DRAFT

Guidelines for Project Document of Spatial Planning

June, 2019

Urban Development Directorate
Ministry of Housing and Public Works
Government of the People's Republic of Bangladesh

Published by

Urban Development Directorate (UDD)
Ministry of Housing and Public Works
Government of the People's Republic of Bangladesh

First Edition
June 2019

Price
Taka 300.00
US$ 9.00

Printed by

Executive Summary

Urban and regional planning deals with decision-making process aimed at realizing economic, social, cultural and environmental goals through the development of spatial visions, strategies and plans and the application of a set of policy principles, tools, institutional and participatory mechanisms and regulatory procedures. Land use planning has an inherent and fundamental economic function. It is a powerful instrument for reshaping the forms and functions of cities and regions in order to generate economic growth, prosperity and employment, addressing the needs of the most vulnerable, marginalized.

To make a rapid spatial data satellite image is more effective than other survey procedures. Photogrammetric method uses satellite/aerial stereo images to create DEM and make geospatial database more effectively. Being latest trends in technologies photogrammetry is now the leading technology for mapping. Within a short period of time, the practice of photogrammetry has changed from analog to digital. The development of digital aerial cameras has advanced significantly over the past ten years. The use of digital aerial images would be more advantageous for all map and image production especially for vector data generation.

Scope of work on the intended GIS Database (Spatial and attribute) development would have to be interlinked the intended GIS Database with different steps of other related activities. A detailed methodology of the specific GIS Database preparation including relating attribute data has been described in the chapter III. Traffic and transportation database would have to be combined with that of database (GIS database) of physical feature, topographic and land use database prepared by other Consulting firm(s).

Seismic hazard maps of the town and region should be prepared following probabilistic and deterministic approaches. Seismic motion estimation is the prime parameter of seismic hazard assessment. Soil liquefaction and slope failures are also belong to seismic hazard. Since, all the urban centers for which seismic hazard assessment would be done are almost flat, slope failure need not to consider for hazard estimation.

The overall objectives of water resources component is to study sub regional water resource system; condition of existing drainage system; prepare land use planning guidelines considering hydrological situation of the project area; make study over hydrological hazards of the area and prepare guidelines for hazard mitigation; prepare flood prediction model of long, medium and short term (100, 50, 20, 5 and 2.33 year period) for Project area; prepare IEE (Initial Environmental Evaluation) for the area.

Aim of hydro-geological study is to identify the aquifer of the region including its seasonal variation. The study is also intended to identify the availability fresh ground water, which would be required for the additional people after implementation of the plan. The hydro-geological data and information shall have to integrate with both spatial and attribute data of output of other components of planning package in order to keep the hydrological system of the region sustainable.

The flora-fauna component would conduct historical study to get information on the spatial distribution of habitats or species and compile habitat or species inventories on various scales, and also recognize the pattern of rarity. The study needs to know if the habitats actually rare have been in this state for a long time or if they were still frequent some decades ago. Information on the underlying process of decline or increase can be achieved by an historical landscape analysis. Time series of old topographic maps or aerial photos, written historical texts or oral information are all valuable sources to outline a picture of the landscape at times when land use was less intensive than today. Maps with the historical distribution of habitats from these sources should be drawn in the same resolution as the actual distribution. By overlaying both maps the survey firm/ shall compute exact balances of losses for all habitat types in the project area.

In Conventional practice, planning projects were awarded to a single consulting firm or consortium that would arrange all the components, equipments, manpower and experts either by its own or by outsourcing. Even the most essential component like physical feature survey is outsourced while GIS database remains with the lead firm. Delay in initiation or mobilization makes project time double. Moreover, unnecessary detail in field data collection due to lack of negotiation between planning and survey professionals' results extension in work schedule. In addition to this, an extremely valuable item for land use planning "Digital Elevation Model" is almost ignored as well as flood modeling. As a result, formation structure plan zoning categories do not have a strong basic parameter.

In contrast to the conventional practice, to get reed of this mega consulting firms (holding a composite single package) splitting the whole package in several independent component came in practice, which covered: (1) Image acquisition, processing and interpretation, (2) Ground verification and attribute collection for physical features, (3) Mouza map digitization and geo-referencing, (4) Socio-economic survey, (5) Transportation survey and modeling, (6) Geological investigation and modeling, (7) Ground water investigation and modeling, (8) Surface water modeling, (9) Ecological (flora and fauna) study, (10) PRA etc. In most cases, each component is awarded to single consulting firm, which seems to result a very efficient operation of each component. In first stage it requires larger involvement from procurement managers. Also, all through implementation period monitoring inputs jumps higher. Moreover, some output is little usable, sometimes not usable to other firms, which results low level output from the consulting firms.

Examining the above mentioned two extreme project management scenarios, it seems that the similar or interlinked components should be awarded in groups. The innovation team recommends combination of (1) Image, (2) Ground verification, (3) Mouza, (8) Surface water modeling, (9) Ecological (flora and fauna) study, (10) PRA etc with input from individual consultant of Hydrology, Ecology and Urban planners. An accurate interpretation of image is essential for accurate attribute collection, mouza map geo-referencing, DEM, surface water modeling, identification of conservation area (wetland and vegetation), existing land forms (input of social mapping for PRA). On the other hand, the outputs from these associate components needs to be compiled into one single platform ie, GIS database to make planning decisions.

In similar way, Transportation survey and modeling requires huge field data from households for trip generation study that can be merged socio-economic survey. In contrast, major part of data base can be supplemented from published database of BBS, which may reduce the volume of primary data collection. So, transport and social component may be combined. Moreover, combination of Geology and Ground water would reduce cost of operation from both client and consultants side.

TABLE OF CONTENTS

Chapter I
Terms of Reference for Spatial Planning

1.1 Introduction

Urban and territorial planning can be defined as a decision-making process aimed at realizing economic, social, cultural and environmental goals through the development of spatial visions, strategies and plans and the application of a set of policy principles, tools, institutional and participatory mechanisms and regulatory procedures. Urban and territorial planning has an inherent and fundamental economic function. It is a powerful instrument for reshaping the forms and functions of cities and regions in order to generate endogenous economic growth, prosperity and employment, while addressing the needs of the most vulnerable, marginalized or underserved groups.

The Guidelines promote key urban and territorial planning principles and recommendations that can assist all countries and cities to effectively guide urban demographic changes (growth, stagnation or decline) and improve the quality of life in existing and new urban settlements. Taking into account the principle of subsidiarity and the specific governance arrangements of each country, the Guidelines should be used through the multi-scale continuum of spatial planning:

At supranational and trans-boundary level: multinational regional strategies could help direct investment to address global issues such as climate change and energy efficiency, enable the integrated expansion of urban areas in cross-border regions, mitigate natural risks and improve the sustainable management of shared natural resources;

At national level: national plans could take advantage of existing and planned economic poles and large infrastructure in order to support, structure and balance the system of towns and cities, including in urban corridors and river basins, to fully unleash their economic potential;

7th FYP Goals and Targets regarding Urban Development: The 7th FYP reflects a continuation of the major goals articulated in the 6th FYP. The core targets set in accordance with the vision and goals of the Perspective Plan under the 7th FYP include (Accelerating Growth, Empowering Citizens, General Economics Division, Planning Commission, 2015, p 39):

- Infrastructural investment and civic facilities in peri-urban growth centres especially around Special Economic Zones
- Inclusive housing and other civic services for urban inhabitants including for people living in informal settlements and slums
- Inclusive urban planning based on sustainable land use planning and zoning
- Increased productivity, access to finance, and policy support for urban micro-small and medium enterprises

Bangladesh Delta Plan 2100: The complexity of the Bangladesh delta necessitates a plan that can adapt to change - a Bangladesh Delta Plan 2100, a long-term, holistic and integrated plan for the Bangladesh delta, Long-term, considering goals for the next fifty to one-hundred years. Holistic: bringing together strategies for the country as a whole. Integrated, considering the needs of all water-related sectors in a single plan.

The formulation of the Bangladesh Delta Plan 2100 draws on experience from the Delta Plan formulation process in the Netherlands, while at the same time adapting to the specific needs of Bangladesh and finding inspiration in Bangladesh's long tradition of resilience and water management.

The Bangladesh Delta Plan 2100 is grounded in a vision of the future for the Bangladesh delta. The formulated Delta Vision has been included in Bangladesh's Seven Five Year Plan (2016-2020) as follows: "Ensure long-term water and food security, economic growth and environmental

sustainability while effectively coping with natural disasters, climate change, and other delta issues through robust, adaptive and integrated strategies, and equitable water governance.

Delta Plan formulates Strategies both on the national level and on the level of Hotspots. Hotspots (stated below) have been selected to combine areas that face similar water-related challenges. Strategies form coherent sets of measures to achieve the Delta Vision and are tested against developed Scenarios for robustness in a changing Bangladesh:

(1) Coastal Zone [27,738 sq. km.]
(2) Barind and Drought prone areas [22,848 sq. km.]
(3) Haor and Flash flood areas [16,574 sq. km.]
(4) Chattagram hill tracts [13,295 sq. km.]
(5) River system and estuaries [35,204 sq. km.]
(6) Urban Areas [19,823]

The Bangladesh Delta Plan 2100 enables the Bangladesh government to integrate short-term, medium-term and long-term planning. The Delta Plan considers the delta as a whole and takes into account the effect of delta management on all sectors, empowering Bangladesh to make optimal, efficient use of limited resources. It enables the Bangladesh government to integrate climate change adaptation and plan for a future delta that ensures water safety, food security and economic growth. By employing adaptive delta management, Bangladesh becomes able to conduct robust planning in the context of a rapidly changing environment.

At city-region and metropolitan level: sub-national regional plans could foster economic development by promoting regional economies of scale and agglomeration, increasing productivity and prosperity, strengthening urban-rural linkages and adaptation to climate change impacts, reducing disaster risks and intensity in the use of energy, addressing social and spatial disparities and promoting territorial cohesion and complementarities in both growing and declining areas;

At city and municipal / Upazila town level: city development strategies and integrated development plans could prioritize investment decisions and encourage synergies and interactions between separate urban areas. Land-use plans could contribute to the protection of environmentally sensitive areas and to the regulation of land markets. Urban extension and infill plans could minimize transport and service delivery costs, optimize the use of land and support the protection and organization of urban open spaces. Urban upgrading and retrofitting plans could increase residential and economic densities and promote more socially integrated communities;

At neighborhood level: street development and public space plans and layouts could improve urban quality, social cohesion and inclusion, and the protection of local resources. Participatory planning and budgeting, involving communities in managing urban commons, such as public spaces and services, could contribute to improved spatial integration and connectivity, human security and resilience, local democracy and social accountability.

Different types of urban and territorial planning methods and practices exist and have been tested in many countries: city-wide strategic planning, master planning, community planning, land-use planning, etc. They all aim to influence urban forms and functions and do so in different ways; even plans that are not implemented have an impact on the real world, for instance by becoming obstacles to sustainable change. The spectrum of planning methods is broad and reflects an evolving continuum within which top-down and bottom-up approaches are combined to various degrees in each particular context. Whatever the approach, successful implementation of plans always requires strong political will, appropriate partnerships involving all relevant stakeholders and three key enabling components:

Enforceable and transparent legal framework: The emphasis should be on the establishment of a system of rules and regulations that provide a solid and predictable long-term legal framework for

urban development. Special attention should be paid to accountability, implementability and the capacity to enforce the legal framework where applicable;

Sound and flexible urban planning and design: Specific attention should be paid to the design of the common space, since it is one of the main contributors to urban value generation, with provision of appropriate street patterns and connectivity and the allocation of open spaces. Equally important is clarity in the layout of the buildable blocks and plots, including appropriate compactness and mixed economic use of the built area, in order to reduce mobility needs and service delivery costs per capita. Finally, the design should facilitate the strengthening of the social mix and interaction and the cultural aspects of the city;

A financial plan for affordability and cost-effectiveness: The successful implementation of an urban plan depends on its sound financial basis, including the ability of initial public investments to generate economic and financial benefits and to cover the running costs. Financial plans should contain a realistic income plan, including the sharing of urban value between all stakeholders, and an expenditure provision to address the requirements of the urban plan.

The three components cited above should be balanced to ensure positive and achievable urban outcomes. That should lead to increased cross sectoral synergies, delivery-focused partnerships and streamlined and effective procedures.

1.2 Structure Plan Zoning Categories

Zoning categories of Development Plan may follow hazard mitigation guidelines considering hydrological situation of the project area. Land use planning has been used as an important tool in disaster mitigation. In this option, risks are reduced not by hazard proneness of the site, but by changing the functional characteristics of the hazard area. This can be applied when the hazard proneness of the sites varies within planning area.

Conservation Zone: Water bodies are our life providers. So, all existing water courses, rivers, lakes, tanks should be protected. The boundary of water bodies and inundation should be delineated as per flood analysis. Flood and Land Zoning and relate to high tide level or high flood level. No construction should be permitted in water bodies' premises and the water spreads. Fishing activities, boating and picnics along the river banks, recreational activities are considered as only exceptions. Platforms for fishing and rain shelters, jetties for boating should be considered as friendly structures. This area is the most frequently flooded area (2.33 year return period flooding). Characteristics of this area need to be preserved. However, the existing rural homesteads located in this zone should not be evicted or allowed to be expanded. Agricultural activities are allowed in this zone without changing the characteristics of land. Natural flow of water should not be interrupted under any circumstances.

Agricultural Zone: The prime fertile agricultural land (within 2.33 to 5 years return period inundation), existing plantations and aquaculture areas provide the major services for food security. These existing agricultural/rural land use activities to be kept intact, and urbanization should not be allowed. The permissible major uses are like: agriculture, horticulture, orchards and nurseries dairy and poultry, farm housing, fish farming, cottage industry. This area is totally dedicated for agricultural activities. Some agro-supporting activities like cold storage, Fertilizer storage, mini godown etc may be allowed in this area.

Rural settlement Zone: Rural settlements are the hub of rural livelihood which contains traditional culture as well as ecology and generates agriculture production. Low density rural settlements are composite hub for rural livelihood. In this plan, the areas within 5 to 20 years return period inundation are proposed for rural settlement. Other than dwellings, agricultural and related facilities that enhance livelihood, nothing should be allowed in this area. As required amount of manpower is already available in the designated areas, no additional dwelling units (residential land) should be allowed in this area.

Rural settlements are one of the major land uses of the project area. These areas also need community

services. For the areas for which such services are not allocated, following principals need to be followed:

a) To ensure compact urban development, community services should be placed only in the designated urban areas and rural settlements.
b) Community or neighborhood boundary need to be defined objectively.
c) Threshold population for each of the community need to be determined and based on the same, need for different kinds of services will be identified.
d) Maximum participation of the stakeholders should be ensured to identify the locations for different kinds of services. This will maximize the possibility of implementation of the services.
e) Place making approach of planning can be adopted for planning the community level planning.
f) Utmost effort should be there to ensure utilization of existing infrastructures (e.g. roads) and minimize destruction of any structures.
g) Flood level and return period should be considered carefully for identifying the location of the infrastructures.
h) Instead of locating these services dispersedly, it is better to locate these facilities in cluster. This will be helpful to ensure compact development.

Designated Urban Areas: In this plan, the areas over 20 years return period inundation are proposed for urban and urban promotion. With much lower current density, it is expected that these areas would be able to host the increased population in the years to come. Plan of these urban centers are prepared to ensure safe, easily accessible, environmentally sustainable and healthy living environment. These areas are also the main centers of employment and economy with various types like higher order commercial establishments, specific non-polluting green industrial establishments, mixed/multiple uses in the concerned master plans, urban infrastructure etc. The corridor is supposed to have interchange of goods from one mode of transport to another mode of transport especially through these nodal points. The corridor would act as a transit hub among different modes of transport. Loading, unloading and elated main and ancillary activities are to be in these uses.

Urban Promotion Zone: Apart from the designated urban areas within areas over 20 years return period inundation, there are many places where economic agglomeration can be observed. These areas have very high potentiality for future urban formation. These areas are relatively flood free. Detailed plan for these areas are not developed.

Restricted Zone: The zone comprises Cantonment, along with other key point installation. For, this surrounding, land use should be kept a rural/agriculture/conservation.

Water Body Buffer Zone: According to water act for shore up to 50 meters of rivers within the planning area has been designated as no construction zone. In addition to other water bodies it is 10 meters. The buffer would preserve the conservation zone as well as water and environmental resources.

Border Buffer Zone: The 'Joint India-Bangladesh Guide Lines for Border Authorities, 1975' suggests that the border security forces on both sides shall observe some simple rules to avoid possibility of unpleasant incidents, which includes defensive works of any nature within 150 yards on each side of the border. Within this zone any construction would require clearance from the border guard authority.

