5.3 PRELIMINARY DESIGN OF HIGHWAY AND ASSOCIATED FACILITIES

5.3.1 Design Standards and Criteria for Preliminary Highway Design

For designing a highway, it is commonly required that the type and function of the highway be identified according to some principle of road classification. The highways and roads are, typically in most standards, classified by;

- Road type: Access-controlled, or not,
- Area of the road: Rural, or Urban,
- Terrain of the area: Level, (or Rolling), or Mountainous, and
- Traffic level in the target year: ex. ADT ranking.

By identifying such attributes, a highway is ranked to a class of the applied standard and, usually a corresponding design speed is specified.

As shown in Table 5.3.1, the highway of the Padma Bridge Project is to be planned as a highway with full control of access in the rural area on the flat terrain, and the traffic demand is forecast as 41,550 vehicles a day for the target year, 2025, ten years after commissioning. Accordingly, the Project highway will be assigned to a rather high-grade class of any standard to be applied with a design speed of 80 km/h, at lowest.

Table 5.3.1 Road Classification Principle from Geometric Design Aspect

	General Case	Padma Bridge Project
Road Type	Control of access, or No control of access	Control of access
Area	Rural, or Urban	Rural
Terrain	Level, (or, Rolling,) or Mountainous	Level
Traffic Projection for Target Year	ADT ranking	41,550 vehicles per day for 2025
	↓	↓
	Road Class No. of lanes Design Speed	Clear the relevant Standards requirement 4 lanes > 80 km/h

There are two potential design standards to be possibly applied to the preliminary design of the Project highway, ——— namely,

- RHD Geometric Design Standards of Bangladesh, and
- Asian Highway Classification and Design Standards of the UN ESCAP,

As a basic policy for designing the Project highway, these two standards are to be jointly applied to the geometric design in coordination with each other, ——— consequently, leading inevitably to adoption of a higher standard of the two on each design aspect.

Table 5.3.2 shows the main features of the geometric design, specified by the two standards, as well as the Japanese standards for reference purposes only. The Project highway, having such attributes as shown in Table 5.3.1, is classified as;

- Type-2 (design speed; 80 km/h) of the RHD Geometric Design Standards, and
- Primary, Level Terrain (design speed; 120 km/h) of the Asian Highway Classification & Design Standards.

Jointly applying these two standards tends to adopt more dominantly the AH standard, which has apparently a higher design speed than the RHD standard. But actually the difference in the total bridge widths between them in case of future railway loading is quite little, and consequently the effect to the construction cost is minimal. Moreover, though present condition of NH8 which connects to the project is lower than the AH standard, the road could be upgraded to the standard within 100 years which is the design life of Padma Bridge. It will be extremely difficult and costly to widen such a huge bridge after a completion. In addition, the Study Team believes that, from the traffic safety aspect, provision of the continuous shoulder with an insufficient width must be avoided, and that the shoulder width of 1.8 m specified by the RHD standard is too narrow to be adopted to the Padma Bridge. However, the bridge width applying RHD standard is considered as an alternative design for minimum investment.

As for determination of the number of lanes, neither the RHD nor the Asian Highway standards contain appropriate provisions for the number of lanes. Therefore, the number of lanes on the Project highway has been planned as two lanes in each direction (four lanes in total), based on the objective judgment of the planned highway conditions and the projected traffic demand, referring to the relevant provisions of the Road Structure Ordinance of Japan.

Table 5.3.2 Main Features of Relevant Geometric Design Standards

Standards	Bangladesh RHD Geometric Design Standards	UN ESCAP Asian Highway Classification & Design Standards	Japan Road Structure Ordinance
Classification	Type-2	Primary, Level Terrain	1-2
Design Speed	80 km/h	120 km/h	100 km/h
No. of Lanes	4	-	4
Horizontal Alignment			
Minimum Curve Radius, Desirable (Absolute)	400 m (280 m)	1,000 m (520 m)	700 m (380 m)
Transition Curve Omission	R > 2,000 m	R > 2,100 m	R > 3,000 m
Minimum Curve Length	-	-	170 m
Minimum Transition Curve Length	-	100 m	85 m
Vertical Alignment			
Maximum Longitudinal Gradient	4 %	4 %	3%
Critical Slope for Climbing Lane		3 % - 800 m	-
Minimum Vertical Curve Radius			
Crest, Desirable (Absolute)	4,500 m (3,000 m)	-	10,000 m (6,500 m)
Sag, Desirable (Absolute)	3,000 m (2,000 m)	-	4,000 m (3,000 m)
Cross Section			
Lane Width	3.65 m	3.5 m	3.5 m
Carriageway	7.3 m(2x3.65)	7.0 m(2x3.5)	7.0 m(2x3.5)
Median	1.6 m(2x0.3+1.0)	4.0 m	Desirable Min. 4.5 m(2x0.75+3.0) Absoluet Min. 3.0 m(2x0.5+2.0)
Shoulder	2.7 m(Hard S. 1.8m)	3.0 m	Desirable Min. 2.5 m Absolute Min. 1.75 m
Total Width (Effective Width)	21.6 m (19.8 m)	(24.0 m)	(23.5 m)
ROW	-	50 m, desirably	-
Crossfall	—	2 %	1.5 % - 2.0 %
Maximum Superelevation	—	10 %	10 %

5.3.2 Geometric Design of Project Highway

(1) Route Selection for Project Highway

The route of the Project highway to be proposed at the Mawa-Janjira site by the Study has been selected through investigation and analysis of the following conditions.

(a) Existing Road Network

The Project highway to be planned at this location has a character that it supplements an important, but missing, link on the National Highway No.8 (NH8) over the Padma River. This naturally leads to the primary requirement that its route smoothly connect some existing points on NH8 on both river banks. Thus, the connecting point at the Mawa side is set to be exactly the ending point of the rehabilitated NH8, while that at the Janjira side a point on the newly aligned NH8 near the Charjanajat ferry ghat.

Between the two connecting points to NH8, the Project route crosses several roads including one Regional Highway, 13 local roads under LGED, and some minor trails in the plain on the right bank of the Padma River. Since it will overpass all these crossing roads with grade separation, routing of the Project highway is not primarily affected by this existing local road network.

(b) Topography and River Conditions

The topography of the Project area is dominantly characterized by a world-class major river and its flood plain. The river crossing location has been selected primarily by river engineering screening, taking into account the relative natural stability of the river bank and applicable measures to artificially stabilize the river bank. Subject to the river engineering constraints, the river crossing points on the both banks are fixed, and routing of the approach roads has been drawn in the flood plain on the right bank toward the ending point. There are several crossing inland waterways and waterlogged areas, which are, more or less, unavoidable, no matter how the Project routing is managed.

(c) Geology

The Project area is a flood area almost uniformly covered mainly by sandy soil, which alone hardly affects in any manner the routing of the Project highway. But the river crossing point on the left bank was selected due to the soil condition which has been considerably contributing to the stability of the river bank.

(d) Social Impact Considerations

There are several scattered communities in the Project area on the right bank of the Padma River. Routing of the approach road sections of the Project highway can be managed to avoid relocation of some valuable public/private properties, or reduce the number of affected homesteads, or minimize the community severance, to some extent.

(e) Environmental Considerations

No particular parameters which significantly affect the routing of the Project highway at the Mawa-Janjira site have been detected.

(f) Public Utilities and Railways

It is considered that power lines of 400 KV, gas pipelines, and communication lines are to

be accommodated on the Padma Bridge. But, the routing of the Project highway is not essentially affected by the loading of public utilities.

In some cases in the Study, loading of the broad-gauge, single-track railway on the main bridge section may be also considered. In overall routing of the Project highway, not much attention has to be paid to the railway accommodation, because additional requirements can be met in the process of geometric design of the Project highway and structural design of the main bridge.

(g) Overall Description of Selected Route

The Project highway starts at Mawa on the existing at-grade intersection of NH8 and the existing Regional Highway R812. The distance from the riverbank to the project starting point is about 300 m, and the proposed approach road connects within this interval to the Padma Bridge.

Where the Project highway reaches a riverbank on the side of Janjira, it follows the almost right angle bend of the upper stream and runs along the South Channel up to the Project ending point which connects to the existing NH8.

The distance of the whole project Highway is 17.743 km, which is composed of 0.213 km of the approach road at the Mawa side, 5.580 km of the Main Bridge, and 11.950 km of the approach road at the Janjira side.

On the Janjira side, it intersects with six inland rivers and 14 existing roads (under RHD and LGED). The basic proposed height of the approach road is 8.85PwD which is 1.5 m above the DHWL, 7.35PwD (= 3.04 m from SHWL). The Project Highway connects at Mawa and Janjira to NH8 finished level, by the ADB rehabilitation project, of 8.02PwD and 7.80PwD, respectively. Figure 5.3.1 shows the General Layout of Project Highway.

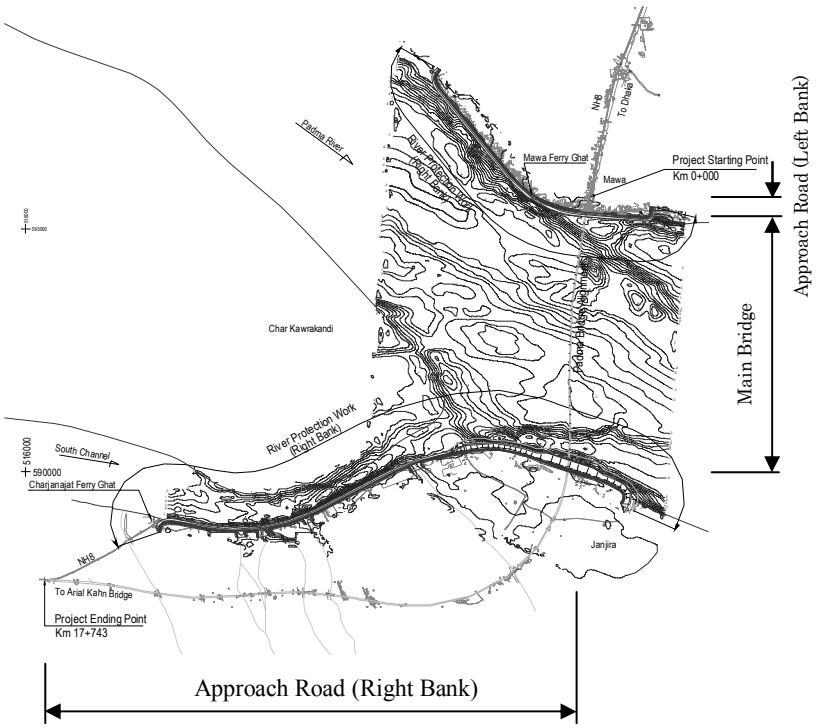


Figure 5.3.1 General Layout of Project Highway

(2) Horizontal Alignment

The basic policy for the horizontal alignment is to have a combination of straight lines, circular curves and transition curves with sufficiently mild and continuous geometry between the starting and ending points. As the route directions at the starting and ending points of the Project highway form almost a right angle, a large, long circular curve with an intersecting angle of about 80 degrees and a radius of 3,000 m, which is the smallest of the radii adopted in the entire Project highway, is set almost adjacent to the end of the main bridge in the plain on the right river bank, and a series of very mild curves and minimal straight lines are extended outward from both ends of this large circular curve.

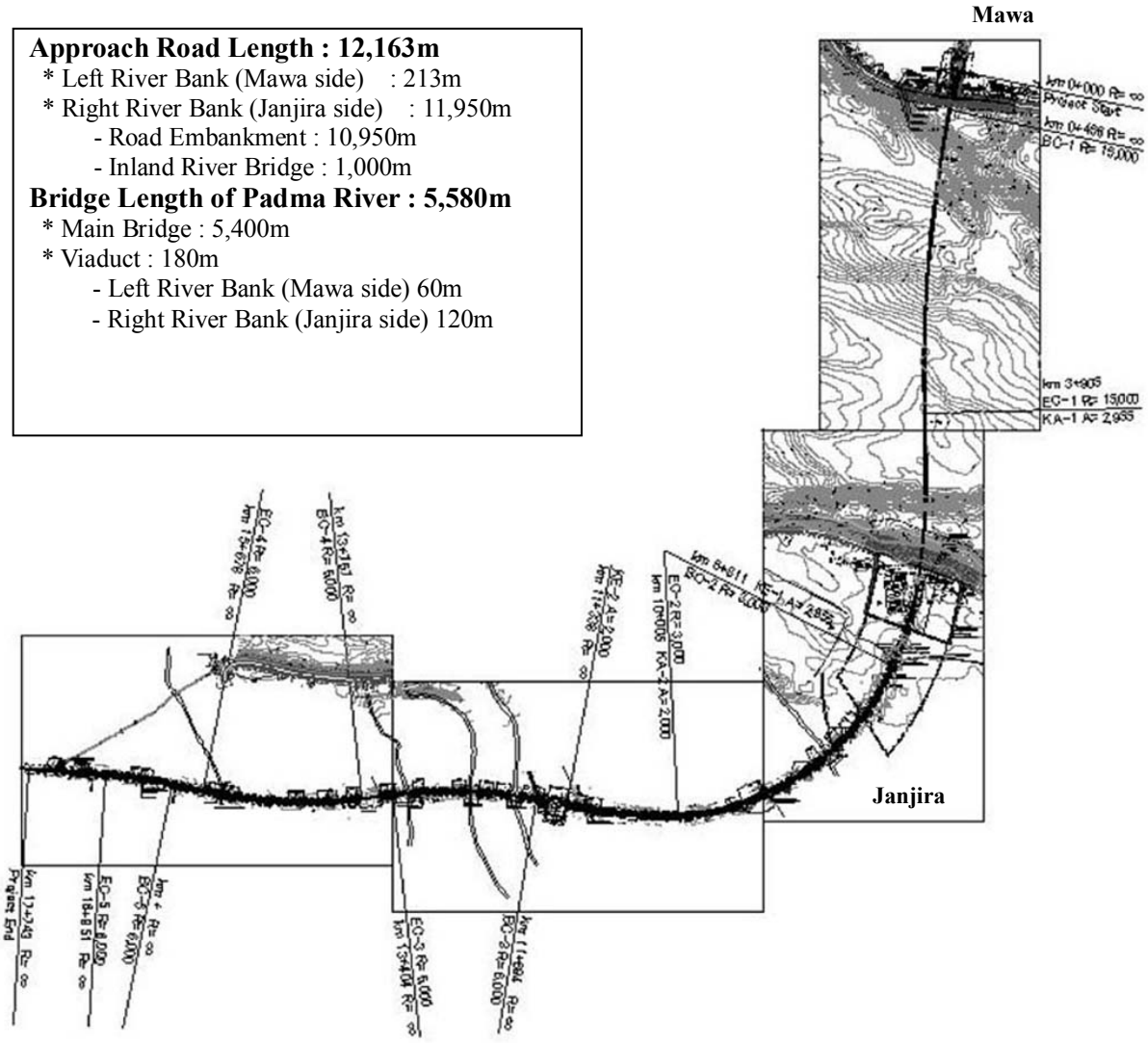


Figure 5.3.2 General View of Horizontal Alignment

(3) Vertical Alignment

Through negotiations with the Bangladesh Inland Water Transport Authority (BIWTA), it has been confirmed that the navigational requirements for the Padma Bridge are;

- Width of the navigable course at the planned bridge site: 4.8 km
- Navigational clearance required for each channel between the adjacent piers
- Horizontal: min. 250 ft.

- Vertical: min. 60 ft. for at least one span, preferably three spans
  min. 40 ft. for other spans

Since the SHWL at the main bridge location is 5.81m PWD, the minimum proposed heights for the principal sections of the Project highway are set as follows;

- Central three spans of the main bridge:
  5.81(SHWL) + 18.29(60 ft.) + 4.60(Girder Height) = 28.70 m PWD
- Other spans of the main bridge:
  5.81(SHWL) + 12.19(40 ft.) + 4.60(Girder Height) = 22.60 m PWD
- Approach road:
  5.81(SHWL) + 3.04(DHWL+1.50) = 8.85 m PWD

These principal sections are inter-connected by slopes of less than or equal to 3% mostly, but 4% at maximum, and vertical curves of adequate radius. The limit of the transition slope is 1% in the section where the railway is supposed to be jointly loaded on the same superstructure with the highway, in case the railway loading is taken into account.

Where the approach road on the right river bank crosses waterways or local roads with a minor bridge or a culvert, some up-and-downs of the proposed height are designed, depending upon the required clearance for these structures.

The basic vertical alignment of the Project highway is shown in Figure 5.3.3 and Figure 5.3.4.

