The approach & methodology, and work task to be performed to accomplish the stated objectives and activities stated in the TOR and as summarized in Section 4 are presented in this chapter.

However, before presenting the methodologies, in the light of TOR our understanding regarding the scope of work and the major steps of activities are discussed

3.1 Mobilization

Mobilization and Orientation

Survey Firms

A brief description of Joint Venture of DECODE-BESTWAY-GEOMARK given below:

The Decode Ltd.

The Decode Ltd. was established in 1997 starting with CAD conversion and contour mapping service facilities working for a number of projects in USA and Europe. With the support of a Denmark Government Development Program, DANIDA, in 2004, Decode launched an extensive training program for its human resources development in the mapping sector. Under this program in the last few years, a considerable number of employees of Decode were trained in the field of photogrammetric mapping techniques and standard in Denmark to enhance the strength of the company to ensure quality product and services.

Best way Foundation

Bestway Foundation provides Engineering Consultancy Services to the sister companies of Bestway Group. Along with the services to the sister company of the group BFL will provide services to districts, municipalities & other agencies.

Bestway Foundation Ltd. provides high quality, cost effective, common sense solutions in civil engineering design, site development, road & street development, structural design, land surveying, GIS Mapping, Software Development, construction management & so on.

Geomark Ltd.

Geomark Ltd. is brand with specific focus to the emerging IT Enabled Services (ITES) specializing in the geospatial applications including consultancy on Engineering &

Architectural Design, Drawing, Supervision, planning GIS, LIS, MIS, AM/FM, processing of remote sensing data, digital mapping/surveying using GPS, geo-spatial and textual data conversion, application software and web page/solutions development and so forth. Apart from ITES, Geomark Ltd. provides professional consulting services particularly for

undertaking research and development studies/projects covering and not limited to land, natural resources, environment, urban/real estate development, infrastructure development, institution and organization studies, land related legislation study, human resources development studies, general education related studies, and so forth.

3.2 Discussion and meeting

Discussion with MSDP project authority, the Survey Firm after initiation of office would call on PD. They will held in depth discussion with

- Project Director PD
- project manager PM

The survey firm also visits the Mymensingh office and its union level office.

3.3 Collection of Documents

For map preparation, basic data will be needed on Mauza maps, road network, river/khal network, population, holding numbers, social, economic and physical conditions in the project area etc. Most of this information will be collected from existing studies, plans and programmes, government publications, public authorities, statistical digests, documentation of external agencies, as well as the records of DLR, respective authorities and other development agencies working in the area. Reference will be made to relevant national reports, plans etc. Major data gaps will be identified and data will be collected through sector studies/surveys.

3.3.1 Mauza map collection

Mauza sheets/maps of RS/CS or latest version will be collected covering the entire project area. The mauza sheets having distortion due to rapping or pasting cloths/tape in the mauza maps will be avoided during collection of mauza maps. Before scanning of mauza maps all collected mauza maps will be submitted to UDD for review and quality check/authentication.

3.3.2 Satellite Image Collection

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, Geo-Eye Inc.

The GeoEye-1 Satellite image in 0.5-meter panchromatic and 1.74-meter multispectral four-band images in stereo pairs will be procured. The 0.5-meter pan and 1.74-meter multispectral imagery will also be used to yield 0.5-meter color imagery (pan-sharpened)

3.3.3 Preparation of Base Map

Preparation of base map is an important requirement for planning and designing of the assigned project. The base map will be used to depict the survey findings. Preparation of base map comprises the following item of works presented in steps:

- Collection of RS/CS Maps,
- Scanning of Mauza Maps,
- Digitization of RS/CS Maps,
- Edit Plot Check of Digitized Coverage,
- Identification of GCP on digitized RS/CS Maps,
- GCP survey,
- Geo-referencing of RS/CS Maps, and
- Preparation of Arc/Info Coverage and Map Layout of RS/CS Maps

3.3.4 Collection of RS and CS Mauza Maps

Mauza sheets/maps of RS/CS or latest version will be collected covering the entire project area. The mauza sheets having distortion due to rapping or pasting cloths/tape in the mauza maps will be avoided during collection of mauza maps. Before scanning of mauza maps all collected mauza maps will be submitted to UDD for review and quality check/authentication.

3.3.5 Scanning of Mauza Maps

To minimize the distortion and deviations scanning of mauza maps will be carried out using drum scanner. Extra care will be taken for maintaining the proper rotation and alignment of

mauza sheets during scanning. Later on all scanned mauza files will be submitted in soft format to UDD for preservation.

3.3.6 Digitization of Mauza Maps

On screen digitization method will be used for digitization of mauza maps. GIS based Arc/Info or Arc/View software will be used for this purpose. Feature wise manuscripts will be developed for digitizing the mauza maps and all features will be stored as layer coverage with a separate ID or code number of respective features in the GIS database. To keep uniqueness of all features the ID or code numbers of respective features will be finalized as per suggestion and discussion with UDD.

Manuscript-1: Point Features

This manuscript will contain all point features like boundary and other reference pillars, traverse stations, GT stations, bench marks etc. Every point will be stored with a numeric user ID representing feature type.

Manuscript-2: Polygon Features

This manuscript will contain all polygon type or closed boundary features like pond, water bodies, structures, plot and mauza boundaries etc. All features will be stored as polygon having a numeric user ID representing feature type.

Manuscript-3: Line Features

This manuscript will contain all line type features like roads, railways, drainage, sewerage line, embankment/flood wall etc. All features will be stored as line having a numeric user ID representing feature type.

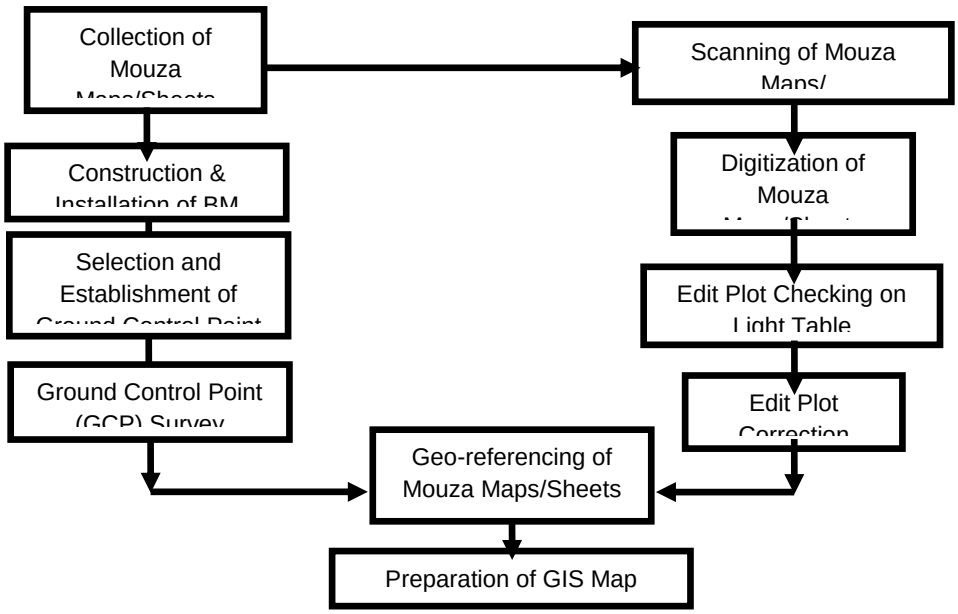

Figure 1: Flow Diagram of Base Map Preparation

3.3.7 Edit Plot Check of Digitized Coverage

After digitization of mauza maps, edit plots will be produced containing all the features and boundaries in different colors. The digitized mauza maps will be checked and verified by superimposing on the original mauza maps using the light table. The checking of digital mauza maps will be done by the joint team of UDD and consultant. All possible errors (missing arcs, dislocation arcs, wrong or missing polygons, labels, tic locations, ID etc.) will be solved with this edit plot check and final digital mauza maps will be prepared. After digitization and necessary edit plot check, both soft and hard copy of all the digital mauza maps will be supplied to UDD for preservation.

