible. The response plan should include:

- Identification and declaration of potential emergencies
- Signal/warning mechanism
- Activities and their Levels
- Command and control structure
- Individual roles and responsibilities of each specified authority to achieve the activation as per response time
- Emergency procedures
- Alternate plans and contingency measures
- Coordination with External parties

10.7.1 Identification of Emergency

Identification of all the hazards and risks associated with each activity which may lead to an emergency and anticipate the actions to be taken before or after the emergency arises. This section identifies the hazardous areas and activities in both construction and operation phases. Probable emergencies that might arise due to these hazards for the duration of the project have been listed below:

Hazardous Area

- Fuel storage areas
- Kitchen premises in labor camps
- Electrical installations - improper laying of cables
- Scaffolds

The potentially hazardous areas and activities during project operations will be a storage area of broken panels, hazardous waste such as used oil, oily rags etc.

Emergency Situations

The possible emergency situations identified for the construction and operation phases of the Project areas listed below:

- Fire and Explosion
- Leakage of fuel from storage areas
- Short-circuit at campsite/project site

Mechanical and Electrical Hazards

- Structural Collapse
- Accidentally dropped object
- Loss of stability and
- Electrocution

Occupational Hazards

- Outbreak of Disease / Illness;
- Handling of chemicals
- Accidents due to vehicle movement; and
- Vandalism

10.7.2 Emergency Equipment

To tackle the emergency situation, onsite emergency equipment such as first aid box, fire-fighting equipment and personal protective equipment shall be available at the project site. The adequacy and condition of these items should be assessment at periodic intervals. Inventory and locations of respective emergency equipment's shall be displayed at project office building, construction areas and other work areas; It is to be ensured that the staff of developer is trained on the usage of each type of emergency equipment First aid boxes shall be provided at identified locations throughout the plant premises. During the construction phase, fire extinguishers and sand buckets will be provided at critical areas such as fuel storage area, waste storage area, labor camps, kitchens, first aid center, areas with electrical installations and project office.

10.7.3 Emergency Response Team (ERT)

The Emergency Response Team (ERT) will be set up at the beginning of the construction phase and the same will be revised for the operation phase. Each personnel identified as part of the ERT shall be designated roles and responsibilities for handling emergency situations. The ERT will comprise of the Site Supervisor, EHS Manager, Safety Officer, Evacuation Officer and representative from workers/employees. The priority in managing emergency situation will be:

- Preservation of Life (self, team, community)
- Protection of the Environment
- Protection or Property/assets
- Preservation of Evidence

The Emergency Response Team should coordinate with external agencies such as Fire brigade, Police Department, Hospitals/Ambulance Services, Utility departments (electricity, gas and water) and local authorities.

10.7.4 Response Process

During the emergency situation such as fire, collapse of scaffolding, cave- in during excavation, etc., all personnel at site including the designated Evacuation officer must be immediately notified. The procedures to be followed during an emergency are:

- All equipment must be shut down.
- In case of fire, it must be contained with the correct extinguisher only by those trained to do so.

- Those requiring assistance must be assisted and first aid must be rendered only by those trained to do so
- All personnel on site must follow the instructions of the Evacuation Officer
- Evacuation must be undertaken in accordance with the emergency layout plan
- Visitors that are not familiar with the evacuation procedure must be assisted
- Personnel must follow the directional pointers to the nearest assembly points
- The evacuation officer must be the last one to leave the area
- Personnel in the immediate vicinity of the collapsed building move away from the building to a safe location - there could be a secondary collapse

The task of the professional Emergency Services must not be obstructed.

10.7.5 Training, Reporting and Documentation

All site personnel, including contractors, are to be trained in the appropriate responses to possible emergencies and disasters. Training is to include, but not limited to the following:

- Firefighting
- First Aid
- Emergency Evacuation

Information on all emergency situation should be documented and reported to the proper authority. All near misses and unsafe acts will be written in logbooks / reported in the 'Near miss, unsafe acts, hazards and sub-standard conditions report' and verbally communicated to the concerned Site Supervisor within a reasonable time. All accidents and incidents will be immediately reported to the EHS Manager, and requisite forms completed.

CHAPTER 11
CONCLUSIONS AND RECOMMENDATIONS

11.1 INTRODUCTION

The Government envisaged establishing a trained, competent and well-equipped unit to respond to this critical gap in the management of disaster risk in Bangladesh. The Bangladesh Urban Resilience Project (URP) represents the second phase of a multi-phase national DRM program to build institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh. Construction of the RAJUK's Urban Resilience Unit (URU) building is a bold and timely initiative for Dhaka and the rapidly expanding urban center of Dhaka. Seismic assessment and resilience must be incorporated into urban development, especially of Dhaka City.

The objective of the overall engagement is to develop a comprehensive approach to managing earthquake risk through a structured process of knowledge development, education, and planning that involves a wide range of stakeholders to increase engagement and ownership.

The Project comprises five components, namely:

Component A: Reinforcing the Country's Emergency Management Response Capacity
Component B: Vulnerability Assessment of Critical and Essential Facilities
Component C: Improved Construction, Urban Planning and Development
Component D: Project Coordination, Monitoring and Evaluation
Component E: Contingent Emergency Response

The Urban Resilience Unit (URU) is envisaged to encompass the development of competencies related to urban resilience such as risk assessment, earthquake engineering, construction standards, in-situ and laboratory construction material testing, specialized construction training, and risk-sensitive land use planning. It has been planned that URU would be equipped with a specialized training facility geared toward competency building of construction activities. A testing facility for in-situ and laboratory of construction materials and structural components has also been proposed for this unit. The URU will be accommodated into new premises to be built in RAJUK's own land. The building will be constructed at Mohakhali in the heart of Dhaka; by the side of Gulshan-Mohakhali Road (Bir Uttam A K Khandakar Avenue), which will be the administrative headquarters of URU, RAJUK.

The project was initially planned to have a 30-storied building with 4 basements. However, due to anticipated difficulty in earth excavation and dewatering during construction as well as limitation of funding RAJUK decided to complete the project in two phases. Phase I involves construction of a 10-storied building with 2 basements on the southern side of the project site. Phase II involves construction of a 22-storied building with 4 basements.

As a part of the EIA of the proposed project, the baseline environment (including physical, biological and socio-economic environment) within and surrounding the project areas has been carefully surveyed and documented. The project activities during both construction and operational phases have been analyzed in order to assess their impacts on the baseline environment. The environmental impacts resulting from the proposed project activities have been assessed and evaluated for: (a) construction phase, and (b) operational phase. The potentially significant environmental impacts resulting from the project have been identified, and measures to mitigate the adverse impacts and enhance positive impacts have been proposed. In addition, occupational health and safety issues have been addressed extensively. Traffic is anticipated to be a major issue as the project site is located in a bustling commercial as well as residential area. Therefore, baseline traffic situation was assessed and impact of induced traffic from the said project has been modelled. Furthermore, mitigation measures to reduce the impact of this project within the project area and around the said location have been proposed. Finally, an environmental management plan (EMP) has been developed for guiding management of project activities during construction and operational phases. This section summarizes the major conclusions from the assessment of impacts and recommendations for the EIA study.

11.2 CONCLUSIONS

During construction phase, the possible effects of project activities on ecological, physic-chemical and socio-economic parameters have been evaluated. The ecological impacts of the project activities appear to be minor in nature.

The physico-chemical environmental parameters, those would be affected by the project activities during construction phase include earth excavation, drainage congestion, water pollution, noise pollution and air pollution have been identified. Traffic congestion and obstruction to pedestrian movement due to vehicular movement and other project activities (e.g., storage of excavated soils/ delivery of construction material, hospital equipment, etc.) are important concerns. Proper mitigation measures, as suggested in the EMP, should be followed to reduce such adverse impacts to the extent possible. The project activities are likely to generate opportunity for significant employment. During the operational phase, the project is likely to bring about significant benefit through development of competencies related to urban resilience: risk assessment, earthquake engineering, construction standards, in-situ and laboratory construction material testing, specialized construction training, and risk-sensitive land use planning addressing the need of the nation.