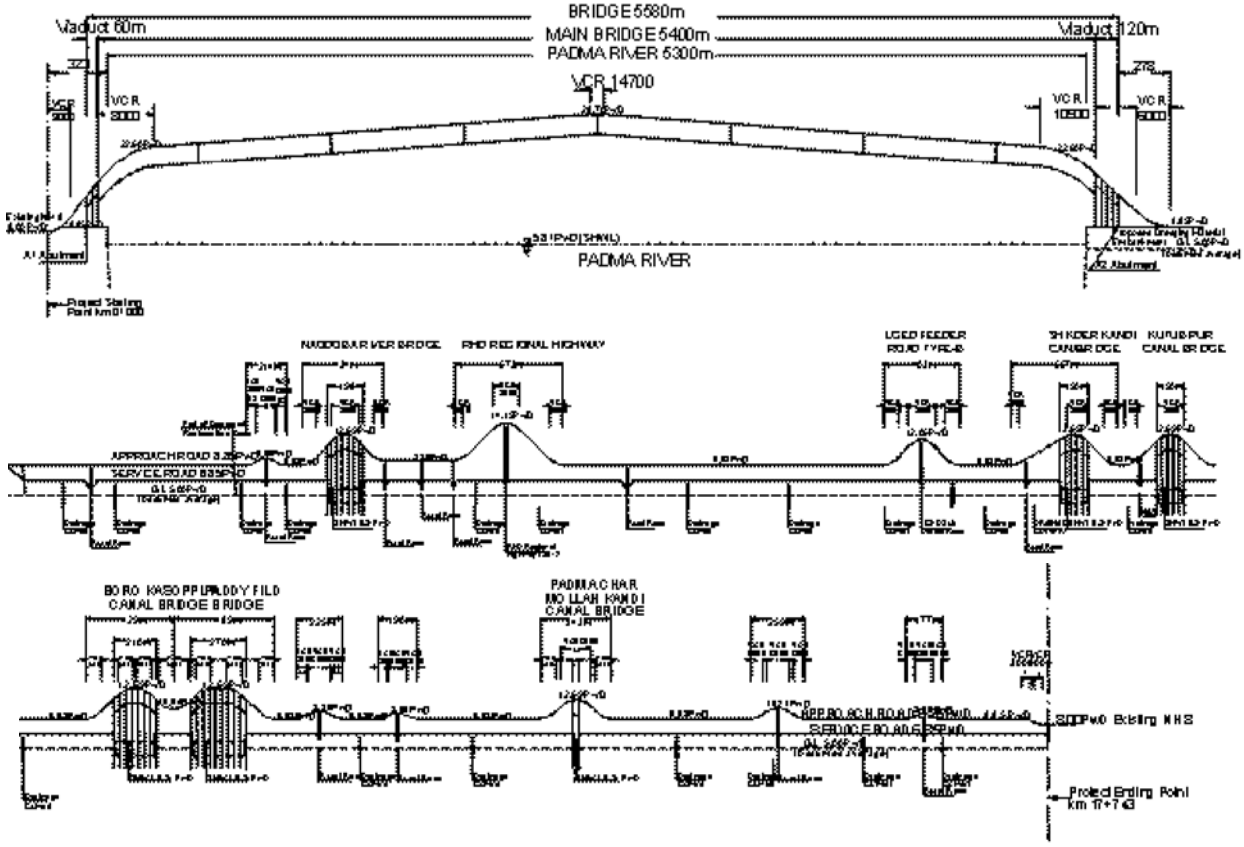


Figure 5.3.3 General View of Vertical Alignment

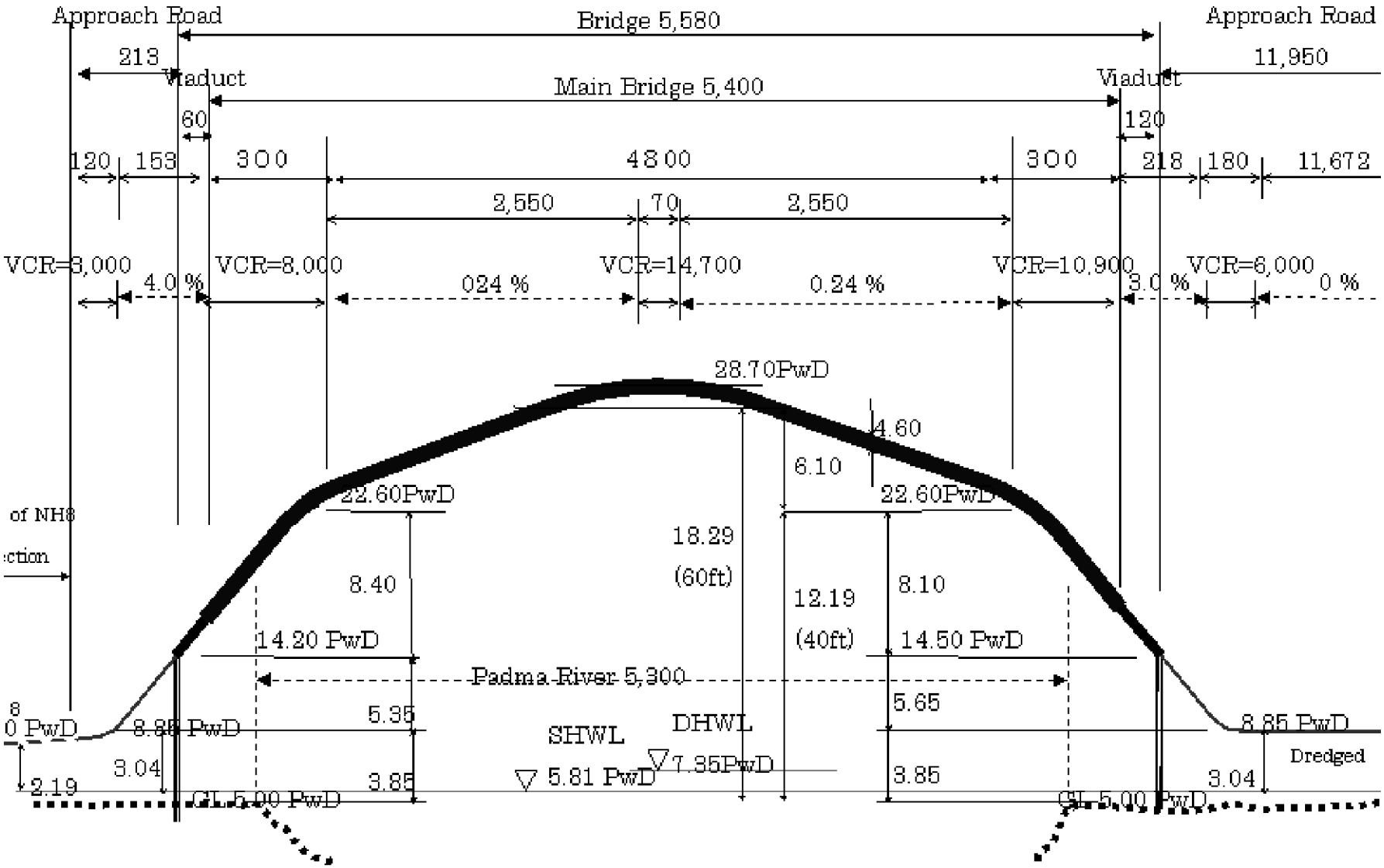


Figure 5.3.4 Basic Vertical Alignment of Padma Bridge Portion

(4) Cross Section

It is judged that even though the primary emphasis is put on the AH standard which generally has higher quality requirements, the typical cross section of the Project highway should be determined separately for the main bridge and the approach road.

Thus, the basic policy for the cross section has been concluded as follows:

- Main bridge:
  AH standard with staged minor modification
- Approach road:
  AH standard

The typical cross sections for these cases are shown in Fig. 5-3-5 through Fig. 5-3-7

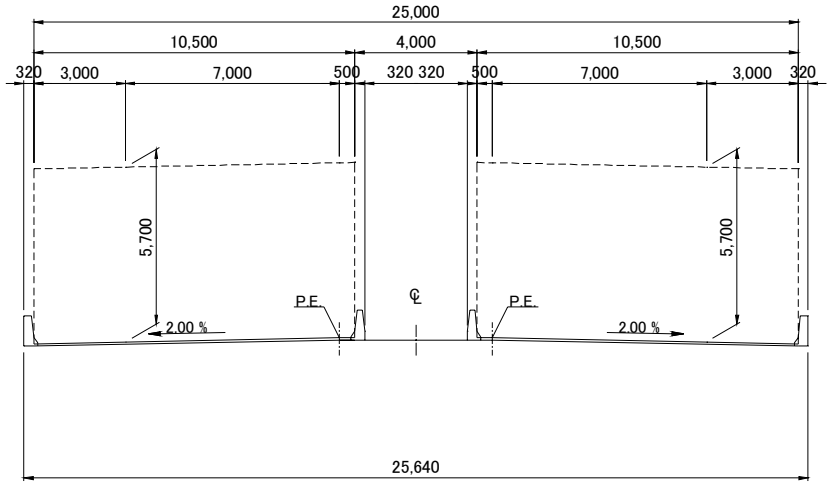


Figure 5.3.5 Typical Cross Section for Main Bridge at Initial Stage

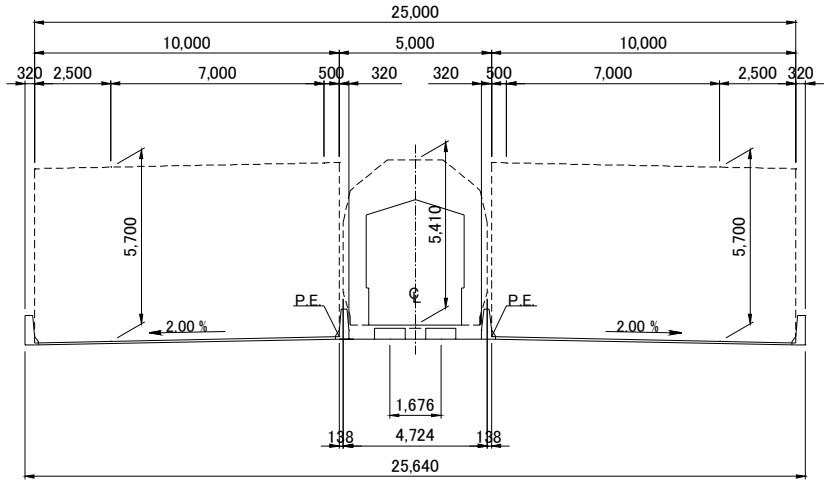


Figure 5.3.6 Typical Cross Section for Main Bridge after Railway Loading

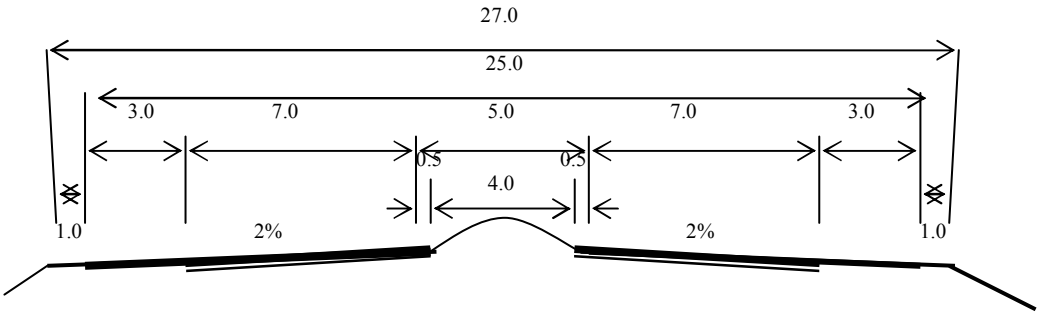


Figure 5.3.7 Typical Cross Section for Approach Road

5.3.3 Preliminary Design of Approach Road

(1) Embankment

The approach road is an embankment, in structure, with the basic proposed height of 8.85 m PWD (3.04 m above SHWL) at the right bank. However, at a number of locations where it crosses local roads and waterways, the approach road is required to have a higher elevation than the basic proposed height so as to ensure the required minimal clearance for the minor structure for the crossing road or waterway, consequently leading to a profile with intermittent rises-and-falls over the basic proposed height.

As for the cross section, the embankment has a crest width of 27.0 m, a slope gradient of 1:3 at both sides, a typical crossfall of the road surface of 2%, and a total right-of-way width of 100 m as shown in Figure 5.3.8.

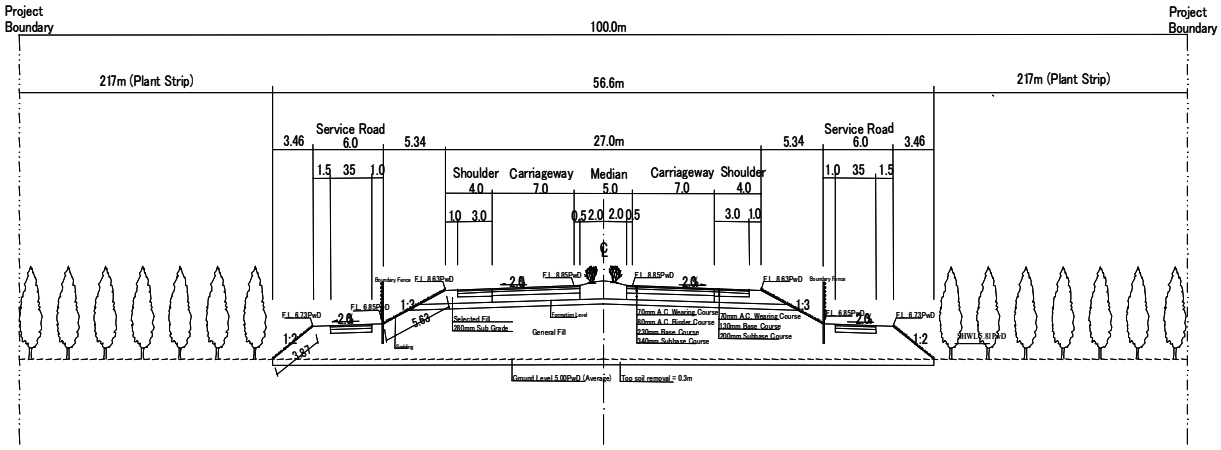


Figure 5.3.8 Typical Cross Section of Approach Road

The available earthwork material from the side borrow is predominantly fine sand with variable amounts of silt and some clay. But the earth to be dredged in a massive amount from the river training work of the Project is expected to have lower silt contents, and should be effectively utilized for embankment.

As the longitudinal gradient on the approach road is basically 0% (level), except for the intermittent rise-and –falls over the crossing roads or waterways, the surface water on the approach road can be catered for by direct transverse run-off along the crossfall of the pavement and the slope of the embankment. As the ground along the approach road generally has no distinct topographic gradient in any direction either, no longitudinal drainage is required at the edge of the pavement or at the foot of the embankment.

(2) Service Roads

The service road is planned at both sides along the approach road, leading the crossing local traffic to the nearest underpass to be provided for a crossing local road or trail. The cross section of the service road is typically as shown in Figure 5.3.9, with a total width of 6 m. The basic formation level of the service road is set to be 2 m lower than that of the approach road of the Project highway (8.85 – 2.0 = 6.85 m PWD).

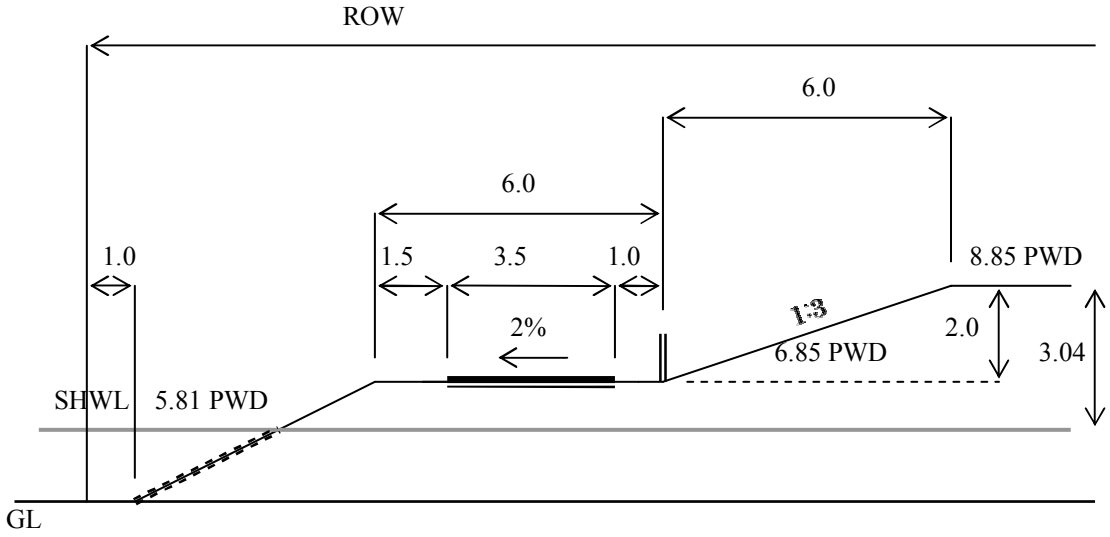


Figure 5.3.9 Typical Cross Section for Service Road

(3) Pavement

The pavement design by the AASHTO method for the approach road of the Project highway is conducted under the conditions as shown in Table 5.3.3, the essence of which is derived from the above traffic data and 1990 Road Master Plan, ADB, and the design traffic load per lane (ESAL) is calculated accordingly.

Table 5.3.3 Pavement Design Conditions

Parameters	Conditions
1) Design Period	10 Years （2015-2025）
2) Design Traffic Volume	122.03 million. vehicles in 10 years
3) Traffic Composition	Truck 18.9%, Bus 63.3%
4) Design Axle Load	Truck(2Axle) 8.42ton、Bus (2Axle) 6.85ton
5) Lane Distribution	120%
6) Design Load （ESAL）	38.02 million. ESAL / Lane
7) Pavement Material	* Asphalt Concrete: 5cm Wearing Course + 10cm Binder Course * Base: Crushed stone base (CBR 80 equivalent) * Subbase: Granular material (CBR 30 equivalent) * Subgrade: Selected material (CBR 8, assumed)

The pavement design resulted in a total thickness of 72 cm for each layer as shown in Table 5.3.4, and the typical cross sections, as shown in Figure 5.3.10.

For the pavement on the ramps, the same composition and thickness as the carriageway will be applied, while the service road will have the minimally required pavement composition,as shown in Figure 5.3.11.

Table 5.3.4 Pavement Design Outcomes

Design Pavement Thickness	A.C. Wearing Course:	7 cm
	A.C. Binder Course:	8 cm
	Base Course:	23 cm
	Sub Base Course:	34 cm
	Total;	72 cm

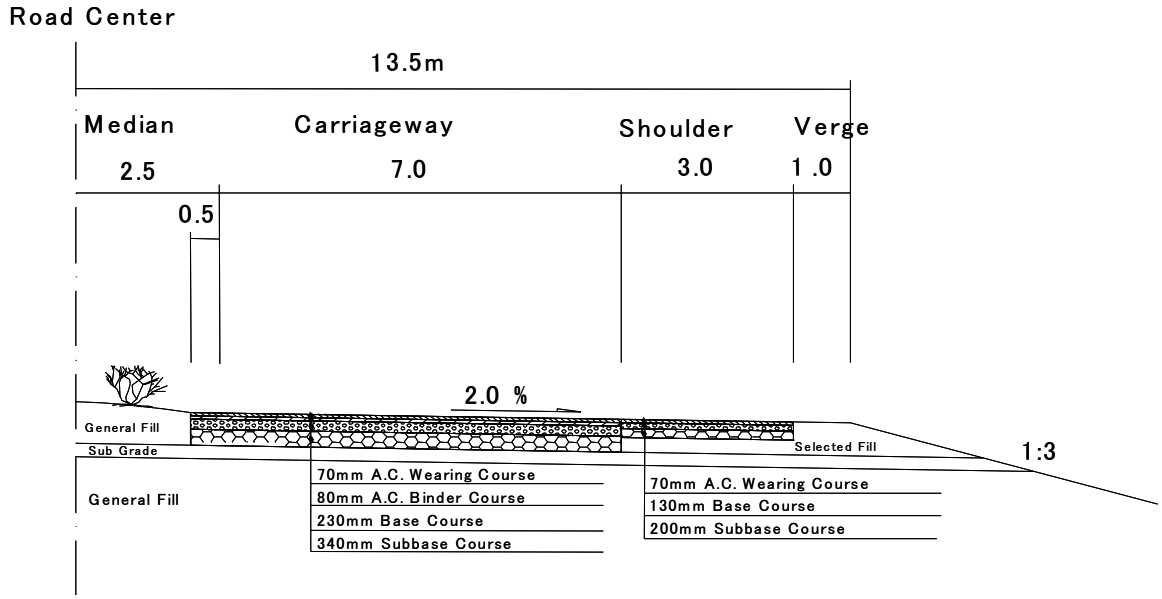


Figure 5.3.10 Typical Cross Section for Pavement of Embankment Carriageway

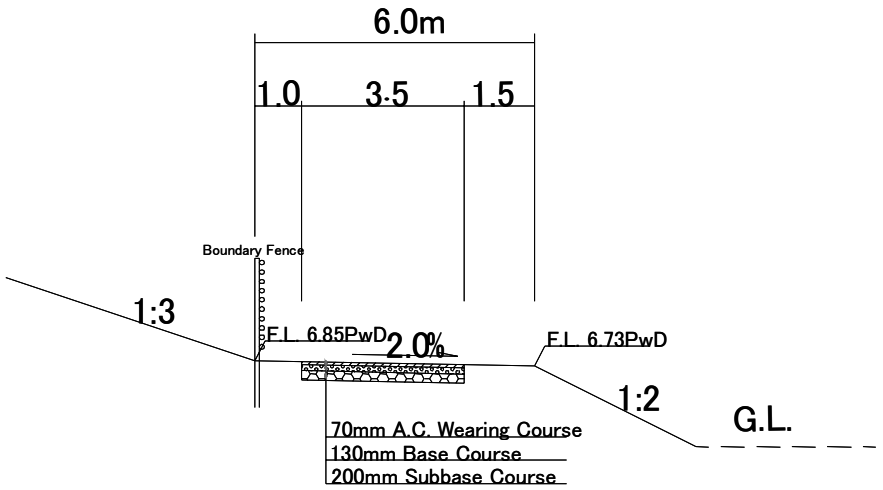


Figure 5.3.11 Typical Cross Section for Pavement of Service Road

(4) Minor Structures

(a) General View of Approach Road

The approach road of the Project Highway will have some minor transverse structures at locations crossing inland waterways or existing local roads, or requiring facilities for ground water drainage. The general features of the approach road with these transverse structures, as well as the embankment, the service road, and the slope protection, in the right-of –way range are as shown in Figure 5.3.12.

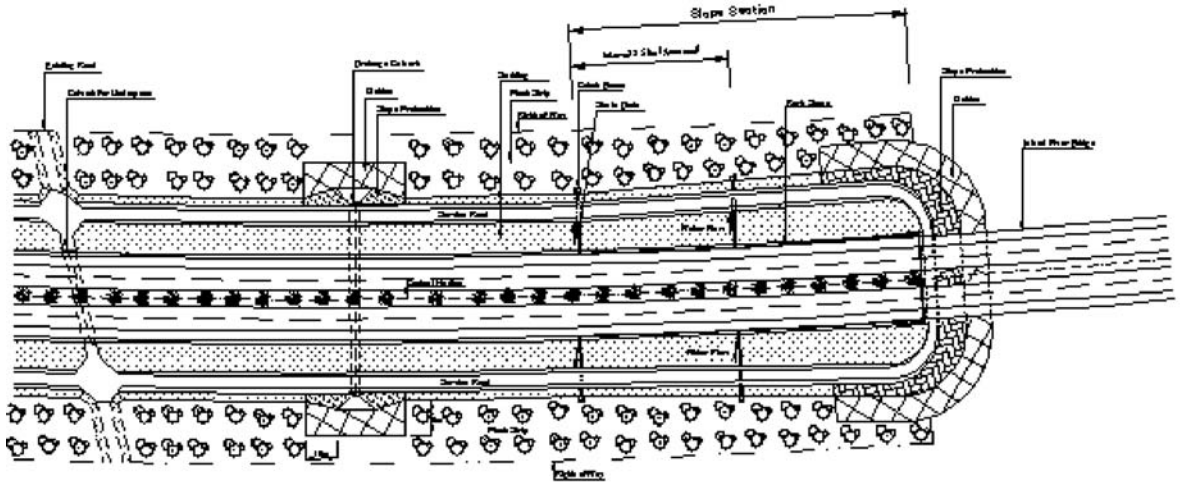


Figure 5.3.12 General View of Approach Road

(b) Bridges on Approach Road

On the right bank of the Padma River, the Project highway crosses five minor inland waterways and one paddy field, which are supposed to be used usually as local navigational channels during most of the period of the year. Through negotiations with the authority in charge, BIWTA, it was concluded that the required navigational clearance for these waterways is horizontally 20 m and vertically 5 m above the water level equal to the SHWL of the Padma River (5.81 m PWD). Those bridges are planned to be single- or multi-spanned with a combination of 20 m and 30 m span lengths.