National Highway Buffer Zone: One of the prime development control measures for the planning area is to prohibit ribbon development in order to maintain efficient traffic carrying capacity of the national highway. On the other hand, any high intensity development in the existing urban centers or growth centers can easily be served with required utilities. For this the plan recommends to prohibit any high intensity development within 100 meters from both sides of the national highway.

1.3 Growth Center:

Growth centers play the most vital role in economic development of the area. Usually these growth centers are hierarchically linked with one another to form a network where the economy circulates and agglomerates. This economic circulation and agglomeration acts as the lifeblood of the economy of the corridor. For the sake of planning, growth centers are defined into the following categories:

Level 1: Serves as the regional market. Very old and established urban center (may also serve as the administrative hub). It is primarily used by intermediary traders exchanging with large buyers and are focal points for wholesale and retail sale of agricultural and non- agricultural goods and services. Large urban centers need regional connectivity. Have highest potentiality of future development.

Level 2: Secondary Market, typically serving a Thana. They are used by intermediary traders exchanging with large buyers, and are focal points for wholesale and retail sale of agricultural and non-agricultural goods and services.

Level 3: local assembly markets, used by farmers and local traders exchanging with intermediary traders who move agricultural produce up to higher levels of the marketing system, and for the sale of foodstuffs, agricultural inputs and retail goods.

Hierarchy of these growth centers is declared Based on the hierarchy; these growth centers are linked with one another to form a network. Level-1 growth centers are linked with the national highway so that they can contribute in fulfilling the national demand of different kinds of goods. Growth centers being the lifeblood of the economic activities of the corridor, the planning team suggests to follow the following development strategies for these centers:

- Promote mixed use development in the Rural Growth Centers using the principle of Planned Unit Development (PUD).
- Ensure hierarchical connectivity with the economic nodes and surrounding rural settlements based on the economic demand of the growth centers
- Promote agro-based and agro-supporting, small and cottage industries in the growth centers
- Ensure well-coordinated agricultural value chains in the project area and barrier-free direct entry of the agro-products in the competitive market
- Ensure integrated and planned development considering all agents of development (power, infrastructure, policy support etc.)
- Promotion of Rural Growth Centers as Trading Hub of the Rural Community
- Access of the rural folks of all income-groups (specially marginalized groups) should be ensured in the Growth Centers

Table 1.1: Standards of different Types of Services

Sl. No.	Land use Components		Standard (acre per population)	Remarks
1	**Residential**			
	A	Private/General Residential	100-150 person/1 acre	
	B	Public/Govt. Residential	150-200 person/1acre	
2	**Education**			
	A	Nursery/Elementary School	2 acre/10,000 population	
	B	Primary School	5 acre/5,000 population	
	C	Secondary School	10 acre/20,000 population	
	D	College/University	5-10 acre/20,000 population	
	E	Vocational Training Center	5 acre	1/ Pauroshava
	F	Others (Library, Public Library)	0.5 acre/20,000 population	1/ Pauroshava
3	**Open Space and Recreation**			
	A	Central Park	5-10 acre	1/ Pauroshava
	B	Neighborhood/Community Park	1 acre/10,000 population	
	C	Playground/Play Field	3 acre/20,000 population	
	D	Stadium (Indoor and Outdoor)	5-10 acre	Optional/1/
	E	Cinema Hall	3 acre	1/ Pauroshava
	F	Club House	1 acre	Optional/1/
4	**Commercial**			
	A	Wholesale Market	3-5 acre	1/ Pauroshava
	B	Retail sale / Kitchen Market / Neighborhood Market	0.5 acre/10,000 population	
	C	Shopping Complex	0.5 acre/20,000 population	
	D	Cattle Market(Hat)	1-1.5 acre	1/ Pauroshava
5	**Industrial**			
	a	General/ Agro /Cottage Industry	2-5 acre /10,000 population	
	b	Heavy Industry	10 acre	As per local requirement/Optional / 1/ Pauroshava
6	**Administrative**			
	a	Upazila Complex	10 acre/Upazila	
	b	Pauroshava Office	3 acre/Pauroshava	
	c	Word Councillor's Office	0.10 acre/Office	
	d	Jail/Sub-Jail	10 acre/Upazila	
7	**Community and Social Services**			
	a	Eidgah	2 acre/20,000 population	
	b	Graveyard	1 acre/20,000 population	
	c	Cremation Ground	0.5 acre/20,000 population	
	d	Mosque/Temple/Church	0.5 acre/20,000 population	
	e	Community Center/ Auditorium	0.5 acre/20,000 population	
	f	Club/Gymnasium	0.10 acre	Optional
	g	Day Care Center	0.10 acre	Optional
8	**Health**			
	a	Upazila Health Complex	5 acre/50 bed hospitals	1/ Pauroshava

(Table continued)

(Table continued)

Sl. No.	Land use Components		Standard (acre per population)	Remarks
	b	Specialized Hospital	1 acre	1/ Pauroshava
	c	Maternity/ Child Care Center	1 acre/20,000 population	
	d	Clinic	0.25/20,000 population	
9	**Utility**			
	a	Electricity Supply/ Electric Sub-station	1 acre/20,000 population	
	b	Water Supply Station with Treatment Plant	1 acre/20,000 population	
	c	Gas Supply Station	1 acre/20,000 population	
	d	Waste Disposal Ground	2-3 acre/ Upazila/ Pauroshava	
	e	Waste Collection Point	0.2 acre per Station	
	f	Sewerage Treatment Plant	As per Local Requirement	
	h	Drainage Treatment Plant	As per Local Requirement	
10	**Transport and Communication Infrastructure**			
	a	Bus Terminal	1 acre	1/ Pauroshava
	b	Bus Stand	0.5 acre/20,000 population	
	c	Truck Terminal	1 acre	1/ Pauroshava
	e	Rickshaw/Van/Tempo Stand	0.25 acre/Station	
	f	Fuel/Filling Station	0.5 acre/20,000 population	
11	**Government Services**			
	a	Police Station	3-5 acre	1/ Pauroshava
	b	Police Box	0.5 acre/Box	
	c	Post Office	0.5 acre/20,000 population	
	e	Fire Service	1 acre/20,000 population	
	f	Telephone Exchange	0.25 acre/20,000 population	
12	**Miscellaneous**			
	a	Slaughter House	0.15/20,000 population	
	c	Foreign Offices		Optional
13	**Circulation Network (Road)**			
	Road Type		**ROW**	
	a	Pauroshava Primary Road	60-100 Feet	
	b	Secondary Road	30-40 Feet	
	c	Local/Connecting Road	Minimum 20 Feet	
	d	Walkway/Footpath	5-8 Feet	
14	**Drainage Network**			
	Drain Type		**Width**	
	a	Primary Drain		As per local
	b	Secondary Drain		As per local

1.4 Corridor Planning

Broadly, transportation-related corridor planning is the coordination of transportation and land use activity within a linear area, usually along a major transportation link, such as a state highway. Corridors can be defined narrowly, to include only one road and its adjoining land use, or more broadly to include a network of parallel routes and transit lines. Metropolitan planning organizations (MPOs), such as National Physical Planning Agency, have completed numerous corridor studies over the years. MPOs are in a unique position to plan for corridors, given our regional jurisdiction, enabling National Physical Planning Agency to conduct a planning exercise across municipal and county boundaries. Many MPOs, National Physical Planning Agency included, also organize anticipated growth in corridor form. As National Physical Planning Agency's mission is to plan for and program transportation improvements, corridor plans are prepared to coordinate anticipated or proposed major public improvements with existing and proposed land uses.

Corridor plans provide transportation departments, local governments (including municipal and region), landowners, developers, and residents along the corridor with an overall vision, as well as guidance and coordination on what future infrastructure improvements are needed. Corridor plans often include descriptions of capital improvements, implementation phasing, access and circulation issues, and protected lands.

1.4.1 Justification of Corridor Plan

While planning is a systematic method of achieving optimum mix of activities to ensure livable and sustainable living environment for the people, it is often very complex. Among many reasons, some are (1) it demands sophisticated technology intensive survey and analytical methods, (2) conflict minimization among different stakeholders is often easier said than done, (3) finding environmentally sound, economically viable and pragmatic solution is tough to find. Below are examples of typical problems that, when combined, may warrant a corridor study:

- Inappropriate speeds
- Congestion
- Lack of alternative transportation modes
- Unattractive street environment that limits commerce or development along the corridor
- Uncontrolled access (such as excessive curb cuts) along higher speed roadways
- Lack of sidewalk and bike infrastructure
- Parking facilities are not coordinated with land uses along corridor
- Crashes and fatalities
- Housing, commercial or industrial disinvestment
- Need for visioning for future development

1.4.2 Benefits of Corridor Plan

Corridor planning is relatively less emphasized part of the development planning process of Bangladesh. In fact, this is the first ever corridor project in Bangladesh. Usually this approach of planning considers multi-modal transport system with respect to the surrounding land uses that respects and enhances our natural and human environments. The Corridor Plan usually integrates several elements to produce an integrated highway based solution. This process identifies transportation services, determines competing demands for different kinds of land uses, and integrates the findings into a common vision for the entire project area that will expedite overall development of the project area maintaining cohesiveness with the national development agenda and vision. Benefits of corridor planning are:

- Improved access along a corridor when land use and transportation planning is coordinated
- Connecting infrastructure to development decisions, reducing infrastructure costs
- Coordinated redevelopment and economic development along a corridor
- Resolution of major planning issues prior to the initiation of project development
- Identification and possibly preservation of transportation right-of-way
- Protection of transportation investments
- Intergovernmental cooperation, partnerships with diverse public and private agencies and Organizations
- Asset management

1.4.3 Role of Corridor in a Community

The corridor's overall role in a community is often overlooked because it tends to be qualitative. It is Critical to understand that the corridor helps to establish the community's identity, through linking major sections of the community, serving major economic needs or accommodating community needs, such as open space. Corridors link the various components of community-residences, businesses and institutions—and often form the economic spine of a community.

1.4.4 Justification to Integrate Transportation and Land Use

Land use patterns shape transportation, and often transportation investments shape land use patterns. Different land use scenarios can have widely varying effects on transportation options, open space, energy consumption, and infrastructure costs. Land use patterns can support transit, walking, and bicycling; or they can preclude these options by only supporting automobile travel, for instance, by not providing sidewalks, bike lanes, or enough density to make transit feasible.

Highways and bridges shape growth. Building a new highway into rural or undeveloped areas invariably brings development (without appropriate land use controls). This development adds more users to the highways, causing congestion. The solution for many years was to keep adding capacity by building more roads or widening roads, however, research over the last decade has shown that one cannot "build one's way out of congestion," at least not for long. What is needed is a change in transportation and land use planning, with coordinated policies, project development and decision-making, to better link land use with transportation.

Communities that integrate transportation and land use planning and policies are better able to manage growth, improve the efficiency of travel, and contain infrastructure costs. Metropolitan planning organizations like National Physical Planning Agency are uniquely suited to address these concerns, as they play a large role in transportation investments and decision-making, while also creating a long-range land use and transportation plan for the region. A larger challenge lies in influencing local land use decision-making, as most land use policies are local, and coordinating these policies and decisions with regional and transportation planning and with the plans of neighboring municipalities.

Achieving a better transportation-land use linkage is the foundation of the smart growth movement. This linkage can lead to supportive land development patterns that create a variety of transportation options, including biking, walking, public transit, and better connected road networks. It can also facilitate mixture of land uses, which might have been otherwise found incompatible, in higher-density, pedestrian-oriented development patterns.

1.4.5 Keystone Principles of Corridor Management

The Commonwealth adopted 10 Keystone Principles for Growth, Investment and Resource Conservation in May 2005, to guide investment and support local growth and economic development in the state. They are:

- Redevelop First
- Provide Efficient Infrastructure
- Concentrate Development
- Increase Job Opportunities
- Foster Sustainable Businesses
- Restore and Enhance the Environment
- Enhance Recreational and Heritage Resources
- Expand Housing Opportunities
- Plan Regionally; Implement Locally

1.4.6 Key Elements of Corridor Plan

Every corridor study should at a minimum include the following elements, as described in this report. These elements represent the baseline conditions that should be included, with the hope that some of the more sophisticated tools and techniques will also be used, depending on the goals of each study.

Transportation:

- Roadways
- Transit Facilities
- Pedestrian and Bicycle Facilities
- Transportation Capital Projects

Land Use:

- Existing Land Use
- Future Land Use
- Cultural and Historic Resources
- Natural Features (at a minimum, wetlands, steep slopes, and floodplains should be mapped)
- Density/Form/Community Types

Regulations and Studies:

- Comprehensive or Master Plan and Other Studies
- Long-Range Plan Characterization of Community Types
- Zoning and Subdivision and Land Development Ordinances
- Zoning for Smart Growth

Demographics:

- Existing and Forecasted Population and Employment
- Major Employers
- Environmental Justice

Economic Development:

- Review of Local Economic Development Incentives

(Source: Corridor Planning Guide, Towards a more meaningful integration of transportation and land use, September 2007, Delaware Valley Regional Planning Commission, 190 North Independence Mall West, 8th Floor, Philadelphia PA 19106-1520, www.dvrpc.org)

1.4.7 Best Corridor Planning Practices

Economic corridors are integrated networks of infrastructure within a geographical area designed to stimulate economic development [Hans-Peter Brunner (August 2013), "What is Economic Corridor Development and What Can It Achieve in Asia's Sub-regions?", ADB Working Paper Series on Regional Economic Integration, no 117, Asian Development Bank, Metro Manila, Philippines]. Economic corridors refer to transport networks that support and facilitate not only the movement of goods and services but also of people as well as the exchange of information. Economic corridors are not limited to hard infrastructure such as highway systems, rail lines or ports but also include soft infrastructure such as trade facilitation and trade capacity building

Economic corridors connect economic agents along a defined geography. They provide connection between economic nodes or hubs, usually centered on urban landscapes, in which large amount of economic resources and actors are concentrated. They link the supply and demand sides of markets. This term is often synonymously used for trade corridor. Although many authors use "economic corridor" and "development corridor" interchangeably, others describe development corridors as an ingredient necessary for achieving economic corridors. An economic corridor, as described by the ADB and AfDB, has the following characteristics (http://research.bworldonline.com/popular-economics/story.php?id=350&title=Economic- corridors-boost-markets,-living-conditions):

- Covers smaller and defined geographic space, straddling a central transport artery;
- Highlights bilateral rather than multilateral initiatives, mainly at border crossings between two countries; and
- Stresses physical planning of the corridor and its surrounding area for focused infrastructure development that will yield maximum benefits.

Corridor planning allows the communities to work collaboratively, using accurate, updated, corridor-wide data to improve local land use planning and transportation decision- making so as to support the long term success of the region as a whole (Androscoggin Valley Council of Governments, Maine's Best Practices for Development of Multi-Modal Corridor Management Plans, (December 2007; www.hcpcme.org /transportation/./ Corridor Planning Guide121207.pdf).

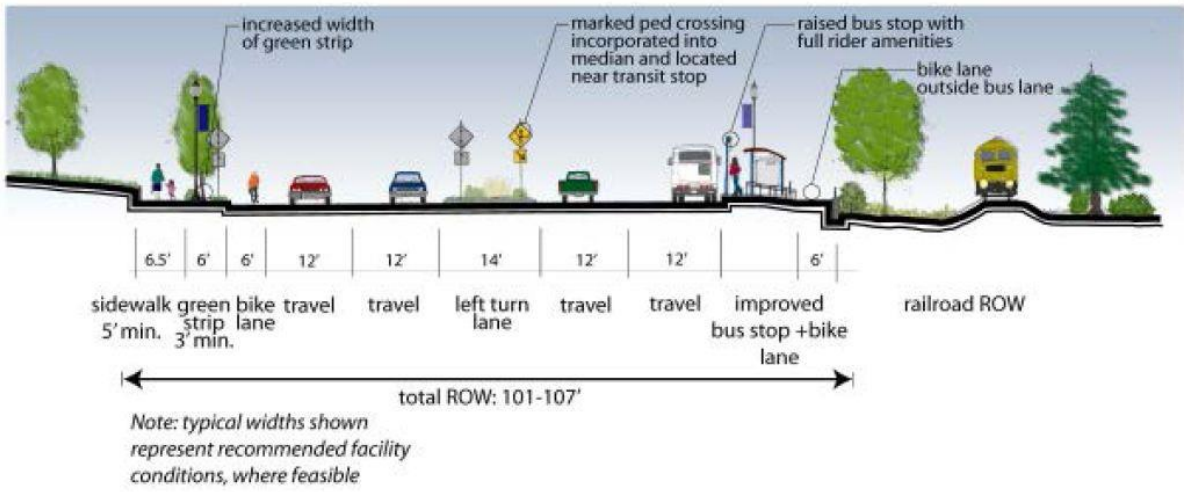


Figure 1.1: Cross Section of a Corridor with Recommended Facilities

The economic corridor approach looks at regional transport routes not only as a means of transporting goods and services, but also as a tool for stimulating social and economic development in the areas surrounding the route. Economic corridors accomplish this by creating industry and social facilities in conjunction with transport infrastructure. In doing so, they develop rural and border areas, increase the earnings of low-income groups, and create employment.