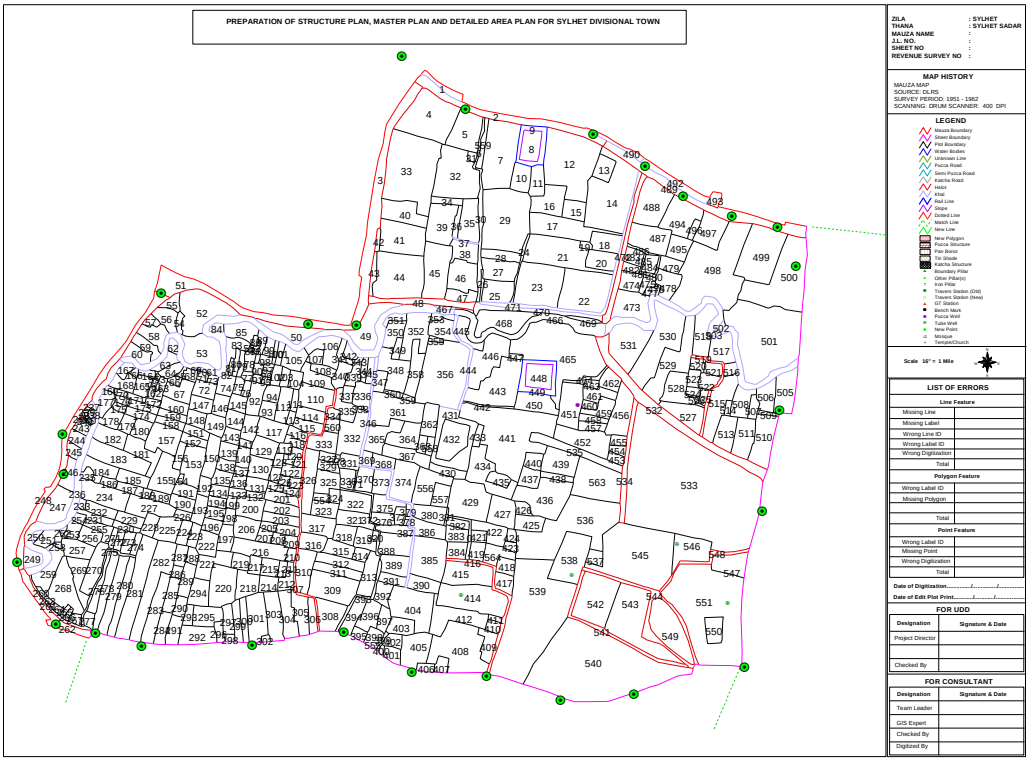

Figure 2: Sample Digitized Mouza Map printed for Edit Plot Checking

3.3.8 Identification of GCP (Tic) on digitized RS and CS Maps

At least 4 nos. of Ground Control Points (GCP) will be selected on each mauza sheets identical with the real field condition. For accuracy and quality work maximum efforts will be given to identify as many as GCP for each mauza sheets. A joint team of UDD and consultant will select the GCP on mauza sheets.

3.3.9 Geo-referencing of RS and CS Mauza Maps (Joining of Mauza Maps)

Geo-referencing of mauza sheets will be done using GCP points (Northing, Easting) and GIS based software Arc/Info 3.5 or latest version with approval of PD, UDD. After geo-referencing of all the mauza sheets of the project area, the mosaic mauza maps of the project area will be found having all the mauza features (point, line, and polygon) with GCP points in different layers.

3.3.10 Edge Matching of Mauza Maps

We have already explained our methodology of composite map preparation. Therein we have narrated the process through which all the sheets of the mauza maps will be mosaiced. In this section we again explain that. We know that a RS/CS mauza map consists of a single sheet or more than one sheet. That means that the mauza maps of the project area are divided in to

many sheets. For preparing plans we need to mosaic them to have a composite map by edge matching. Edge matching will be done with the help of GPS readings. The four TIC points on each sheet having latitude and longitude readings will enable the work of edge matching with perfection.

3.3.11 Preparation of Arc/Info Coverage (Topology) of the Project Area

Final map coverage and layout of the project area (mosaic mauza of project area) will be done as per specification suggested by UDD using GIS based Arc/Info and Arc View software. All the features of mauza maps including plot, mauza and boundary of the project area will be identified and shown in the base/study area maps in separate layer. Later on this study area map will be incorporated in the physical and topographic survey maps. Both soft and hard copy of base/study area map will be supplied to UDD as per specification and scale mentioned in the TOR.

3.3.12 Demarcating the Project Area/Boundary

After correction of Geo-referenced Mouza sheets all the Mouza sheets will be combined together to form the Project Boundary. After this process the survey team will identify the boundary of the project area in real world. The consultant team and UDD will supervise and guide the survey team to demarcate the actual boundary of the project area.

All the geo-referenced Mouza sheets of the project area, the mosaic Mouza maps of the project area will be digitized having all the Mouza features (point, line, and polygon) with GCP points in different layers. A joint team comprising the Consultants and UDD officials will verify the draft final base maps. After getting approval from UDD officials, final maps will be prepared.

3.3.13 Survey Plan

This will be a highly qualified group of well-equipped and well-organized staff for its field survey and GIS mapping projects. The most modern survey equipment like Total Station, Digital level, and satellite based survey equipment like RTK-GPS, DGPS will be engaged for

the field survey and data acquisition campaign. A quality Control team lead by a Quality Control Manager will be engaged. The quality control will be maintained in two stages, in the field and in the office.

Quality Control in the Field

- Use of satellite based advanced survey technique,
- Maintain & monitor daily log sheets and level books in the field,
- Daily checking of the field equipment before starting the work,
- Routine check and calibration of the survey equipment,
- Frequent field visit by the joint team comprising the senior staff of Consultants and project officials of UDD, and
- Interaction with project officials in the field level

Quality Control in the Office

- Daily review meeting with survey groups,
- Spatial and temporal Comparison of the survey data,
- Daily updating and processing data and Maps, and
- Frequent interaction and review meeting with project officials

3.4 GPS and GIS Technique

The automation, digitization and geo-reference of planning information deserves attention to the quality, vision of the extent of future applications, flexibility for the possible user groups and openness to easy access, all of which we are lacking in our country

Now a day's all the planning activities need to deal with a large amount of digital and spatial data and maps, charts and reports. The Planners also need an automated information system

like Geographical Information System (GIS) capable of dealing with spatial database to make their task efficient and effective. For which a digital and geo-reference data and information are very much needed. A comprehensive GIS includes software and hardware used to capture, store, organize, manipulate, analyze and display spatially referenced information. Easy manipulation and display of information helps to facilitate the decision making process by allowing planners to customize the maps and models produced.

3.4.1 GPS Based Advanced Survey Technique

Digitizing of existing mauza maps is time consuming with possibility of error, which can be easily converted to digital map by using scanner and processing through appropriate software with high accuracy. Spatial data collection and geo-reference digital mapping have now become very easy with satellite based advanced survey techniques using Global Positioning System (GPS) and Geographical Information System (GIS) with accuracy of centimeter level. Furthermore the development of high-resolution images helps to determine the spatial features as well as verify the survey data more accurately.

The Global Positioning System (GPS) is worldwide all-weather radio-navigation and positioning system formed from a constellation of 24 satellites and their 5 nos. ground control & monitor stations. GPS receivers use these US Navigation Satellites for Timing and Ranging (NAVSTAR) to calculate positions accurate to matter of meters. GPS receives radio waves, modulated for positioning, transmitted by a maximum number of 24 satellites, which enables to work out the distance between satellite and observation points. By receiving radio waves from four satellites simultaneously it is possible to find out the three-dimensional co-ordinates and time (UTC) of the observation point with an accuracy level which cannot be conceived in traditional ground survey. The facility of GPS has been utilized in different kinds of ground surveys including geodetic, topographic and hydrographic survey in the recent times. Differential Global Positioning System (DGPS) is different versions of GPS technology, each with its own range of applicability and accuracy level. GPS based surveying has a number of advantages over conventional surveying methods. These are:

- Highly accurate
- Very fast
- Line of sight not required
- Digital/Computerized data storage, processing facility
- Unified 3-dimensional global co-ordinate system (x,y,z) output

GPS based survey with its computer based data storage and processing facility on and off the field offers immense flexibility in map production under a GIS environment. To ensure precision and accuracy in survey work and to facilitate geo-reference/digital map production by GIS software and finally to complete the whole work in a rather shortened time schedule, GPS technology was the best and logical approach to be followed.

3.4.2 Differential Global Positioning System (DGPS)

To obtain precise position from a GPS receiver, we use techniques called "Differential GPS". This involves at least two GPS receivers. One is stationary, at a known point or bench mark; we call this the "Base or Reference" receiver/unit and the other rover receiver/unit. The base unit ties all the satellite measurements into a solid local reference i.e. known point or bench mark. The Base receiver measures and records the timing errors and then transmit correction information to the other receivers those are roving around. The roving GPS receivers, possibly moving at an unknown point, calculates precise position by using the signals it receives from the satellites, and the correction information receives via radio from the Base. The correction information could be transmitted through online radio communication system or could be incorporated by off-line data processing software. Differential GPS usually gives about one meter accuracy.