(c) Box Culverts

Where the Project highway crosses the local roads, the crossing roads are planned to be provided with an underpass of the box culvert type. The dimension and the proposed elevation of the underpasses for each road were determined through negotiation and agreement with RHD and LGED.

(d) Drainage Culvert

Since the approach road crosses the flood plain, transverse culverts are required at 16 potential stagnant water locations for ground water drainage.

5.3.4 Associated Facility Plan

(1) Toll Gate

Since the Project highway is not a network type toll road, but one of the stand-alone type with a single toll section, the simplest toll system with a flat toll rate by vehicle class, having only a single, barrier-type, toll gate in each direction of traffic, is adequate. It is generally required that the toll plaza be located in a section with a straight line horizontal alignment, desirably, or as mild a curve as possible, and a vertical gradient of less than 2%. Due to lack of a proper space on the left river bank, and complying with this requirement, the location of the toll gate has been determined at around km 11+500 on the right river bank jointly for both directions of traffic, as shown in Figure 5.3.16.

For the Project highway, which is located in a rural area, a peak hour factor of 0.08 is multiplied to the forecasted ADT for 2025, 41,550 / 2 vehicles a day in one direction, and the design hourly volume is calculated as 1,662 vehicles an hour. The average service time for the flat toll rate system is empirically around 8.0 seconds per vehicle. Then, if the service level is set as the average queue length of 1.0 vehicle per lane, the required number of lanes in one direction at the toll gate results in 5 lanes.

Though at the roadside of the toll gate, a toll office, where the toll collection is administered, must be positioned, an operation and maintenance station for the entire Project highway, which is the site base of the toll road operator, should be provided at the same location, because the Project highway is a single-section, stand-alone type toll road. The layout plan of the toll plaza and the adjacent operation and maintenance station is as shown in Figure 5.3.13.

Incidentally, the Study Team notes a claim by some Bangladeshi counterparts that the toll gate in each direction should be separately located in the vicinity of the directional entrance so as to physically prevent the users with no money from using the toll road (i.e. crossing the Padma River). Responding to this claim, the directionally separate toll gate plan, which obliges the Study to alter significantly the approach road design on the left river bank, causing a shift upward of the starting point of the Project highway, an increase in the Project length by approximately 500 m, and re-alignment of the connecting NH8, the crossing Regional Highway R812 and the intersection between them, as shown in Figure5.3.14, is presented as an alternative option to the single toll gate location plan.

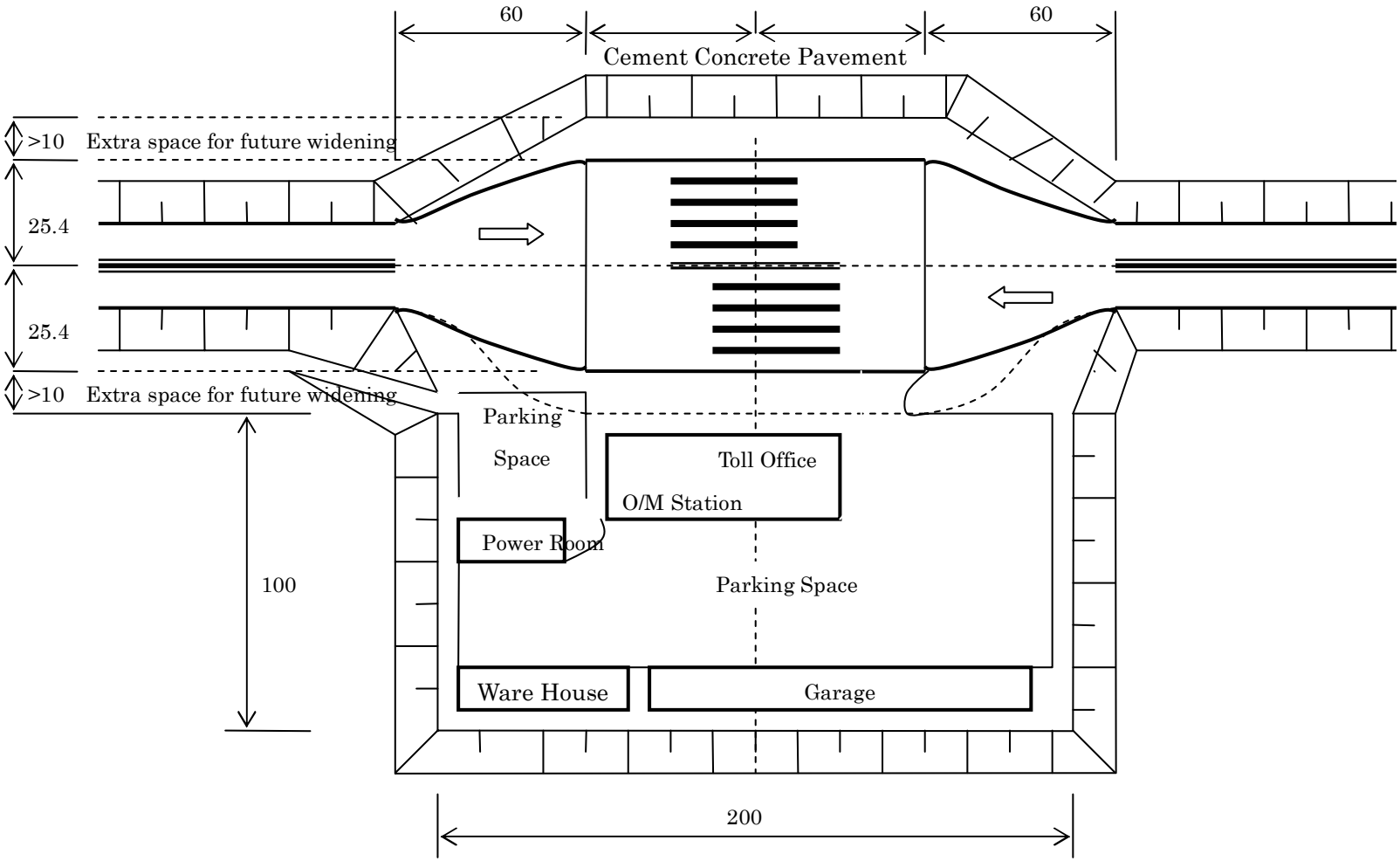
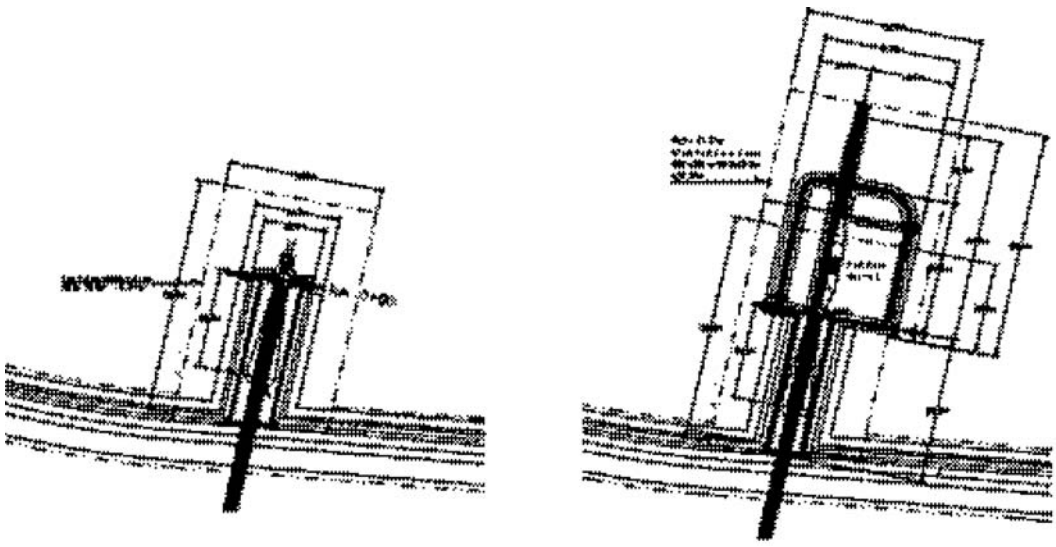


Figure 5.3.13 An Example Layout for Toll Plaza and O/M Station



(A) Proposed Joint Toll Gate Case **(B) Alternative Directionally Separated Toll Gate Case**

Figure 5.3.14 Comparison of Approach Road Shapes on Left River Bank

(2) Service Area

The location of the service area should be selected near the bank of the Padma River, for the reason of the utilization of the Padma Bridge, which is to be designed from an aesthetically sophisticated landscaping spirit over the 6 km wide Padma River, as a tourism resource. Moreover, the right bank should be selected for two reasons, (1) the effective utilization of the reclaimed ground to be formed by the earth dredged from the river training work of the Project along the right river bank line, and (2) there is simply no space on the left bank where the approach road of the Project highway is too short to provide a service area.

The size of the Project service area is tentatively supposed to be "medium," for which the parking capacity is around 150 lots in one traffic direction, according to the Japanese standard.

Besides the parking spaces, the facilities to compose a service area basically include the dining/store building, toilet, gas/repair station, and landscaped/plaza area, for which adequate layout should be considered making good use of the character of the location and, particularly, taking into account the availability of water supply and sewage means. Other facilities, such as a hotel, observatory, picnic area, sports area, amusement center, shopping center, culture center, and so on, could be provided, based upon the demand for them, the culture of the country, the local conditions of the location, the way of business implementation, or the type of financing for the facilities or the Project.

The elevation of the service area should be equal to or higher than the basic proposed height of the approach road in the flood plain on the right river bank, 8.85 m PWD, which requires a considerable amount of earth depending upon the whole size of the service area.

An example plan of the service area is shown in Figure.5.3.15, and the facility plan for the Project highway in Figure 5.3.16.

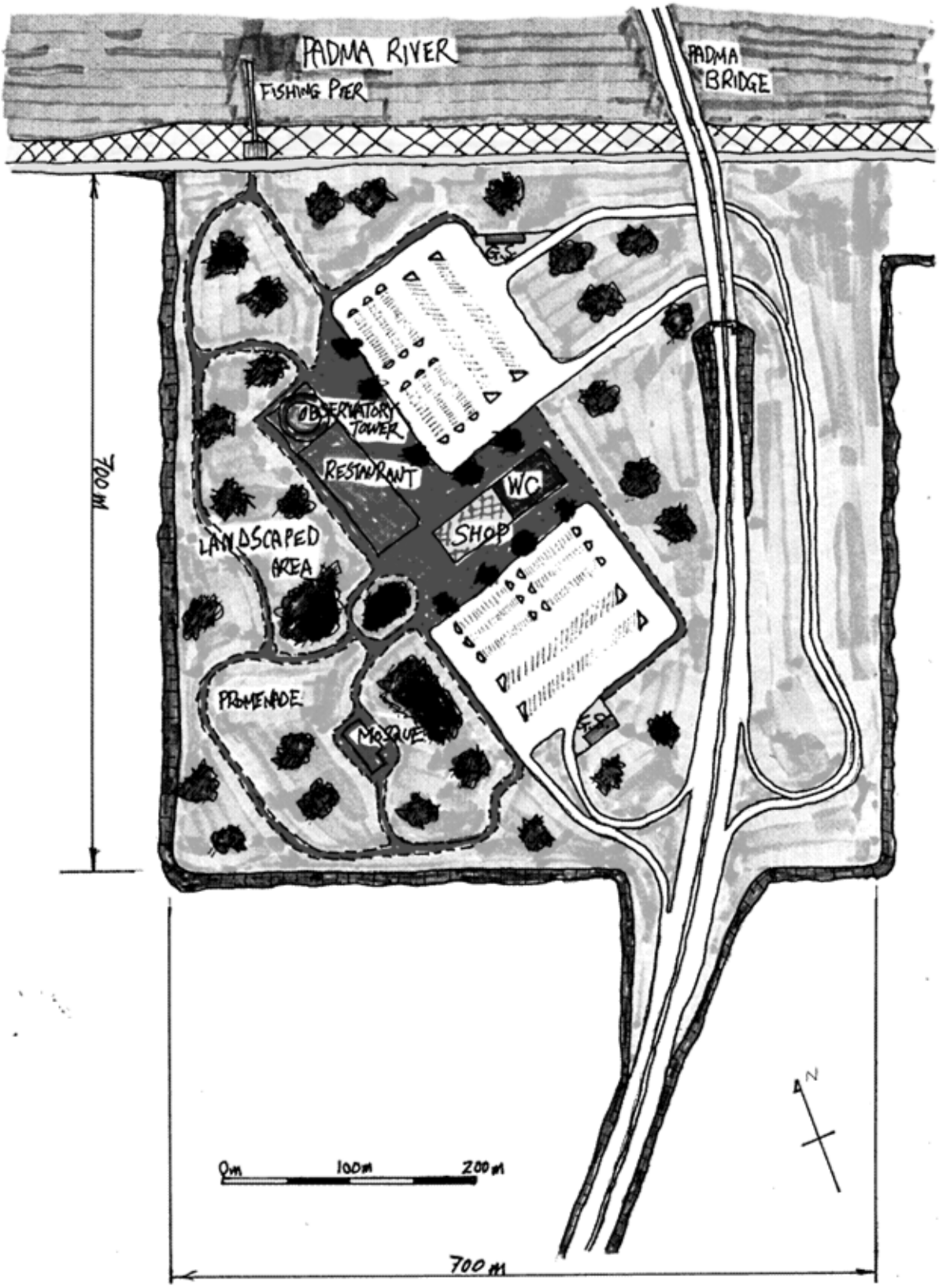


Figure 5.3.15 An Example Plan of Service Area

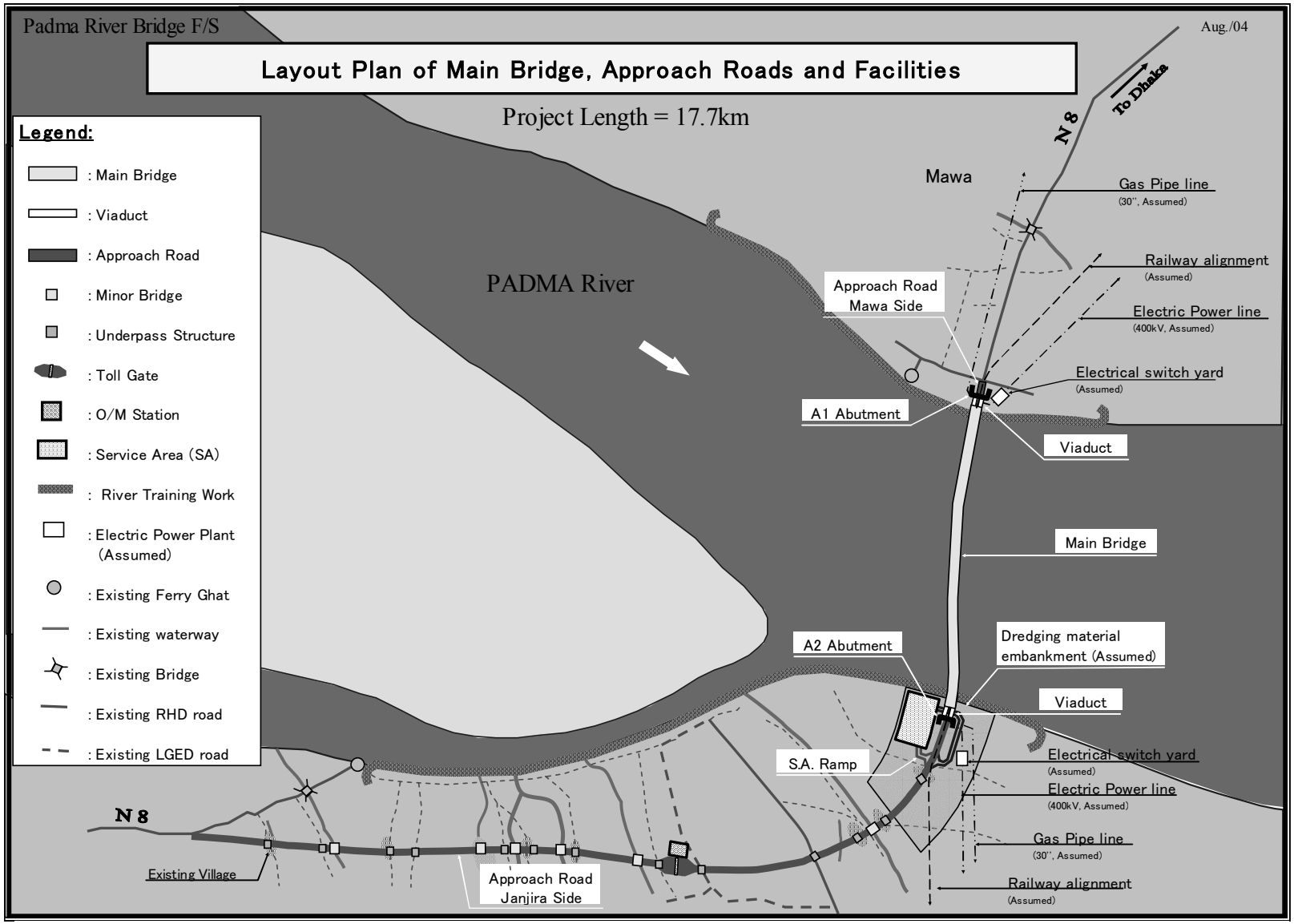


Figure 5.3.16 Layout Plan for Facilities on Project Highway

5.4 PUBLIC UTILITIES

5.4.1 Summary of Utilities

The following public utilities have been considered for this project.

- 230kv and 400kv Power Lines
- Gas Pipe Lines
- Communications Lines
- Lighting
- Water Supply
- Sewage

5.4.2 Design Criteria and Standards adapted to Public Utilities

(1) 400kV Power Line

The bridge has provision to equip a 400kv power cable line to be installed on a cable tray on the downstream side of the bridge. The major design criteria and standards applied are shown in Table 5.4.1.

Table 5.4.1 Design Criteria and Standards for Power Line

Type of Power Cable	UV-resistant Oil Filled Power Cable	
Rated Voltage	400kV	
Size of Cable	2500mm2	
Numbers of Circuit	2 circuits (one spare cable is to be added)	
Current Carrying Capacity / Transmission Capacity	1600A, (1,108MVA)	
Distance	Bridge part	6,400 m
	Bridge ends to Switchyards	approx. 500 m (Left Bank)
		approx. 500 m (Right Bank)
Installation Method	Cables are to be laid on cable tray, which is to be provided on the downstream side of the bridge.	
Auxiliary Facilities	Cable on bridge	Expansion-absorbing facility, Straight Joint (720m intervals), Pressure oil supply system
	Switchyards	Cable heads, Lightning Arresters, Reactors, Disconnecting Switches
Applied Standard	IEC standards 62067 and 60141 or other international standards accepted by PGCB	

(2) Natural Gas Pipe Line

The bridge has the provision to install a natural gas pipe line on the upstream side of the box girder. The major design criteria and standards to be applied are tabled below.

Table 5.4.2 Design Criteria and Standards for the Gas Pipe Line

Type of Pipe	High-pressure Gas Pipe	
Out side Diameter	30 inch	
Thickness of Pipe	14.27 mm (for straight part)	
	17.5 mm (for bending part)	
Numbers of Pipe	1 no.	
Maximum Transmission Capacity	500 mmcftd (Million Cubic Feet per Day)	
Grade of Steel	X65 (API 5L)	
Installation Method	Gas pipe is to be installed on upstream side of bridge girder with supporting structure.	
Auxiliary Facilities	On Bridge	Expansion-absorbing facility
	At Banks	No station facilities required
Applied Standard	ASME B31.8 and API Specification 5L or other international Standard accepted by GTCL	

(3) Communication Line

The PVC conduit pipe of 110mm is to be installed within the box girder. The major design criteria and standards to be applied are tabled below.