No universal definition of economic corridor can be found anywhere in the scholarly literatures. This term was first coined by ADB in 1998. Corridor can be defined from many perspectives to serve many purposes. Traditionally corridors are defined for transportation planning. The concept of using transport corridors as a means to develop the regions around the corridors is known as the economic corridor concept or the development corridor concept.

ADB argues that South Asia is one of the least economically integrated regions in the world, with comparatively high barriers to trade and investment. Political boundaries cease to be economic boundaries and spatial- economic regional planning takes the lead. In short, the economic corridor approach transforms transport corridors into engines of socioeconomic development. Generally characteristics of economic corridors can be summarized as (Gadzeni Mulenga, NEPAD, Regional Integration and Trade Department - No. 1. April, 2013, Developing Economic Corridors in Africa: Rationale for the Participation of the African Development Bank):

- A smaller, defined geographic space, usually the area straddling a central transport artery such as a road, a rail line, or a canal;
- Bilateral rather than multilateral initiatives focusing on strategic nodes, particularly border crossings between two countries, principally to promote a sense of ownership;
- An emphasis on physically planning the corridor and its surrounding area, to concentrate infrastructure development and maximize benefits; and
- Strong public-private partnerships, which promote sustainability.

Usually corridor development follows a sequence of stages for transformation (Gadzeni Mulenga, NEPAD, Regional Integration and Trade Department - No. 1. April, 2013, Developing Economic Corridors in Africa: Rationale for the Participation of the African Development Bank). These sequences provide essential insight for this plan. These stages are summarized below:

- First stage (Physical development): Priority of this phase is development of physical facilities needed for efficient and effective transportation and trade by establishing and revamping transport links; improving the quality of infrastructure, increasing carrying capacity, and dealing with related safety issues; upgrading infrastructure associated with priorities such as rural agriculture, agro-industry, and tourism; encouraging multimodal structures; and upgrading border areas.
- Second stage (Logistics development): At the second phase logistical support is provided to harmonize corridor policies, regulations and institutions, moving people and goods more efficiently and facilitating storage, warehousing, trucking, insurance and freight management,

and related services. It is also important to implement cross-border trade agreements; simplifying, standardizing and harmonizing immigration and quarantine procedures; promoting information and communication technologies; and establishing a logistics center.
- Third Stage (Economic and social development): This stage promotes investments in areas such as agro-industry and manufacturing, natural resource-based enterprises, small-scale industries, trade, schooling, and health facilities, all located near the corridor.
- Fourth Stage (Integration of crosscutting issues: This stage addresses environmental and institutional capacity concerns and other social issues.

A good corridor plan should have following characteristics:

- Comprehensive, based on a full understanding of the dynamics of transportation and all interacting influences within the corridor;
- Proactive, seeking to identify and address transportation-related problems before they arise, rather than after they have grown to the point of being intolerable;
- Visionary in nature, meaning that the recommended strategies for the corridor arise from a shared vision for the corridor established by local communities and state agencies with jurisdiction over the corridor; and
- Collaborative, meaning those transportation agencies, local governments, stakeholders and the national government.

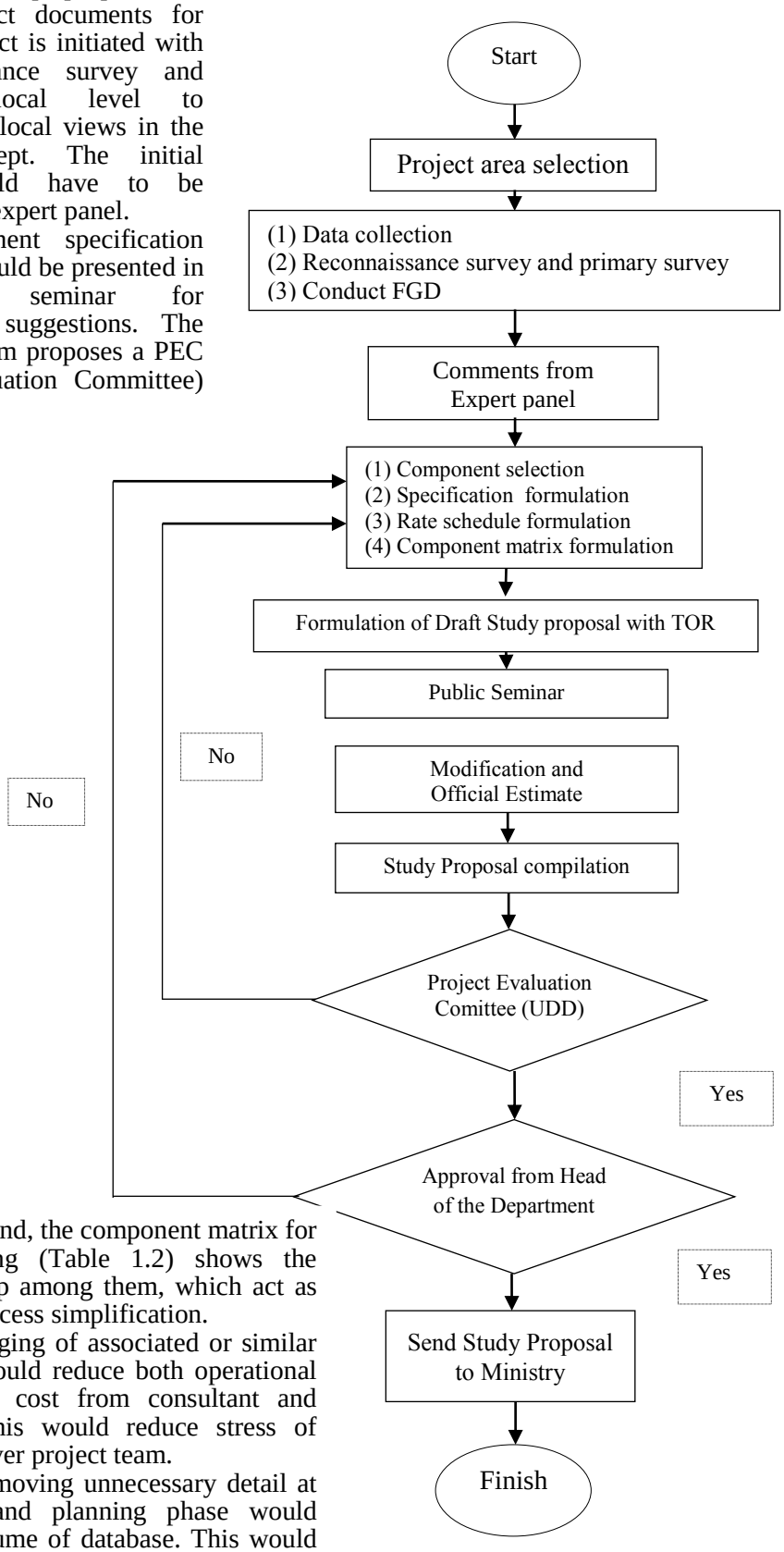
As stated earlier, most of the corridor plans concentrate primarily on the transport network. Then land use plan is reoriented to minimize conflict. For example, Cache Valley South Corridor Development Plan has been developed to (1) create a transportation system which produces an efficient flow of goods, services, and travelers while sustaining business and industry; (2) Provide opportunities for the full participation of all government entities within the corridor to manage future growth along the corridor; and (3) Direct new growth in a manner that is consistent with the principles of the Envision Cache Valley process and which identifies future land uses, roadways, and vehicular access points. The plan also laid down some challenges and proposals. Some of these issues are stated below:

- Limiting development to “clustered nodes” at existing and future intersections.
- Establishing 300’ and 500’ open space buffers along both sides of the highway, depending on the proximity to the clustered nodes.
- Prohibiting new residential uses within the open space buffers, helping eliminate the need for sound walls, berms and other obtrusive buffering techniques.
- Encouraging residential, commercial, mixed-use and industrial uses within the existing cities
- Prohibiting strip development along the highway.
- Encouraging better property maintenance and upkeep.
- Prohibiting commercial advertising signs along the highway.
- Adjusting of land earmarked for commercial uses to match realistic market projections.

1.5 Process Map for Project Document

The process map proposed to prepare Project documents for planning project is initiated with a reconnaissance survey and FGD at local level to accommodate local views in the project concept. The initial concept would have to be rectified with expert panel.
After component specification Draft TOR would be presented in a public seminar for stakeholders' suggestions. The Innovation team proposes a PEC (Project Evaluation Committee)

Figure 1.2: Proposed process map



On the other hand, the component matrix for spatial planning (Table 1.2) shows the interrelationship among them, which act as a model for process simplification.
Moreover, merging of associated or similar components would reduce both operational or supervision cost from consultant and client part. This would reduce stress of management over project team.
In addition, removing unnecessary detail at both survey and planning phase would reduce the volume of database. This would finally simplify the project implementation procedure.

1.6 Component Matrix and Rate Schedule for Spatial Planning

In spatial planning components are interrelated, one dependent and linked with another. In this situation there should be a clear demarcation about the overlapping, critical components, which would start earlier, which later, arranging order of components needed to be decided.

Table 1.2: Component Matrix for Spatial Plan

Input Component	**Cross-cutting Components**									**Out Put Component**
	Digital Elevation Model	Physical feature database	Demographic Profile	Socio-economic profile	Transport Projection	Geo-technical Profile	Hydrological Model	Ecological Hotspots	Public Participation	
Digital Elevation Model										Drainage alignment
Physical feature database										GIS database
Demographic Profile										Space requirement for settlement
Socio-economic profile										community facilities requirement
Transport Projection										Transport alignment
Geo-technical Profile										Soil suitability zonation
Hydro geological Model										GW availability
Hydrological Model										Flood Zonation
Ecological Hotspots										Conservation area
Public Participation										Draft Spatial Plan

Conventionally, planning projects were awarded to a single consulting firm or consortium that would arrange all the components, equipment, manpower and experts either by its own or by outsourcing. Even the most essential component like physical feature survey is outsourced while GIS database remains with the lead firm. Delay in initiation or mobilization makes project time double. Moreover, unnecessary detail in field data collection due to lack of negotiation between planning and survey professionals' results extension in work schedule. In addition to this, a extremely valuable item for land use planning "Digital Elevation Model" is almost ignored as well as flood modeling. As a result, formation structure plan zoning categories do not have a strong basic parameter.

In contrast, to get reed of this mega consulting firms (holding a composite single package) splitting the whole package in several independent component came in practice, which covered: (1) Image acquisition, processing and interpretation, (2) Ground verification and attribute collection for physical features, (3) Mouza map digitization and geo-referencing, (4) Socio-economic survey, (5) Transportation survey and modeling, (6) Geological investigation and modeling, (7) Ground water investigation and modeling, (8) Surface water modeling, (9) Ecological (flora and fauna) study, (10) PRA etc. In most cases, each component is awarded to single consulting firm, which seems to result a

very efficient operation of each component. In first stage it requires larger involvement from procurement managers. Also, all through implementation period monitoring inputs jumps higher. Moreover, some output are little usable sometimes not usable to other firms, which results low level output from the consulting firms.

Observing the above mentioned two extreme project management scenarios, it seems that the similar or interlinked components should be awarded in groups. The innovation team recommends combination of (1) Image, (2) Ground verification, (3) Mouza, (8) Surface water modeling, (9) Ecological (flora and fauna) study, (10) PRA etc with input from individual consultant of Hydrology, Ecology and Urban planners. An accurate interpretation of image is essential for accurate attribute collection, mouza map geo-referencing, DEM, surface water modeling, identification of conservation area (wetland and vegetation), existing land forms (input of social mapping for PRA). On the other hand, the outputs from these associate components needs to be compiled into one single platform ie, GIS database to make planning decisions.

Similarly, Transportation survey and modeling requires huge field data from households for trip generation study that can be merged socio-economic survey. In contrast, major part of data base can be supplemented from published database of BBS, which may reduce the volume of primary data collection. So, transport and social component may be combined. Moreover, combination of Geology and Ground water would reduce cost of operation from both client and consultants side.

Table 1.3: Standard Rate Schedule for Spatial Planning

Sl no.	Item	Unit	Cost (Tk.)
1	High resolution 3D satellite images with 0.50m resolution	sq.km	4284.00
2	Image Processing (Interpretation, Digitizing, Geo-referencing (AT, DEM, Database Preparation)	acres	62.50
3	Urban area survey	acres	1250.00
4	Rural settlement survey	acres	600.00
5	Rural drainage and agricultural land demarcation Survey	acres	40.00
6	Construction and installation of BM Pillars	Nos.	20000.00
7	Mauza Map procurement	Nos.	600.00
8	Mauza Map Digitization (Scanning, Digitizing, Editplot Checking, Geo-referencing, Database Preparation)	acres	12.00
9	Socio-economic and transportation household survey (Questionnaire)	Nos.	1200.00
10	Intersection survey	Nos.	1300.00
11	Water way port or Terminal survey	Nos.	1300.00
12	O-D survey	Nos.	800.00
13	Regional transportation model	Nos.	2500000.00
14	PRA	Nos	15000.00
15	Engineering Geological Survey (Boreholes)	Nos.	31,308.75
16	Grain Size Analysis	Nos.	3,061.30
18	Atterberg Limits Determination	Nos.	3,478.75
19	Specific Gravity Determination	Nos.	1391.5
20	Direct Shear Test	Nos.	4,870.25
21	Unconfined Compression strength Determination	Nos	4,174.50
22	Triaxial	Nos.	14,610.75
23	Consolidation Test	Nos.	17500
24	PS Logging	Nos.	250,470.00
25	Single microtremor	Nos.	25000.00
26	MASW	Nos.	55,660.00
27	Establishment of Monitoring Well	Nos	222,600.00
28	Lab Test (Water Quality Test)	Nos.	14000.00
29	Major Cataion, Anaion and trace element Analysis	Nos.	41750.00
30	Surface resistivity survey for aquifer identification, Schlumberger array, 300 meter depth of investigation,	Nos.	83500.00
31	Maintenance for Monitoring Well	Person /months	3500.00
32	Ecological study	Tk./sq,km	2000.00

Chapter II
Image Processing and Interpretation

2.1 Satellite Image Processing and Interpretation: Photogrammetric method uses satellite/aerial stereo images to create Digital Elevation Model and make geospatial database more effectively. With the advent of latest trends in the technologies and unique customer requirements, photogrammetry is now the leading technology for mapping. The field of photogrammetry is a rapid science with new technologies being developed constantly. Within a short period of time, the practice of photogrammetry has changed from analog to digital. The development of digital aerial cameras has advanced significantly over the past ten years. The use of digital aerial images would be more advantageous for all map and image production especially for Digital vector data and Orthophoto generation.

Since the internal precision of extracted DEMs is strictly related to the mean scale of photographs, image quality, pixel dimension and, obviously, morphology of the area, Image Collection is a crucial part of the project. Image will be collected from Satellite image provider. The Satellite image in 0.5-meter panchromatic and 2 meter multi spectral four-band images in stereo pairs will be procured. The 0.5-meter pan and 2 meter multi spectral imagery will also be used to yield 0.5-meter colour imagery (pan-sharpened). In case of Aerial/UAV resolution is 0.1 metre.

Image processing will be done after collecting raw digital images. The tasks involved in image processing are

- Epi-polar Correction
- Color Balance
- Contrast Adjustment
- Sharpening
- Pyramid
- Bit Rate Setting

GCP Collection: Ground control points will be selected by photo identification of existing ground features. Considerable number of GCP will be collected as required for the whole study area. All GCPs will be collected by conducting field survey using RTK GPS method. After collecting GPS data of the GCP, post processing will be done day to day in the sites. Accuracy level will be maintained within 10 cm.

Aerial Triangulation: Aerial Triangulation is a mathematical process used to determine the real world position, height from mean sea level and orientation of each photograph. Aerial Triangulation will provide the accurate stereo (3D) model of image. One of the most advanced aerial triangulation is Inpho Match-AT.