3.4.3 Real Time Kinetics (RTK) GPS

RTK is a special form of Differential GPS that gives about one hundred times greater accuracy. The GPS system uses a coded signal from which a receiver derives distance and thus position. The GPS satellite provides the equivalent of tape measure from space. The tape labeled tick marks at ~300m intervals (the C/A code), as well as unlabelled tick marks at ~20m intervals (the carrier). A GPS receiver can measure the code to one-meter (1m) precisions, and the carrier to one-centimeter (1cm) precision. A receiver that can compute the "Labels" on the carrier can then deliver centimeter position accuracy. This is what RTK does.

3.4.4 Establishment of Reference Station for DGPS Survey

Reference stations for Differential Global Positioning System (DGPS) survey will be established in the project area. RTK-GPS static survey and baseline network adjustment technique will be used for this purpose. JICA BMs in or around the project area will be used as reference for establishment of DGPS reference stations. These reference stations will be used for recording and transmitting differential correction for DGPS rover units.

3.4.5 Approach and Methodology of Survey and GIS Mapping

GPS based advanced survey technique will be used for preparing the Geo-reference Topographic, Physical Feature and Land Use Map of the project area. Arc-info/Arc Map based GIS software will be used for mapping purposes. The methodology of field survey, data processing and GIS mapping are described below:

3.4.6 Baseline Survey by RTK-GPS

The Baseline survey and simultaneous data collection is static mode at two or more fixed points using two or more duel frequency GPS receivers. The measurement network for RTK-GPS baseline survey will be planned by connecting the BM points to be established and the selected reference BM points (known Latitude, longitude and ellipsoidal height) available inside and around the project area. A line connecting two measurement points is known as baseline. It is important to emphasis that the configuration of network was based on practical considerations rather than requirements of an ideal network.

The GPS measurement consist a simultaneous static measurement with dual frequency GPS receivers at the ends of a baseline concerned. Measurement or logging time for a session is usually one hour. During the measurements the GPS receivers at the two points record the information or data (Latitude, Longitude, Ellipsoidal Height) on the configuration of available satellite at the time, which at the end of day's work will be processed using Trimble Geomatic Office software. If results from the field measurements found unacceptable, measurements will be repeated.

The verified results of each baseline will be stored for the subsequent network adjustment. After completing the baseline survey, network adjustment will be done with respect to the known values (Latitude, Longitude, and Ellipsoidal Height) of selected reference BMs available inside and around the project area. The adjustment module of Trimble Geometric

Office software will be used for network adjustment. After network adjustment the precise co-ordinates (Latitude, Longitude, and Ellipsoidal Height) of each BM will be obtained.

The survey team & their responsibilities have been listed below:

	Feature	Survey Activities
1.	Point, Line and Closed Boundary Features (where satellites signal available) DGPS closed boundary survey	DGPS position survey DGPS alignment survey
2.	Establishment of Secondary Control Points for Total Station Team (Team-C)	RTK fast Static Survey and use of project GEOID Model
3.	Point, Line and Closed Boundary	Position, alignment, boundary and spot/ land
4.	Water bodies	Alignment, boundary and bed level survey

3.4.7 DGPS Survey (Line, Point and Closed Boundary/Polygon Features)

DGPS experts of the DGPS group will walk over the both sides of the road or embankment with the DGPS rover unit in a backpack to measure and store the alignment in x and y co-ordinates of roads, embankment and other line features roughly at 1 to 3m intervals. The point and closed boundary features also surveyed by the DGPS groups. The optical teams will pic-up the crest level of the road. DGPS group is also responsible for taking the position and the information of the structures (hydraulic structures, bridges and culverts etc.). At the end of day's survey, the DGPS data will be downloaded and post-processed in the office using Pathfinder Office software and stored into GIS database.

3.4.8 RTK-GPS Fast Static Survey (Establishment of Secondary Control Points for TS Survey)

The Secondary Control Point (SCP) will be established using RTK fast static survey technique and GEOID Model of the project. These SCPs will be used by the total station groups as reference points (Station and Back Points) for feature and land topography survey.

3.4.9 Physical Infrastructure Survey

Physical feature surveys provide the basis for understanding many planning problems. In a planning work such as Detailed Area Planning, precise locations and dimensions of physical features such as rivers, drainage channels, building, roads etc. are important. Thus to know existing information about physical features of an area, physical feature survey is carried out. From the physical feature map information such as access to the area, available roads in different conditions (such as Pucca, kutcha), right of way, location of natural barriers, structures, utility services, etc. are collected. These information aids in planning. Decision can be taken whether a new access is required, or if there is any scope for expansion/improvement of roads. If a new link road is proposed, it is going to interact with the existing structures and natural barriers. For examples a bridge may be required over a road.

Table 1: Physical feature

	Physical features	**Illustrated**
a.	River	Indicate alignment, direction of flow & width
b.	Khal	Indicate alignment, direction & width
c.	Drainage Channels	Natural and improved (with flow direction & width)
d.	Ponds/Tanks/Ditches	Indicate them
e.	Marshalands/Flood Prone Area	Land liable to flooding during monsoon
f.	Building / Structures	Pucca / semi pucca structures & storey
g.	Roads	Pucca/HBB/Kutcha, earth etc.
h.	Bus/Trucks Terminals	Indicate right of way and any areas that are covered by the electricity system.
i	Flood Works	Embankments, pumps stations, sluice gates length, width, condition of abutments and wing-walls.
j.	Bridge / Culverts	Indicate location, covered area, type of structure

k.	Utility Mains and Row	Electric, gas and telephone etc.
l.	Utility Substations	Electric, Water works, waste disposal and treatment, gas, telephone line etc.
m.	Deep Tube well Stations	R.C.C. DPHE and other deep tube well stations and output
n.	Mauza, Union/Ward, Thana and District Boundary	Administrative boundaries
O	Khash land	Indicate Administrative boundaries

The features identified above should be provided in the Base map. Names of settlements, village, rivers, khals, lakes, roads, markers, etc. must be indicated in the maps.

Table 2: Physical Infrastructure

	Survey Item	**Illustrated**
a.	Physical Infrastructure	Type, width, length and name of road, road level above datum, slopes, borrow pit. - Identification of any bridge or culvert with their length & width. - Identification of the water supply system, location of overhead water tank and its capacity, location of pumps for direct supply - Identification, location and capacity of electric substation, telephone exchange, gas substation etc. Treatment plant, waste disposal sites. - Identification, location of electricity, telephone, gas and other utility lines of different capacity.
b.	Other Items	- If any new items identified during the survey.

3.4.10 Total Station Survey (Line, Polygon and Point Features)

Location and dimension of most of the physical infrastructures will be surveyed and stored using RTK-GPS supported Total Station (TS) survey technique. The cross-sections of road, drainage divide, drainage channel and borrow pits will also surveyed using Total Station where actual representative of the cross and longitudinal section of the feature can be drawn using GIS or other software. Data will be recorded in the TS memory card with separate ID or code number for each structure. Later on the TS data will be transferred directly to the GIS database where the feature will be kept in separate layer wise as per specified code or ID.

3.4.11 DGPS Survey (Point Features)

Location of point features such as telephone, electricity poles, small hydraulic structures etc. will be surveyed using Data Logger ProXR DGPS. Position data of such features will be stored in DGPS handheld computer with individual ID or code. Later on this data will be transferred to GIS database in layer wise after incorporating the differential correction and necessary processing.

3.4.11 Image Processing

Stereo Satellite Image (3d Image) of high resolution (0.5 m, Multispectral (RGB+NIR)) will be purchase for cross checking the physical feature and physical infrastructure data collected by total station and Digital Photogrammetric Workstation Software will be used. Stereo Satellite Image will be geo-referenced by collecting GCP in respect to established bench mark (BM) of Survey of Bangladesh (SoB) with RTK GPS and Stereo model will be created in real world coordinate by Aerial Triangulation Software.

As it is understood that the proposed assignment includes the works as shown in the flow chart in next page, the methodology has been prepared based on these activities and the assignment will be carried out accordingly.