Table 5.4.3 Design Criteria and Standards of Communication Line

Type of Communication Cable	Optic Cable	
Numbers of core and cable	Detailed specification is not determined	
Conduit pipe	PVC conduit pipe 110mm dia. x 1 no.	
Installation Method	PVC conduit pipe is to be installed within the box girder	
Auxiliary Facilities	On bridge	No special facility is required
	At Banks	Joint boxes will be installed on the both ends of bridge, and the optic cable is to be laid within the cable duct up to the boundary.
Applied Standard	IEC standards 60793 and 60794 or other international standards accepted by BTTB	

(4) Lighting

Lighting is to be installed on the bridge, approach road, service area and toll gate. The power source for the lighting is to be 400/230V, which will be supplied from electrical power distribution panels to be set on both the river banks. The maximum voltage drop of lighting circuit permitted is up to 7% at the ends.

Full performance of lighting on the bridge and approach road is to be ensured even when the public power source is cut off, by an emergency power supply system. The major design criteria and applied standards are shown in Table 5.4.4 below.

Table 5.4.4 Design Criteria for Bridge and Approach Road Lighting

Standard Luminance	0.7 cd/m^2 (for express way, no light affecting the road)
Required illuminance for luminance	15 lx/cd/m^2 (for asphalt road)
Type of Lamp	High-pressure Sodium Lamp 270W, Semicutoff type
Height of lighting pole	10m
Arrangement of lighting pole	Single-sided
Spacing of lighting pole	35m
Applied Standard	"Road Lighting Standard" (Japan Road Association)

(5) Power Supply System

The power supply systems shall have enough capacity for the lighting and other facilities

installed on the bridge, approach roads, at the toll gate, O&M building, service area, and the system is to receive the public power distribution of 33kV or 11kV at the banks of both the Mawa and Janjira. The power supply systems shall equip diesel-engine generators for emergency power supply. Power receiving stations are to be built at Mawa and Janjira banks. The receiving stations for the service areas shall be independent of the other parts, to allow a third sector to manage the service area.

The power source for the 400kV switchyard is to be provided by the power sector, and is not included in the power supply system.

Table 5.4.5 Expected Capacity of Facilities at Mawa and Janjira, excluding Service Area

Place	Electric Facilities	Unit	Qty	W/unit	Total W	pf	VA
Bridge	HN Lamp	nos.	183	270	49,410	0.8	61,763
Approach Road	HN Lamp	nos.	143	270	38,610	0.8	48,263
Toll gate	HN Lamp	nos.	8	270	2,160	0.8	2,700
	Fluorescent lamp	nos.	10	40	400	0.8	500
	Miscellaneous	lot	1	1,000	1,000	0.8	1,250
O&M Building	Fluorescent lamp	m2	300	10	3,000	0.8	3,750
	Air Conditioner	m2	300	40	12,000	0.8	15,000
Other Area	Security Lamp HN	nos.	10	270	2,700	0.8	3,375
	Miscellaneous	lot	1	200	200	0.8	250
	Emergency Drainage Pump	no.	1	30,000	30,000	0.8	37,500
	Sewage Booster Pump	no.	1	10,000	10,000	0.8	12,500

Table 5.4.6 Expected Capacity of Facilities for Service Area

Place	Electric Facilities	Unit	Qty	W/unit	Total W	pf	VA
Resting Place	Air Conditioner	m2	250	50	12,500	0.8	15,625
	Fluorescent lamp	m2	250	10	2,500	1.8	1,389
Restaurant	Air Conditioner	m2	950	50	47,500	2.8	16,964
	Fluorescent lamp	m2	950	10	9,500	3.8	2,500
Toilet	Air Conditioner	m2	350	50	17,500	4.8	3,646
	Fluorescent lamp	m2	350	10	3,500	5.8	603
Shop	Air Conditioner	m2	255	50	12,750	6.8	1,875
	Fluorescent lamp	m2	255	10	2,550	7.8	327
Gas Station	Pump	nos.	3	10,000	30,000	7.8	3,846
	HN Lamp	nos.	2	270	540	7.8	69
	Fluorescent lamp	nos.	10	40	400	7.8	51
	Air Conditioner	m2	100	40	4,000	7.8	513
Area	HN Lamp	no.	10	270	2,700	7.8	346
	Water Supply Pump	no.	1	200,000	200,000	0.8	250,000
	Emergency Drainage Pump	no.	1	30,000	30,000	0.8	37,500
	Sewage Pump	no.	1	30,000	30,000	0.8	37,500
	Septic Facility	no.	1	10,000	10,000	0.8	12,500

5.4.3 400kV Electric Power Transmission Line

The entire power grid in Bangladesh has been planned and constructed by the Power Grid Company of Bangladesh Ltd., PGCB, which was established in 1996, and has long and mid-term development plans for the power grid in Bangladesh up to 2015. There was no plan to construct a 400kV interconnecting line in the long term plan, but recently PGCB planned to construct a 400kV interconnecting line from Dhaka to Khulna in 2015 to meet with the rapid increase of the power demand in the west zone, which is publicly put up on their home-page.

The PGCB has keen interest to use Padma Bridge for equipping their power line, if the cost thereof is less than that of developing another independent interconnecting route, by constructing towers in the river. Only a 400kV line will suit their purpose.

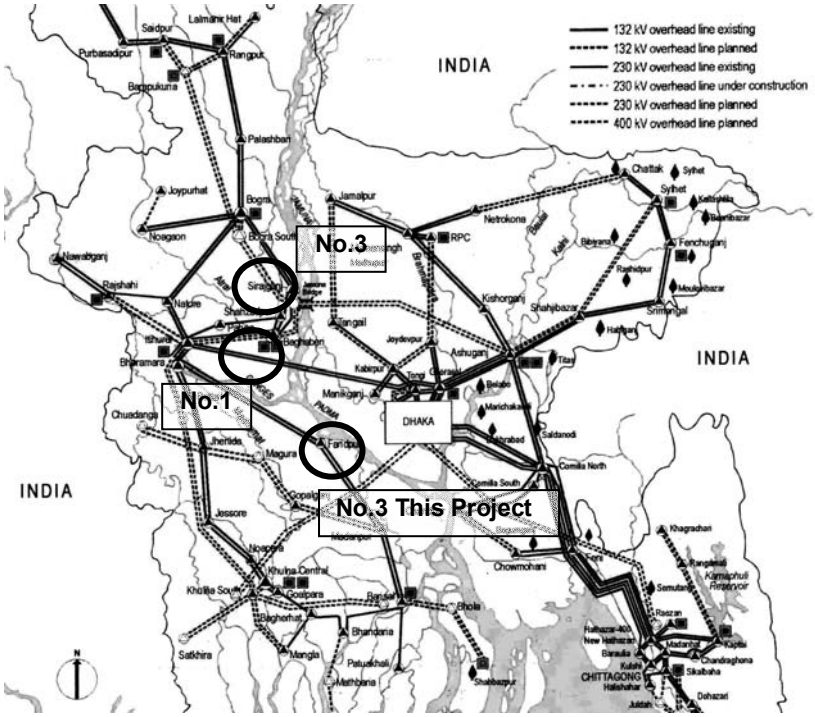


Figure 5.4.1 Power Grid and Interconnection Line in Bangladesh

It is proposed to allow provision for both 230kV and 400kV Power cables on an external cable tray supported from the bridge structure. It is easier to lay the cable on the tray than inside the box girder, and no cooling system is therefore required. However as the cables are exposed in the sun, the sheath of the cable will be eroded by the ultraviolet light. In the recent past, anti-ultraviolet light cables have been developed, and are used for the 500kV power line equipped on Honshu-Shikoku Connecting Bridge. Such anti-ultra-violet cable shall be used when this alternative is applied. A typical arrangement is shown in Figure 5.4.2.

The connection of power cables and overhead lines is to be made at both ends of the bridge. Therefore, PGCB requested to keep the space for the switchyard to connect the power cables to the overhead line. Lightning arresters, reactors and disconnecting switches are necessary in the switchyard to protect the power cables from the lightning, to compensate the capacitance of the power cables, and to maintain the cables by cutting off from the overhead lines, respectively. The general layout of the switchyard is designed for estimating the space as shown in Figure 5.4.3.

PGCB also requested to keep the right of way of the overhead transmission line, 20 meters on both sides from the center line and no building is allowed to be constructed within the right-of-way.

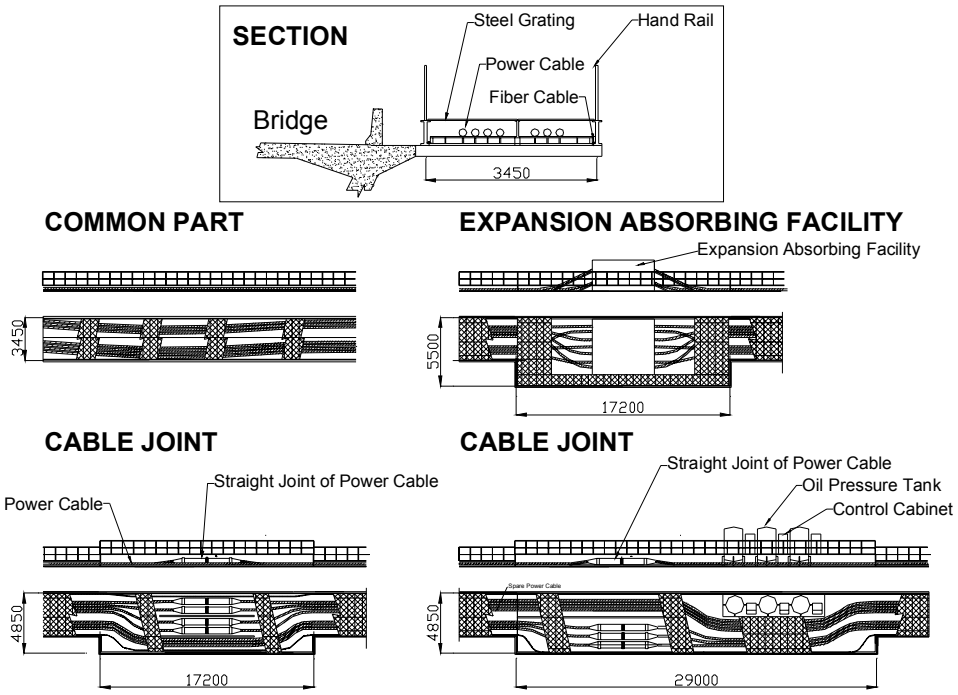


Figure 5.4.2 Arrangement of Power Cables on Cable Tray

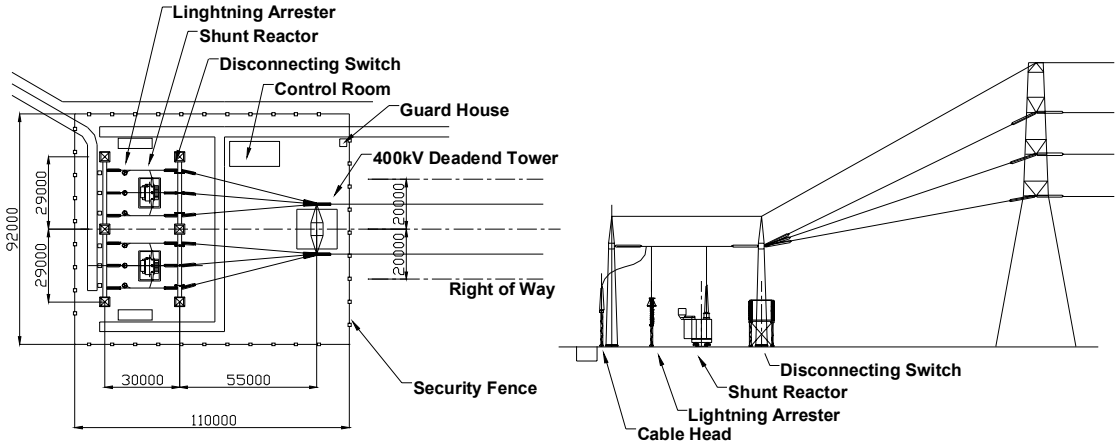


Figure 5.4.3 General Layout of 400kV Switchyard

5.4.4 Gas Pipe Line

The gas field is only available on the east bank of Jamuna and Padma Rivers. Only the pipe line Sirajganj – Baghabari – Ishuldi is available on the west bank and it is connected to the east bank through the pipe line on the Jamuna Bridge as shown in the Figure 5.4.4.

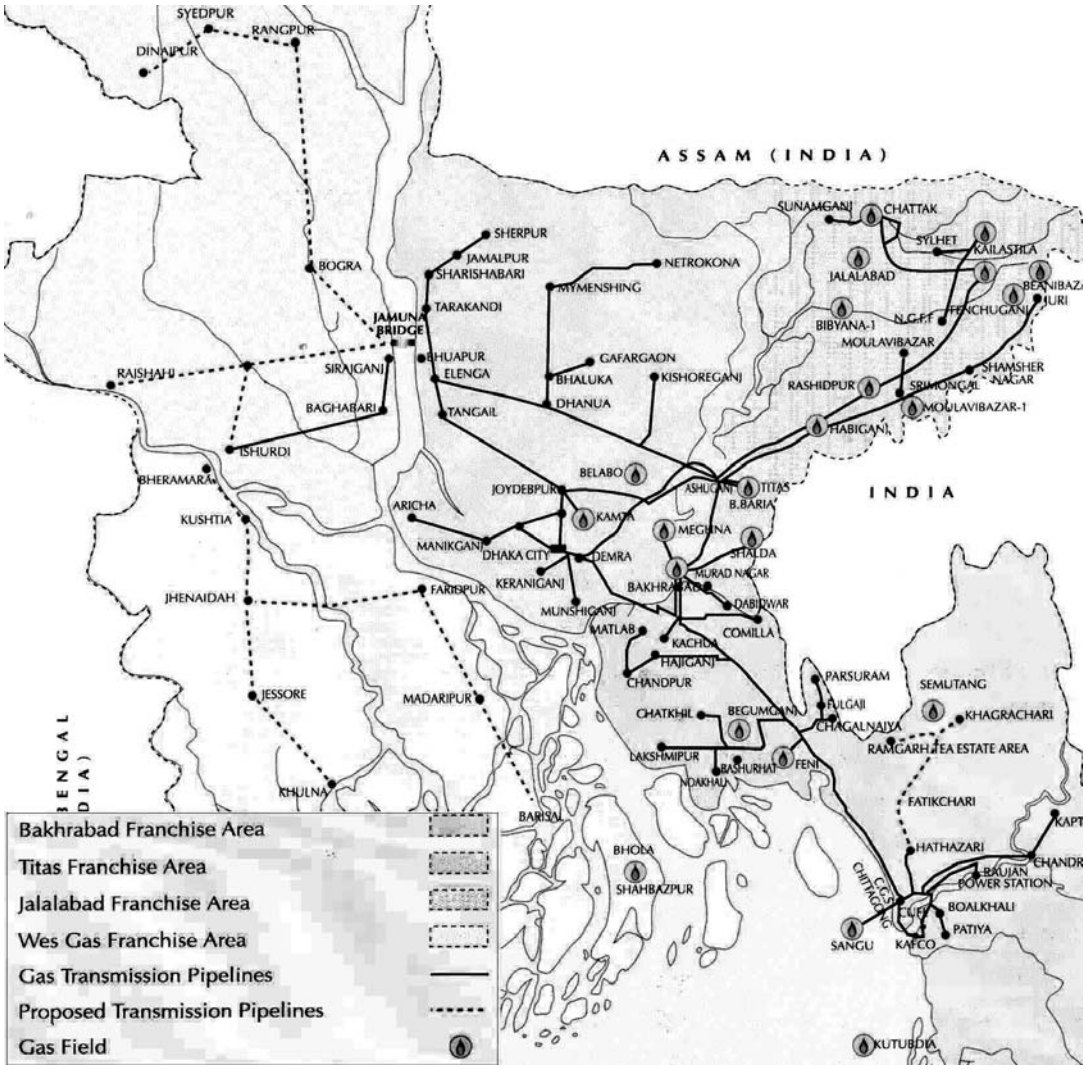


Figure 5.4.4 Gas Pipe Line in Bangladesh

GTCL requested to have provision to install a 30 inch hi-pressure pipe to transfer 500 mmcfd (Million Cubic Feet per Day) of gas with the same installation set up as the Jamuna Bridge.

No special space is required in either bank for the gas facility, such as bulb and its control equipment, is required within the service area, except pipe line route on which no road and pavement is accepted for their maintenance. At least 10 m width on one-side of the center-line is required, if the pipe line is set in the corner of the Project area.

5.4.5 Communication Line

Bangladesh Telegraph and Telephone Board, BTTB, is now constructing an optic fiber network between Chittagong – Dhaka – Sylhet to develop an IT network and it will be extended to Bogra and Rangpur. For many decades, communication in Bangladesh was relying on wireless media, because of the flat nature of Bangladesh, which is a

topographical advantage. However, BTTB have a perception that spreading an optic fiber network is an urgent need and will have a huge demand.

At present, BTTB has no certain plan for developing the network in this area. BTTB requested to have provision to install PVC pipe of 110mm in the box girder.

5.4.6 Lighting

Lighting will be provided on the bridge, approach road, toll gate, service area and other areas within the area covered by the Project. The proposed arrangement on the bridge is shown in Figure 5.4.5.

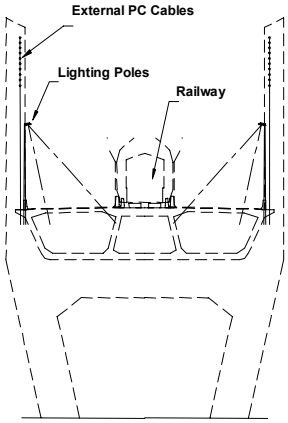


Figure 5.4.5 Arrangement of Lighting Poles

Chapter 6 Construction Plan and Cost Estimate

6.1 METHODOLOGY

Estimates of costs were prepared based on the construction plan and construction methods, in consideration of the procurement circumstances of labor, equipment and materials. For the cost estimation, considerations should be taken of the high water and low water seasons, possible procurement from local sources, international standard quality, and proper division of construction sections in consideration of technical characteristics and physical and economical scale.

6.2 CONSTRUCTION PLAN AND CONSTRUCTION METHODS

6.2.1 Construction Plan

In consideration of river water movement in the high water and low water seasons, the construction should be effectively mobilized and accomplished, resulting in economy. It will also procure a large amount of construction equipment and construction materials. Therefore, the strategic idea should be to maintain access to the large scale of construction equipment such as dredgers, large size pile driving barge and equipment, and carrying barges/pontoons to the work sites.

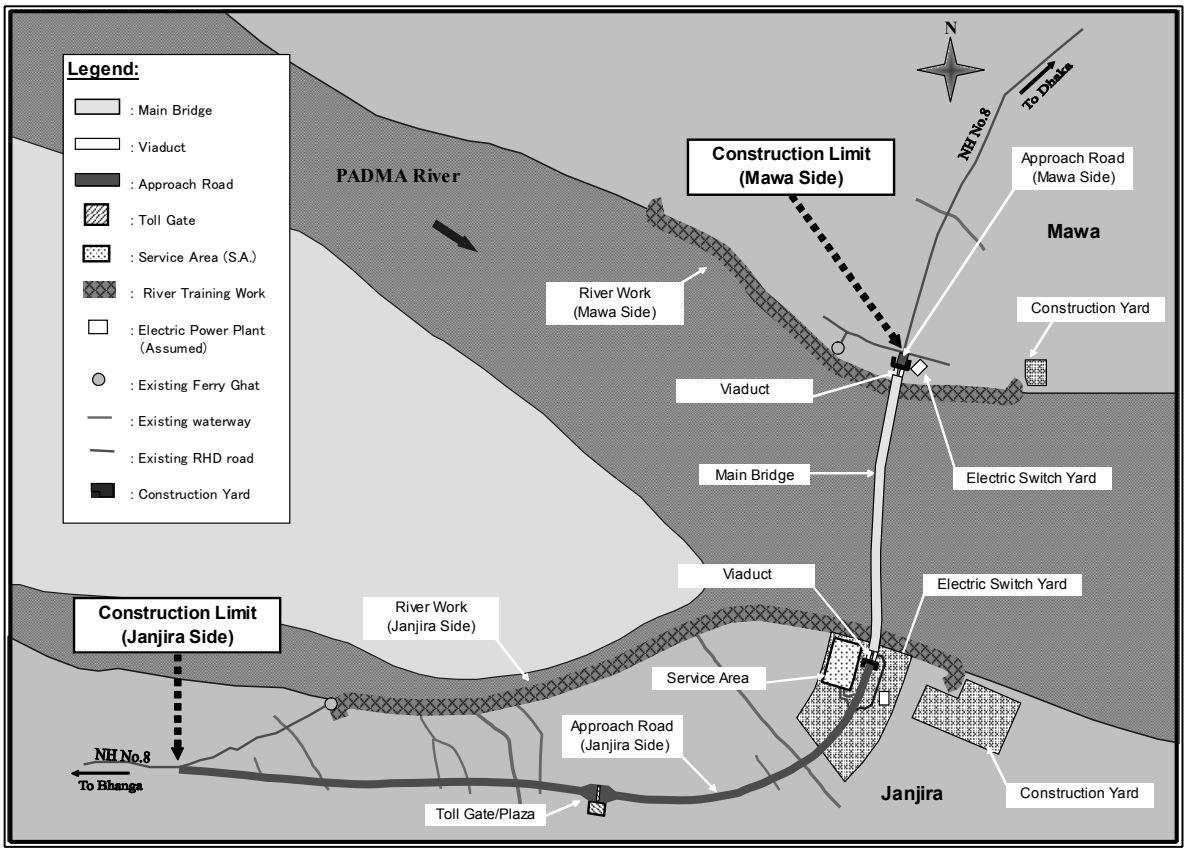


Figure 6.1.1 Construction Plan

It is expected that bridge contractor will establish a pile cap shell precasting yard, concrete batching plant, storage area, temporary work harbor, and other facilities on the working area

reclaimed by the river works contractor. It is envisaged that the large size piles of 3.0m diameter would be fabricated overseas in places such as Japan and Korea and transported by seagoing barges to a port in Bangladesh. And then the piles could be transferred to the low draft barges before shipment to the construction site.