Input for AT	Output of AT
- IMU, RPC data - GPS (on board) - GCP (collected from field) - Image	Geo referenced Stereo Model

Digital Mapping from Stereo Model: After the orientation of stereo models, digital mapping will be carried out. We propose ArcGIS Geo-database/ shapefile model for storing geo-spatial data. The proposed Geodatabase and its Feature classes will be designed based on the followings:

- Projection Parameters of the Coordinate System
- Name and type of layer (feature classes)
- Structure of Attribute Tables of the Feature classes

Digital Photogrammetric Workstation e.g. Datem Summit Evolution (DPW) will be used as the platform for acquiring features from digital stereo images (model). Feature registration will be done considering and measuring the position of the object under its accuracy level. The Summit Evolution & Stereo Plotter of DAT/EM will be used for identifying and registration of the objects and ArcGIS would be used for vector data storing and editing.

Attribute Data Collection: Attribute data of the features will be collected from the field after producing base map. It will be a step by step procedure.

Map Updating: Attribute data collected from the field, will be incorporated into the features in this stage.

Field Check: Field checking will be done check the following:

- Dimension and shape of the features
- Accuracy of feature's attributes
- Missing objects.
- Data will be collected by total station where cloud will be found in the image or some object which is not able to identify in image.

DTM/DEM/TIN/Contour Generation:

- DTM Point: Digital photogrammetry is able to acquire 3D points for high spatial resolution DEM generation through semi-automatic procedures, overcoming the problems of process. In the approach, DTM Points will be generated from Stereo Pair images by the software, and editing of the software generated DTM points will be done by the Photogrammetry comparing them with stereo model. Creating and editing of Breaklines will be done after this stage.
- Contour: After creating DTM Points, Contour lines will be produced l. The contour lines will be delivered in 1 km x 1 km or 5 km x 5 km blocks or one single file for the project area.
- DEM: Using DTM Points DEM will be generated at a resolution of 10 meters in 1 km x 1 km or 5 km x 5 km blocks or one single file for the project area.
- TIN: Using DTM Points TIN will be generated and delivered in 1 km x 1 km or 5 km x 5 km blocks for the project area.
- OrthoPhoto: Orthophotographs to create Geographic Information System (GIS) database.

Ortho-rectification of Images: Image distortions caused by topography and image orientation would have to be geometrically corrected by the incorporation of a terrain model through Ortho rectification process. Ortho-rectification of every image will be carried out using digital photogrammetric system based on result of aerial triangulation and the generated DEM.

Mosaicing of OrthoPhoto: Individual rectified photograph will be assembled to form seamless mosaic. Mosaicing of OrthoPhoto includes the following tasks

a) Seam line Drawing: Drawing the boundary of the image delineating which part of the image will go which image.
b) Balancing of Color and Contrast within different images
c) Feathering

Submission of Report on Image Processing and Interpretation: Study Area Map (Digital copy in ARC/INFO format & Hard Copy) along with report stating the status of collected information, procedure of establishment of permanent Ground Control Point (GCP) and Temporary Ground Control Point (TGCP), demarcation of study area boundary including the technical specifications have to be submitted.

2.2 Satellite Image Specification:

AOI	Area of Interest
UDD	Urban Development Directorate
DEM	Digital Elevation Model
DTM	Digital Terrain Model
GPS	Global Positioning System
GCP	Ground Control Point
HR	High Resolution
RMS	Root Mean Square
VHR	Very High Resolution
WV	World View
GE	Geo Eye
DRA	Dynamic Range Adjustment
NIR	Near Infrared
RPC	Rational Polynomial Coefficient

Requirements:

1. Ortho-ready Standard Satellite Image in Digital Format
2. 4 Band Image (Red, Green, Blue & NIR)
3. Metadata and header files and RPC files
4. Manufacturer's Authorization Letter: The Supplier must submit original manufacturer's authorization letter as per tender clauses.
5. The provider/Satellite image company will ensure that they are supplying satellite imagery for a minimum of 05 (five) years in Bangladesh.
6. The provider/Satellite image company must be able to show proven record that the provider supplied 15000 sq km VHR satellite image imagery to at least in 1 (one) reputed Bangladeshi organization for mapping along with Telephone & Fax number, email and website address (if any) of the particular agencies.
7. Image for urban area (0.31 meter) and rural area (0.5 meter) must be provided from the same satellite image provider
8. 60% of the imagery must be in archive (not older that November 2018) and Rest 40% need to provide with 2 months after awarded the project

Coordinate System:
Any Geo-referenced data must be released to the client with the following characteristics:

- UTM projection with WGS1984 ellipsoid
- Specification of ortho-ready standard satellite images

Specification of Stereoscopic Satellite Image for Urban Area:

a. The imagery must have the following ground resolution at nadir *without enhancement by any kind of re-sampling operation are-*
   i. Panchromatic: 0.31 meter
   ii. Multispectral: 1.24 meter

b. Band combination for multispectral image-
   i. Blue
   ii. Green
   iii. Red
   iv. NIR

c. Cloud coverage in single image acquisition frame must not exceed 15%. Other area should be visible clearly.
d. Absolute accuracy of the image is within 3.5 meter CE90
e. There should be no uncovered areas between the scenes
f. Archive or New Acquisition
g. Image must be in Geo TIFF format
h. The image must be delivered in UTM projection with WGS1984 ellipsoid.
i. Pixel depth should be 8 bit/pixel
j. Metadata and header files: Each satellite scene must be accompanied with its related header file, which should meet following requirements.
   i. There must be no ambiguity between the name of the header and the name of the related satellite scene (in GeoTIFF format)
   ii. The header file must content identifier of the image
   iii. The header file must have acquisition date and time
   iv. There must be RPC file
k. DRA contrast adjustment should be done before delivery
l. There should not be any dead pixel
m. The image must have index shape file.

Specification of Stereoscopic Satellite Image for Rural Area:

n. The imagery must have the following ground resolution at nadir ***without enhancement by any kind of resampling operation are-***
   i. Panchromatic: 0.5 meter
   ii. Multispectral: 2.0 meter

o. Band combination for multispectral image-
   i. Blue
   ii. Green
   iii. Red
   iv. NIR

p. Cloud coverage in single image acquisition frame must not exceed 15%. Other area should be visible clearly.
q. Absolute accuracy of the image is within 3.5 meter CE90
r. There should be no uncovered areas between the scenes
s. Archive or New Acquisition
t. Image must be in GeoTIFF format
u. The image must be delivered in UTM projection with WGS1984 ellipsoid.
v. Pixel depth should be 8 bit/pixel
w. Metadata and header files: Each satellite scene must be accompanied with its related header file, which should meet following requirements.
   i. There must be no ambiguity between the name of the header and the name of the related satellite scene (in Geo TIFF format)
   ii. The header file must content identifier of the image
   iii. The header file must have acquisition date and time
   iv. There must be RPC file
x. DRA contrast adjustment should be done before delivery
y. There should not be any dead pixel
z. The image must have index shape file.

2.3 Topographic survey by using UAV (Drone)

i. The topographic survey must be in detailed level by using Drone to generate point cloud data of surveyed area. The geo-coordinate of each point of point cloud need to be referenced with respect to nearest SOB BM by using Real Time Kinematic Global Positioning system (RTK-GPS) with Horizontal and Vertical accuracy higher than 5cm in both planes. Image Resolution must be at least 5 cm Ground Sample Distance.
ii. Physical features in the study area must include, but not limited to, the following features:
    a. All existing buildings and other structures with proper shape, number of floors, usage, structure type, condition, construction year, holding number, owner name;
    b. Electric pole, tube well, and other utilities within the site;
    c. Road (Type, width, name etc.) and Water bodies (pond, canal, river etc.) located within the surveyed area;
    d. Land use of the surveyed area;
    e. Any other distinct features such as bridges, culvert, shako, monument etc.
iii. HFL (Highest Flood Level) need to be provided with reference to SOB Bench Mark (BM);
iv. Development of Digital Elevation Model (DEM) shall be done based on topographic survey field data and using GIS tools and techniques;
v. Survey data must be prepared in GIS shape file/ Geo- database using Bangladesh Universal Transverse Mercator (BUTM) projection system where X, Y, Z values of the all features need to be provided;

Specification of Survey and Data Preparation:

i. To perform aerial imagery collection, images must be captured in very high resolution considering at least 5cm Ground Sample Distance (GSD) and forward and side image overlap should be considered 80% &65% consequently.
ii. Aerial imagery must be captured in the sunny days, preferably in between 9AM to 4PM when the sun angle is higher than 30 Degree. Aerial imagery collection shall be maintained considering exact specification described in Flight planning stage.
iii. With reference to permanent BM established by SOB, sufficient GCPs should be established throughout the entire survey area.
iv. Aerial triangulation (AT) need to be performed based on the aerial imagery, flight data (GPS/INS) and GCP data.
v. A Digital Photogrammetric Workstation must be used as the platform for acquiring features from digital stereo model with required Z values.
vi. ArcGlS Geodatabase, shapefile must be used for storing geo-spatial data. For attribute Data Collection, preferably a mobile app needs to be used to collect attribute data (such as name, type, building floor height, no. of floor, uses of building & land, type and use of pole and other features etc.) of all the features extracted from UAV images.
vii. Spatial data shall be updated through processing attribute data collected from the field and GIS database shall be finalized.
viii. High spatial resolution (at least 1.0 meter) DEM/DTM must be generated for the entire survey area. DTM points shall be generated in 1m Grid interval.

Deliverables:

i. High resolution (5 cm) orthophoto
ii. Digital Elevation Model (DEM) at 1m grid interval
iii. Contour line at 0.5m interval
iv. Physical features map in geo-database
v. Land use map

Chapter III
GIS database for Physical Feature and Attribute

3.1 Methodology of GIS Database Preparation

The GIS firm would have to follow the following step-wise integrated activities for the stated scope of work on the intended GIS Database (Spatial and attribute) development. It would have to interlink the intended GIS Database with different steps of other related activities. A detailed methodology of the specific GIS Database preparation including procedure for relating its output with that of other attribute data and activities (both attribute and spatial data of physical feature, topographic, land use, transportation, hydrological, socio-economic and other required data), which would be imparted by other consultants and Geological study has to be mentioned in the proposed technical proposal.

Bench Mark Establishment, Satellite Image Processing and Ground Verification

Construction and Establishment of Bench Mark (BM)/ Ground Control Point (GCP): Pillars covering the project area (pillar 10"X10", Base 3'X 3', height 5'). RCC pillars are to be constructed marking unique identification number Coordinate X, Y of these pillars along with Z value is to be marked on base map for future reference.

Existing Land Use Database (both attribute and spatial) would indicate the use of each plot of land and each building. The GIS firm would visit each and every site to record existing usage with specified notation and colours as per direction of the PD. The output of this Survey will be one or more maps showing existing Gross Rural agricultural land use, Residential, Commercial, Administrative and Cultural zones, nature of rural area or rural urban fringe area (high, lower), water courses and water bodies, roads demarcating the main zones and plantation/vegetations as per direction of PD . Map scale should be RF 1: 3960 or as per direction of PD. Annotations or colour of map shall be recorded and presented in any colours as specified by Urban Development Directorate.

Physical Feature Database would have to be prepared for the whole of project (urban, rural and urban fringe) area. Location and dimension (X, Y, Z value) of all existing structures including building type, height, floor type and use of each floor, homestead boundary, all water control structures including khal (natural and man-made), embankments, dykes, box culvert, sluice gate etc., vegetation cover, culmination between flood Plain and homestead, ground water harvesting devise, river ghat/ganj, railway station and railway line, all type of roads, location of all existing exposed light/electric, telephone posts and national electric grid/towers, gas, water, sewerage line etc.

Social Infrastructure: Social Infrastructure database (Education, Religious, Sports, Recreation, Community and Socio-Cultural Services/Facilities etc.)

Road Network: All transport infrastructure including road, railway, waterway and airport facilities.

Administrative: Administrative areas with building types.

Housing: Land use with building type with level of residential services

Vegetation: Vegetation type for ecological study.

Hydrological Data: Identification of water bodies including pond, ditch, beels, haors etc. (both perennial and seasonal), direction of flow of the river, khal/canals, precipitation analysis, delineation of catchments area, encroachments and blockage in the river, khal/canals, identification of water control structures including operational condition and reason for non-operational condition (in case of non-operational water control structures).

Recreational Open Space database: Parks, playgrounds, river bank, historical space and other open spaces should be surveyed to find out its details like location, size and attached facilities. T

Health Facilities database: Dispensaries, health centres and Hospitals showing their location and capacity should be collected and presented with a report covering explanatory notes by showing a possible quality of existing and future health facilities including community health.

Educational Facilities database: Information on different categories of schools, colleges, university and other education related institutions with the location, sizes and capacity.

Agricultural Land database: The agricultural land demarcation database would be based on height of land, cropping pattern, cropping type, land utilization and flood level.

Archaeological site database: Location of archaeological site, detailed design and history of the archaeological feature should be collected from the site.

Pollution database: Study of noise and waste (solid/liquid including household and industry; night soil) pollution, ambient air quality during peak hour, quality assessment of drinking and surface water, quality assessment of top soils.

Inventory of Existing Flora and Fauna: Identify existing flora and fauna, Stating which species are rare and which species are endangered, Identify the habitats of the flora and fauna, Identify the characteristics of the flora and fauna Spatial Distribution of Habitat: Spatial Distribution of flora and fauna, Location map of flora and fauna, Location and Spatial Distribution of rare and endangered Species.

3.2 Field Check: Field checking will be done check the following:

- Dimension and shape of the features
- Accuracy of feature's attributes
- Missing objects.
- Data will be collected by total station where cloud will be found in the image or some object which is not able to identify in image.

Ground Verification with Cadastral data: For ground verification map obtained from image processing and interpretation with Geo referenced Cadastral map would have to be used.

Selection of Ground Control Point (GCP): About 30 nos. of GCP (Tic) should be selected in Geo-referenced image for each of mouza sheet for conducting GCP survey. The joint team of UDD and consulting firms will select the GCP. Geo-referenced (x, y, z) permanent Bench Mark (BM) pillars uniformly distributed covering the project area have to be established to carry out the total topographic, physical feature and land use survey. Design, drawing of BM pillars have to be approved by the Project Director (PD)

Edit Plot Checking of Digitized Mouza Maps and Geo-referencing with Image: After digitization of mouza maps edit plots will be produced containing all the features in different colours. The digitized coverage of mouza maps will be verified with the scanned image of mouza maps. This checking will be done with the joint team of UDD and the respective GIS firm. By this onscreen edit plot check all possible errors (missing arcs, dislocated arcs, wrong or missing polygon labels, tic location and ID etc) will be solved and final digitized mouza maps will be prepared. After finalization of digitization of mouza maps.

Drainage pattern of rural area (from image) would cover:

- Ground verification would cover the following features:
- Location and alignment of all roads, flood embankments and other Water control structures.
- Closed boundary/outline of homestead, bazars, water bodies, swamps, forest etc.
- Spot heights or land levels at roughly 10 m intervals for rural areas.
- Location and alignment of Primary drainage: rivers, lake, canal, drainage channels and irrigation channels/canals showing depth and direction of flow.
- Generating contours at 0.5 meter intervals with denser intervals for undulations.

Drainage pattern of urban area would cover:

- Topographic survey by using Total Station or level machine to supplement 3-D data (X, Y, Z value) location and alignment of all roads, flood embankments and other Water control structures.
- Spot heights or land levels at roughly 5 m intervals for urban area.
- Generating contours at 5 cm intervals with denser intervals for undulations.
  Location and alignment of Secondary and Tertiary drainage channels showing depth and direction of flow.

Occupancy Type and Land Use Database Updating: Land use information have to be extracted from physical feature survey as per specification of TOR After completion of data processing and draft mapping, land use survey have to be updated through field verification.

3.3 **GIS Database:** In this stage attribute data would have to be related with all attribute data and other related data.

Other Related Database: Other related surveys and studies (traffic survey, hydrological studies, bathymetric report studies, Formal and Informal Industrial Sector Database, Recreational Open Space database, Health Facilities database, Educational Facilities database, Agricultural Land database, Archaeological site database and Pollution database etc.) shall also be conducted.

Interactive Digital Model on Bio-Diversity and Human Intervention (along with GIS Shape file and thematic maps): Description of baseline and trends of existing flora and fauna, if the project were not to go ahead; Explanation of the criteria used to evaluate existing flora and fauna; and assess the significance of impacts of the project. Statement of methodology used, Presentation of analytical techniques used and the analysis itself; and interpretation from the analysis.

An interactive digital model of existing habitat, decline of habitat and possible areas of conservation, Identification of likely impacts on existing flora and fauna; and an explanation of their significance and the level of certainty with which this can be stated, A digital map of the existing flora and fauna, Description of legal and policy consequences, Thematic map for providing planning guidelines.