An Environmental Management Plan (EMP), including monitoring requirements, has been developed to ensure implementation of the “mitigation measures” identified in the environmental assessment. A Grievance Redress Committee has been suggested where aggrieved parties may launch complaint during the operational phase, which will be addressed by the committee upon formal hearing and investigation.

11.3 RECOMMENDATIONS

It has been found that most of the adverse impacts resulting from the proposed project during construction phase would be minimal. However, these impacts could further be minimized if appropriate mitigation measures are taken. The project would bring about socio-economic benefits during its operational phase through improvement of resilient building construction, risk reduction, disaster preparedness and trained personnel in the entire country.

Mitigation and abatement measures to reduce or eliminate the identified potential adverse impacts and to enhance beneficial impacts have been suggested. An environmental management plan (EMP), including a monitoring program has been developed. However, it is important that the RAJUK administration sets up a designated team with specific responsibilities to ensure proper adherence to the suggested EMP. The EIA report may now be submitted to the Department of Environment (DoE) for obtaining necessary environmental clearance.

REFERENCES

Arfanuzzaman M. and Rahman A.A. (2017), Sustainable Water Demand Management in the face of Rapid Urbanization and Groundwater Depletion for Social-ecological Resilience Building, J. Global Ecology and Conservation, Vol.10, p. 9-22.

BBS (2012), Statistical Year Book of Bangladesh, 32nd edition, Bangladesh Bureau of Statistics, August 2013, Government of the People's Republic of Bangladesh, Dhaka.

BBS (2014), Urban Area Report, Population & Housing Census 2011 National Volume 3, Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning. ISBN-978-984-519-036-7.

BNBC (2017),Bangladesh National Building Code (Draft), Bangladesh House Building Research Institute, Dhaka.

BRTC, BUET (2015), Report onGeotechnical Investigations on Sub-Soils forConstruction of Urban Resilience Unit (URU) Buildingincluding Research, Training, and TestingLaboratory Facilities under RAJUK atRAJUK Zonal Office Premises, Mohakhali, Dhaka

CASE (2019), Clean Air and Sustainable Environment Project, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh, Dhaka, retrieved August 28, 2019 from http://case.doe.gov.bd/.

DNCC (2019), Dhaka North City Corporation, retrieved from website http://www.dncc.gov.bd/

ECA (1995), Environmental Conservation Act 1995, Department of Environment, Ministry of Environment, Forest and Climate Change, Bangladesh

ECR (1997), Environmental Conservation Rule 1997, Department of Environment, Ministry of Environment, Forest and Climate Change, Bangladesh

EPA (2019), Airnow Department of State, retrieved on September 2, 2019 from https://www.airnow.gov/index.cfm?action=airnow.global_summary#Bangladesh$Dhaka

GB 12523-90. (1990), Noise limits for construction site, SAC, available in https://standards.globalspec.com/std/934869/sac-gb-12523-90

GoB (2006), Noise Control Rules, 2006', Ministry of Environment and Forest, Government of the People's Republic of Bangladesh, Dhaka.

IUCN Bangladesh (2002), Bio-ecological Zones of Bangladesh. The World Conservation Union, Bangladesh Country Office, Dhaka, Bangladesh. pp. 139.

Marsh A.H., and Richings W. V. (1991), Measurement of Sound Exposure and Noise Dose, Handbook of Acoustical Measurements and Noise Control, edited by Harris, C.M., McGraw Hill Book Co., NY.

OSHA (1970), Occupational Safety and Health standards: Occupational health and environmental control (Standard No. 1910.95:Occupational Noise Exposure)

WBG (2007), Environmental, Health & Safety (EHS) Guidelines, International Finance Corporation (IFC), World Bank Group (WBG), April 30, 2007.

https://new.usgbc.org/leed, accessed on 08 September, 2019

https://medium.com/typeiqs/steps-for-leed-advisory-a904e99844fd, accessed on 08 September, 2019

https://www.everbluetraining.com/leed-credential-benefits, accessed on 08 September, 2019

ANNEX A

Terms of Reference (ToR)

Section 7. Terms of Reference

Terms of Reference
for
Environmental Impact Assessment for Proposed 30 Storied Building of Urban Resilience Unit – *Sub-Components B &C*

1. Introduction

1.1 Bangladesh is highly vulnerable to earthquake due to its geological location and given the lack of recent earthquake events, an understanding of earthquake risk and corresponding strategies to mitigate the impact of such events is lacking. A National Plan on Disaster Management (2010-2015) includes an Earthquake Management Plan and a National Earthquake Contingency Plan, which have been developed under the Ministry of Disaster Management and Relief. These plans identify response and risk reduction activities with corresponding lead and support agencies. However, the plans lack the comprehensive vision of a national earthquake strategy, and a convincing demonstration of benefits, implementation, and controls. Furthermore, the institutional structure for multi-stakeholder engagement to deal with a problem as complex as urban earthquake risk is also lacking and the existing plans do not engage agencies and organizations in a sustainable way.

1.2 To respond to this critical gap in the management of disaster risk in Bangladesh, Bangladesh Urban Resilience Project (URP) represents the second phase of a multi-phase national DRM program to build institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh. The objective of the overall engagement is to develop a comprehensive approach to managing earthquake risk through a structured process of knowledge development, education, and planning that involves a wide range of stakeholders to increase engagement and ownership.

1.3 The Project comprises five components briefly described below:

Component A: Reinforcing the Country's Emergency Management Response Capacity

An emergency management system will be put in place that will mobilize the resources at all levels and assign roles and responsibilities more efficiently. The system will be guided by international standards and principles of emergency management and in conformity with national laws and guidelines incorporated in the Disaster Management Act of 2012 and SOD 2010. The overall goal is to design and operationalize an integrated emergency management

system in Bangladesh that will enable the country to plan and respond to both common, everyday emergencies as well as major disasters in an organized and effective manner.

Component B: Vulnerability Assessment of Critical and Essential Facilities

The objective of this component is to develop the consensus-driven analytical foundation required for longer-term investments to reduce risk in the built environment of Dhaka, Sylhet and other cities in Bangladesh. It concentrates on two activities, the first of which is an assessment of the vulnerability of the built environment in Greater Dhaka to earthquakes and other major hazards, focusing on essential and critical facilities and infrastructure. The second activity is the development of risk-sensitive land use planning as a practice in Bangladesh. This will be informed by an understanding of the hazards, vulnerability, and risk facing urban centers, and by clearly stated consensus-driven disaster risk management (DRM) objectives and policies.

Component C: Improved Construction, Urban Planning and Development

The objective of Component C is to put in place the institutional infrastructure and competency to reduce long-term disaster vulnerability in Dhaka. It would address both the existing built environment as well as future development. The overall scheme for component C covers four areas of investment: (1) create a unit within RAJUK to support the integration of risk information into development planning; (2) put up the infrastructure and processes to ensure an efficient and integral mechanism for land use and zoning clearance, permitting and approval of site and building plans; (3) improve competency through professional accreditation, trainings, continuous education, as well as forums; and (4) strengthen building code implementation and enforcement.

The following activities will be implemented under Component C:

- Create and operationalize an Urban Resilience Unit (URU) in RAJUK (Component C1)
- Establish an electronic construction permitting system (Component C2, US$ 8.7M)
- Set up a professional accreditation program for engineers, architects and planners (Component C3)
- Improve building code enforcement within RAJUK jurisdiction (Component C4)

Component D: Project Coordination, Monitoring and Evaluation

The objective of Component D is to provide necessary funding for project coordination, monitoring and evaluation. It will also ensure periodic evaluation of the investment program to highlight the outputs and outcomes in support of a longer-term investment program.