At the initial stage, construction yards should be prepared on the downstream side of the project alignment on each river bank side. The construction yards will be built with temporary ports for loading and unloading of the major construction equipment and materials. The construction yards include management offices, material storage yards, and concrete mixing plants, etc. Accommodation facilities are to be built adjacent to the construction yards. The asphalt mixing plant location should be concluded subject to environmental circumstances.

For this project, the unique idea is a dredging operation at the initial stage and reclamation. The dredging operation is necessary to maintain access for the equipment and barges for the foundation work of the main bridge, using 3.0 m diameter and 90 m long steel piles. The work of the pile foundations of the main bridge and the river works of the downstream part will be in the earlier part of the construction. During the dredging operation on the right river bank, approximately 9 million cubic meters of dredged sandy soils may be produced, this volume will be used for the approach road embankment and the Service Area (S.A.) embankment, and also reclamation of part of the project area.

The pile foundations for the main bridge would be operated basically from one side of the planned bridge towards the other part, followed by concrete work for the pile caps and pier shaft. After the construction of the pier structures, the construction of the bridge deck will start from several locations on the piers completed depending on the number of Form Traveler sets on the site.

Prior to the road embankment, especially the approach road of the Janjira side, of which the length is approx. 4km, along side the road alignment a temporary road with gravel spread atop the natural ground will be constructed mainly for construction purposes. Also temporary crossings and bridges will be provided at the existing streams and rivers. The approach road embankment will start by using the dredged sand material.

6.2.2 Construction Methods

(1) Bridge

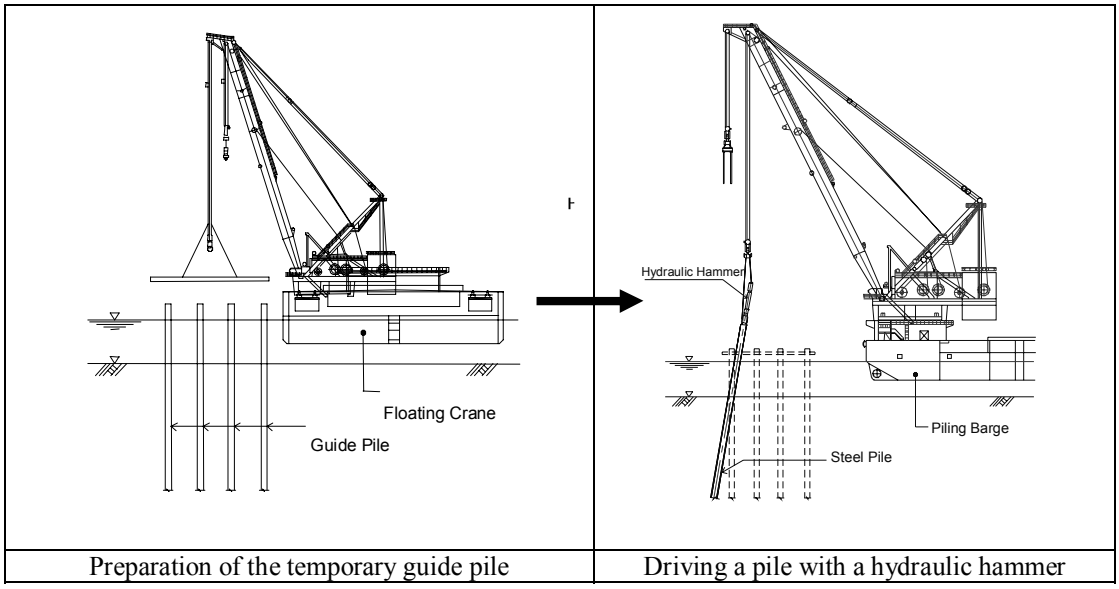
It is expected that a pilling barge would be of the type used in offshore platform works, with a crane lifting capacity of 1,800 tons and 360 degree turning capability to drive the large diameter piles of 3.0m and length of 90m long. All operations following the pile driving could use the support barges. It is envisaged that two floating concrete batching plants plus a back up plant would be required for the infill concrete for the bridge construction.

Pile foundations for the bridge will be constructed with the following sequence;

1) Installing the temporary guide pile with the floating crane prior to the permanent pile driving,
2) Locating the large size piling barge in the proper position with some anchoring for the piling,
3) Positioning and driving piles one by one, and
4) Moving the piling barge to the next pier.

The piling method with barge is shown in Figure 6.2.1.

The pile cap shells would be fabricated in the working land area on the tracked bed and transferred to the working harbor where they would be lifted by a carrying barge. The shell would be transported to the pier and placed over the piles. This would be followed by the placing of underwater concrete to form a plug in the shell, dewatering of the shell, fixing of reinforcement and placement of structural concrete. The pier column would be constructed in situ after completing the pile cap.



Preparation of the temporary guide pile	Driving a pile with a hydraulic hammer

Figure 6.2.1 Construction of the Pile Foundation with Piling Barge

The bridge deck will be built using Form Travelers with segments repeated in a cast-in-situ method along the entire span length; the first part of this building is a pier table on each pier; the Form Travelers (bridge-builder) can be assembled connecting with the pier table; each traveler moves outward from the pylon a single segment at time; repeating this routine cycle until the final concrete segment in each span is completed, in this routine, some segments require cable anchorage for picking up the bridge deck by cables. The general construction sequence of the Extradosed Bridge is shown in Figure 6.2.2.

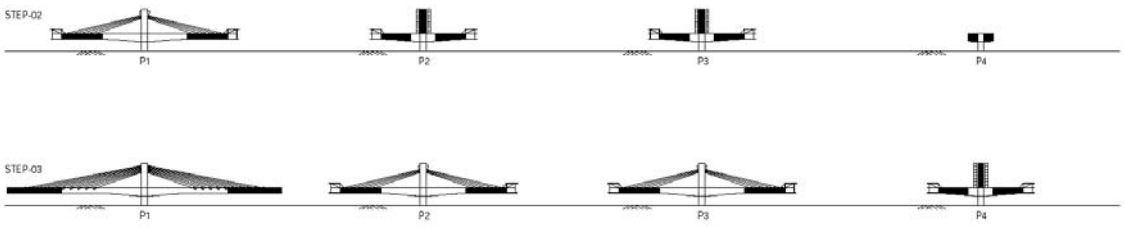


Figure 6.2.2 Bridge Deck Expanding with Form Traveler (in-situ)

(2) Approach Roads

Prior to starting the road embankment, the natural ground surface to be occupied by the road embankment should be removed to a depth of at least 30 cm as clearing and grubbing works. In addition to this removal, the unsuitable material portion, if any, also must be removed. The road embankment should be structured layer by layer with compaction to obtain the specified density, and sub-grade material will be laid atop the embankment structure. The road surface will be paved with asphalt concrete mixture as designed, holding the proposed height.

(3) Service Area and Toll Gate/Plaza

The toll gate and plaza, which will be located on the approach road of the Janjira side, will be constructed with the longitudinal gradient of less than 2.0% of concrete pavement for the plaza area. The service area will be reclaimed soil material dredged from the right river bank.

(4) Public Utilities and Facilities

The construction or installation of the public utilities on the bridge such as Transmission Lines, Gas Pipe Line and Communication lines, etc. will be the responsibility of the authorities concerned. However, the bridge structures should be built so as to withstand the future loadings transferred from the utility lines.

(5) River works

The river works could be categorized into two types of river bank protection, i.e., Type A and Type B, they consist of concrete cubes or stone rip rap with geo-textile sheets beneath. Type A is constructed on the land above the Standard Low Water Level (SLWL), and its toe portion will naturally be scoured and lowered by the river flow. Type B consists of concrete cubes and stone rip rap and with geo-textile sheets with bamboo frame. Type B would be constructed under the river water and on the riverbed where excavated by dredger, and after that it will be lowered naturally by the river flow scour. The construction will be convenient in the low water season, i.e., from November to May.

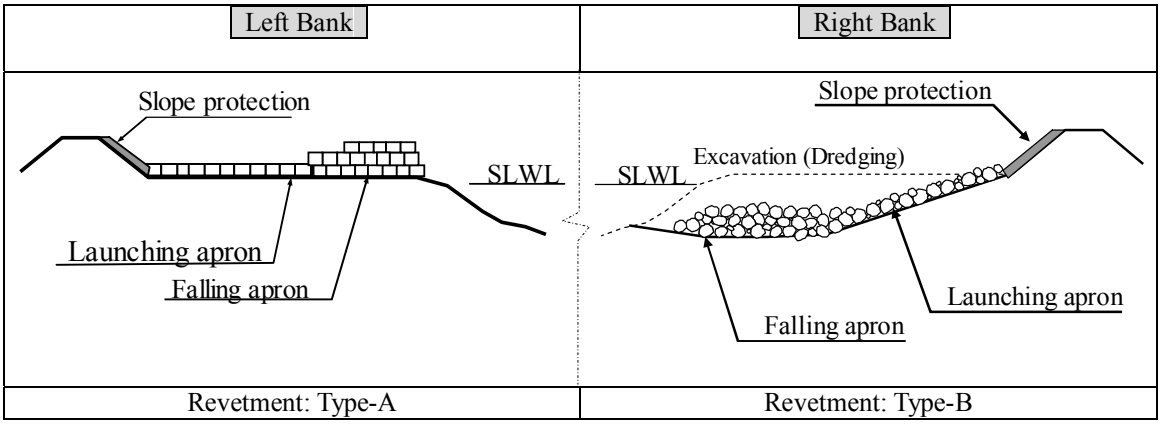


Figure 6.2.3 Bank Protection Method

6.3 PROCUREMENT OF LABOR, EQUIPMENT AND MATERIALS

6.3.1 Summary of Required Quantities

The preliminary estimated quantities of the major materials for this Project, including bridge and the river works is shown in the table below.

Table 6.3.1 Summary of Required Quantities

Major materials	Unit	Required Quantity	Remarks
Rock	ton	1,400,000	River works
Cement	ton	750,000	Concrete for structures
Sand	cu m	2,200,000	Ditto
Aggregate	cu m	210,000	Ditto
Reinforcement	ton	45,000	Concrete structure
PC strand	ton	12,000	Incl. external cables
Steel pipe piles (3.0 m diameter)	ton	68,000	Main bridge foundation
Geotextiles	sq m	840,000	River bank protection
Bitumen	lit.	2,500,000	Road pavement
Dredged material (sand)	cu m	9,500,000	Road embankment and reclamation

6.3.2 Labor

Un-skilled and common laborers for the construction works will be recruited from the area surrounding the Project site in Bangladesh. However, the number of special workers for construction of the large scale bridge and sophisticated structures are inadequate in this country, so they will have to be recruited from other neighboring countries.

6.3.3 Materials

Based on our interviews with the local companies and the existing project reports in Bangladesh, the availability of the main construction materials was investigated. These are described below:

(1) Rock

Rock that is more than 100 kg weight to be used for the slope protection of the river works such as the guide bunds and the revetments is assumed to be mainly provided from outside of Bangladesh. It, for instance, could be imported either from India, Malaysia, Indonesia or Thailand.

The rock from India and Indonesia could be obtained from the same source used for the river works of the Jamuna Bridge. Transportation of the rocks would have to be by train from India, or by barge to Bangladesh from other countries. The rock quarry of the Chittagong Hill Tracts in Bangladesh is not a suitable place because there is no proper approach to there.

- India (Visakapantam)
- Indonesia (Karimun)
- Malaysia (Hulu Langat in Selangot Darul Ehsan)
- Thailand

(2) Boulders

The size 50 mm to 100 mm cobble stones is widely available in Panchagah, northern part of Bangladesh, and 100 mm to 400 mm boulders are in Sylhet. More than 400 mm boulders could be imported from Pakaur, eastern part of India.

The Pakaur boulders and some Sylhet boulders, chosen for their rounded shape, would be placed in a layer on mattresses for protection of the fabric and to sink the mattresses down onto the dredged slope of the guide bund.

- India (Pakaur)
- Bangladesh (Sylhet)

(3) Coarse aggregate

Coarse aggregate could be provided from Bholagnj in Sylhet. But a sufficient delivery capacity for the project would be highly questionable; importing it from an Indian quarry should be considered.

- India
- Bangladesh (Bholagnj)

(4) Fine aggregate

Fine aggregate could be provided from Chatak (Sylhet) in the eastern part of Bangladesh, or Panchagah, Domar or Patgram in the northern area. Therefore, almost all the fine aggregate to be used for the concrete material will be provided from domestic quarries in Bangladesh.

- Bangladesh (Chatak, Panchagah, Domar, Patgram)

(5) Cement

There are many cement factories in Bangladesh. Following are three existing major factories in this country:

- Holcim Bangladesh (Megnaghat)
- Cemex Cement Bangladesh (Mongla)
- Hidelberg cement factory (Chittgong)

Supply from each plant might be insufficient for the bridge construction, and therefore a part of the cement shall be imported from other neighboring countries, such as India, Malaysia, and Thailand.

The Chatak cement factory in Sylhet, which was a national enterprise and had experience providing some cement for the Jamuna and Rupsa bridge construction has been closed.

Meanwhile, an international joint venture cement factory (the Lafage Surma Cement of Bangladesh) composed of three countries, Bangladesh, France and India, is planned to be established in Sylhet, northern part of Bangladesh near the border with India. It is actually under construction at the moment, and it seems that it will be opened up from January, 2006. If this factory is launched before starting this project, quantities of imported cement from outside countries might be reduced.

(6) Reinforcement

There are some steel factories in Bangladesh. Among them, three major factories are shown below:

- Bangladesh Steel Re-rolling Mills(BSRM) (Chittagong)
- Rahim Steel Mills (Sonargaon)
- Elit Steel Mills (Dhaka)

The BSRM is the largest steel factory in Bangladesh and they produce steel in accordance with the ASTM (American Society for Testing Material) requirements. Therefore, they might be able to supply their products for a part of the bridge construction. The other

factories will be for providing minor steel other than steel used for the bridge.

On the other hand, regarding the imported steel material, India, Thailand, Malaysia, Korea and Japan are available.

(7) PC strand and equipment

All of the pre-stressing steels and equipment will be imported from other countries.

(8) Steel pipe pile

Large size of steel pipes used for the bridge foundation will be imported from other countries.

(9) Summary of Procurement source of materials

Procurement source for the major materials to be used for the Padma bridge construction is summarized in Table 6.3.2.

Table 6.3.2 Procurement of Materials

Item	Bangladesh	Other countries	Remarks
Rock for River works		O	India, Indonesia, Malaysia, Thailand
Boulders for River works	Δ	O	India
Coarse aggregate	Δ	O	India
Fine aggregate (sand)	O		
Cement	Δ	O	India, Malaysia, Thailand
Reinforcement	Δ	O	India, Malaysia, Thailand, Korea, Japan
PC strands		O	Japan, Korea, China
Steel pipe piles (φ>2m)		O	Japan, Korea, China
Geotextiles for River works	O		
Bitumen	O		
Timber	O		
Gasoline	O		

Remarks; O Available, Δ Questionable for supply

(10) Quarries in Bangladesh

There are four quarry sites for the fine and coarse aggregate to be provided for the Padma bridge construction in Bangladesh. These quarries in the country are summarized in table and figure below.

Table 6.3.3 Quarry Sites in Bangladesh

No.	Location	Type of Material	Distance from Site	Remarks
Fine Aggregate				
⑴	Chatak	Sand	240km	Concrete mixture
⑵	Domar	Sand	300km	ditto
⑶	Patgram	Sand	320km	ditto
⑷	Panchagah	Sand	310km	ditto
Coarse Aggregate				
01	Bholagnj	Aggregate	240km	ditto

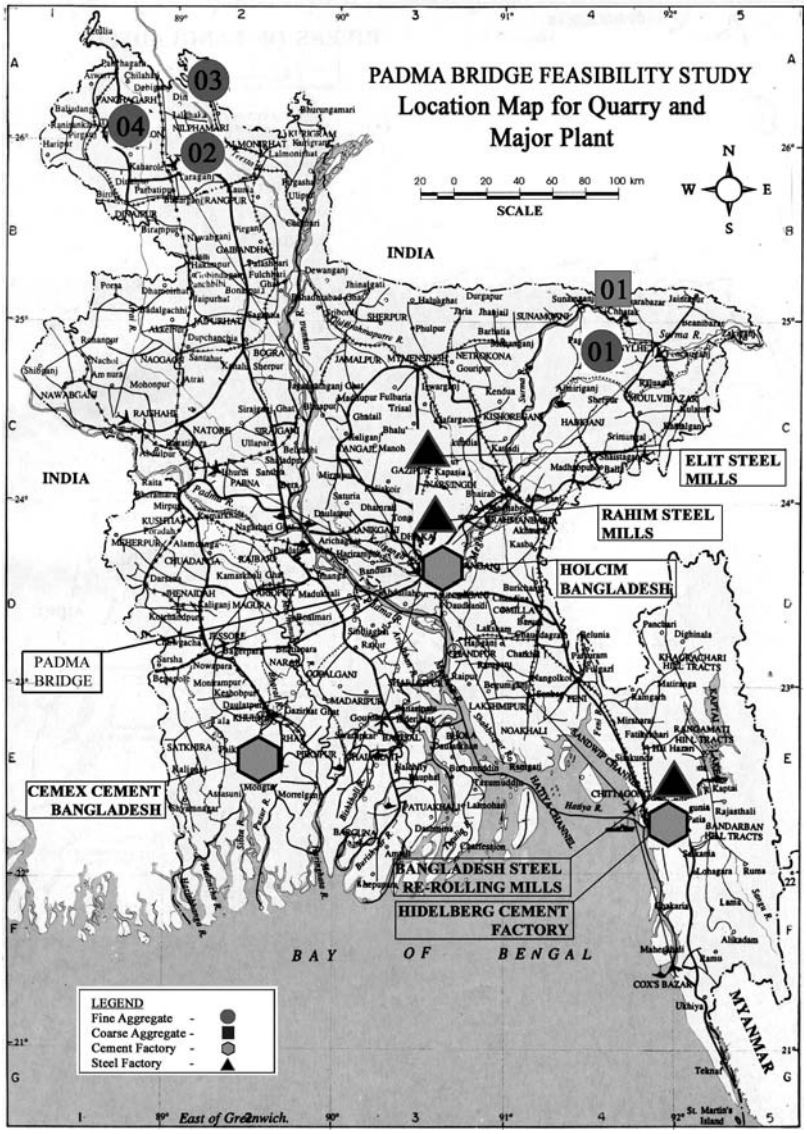


Figure 6.3.1 Quarry Sites in Bangladesh

6.3.4 Equipment

Some of the common equipment, such as a bulldozers, backhoes and wheel loaders etc., to be used for the construction of the bridge, road and river work will be available from within Bangladesh. Heavy equipment and/or special equipment such as girder erection equipment and pile driving barge etc. will be basically procured from outside of Bangladesh. If some of the equipment for construction is unavailable from neighboring countries, it will be procured from Japan, Korea, USA or the EU.