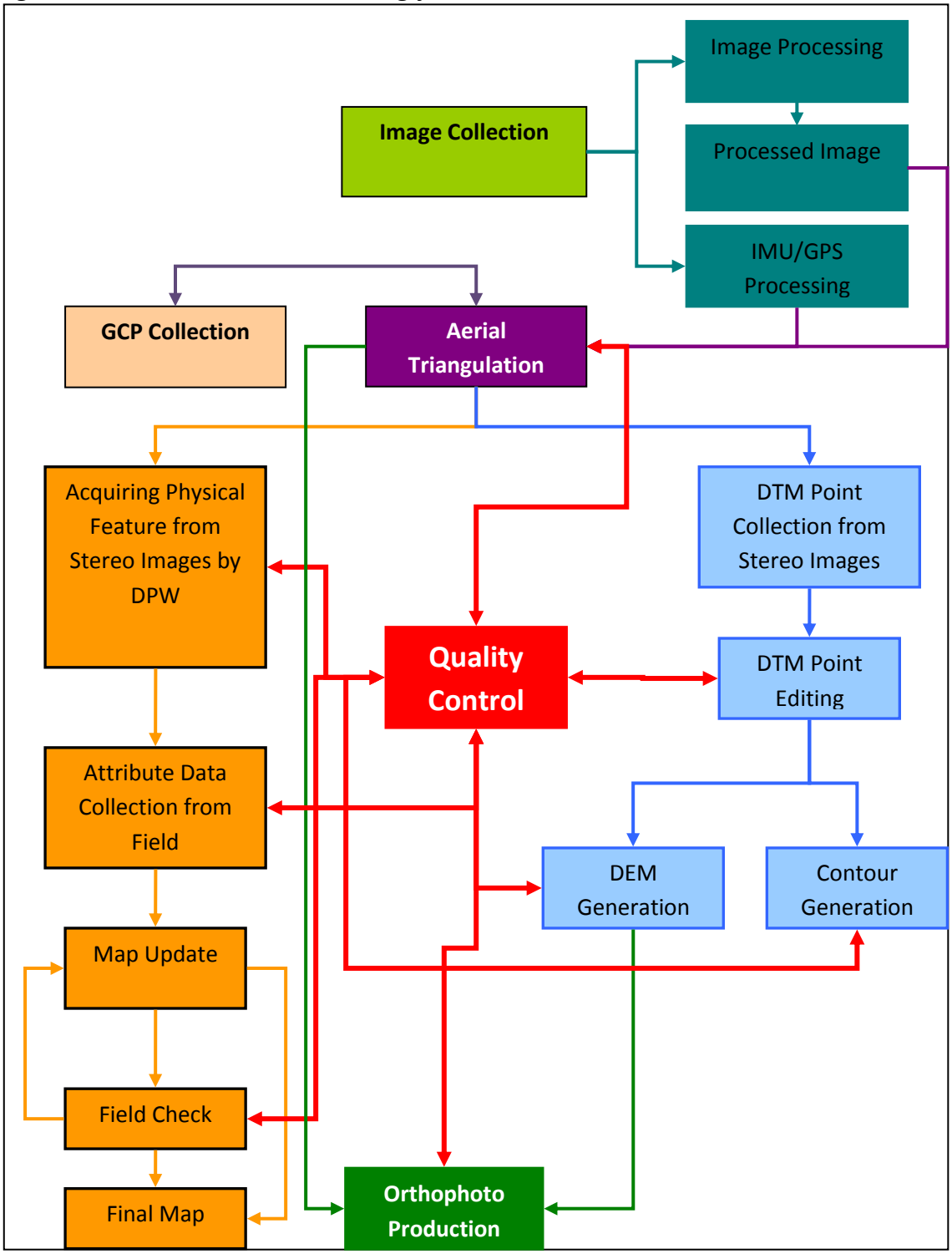

Fig 3.3

Figure 3: Flow Chart of Methodology

3.4.12 Image Collection

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, GeoEye Inc.

The GeoEye-1 Satellite image in 0.5-meter panchromatic and 1.74-meter multispectral four-band images in stereo pairs will be procured. The 0.5-meter pan and 1.74-meter multispectral imagery will also be used to yield 0.5-meter color imagery (pan-sharpened).

Image Processing

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

GPS/INS Processing

Raw IMU (GPS/INS) data of image will be processed and adjusted to accomplish Aerial Triangulation.

3.4.13 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 project area. All GCPs will be collected by conducting field survey using DGPS method. After collecting DGPS data of the GCP, post processing will be done day to day in the sites. Accuracy level will be maintained within 10 cm.

3.4.14 Aerial Triangulation

Aerial Triangulation is a mathematical process used to determine the position and orientation of each photograph at the moment of exposure.

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

3.4.15 Digital Mapping from Stereo Model

After the orientation of stereo models, digital mapping will be carried out. We propose Arc GIS Geo-database model for storing geo-spatial data. The proposed Geo-database 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 (DPW) will be used as the platform for acquiring features from digital stereo images (model).

Figure 4: Photograph of a DPW

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 Arc GIS 9.3 of ESRI will be used for vector data storing and editing.

3.4.16 Attribute Data Collection and Field Verification

Attribute data of the features will be collected from the field after producing base map. It will be a step by step procedure. GPS and total station will be used for filed object verification

Map Updating

Attribute data and missing map object 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

Data Delivery

After the collection of all filed database, final map data will be produced and delivered to UDD for approval.

3.4.17 DTM/DEM/TIN/Contour Generation

DTM Point

Digital photogrammetry is able to acquire3D points for high spatial resolution DEM generation through semi-automatic procedures, overcoming the problems of process.

In our 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 Photogrammetrist comparing them with stereo model. Creating and editing of Break lines will be done after this stage.

Contour

After creating DTM Points, Contour lines will be produced with 1.0 meter contour interval. The contour lines will be delivered in 1 km x 1 km or 5 km x 5 km blocks for the project area.

DEM

Using DTM Points DEM will be generated at a resolution of 5 meters in 1 km x 1 km or 5 km x 5 km blocks 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.

Ortho Photo

An orthophoto or orthophoto graph is a photograph geometrically corrected ("orthorectified") such that the scale is uniform: the photo has the same lack of distortion as a map. Orthophoto graphs are commonly used in the creation of a Geographic Information System (GIS).

Rectification of Images

Orthorectification is a process by which image distortions caused by topography and image orientation are geometrically corrected by the incorporation of a terrain model.

Ortho-rectification of every image will be carried out using digital photogrammetric system based on result of aerial triangulation and the generated DEM. Obliqueness of the images will be adjusted in this stage.

Mosaicing of OrthoPhoto

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

i) Seam line Drawing: Drawing the boundary of the image delineating which part of the image will go which image.
j) Balancing of Color and Contrast
k) Feathering

3.5 Topographic Survey

Topographic survey will be conducted by Optical Level in respect to established bench mark (BM) of Survey of Bangladesh (SoB) and 3d Stereo Satellite Image. Topographic data (DTM Points) having X, Y and Z values will be collected at 5 meter grid in urban area and 10 meter grid in rural area.

3.5.1 Land use survey

Land use planning is basically concerned with the location, intensity and amount of land development required for various space-using functions of city life. As planning is concerned with the use and development of land, studies of the existing pattern of land use are fundamental to the subject. This is done through land use surveys. Land use survey basically records the use of land by its functional activity such as residential, industrial or commercial. These are major land uses. As the scale of the map is enlarged, areas with these predominant uses may be further subdivided as required until the individual use of each building and plot of land can be shown.

Total Station and DGPS survey technique will be used for land use survey and land use data will be cross checked by Stereo Satellite Image. Each survey feature will be recorded with individual ID or code. Later on land use features will be identified and classified using the recorded code and separated in different layers during data processing stage, from where the category wise land use map can be drawn using the identification layers of each land uses features. The land use map will be prepared indicating the broad categories of land use indicated below:

Table 3: Land Use Categories

	Physical features	**Illustrated**
a.	Residential	Planned, unplanned, average density (high, middle and low).
b.	Commercial (Markets and Shops/Workshops)	Established markets with ancillary shop groups of shops including small workshops.
c.	Industrial (as classified by Acts and Rules)	Main activity, type of waste effluent.

d.	Institutional Educational Facilities, Health Facilities	Primary/secondary and other schools, clinics, hospitals, etc.
e.	Mixed Use	Mixed areas without a dominant land use (Residential + Commercial, Office + Residential, Commercial + Office, Residential + School).
f.	Agricultural	All types of agricultural uses.
g.	Recreation/Sports	Parks, play/sports grounds, indoor facilities, zoological garden, stadium.
h.	Religious/Cemetery	Mosques, temple, church, mazar and others.
i.	Graveyard, crematory, cemetery	Sites.
j.	Historic	Historic structures or sites.
k.	Borrow pits	Areas cut for fill material.
l.	Vacant	Vacant land with no apparent use.
m.	Disaster prone areas	Flood (Indicating the flood affected area in 1998), Earthquake and fault-line.
n.	Waste disposal	Dustbins and Dumping grounds and other informal point.
o.	Public gathering	Places of Public meeting, open-air cultural performance and religious gathering.
p.	Garden	Indicating bettle leaf, etc.

2.5.4 GIS Mapping (Arc/Info Coverage and Map Lay Out in ArcMap)

Topographic mapping will be done by using PC Arc/Info and Arc Map based GIS software. All data will be provided both in soft (x, y, z) with and hard copy.