Component E: Contingent Emergency Response

Following an adverse natural or man-made event that causes a major disaster, the Government may request the Bank to re-allocate project funds to this component (which presently carries a zero allocation) to support response and reconstruction.

1.4 Core to the success and implementation of **component C** of the Bangladesh Urban Resilience Project (URP) is institutional strengthening by the creation of a new organizational unit in RAJUK and termed as the **Urban Resilience Unit (URU)** to encompass the development of competencies related to urban resilience such as risk assessment, earthquake engineering, construction standards, in-situ and laboratory construction material testing, specialized construction training, and risk-sensitive land use planning. *The URU will be equipped with a specialized training facility geared toward competency building of construction activities. It will also set up a testing facility for in-situ and laboratory of construction materials and structural components.*

1.5 Internal approval has been granted by RAJUK's management to create the Urban Resilience Unit (URU) and its Project Director has already been appointed. This project will support the setup, structuring, training and providing necessary facilities, resources, and equipment of URU. It would also support its core activities to ensure it sustainability. The URU will then be absorbed into the RAJUK organization after the project period as an Urban Resilience Division (URD). The URU will be accommodated into new premises to be built in RAJUK's own land located at Gulshan-1, one of the prime locations of Dhaka city. This Consultancy service is intended to do an EIA of proposed new premises as URU headquarters.

2. Project Description

The selected site for URU Building is located in Mohakhali in the heart of Dhaka; by the side of Gulshan-Banani, the administrative headquarters of URU, RAJUK. The land is owned by RAJUK.

The major activities and issues during the construction phase of the proposed 30-storied office building project are the following:

- Construction of 30 storied tower and associated civil works
- Electrification and other ancillary works.
- Provision of other supporting/ancillary facilities.
- Worker health and safety issues.

URU, RAJUK will be responsible for operation and maintenance of the 30-storied building.

The major issues that need to be addressed during the operation phase are:

- Impact of additional volume of traffic to be generated in the adjacent road network
- Generation of solid waste and their disposal.
- Generation of wastewater and their treatment.
- Power generation of power plant
- Fire safety, natural disaster and risk management.

Typical impacts during construction phase include air pollution, noise pollution, vibration, traffic congestion, drainage congestion, and impacts related to waste management. Health and safety issues are important considerations during construction phase. After commission of the building the impact on light and wind, traffic, sewerage disposal, water supply etc. will become important.

3. Objective of the Service

To get the site clearance and environmental clearance from the Department of Environment (DoE), Bangladesh as per the Environmental Conservation Act 1995 (ECA 1995) and Environmental Conservation Rules 1997 (ECR 1997), RAJUK need the detail EIA for proper approval. Also, as the project is financed by the World Bank Group, as per their requirement of development project, RAJUK should follow the Operational Manual of World Bank OP 4.01 Environmental Assessment hence to submit the EIA report to the World Bank group for their approval. The prime objective is to mitigate the environmental impacts as well as to recommend the best features to make the structure an example in maintaining environmental policies by incorporating the suggested recommendations by EIA consultant into the final design and implementation of the building.

4. Environmental Concerns to be Addressed in the EIA

Following aspects should be addressed as per the rules and regulations in the EIA study which in future will be incorporated in the final design of the URU, RAJUK building.

4.1 Physical

The impact of physical activities and elements on the environment are to be addressed:

- Impacts of construction activities such as site clearance, earthworks and spoil disposal.
- Impacts of operation and maintenance activities
- Impacts of accidental oil and chemical spills
- Impacts of solid waste, trade and sewage effluent
- Impacts on Air and Noise Quality
- Impacts on Water Quality
- Impacts of the supporting infrastructure on the project site
- Impacts of access routes and transportation infrastructure
- Impacts on visual aesthetics and landscape
- Socio Economic Baseline

Demands/requirements of the following shall not only be described but also quantified:

- Water supply
- Drainage
- Sewage disposal; empirical data must be provided to show that the sewage treatment facility has the capacity to remove the nutrients to meet the National Sewage Effluent Standards;
- Solid Waste Disposal
- Transport systems
- Energy demands (fossil fuels, wind, sun)
- Communications and other utility requirements
- Transport systems and supporting infrastructure requirements.

4.2 Natural Hazards

- Impact of Natural Hazards: Heavy rainfall induced flooding, earthquakes etc., are to be analyzed. The natural hazard risk assessments must take into account climate change projections.

4.3 Manmade Hazards

Impact of manmade hazards

- Composition of different nature of offices in addition to RAJUK office while RAJUK considers for renting.

- Car management in building place.

4.4 Heritage

Impact of the development on any archaeological site identified in the assessment. Explore how salvaging works and archaeological recovery would affect or can be integrated with the proposed development.

4.5 Social

- Effects on socio-economic status such as changes to public access and recreational use, impacts on existing and potential economic activities, contribution of development to national economy and development of surrounding communities.
- Safety and security arrangement.
- Support staff needs.

4.6 Site Analysis

The Consultant will visit the site and will take note of the general configurations of the site, topographical features, soil characteristics, approach to and from the site, usage of surrounding areas, site services like power, water and gas supply, sewerage and drainage system. They will also collect information on vegetation of the area, climatologically data like wind direction, effect of flood, tide in the site, etc.

The consultant will carry out site analysis to locate the best possible location and Orientation for the construction taking into consideration the environmental parameters and possible impacts.

4.7 Traffic Impact Assessment (TIA)

The project site is in the prime location of Dhaka city and the proposed 30 storied building for URU is likely to add a considerable volume of traffic to the already existing crowded area, therefore, the consultant, should carry out a Traffic Impact Assessment (TIA) for the project as a part of the EIA. The TIA should include the followings:

- A Digital Topographical survey of the project area and the adjacent areas. Secondary data available with the RAJUK will be used, if needed.
- A detail traffic volume and traffic composition study at major intersections.
- An estimation of project induced trips and its distribution and assignment into the road network using macroscopic modelling.
- Parking and loading/unloading requirements caused by the proposed development.

- Assessment of existing traffic operating conditions near the project site and of surrounding major study intersections using microscopic modelling.
- Projection of traffic volumes to assess future traffic operating conditions with and without the proposed development.
- Preparation of a traffic impact study report with recommendations to address the adverse effects, if any.

4.8 Recommended Mitigations

Mitigation and abatement measures shall be formulated for each potential negative impact identified. This will also include recommendations for the maximization and enhancement of beneficial impacts, energy conservation and the use of green building technology.

4.9 Residual Impacts

Identify any residual negative impacts for which no solution for mitigation has been proposed.

4.10 Identification and Analysis of Alternatives

Alternatives to the site location may be omitted as there is no other site own by RAJUK in such large area also suitable for this type structure.

5. Expected Qualifications of the Consultant

The consultant may hire diverse background specialist for complying the TOR requirements where the consultant will be the key responsible person.

The consultant required to successfully complete this EIA is expected to include but not limited to the following professionals:

- Environmental Specialist 3 nos (Areas are Water quality, Waste Management, Occupational safety and hazards)
- Transport Specialist
- Ecologist
- Environmental Economist
- Environmental Chemist or Chemical Engineer
- Engineering geologist
- GIS and RS Expert
- Urban Planner
- Anthropologist

- Social Expert
- Green Building Architect

The consultant should have following educational degree and experiences-

- Minimum Post Graduate Degree in Environmental Engineering/Environmental Science/Environmental Management or respective areas.
- The consultant should have minimum 8 (Eight) years of relevant experience.
- The lead or signing person of the different parts of EIA components should have minimum significant experience in executing the EIA study of similar big projects funded by the World Bank, GOB, ADB, JICA, SIDA or any such international development partners.
- Should have national and foreign trainings in relevant sectors.
- Consultant with PhD degree from reputed international Universities in relevant education will be given priority.
- The consultant must be bounded to amend the EIA until the RAJUK find the compliance between the TOR requirements and submitted EIA.