Heavy and especial equipment that is to be used for this project including bridge and river works is summarized in the table below. The supposed capability of the equipment is shown under "Expected Capacity" in the table as a reference.

Table 6.3.4 Heavy and Especial Equipment for Construction

Equipment	Expected Capacity	Operation Items
Dredgers	10,000 Hp * 1 set, 6,000Hp * 2sets	Dredging river channel
Piling barge	1,800 ton class of lifting capacity	Piling in the river section
Hydraulic hammers	51.0 ton/m IHC S-500 etc.	Pile driving equipment with piling barge
Pile carrying barges	10,000 ton of carrying capacity	Pile transportation
Floating concrete batching plants	200 m^3/h * 2 sets	Production of concrete
Stone carrying barges	4,000 m^3 of carrying capacity	Carriage of rock
Concrete mixing plants	200 m^3/h * 4 sets	Production of concrete
Erection traveling forms	400 t･m class * 30 units	Erection of girders
Tractor shovels (wheel type)	7 m^3 of shovel capacity	Stowage of rocks and boulders etc.
Heavy dump tracks	50 tones of carrying capacity	Carriage of rock sand boulders etc.

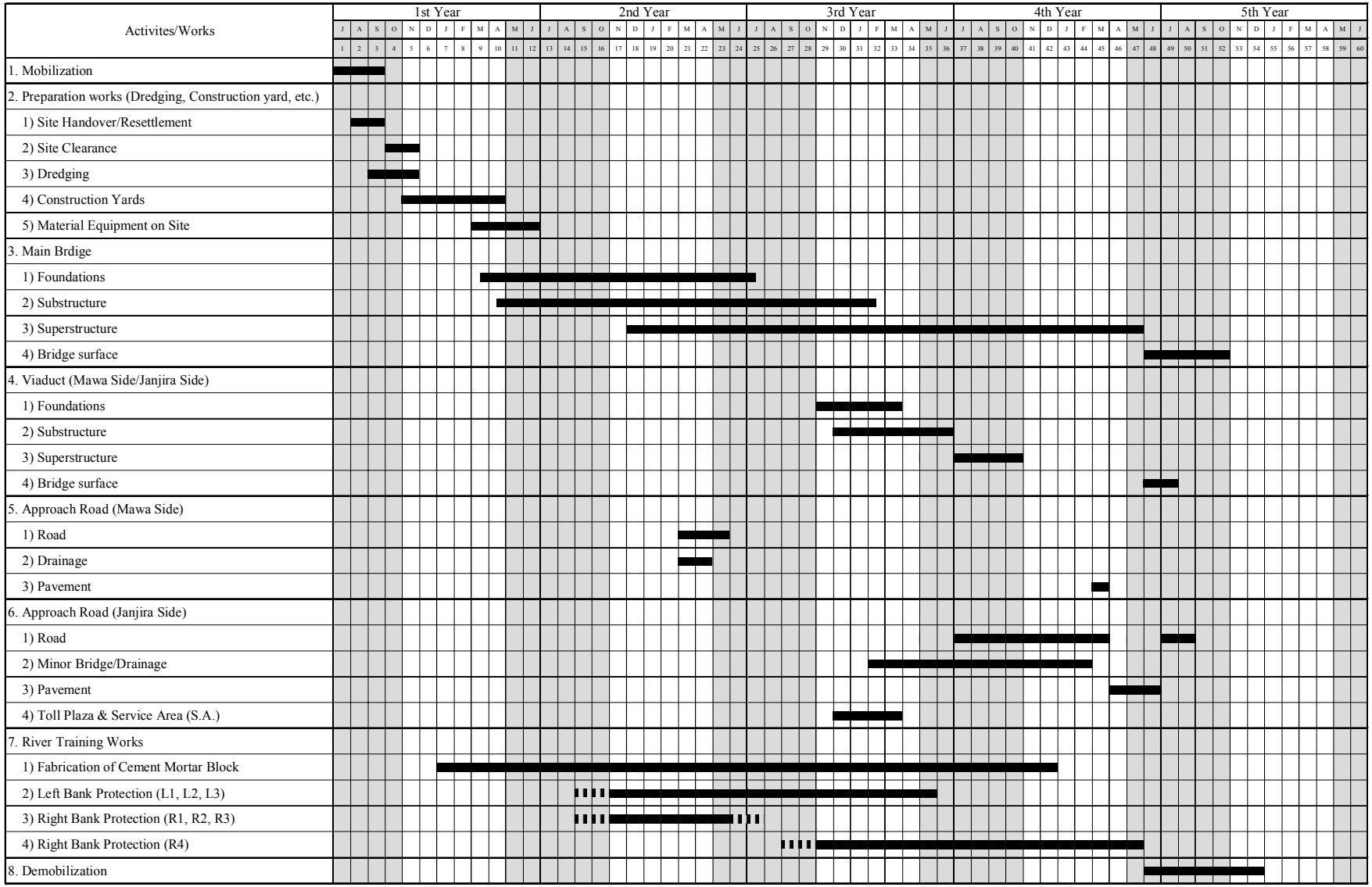
(Subject to change)

6.4 TENTATIVE CONSTRUCTION SCHEDULE

The shortest construction schedule was planned to facilitate the earliest possible commissioning of the project. The tentative construction schedules for the construction of the bridge, the river works and approach roads are shown in Figure 6.4.1. The term of the critical activities for the bridge construction, which is the longest contract on the project, have been estimated in consideration of the experience gained on the Jamuna Bridge project and other major projects.

- The piling work with the large size piling barge, assuming the same level of productivity as on the Jamuna Bridge and also being based on similar experience of piling activities, could be required over periods at the minimum of 16 months.
- The bridge deck erection works could be achieved over periods of 30 months in case of using a total of thirty Traveler Forms to be operated at the same time in the working position.
- The river works that would be constructed over the three periods of the low water seasons could be totally achieved over a period of 41 months including the cubical block production in the working area.
- The road embankment works would be commenced after providing dredged material by the RTW contractor from the riverbed dredging for the right bank protection work. The road construction works would be accomplished before completion of the bridge construction.

The overall construction schedule for the project, bridge, river works and roads, is estimated at 54 months or 4 and a half years, including the mobilization and demobilization works.



Remarks;
- High Water Season
- Low Water Season

Figure 6.4.1 Tentative Construction Schedule

6.5 COST ESTIMATE

6.5.1 Cost Estimate Procedures

As for the basic information for preliminary cost estimation of this project, a possibility of the procurement in Bangladesh in relation to the labor, materials and equipment, and also imported items from other countries were investigated by the Study Team through the past bridge construction reports and an interview survey with the local construction companies. These have provided a considerable source of information. The source of the base data includes the following:

- RHD Schedule of rates for use with the new technical specifications
- Padma bridge pre-feasibility study engineer's cost estimates
- Jamuna bridge project engineer's cost estimates
- Engineer's estimates for the Paksey bridge and Rupsa bridge project

The procedure for the cost estimate and components are as shown in figure 6.5.1.

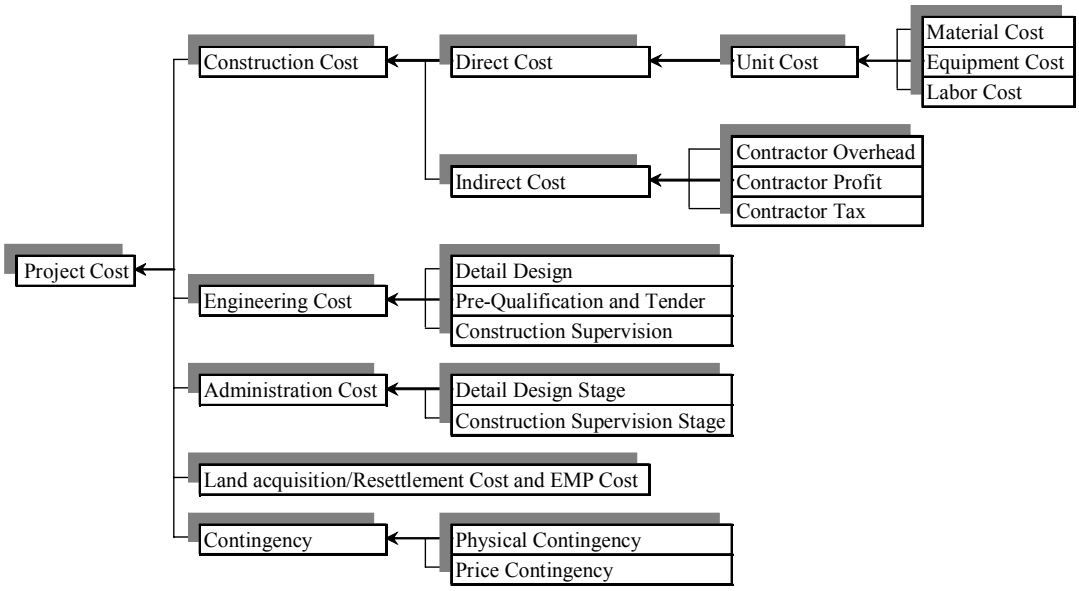


Figure 6.5.1 Cost Estimate Procedures

The US dollar will be adopted as the base currency for the cost estimates. The following currency exchange rates, which were based on the month of July 2004, are assumed:

Base date; July 2004
US$1.00 = 60.0 Taka = 110 Yen

6.5.2 Estimate of Cost for Alternatives

The cost estimate in this feasibility study was carried out for the following 3 configurations on the basis of the Alternative-H1, that is to say, the base case. These alternatives are addressed in a dedicated section of this report in detail.

- Alternative-H1: PC extradosed girder bridge [Base case] based on the Bridge Width of the Asian Highway Standard with Reduced Median Width
- Alternative-H2: PC extradosed girder bridge and PC cable stayed girder bridge based on the Bridge Width of the Asian Highway Standard with Reduced

Median Width

- Alternative-H3: PC extradosed girder bridge based on the Bridge Width of the RHD Standards

6.5.3 Project Cost

The total project cost was totaled from the construction cost, engineering cost, administration cost, land acquisition/resettlement and EMP cost, contingencies and duty tax as shown the figure 6.5.1. The general description of these costs is presented below.

(1) Construction Cost

Construction cost is composed of three construction work categories, Bridge construction cost, Approach roads construction cost and River works construction cost. The unit cost rate in each cost of the work category has been estimated based on the basic price which was investigated with the RHD and the local construction companies by the Study Team at this feasibility study stage.

(a) Main Bridge

The major activities involved in the construction of the bridge include the piling work, girder erection work and external cable erection work.

Regarding the piling work, it is estimated that the piling equipment, such as the large sized piling barge required for the installation of piling, only one set will be procured in consideration of the viability of the project because few are available in the world. The piling equipment will be required at the site for a minimum period of 16 months, assuming installation can take place without incident.

In relation to the girder erection work, it was estimated based on the cast in situ erection method, which is more reasonable compared with the pre-cast erection method for the bridge formation including bridge foundation of this project. A total of 30 units of the Form Traveler will be required for the shortest schedule of the bridge construction and also to facilitate the earliest possible commissioning of the project. The construction method which formed the basis of the cost estimates is described in Section 6.2.

External cable erection work on the permanent bridge would be the first in Bangladesh. By using the external cable for common girder bridges, the span length would not only be able to be longer than the continuous box girder bridge but also it would reduce the concrete volume of the girder itself. The cost of the external cable consists of the PC strand and PF pipe; these are to be imported from neighboring countries.

Unit prices of the major items for bridges and concrete structures are shown in Table 6.5.1.

Table 6.5.1 Unit Price of Major Items for Bridges and Concrete Structures

Item	Spec., quality, shapes, etc.	Unit	Unit Price	
			LC (Taka)	FC (USD)
Pylon				
Concrete class A (mixing & placing)	40 N/mm^2	m^3	4,607	37.08
Rebar	SD295 (D13-32)	t	35,650	0.00
Form		m^2	344	0.00
Cable saddle		Each	0	99,473.00
External cable for main girder				
External cable erection	Extradosed cable	t	3,450	4,235.00
External cable fixing	ditto	Each	8,261	440.00
External cable tension adjustment	ditto	Each	21,437	0.00
PE pipe setting	ditto	m	141	38.24
Main girder (box girder)				
Wargen equipment Cost		L.S	0	22,078,236.60
Wargen assembling and desmantle		Each	486,338	0.00
Concrete class A (mixing & placing)	40 N/mm^2	m^3	4,607	37.08
Rebar	SD295 (D13-32)	t	35,650	0.00
Form		m^2	344	0.00
Longitudinal exterior prestressing	19S15.2mm	t	13,189	3,274.13
Longitudinal interior prestressing	12S15.2mm	t	13,189	3,274.13
Transverse prestressing	1S28.6mm	t	12,852	4,092.66
Steel tibular driven piles	3m diameter	m	0	7,390.00
Concrete class C (mixing & placing)	Pilecap	m^3	3,548	36.72
Rebar	ditto	t	35,650	0.00
Form	ditto	m^2	230	0.00
PC T girder				
Girder production	Precast posttension	Each	175,361	6,917.45
Girder erection	ditto	t	105	0.00
Erection equipment, assemble and dismantle	ditto	Each	153,044	0.00
Erection equipment, operation	ditto	Set/span	0	33,455.40
Cast-in-place RC piles	1.2m diameter	m	20,085	80.68
Concrete class C (mix & place) for substruct.	24 N/mm^2	m^3	3,548	36.72
Rebar for substructure	SD295 (D13-32)	t	35,650	0.00
Form		m^2	230	0.00

(b) Approach Roads

The estimate of the cost for the approach roads is composed of several components, such as the main road, toll plaza, service area, reclamation and minor bridges. These components include earthwork, pavement, slope protection, road facilities, box culverts, buildings and the like. Unit prices of the major items except for those related to the bridges and concrete structures are shown in Table 6.5.2.

The entire 700m length of the Mawa side approach embankment and 11.95km of the Janjira side approach embankment are assumed to be constructed by hydraulic placement of dredged material by the river works contractor. And the embankment of the service area is also to be built using dredged material from the riverbed the same as the road embankment.

The construction of the approach roads involves relatively low technology methods and uses much local material; therefore, it is within the capability of local contractors.

Minor bridges only located on the Janjira side approach road represent approximately 38% of the total cost of approach roads construction. This is because the total length of the minor bridge has reached about 1.0km.

Table 6.5.2 Unit Price of Major Items for Road and Building

Item	Spec., quality, shapes, etc.	Unit	Unit Price	
			LC (Taka)	FC (USD)
Road				
Excavation / Backfilling		m^3	47	0.00
Embankment		m^3	36	0.00
Surface pavement (Asphalt t=150mm)	Main road, ramp	m^2	645	7.06
Surface pavement (Asphalt t=70mm)	Bridge, shoulder	m^2	320	3.30
Surface pavement (Concrete t=250mm)		m^2	1,286	10.27
Base course		m^2	428	0.00
Subbase course		m^2	623	0.00
Subgrade		m^3	58	0.00
Rip-rap		m^2	2,521	0.00
Gabion		m^3	3,231	0.00
Sodding		m^2	33	0.00
Plant strip		m^2	25	0.00
Concrete curb		m	188	1.84
Gurd rail		m	3	44.00
Building				
Operation related building	Toll facilities	m^2	10,606	75.76
Maintenance related building	Bridge, road and river works	m^2	5,303	37.88

(c) River Works

The major cost of the river works is for the wet earthworks, revetment works and temporary work. Unit prices of the major items for river facilities are shown in Table 6.5.3.

The wet earthworks include dredging and excavating the slopes to shape for the revetments and transportation and placing of the dredged material to form the road embankment and foundation of the service area and/or toll plaza.

The revetment works that occupy the major cost of the river works is divided into two types as described in the dedicated section of this report. Revetment type-A is to be used on the relatively less erodible section of the bank such as the left bank and the south channel at the project area in the Padma River. Since the total length of the revetment type-A reached 12.4km, which includes 6.0km on the Mawa side and on the 6.4km Janjira side, it will require a huge volume of construction material to form the slope protection. Therefore, the mortar cubical block, which is a reasonable local production, has been adopted for the revetment type-A. Regarding the revetment type-B, a large proportion of the construction cost is an import material like the rock for the armoring of the slope protection, therefore, unit cost for the construction has became more costly compared with the revetment type-A.

Temporary work to build the river flow protection wall in the river using the steel driven pipe has been mainly estimated for easier construction of the revetment type-B on the right bank.

Table 6.5.3 Unit Price of Major Items for River Facilities

Item	Spec., quality, shapes, etc.	Unit	Unit Price	
			LC (Taka)	FC (USD)
River Facitities				
Cubical block production		m^3	1,098	26.00
Cubical block placing with geotextile	Slope protection	m^2	832	15.60
Connected c-blocks placing with geotextile	Launching apron	m^2	1,231	15.60
Cubical block placing for falling apron	Falling apron	m^3	1,333	27.30
Furnishing and placement of geotextile		m^2	232	0.00
Furnishing and placement of geotextile with partition wall		m^2	3,386	3.24
Furnishing and placement of bamboo fascine mattress		m^2	315	0.00
Furnishing and placement of rip rap		m^3	4,245	0.00
Furnishing and under water placement of rock	Launching and Falling apron	m^3	112	108.35
Dredging and excavation to form slopes of revetment		m^3	0	2.00
Wiermesh mattress	4000x2000x360, Brick-fill	m^2	672	0.00
Steel pile anchor work	φ80mm steel pile * L=5m	m	545	0.00
Temporary Cofferdam				
Steel pile driving and drawing work	φ800mm steel pile * 2000nos.	m	0	573.00

(2) Engineering Cost

Engineering cost consists of the detailed design cost and the construction supervision cost.

The cost of the detailed design by a consultant has been assumed at 2.0% of the construction cost for Aternative-1, 3 and 5 which have adopted the continuous extradosed girder for the main bridge.

On the other hand, in case of Alternative-H2, which has combined the continuous extradosed girder with the cable stay girder in the middle range of the bridge has been estimated at 3.0% in consideration of the technical difficulty for the cable stay bridge design.

(3) Administration Cost

Administration cost is the cost to be paid to the executing agency JMBA during detailed design and construction supervision. These costs have been assumed and estimated as just 10% of each stage in the Engineering Cost.

(4) Land Acquisition/Resettlement and EMP (Environmental Management Plan) cost

The land acquisition and resettlement cost and EMP cost are addressed in a dedicated section of this report. These costs are included in the project cost since it would be conducted during the construction period.

(5) Contingencies

Contingency in this estimate allows a physical contingency for the physical extras which may occur during construction period. It includes unforeseen ground conditions, exceptionally inclement weather, quantity changes, delays beyond the control of the contractors, unexpected incidents and the like.

The physical contingency cost has been set at 15% of both construction cost and engineering cost.

(6) Project Cost

The project cost estimate was prepared in accordance with the foregoing for the 5 configurations as mentioned above in Table 6.5.4.

Table 6.5.4 Project Cost Comparison

Project Cost	Total amount (Unit : USD)		
Briidge alternatives	**Alternative-H1**	**Alternative-H2**	**Alternative-H3**
Bridge type	Extra-dosed girder	Extra-dosed plus Cable stay girder	Extra-dosed girder
Carriage purpose of bridge	Road	Road	Road
Bridge width	21.5m	21.5m	17.1m
Project cost items			
1. Construction cost	833,593,440	856,174,562	746,944,948
1) Bridge	423,396,040	445,977,162	336,747,548
2) Approach roads/Toll gate/S.A	49,193,790	49,193,790	49,193,790
3) River works	361,003,610	361,003,610	361,003,610
2. Engineering cost	50,015,590	59,932,210	50,015,590
1) Detailed design (2~3% of item-1)	16,671,860	25,685,230	16,671,860
2) Construction supervision (4% of item-1)	33,343,730	34,246,980	33,343,730
3. Administration cost	5,001,550	5,993,210	4,481,650
1) Details design stage (10% of item-2 1))	1,667,180	2,568,520	1,493,880
2) Construction supervision stage (10% of item-2 2))	3,334,370	3,424,690	2,987,770
4. Land acquisition and resettlement, and EMP cost	75,000,000	75,000,000	75,000,000
5. Physical contingency (15% of item-1)	125,039,010	128,426,180	112,041,740
6. Duty tax (VAT etc) (14.5% for importation of item-1+2)	89,686,310	92,984,830	80,891,490
Total project cost	**1,178,335,900**	**1,218,510,992**	**1,069,375,418**
(Project cost ratio)	(1.00)	(1.03)	(0.91)

Remarks; Project cost does not include the electric facilities for power supply systems, this would have to be born by the Power Grid Company of Bangladesh (PGCB). The following shows an individual cost of the electrical utilities construction.