PRA data: The Survey firm would prepare spatial data with the output from PRA sessions. Relating all collected spatial and attribute data with other spatial database.
Submission of Report: GIS Database

3.4 **Planning Proposal Database**
Incorporate hazard planning data: In this stage the team would incorporate water resources management, geological hazard, transportation, social and planning data with the GIS database;
Analysis and planning: GIS firm would provide necessary service for required analysis and planning. In addition, this they would provide service to add planning proposals to GIS database.
Plan Book preparation: After completion of GIS database with planning proposals the firm would prepare Plan Book with digital database.
Submission of Report: Planning database

3.5 **GIS Database Compilation:** The report will contain evaluation of both quantity (as per ToR) and quality/ accuracy of spatial and attribute data. In addition if part of the survey is partially incomplete or inaccurate during the earlier stages the report will ensure completeness and accuracy of the database (as consultation with the PD during the work)
Submission of Report: GIS Database Compilation

3.6 **Detail planning maps:** After completion of GIS database with planning proposals the firm would prepare digital database and PDF for map printing in 1: 3960 scale or as per direction of PD. In this stage Web GIS will have to be developed.
Submission of Report: Detail Planning maps

3.7 Qualification, Experience and Responsibility of Project Team of GIS firm

A. Photogrammetric Expert–(6 mm.)
Qualification: M.Sc in Geography, Geo-informatics, GIS, Urban/Regional Planning, Information Technology or a relevant combination of education.
Experience: At least 10 years professional experience in relevant field. Advance knowledge in 3D Mapping using GIS, remote sensing and experience in planning and implementation of Stereo mapping logistics as well as advance knowledge in the use of, ArcGIS 9 or later version.
Responsibility: (i) To prepare topographic, physical feature, land use and other related map of the area, (ii) To prepare, supervise, manage and monitor digital database (Spatial and attribute) of the project. (iii) Installation and troubleshooting of GIS; (iv) Ensure the quality of the map and related work. (v) Preparation of working paper, reports and plan of the project.

B. Survey Expert (6 mm)
Qualification: B.Sc Engineering in Civil/URP/Geography/Surveying.
Experience: Minimum 10 years practical experience in Digital Geo-referenced physical feature and topographic survey and 3-D surveying.
Responsibility: (i) To design different surveys for the project (ii) To conduct, coordinate and monitor physical feature, topographical and land use, survey; (ii) Ensure quality and accuracy of survey data; (iii) To compile all the survey data into digital format; (iv) Experienced in RTK GPS/Total Station/Digital Level survey and processing; (v) To arrange survey trainings for Project staff. (iv) Preparation of working paper, reports and plan of the project.

C. GIS/RS Expert (12 mm)
Qualification: Bachelor in Geography, Geo-informatics, GIS, URP and related fields.
Experience: At least 10 years professional experience in relevant field. Advance knowledge in Mapping using GIS, remote sensing, relational database management and Geo-database modelling and experience in planning and implementation of field mapping logistics as well as advance knowledge in the use of, ArcGIS, RTK GPS for gathering field data is essential. Advance knowledge in 3D Mapping using GIS, remote sensing and experience in planning and implementation of Stereo mapping logistics.
Responsibility: (i) To prepare topographic, physical feature, land use and other related map of the area, (ii) To prepare, supervise, manage and monitor digital database (Spatial and attribute) of the project. (iii) Installation and troubleshooting of GIS in UDD project office and head office; (iv) Ensure the quality of the map and related work; (v) To work with a multi-disciplinary team environment to synchronize the multi-sectoral data into GIS database; (vi) To incorporate water resources management, geological hazard, transportation, social and planning data with the GIS database; *(vii) Preparation of working paper, reports and plan of the project as assigned by the PD;* (viii) to prepare plan maps.

D. Ecologist– (6 mm.)
Qualification: Master's Degree in Environmental Science, Ecology, Forestry and Wood Technology, Marine Biology, Zoology, Botany or Related discipline
Experience: At least 10 (Ten) years' experience in the study and management of flora and fauna.
Responsibility: (i) To make an inventory of all types existing flora and fauna in the project area including endanger species; (ii) to identify the potentiality of the natural resources (flora and fauna); (iii) To identify environmental hazards that might de imparted on the flora and fauna due to proposed development; (iv) To prepare a map of habitat for existing flora and fauna of the project area indicating communities of various species of plants including the areas; (v) To earmark the areas, which would not be disturbed by any kind of development; (vi) To make recommendations to protect the forest resources from environmental hazards and also to preserve the endangered species from depletion to attain sustainable development; (vii) To develop an interactive digital model for the whole ecological system with special reference to flora and fauna.

4. Report Submission Schedule and Mode of Payment

Sl no.	**Report**	**Language**	**Copy**	**Period of Submission**	**% of Contract amount**
1	Inception Report	English	10	End of 1st month	10%
2	Image procurement	English	10	End of 2nd month	10%
3	Satellite Image Processing and Interpretation	English	10	End of 4th month	10%
4	Mouza map digitization	English	10	End of 6th month	10%
5	Ground Verification with Cadastral data	English	10	End of 8th month	10%
6	Interactive Digital Model on Bio-Diversity and Human Intervention	English	10	End of 10th month	10%
7	GIS Database	English	10	End of 12th month	10%
8	Planning Proposal database	English	10	End of 14th month	10%
9	GIS Database Compilation	English	10	After Plan	10%
10	Detail Planning maps	English	10	After Plan	10%

5. Database Format

5.1 Physical Infrastructure Database Format

Sl. No	Physical Feature Name	Data Type			Z Value (Z measurement level)			Description
		Point	Line	Polygon	On Top	On Ground/ level	Not Required	
1A. Water bodies								
1	1. River Edge			x		x		
2	2. Khal Edge			x		x		
3	3. Drainage Channels			x		x		Name, width
4	4. River/khal centreline		x			x		Name, width
5	5. Flow direction	x					x	
6	6. Ponds/Tanks/Dishes			x		x		
7	7. Coastline		x			x		
B. Building/Structure		Pucca / Semi pucca / stories, Building area>15 sqm (Depending on map Scale)						
8	1. House			x	x			Residential Building
9	2. Industry			x	x			Industrial Building
10	3. Commercial			x	x			Commercial Building
11	4. Mixed			x	x			Mixed Use
12	5. Boundary Wall		x		x			Wall use as boundary
C. Roads								
13	1. Road Pucca		x	x		x		Asphalt Road
14	2. Road HBB		x	x		x		HBB Road
15	3. Road Katcha		x	x		x		Katcha Road
16	4. Path Pucca		x	x		x		Pucca Path
17	5. Path Katcha		x	x		x		Katcha Path
18	6. Traffic Island/ Divider		x	x		x		
19	8. Road/Path Centreline		x			x		Name, width
D. Railways								
20	1. Railway Row Line		x			x		
21	2. Railway centreline		x			x		
22	3. Railway Junction Points	x				x		
E. Other Structure and Flood works				Length, width, condition of abutments and wing-walls				
23	1. Bridge / Culverts			x	x			Type, area, Name
24	2. Embankments			x	x			Name, length
25	3. Pump Station for Flood			x		x		Name
26	4. Sluice Gates		x		x			Name
27	5. Bus/Trucks Terminals			x		x		Indicate right way and areas
28	Harbor/ Bathing/boat Jetty		x		x			Harbor, Boat jetty
F. Natural Features								
29	1. Forest			x	x			Area > 2500 Sqm
30	2. Group of trees			x	x			Area < 2500 Sqm
31	3. Group of Trees Point	x			x			
32	4. Wetlands / Bog/ Marshland/ Flood prone area			x		x		Area > 2500 Sqm
33	5. Sand/Sand Dunes			x		x		Area > 2500 Sqm
34	Significant Single Tree	x				x		Easily identified single tree
E. Utility Services								
35	1. High voltage Electric Line		x		x			National/regional grid
36	2. Telephone Line		x		x			
37	3. Gas Line		x			x		

38	4. Utility Substation	**x**				**x**		Electric, Telephone exchange, Gas
39	5. Overhead Water Tank			**x**	**x**			Name, Capacity
40	4. Waste disposal and treatment points	**x**				**x**		A dustbin of municipality and other informal points
41	3. Water work			**x**		**x**		
42	5. Deep Tube well Stations	**x**				**x**		R.C.C EPHE and other deep tube well stations and output
F. Area Polygon								
43	Residential Area			**x**		**x**		Planned, Unplanned, Density (High, Middle, Low)
44	Commercial Area			**x**		**x**		Established markets with ancillary shop, groups of shops including small workshops
45	Institutional, Educational, Health Govt office			**x**		**x**		School/college/madrasa, clinics, hospital, govt office
46	Industrial (as classified by acts and rules)			**x**		**x**		Main activity, type of waste effluent
47	Agricultural Area			**x**		**x**		All types of agricultural uses
48	Recreation / sports			**x**		**x**		Parks/play/sports ground, indoor facilities, zoological garden. Stadium area
49	Religious / cemetery			**x**		**x**		Mosques, Temples, Church, Mazar and others
49	Graveyard. Cemetery			**x**		**x**		Sites
51	Historic Place			**x**		**x**		Sites
52	Borrow Pits			**x**		**x**		Areas cut for filling material
53	Vacant Land			**x**		**x**		Vacant land with no apparent use
54	Public gathering			**x**		**x**		Place of public meeting, open-air cultural performance and religious gathering
55	Garden			**x**		**x**		Indication Rea, pineapple etc
56	Disaster prone areas			**x**		**x**		Flood, (indicating the flood affected area in 1998) Earthquake and fault line

5.2 Spot Level Data Format

Sl. No		Survey Item	Illustrated			
		Special DEM Object	Map object which may be used if registered with a view to DEM use			
			As break line	As terrain points	For delimitation of unsurveyed	For Mask Areas
		Spot height	Road Pucca		Coastline	Building
		Special elevation point	Road Katcha		Pond	Pond
		Contour line	Path Pucca			Wetland/bog/marsh land
		Break line	Path Katcha			
		Mask Area	River Edge			
		Unsurveyed Area	Khal Edge			
		DEM Boundary	Pond			
			Drain channel			

Note: Name of settlements, village, roads, khals, markets, etc. must be clearly indicated in the physical features maps.

5.3 Occupancy Type and Use Class

Occupancy Type		Code	Nature of Use or Occupancy
A:	Residential	A1	Detached single family dwelling
		A2	Flats or apartments
		A3	Mess, boarding house dorms, hostels
		A4	Minimum standard housing
		A5	Hostels & lodging hours
B:	Educational	B1	Educational facilities
		B2	Pre-school facilities
C:	Institutional	C1	Child care Institutional
		C2	Custodial institutions for physically handicapped
		C3	Custodial institutions for physically capable
		C4	Penal mental institutions
D:	Health care	D1	Normal medical facilities
		D2	Emergency medical facilities
E:	Assembly	E1	Large assembly with fixed seat
		E2	Small assembly with fixed seat
		E3	Large assembly without fixed seat
		E4	Small assembly without fixed seat
		E5	Sports facilities
F:	Business Mercantile	F1	Offices
		F2	Small shops & markets
		F3	Large shops & markets
		F4	Garages & petrol stations
		F5	Essential services
		F6	Footloose business/ mechanism
G:	Industrial	G1	Low hazard industries
		G2	Moderate hazard industries
H:	Storage	H1	Less fire risk storage
		H2	Moderate fire risk storage
J:	Hazardous	J1	Explosion hazard buildings
		J2	Chemical hazard buildings
K:	Misc.	K1	Private garages & special structures
		K2	Fences, tanks & towers
L:	Open Space	L1	Cropping including forestry
		L2	Fishing
		L3	Livestock
		L4	Recreational
		L5	Reserved
M:	Mixed use	M1	As applicable

5.4 Checklist for logistics of the GIS firm for the proposed Activity

	Item	Description	Tools
1	BM Installation	XYZ (reference to sob BM) with network adjustment processing Report	RTK GPS
2	Mouza Collection& Scanning	Original Mouza sheet collection and Scanning with 300 dpi in Dram scanner	Dram scanner
3	Mouza Geo-reference	At least 4 GCP need to collect per sheet and GCP should be taken in known place like Mouza BM/Pillar/Traverse Station/old Building/or any other permanent structure exists in Mouza Map	RTK GPS
4	Mouza database	Mouza sheet must be scan in 300 DPL in dram scanner and digitize should be at fixed scale and that would be at 1:500 scale	GIS Software with License
5	Satellite Image Processing	Image ortho rectification	GIS Software with License
		Image Geo-reference with adequate GCP	RTK GPS
		Areal Triangulation	GIS Software with License
6	Topographic Map	Spot level (10m interval) with break line	Photogrammetric stereo Image processing, RTK GPS and total station
		DEM/TIN	GIS Software with License
		Contour 0.3m	
		Cross Section& Long Section of Road, Lake, River and other linear feature (30 meter)	
7	Physical feature Map	Building Structure	Photogrammetric stereo Image processing, RTK GPS and total station
		Transport& Communication Network	
		Water bodies	
		Alignment of Linear Feature	
8	Land use Map	From the physical feature survey Existing Land use Map will be prepared,	GIS Software with License
9	Socio economic survey		
10	Transport survey		

Note: Copies of valid license of the equipment and software has to be attached with the technical proposal.

5.5 Land Use and Land Cover Classification System for Small town

Level 1	Level 2	Level 3
1.Urban	11.Residential	111. Residential one (detached single) 112. Residential two (low rise) 113. Residential three (up to six storey) 114. Residential four (high rise 6+) 115. Residential five (Special residential)
	12.Commercial and service	121. General retail (CBD. Shopping Centre, sales and service) 122. Professional services and office 123. Mixed use (residential, commercial, and/or industrial)
	13.Industrial	131. Light industry/warehousing 132. Heavy industry 133. Industrial/research park
	14. Transportation, Communication and Utilities	141. Transportation (road, rail, air) 142. Communications/utilities (Water, Sewer and power plants, solid waste disposal, easements)
	15. Public or institutional	151. Parks, recreation, and public open space (ball fields, golf courses, etc.)
2.Agriculture	21. Cropland and pasture 22. Orchards, groves, vine yards and nurseries 23. Confined feeding operation (beef, hog, dairy, poultry) 24. Other agricultural land (barns, stables, research)	
3. Forest	31. Deciduous forest (70 percent lose leaves) 32. Evergreen forest (70 percent remain green) 33. Mixed forest (combination of deciduous and evergreen)	
4. Water	41. Streams, rivers and canals 42. Lakes 43. Water Supply reservoirs	
5. Wetland	51. Forested Wetland 52. No forested Wetland	
6. Barren land	61. Strip mines, quarries and gravel pits 62. Transitional areas (e.g. cleared for agriculture or development)	

Chapter IV
Transport and Social Profile

4. Scope of Work

4.1 Scope of Work for Transport Planning: The Consulting firm shall conduct all necessary traffic and transport surveys and studies for the project, and prepare working paper on the relevant fields under study, and also assist the UDD team members in preparation of final plan and all relevant reports till completion of the project. The Consulting firm would extend all necessary assistance particularly in gathering and procuring all relevant traffic and transportation related attribute and spatial data of relevant feature within the project area; GIS database operation and management, analysis and preparation of all maps and reports till completion of the project.

The Consulting firm shall collect all relevant data and information through digital survey and upload the collected data to website instantly through online communication device; at the end of each month submit a report containing all information have been uploaded to website and ensure that all data and information are accessible to viewer.

The Consulting firm shall be responsible for quality of data and information collected, data processing, cleaning and editing, and presentation into tabular form including preparation of working paper as required by PD. The Consulting firm shall deliver all raw and processed data along with working papers containing guidelines for preparing the planning package.

The scopes of the work comprise the following:

- Collection of Data and Information of Vehicle Registration from Bangladesh Road Transport Authority (BRTA) for statistical analysis of the past trends in growth on the basis of types and numbers of different vehicles registered in the project area.
- Study of the existing road network and collect detail information like type and condition of pavement, existing width and possibility for future extension in details with appropriate explanatory notes. In this survey road hierarchy, network and traffic circulation pattern will be studied.
- Traffic volume and O-D surveys in major roads intersections and river ghats *(if there is any significant one exists)*, both day and night time for peak and off-peak period should be surveyed by dividing the project area into zones based on administrative boundaries and presented with sufficient maps and charts showing origin and destination and volume of traffic.
- Critical traffic Junctions should be separately studied and conditions illustrated graphically.
- Trip generation or Household Interview survey at different locations should be conducted in the project area to determine the travel behavior (travel pattern) of people by dividing the project area into traffic zones based on administrative boundaries. The number of questionnaire to be surveyed should be determined in consultation with project team.
- Travel Time Survey should be carried out in order to find out the speed and existing condition of the roads. Also this survey is necessary to find out the Generalized Cost of trips.
- Public Transport (Bus and Other Local Transports) Survey should be conducted in the study area to assess the present public transport scenario.
- A survey should be conducted to determine the goods movement and their mode of shipment of the project area.