6. Expected Deliverables of the EIA Study

A detailed analysis of the various project components shall be done in order to identify the potential environmental impacts, both negative and positive, of the project at all stages. The identified impacts must be profiled to assess the magnitude and importance of the impacts. The extent and quality of the available data shall be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. The impact must take in account the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Where possible, impacts must be quantified.

Each project activity or impact is to be assessed and ranked for both the magnitude and importance of the impact and presented in a weighted matrix for all the phases of the project (i.e. preconstruction, construction and occupation and operational). The consultant shall also prepare an operational and health safety plan for workers considering environmental aspects of the projected works. In the inception phase, the consultant will conduct the situation analysis along with other issues that will include the baseline survey and stakeholder analysis.The final Environmental Impact Assessment (EIA) report and management plan report would be followed by the Draft Final Environmental Impact Assessment and Stakeholders inputs. All the deliverables are compliance of the requirement of the World

Bank guideline and Department of Environment (DoE) of Bangladesh in the aspects of any environmental issues.

6.1 Environmental Monitoring and Management Plans

Develop an EMP that consists of a set of mitigation, monitoring, and institutional measures to be taken during different stages of the project (pre-construction, construction, and operation) to mitigate the adverse environmental impacts, offset them, or reduce them to acceptable levels. The EMP should also include an Emergency Response Plan. The EMP should identify and summarize all anticipated significant adverse impacts, and describe each mitigation measures. Furthermore, the EMP should contain clear and agreed allocation of responsibility amongst project proponents and government agencies for implementation of the mitigation measures as well as their oversight and monitoring.

Environmental monitoring plan is an integral part of an EMP, which outlines the specific information to be collected for ensuring the environmental quality at different stages of project implementation. The parameters and their frequency of monitoring should be provided along with cost of the monitoring plan and institutional arrangements for conducting monitoring. Reporting formats should be provided along with a clear arrangement for reporting and taking corrective action.

At a minimum the draft monitoring plan should include but not limited to:

- Introduction outlining the need for a monitoring program
- The activity being monitored and the parameters chosen to effectively carry out the exercise
- The methodology to be employed and the frequency of monitoring
- Frequency of reporting to RAJUK
- The sites being monitored; these should incorporate a control site where no impact from the development is expected
- Raw data to be collected and relevant Tables and graphs to be used

6.2 Public Consultation Report

In order to ensure that all relevant issues have been covered by the EIA it is essential to consult potentially affected people and other relevant stakeholders (such as NGOs from the area) early in the EIA process, so that their views and concerns about environmental issues can be addressed to the extent possible.

6.3 Recommendations for Design Consultant

The EIA should have some valid recommendations for the design consultant of the building that to be incorporated in the design and implementation of the project. The recommendations by the EIA consultant should be focused on requirements of getting green building LEED Platinum Certificate. A separate chapter of recommendations in getting LEED Platinum Certification of Green Building status should be included in the complete EIA report by the consultant.

6.4 Timeline & Payment Schedule of the EIA Study

This will be a 3 months contract starting from the day of signing contract between RAJUK and the consultant. The complete EIA report needs to be submitted no later than the agreed date with all the required attachments as per the TOR. The submitted report shall be reviewed by both RAJUK and the World Bank Team hence the report must be accepted by both authorities. The Focal Person of the URP: RAJUK assigned by the Project Director will look after the day to day activities of the EIA study hence will report to the Project Director. The consultant should be willing to accept advices from the appointing authority also to repeat lab tests or other studies until the tests or study report accepted by the authority. The comprehensive payment schedule

Payment#	Size of Payment	Deliverables
1st Payment	10% of Contract Amount	Upon submission of ***"Inception Report"*** and accepted by the Client.
2nd Payment	40% of contract amount	Upon submission of ***Draft Final EIA report followed by the validation meeting with the Stakeholders*** and accepted by the Client.
3rd Payment and Final Payment	50% of Contract Amount	Upon submission of Final EIA report incorporating the inputs from the stakeholders supported by EMP (Environmental Management Plan) and accepted by the Client

7. Structure of the ESIA Report

The consultant should include broadly but not limited to the following:

I. Executive Summary

II. Policy, Legal and Administrative Framework

III. Project Description

IV. Baseline Data

V. Impacts on Environmental Parameters

VI. Assessment of Traffic Impacts

VII. Environmental Parameters in Design and Mitigation Strategies

VIII. Environmental Management Plan

IX. Public Consultations

X. Recommendations for Design Consultant for achieving LEED Platinum Certificate

XI. Annexure

The completed report written in English with the executive summary translated into Bengali must be submitted by the consultant.

ANNEX B

Recommendations for LEED Certification

Recommendations for LEED Certification

INTRODUCTION

Leadership in Energy and Environmental Design (LEED) program is a green building certification program and the most significant international symbol of excellence in design, construction, and operation of high-performance green buildings and neighborhoods. Developed by the U.S. Green Building Council (USGBC), LEED is a framework for identifying, implementing, and measuring green building and neighborhood design, construction, operations, and maintenance. The LEED Certification process facilitates the practice of designing, constructing and operating buildings to maximize occupant health and productivity, use fewer resources, reduce waste and negative environmental impacts, and decrease life cycle costs.

The proposed RAJUK URU Building project intends to get LEED Certificate. To address this objective, a set of recommendations to be incorporated in design and implementation has been prepared by the EIA Team and is presented here.

- Throughout LEED certification, the advisory project team is responsible for guiding and developing the full management process, evaluation, advisory, and building documentation.
- For URU Project: BD+C Building Design and Construction should be followed. This criteria is for new construction or major renovations; includes New Construction, Core & Shell, Schools, Retail, Hospitality, Data Centers, Warehouses & Distribution Centers, and Healthcare.

CRITERIA FOR LEED CERTIFICATION

There are total nine (09) criteria, which need to be addressed for LEED Certification. Those are as follows:

- Integrative Process (IP)
- Location and Transportation (LT)
- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy and Atmosphere
- Materials and Resources (MR)
- Indoor Environmental Quality (EQ)
- Innovation (IN)
- Regional Priority (RP)

There are four categories of LEED rating systems such as Platinum, Gold, Silver and LEED Certified, comprising of total of 110 credit points. Each credit point is allocated based on the environmental impacts and human benefits of the building-related impacts that it addresses. Projects achieve certification if they earn points according to the following levels:

- LEED Certified™: 40-49 points
- LEED Silver®: 50-59 points
- LEED Gold®: 60-79 points
- LEED Platinum®: 80+ points

LEED CERTIFICATION AND THE PROPOSED RAJUK URU PROJECT

Since one of the goals of the proposed project is to obtain LEED Certificate, the EIA Team has interacted with the Design Consultant appointed by the RAJUK in several meetings with the aim to discuss on the window of opportunitiesthat can be incorporated in their design to get maximum credit points for the certification process. During this time, the EIA Team identified some important issues which could be addressed in the finalization of the design process. These are:

- The Architectural Design should reflect the Master Plan for the site in its entirety. Equal emphasis should be given on both the Phases (i.e. I and II).
- The Phase-I (10 storied building) and the Phase-II (22 storied building) should be aligned in a way to maximize the benefit.
- Efficient pedestrian circulation/crossings without interruption of traffic movement should be included in the design.
- The design should be done incorporating the LEED Platinum Certification criteria including but not limited to construction materials, sunlight utilization, fire safety, plantation, rain water harvesting, water reuse, wastewater management, energy utilization, indoor environmental quality, traffic management, occupational health and safety, water consumption, solid waste management, etc.
- Traffic management should address the local traffic along with internal traffic.
- Equipment and machinery specifications should be considered in designing the building and floor layouts.
- The Architectural Design should provide floor-wise equipment and machinery arrangements as per the list provided by the Client.
- The Design Consultant should prepare a summarized table showing the Points Scored in each category of the LEED Platinum Certification criteria for the options adopted in the design.
- Fire Safety measures/arrangements should be clearly depicted in the design.
- Shake Table Room should accommodate the equipment as per requirement without encroaching into the set-back area.