GIS data processing and mapping cover the following activities:

- Survey data processing,
- Development of GIS data base, and
- Development of Map layout and legend

As per ToR Geodetic reference, grid and vertical datum for GIS mapping is as below:

- Scale : As per TOR,
- Map size : As per TOR,
- No. of maps : As per TOR,
- Software : GIS (ArcView & ArcInfo),
- Plotting by : HP Plotter using GIS software,
- Geodetic reference : BTM (Bangladesh Transverse Mercator),
- Projection parameter : Scale factor : 0.9996,
  Central meridian : 90° E,
  False easting : 500,000m,
  False northing : -2,000,000m, and
  Latitude of origin : 0° (equator),
- Spheroid : Everest 1830,
  Semi-major axis a : 6,377,276.345m,
  Semi-minor axis b : 6,356,075.413m, and
  Inverse flattening 1/f : 3008017,
- Datum shifts from WGS84: Rotation x : 0.00,
  Rotation y : 0.00,
  Rotation z : 0.00,

Translation x	:	-283.729m,
Translation y	:	-735.942m,
Translation z	:	-261.143m, and
Scale	:	0 ppm

- Reference vertical datum : m PWD (Public Works Department), Bangladesh

3.5.2 Survey Data Processing (GPS and Total Station Data)

GPS and TS data can be stored in WGS84 format (latitude, longitude, ellipsoidal height in meter) or in any projection such as the BTM (Northing, Easting, ellipsoidal height in meter). In order to minimize the error the data will be stored in BTM projection system (as specified in the TOR) in an available file format such as .gen, .shp, .dxf, or .fat. However, conversion of data will be done in the .gen format. i.e. in Arc/Info format.

Development of GIS Database

All spatial information or data from different survey such as line and point features, structures dimensions etc. will be processed and stored under a comprehensive GIS database component. Geographic information System (GIS) software such as Arc Map and Arc/Info will be used for data processing and preparing maps. Later on digitized and geo-referenced mauza maps will be incorporated in the surveyed map.

Preparation of Coverage Description/Information Log-sheet

The log sheet will be maintained for all the developed coverage (created and updated in PC Arc/Info) where detailed description will be noted down with specific technical terminology of Arc/Info format. The log sheets will be supplied to the client during hand over data and maps. In the TOR, instruction and format of such log-sheet is mentioned as below:

Preparation of Map Layout and Legend

A standard map layout will be developed by consultation with concern project officials. Leading GIS software for map production Arc Map 9.3 will be used to develop the standard layout for mapping. Legend for map features will be selected from the available symbol palettes in Arc Map 3.2 and all the soft data will be supplied as PC Arc/Info 3.5 format. Proposed coverage description and legends (compatible to use in PC Arc Info and Arc Map)

are enclosed as **Table No. 2.3** if required; later on this legend will be updated and finalized as per suggestion by UDD. Base maps will be prepared on the enlarged map for the project area indicates following features:

Table 4: Proposed Coverage Description and Legend

Proposed Coverage Name	Feature Type	Coverage Type
• Mauza name and Boundary	Line	Shape/Coverage
• Ward no. and boundary	Line	Shape/Coverage
• Zone no. and boundary	Line and annotation	Shape/Coverage
• Pourashava boundary	Line	Shape/Coverage
• Thana name and boundary	Line	Shape/Coverage
• Mahalla name and bundary	Line and annotation	Shape/Coverage
• Plot boundary	Line/Polygon	Shape/Coverage
• Holding no. and boundary	Point and line	Shape/Coverage
• Park and playground with name	Point/Polygon	Shape/Coverage
• Vacant land with name	Line/Polygon	Shape/Coverage
• Location of primary school with name	Point/Polygon	Shape/Coverage
• Location of high school with name	Point/Polygon	Shape/Coverage
• Location of college with name	Point/Polygon	Shape/Coverage
• University with name	Point/Polygon	Shape/Coverage

• Road with name	Line/Polygon	Shape/Coverage
• Railway line	Line	Shape/Coverage
• River, khal, pond and other water bodies with name	Line/Polygon	Shape/Coverage
• Bridge, under pass and over pass	Point	Shape/Coverage
• Road divider and road island	Line/Polygon	Shape/Coverage
• Footpath	Line/Polygon	Shape/Coverage
• Dustbin and container	Point/Polygon	Shape/Coverage
• Mosque	Point/Polygon	Shape/Coverage
• Mazar	Point/Polygon	Shape/Coverage
• Madrasa	Point/Polygon	Shape/Coverage
• Mandir	Point/Polygon	Shape/Coverage
• Temple	Point/Polygon	Shape/Coverage
• Graveyard	Point/Polygon	Shape/Coverage
• Hospital	Point/Polygon	Shape/Coverage
• Clinic	Point/Polygon	Shape/Coverage
• Health facilities	Point/Polygon	Shape/Coverage
• Community center	Point/Polygon	Shape/Coverage
• Slum with name	Point/Polygon	Shape/Coverage
• Plot wise land use	Polygon	Shape/Coverage
• important establishment with name	Point/Polygon	Shape/Coverage

3.6 Socio-Economic Survey

Planning is principally directed towards people and their needs such as housing, shopping, employment, education, and health services. Detailed information on population is, therefore, essential for deciding land requirement for these needs as well as allocating land between various competing uses. The urban planner must therefore study the existing population in terms of its size, structure, socio-economic characteristics and spatial distribution. He must also equip himself to make predictions about future population in order to assess probable needs in terms of schools, houses, shops, offices, factories and the like, over forthcoming periods of time. Socio-economic data can be collected from secondary sources and primary source through questionnaire survey.

A socio-economic survey for collection of primary data will be conducted in the proposed project area that can assist in meaningful exercise in planning with proper focus on the house hold area. It is clearly understood that the purpose of this socio-economic survey is to obtain the project related socio-economic data on households in the project area.

Data on socio-economic condition will be collected from both secondary and primary sources. General information on Demography, Family size, Age, Religion, Education, Employment and Occupation Pattern, Land Ownership Pattern, Land Value, Land Utilization, Income Level, Health and Recreation Facilities, etc. will be collected from the primary sources through a specially designed socio-economic questionnaire survey.

A stratified weighted random sampling method will be used to conduct the socio-economic survey. The study area will be divided as established urban, newly urbanized within the study area, newly growing area, and rural area. The localities in the study area will be identified depending on this classification. Depending on the actual number of units, some areas from each of these 4 categories will be selected for the sample frames. A complete list of households will be prepared for these selected units, and will be our sampling frame. The purpose of this sub-classification is to ensure that the samples are drawn across the whole study area and no important type is left out, and also duly represented in the sample size according to their number. The sample size will be about 3-5% of the estimated house hold of the year 2006 to be calculated on the basis of 2001/1991 census figure.

A compact and extensive coded questionnaire, suitable for processing by computer will be prepared and finalized in consultation with PD, KDA. The questionnaire will capture a wide variety of information on the basis of the following format as envisaged by the TOR.

Table 5: Socio-economic survey format

Item		**Illustrated**
1.	Demographic information	Age, sex, growth rate, household size, migration etc.
2.	Family Size	No. of household, No. of family member
3.	Age, Religious group	Age specific group, Religious status
4.	Educational Status	Primary, Secondary, higher & others
5.	Occupation Pattern	Government, private, formal, informal and others
6.	Income Level	Lower, medium and higher (income range)
7.	Ownership Pattern	Land ownership information, transfer procedures etc.
8.	Land Value	Low land, ditch land, built-up, buildable land etc.
9.	Health Facilities	Type of facilities in hospital, private clinic and dispensary etc.
10.	Recreation Facilities	Active and passive

During field survey, proper supervision will be ensured by the experienced surveyors for quality data and in case of necessary, repeat interviews and spot checking will be done.

It is expected that from the survey, the following type of data/information (but not limited to this) will be available for using in the plan preparation.

- Holding information like area of holding, number and types of housing structure;

- Housing size, age, sex composition, educational, employment and occupational status, income, expenditure, etc;
- Land tenure ship structure, nature of land, utilization of land, income from land,
- Holding information like house structure, service provision such as electricity, gas supply, water supply connection, etc;
- Sanitation information, type of latrine, sewerage, drainage system, etc.;
- Holding information about urban facilities such as road, telephone, hospital, clinic, community center, etc.; and
- Information about household's attitude towards development works and initiatives.

3.7 Traffic and Transportation Survey

Analysis of present situation

The findings of the traffic and transportation study will form major input towards preparing the proposed strategy, structure, and other spatial development plans for the study area. The main purposes of the sectoral study would be to analyses the study area including an assessment of external links and preparation of realizable proposals for improving the traffic and transportation system by maximizing the capacity of existing infrastructure.