4.2 Typology for Different Types of Surveys, Studies and Activities

The Consulting firm shall have to follow the following step-wise integrated activities for the stated scope of work on the intended different survey works. He/she would have to interlink the intended survey activity with different steps of other related activities conducted by other different Consulting firms'. A detailed methodology of the specific survey work including procedure for relating its output with that of other different surveys and activities (both attribute and spatial of hydrological, coastal, socio-economic and other required hard and soft data), which would impart by other different Consulting firms' has to be mentioned clearly in the proposed technical proposal. The Consulting firm

has to combine the traffic and transportation database with that of database (GIS database) of physical feature, topographic and land use database prepared by other Consulting firm(s). The Consulting firm has to perform the following tasks relating to traffic and transportation surveys and studies:

A. Social Survey

Formal and Informal Industrial Sector Database: Preparation of database for studying formal and informal industries, editing, piloting, finalization and printing of questionnaire by the GIS firm. The attribute data of surveyed commercial and industrial enterprises shall be linked with spatial data collected from physical feature and land use survey. He/She would also ensure the quality of database (data editing, data cleaning) and would perform data analysis, tabulation, present it in graphs and figures, and preparation of report. The database shall contain the following:

(a) Details of location, size and capacity of the existing

(b) Details of labour statistics with the housing conditions and their quality of life

The firm shall prepare report on the basis of output of the surveyed data showing industrial prosperity and recommendation for Project area. All the collected attribute and spatial transportation data shall be linked with other spatial database by the GIS firm.

PRA data: The Survey firm would prepare spatial data with the output from PRA sessions.

Relating all collected spatial and attribute data with other spatial database.

B. Transport Surveys and Studies

(a) Collection of Data and Information of Vehicle Registration from Bangladesh Road Transport Authority (BRTA): Collection of data and information relating to registration of vehicle from BRTA and performing statistical analysis of the past trends in growth on the basis of types and numbers of different vehicles registered in the project area.

(b) Road Surveys: In this survey detail of existing roads like type and condition of pavement, existing width and possibility for future extension should be studied and presented with appropriate explanatory notes. Road survey would include hierarchy, network and circulation pattern.

(c)Traffic Volume and Origin and Destination (O-D) Survey: Traffic volume and O-D surveys in major roads intersections and river *ghats (if there any of these exist)*, both day and night time for peak and off-peak period should be surveyed by dividing the project area into zones based on homogeneity of land use and presented with sufficient maps and charts showing origin and destination and volume of traffic.

(d) Study of Critical Traffic Junction Survey: Critical traffic Junctions should be separately studied and conditions illustrated graphically.

(e) Trip Generation Survey/ Household Interview Survey: Trip generation or Household Interview Survey at different locations should be conducted in the project area to determine the travel behavior (travel pattern) of the people by dividing the project area into traffic zones based on administrative boundaries. The number of questionnaire to be surveyed should be determined in consultation with PD.

(f) Travel Time Survey: Survey will be conducted in major selected routes for understanding present road condition and travel time.

(g) Public Transport Survey: Consulting firm shall conduct survey for all public transport modes.

(h) Goods Movement and Their Mode of Shipment Study: The Consulting firm shall also conduct goods movement and their mode of shipment study of the project area.

C. Data Analysis and Interpretation

Social Survey: Attribute Data: Socio-Economic, Urban-Rural Economy and Social Infrastructure: House-hold Sample (with appropriate sample size) survey will be done using the approved Questionnaire based on specified Questionnaire format indicated in TOR. Case Studies will be conducted highlighting the issues like tourism development, housing for disadvantaged group, informal economic activity, traffic congestion, drainage, water logging, unauthorized encroachment, waste disposal, playground and park, stakeholders participation for planning and development control.

Inventory of survey will have to be prepared as per format. Data processing, analysis of survey data and mapping.
Transport Study: (a) Determination of Peak and Off-Peak Traffic Volume and Analyze Capacity of Roads: On the basis of the survey results the Consulting firm shall determine the peak hour and off-peak hour traffic volume; and also analyze the capacity of roads and also prepare information for a traffic impact study of land use proposals on the street corner.
(b) Land Value and Land Use Forecast: The Consulting firm shall forecast the land value and land use as impacted by changes in transportation accessibility and policies; and develop integrated land use and transportation model.
(c) Determine the Level of Goods Movement and Their Mode of Shipment: The Consulting firm shall determine the levels of goods movement and their mode of shipment to forecast regional and long-distance commodity flow and truck demand to develop alternative pricing strategies and freight specific facilities.
(d) Simulate Transportation Operations: The Consulting firm shall simulate transportation operations in details at the project area including multimodal operations of automobile, motorcycle, bicycle and pedestrians etc. to increase safety and improve overall operations. The Consulting firm shall also evaluate the effects of changes in roadway geometry, operating characteristics, land use and travel demand.
(e) Simulate Traffic Flow to Analyze and Solve Traffic Bottleneck: The Consulting firm shall simulate vehicular traffic flow to analyze and solve traffic bottlenecks that might occur under ordinary or even extreme conditions, such as special events and evacuations from natural or man-made disasters. The Consulting firm shall also compare policies for alleviating peak-period congestion and examine the effectiveness of emergency evacuation plan.
(f) The Consulting firm shall develop a 20-year Prediction Model for transportation of the project area by using ARC GIS compatible Transportation Analysis Software (e.g., CUBE 6 or equivalent) and prepare report on the basis of output of the surveyed data showing a prediction model of 20-year period for Project area.
(g) The Consulting firm shall take photograph and geo-coordinate of the survey locations and upload them in the Web site instantly through online communication device; and also upload the surveyed data to website and computer at the same day.

4.3 Activities to Accomplish the Task

(1) Inception: (a) Mobilization: mobilization, reconnaissance survey, project design

Deployment of Key Personnel and supporting staff for the intended project, tentative project management plan and tentative work schedule. The Consulting firm shall conduct reconnaissance survey including Focus Group Discussion, Tea Stall Meeting etc.; steps taken immediate after signing the contract including initial meeting with the local public representatives including Mayor of the municipalities, UP chairman, counselor etc.

(b) Inception: Collections of maps, basic statistics and information

To start the survey process the existing situation of the planning area has to be represented in a set of maps and in a collection of basic statistics and information.

Collection of Physical infrastructure maps and reports Includes

- Maps and reports on Upazila.
- Maps and reports on national and regional highways.
- Maps on feeder and rural roads etc.
- Existing road network of the planning area

Collection of Basic statistics: present activities

- Number of inhabitants/households, differentiated according to income level/type/density and quality of housing
- Production and employment (formal/informal, number and size of establishments, type of production/activity, income/education level)
- Public services (education, health, security etc.) and utilities (drinking water,

sewerage/sanitation, garbage disposal, gas, electricity, telecommunication); administrative institutions
- Commercial activities (shops, markets both formal and informal)
- Transportation facilities (roads, public transportation, parking facilities, waterways, railway, foot path etc.)

(2) Transport survey report: All traffic and transportation related survey data including vehicle registration, traffic volume, O-D survey, critical traffic junction, trip generation, travel behavior, goods movement and mode of shipment etc.

- A questionnaire shall be designed in online communication device (tablet) compatible format (apps), where necessary, in consultation with PD.
- Questionnaire shall be designed on vehicle registration, traffic volume, O-D survey, critical traffic junction, trip generation, travel behavior, goods movement and mode of shipment in consultation with PD.
- Surveys will be conducted on major road intersections, and household level on the issues stated in the ToR in consultation with PD.
- During conducting the survey, geo-coordinate and photograph of the road intersection and household including photograph of the respondent has to taken and would be uploaded to website instantly by using online communication device (tablet).
- The Consulting firm shall check the quality of data and upload the data to computer at the end of same day.
- The Consulting firm shall identify the location of survey and the household as well on physical feature map and link the surveyed location and household with that of spatial database in Arc GIS.
- The Consulting firm shall link the attribute data of traffic and transportation survey with that of spatial data base in Arc GIS.
- The Consulting firm shall provide spatial translation of the interpretation obtained from data analysis to draw a scenario of output of traffic and transportation survey on space.
- Inventory of survey will have to be prepared as per format prepared in consultation with PD. Data processing, analysis of survey data, mapping, working paper containing planning strategy and development options, and reporting will be made as per requirement of TOR.
- All the collected data and information (both spatial and attribute) shall be interlinked with that of different other surveys (including physical feature, topographic, land use etc.) conducted by different other Consulting firms.
- After completion of all survey work and linking all attribute and spatial database with each other the Consulting firm will submit survey report stating actual methodology explaining detailed procure adopted in the field survey, problems faced during survey work, how the problems were solved, interlinking of database with that of different other surveys (including physical feature, land use, topography etc.). The report shall also contain detailed information relating to data uploaded to website. The Consulting firm shall submit all raw database including map, questionnaire, photograph etc and spatially linked database along with survey report.

(3) Interim report: Data processing, analysis, interpretation, presentation, formulation of working paper

- A review of the work plans and time schedule for the remaining period of the contract.
- Interim report containing requisite working paper (if more than above stated required) shall be prepared by the Consulting firms as directed by the PD.
- The working paper (content of working papers shall be determined in consultation with the PD) shall contain analysis of existing situation on traffic and transportation of the planning area.
- SWOT analysis, and Identification of problem area and requirement on space; and analyzing them with respect to surveyed data and information.
- Assist the Project team members in formulation of planning standard with respect to traffic and transportation of the planning area; and also by integrating results of different other surveys

(including physical feature, land use, topography, geology etc.) in close co-ordination with different other Consulting firms, who conducted such surveys and studies.

- Assist the Project Team members in formulation of policies for planning package and development of alternate strategies to attain the traffic and transportation related policies in close co-ordination with different other Consulting firms, who conducted different surveys and studies including physical feature, land use, topography, geology etc.
- Assist the Project Team members in analysis of alternative strategies and selection of most appropriate option among the developed alternatives in close co-ordination with different other Consulting firms.

(4) Final report: Policies, Strategies, Development Control Plan for National and Regional Highway Corridor and Action Plan:

- Formulation of Policies for planning package and development of alternate strategies to attain the policies;
- Analysis of Alternative Strategies and selection of most appropriate option among the developed alternatives from the output of SWOT analyses for preparing the planning package.
- Preparation of Transport Plan.
- The Development Control Plan for National and Regional Highway Corridor. Corridor Development Plan would cover the areas outside the urban areas along with the national and regional highway of the Region to prohibit ribbon development. The planning period for the component is 10 years.
- Action Plan shall be prepared for the proposed bankable projects for the Transport sector.

3. Qualification, Experience and Responsibility

A. Team Leader/ Transportation Engineer– 1 Person (4 mm.)
Qualification: B.Sc Engineering in Surveying/Civil/Traffic Engineering/Transport Planning/ Equivalent
Experience: Minimum 15 (Ten) years practical experience in transportation surveys and studies and transportation projects in the country.
Responsibility: (i) To design transport surveys for the project (ii) To conduct, coordinate and monitor traffic and transportation related surveys and studies;(ii) Ensure quality and accuracy of survey data; (iii) To compile all the survey data into digital form;(iv) To conduct database management and operation. (v) To assist the GIS Expert in transferring survey data into GIS, (v) To arrange survey trainings for UDD staff. (iv) Preparation of working paper, reports and plan of the project as assigned by the PD; (vii) Any other survey and studies related Jobs

B. Sr. Transportation Planner – 1 Person (2mm.)
Qualification: At least Master's Degree in Traffic Engineering/ Transportation Planning/ Equivalent
Experience: 10 (Ten) years working experience in Transportation Planning/ Traffic Engineering with experience in using ARC GIS compatible Transport Planning Software.
Responsibility: (i) To study existing transportation system of coastal region with seasonal variation and disaster; (ii) To analyze the capacity of roads and also prepare information for a traffic impact study of land use proposals on the street corner. (iii) To forecast the land value and land use as impacted by changes in transportation accessibility and policies; and develop integrated land use and transportation model.(iv) To determine the levels of goods movement and their mode of shipment to forecast regional and long-distance commodity flow and truck demand to develop alternative pricing strategies and freight specific facilities. (v) To simulate transportation operations in details at the project area including multimodal operations of automobile, motorcycle, bicycle and pedestrians etc. to increase safety and improve overall operations; and also evaluate the effects, if changes in roadway geometry, operating characteristics, land use and travel demand. (vi) To simulate vehicular traffic flow to analyze and solve traffic bottlenecks that might occur under ordinary or even extreme conditions, such as special events and evacuations from natural or man-made disasters; and also compare policies for alleviating peak-period congestion and examine the effectiveness of emergency evacuation plan. (vii) To prepare guidelines for improved transport system, affordable to the coastal

people; (viii) To work closely with the GIS expert to find out new transportation network in the area from Satellite Image and also relating the findings into transportation studies and also in the GIS database(ix)Preparation of working paper, reports and transport plan of the project as assigned by the PD.

C. Traffic Engineer – 1 Person (3 mm.)
Qualification: Bachelor of Civil/ Transportation Engineering/ Equivalent
Experience: At least 5 years' experience traffic and transport related survey.
Responsibility: (i) To plan, supervise and monitor the traffic and transport related digital (where necessary) surveys by using online communication device (Tablet). (ii) To ensure the quality of survey data. (iii) To capture the geo-coordinate and photograph of the survey location and respondent and household surveyed; and upload to the web site instantly. (iv) To upload/enter the surveyed data into computer. (v) To coordinate and assist UDD project team with project activities and presentation/ reporting. (vi) Assist the Transportation Engineer (TL) and Sr. Transportation Planner in all activities.

D. Socio-Economic Analyst - 1 Person (4 mm.)
Qualification: Master Degree in Social Science
Experience: 05 experience in conducting socio-economic survey and analysis
Responsibility: (i) To prepare, piloting, editing and finalization of socio-economic and other related survey questionnaire in consultation with the Team Leader and PD. (ii) To conduct, supervise and monitor socio-economic and other related questionnaire surveys. (iii) To supervise and monitor data entry, editing and presentation of data in tabular form. (iv) To analyze the data as directed by PD and presentation in graphs and figures. (v) Preparation of working paper, reports with recommendation as assigned by PD; (vi) Preparation of Socio-economic development model for the project area for the next 20-years. (vii) To work with a multidisciplinary team to integrate the outputs of socio-economic and other questionnaire surveys with attribute and spatial data of other components of the project in GIS database (vii) Any other related Jobs as assigned by the Team Leader and PD.

E. GIS Expert– 1 Person (2 mm.)
Qualification: Bachelor of URP/ Equivalent
Experience: At least 5 years' experience traffic and transport related surveys and studies.
Responsibility: (i) To ensure the quality of survey data. (iii) To plan and graphically present survey locations along with the geo-coordinates and photograph of the survey stations, respondent and households surveyed; and production of maps, reports etc. (iv) Toupload/enter the surveyed data into computer. (v) Any other related Jobs.

F. Survey Supervisor– 1 Person (3 mm.)
Qualification: Bachelor of URP/Geography/Equivalent
Experience: At least 2 (Two) years' experience traffic and transport related survey.
Responsibility: (i) To supervise and monitor the traffic and transport related digital (where necessary) surveys by using online communication device (Tablet). (ii) To ensure the quality of survey data. (iii) To capture the geo-coordinate and photograph of the survey location and respondent and household surveyed; and upload to the web site instantly. (iv) To assist in survey data analyses and preparation of transportation model. (v) Any other related Jobs.

4. Report Submission Schedule and Mode of Payment

Sl no.	Report	Language	Copy	Period of Submission	Contract amount
1	Inception Report	English	10	End of 1st month	20%
2	Survey Report	English	10	End of 4th month	40%
3	Interim report	English	10	End of 5th month	20%
4	Final Report	English	10	End of 12th month	20%

Chapter V
Geological Study

5.1 Objectives of the work comprise the following:

a) Earthquake hazard assessment for Region
b) Preparation of risk sensitive land use plan for the area stated above.
c) Development of scenario-based spatial earthquake contingency plan for Project's urban areas.
d) Preparation of ward-based spatial contingency plan for Project area.