The features included in the design of the proposed project has been reviewed thoroughly by the EIA Team in the light of LEED Certification Criteria and a set of recommendations has been prepared for each of the criteria. These are presented below. It should be mentioned here that, for RAJUK URU Building project, BD+C Building Design and Construction should be followed since this criteria is for new construction or major renovations. It includes new construction, Core & Shell, Schools, Retail, Hospitality, Data Centers, Warehouses and Distribution Centers, and Healthcare.

Integrative Process (IP)

The Urban Resilience Unit Project should be done in an “Integrated”way.This process ensures integrated, cost-effective adoption of green design and construction strategies.This process uses cross-discipline design and decision making, beginning at the programming and pre-design phase.

Recommendations:

- RAJUK should prepare the project goals to achieve sustainability
- Preliminary rating goals should be set. The goal is to optimize the integration of green strategies across all aspects of building design, construction and operations, drawing on the expertise of all participants.
- Integrated Project team with necessary professionals, including the Project Director (PD) or PD's representative, should be created. As early as practical, a preliminary LEED meeting should be conducted to formulate a LEED action plan.
- Decide the LEED certification level to pursue (Certified, Silver, Gold, or Platinum);
- Selecting the LEED credits to meet the targeted certification level;
- Identify the responsible parties to ensure the LEED requirements for each prerequisite and selected credit are met.
- Possible Strategies for Energy and water efficiency should be analyzed.
- During implementation stage, documentation is needed on how the analysis have been addressed in Design and Building Form. A narrative explanation of the energy and water evaluation in the energy analysis section should be provided in the Integrative Process worksheet (Provided by USGBC) and Simple box energy modeling should be used.

Location and Transportation

The Location and Transportation (LT) category rewards thoughtful decisions about building location. Credits can be earned if a compact development is adopted considering alternative transportation, and connection with amenities, such as restaurants and parks.Well-located buildings take advantage of existing infrastructurepublic transit, street networks, pedestrian paths, bicycle networks, services and amenities and existing utilities, such as electricity, water, gas, and sewerage. Compact communities promoted by the LT credits encourage robust and realistic alternatives to private automobile use, such as: walking,biking,vehicle shares, and public transit.

Recommendations:

- It should be highlighted that RAJUK is using its own land which is previously used. This would increase the credit as sensitive land is not affected.
- As project site is at Mohakhali, Dhaka does not encroach into wetlands, water body or effect the threated species it should earn higher points. Design Consultant of RAJUK

should design of the project such that the development footprint does not encroach on the sensitive areas.

- As the project site is at Mohakhali, which is a developed area, it would promote walkability, and transportation efficiency and reduce vehicle distance traveled thus have the potential to improve public health by encouraging daily physical activity. Therefore, it will work as a positive factor and should be highlighted for increased score.
- According to the guideline a building constructed such that the building's main entrance is within 1 half mile (800 meter) walking distance of the main entrance of four to seven (01 point) or eight or more (2 points) existing and publicly available diverse uses. Therefore, RAJUK-URU would likely earn higher points and should be addressed by the Design Consultant.
- Design Consultant of RAJUK should highlight the fact that the project location have multimodal transportation choices or otherwise reduced motor vehicle use, thereby reducing greenhouse gas emissions, air pollution, and other environmental and public health harms associated with motor vehicle use, thus earn high score.
- For this urban resilience unit project, on a site map of Dhaka, identify the location of any transit stops that appear to be within ½ mile (800meters) of the project.
- Design should confirm walkability, plot walking routes and distances from transit stops to the nearest functional entry of the project.
- In addition to vehicle parking facilities such as Bicycle storage spaces, shower and changing facilities should be provided to promote bicycling and transportation efficiency and reduce vehicle distance traveled with an aim to improve public health by encouraging utilitarian and recreational physical activity.
- To minimize the environmental harms associated with parking facilities, including automobile dependence, land consumption, and rainwater runoff, parking footprint should be reduced, provided required numbers of car according to Building Code must be provided.
- To reduce pollution by promoting alternatives to conventionally fueled automobiles, facilities can be given for Green Vehicles, which will encourage people to use green vehicle. Therefore, calculation and installation should be done for preferred parking spaces and alternative-fuel fueling stations.

Sustainable Sites (SS)

The Sustainable Sites (SS) category rewards decisions about the environment surrounding the building, with credits that emphasize the vital relationships among buildings, ecosystems, and ecosystem services.It focuses on restoring project site elements, integrating the site with local and regional ecosystems, and preserving the biodiversity that natural systems rely on.The rainwater runoff from these hardscape areas frequently overloads the capacity of natural infiltration systems, increasing both the quantity and pollution of site runoff.

Recommendations:

- Environmental site assessment should be performed by the Client to assess site conditions before design to evaluate sustainable options and inform related decisions about site design.
- A site inventory and site analysis at the proposed site is imperative. These information should be used to indicate how evaluated site features influenced the project design.
- Top soil needs to be preserved before construction work to restore after finishing the construction work.
- During Site development, habitat of other animals (if any) should be protected or restored in the site of this project to promote biodiversity.
- Open space should be given emphasis during design. In this project.Calculation of required open space and vegetated area must be provided.
- Rainwater management should be considered with great importance. Therefore, appropriate option and path for the project should be selected in the context of Dhaka city rainfall. Green Infrastructure (GI) and low-impact development (LID) strategies should be integrated into the site design to manage, on site, 100% of the total volume of runoff calculated for the selected rainfall event and the project's developed conditions.
- As Mohakhali shows an urban heat island effect in the context of Dhaka, therefore, serious focus should be given to reduce Heat Island Effect. Both the roof and non-roof surfaces should be considered while assessing this factor. Hardscape should be minimized in early design stage. Vegetated roof systems or high-reflectance roofing materials that comply with the prescribed form should be promoted. On the site plan, the area of vegetated roof and high-reflectance roof should be specifically mentioned.
- Night sky access and nighttime visibility should be improved through design modification, thus reduce the consequences of development for wildlife and people. Light Pollution reduction should be considered in design. The requirements should be maintained using either BUG method or the Calculation Method.
- Appropriate Tenant design and construction guidelines should be followed.

Water Efficiency (WE)

To support water management and identify opportunities for additional water savings by tracking water consumption, metering should be done at building level.

Recommendations:

- Outdoor water use must be reduced. The plant species and water requirement narrative should be developed.
- ***WaterSense*** Water Budget Tool may be used to calculate the water savings.

- Indoor water use must be reduced/ controlled. Documentation should be prepared including a narrative describing the non-potable water source, plumbing system design drawings that highlight the non-potable water system, and supply and demand calculations.
- All installed equipment within the project scope must meet the minimum requirements from the LEED prescribed table.
- To conserve water used for cooling tower makeup, while controlling microbes, corrosion, and scale, in the condenser water system, Water Metering should be done.

Energy and Atmosphere

Fundamental Commissioning and Verification is Mandatory for LEED certification.Minimum Energy Performance must be achieved. Otherwise the building cannot go for certification.To support energy management and identify opportunities for additional energy savings by tracking building-level energy use, Energy Metering at Building Level is a must.Management for Fundamental Refrigerant is also mandatory.