In order to carry out the necessary analysis to fully appreciate the present traffic and transportation problems within the study area, it will require establishing a comprehensive database. This database will be formulated from (i) available data extracted from previous studies, if any, (2) from previous other studies (like BTSS), and (3) supplementary surveys as necessary to be undertaken by the consultants. These data base will be used in the assessment of the present situation and will also form the basis for the analysis of the action plan and long-term strategies.

Activities to be performed

The Terms of Reference provide a broad guideline about the activities to be performed in relation to the transportation study that include:

- Analysis of the study area,
- An assessment of the external links,
- Sectoral programmes to address the deficiencies,

- Examine compatibility of the existing and committed proposals by various agencies, and
- Preparation of realizable proposals for improving the traffic and transportation system.

In order to carry out the mentioned activities, various surveys will be required. The scale of surveys to be carried out will require the establishment of a management survey team comprising a survey director, field supervisors, surveyors, and data entry operators and supervisor. The structure and composition of the field survey team will vary depending on the type of survey and transport mode. A general team structure is shown in **Figure 4.2.3-3**. However, the exact team structure to be adopted for this study and the preparation of the survey methodology and programme will be defined following pilot studies. These will be used to test field conditions and procedures, verify the format of the survey forms, evaluate staff performance, establish requirement of surveyors, and identify unforeseen problems.

The first stage towards conducting the transport surveys would require dividing the whole of study area into imaginable geographic zones. The zone boundaries will be based where possible on the following:

- administrative boundaries,
- incorporate natural boundaries,
- road alignment, and
- existing and proposed land use boundaries

The approach and methodology proposed to be used for the surveys and analysis of the collected data are discussed in more detail below. Full cooperation will be required from all concerned authorities, especially particular assistance from the police.

3.8 Transportation Infrastructure and Facilities

This component of information is essential for preparation of an inventory of existing facilities available, in the study area for the transportation of passengers and goods by all the 3 modes of road, river and railway. The infrastructure data gathering programme will fall into these three modes of groups. The required information will be collected from the relevant authorities as

well as field surveys to be conducted by the consultants. In addition to this data gathering exercise from primary and secondary sources, an overview appraisal will be developed of the interaction of modal groups, particularly in relation to the spatial development pattern and proposed or committed strategic infrastructure and future development.

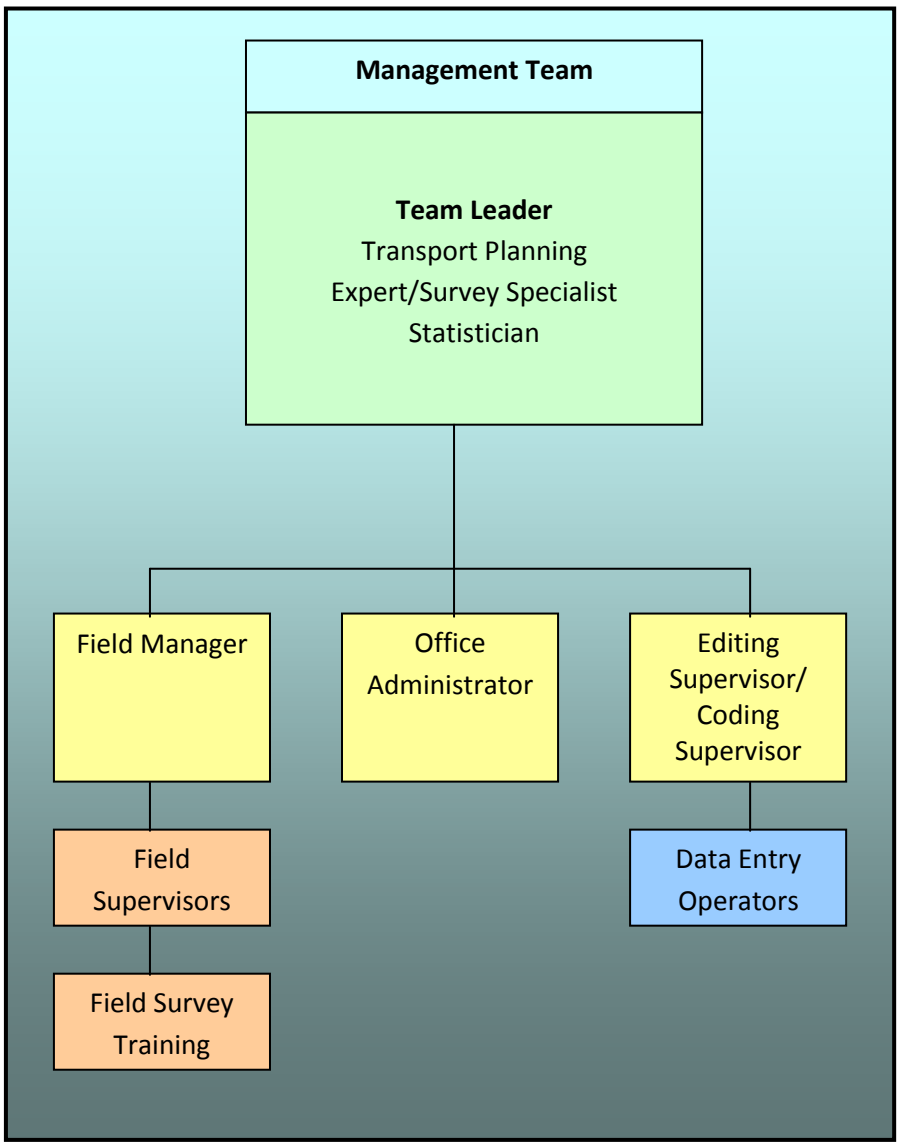

Figure 5: Transport Survey Management Organization

The consultant will review existing information and where necessary carry out surveys to obtain further information on available facilities for the 3 modes in the area. Major information to be collected by mode is mentioned below

Road

- Road network by hierarchy,
- Physical condition of roads (row, x-sectional elements, pavement type and condition etc.),
- Geometrics of major road intersections,
- Truck routes, and their loading and unloading areas,
- Bus route and terminals,
- Traffic control, management, and signaling, and
- Parking

River

- Location of existing Ghats and terminals,
- Physical condition and facilities,
- Inter-modal transfer facilities

The summarized information collected on completion of this activity will form a part of the report on the proposed traffic and transportation study.

3.8.1 Transportation Fleets and Services

In addition to the physical infrastructure and facilities, information will be obtained on the transportation services and fleets operating within the study area. Most of the information will be collected from various registration authorities for different types of vehicles and from their owners' and operators' associations. However some field surveys and verifications will be required especially related to non-motorized vehicles. The major information to be collected by mode includes the followings.

Road

- Number of motorized vehicles by their types, condition and ownership,
- Number of buses by route,
- Extent of and forms of public transportation services, their service conditions, fare levels etc.,
- Number of trucks, condition and ownership,
- Number of tempos and their service route, fare level, extent of service,
- Number of rickshaws and fare levels,
- Number of all other types of NMVs,

- Types of goods carried, and
- Information on cost by different modes

River

- Number, types, condition, and capacity of ferries and other river transport operating in the study area,
- Services operated and their frequency,
- Types of goods carried, and
- Cost

The summarized information collected on completion of this activity will also form a part of the report on the proposed traffic and transportation study to be carried out under the project.

3.8.2 Volume and Movement Patterns

The volume and movement pattern of people and goods within the study area will be collected through a series of volume and O-D surveys for all the modes - road, and river; separate methodologies will be followed for the modes.

In addition to collecting information on volume and pattern of traffic movement by traffic surveys, the consultants would try to accommodate certain important questions regarding people's attitude, preference etc. in the questionnaire for the housing sector study to be carried out under the project.

The methodologies to be followed to determine volume and movement pattern of traffic are discussed below.

Road

A comprehensive O-D survey extended to the whole of the study area will be carried out. As already discussed, for this purpose the whole survey area will be divided into a suitable number of traffic zones depending on the homogeneity of activities in the zone.

The road side interview method will be followed. With the assistance of policemen, vehicles of all types will be stopped and questioned regarding their origin and destination and other journey data. The surveyors will enter all these information in a recoded form.

The interview sites will be located as near as possible to the zone boundaries. Each interview team will consist of at least 5 members (exact number will depend on field condition) two

members for each direction and a team leader. In each direction one member for making a classified count of all vehicles and pedestrians passing and the other member conducting the actual interviews. Manual hand-held counters will be used for counting purpose.

Sampling procedure will be used for taking interviews. Sample size and survey hours will be determined from field conditions. Depending on field conditions in most locations, survey hours will be between 12-18 hours.