5.2 Scope of work

a) Preparation of geological map of the study area.
b) Development of sub-surface lithological 3D model of the study area.
c) Preparation of soil classification map by using geophysical and geotechnical investigations of the study area.
d) Development of engineering geological map based on AVS30 values of the study area.
e) Foundation layers delineation and determination of engineering properties of the sub-soil.
f) PGA, Sa (T) Maps at 0.2 and 1.0 second periods values of 10% exceedance probability during next 50 years for local site condition determination of the study area.
g) Risk Sensitive Building Height determination of the study area.

5.3 Detailed Activities for the Scope of Work

5.3.1 Review of Regional morphotectonic and neotectonic mapping and crustal movement modeling for the identification of potential earthquake sources
5.3.2 Review of active faults mapping and modeling Updated by CDMP
5.3.3 Engineering geological mapping

The objective of the preparation of engineering geological map based on geo-technical properties of soil is to develop the geotechnical and geophysical characteristics of the soft sub-surface sedimentary deposits which caused damages to the infrastructures. This information is often used for foundation engineering, land use mapping and seismic hazard assessment. The purpose of engineering geological investigations is to generate AVS30 maps for the targeted areas. The investigated area shall be differentiated into number of potential grid sizes. AVS30 shall be calculated for each grid of the targeted areas. Following investigations given in Table 5.1 that should be conducted for the preparation of engineering geological maps for rural part.

It is to be noted that secondary data of any type on investigations can be used for improving and comparing the findings. But data quality should be assessed before using them.

The survey firm shall have to provide land use based interpretation from the findings of geotechnical and geophysical investigations for preparing earthquake risk oriented land use plan.

Deliverables: (I) Submission of all geotechnical and geophysical investigations in raw and processed format as well as analysis, (II) Engineering geological maps of the Payra-Kuakata Comprehensive Master Plan Focusing on Eco-Tourism Project, (III) Land use based interpretation of engineering geological map and development of guidelines and strategies for preparing earthquake risk oriented land use plan for urban areas of.

Table 5.1: Geotechnical and geophysical investigation to be carried-out in the urban areas

Activity	**Item of Expenditure**	**Standard** (Sq Km)		**Unit**	**Quantity**
		Urban area	**Region**		
Engineering Geological Survey	Engineering Geological Survey	1-3	5-8	No.	**90**
	SPT Boring (30 meter)				
Lab Test	Grain Size Analysis			No.	90X3
	Atterberg Limits Determination			No.	90
	Specific Gravity Determination			No.	90
	Direct Shear Test			No.	30
	Unconfined Compression strength Determination			No.	30
	Triaxial			No.	30
	Consolidation Test			No.	30
Geo-Physical Test (up to 30 m)	PS Logging	10	15-18	No.	15
	Single microtremor	10-12	15-20	No.	30
	MASW	10	1518	No.	30

5.4 Seismic hazard assessment

The seismic hazard maps of the cities should be prepared following probabilistic and deterministic approaches. Seismic motion estimation is the prime parameter of seismic hazard assessment. Soil liquefaction and slope failures are also belong to seismic hazard. Since, all the cities for which seismic hazard assessment will be done are almost flat, slope failure need not to consider for hazard estimation in this study. Detailed requirement of seismic hazard mapping is given below:

Nature of seismic motions: Probabilistic seismic motion: PGA, PGV, Sa (T) of 5% damping at 0.3 and 1.0 second periods values of 2% and 10% exceedance probability during next 50 years should be calculated at each grid.

Site amplification analysis:
Method demonstrated in Earthquake Hazard Reduction Programme (NEHRP) can be used for determining site specific amplification factor with respect to AVS30 which also consider non-linearity for both deterministic and probabilistic cases. Ground amplification should be calculated with Vs≈760m/s at engineering bed layer.

Liquefaction susceptibility and probability:

Liquefaction susceptibility and probability determination. Awarded agency should consider the contributions of all potential seismic sources during the preparation of seismic hazard maps.

Deliverable: Seismic hazard assessment for peak ground acceleration/velocity and soil liquefaction; and its land use based interpretation including development of guidelines and strategies for preparing earthquake risk based land use plan for urban areas.

5.5 Deliverables and Timeframe

The outlines of the deliverables and the timeframe for their submission are given in the Table below. Any innovative methods, concepts and ideas beyond the outlines of the deliverables can be included with the activities and corresponding reports. The timeframe can be reshuffle as well.

Table 5.2: List of deliverables with their tentative outlines

Sl No.	Deliverables	Outline of Deliverables	Period of Submission	Mode of Payment
1	Inception Report	• Introduction • Description of objectives and scope of sub-activities • Team formation and structure of survey team • Actual work schedule for the work • Immediate action taken after signing agreement • Description of sub-activities • Method and materials for each activity • Required resources allocation • Revised work schedule for completion of the work	End 1st month	20%
2	Interim Report	• Introduction • Outcome from review of such reports • Land use based interpretation of such outcome • Revised work schedule for accomplishing rest of the work • All raw data gathered from field investigation • Sample of log with depth wise digitally geo-coded photograph • Sample of digitally Geo-coded photograph at the last depth • Sample of layer change with digitally geo-coded photograph • Laboratory test result of the sample collected	End of 4th month	40%
3	Draft Final Report	• Hazard Assessment • Method of seismic hazard mapping • Setting attenuation formula • Seismic motion at engineering bed rock and ground amplification • peak ground acceleration, velocity and duration maps • Intensity maps • Determined liquefaction, ground failure and landslide characteristic.	End of 6th month	20%
4	Final Report	• Suitability Analysis (high rise-low rise Structure, Foundation Depth, soil type) • Multi-criteria Analysis • Guidelines and Strategies for planning packages (Structure plan, Urban area plan etc.)	End of 8th month	20%

3. Qualification, Experience and Responsibility of Geological study team

A. Geologist [1 Persons (1x6=6 mm)]
Qualification: M. Sc. in Geology.
Experience: 05 experience in engineering and hydro- geological survey and analysis
Responsibility: (i) To conduct and supervise boreholes for geological surveys for the study area; (ii) To check and monitor the accuracy of the borehole preparation process, collected sample and data for the geological survey; (iii) To conduct lab test of the collected samples and interpretation of the results of lab test; (iv) To prepare seismic hazard, vulnerability, damage and risk assessment map for the area, (v) To prepare micro zonation map for the area. (vi) To provide land use based interpretation of seismic hazard map for developing guidelines to prepare risk sensitive land use plan (vii) Any other related jobs assigned by PD

B. Civil Engineer [1 Person (1x6=6 mm)]
Qualification: B.Sc. engineering in civil
Experience: 5 years working experience in engineering and hydro geological survey and analysis.
Responsibility: (i) To work the geologist for conducting engineering and hydro-geological survey and analysis for the study; (ii) To assess the strength of road, buildings and other infrastructures to measure seismic vulnerability; (iii) To assist the geologist in conducting aquifer test for delineating the area for ground water harvesting; (iv) Any other related Jobs (v) Assist PD and PM in preparing plans and reports

C. Hazard Mitigation Specialist [1 Persons (1x6=6 mm)]
Qualification: M. Sc. in Geology or relevant Faculty
Experience: 10 experience in engineering and hydro- geological survey and analysis
Responsibility: (i) To supervise boreholes for geological surveys for the study area; (ii) To monitor the accuracy of the borehole preparation process, collected sample and data for the geological survey; (iii) To supervice lab test of the collected samples and interpretation of the results of lab test; (iv) To prepare seismic hazard, vulnerability, damage and risk assessment map for the area, (v) To prepare micro zonation map for the area. (vi) To provide land use based interpretation of seismic hazard map for developing guidelines to prepare risk sensitive land use plan (vii) To prepare contingency plan, (viii) Any other related jobs assigned by PD

Table 5.3: Overview of the Infrastructure Suitability Classes

Sl No.	Infrastructure Suitability	Sediments Overlying the Madhupur Clay	Sediment thickness above Dupitila Formation [m]	Average Elevation msl	SPT N30 down to 20 m	Plasticity	Infrastructure foundation suitability	Suggested land use suitability
1	Very Good	Madhupur Clay is exposed 2-3 m thick, compacted sediments.	7-11	11-16	29	Stronger Plasticity	4-6 story light infrastructure is suitable with a foundation depth of up to 3 m. Large and tail infrastructure requires pile foundation placed on Dupi Tila Sandstone.	Commercial area Residential area Industrial zone
2	Good	Highly dissected Madhupur Clay is exposed	8-12	11-15	11-27	Stronger Plasticity	4-6 story light infrastructure is suitable in Madhupur Clay. General foundation depth is within 4 m, at places higher Large and tall infrastructure requires pile foundation placed on Dupi Tila Sandstone.	Commercial area Residential area Industrial zone
3	Moderate	Moderate thickness (12 m) of soft sediments	10-15	7-11	7-25	Weaker Plasticity	4-6 story light infrastructure requires on-site subsoil investigation and proper foundation design. Deep pile foundation is needed for large and tail infrastructure	Industrial zone Residential area Commercial area Agricultural Zone Park and Recreation
4	Poor	5-7 m of loose and soft silty clay and clayey silt with few layers of organic clay, at places Madhupur clay is missing	12-20	6-7	7-25	Weaker Plasticity	Detail subsoil investigation and proper foundation design is required for all types of infrastructure, due to low bearing capacity with hazard potential.	Agricultural zone Flood flow zone Wetland Rural settlement Park and Recreation
5	Very Good	Mainly silty clay, with alternate layers of Organic clay and peat. Thickness is more than 10 m. In low floodplain areas less organic layers can be expected.	20->50	5-7	5-22	Weaker Plasticity	Detail subsoil investigation for deep pile foundation is essential, due to very low bearing capacity and high hazard potential. Shallow foundation is not preferred.	Agricultural zone Flood flow zone Wetland Rural settlement Park and Recreation

Chapter VI
Water Resources Management

6.1 Objectives

The overall objectives of project were to prepare a development plan with some specific objectives:

- To study sub regional water resource system;
- To study the condition of existing drainage system;
- To prepare land use planning guidelines considering hydrological situation of the project area;
- To make study over hydrological hazards of the area and prepare guidelines for hazard mitigation;
- To prepare flood prediction model of long, medium and short term (100, 50, 20 5 and 2.33 year period) for Project area;
- To prepare IEE (Initial Environmental Evaluation) for the area.

6.2 Scope of Work

In the context of Individual Consultant as a Water Resources Management Expert details of the work to be undertaken in this study are given in. The scope of work for the job under this study is limited to the following as per the Terms of Reference:

- Direct observation through field visit of the study reach;
- Public consultation during field visit on the project corridor;
- Collection of data on existing setting of the project corridor;
- Collection and processing of secondary data from UDD and other organizations;
- Collection of people's opinion from local perspectives on drainage opening and length;
- Carrying out statistical analysis of water levels over the project corridor for determination of the water levels for different return periods and prepare a land use planning;
- Assessment of initial environmental examination for the project corridor;
- Consultation with UDD personnel during different phases of the study;
- Reporting on the study.

6.3 Expected Outputs

The Output of the component: water resources management of the project would be covered within four working papers; the first three with Interim report-I & Interim report-II and the fourth after Draft Final Report. The expected outputs of the study are as follows:

- Working Paper 1: Hydrologic Characteristics of the Region
    - A set up of sub regional water resources system and drainage network;
    - A hydrological analysis;
    - Estimation of Water Level for Different Return Period;
    - Impact of Climate Change on Water Level
- Working Paper 2: Hydrological Hazard assessment
    - Introduction
    - Water Level Gauges on the Corridor
    - Estimation of Flood Inundation
- Working Paper 3: Policy Guidelines for Land Use Planning and Hazard Mitigation;
    - Introduction
    - Flood and Land Zoning
    - Multi Purpose Uses of Corridor
- Working Paper 4: Initial Environmental Examination (IEE);
    - Assessment of the changes in the existing natural setting due to development of the corridor;
    - Prepare Environmental Management Plan (EMP) for the proposed project to reduce the negative impacts and ensure sustainable development.
    - Outline of relocation and rehabilitation plan.

6.4 QUALIFICATION, EXPERIENCE AND RESPONSIBILITY

A. Water Resources Management Specialist (12 mm) [The expert will work as per requirement]

Qualification: M.Sc. / PhD in Water Resources Engineering/ WRD/ equivalent.
Experience: 15 years working experience in WRD, water modeling, drainage design and water resources development related activities.

Responsibility: (i) To study sub regional water resource system; (ii) To study the efficiency of existing drainage system; (iii) To prepare land use planning guidelines considering hydrological situation of the project area; (iv) To make study over hydrological hazards of the area and prepare guidelines for hazard mitigation; (v) to prepare flood prediction model of long, medium and short term (100, 50, 20, 5 and 2.33 year period) for Project area; (vi) to prepare primary and secondary drainage plan along with retention area for Project area (vi) To prepare IEE (Initial Environmental Evaluation) for the area.

Chapter VII
Ground Water Assessment

7.1 Objective

The aim of hydro-geological study is to identify the aquifer of the region including its seasonal variation. The study is also intended to identify the availability fresh ground water, which would be required for the additional people after implementation of the plan. The hydro-geological data and information shall have to integrate with both spatial and attribute data of output of other components of planning package in order to keep the hydrological system of the region sustainable. Objectives of the work comprises the following:

- To identify the aquifer level of the region including its seasonal variation
- To identify the potential area of groundwater recharge and areas potential for drawing fresh ground water
- To develop a model for interfacing between surface water and ground water.
- To identify the areas of interruption including probable change in the in the hydrological cycle due to human intervention and Climate Change.
- Development of an interactive digital model comprising of interfacing between surface water and ground water, and interruption in the hydrological system along with the mitigation measures.

7.2 Scope of Work

Detailed activities for the scope of work are stated below:

7.2.1 Establishment of Monitoring Well

The Department shall identify the suitable location for establishing the monitoring well in the project area, and establish the monitoring wells in consultation with PD. The department shall also responsible for data collection, regular monitoring and management of the Monitoring Well. The department shall establish 2 nos. of Monitoring Well in each upazila in consultation with PD.

7.2.2 Aquifer Pump Test

The department shall establish required number of wells to conduct aquifer pump test for examining the quantity of groundwater, which might be drawn without disturbing the hydrological system of the area. The department shall also be responsible for data collection, and management for the wells established for the said test. The Department shall establish at least two wells for aquifer pump test in consultation with PD.

7.2.3 Lab Test for Examining the Water Quality

The department shall conduct the Lab test for examining the ground water quality including (i) Major Cataion and Anaion, (ii) Trace Element Analysis, (iii) Grain Size Analysis, and (iv) Porosity and Permeability Analysis.

7.2.4 Data Analysis and Interpretation

The department shall conduct analysis and interpretation of all collected primary and secondary data and information

7.2.5 Development of Digital Interactive Hydro-Geological Model

Finally, an interactive digital model comprising of interfacing between surface water and ground water, and interruption in the hydrological system along with the mitigation measures shall be developed.

7.2.6 Deliverables and Time-frame

The outlines of the deliverables and the timeframe for their submission are given in the Table-4 below. Any innovative methods, concepts and ideas beyond the outlines of the deliverables can be included with the activities and corresponding reports. The timeframe can be reshuffle as well.

Table 7.1: List of deliverables with their tentative outlines

Sl No.	Deliverables	Outline of Deliverables	Period of Submission	Mode of Payment
1	Inception Report	□ Description of objectives and scope of sub-activities □ Team formation and structure of survey team □ Actual work schedule for the work □ Immediate action taken after signing agreement □ Description of sub-activities □ Method and materials for each activity □ Required resources allocation □ Revised work schedule for completion of the work	End 1st month	20%
2.	Interim Report	Establishment and operation of Monitoring Well and starting of other related activities □ Selection of Site for Monitoring Well Establishment □ Installation, Testing and commissioning of Monitoring Well □ Operation of Monitoring Well □ Revised work schedule for completion of the work	9th month	40%
		Dry Seasonal Data Collection, analysis and interpretation along with Spatial distribution (GIS Shape File) □ Identified aquifer level of the region including its seasonal variation □ Areas potential for drawing fresh ground water during dry season and threshold limit for drawing ground water □ Areas of interruption including probable change in the in the hydrological cycle due to human intervention □ Spatial distribution of dry season data (shape file) □ Revised work schedule for completion of the work		
		Wet Seasonal Data Collection, analysis and interpretation along with Spatial distribution (GIS Shape File) □ Identified aquifer level of the region including its seasonal variation □Spatial distribution of wet seasonal data (shape file) □ Changing scenario for drawing fresh ground water during wet season □ Areas of interruption including probable change in the in the hydrological cycle due to human intervention □ Revised work schedule for completion of the work		
3	Draft Report	Groundwater Scenario of the Whole Hydrological Year along with Identification of Potential Area of Groundwater Recharge and Drawing; and Surface water and Groundwater Interfacing Model including GIS Shape File and Thematic Map □ Identification of aquifer level of the region including its seasonal variation. □ Analytical Presentation of drawing fresh ground water and recharge area considering seasonal variation. □ Areas of interruption including probable change in the hydrological cycle due to human intervention the inter protection □ Spatial distribution of wet and dry seasonal data (shape file) including thematic maps. □ Interactive digital model for surface and groundwater interfacing in the region along with GIS shape file and thematic maps	End of 10th month	20%
4	Final Report	Recommendation on Sustainable Hydrological System Human Intervention and Climate Change of the Project Area and Posting the Report on Website □ An interactive digital model comprising of interfacing between surface water and ground water, and interruption in the hydrological system along with the mitigation measures. □ Recommendation on the remedial measures to make the hydrological system of the region sustainable □ Integration of hydro-geological data and information (both attribute and spatial) with other components of the project	End of 12th month	20%

7.3 QUALIFICATION, EXPERIENCE AND RESPONSIBILITY

A. Hydro-Geologist 1 Person (1x4=4 mm.)

Qualification: M. Sc. in Geology.