Recommendation:

- To further support the design, construction, and eventual operation of a project that meets the owner's project requirements for energy, water, indoor environmental quality, and durability, Enhanced Commissioning should be done.
- Ensure ongoing compliance with the Owner's project requirements (OPR), Basis of Design (BOD) and Commissioning (Cx)requirements by reviewing the HVAC&R contractor's submittals.
- Energy Performance of the building has to be optimized. Whole-Building Energy Simulation can be used to measure the efficiency, load reduction and HVAC-related strategies during design process. Prescriptive compliance: ASHRAE Advanced Energy Design Guide can also be followed.
- Advanced Energy Metering should be used.
- To increase participation in demand response technologies and programs that make energy generation and distribution systems more efficient, increase grid reliability, and reduce greenhouse gas emissions, there should be a Demand Response analysis.
- All the scopes of Renewable Energy sources should be explored and used as much as possible to reduce the load on fossil fuel.
- Enhanced Refrigerant Management should be considered.
- To encourage the reduction of greenhouse gas emissions through the use of grid-source, renewable energy technologies and carbon mitigation projects, Green power should be utilized at maximum level. Carbon Offsets should be considered.

Materials and Resources (MR)

The Material and Resource credits focuses on minimizing the imported energy and other associated issues like extraction, processing, transports, maintenance, and disposal of building materials. The materials are designed to support lifecycle approach that improves performance and promotes resource efficiency each requirement identifies a specific action that fits into a larger context of a life cycle approach to embed in parts reduction.

Recommendation:

- In this RAJUK-URU Project, all building materials like concrete, steel, glass etc. should be selected with utmost importance. The Life-Cycle assessment should bedone for every material.
- As the project site contains some existing structures, which will be demolished, the building materials can be reused. Identify and quantify the surface areas of the structure, building enclosure and interior elements, like walls, doors, coverings and ceiling systems may or may not be retained. Therefore, calculation should be done to identify the percentage of total area that will be reused.
- To encourage adaptive reuse and optimize the environmental performance of products and materials Building Life-Cycle Impact should be reduced. Whole-Building Life-Cycle Assessment should be done.

Building Product Disclosure and Optimization:

- *Environmental Product Declarations:*To reward project teams for selecting products from manufacturers who have verified improved environmental life-cycle impacts. Such products from manufacturers will be selected for which the available EPD (Environmental Product Declaration) meet at least one of the credit criteria.
- *Sourcing of Raw Materials and Material Ingredients*:To reward project teams for selecting products verified to have been extracted or sourced in a responsible manner,raw material manufacturers who produce products should verify to have improved lifecycle impacts.

Waste Management:

- Construction and Demolition Waste Management Plan must be done to reduce construction and demolition waste disposal in landfills and incineration facilities by recovering, reusing, and recycling materials. A final waste report for this project has to be submitted with following information:
- Identify the possible waste types and quantities that may be generated by different occupations and spaces. For example, for this project main need a large area devoted to paper recycling.

- Provide dedicated areas accessible to waste and building occupants for the collection and storage of recycle materials for the entire building collection and storage may be separate location recyclable materials must include mixed paper, corrugated cardboard glass, plastic and metals.Take appropriate measures for the safety of collection storage and disposal operations.

Indoor Environmental Quality (IEQ)

Recommendations:

- As this project will function as a commercial building, ENHANCED INDOOR AIR QUALITY STRATEGIES should be taken to promote occupants' comfort, well-being, and productivity by improving indoor air quality. A narrative should be prepared indicating the ventilation type and strategies pursued, detailing how compliance was achieved.
- To reduce concentrations of chemical contaminants that can damage air quality, human health, productivity, and the environment. LOW-EMITTING MATERIALS should be promoted.
- During construction, coordinate a review of the construction submittals to ensure that selected products meet the credit requirements and do not exceed the allocated VOC emissions.
- The selected contractor should take INDOOR AIR QUALITY MANAGEMENT PLAN to promote the well-being of construction workers and building occupants by minimizing indoor air quality problems associated with construction and renovation. Documentation with photographs will be needed. Include compliance with SMACNA guidelines and other credit requirements in drawings and specifications. Develop and implement an indoor air quality plan.
- To establish better quality indoor air in the building after construction and during occupancy, INDOOR AIR QUALITY ASSESSMENT should take place.Flush -out or Air Testing should be done.
- Thermal comfort should be given importance to promote occupants' productivity, comfort, and well-being by providing quality thermal comfort. Design ventilating and air-conditioning (HVAC) systems and the building envelope to meet the requirements of ASHRAE Standard 55-2010 or ISO 7730-2005 and EN 15251-2007.
- For a successful office space, Interior lighting should be done by providing high-quality lighting to promote occupants' productivity, comfort, and well-being.Steps should be taken to control glare.
- Daylight simulations should be done in prescribed method to achieve points.
- Introducing sufficient daylight into the space will connect the building occupants with the outdoors, reinforce circadian rhythms, and reduce the use of electrical lighting.
- Quality views should be given to the building occupants to create a connection to the natural outdoor environment. In this project, For the Phase I building, there is view to

the southern part. However, the view from the northern part will be hampered for the Phase II building. Master plan should promote maximum opportunity for both the buildings.

- To provide workspaces and classrooms that promotes occupants' well-being, productivity, and communications through effective acoustic design.

Innovation (IN)

Recommendations:

- Additional strategies incorporating innovative approach and piloting of those approaches should be done.
- Adopt strategies to be developed to earn the exemplary performance point.
- To encourage the team integration required by a LEED project and to streamline the application and certification process develop LEED Certified professional in the process.
- Innovative facade maybe incorporated if designed with innovation.

Regional Priority (RP)

- To provide an incentive for the achievement of credits that address geographically specific environmental, social equity, and public health priorities. One point is awarded for each Regional Priority credit achieved, up to a maximum of four.

A Checklist for LEED V4 BD+C is has been provided below:

Table B-1: The Checklist for LEED V4 BD+C:

Y	?	N			
			Credit	Integrative Process	**1**
0	**0**	**0**	**Location and Transportation**		**16**
			Credit	LEED for Neighborhood Development Location	16
			Credit	Sensitive Land Protection	1
			Credit	High Priority Site	2
			Credit	Surrounding Density and Diverse Uses	5
			Credit	Access to Quality Transit	5
			Credit	Bicycle Facilities	1
			Credit	Reduced Parking Footprint	1
			Credit	Green Vehicles	1
0	**0**	**0**	**Sustainable Sites**		**10**
Y			Prereq	Construction Activity Pollution Prevention	Required
			Credit	Site Assessment	1
			Credit	Site Development - Protect or Restore Habitat	2
			Credit	Open Space	1
			Credit	Rainwater Management	3
			Credit	Heat Island Reduction	2
			Credit	Light Pollution Reduction	1
0	**0**	**0**	**Water Efficiency**		**11**
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
			Credit	Outdoor Water Use Reduction	2
			Credit	Indoor Water Use Reduction	6
			Credit	Cooling Tower Water Use	2
			Credit	Water Metering	1
0	**0**	**0**	**Energy and Atmosphere**		**33**
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	6
			Credit	Optimize Energy Performance	18
			Credit	Advanced Energy Metering	1
			Credit	Demand Response	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
			Credit	Green Power and Carbon Offsets	2

0	0	0	**Materials and Resources**		**13**
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
			Credit	Building Life-Cycle Impact Reduction	5
			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
			Credit	Building Product Disclosure and Optimization - Material Ingredients	2
			Credit	Construction and Demolition Waste Management	2

0	0	0	**Indoor Environmental Quality**		**16**
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
			Credit	Enhanced Indoor Air Quality Strategies	2
			Credit	Low-Emitting Materials	3
			Credit	Construction Indoor Air Quality Management Plan	1
			Credit	Indoor Air Quality Assessment	2
			Credit	Thermal Comfort	1
			Credit	Interior Lighting	2
			Credit	Daylight	3
			Credit	Quality Views	1
			Credit	Acoustic Performance	1