A total counts will be made for few days at some locations (control stations) to raise the survey data for 24 hours for all other locations. The survey will be conducted on different similar days at different locations. Volume counts may be repeated few times at some major locations.

Besides O-D surveys, separate vehicle counts will be made at all strategic locations and critical intersections, record of congestion and queue lengths will also be made at these points. Separate pedestrian counts will also be made at these points.

Another important aspect of the road traffic survey will be determining their journey times. On-board observer method will be followed for public transport services. The moving observer and licence plate method will be followed for other types of vehicular traffic. Spot-speed will be measured at strategic locations.

A parking survey will also be carried out at major parking locations to determine accumulation, duration, turnover utilization, extent of illegal parking and cordon counts to determine net vehicles in core zones.

River

Direct counting of arriving and departing passengers in the study area will be made at the Ghats and river terminals. These data will be supplemented by data collected from the service operators (public and private).

For goods traffic, a destination survey will be made between traffic in relatively large and small units. In case of large mechanised units, inquires will be made with the shippers, IWTC, jute and other bulk commodity traders. For small units, like country boats, direct and O-D surveys will be made at the Ghats/loading and unloading points. Similar techniques like interview method for road traffic will be applied for the boat or river traffic survey.

3.8.3 Analysis of Volume and Movement Patterns

After completion of the traffic and transportation surveys as discussed above, sufficient information will have collected and collated to proceed further with the planning activities. The collected information will be collated and analyzed with the help of a wide variety of computer programmes. The final selection of the package for data collation, statistical and spatial analysis, matrix building etc. will be assessed during actual designing of the surveys and at the data collection stage.

The validation of the survey data will form an integral part in the process of collection analysis. The output of the data collation, analysis and model will be presented in tabular and graphical forms indicating the volume and movement patterns of the people and goods within the study area. These outputs will be used to identify the principal corridors, desired line of travel and to assess the adequacy of the existing transportation system against the present and future requirements. The analyses would also reveal which areas within the system are deficient and creating problems. Identification of the problems, their extent and causes would eventually enable consideration of their remedial measures. These are discussed hereunder.

3.8.4 Current Problems and Their causes

As already mentioned, from the analysis of the collected data a detailed assessment of the volume and pattern of traffic movement, the operational performance and the efficiency of use of the existing infrastructure will be made. Traffic volume and performance will be assessed with respect to the following aspects:

- Volume of traffic along major corridors by type,
- Traffic movement by time of day,
- Person trips by time and mode,
- Commodity carried by type of goods vehicles,
- Congestion point identification,
- Inadequate capacity locations,
- Public transport services, capacities, journey times by modes,
- Modal split for goods and passenger traffic safety conditions,
- Conditions and facilities for non-motorized transportation including pedestrians,

- Loading/Unloading of goods, and
- Parking capacities

These assessments will provide a clear understanding of the major problems and issues affecting traffic circulation and transport services in the study area. They will also provide an insight to the causes for such problems.

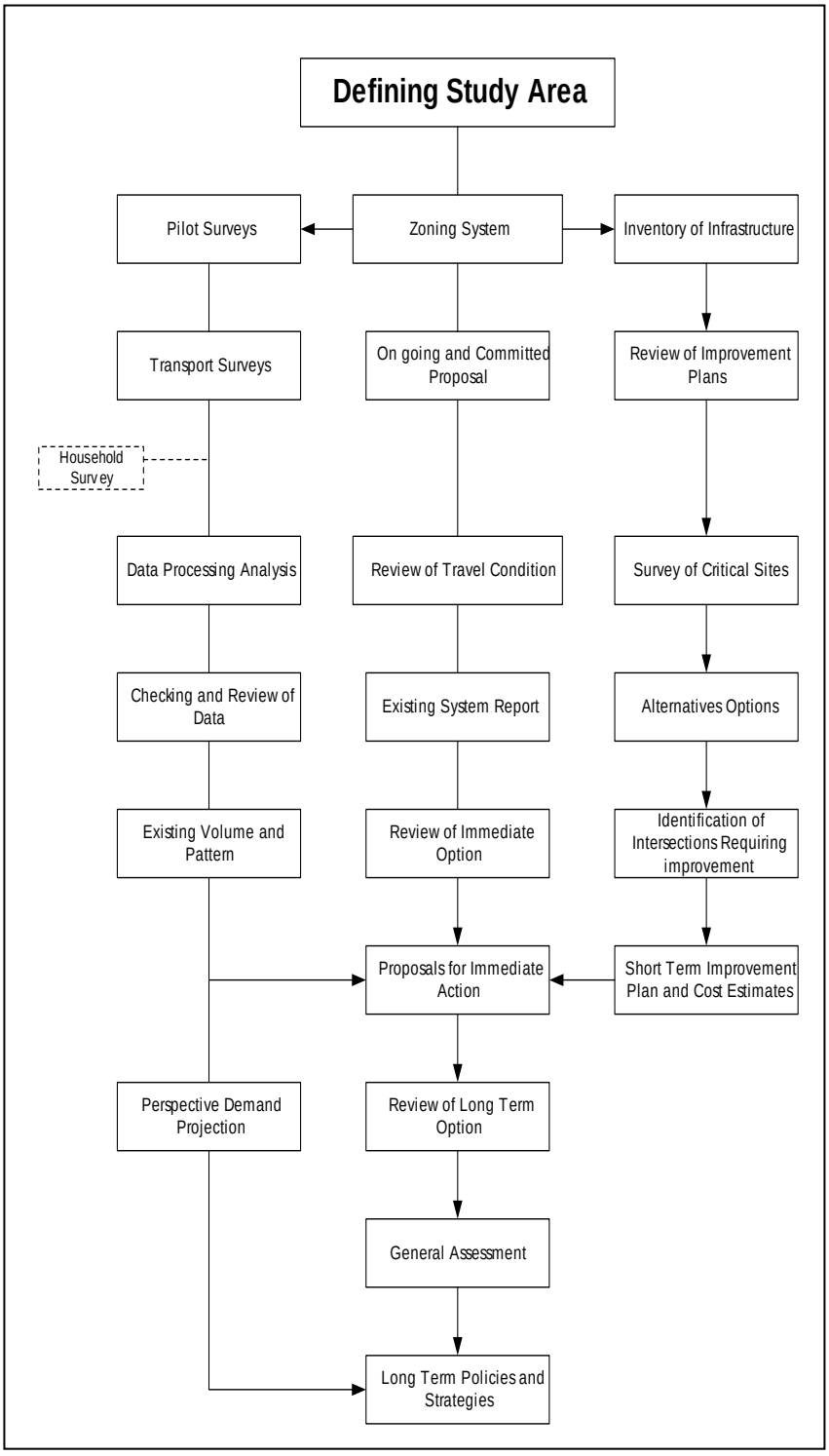

Figure 6: Activities Related to Traffic and Transportation

3.9 Preparation of Proposals for Improvement of the System

Identification and examination of viable options to improve the efficiency of the transportation facilities within the existing infrastructure will be a major objective for the transportation study. Various options will be examined for immediate, mid-and long-term considerations. To suggest immediate actions, the options to be examined can be categorized as follows:

- traffic management,
- low cost infrastructure,
- enforcement,
- improvement of public transport,
- management of NMTs, and
- institutional aspects

Under these broad categories, various measures will be assessed considering the identified problems and system deficiencies.

The traffic management aspect will consider signaling, intersection layouts, one-way flow, lane reservation for NMVs, various types of segregation (by space, time, level etc.) and operational restrictions.

The low cost infrastructure improvement options will include lane marking, median, channelization, bus stops, bus and truck parking areas, freight transfer points etc.

Improvement of public transport will consider rerouting, new routes and service frequencies, fleet size, interchange points etc.

The institutional arrangements will consider improvements in planning and regulatory functions of responsible agencies and coordination among them.

Management of NMTs will consider various segregation and restriction measures as well as new facilities for their safe and smooth operation.

After reviewing and assessment of various options available and considering their effectiveness and cost in relation to the magnitude of the identified problems, the consultants will develop a

programme of works/actions needed for the immediate improvement of the traffic and transportation systems in the Study Area. Appropriate authorities will also be identified for implementation of the proposals.

3.9.1 Long Term Policies and Strategies

The team leader will examine all the on-going and committed major infrastructure proposals in the study area and their likely effect on the transportation system of the city. All such proposals affecting the transport system will be shown on a map together with their likely effects on existing transport infrastructure. An assessment of their effects will also be made towards addressing the present deficiencies as identified by the various surveys conducted.