Experience: At Least 10 (Ten) experience in hydro- geological survey, analysis and modeling

Responsibility: (i) To conduct, and monitor, supervise hydro-geological surveys and studies; (ii) To analyze hydro-geological data and information collection from primary and secondary sources. (iii) To conduct lab test of the collected samples and interpretation of the results of lab test; (iv) To prepare seismic hazard, vulnerability, damage and risk assessment map for the area, (v) To identify the areas potential for drawing fresh ground water, and also areas of interruption including probable change in the in the hydrological cycle due to human intervention. (vi) To interlink the attribute and spatial data of hydrogeology with that of other components of the project (vii) To prepare an inter active model for interfacing surface water and groundwater, and (viii) To recommend possible mitigation measures for interruption in the system due to human intervention. (ix) To prepare report on the assigned task.

B. Associate Geologist 1 Person (1x4=4 mm.)

Qualification: M. Sc. in Geology.

Experience: 05 (Five) experience in hydro- geological survey and analysis

Responsibility: Assist the Hydro-Geologist-

(i) To conduct, and monitor, supervise hydro-geological surveys and studies; (ii) To analyze hydro-geological data and information collection from primary and secondary sources. (iii) To conduct lab test of the collected samples and interpretation of the results of lab test; (iv) To prepare seismic hazard, vulnerability, damage and risk assessment map for the area, (v) To identify the areas potential for drawing fresh ground water, and also areas of interruption including probable change in the in the hydrological cycle due to human intervention. (vi) To interlink the attribute and spatial data of hydrogeology with that of other components of the project (vii) To prepare an inter active model for interfacing surface water and groundwater, and (viii) To recommend possible mitigation measures for interruption in the system due to human intervention.

Chapter VIII
Ecological survey for Land Use Planning

8.1 Objective of Flora and Fauna survey

a) To identify common and rare species of flora and fauna in the study area
b) To identify the factors affecting the integrity of the existing flora and fauna in the ecosystems and the conservation status of relevant habitats and species;
c) To set forth planning policies on preserving the species and ecology sensitive land use planning to keep the ecological system sustainable
d) To develop an interactive digital model for the ecological system for the study area

8.2 Methodology for Flora and Fauna survey

The team shall conduct historical study to on the spatial distribution of habitats or species and compile habitat or species inventories on various scales, and also recognize the pattern of rarity. The team needs to know if the habitats actually rare have been in this state for a long time or if they were still frequent some decades ago.

Information on the underlying process of decline or increase can be achieved by an historical landscape analysis. Time series of old topographic maps or aerial photos, written historical texts or oral information are all valuable sources to outline a picture of the landscape at times when land use was less intensive than today. Maps with the historical distribution of habitats from these sources should be drawn in the same resolution as the actual distribution. By overlaying both maps the team shall compute exact balances of losses for all habitat types in the project area.

The communities, which have been rare for a longer time (mainly because of special landscape conditions) and which communities have just recently declined in spatial extent shall be identified through the historical analysis. The historical analysis shall depict wet meadows some decades ago and, within land reclamation schemes, the recent drainage of the valley bottom. Subsequently, the drained meadows were turned into crop fields. Drainage is a major factor for the loss of species that are adapted to wet habitat conditions

8.2.1 Floral Survey

A long transect line would be considered for the initial study for the floral compositional survey. For species diversity Shannon diversity index would be followed. Road side vegetation along with homestead vegetation would be considered. Quadrate survey for each location would be conducted during primary visit where density of species would be determined. Hedgerow survey would be conducted to understand species composition. Moreover, one FGD with local people, key informant interview (KII) with Agriculture Officer for floral information:

a. Types of common flora
b. Types of rare species
c. Types of special vegetation (eg. Mangrove)
d. Types of cultivation occurred
e. Major cropping pattern
f. Other cultivated plants
g. Literature review

8.2.2 Faunal Survey: Faunal survey comprises of Avifauna, Herpetofauna (Amphibians, Reptiles), Fishes, Cetaceans, Mammals, and Crustaceans.

Avifaunal survey: Data would be collected by strip transect sampling, opportunistic survey and visual observation:

h. Opportunistic bird sightings
i. Breeding ground identification of Avifauna
j. Seasonal variation
k. Species composition considering shore birds, migratory birds and resident birds
l. IBA's data for birds staging site

Herpetofaunal survey (Amphibians and Reptiles): For both amphibians and reptiles study sites would be divided into different habitat niches and conducted every where including paddy field, eco-park roadsides, burrows, leaf litter, low-lying vegetation, rain water retention areas, temporary stagnant water etc:

m. Targeted species specific study
n. Nocturnal survey
o. Location of sensitive areas

Fisheries study: Reconnaissance survey, field visit, interviewing cross section of people, FGD, interviewing fisheries related people, secondary data along with:

p. Sampling time
q. Sampling procedure
r. Identification of Hilsha spawning ground
s. Seasonal variation
t. Sampling locations
u. Information from fish catch form open water
v. Primary productivity: Limnology and water quality survey
w. Identification of aquatic micro-organism in laboratory

Cetacean's survey: Cetaceans are considered to be the mega fauna within the fresh and marine water which comprised of Dolphins and Whales. Survey through mechanized boat (18 noticle mile/ hour) with digital devices, jig jag movement through transect line. Also, with a FGDs:

x. Observation time
y. Study area for the Cetacean survey

Mammalian study: Two types of observational methods: (1)direct observations, (2)identifications of dung, tracks and other signs. Inventory methods include:

a. Observational methods
b. Order chiropetra
c. Order rodentia
d. Order carnivora
e. Order artiodactyla
f. Location of Mammalian survey

Invertebrates survey methods: Accumulation of KII, FGD and secondary literature (butterfly, moth, otonata, bee, micro invertebrate)

Identification of Ecologically sensitive areas: secondary literature, Biological zones, IUCN data, GIS database etc.

8.3 Comparative assessment of plant and animal communities: A comparative assessment of flora and fauna through proper mapping after secondary and primary data.

8.4 Indentifying abiotic data factors impact: Analyze strata of geology, physical parameter like soil, sediment, temperature, pH and how landscape changed within decades.

8.5 Evaluation and Goal Development Based on "Target Species"

It is obvious that remaining populations of a threatened species have to be considered with the highest priority. The management of lost habitats and home-ranges should be adjusted to the needs of these populations. The target species approach is usually more general. It is based upon the principle that it is never possible to focus on all species in any given planning area.

The various classes of species that shall be used to gather evidence on the habitat characteristics of a planning area are defined below:

Indicator species: species which indicate special factors such as pH, humidity, temperature, trophic level, nutrient conditions.

Umbrella species: species which prove that the habitat requirements for a broad range of other species are "covered".

Flagship species: Particularly attractive or appealing species which leads public opinion towards nature conversation regardless of cost or restrictions.

Target species (Goal species): species (groups) upon which politicians, nature conservation authorities, or other bodies have agreed to focus in any given area.

Identification of critical Species:

During the survey any critical habitat (also why it is critical) and its significance needs to be identified, and protection status recorded in practice, a check of each individual species against the following will be required in order to be to determine its protection status:

- IUCN's threatened category (Red Data Book-both National and global threatened category);
- Species protected under Bangladesh Wildlife Preservation Act (1974);
- Species protected under any protocol, conventions and any other agreement;
- Species considered as flagship species, keystone species or other significant species; and
- Endemicity of the species

8.6 Integrated Evaluation of Species and Habitats

Particular habitats with a high species diversity, and remnants of representative ecosystems (climax ecosystem') which exist on sites which are now normally in economic use, represent the basic skeleton network of a species conservation concept. In this context, the firm/ shall identify and assign the rank to the very important habitats and the most heavily impacted sites; and then shall classify them according to their species and habitat diversity.

Identification of potential Impacts on Existing Ecosystem:

The firm/ shall identify whether the project construction could potential result in significant:

- Lethal or sub lethal effects to biota
- Disturbances to animals
- Destruction of important vegetation habitat
- Disturbances/reduction to natural breeding and recruitment
- Permanent degradation of migration and migratory pattern
- Disturbance to resting and roosting sites for local area animals
- Hindrance of the natural regeneration process in the project area
- Reduce the asthetic values of habitat/ecosystem

8.7 River Habitat Surveys (RHS) and River Corridor Surveys (RCS)

A RHS and/or a RCS shall be conducted at locations a proposed road crosses a water course. The need for further surveys of riverine habitats depend upon the extent of the potential impacts on bank-side and in-channel features, and the apparent nature conservation value of these features. This shall be reviewed on the basis of the results of the walkover survey.

The RCS method shall provide information on the vegetation and the physical structure of the water course. This method shall be used at the location of, as well as upstream and downstream (for at least 1km) of, any proposed crossing points. The survey would also include the spawning ground of fishes and fish migration.

8.8 Characterizing Impacts and Mitigation

Illustrate how significant impacts (adverse or beneficial) that might occur due to proposed development, in the absence of mitigation and compensation measures, shall be quantified and characterized in the following way:

- determine the value of existing flora and fauna affected, through survey and study;
- assess impacts affecting those flora and fauna, which meet or exceed a defined threshold value, with reference to ecological processes and functions as appropriate;
- quantify the extent, magnitude, duration, timing and frequency of the impacts;
- assess impact reversibility;
- explain the level of confidence in these predictions; and
- Identify likely significant impacts in the absence of any mitigation.

8.9 Determining Value

The value of the existing flora and fauna shall be determined on the basis of the following:

- whether, as part of screening, potentially affected features or resources are considered sufficiently valuable that there could be a significant effect that would trigger an EIA;
- A ‘threshold’ level of value of the species;
- Deciding what mitigation is appropriate.
- Considering legal and policy implications

8.10 Evolution of Project Design and Mitigation

- Identify measures to avoid or reduce negative impacts;
- Identify opportunities for enhancement;
- Demonstrate likely success of mitigation measures; and
- Provide sufficient information for mitigation measures to be implemented effectively, e.g. through an Environmental Action Plan (EAP).

8.11 Identify Significant Residual Impacts and Their Legal, Policy and Development Control Consequences

- Produce a clear summary of the significant residual impacts of the project incorporating mitigation and enhancement measures;
- Where significant impacts cannot be avoided/reduced, identify compensation measures to be implemented;
- Consider the consequences of significant residual impacts in the light of planning policies and legislation; and
- Include mitigation, compensatory actions and enhancements in the EAP or similar.

8.12 Determination of Impact of Climate Change on Bio-Diversity

The firm/ would identify the probable impact of climate change (CC) on spatial dimensions of natural habitats including the processes/factors of eco-system services and functions within the study area.

8.13 Mapping of the Site

Map the site of the flora and fauna in ARC GIS and present at a scale in consultation with PD.

8.14 Development of an Interactive Digital Model

The survey firm/ shall develop an interactive digital model of existing habitat, decline of habitat and possible areas of conservation.

8.15 Deliverables and Timeframe

Table 8.1: List of deliverables with their tentative outlines

Sl No.	Deliverables	Outline of Deliverables	Period of Submission	Mode of Payment
1.	Inception Report	□ Description of objectives and scope of sub-activities □ Team formation and structure of survey team □ Actual work schedule for the work □ Immediate action taken after signing agreement □ Introduction □ Description of sub-activities □ Method and materials for each activity □ Required resources allocation □ Revised work schedule for completion of the work	End 1st month	20%
2	Inventory of Existing Flora and Fauna	□ Identify existing flora and fauna □ Stating which species are rare and which species are endangered □ Identify the habitats of the flora and fauna □ Identify the characteristics of the flora and fauna	End of 3th month	20%
3.	Spatial Distribution of Habitat	Spatial Distribution of Habitat (along with GIS Shape file and thematic maps) □ Spatial Distribution of flora and fauna □ Location map of flora and fauna □ Location and Spatial Distribution of rare and endangered Species	End of 6th month	20%
4	Draft Report	Interactive Digital Model on Bio-Diversity and Human Intervention (along with GIS Shape file and thematic maps) □Description of baseline and trends of existing flora and fauna, if the project were not to go ahead; □ Explanation of the criteria used to evaluate existing flora and fauna; and assess the significance of impacts of the project □ Statement of methodology used □ Presentation of analytical techniques used and the analysis itself; and interpretation from the analysis	End of 9th month	20%
5	Final Report	Interactive Digital Model on Bio-Diversity and Human Intervention (along with GIS Shape file and thematic maps; and Recommendation on Eco-Sensitive Land use Planning) □ An interactive digital model of existing habitat, decline of habitat and possible areas of conservation □ Identification of likely impacts on existing flora and fauna; and an explanation of their significance and the level of certainty with which this can be stated □ A digital map of the existing flora and fauna □ Description of legal and policy consequences □ Thematic map for providing planning guidelines	End of 12th month	20%

8.16 Qualification, Experience and Responsibility

A. Ecologist– (12 mm.)

Qualification: Master's Degree in Environmental Science, Ecology, Forestry and Wood Technology, Marine Biology, Zoology, Botany or Related discipline

Experience: At least 10 (Ten) years' experience in the study and management of flora and fauna in the coastal region of Bangladesh.

Responsibility: (i) To make an inventory of all types existing flora and fauna in the project area including endanger species; (ii) to identify the potentiality of the natural resources (flora and fauna); (iii) To identify environmental hazards that might de imparted on the flora and fauna due to proposed development; (iv) To prepare a map of habitat for existing flora and fauna of the project area indicating communities of various species of plants including the areas; (v) To earmark the areas, which would not be disturbed by any kind of development; (vi) To make recommendations to protect the forest resources from environmental hazards and also to preserve the endangered species from depletion to attain sustainable development; (vii) To develop an interactive digital model for the whole ecological system with special reference to flora and fauna.

B. GIS Expert- (6 mm.)

Qualification: Master Degree in Statistics, Applied statistics, Geography, Bachelor of Urban and Rural/Regional Planning or related discipline.

Experience: 05 (Five) experience in database management and analysis

Responsibility: (i) Survey and database design for Existing Flora and Fauna survey data for the study area; (ii) Supervise and monitor data entry and maintain the quality of database. (iii) Management, processing, editing and cleaning of collected data. (iii) To assist the Baseline Survey of Existing Flora and Fauna Expert in data analysis and interpretation. (iv) Spatially link Existing Flora and Fauna related survey data with base map. (v) Integrate Existing Flora and Fauna data with different sectoral data (both spatial and attribute) into GIS and develop an interactive matrix. (v) To assist the Survey of Existing Flora and Fauna Expert in data analysis and interpretation and preparation of report.

C. Associate Ecologist– (12 mm.)

Qualification: At least Bachelor Degree in Environmental Science, Ecology, Forestry and Wood Technology, Marine Biology, Zoology, Botany or Related discipline

Experience: At least 5(five) years' experience in the study and management of flora and fauna in the coastal region of Bangladesh.

Responsibility: (i) To make an inventory of all types marine resources in the project area including endanger species, (ii) to identify the potentiality of the marine resources (flora and fauna); (iii) To identify environmental hazards that might de imparted on the marine resources; (iv) To prepare a map for marine resources of the project area indicating communities of various species of plants including the areas that would be disturbed proposed development; (v) To earmark the areas, which would not be disturbed by any kind of development; (vi) To make recommendations to protect the marine resources from environmental hazards and also to preserve the endangered species from depletion to attain sustainable development; (vii) To develop an interactive digital model for the whole ecological system with special reference to marine resources in the project area.

Guidelines for Project Document of Spatial Planning

Urban Development Directorate
82, Segunbagicha, Dhaka-1000
Bangladesh