0	0	0	**Innovation**		**6**
			Credit	Innovation	5
			Credit	LEED Accredited Professional	1

0	0	0	**Regional Priority**		**4**
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1

0	0	0	**TOTALS**	Possible Points: **110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

ANNEX C

Environmental Standards

Table 1: Bangladesh Standard for Inland Surface Water

Best practice based classification	Parameter			
	pH	BOD mg/l	DO mg/l	Total Coliform Number/100
Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
Water usable for recreational activity	6.5-8.5	3 or less	5 or more	200 or less
Source of drinking water for supply after conventional treatment	6.5-8.5	6 or less	6 or more	5000or less
Water usable by fisheries	6.5-8.5	6 or less	5 or more	-
Water usable by various process and cooling industries	6.5-8.5	10 or less	5 or more	5000 or less
Water usable for irrigation	6.5-8.5	10 or less	5or more	1000 or less

Source: Rule 12, Schedule-3, ECR. 1997, Bangladesh

Figure 2: Bangladesh Standards for Drinking Water

Parameters	Units	Bangladesh Standards
Aluminum	mg/l	0.2
Ammonia (NH3)	mg/l	0.5
Arsenic	mg/l	0.05
Balium	mg/l	0.01
Benzene	mg/l	0.01
BOD5 20°C	mg/l	0.2
Boron	mg/l	1.0
Cadmium	mg/l	0.005
Calcium	mg/l	75
Chloride	mg/l	150- 600
Chlorinated alkanes	mg/l	0.01
1,1 dichloroethylene	mg/l	0.01
1,2 dichloroethylene	mg/l	0.03
Tetrachloroethylene	mg/l	0.03
Trichloroethylene	mg/l	0.09
Chlorinatedphenols pentachlorophenol	mg/l	0.03
2.4.6 trichlorophenol	mg/l	0.03
Chlorine (residual)	mg/l	0.2

Parameters	Units	Bangladesh Standards
Chloroform	mg/l	0.09
Chromium (hexavalent)	mg/l	0.05
Chromium (total)	mg/l	0.05
COD	mg/l	4
Coliform (fecal)	n/100 ml	0
Coliform (total)	n/100 ml	0
Color	Hazen unit	15
Copper mg/l	mg/l	1
Cyanide	mg/l	0.1
Detergents	mg/l	0.2
DO	mg/l	6
Fluoride	mg/l	1
Hardness (as CaCO3)	mg/l	200-500
Iron	mg/l	0.3-1.0
Kjeldahl Nitrogen (total)	mg/l	1
Lead	mg/l	0.05
Magnesium	mg/l	30-35
Manganese	mg/l	0.1
Mercury	mg/l	0.001
Nickel	mg/l	0.1
Nitrate	mg/l	10
Nitrite	mg/l	<1
Odor	mg/l	Odorless
Oil and grease	mg/l	0.01
pH	mg/l	6.5-8.5
Phenolic compounds	mg/l	0.002
Phosphate	mg/l	6
Phosphorus	mg/l	0
Potassium	mg/l	12
Radioactive materials (gross alpha activity)	Bq/l	0.01
Radioactive materials (gross beta activity)	Bq/l	0.1
Selenium	mg/l	0.01

Parameters	Units	Bangladesh Standards
Silver	mg/l	0.02
Sodium	mg/l	200
Suspended particulate matters	mg/l	10
Sulfide	mg/l	0
Sulfate	mg/l	400
Total dissolved solids	mg/l	1000
Temperature	°C	20-30
Tin	mg/l	2
Turbidity	JTU	10
Zinc	mg/l	5

Source: Rule 12, Schedule-3, ECR.1997, Bangladesh

Figure 3: Bangladesh Standards for Waste from Industrial Units or Project Waste

Parameters	Units	Inland Surface Water
Ammonical Nitrogen (as elementary N)	mg/l	50
Ammonia (as free ammonia)	mg/l	5
Arsenic	mg/l	0.2
BOD5 20°C	mg/l	50
Boron	mg/l	2
Cadmium	mg/l	0.50
Chloride	mg/l	600
Chromium (as total Cr)	mg/l	0.5
COD	mg/l	200
Chromium (as hexavalent Cr)	mg/l	0.5
Copper	mg/l	0.5
Dissolved Oxygen (DO)	mg/l	4.5-8
Electrical Conductivity (EC)	micro mho/cm	1200
Total Dissolved Solids	mg/l	2100
Fluoride (as F)	mg/l	2
Sulfide (as S)	mg/l	1
Iron (as Fe)	mg/l	2
Total Kjeldahl Nitrogen (as N)	mg/l	100
Lead (as Pb)	mg/l	0.1
Manganese (as Mn)	mg/l	5
Mercury (as Hg)	mg/l	0.1

Parameters	Units	Inland Surface Water
Nickel (as Ni)	mg/l	1.0
Nitrate (as elementary N)	mg/l	10
Oil and Grease	mg/l	10
Phenolic Compounds (as C6H5OH)	mg/l	1.0
Dissolved Phosphorus (as P)	mg/l	8
pH	mg/l	6-9
Selenium (as Se)	mg/l	0.05
Zinc (as Zn)	mg/l	5
Temperature	°C	Summer-40, Winter-45
Suspended Solids (SS)	mg/l	150
Cyanide (as Cn)	mg/l	0.1

Source: Rule- 13, Schedule-10, ECR.1997, Bangladesh

Figure 4: IFC Indicative Values for Treated Sanitary Sewage Discharges

Pollutants	Units	Guideline values
pH	-	6-9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN/ 100ml	400

Source: IFC EHS General Guidelines 30 April, 2007

Figure 5: Bangladesh Standards for Sewage Discharge

Pollutants	Units	Standard limit for discharge into surface and inland water bodies
BOD	mg/l	40
Nitrate	mg/l	250
Phosphate	mg/l	35
Suspended Solids (SS)	mg/l	100
Temperature	°C	30
Coliform number	Per 100 ml	1000

Source: Rule- 12, Schedule-9, E.C.R.1997, Bangladesh

Figure 6: WHO* Ambient Air Quality Guidelines

Parameters	Guideline value	Averaging period
PM 10 (µg/m³)	20	Annual
	50	24 hour
PM 2.5 (µg/m³)	10	Annual
	25	24 hour
NOx	40	Annual
	200	1 hour
SOx	20	24 hour

Source: WHO guideline available at www.who.int/en

*World Health Organization (WHO) Ambient Air Quality Guideline Values (2005 and 2000), which are also being referred in the World Bank and IFC's General EHS Guidelines (2007)

Figure 7: Ambient Air Quality Standards of Bangladesh

Parameter	Standard	Average time
Carbon Monoxide (mg/m³)	10	8 hour
	40	1 hour
SPM (µg/m³)	200	8 hour
PM 10 (µg/m³)	50	Annual
	150	24 hour
PM2.5 (µg/m³)	15	Annual
	65	24 hour
NOx (µg/m³)	100	Annual
Ozone (µg/m³)	235	1 hour
	157	8 hour
SOx (µg/m³)	80	Annual
	365	24 hour

Source: Bangladesh Gazette 19th July, 2005 under ECR 1997

Figure 8: Bangladesh Standards for Ambient Sound Level

Category area	Day (dB)	Night (dB)
Silent Zone*	50	40
Residential Area	55	45
Mixed Area**	60	50
Commercial Area	70	60
Industrial Area	75	70

Source: Bangladesh Gazette 7th September, 2006 under ECR, 1997

* Area up to radius of 100 m around hospitals or educational institutions or special institutions/establishments identified/to be identified by the government designated as silent zone where use of horns of vehicles or other audio signals, and loudspeakers are prohibited)

** Mainly residential area, and also simultaneously used for commercial and industrial purposes.

Figure 9: The WB/IFC Noise Level Guidelines*

Receptor	One hour LAeq (dB)	
	Daytime (07:00 –22:00)	Night time (22:00 –07:00)
Residential, institutional, educational**	55	45
Industrial, commercial	70	70

Source: IFC EHS General Guidelines 30 April, 2007

** Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.*

*** For acceptable indoor noise levels for residential, institutional, and educational settings refer to WHO (1999).*

Noise Standard for Occupational Exposure

Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA-USA). No exposure in express of 115 dB (A) is to be permitted. For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column (1), the permissible level is to be determined by extrapolation on a proportionate scale.