Description	Cost (USD)
400kV Power Cable	51,632,900
400kV Switchgear	9,425,760
Total cost of the power supply systems	61,058,660

6.5.4 Operation and Maintenance

The operation and maintenance is described in a dedicated section of this report. The operation and maintenance cost was estimated based on the Jamuna bridge operation which have considerable annual maintenance experience under control of the OMAC.

Allowances for maintenance of the river works include a stockpile of repair material to be stored at the site, regular studies by consultants to forecasts river changes, and a sum for periodic contracts for remedial works.

In addition to routine annual maintenance, relatively large maintenance costs will be

incurred at predictable intervals for such items as resealing or resurfacing roads, and replacing bearings and movement joints.

6.5.5 Foreign and Local Cost Analysis

The anticipated share between foreign and local currency expenditure, based on the cost estimation analysis, is estimated as follows:

	Work item	Foreign	Local
1)	Main bridge and Viaducts	81%	19%
2)	Approach roads	29%	71%
3)	River works	69%	31%

Chapter 7 Environmental Studies

7.1 INTRODUCTION

The main objectives of the environmental study are to

- identify the significant environmental impacts (positive and negative)
- propose possible mitigation measures
- follow the requirements of the environmental guidelines prepared by JICA, JBIC, GoB and other donor agencies, and
- prepare a preliminary EMP with an indicative cost estimate.

The steps of the environmental study implemented for the Padma Bridge Feasibility Study are as follows:

- Environmental assessment of the Padma River eco-system in relation to the initial screening,
- Initial Environmental Examination (IEE),
- Environmental Impact Assessment (EIA), and
- Preliminary Environmental Management Plan (EMP) to counteract the negative impacts.

An initial environmental assessment for four alternative sites and the Padma River eco-system was carried out as part of the initial screening during May to July, 2003 and was presented in Chapter 1 of Appendix-11 (Summary is given in Section 3.2.4 of the Main Report of DFR). The IEE was conducted for two preferred sites (Paturia – Goalando and Mawa – Janjira) during August to December, 2003 and the results were given in Chapter 2 of Appendix-11 (Summary is given in Section 3.3.4 of the Main Report of DFR). The EIA was executed from June to December, 2004 for the selected site (Mawa – Janjira) and detail results are presented in Chapter 3 of Appendix-11. This also includes a preliminary EMP. In this Main Volume of the Draft Final Report, major findings are explained.

Environmental studies, their target and output are shown below. The last 3 steps will be conducted after the Feasibility Study.

Stage	Environmental Activity	Target	Output
Initial Screening (Selection of 2 preferred sites from 4 conceivable sites)	Environmental assessment for initial screening	1. To identify critical issues like ecological parks, ethnic minorities, habitats of endangered species, etc. 2. To identify difference in environmental settings among 4 sites 3. To estimate difference in anticipated impacts among 4 sites	1. Compare 4 sites
Final Site selection (selection of final site from 2 preferred sites)	Initial Environmental Examination (IEE) for two preferred sites	1. To identify possible critical impacts 2. To compare 2 sites from environmental aspect	1. Whether the project can go ahead or not 2. Compare 2 sites
Study on selected site	Environmental Impact Assessment (EIA) for the selected site	1. To identify impact 2. To propose possible mitigation measures 3. To prepare a framework of EMP	1. Whether any major change in project components is required or not 2. Whether negative impacts are mitigable or not
Detail design	Environmental Management Plan (EMP)	1. To prepare mitigation plan 2. To prepare EMP implementation plan 3. To estimate EMP implementation cost	1. Fix the mitigation plan 2. Fix the implementation schedule and institutional arrangement 3. Fix the monitoring plan 4. Estimate the cost
Construction	Implementation of EMP	1. Implement mitigation measures 2. Monitor parameters 3. Revise EMP, if required	1. Mitigation measures implemented. 2. Monitoring data available
Post construction	Monitoring	1. Continue monitoring 2. Take steps if required	1. Environmental friendly sustainability

7.2 SCOPE & APPROACH

7.2.1 Scope of EIA

The scope of the EIA study is based upon the requirements of the environmental guidelines of JICA, JBIC and GoB. The scope of works include:

- Review of all relevant environmental reports including monitoring of Jamuna, Paksey & Bhairab Bridges
- Project description from environmental aspect
- Supplementary secondary & primary data collection
- Data analysis to describe the natural environment, social environment and environmental pollution, especially for the negative impacts identified in the IEE
- Environmental quality survey on air, noise, water (surface & ground) & riverbed material
- Input from SIA study
- Input from mathematical modeling study
- Conducting questionnaire survey
- Meeting with stakeholders (FGD & PRA)
- Analysis of environmental impacts
- Identification of mitigation measures
- Preparation of Preliminary EMP to reduce or eliminate significant environmental impacts, and

- Preparation of approximate environmental cost.

7.2.2 Approach of EIA

The EIA study approach can be summarized as follows:

- The Project component is described from the environmental aspect
- Review of the EIA of the large bridges constructed in Bangladesh is done together with a comparison of the present situation with that anticipated in the EIA
- Detailed methodology is set up
- Environmental base line is described from both primary and secondary data
- Impact is assessed
- Mitigation measures are proposed
- Impact evaluation is made considering the mitigation measures
- Preliminary EMP is proposed with approximate cost estimates
- Recommendations are made for further studies required.

7.3 EIA STUDY AREA AND PROJECT COMPONENTS

The Environmental Impact Assessment (EIA) was carried out for the selected Mawa – Janjira site of the Padma Bridge. The impact area covers a section of the Padma River and its tributaries, associated channels and drains, and the land area in the vicinity of the approach road. The Work Area is in the districts of Munshiganj, Shariatpur and Madaripur.

Major project components include, main bridge, bridge connecting approach roads, and river training works. Details of the project component from the environmental aspect can be found in Chap 3 of APP – 11.

The construction of the proposed Padma Bridge is to include the following major project activities:

- Land Acquisition including Infrastructure
- Main Bridge & Viaducts
- River Training Works (RTW)
- Bridge Connecting Approach Roads
- Service Area, and
- Toll Gate Area.

Details of each activity and its possible environmental impact are given in Chap 2 of APP 11.

7.4 ENVIRONMENTAL INVESTIGATION OF SIMILAR PROJECTS

A number of large bridge projects have already been implemented in Bangladesh. In all cases, EIA were conducted. However, there is no systematic study for environmental monitoring at the operational stage. To compare between the impacts anticipated in the EIA stage and the present condition, JICA Study Team made an environmental investigation of the following bridges:

- Padma Bridge pre-feasibility study
- Jamuna Bridge
- Paksey Bridge
- Bhairab Bridge, and
- Rupsa Bridge

Details of those studies are given in Chap 3 of APP – 11. Review of the environmental condition after the completion of construction is very limited in Bangladesh. Investigation by the JICA Study Team gave an opportunity to review the environmental situation first hand. The major conclusion can be drawn that, in every case, the actual impact is much less than expected. This is because of the natural, topographic, hydraulic and biologic setting of the bridges. It has also been found that the normal impact from a bridge project, like increased flooding upstream and erosion downstream, seen in other parts of the world are not observed with major Bangladeshi bridges. This is because of the scale of the river and flood plane. As a result, it can be expected that the actual environmental impact for Padma Bridge construction would be less than the environmental impact to be found in this EIA following the classical approach. On the other hand, with all major bridges, social impact was found to be critical. The JICA Study Team is giving due importance to this issue.

7.5 METHODOLOGY

7.5.1 General

The specific job of EIA study is to identify the potential environmental parameters to be affected by the project, assessing the impact of the project on them, and then recommending mitigation measures for negative impacts and enhancing the positive impacts where cost is reasonable and possible.

This section contains details of the methodology adopted to carry out the EIA. EIA methodologies are considered to be organized tactics which seek to identify, predict and evaluate the environmental impact of development projects.

The Work comprises data collection for the natural environment and socio-economic context for the Work Area, a questionnaire survey, baseline quality assessment for air, water, dredge material and noise, data analysis, analysis of environmental elements affected significantly based on the results of IEE previously executed, and carrying out EIA for the proposed bridge site based on various guidelines. A preliminary Environmental Management Plan (EMP) is to be prepared based on the EIA findings to mitigate negative environmental impacts and to enhance positive impacts of the project.

The present environmental study has been carried out in conformity with the requirements of the environmental guidance of JICA, the 1995 Environmental Protection Act of DoE and 1997 Environmental Conservation Rules of DoE, as well as environmental guidance of other agencies such as ADB, WB, etc.

Scoping and bounding of the EIA was carried out first based on the result of the IEE conducted in an earlier phase of this Feasibility Study.

Information disclosure and public participation were given continuous focus throughout the Study period in conformity with new JICA environmental guideline.

7.5.2 Baseline Data Collection

(1) Secondary Data

The secondary data were collected on the following from various organizations.

Table 7.5.1 Collection of Secondary Data

Sl No	Type of Data	Source of Data
• **Natural Environment**		
1.	General topography of the project area	UZ, SoB and BCL
2.	Regional hydrology and flood pattern	BWDB, IWM, BCL and JICA Study Team
3.	Present river erosion and siltation pattern	BWDB, IWM, BCL and JICA Study Team
4.	Drainage condition	BWDB, IWM, BCL and JICA Study Team
• **Ecological Environment**		
1.	Water bodies	IWM, UZ and JICA Study Team
2.	Fisheries situation	DoF, UZ, BCL and IUCN
3.	Vegetation / agricultural situation	DEA UZ, IUCN and BCL
4.	Wildlife	IUCN, DF and BCL
• **Environmental Pollutions**		
1.	Air	UZ and BCL
2.	Noise and Vibration	UZ and BCL
3.	Water pollution data in the vicinity	BCL
• **Social Environment**		
1.	Land use pattern	UZ and BCL
2.	Historical and cultural area	UZ and BCL
3.	Navigation and water transport	BIWTA, BIWTC, UZ and BCL
4.	Health and sanitation information	UZ and BCL
5	Road accident data	BRTA, UZ and BCL

Source: Visit to various organizations during August-September, 2004

(2) Primary Data Collection

Some of the primary data was obtained from separate sectoral studies carried out within this JICA FS. For the rest, a questionnaire survey, Focus Group Discussion (FGD) and field reconnaissance were carried out.

Under the supervision of JICA Study Team members, two field survey groups were organized and after initial field investigation, a structured questionnaire was prepared. Then field surveys were conducted for primary data collection by those two environmental survey groups during September, 2004. Each survey team consisted of four well-experienced and highly qualified personnel. Prior to moving to the site, a two day training course was organized for the survey team under the supervision of JICA Study Team members. In addition, a riverbank line survey was carried out by GPS in October, 2004. Senior professional experts including JICA Study Team members visited the field from time to time and monitored the data collection program by the field survey teams. Discussions with the local inhabitants, especially the PAPs, were a vital activity during field investigations.

The primary data were collected on the following.

(a) Natural Environment

- River erosion and siltation (from JICA FS hydrological model test)
- Regional hydrology and flood pattern (from JICA FS hydrological model test)
- Drainage condition (from JICA FS hydrological model test)
- Landscape (by direct investigation, within the ROW)

(b) Ecological Environment

- Water bodies loss within ROW (field observation/inventory)
- Fisheries (questionnaire survey and focus group discussion FGD)
- Vegetation/agricultural loss (questionnaire survey and FGD)

- Plant cutting within ROW (field observation/inventory)
- Wildlife (questionnaire survey and FGD)

(c) Environmental Pollution

- Air, noise, dredge material and water pollution data in the project area (environmental quality survey)
- Waste disposal (questionnaire survey and FGD)

(d) Social Environment

- Land acquisition, homestead loss, income loss and split of communities (from JICA FS SIA and Resettlement Study)
- Historical and cultural loss within ROW (field observation/inventory)
- Navigation and water transport (questionnaire survey and FGD)
- Health and safety (questionnaire survey and FGD)
- Road accident (questionnaire survey and FGD)
- Land use within ROW (field observation/inventory)

(3) Environmental Quality Survey

Principal features of the environmental quality survey are summarized below.

Table 7.5.2 Principal Features of Data Collection Activities

Components	Parameters	Site of Sample Collection	Date of Sample Collection
Air Quality	Pb, CO, SO_x, NO_x, and SPM	2 points at Mawa and 4 points at Janjira, along the proposed alignment	During 8 to 9 and 22 to 26 Sept 2004 at Mawa and Janjira respectively.
Noise	Average and peak of 10 minute continuous	2 points at Mawa and 4 points at Janjira, along the proposed alignment	During 8 to 9 and 22 to 26 Sept 2004 at Mawa and Janjira respectively.
Surface water quality	BOD, COD, pH, TDS, DO, SS and Grease & Oil	3 points at Mawa and 5 points at Janjira (Note 1)	9 September 2004 at Mawa and 25 Sep 2004 at Janjira
Ground water quality	pH, Mn, Fe, As, Fe, NH_3-N_2 and Chloride as Chlorine	2 points at Mawa and 2 points at Janjira, along the proposed alignment	9 September 2004 at Mawa and 25 Sep 2004 at Janjira
River bed material	Zn, Cu, Hg and Mn	1 point at Mawa and 1 point at Janjira	9 and 18 Sept 2004 at Mawa and Janjira

Note 1: 3 points at Mawa end (one from Padma river, one from pond, and one from the flood plain) and 5 points at Janjira end (one from Padma River, one from pond, two from channel crossed, and one from the flood plain)

The environmental quality survey was carried out by the Chemical Engineering Department of Bangladesh University of Engineering & Technology (BUET).

7.5.3 Conducting EIA

(1) Data Processing and Analysis

First, all the data collected from secondary sources and the field were checked and edited. The data were then processed and analyzed in the most appropriate manner in consultation with environmental guidelines and under the supervision of a JICA Study Team member. Finally, specifically developed tools were applied for impact assessment.

(2) Impact Assessment

Three types of conceptual models are useful in EIA to define the relationship of

environmental components to one another and to the project, and to serve as a basis for describing and, in some cases, for predicting and assessing impacts. These are,

- Matrices
- Networks
- Seasonal models

Networks and matrices are often interchangeable because the elements of the matrix frequently represent links in the network. In this study, because of the highly visual nature of impacts in matrices, the matrix method for impact assessment was selected for EIA.

Matrices are useful two dimensional models for relating two sets of items represented by rows and columns in the matrix. A common use in EIA is to relate project activities to environmental components. A cross-impact matrix illustrates the project activities (rows) that have an effect on the column listed Important Environmental Components (IECs). The elements of the matrix represent the individual relationships between each project activity and each IEC.

The main value of a matrix lies in its use in communicating complex information in a simplified and easily assimilated form. Items displayed in a matrix can easily be compared and contrasted. Matrices can also be utilized quantitatively by computing means and ranges of rows and columns to provide summarized information.

(3) Impact Prediction

Impacts can be predicted on the basis of the following:

- Modeling
- Correlation with specific key variables
- Trend analysis
- Comparison and projection

All four methods can be employed to various extents in order to predict the impacts on various parameters. In this study, the comparison and projection method was extensively used to predict impact as it is often possible to obtain some estimate of future conditions for a specific area under a specific set of interventions by making comparisons to areas that have already been subjected to similar interventions and where results have been observed and adequately documented. This method is probably most commonly in use since most practitioners tend to evaluate conditions based on their experience of previous projects.

In the last ten years a number of large bridges, namely Jamuna, Paksey and Bhairab, have been constructed. The predicted and actual impacts of these bridges were studied to predict impacts of Padma bridge where ever appropriate. Therefore, selection of the comparison and projection method was especially relevant.

Modeling results from the Institute of Water Modeling (IWM) were used to predict impacts on regional hydrology, flood pattern, river erosion, siltation, and drainage congestion.

(4) Impact Rating

Impacts were evaluated on the basis of:

- Magnitude
  - Type of impact (direct, indirect, cumulative)

- Immediacy
  - Temporal extent (during construction, after construction)
  - Spatial extent (local, widespread)
- Sustainability and Reversibility
  - Mitigability (fully, partially)
  - Monitoring possibility (fully, partially)

Cumulative impacts were carefully evaluated. This is especially important because now there are two large bridges (Paksey at Ishurdi-Bheramara over the Ganges River and Jamuna at Kalihati-Serajgonj over Jamuna River) upstream of the proposed Padma bridge at Mawa-Janjira Site over Padma River.

A 21-point scale has been suggested for the Flood Action Plan Project, for example (1 to 10 for beneficial impacts, 0 for no impact, -1 to -10 for negative impacts). Such a scale was adopted in this study.

7.6 SCOPING AND BOUNDING

7.6.1 Scoping

A scoping process was used to identify various Important Environmental Components (IECs). IECs are components that, by virtue of their importance to ecosystem functioning, production of food and/or maintenance of livelihoods and quality of life, are considered essential and worthy of sustaining at existing or enhanced levels under the proposed project regime.

Selection and prioritization of IECs were done using four avenues.

- General literature review
- Review of IEE of Padma Bridge
- Review of EIA of Jamuna, Paksey and Bahirab Bridges
- FGD/PRA

The first 3 items are used to select potential environmental parameters of the project, while FGD/PRA is carried out to validate the IECs and rank the potential environmental parameters in order of importance.

The infrastructure development in Bangladesh is closely related to a considerable number of environmental parameters or components of the environment, which may be grouped under three mutually interacting major components:

- Natural
- Ecological
- Ambient and
- Social

Various parameters may be affected to different degrees depending on various phases of the project e.g. pre-construction activities, construction activities, and operation and maintenance activities. By identifying those environmental elements significantly affected, assessment is done by means of generally acknowledged practices in Bangladesh, such as checklist, flow chart, and impact matrix. Other qualitative methods adopted by multilateral agencies were also consulted.

7.6.2 Bounding

The spatial boundary of the project influence area was selected on the basis of the following:

- Land that will be occupied by permanent structures
- Land that will be acquired for temporary use or occupation during construction
- Land in the vicinity of project works, where changes in land use are expected as a result of project implementation (settlements, industries, etc.)
- Land where water management, agricultural and fishing practices will change as a direct result of the bridge project (e.g., backwater effect, disrupted drainage, navigation, etc.)
- Land where ecological changes (flora, fauna, soil, water, air) will occur as a result of the infrastructural works

Temporal boundaries refer to the timing and duration of the proposed phases. In this study, two phases were considered: construction phase and operation phase of the bridge. Construction periods are usually relatively brief but induce certain types of impacts of high intensity, e.g., deteriorating water quality or labor influxes. Operational periods are usually longer than construction and induce impacts of longer duration.

7.7 INFORMATION DISCLOSURE AND PUBLIC PARTICIPATION

Disclosure of project information including anticipated impacts and public participation like stakeholders meetings were conducted continuously in this Study in conformity with new JICA guidelines.

Public consultation and participation in EIA aim to achieve the following objectives:

- To enhance the sustainability of projects by ensuring that interventions are relevant to the people of the area.
- To learn from the various social groups living in a project area how they perceive the existing situation, recent trends, existing problems, and potential solutions; this includes collecting local knowledge, information, and ideas about the technical implications and impacts of project design
- To identify the Important Environmental Components (IEC) for the environmental assessment
- To get degree and ranking of IECs as foreseen by the stakeholders
- To determine potential social, economic, and cultural impacts not always foreseen in survey based socio-economic studies
- To provide local communities and socio-economic interest groups with the foundation for a role in post-feasibility project interventions; this means participation in project planning and a role in project implementation, operation, and maintenance.

Ideally, when properly associated with project interventions, “empowered” local groups help stabilize project impacts, provide social channels through which benefits can be provided and mitigation can be managed, and ultimately, result in more sustainable projects.

In this study a number of Focus Group Discussions (FGD) and Participatory Rapid Appraisals (PRA) have been conducted with the Project Affected Population (PAP). The main objectives were to:

- adequately inform the PAPs about the various project components
- assure the PAPs that a thorough EIA is underway

- identify and prioritize various IECs based on local knowledge, and
- identify enhancement and mitigatory measures.

The list of FGD/PRAs conducted is provided in Table 7.7.1 below. A total of 344 participants took part in the FGD/PRAs. The participants included 104 farmers (30%), 98 businessmen (29%) and others 142 (41%). Men and women constitution were 291 (84%) and 53 (16%) respectively. In all consultation meetings, officials and members of the NGOs working locally were included. These NGOs are working in various sectors like income generation, micro credit, education, health and family planning, and small scale rural infrastructure development. Detail proceedings of each FGD/PRA can be found in Volume X: Supporting Studies.