With all these information on the likely effects of the on-going and committed proposals, the next step will be an assessment of future demand/capacity requirements and their geographical patterns. On the basis of future demand, an overview of traffic and transportation infrastructure and service options will be developed. Future demand will be assessed through traffic forecasts.

The list of long-term strategic options cannot be precisely determined at this stage. However, it may include: strategic road options, public transport options, freight options, and restraint measures.

Under the strategic road options, to address the problem of capacity limitations, the consultants will consider new road links and widening of existing roads. For public transport options, alternative options will be examined to accommodate the future anticipated demand. Route alignments and depot/terminal sites will be examined for each of the systems considered.

Freight options would include the provision of depots and other terminal facilities to manage the movement of freight traffic in the study area. Management of slow moving non-motorized transport is expected to be an important issue in the near future. Traffic restraint options for different types of vehicles in different areas can bring significant improvement in system efficiency. However, the consultants are aware that restriction measures of any form are generally dislike by the public and any such proposal will have to take special considerations to avoid public and political conflicts

3.10 Hydrological Survey

Water is one of our most important natural resources. Without it, there would be no life on earth. The supply of water available for our use is limited by nature. Although there is plenty

of water on earth, it is not always in the right place, at the right time and of the right quality. Adding to the problem is the increasing evidence that chemical wastes improperly discarded yesterday are showing up in our water supplies today. Hydrology has evolved as a science in response to the need to understand the complex water systems of the Earth and help solve water problems. Hydrologists play a vital role in finding solutions to water problems, and interesting and challenging careers are available to those who choose to study hydrology. Hydrological surveys of the study area are providing technical hydrologic information to ensure proper and accurate management of the water resources for the benefit of the people of the project area. Hydrologic data are provided to Pourashava, and municipal governments, as well as industry and the general public.

3.11 Formal and Informal Economy Survey

An employment and investment survey of the study area is required to be carried out through collection of secondary data and sample survey of major centers of employment. The TOR also requires to project economic activity and workforce by broad employment sectors.

The informal sector plays a very significant role in our economics, as such; a major proportion of employment is in this sector. The nature, characteristics, growth and other things of this sector is significantly different from those of the formal sector. While most of the required information on the formal sector can be obtained from the secondary sources, information regarding informal sector activities has to be collected from the primary source through sample surveys of the major centers of employment. Accordingly, it is essential that the two sectors be studied separately.

3.11.1 Formal Sector

Information on Formal sector will be collected mostly from the secondary sources. Direct inquiries of large employers, chamber of commerce, trade organizations, owners' associations and labour unions will be conducted. Besides, relevant government agencies (Bureau of Statistics, Ministry of Industry) publish regular reports that contain information on employment, investment, production etc. Furthermore, official records will also be a valuable source of such information.

3.11.2 Informal Sector

At first it would be necessary to identify the nature of informal sector activities in the study area. It is expected that most of these activities will be in the service sector and small manufacturing units. A reconnaissance survey is proposed to identify the nature of activities. Sample surveys will be conducted at the household level and at the business unit level with the help of two separate sets of questionnaires. About 1% of both the units will be surveyed. While the household surveys will be designed to collect information on employees, type and nature of employment, income level etc. The business unit level survey will be conducted to collect information on investment, production, if locally consumed, or "exported", type of trading, number of employees etc.

The objective of this study is to analyses the present economic base of the city and to assess how the significance of its economic base is changing compared to the national economy. This would determine the future growth potential of the city. The Consultants propose to apply standard analytical tools for this purpose such as location quotient and shift and share analysis. The findings of these analyses will depict a clear picture about future employment and investment prospects in the study area.

At this stage, it is difficult to suggest anything about the sampling frame. This should be determined after the proposed reconnaissance survey and consultation with KDA and other concerned agencies.

3.12 Other relevant Study

3.12.1 Population and Migration Survey/Study

The consultants are required to analyze demographic and household data on past growth rates and trends of migration for the district and the study area. These analyses are required to consider likely growth factors affecting greater Mymenshingh District’s population in general, and estimate broad population within the district over the next 20 years. The methodology to be followed to carry out these tasks is discussed next.

Data from both the secondary and primary sources will be utilized to accomplish the specified objectives of the study. The 2011 and 2001 census publications (the district and community series volumes) can provide valuable information on demographic structure, migration and other data related to this study. Although these data have their merit because of comprehensiveness for the entire area, for being a little outdated, and as not all the required information will be available from census publications, a detailed household survey will be

conducted. The sample survey will be conducted with the help of a coded questionnaire suitable for processing by computer. The questionnaire will be prepared in consultation with PD, PM, Senior Urban Planner and will be pre-tested before actual survey is carried out. The questionnaire will be designed for the following purposes:

- to find the demographic characteristics of the population,
- to find the socio-economic characteristics of the population,
- to reveal the migration trend and characteristics in the area, and
- to project population for 20 years

For sampling purposes we propose to divide the study area as established urban, newly urbanized within the study area, newly growing area, and rural area. The localities in the study area will be identified depending on this classification. Depending on the actual number of units, some areas from each of these 4 categories will be selected for the sample frames. A complete list of households will be prepared for these selected units, and will be our sampling frame. The households will be again divided as migrant and non-migrant and as household and non-household units. Total size of the sample will be decided after consultation with PD, KDA. It is expected that the size would be about 1% of the total sample universe. Providing weightage on each group, households will be selected randomly for questionnaire survey.

All relevant data collected through questionnaire survey will be presented in appropriate tabular form. Any change in the trend to that of 2001's census report will be analysed. The survey is also expected to produce evidence on fertility rate in the study area. The population projection will be made both at the aggregate level by time series analysis and at the disaggregate level by cohort survival method. However, monthly national level assumptions regarding survival and fertility rate will be used for disaggregate projections.

3.12.2 Environmental Study

The protection of environmental with the provision of mitigation measures and monitoring plan in any physical and utilities development process is the prime consideration starting from its planning to implementation and operation& maintenance. The aim of the environmental study is to improve the general environment in the project and surrounding area and keep the parameters up to the tolerable limit of the human health and ecosystem including water, air, and sound. In the urban area special consideration is made in water supply, sanitation, solid waste management, drainage, flooding, air, sound, food and health hazards, etc. The consultants will

carry out Initial Environmental Examination prior to formulation of plan along with the survey activities in an integrated manner so that some of the interrelated parameters can be collected with respective surveys. In addition, special PRA will carry out to get the basic information of urban environment. Environmental Impact Assessment (EIA) of the project due to planning of land-use/land management, infrastructure planning, physical facilities planning, transportation planning, etc. will be duly assessed and mitigation measures for the negative impacts be suggested to incorporate in the planning. In addition, an Environmental Monitoring Plan (EMP) will be prepared to follow during construction and operation and maintenance. The environmental study will be carried out in the line with standard guidance outline of DOE, ADB, World Bank as applicable to Bangladesh.

The assignment will be undertaken by the consultant to conform to the following guidelines mainly:

- Environmental Guideline, Department of Environment, Bangladesh,
- ADB's Guideline for Environmental Study and Environmental Management;
- World Bank, Operational Directive OD4.01: Environmental Assessment;
- World Bank, Operational Policy OP4.04: National Habitats;
- World Bank, Operational Policy OP4.02 Environmental Action Plans;
- The World Bank, Environment Assessment, Source book, Volume-I-III (World Bank Technical Papers No. 139, 140 and 154);
- All other relevant regional policies and guidelines;
- The approach for environmental assessment study will comprise the following stages;
- Field reconnaissance survey to assess the container depot site and connecting railway corridor;
- Collection and analysis of secondary data;
- Stakeholders Consultation and Local Enquiry to take preliminary information on Project Site;
- Consultation with concerned authorities to understand legal aspects and requirements of the Project;
- Study of alternative feasible sites from environmental point of view;

- Preparation of checklist of environmental issues likely to be involved;
- Environmental screening to identify critical environmental issues associated with influencing of Project Area;
- Preliminary analysis of alternatives and its ranking from environmental angle; and
- Further study requirements and its scope.

Identification of Environmental Issues

Conceptually, the Environmental Impact Assessment (EIA) will encompass determination of existing environmental status, assessment of probable environmental impacts due to specific activities of the proposed project and recommendation of measures that would mitigate or minimize the environmental impacts. Both Primary and Secondary data for physical environment, ecological environment, economic resource and social resource would be utilized.

3.12.3 Environmental Screening

Environmental Screening for proposed container depot site along with connecting railway corridor will be undertaken in order to determine directly and indirectly related environmental issues and major issues requiring further environmental analysis including the analysis of alternative, if appropriate, to resolve such issues. The environmental screening will include the analysis of available information supplemented by appropriate study area surveys and will adopt the criteria as proposed in Inception Report.