Figure 10: Standards for Occupational Noise Exposure

Total Time of Exposure per Day in Hours (Continuous or Short-term Exposure)	Sound Pressure Level in dB (A)
8	90
6	92
4	95
3	97
2	100
3/2	102
1	105
3/4	107
1/2	110
1/4	115
Never	>115

ANNEX D

FGD Participants List

Construction of 30 Storied Building of Urban Resilience Unit of RAJUK

PC# 1 Venue# Hotel Sarina, Plot #27, Road #17, Banani, Dhaka. Date# 5-9-19 Time# 4:30 – 5:30

Sl	Name	Address	Age	Sex	Profession	Mobile	Signature
1	আলেয়া বাহার বিবি	কাউন্সিলর, ঢাকা উত্তর সিটি কর্পোরেশন = বনানী	৫৫	F	কাউন্সিলর ঢা:উ:সি:ক	0179 6880131	Kalua
2	মো: রফিউল হাসান	সহকারী অধ্যাপক, কুয়েট, খুলনা	৪৭	M	Teaching শিক্ষকতা	01552369885	Rafe
3	আলহাজ্ব মো: মিজানুর রহমান	মসজিদে গাউসুল আজম ৫৪-এ মহাখালী ঢাকা	৪৩	M	ইমামতি	01819116423	
4	Mahabubur Rahman Rubel	The planners & Engineers Ltd Consultant; URU of Rajuk	37	M	Manager	01730041542	
5	Shahin Miah	গুলশান-১, ঢাকা-১২১২।		M	ব্যবসা	01786379412	
6	SHAHEDA AKTER	গুলশান-২ - ঢাকা-১২১২		F	গৃহিণী	01726456813	
7	মো: বাদল	মিরপুর ১ ঢাকা	৩৬		ব্যবসা	01643399558	বাদল
8	মো: আরিফ হোসেন	গুলশান - ২ ঢাকা - ১২১২			ছাত্র	01790324320	আরিফ
9	আবুস সালাম মিয়া	সরকারী টিচার্স ট্রেনিং কলেজ, মহাখালী, ঢাকা।	২৬	M	ছাত্র	01775353470	
10	মো: মাসুদ হাসান	বাড়ী ভিত্তিক ফসলাদি উৎপাদন	২৭	M	Engn	01796838271	

Construction of 30 Storied Building of Urban Resilience Unit of RAJUK

PC# 1 Venue# Hotel Sarina, Plot # 27, Road # 17, Banani C/A. Dhaka Date# 5-9-19 Time# 4.30-5.30PM

Sl	Name	Address	Age	Sex	Profession	Mobile	Signature
11	Abul Kalam Azad	Tsed. Barisharia	44	M	Service	01733062207	
12	[illegible]	[illegible], DNCC	36	M	Planner	01716649209	
13							
14							
15							
16							
17							
18							
19							
20							

Construction of 30 Storied Building of Urban Resilience Unit of RAJUK

PC# 2 **Venue#** Hotel Sarina, Plot # 27, Road #17 Banani C/A. Dhaka **Date#** 5-9-19 **Time#** 6:00 – 7:00 PM

Sl	Name	Address	Age	Sex	Profession	Mobile	Signature
1	মাও: মো: আলী হুসাইন	মসজিদে গাউছুল আযম ৫৫/৭ মহাখালী ঢাকা	80	M	ইমাম	01748446880	
2	আনোয়ারুল কাদের	সহকারী প্রকৌশলী URP, RAJUK	62	M	Engineer	01700769595	
3	উম্মে সুরাইয়া নাসরিন	সহকারী প্রকৌশলী URP, RAJUK	38	F	engineer	01716780910	
4	মো: নাজিম হোসেন ইমন	সহকারী প্রকৌশলী URP, RAJUK	29	M	Engr.	01675877457	
5	Tapan Kumar	Asst Engr. (Civil & Struc) URP: RAJUK Part	29	m	Engr.	01764-496232	
6	নিগার নাহার ইসলাম	RAJUK	30	F	Architect	01748319564	
7	SHADIA MASUD	URP: RAJUK Part	35	F	Engineer	01818380294	Shadia Masud
8	Engr. Al-Emran Hossain	Green Building Academy	42	M	Engineer	01713060898	
9	Engr. Golam Gibria	"	34	M	Engr.	01718443362	
10	Engr. Syed Qudratullah	Retd. Addl. Chief Engineer Dhaka North City Corporation	59	M	Engr.	01552317876	

Construction of 30 Storied Building of Urban Resilience Unit of RAJUK

PC# 2 Venue# Hotel Sarina, Plot # 27, Road #17 Banani C/A. Dhaka Date# 5-9-19 Time# 6:00 – 7:50 PM

Sl	Name	Address	Age	Sex	Profession	Mobile	Signature
11	Md Bourhan uddin.	Inspector Investigation Banani Police station.	42	M	Police	01719122330	
12	Mr. Milton Datta	Incharge Banani Policefari SI.	34	M	Police	01742-459695	Datta
13	MD. Sohel Rana	politician Tritomin come up	28	M	Student	01719177305	
14	M.A. Sadek	Mohakhali. TB Gate	49	M	Business	01818082922	
15							
16							
17							
18							
19							
20							

ANNEX E

Chance Find Procedures: World Bank OP 4.11

Chance Find Procedures

(Ref: The World Bank Operational Manual, 1999 OP4.11)

Construction works could impact sites of social, sacred, religious, or heritage value. “Chance find” procedures would apply when those sites are identified during the design phase or construction period and the related activity will not be eligible for financing under the project.

(1) Cultural property includes monuments, structures, works of art, or sites of significant points of view, and are defined as sites and structures having archaeological, historical, architectural, or religious significance, and natural sites with cultural values. This includes cemeteries, graveyards and graves.

(2) The list of negative subproject attributes which would make a subproject ineligible for support includes any activity that would adversely impact cultural property.

(3) In the event of finding of properties of cultural value during construction, the following procedures for identification, protection from theft, and treatment of discovered artifacts should be followed and included in standard bidding document.

(a) Stop the construction activities in the area of the chance find;
(b) Delineate the discovered site or area;
(c) Secure the site to prevent any damage or loss of removable objects.
(d) Notify the supervisory Engineer who in turn will notify the responsible local authorities;
(e) Responsible local authorities and the relevant Ministry would be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures (in this case, Department of Archeology Bangladesh).
(f) Decisions on how to handle the finding shall be taken by the responsible authorities and the relevant Ministry. This could include changes in the layout (such as when finding an irremovable remain of cultural or archeological importance), conservation, restoration and salvage.
(g) Implementation of the authority decision concerning the management of the finding shall be communicated in writing by the relevant Ministry.
(h) Construction work could resume only after permission is given from the responsible local authorities and the relevant Ministry concerning safeguard of the heritage.

(4) These procedures must be referred to as standard provisions in construction contracts. During project supervision, the Site Engineer shall monitor the above regulations relating to the treatment of any chance find encountered.

(5) Relevant findings will be recorded in World Bank Monitoring and Supervision Reports during project implementation. Completion Reports will assess the overall effectiveness of the project’s cultural property mitigation, management, and activities, as appropriate.