Table 7.7.1 List of FGD/PRAs conducted in Project Sites

Date	Location	Participants
28 September, 2004	Vill: Matborerchar, UZ: Sibchar, Dist: Madaripur	75
04 September, 2004	Vill: Sikerkandi, UZ: Sibchar, Dist: Madaripur	51
07 October, 2004	Vill: Kandipara, UZ: Lauhaganj, Dist: Munshigonj	46
08 October, 2004	Vill: Diara Naoboba, UZ: Janjira, Dist: Shariatpur	30
09 October, 2004	Vill: Medinimondol, UZ: Lauhaganj, Dist: Munshigonj	52
08 October, 2004	Vill: J. Mathbarkandi, UZ: Janjira, Dist: Shariatpur	42
09 October, 2004	Vill: South Medinimondal, UZ: Lauhajang, Dist: Munshigonj	48

In order to learn from the experiences of PAPs in other large bridge sites, separate discussion sessions were carried out in those sites as shown in Table 7.7.2 below.

Table 7.7.2 List of Discussion Sessions in other Large Bridge Sites

Date	Site	Number of Participants
12 & 16 September, 2004	Jamuna Bridge on Jamuna River	7
16 October, 2004	Paksey Bridge on Ganges River	5
16 October, 2004	Bhairab Bridge on Meghna River	6

7.8 ENVIRONMENTAL BASELINE

Extensive investigation was made and compiled in the IEE and EIA stages to establish an environmental baseline, and the results can be found in Chapter 2 and 3 of APP – 11. In this Section, only the important information is provided.

7.8.1 Natural Environment

Topography: According to a topo-survey carried out by the JICA study team in June 2004 it was observed that the ground elevation at Mawa site varies from 6 mPWD (on the riverbank) to 4.50 mPWD (in the countryside), which indicates that the project area is sloping from riverbank towards the countryside. The main features within the project area are: ponds, roads, brickfields, small roadside shops, ferryghat and densely located homesteads including tree plantations. The project area at Janjira is almost flat agriculture land with some homesteads and homestead plantations. According to the topo-survey, ground elevation is sloping from south to north and varies from 6 mPWD to 5 mPWD. The elevation of the river bed at the proposed bridge crossing location ranges from 0.00mPWD (at mid river) to –10.50mPWD (close to the left riverbank). The riverbed slope of the Padma is about 0.00005. The left bank is relatively more stable than the right bank.

Drainage Interference: There are several water bodies located within the project. Among them, the following water bodies originate from the 10km long right riverbank of the Padma within RoW and then cross the proposed 12km long approach road.

- Naodoba River at ch 8+053
- Shikderkandi Khal at ch 11+948
- Kutubpur Khal at ch 12+463
- Borokanopur Khal at ch 13+268
- Low Lying Area at ch 13+678
- Mollah Kandi Khal at ch 15+428

Drainage congestion at Janjira site will occur by the proposed approach road running on the flood plain on the right bank and RTW along the right bank if no adequate drainage structures are provided in the embankments. No channel crosses the 0.273km approach road and 6km RTW at the left riverbank at Mawa site. So, major drainage congestion will not occur at the Mawa site.

Landscape: A detailed landscape survey was conducted along the river banks for a 400m strip on both banks for the entire Padma River (100km) and a description can be found in Chap 2 of APP – 11. The landscape at the Mawa site is dominated by dense commercial and residential areas. The landscape at the Janjira site is dominated by large areas of agricultural land.

7.8.2 Ecological Environment

Agriculture and Vegetation: Detailed investigation was made on cropping season, cropping diversity, cropping pattern and cropping intensity of the project area. Also, a survey was carried out on cropped area by crop type for various project components in addition to unit crop production and unit crop value. It is estimated that total crop loss will be 2396 MT, of which paddy loss is 635 MT (27%). In terms of money, the total loss is around 45 million Taka.

Tree Cutting: A census on trees within RoW of the project was carried out during September-October, 2004 which is presented in Volume X: Supporting Studies. It is understood that a total of 327,868 trees of various sizes and species are going to be affected, out of which 63,105 are banana and 149,054 bamboo plantation. In that census, all types of trees to be affected are identified (more than 100 species) and classified in large, medium, small and sapling categories.

Water Bodies and Fisheries: A field survey on water bodies and fish production was carried out and found that no big water bodies are located in the project area. A total of 58 ponds (4.18 ha) and 74 ditches (2.66 ha) will be affected by the project.

Wildlife: There is no exclusive habitat for any endangered species in the vicinity of the project area.

Environmentally Protected and Sensitive Area: No environmentally protected and sensitive areas are located within the RoW of the project.

7.8.3 Environmental Pollution

Surface Water: Under the Environmental Quality Survey (EQS) of this Study conducted in September, 2004, surface water samples were collected from two locations within RoW of the approach road at Mawa site and five locations within RoW of the approach road at Janjira site. The test results are given in Chap 3 of APP – 11. It can be said that in general water quality of the samples is acceptable.

Ground Water: Groundwater is the main source of drinking water in the four project affected UZs and it is also used for cooking, washing, bathing and irrigation purposes. The

ground water samples were collected from two locations at Mawa and three locations at Janjira. Test results are shown in Chap 3 of APP – 11. In all cases, it was found that though fecal coliform is not present, the concentration of ammonia is higher than the WHO standard of 1.5 mg/l. This indicates the possibility of sanitary contamination and any future plan to develop groundwater as a drinking water source requires extensive sampling and analysis. Though the area is generally affected by naturally occurring arsenic ("Arsenic Contamination of Groundwater in Bangladesh", British Geological Survey), the four samples are not contaminated with arsenic. Concentrations of iron and manganese are above the DOE drinking water standard, which is common in Bangladesh in naturally occurring arsenic areas.

Air Quality: The main air quality problems in the project area occur from localized pollution like dust, vehicle emission, brickfields, industries, etc. Air quality measurements include CO, SOx, NOx, Pb and SPM and were carried out at 2 locations at the Mawa site (once on a holiday and once on a working day) and at 6 locations at the Janjira site. Measurement results are shown in Chap 3 of APP – 11. From the result, it is seen that SOx concentration is high at Mawa junction and Pachchar Bazar. The probable reason is the existence of brick fields in the vicinity. Concentration of NOx was higher than the standard in only one case (Mawa junction). CO was below the standard at all sampling points. SPM was higher than standard at Pachchar and Kutubpur. The highest lead concentration among the sampling sites was found at Mawa junction. Air quality is poor at Mawa junction due to vehicle emission including emission from the ferry and other river transport as well as brick fields.

Noise and Vibration: The noise problem in the project area is minor except for the ferry terminal and occurs from the hydraulic horn and from the movement of buses, auto-rickshaws and trucks on the roads. Noise pollution also occurs due to plying of boat engines in the river and khals, especially at the Janjira site. Slight vibration occurs at Mawa, Charjanajath (Kawrakandi) and Kathabari ferryghats during loading and unloading of heavy vehicles such as trucks, buses etc. Noise levels were measured at locations where air quality measurements were made at Mawa and Janjira sites. Measurements of noise levels are shown in Chap 3 of APP – 11. The only place where the noise level crossed the limit is the Mawa junction.

Dredge Material: For the RTW, a large amount of riverbed soil has to be dredged and possibly will be used for road, toll plaza and service area construction. Thus, riverbed samples were collected from the bed of the Padma River at Mawa and Janjira sites and tested to identify the presence of heavy metals. Test results are shown in Chap 3 of APP – 11.

Anticipating a minor pollution level because there are no major industries nearby and the river has high flow velocity and large flow quantity, test parameters were kept to a minimum since the purpose is to establish a base level. Arsenic was not tested as the area is within the naturally occurring arsenic area. As the only possible use of such dredge material is filling the proposed road or service area, chances of subsequent surface water, ground water or air pollution is low as the top and side of the fill will be sealed.

There is no DOE standard for dredge material. According to the Netherlands standard, the "Action" concentrations for Zn, Cu and Hg are 720, 190 and 10 mg/kg. Also, according to the Canadian standard, the allowable limit for soil in the case of residences and parks are (where indirect human contact is possible, and in the present case, human contact is not possible), 200 and 6.6 mg/kg for Zn and Hg. Present test results show concentrations below those standards. However, since the test parameters and sampling points are limited, more extensive sampling and analysis (also from different depths) is required in EMP if the dredge material is to be used for road, toll plaza and service area construction. If it is found

in the EMP that the dredge materials are highly polluted, they should not be used as fill for road or service areas. Instead, they can be used in concrete mixing.

7.8.4 Social Environment

Project Affected Persons: From the SIA and Resettlement Study under this JICA FS, it is reported that the total Project Affected Persons (PAP) are 19,021, out of which 8,308 are in Mawa and 10,713 in Janjira. The total number of households required to be relocated is 3,150 (1,343 in Mawa and 1,807 in Janjira). The Study did not find any tribal or ethnic minorities living within the project area. Also, no households were identified as belonging to the refugee population. Total income loss of PAPs is approx. Tk. 210 million. The land acquisition requirement for the project is 616 ha. More detail can be found in SIA and Resettlement related sections of this Report.

Charland: According to the mathematical model study under this JICA FS, the increase of water level upstream and downstream of the bridge is expected to be limited mainly due to the fact that the river width is not constrained. As a result, no nearby char will be inundated due to the bridge construction. In the case of Jamuna bridge, as the river width was reduced to around half of the original width, water level at the bridge site was increased significantly and its impact was wide spread as far as 12 km upstream and 8 km downstream of the bridge site. As a result, a number of chars were inundated.

Inside the main stream of the Padma River many char lands have been developed. Upstream of the proposed bridge site a big char land is located. There are about 18 villages located on the char land. The area and population of the char land are 60km2 and 45000 as reported by local inhabitants. The people in the char land are poor and living on agriculture and fishing. The age of the char is about 12 years and, according to a model study, this char may be totally eroded even without a bridge after a few years. Other relevant information is provided in Chap 2 of APP – 11.

Transport: The proposed approach road at Janjira crosses several roads including one Regional Highway, two Feeder Roads (Type-B), 10 local roads under LGED, and some minor trails in the plain on the right bank of the Padma River. Since the approach road will overpass all these crossing roads with grade separation, local communication will not be disturbed and there will be less impact of split of communities. Various vessels, launches and boats are plying on the Padma and only country boats and trawlers are working on the Naodoba River, to be crossed by the approach road.

Historical and Cultural Heritage: No listed archaeological or historical resources are found within the potential project impact area. However, there are about 41 cultural (community) resources present within RoW and these include, schools, madrasha, mosques, eidgha, graveyards and Hindu burning-ghat.

Landuse Planning: In general, the project area at Mawa & Janjira consists of alluvial fertile land. The major area of the project is occupied by agricultural land, especially at the Janjira site, and the rest is homesteads, commercial premises, water bodies, cultural institutes, etc. The landuse survey was carried out for a 300m strip along the RTW, a 150m strip along the approach road and also a 2.5 km x 2.5 km area for a service area at the Janjira site to understand the landuse pattern of the directly and indirectly project affected areas. From the survey, it is evident that at the Mawa site, homestead/settlement (71%) is dominant whereas at the Janjira site, agricultural land (83%) is dominant. The detail information on the landuse pattern and landuse map is given in Chap 2 of APP – 11.

7.9 IMPACT ASSESSMENT AND MITIGATION

7.9.1 Identification of IECs

Selection of Important Environmental Components (IECs) for the EIA is primarily based on the IEE study. The EIA Reports of Jamuna, Bhairab and Paksey Bridges were also consulted in the selection process. Finally, the selection of IECs was validated during FGD/PRAs in the study area. Out of the 40 parameters initially selected, the IEE study identified 8 positive impacts, 8 no impacts and 24 negative impacts (Chap 2 of APP – 11). In the EIA study, 28 parameters were selected as IECs based on results from the IEE and output of public consultation. The selected IECs and the rationale behind their selection are provided in Table 7.9.1. Based on the previous sections, an impact assessment along with mitigation measures for these 28 IECs has been prepared and is given in the following sections.

Table 7.9.1 List of Selected IECs

Sl No	IECs	Rationale for Selection
NATURAL ENVIRONMENT		
1	Regional hydrology and flood pattern	If the bridge is constructed without consideration of regional hydrology/flooding level, then annual and abnormal flood may cause damage in the surrounding area.
2	Drainage congestion	The approach road may have negative impact on the local drainage pattern, especially since the proposed site is located in a floodplain.
3	River erosion and siltation	The change in hydrological regime due to the bridge may induce change in the river morphology, thereby increasing erosion and siltation.
4	Landscape	Improper excavations of borrow pits for the construction of approach roads and other infrastructures may degrade the existing topography and landscape.
ECOLOGICAL ENVIRONMENT		
5	Agriculture	Scope for crop diversification will increase with the opening of the bridge.
6	Tree plantation/cutting	In order to implement project components, trees have to be cut. On the other hand, opportunity for tree plantation arises due to project.
7	Water Bodies and Fisheries	After construction increased velocity may affect longitudinal fish migration. Approach roads in the floodplain may hinder lateral migration. Disposal of waste into the river during construction may be harmful for the fish. During construction, pile driving may affect fish migration. Some fish ponds will be acquired.
8	Wildlife	Construction activities may create disturbance for aquatic and terrestrial wildlife.
SOCIAL ENVIRONMENT		
9	Land acquisition	Land acquisition will impact on local income and may create social disorder.
10	Homestead/Settlement	In order to acquire land, forced displacement of people in the project area will happen. This will lead to an enormous disruption of social life in the local population.
11	Income loss	Agricultural land acquisition, loss of fisheries, loss of business activities and loss of employment will result in loss of income.
12	Agricultural production	The approach road on the right bank will pass mainly through agricultural land.
13	Cultural resource loss	Construction of facilities may damage mosques, educational institutes, graveyards, etc.
14	Navigation/water transport	Normal navigation in the Padma River may be hampered during and after construction of the bridge.
15	Health and safety	The construction workers may be exposed to health risks from drinking water quality, especially arsenic, handling of construction equipment, chemical materials.
16	Employment opportunities	Employment opportunities will be created during construction and in the operation-maintenance period.
17	Women empowerment	Due to construction of the bridge, home based poultry farms, dairy farms, rice husking machines, etc. will be established in the rural areas where women will find jobs. Access to health and education will also increase.
18	Social Infrastructure	The project may contribute to infrastructure development, i.e. educational institutes, markets, mosques, tourism facilities, etc.
19	Industry	Implementation of the project will create scope for establishment of industries in the adjacent areas.
20	Split of communities	In order to maintain proper alignment of the project, communities may be split which will have an effect on ancestral homes and community living.

Sl No	IECs	Rationale for Selection
21	Road transport	Improvement of road transport is the principal objective of the project.
22	Road accidents	Road accidents may be increased during construction and operation.
23	Land use	Land use will gradually change from a pre-dominantly rural setting to an urban setting due to gradual increase in commercial and industrial activities.
ENVIRONMENTAL POLLUTION		
24	Surface and ground water quality	Accidental spillage of chemicals such as fuel, lubricants and solvents may pollute water. Waste disposal from construction sites may pollute the local environment.
25	Air pollution	Air pollution may occur due to the use of vehicles and equipment, cleaning of materials, coating of construction materials, dust from stone/brick crushing.
26	Noise and vibration	During the construction period, noise pollution will be generated by the use of vehicles, pile driving operation, stone crushing, power generators, etc.
27	Soil contamination	Accidental spillage of chemicals such as fuel, lubricants and solvents may pollute the soil.
28	Pollution due to waste	During construction huge quantities of construction and general waste will be generated.

7.9.2 Natural Environment

(1) Regional Hydrology and Flood Pattern

Impact:

During Construction: Most of the river training related works will be carried out during dry season. Other construction will also cause minor impact on flooding.

After Construction: The confinement effect of the bridge may increase the flood level of the river. Such higher water level along with the impact of the approach road may disrupt the regional hydrology for the study area, which is located in a deeply flooded region.

The JICA Study Team conducted a separate Hydraulic Modelling with IWM and simulated 'without project' and 'with project' conditions for the design floods of 25 and 100 years return periods. Simulated highest water levels and maximum discharges at Mawa and Arial Khan Bridge are listed in Table-7.9.2. In general, differences in water levels between 'without project' and 'with project' conditions are approximately 0.1 m. The confinement effect is not significant, as RTW will not confine the normal flow of the river. Therefore the only confinement effect is due to the piers of the bridge, the total width of which is 1% of the river width.

Table 7.9.2 Simulated Water Levels and Discharges

Highest Water Level

Return Period	Mawa (m, PWD)		Arial Khan Bridge (m, PWD)	
	Without Project	With Project	Without Project	With Project
25-year	6.93	7.02	7.10	7.23
100-year	7.49	7.55	7.76	7.78

Maximum Discharge

Return Period	Mawa (m^3/sec)		Arial Khan Bridge (m^3/sec)	
	Without Project	With Project	Without Project	With Project
25-year	117,000	118,000	3,700	3,300
100-year	134,900	134,800	3,900	3,900

Source: JICA Hydraulic Modeling Study

The maximum flooding depth in the flood plains around the proposed bridge site were estimated by the highest water level distributions superimposed on DEM for each return period. The relative comparison of maximum flooding extent by depth between 'without

project' and 'with project' conditions is shown in Table-7.9.3. In general, the maximum flooding extent becomes slightly larger in the 'with project' condition. Details of the Hydraulic Modeling Study can be found in other sections of this report (Sec 4.3.3 Mathematical Modeling).

Table 7.9.3 Comparison of Maximum Flooding Extent by Depth

Without Project

Return Period	Accumulated Flooding Extent by Depth (km^2)				
	Over 2.0m	Over 1.5m	Over 1.0m	Over 0.5m	Over 0.0m
25-year	888	1,074	1,162	1,188	1,196
100-year	1,087	1,163	1,190	1,197	1,197

With Project

Return Period	Accumulated Flooding Extent by Depth (km^2)				
	Over 2.0m	Over 1.5m	Over 1.0m	Over 0.5m	Over 0.0m
25-year	932	1,094	1,168	1,190	1,196
100-year	1,088	1,163	1,190	1,197	1,197

Source: JICA Hydraulic Modeling Study

It is seen from the above analyses that the bridge will not have any significant impact on the regional hydrology and flood pattern in the vicinity of the bridge site. This is mainly due to the fact that the constriction effect of the proposed bridge on the river is minimal.

Mitigation:

During Construction: Careful construction planning is required not to disturb the natural flooding pattern.

After Construction: Adequate waterway opening is already provided as bridge/culvert on approach road in the preliminary design. However, it is recommended that both mathematical and physical modelling be conducted to confirm the hydrological and flood impact during the detail design stage.

(2) Drainage Congestion

Impact:

During Construction: Some localized drainage problem can happen due to unplanned construction activities.

After Construction: Some impacts on drainage may be anticipated by the proposed approach road embankment with a length of 12 km running on the flood plain on the right bank. The approach road will cross two rivers, four khals and one low-lying area. The JICA Hydraulic Modeling Study simulated the impact of the approach road on flooding by considering five major openings. The impacts on flooding were assessed by simulations in terms of changes in flooding duration and water level. Table-7.9.4 shows the changes in flooding duration at the selected locations upstream and downstream of the proposed approach road on the right bank. Flooding duration only changed the impact a little between 'without project' and 'with project' conditions.

Table 7.9.4 Flooding Duration near Proposed Approach Road (Right Bank)

Return Period	Flooding Duration by Days			
	Without project		With project	
	Location-A Upstream of Approach Road (DEM 5.65 mPWD)	Location-B Downstream of Approach Road (DEM 5.25 mPWD)	Location-A Upstream of Approach Road (DEM 5.65 mPWD)	Location-B Downstream of Approach Road (DEM 5.25 mPWD)
25-year	41	72	39	72
100-year	67	78	68	78

Source: JICA Hydraulic Modeling Study

Water levels of local channels crossing the proposed approach road embankment on the right bank were also assessed as shown in Table-7.9.5. At the proposed major crossings, the highest water levels become slightly higher for the 'with project' condition. Details of the Hydraulic Modeling Study can be in other sections of this report (Main Report, Sec 4.3.3 Mathematical Modeling).

Table 7.9.5 Water Level of Local Channel at Crossing of Proposed Approach Road on Right Bank

Without Project

Return Period	No.1	No.2	No.3	No.4	No.5
25-year	6.93	7.06	7.26	7.28	7.39
100-year	7.49	7.64	7.83	7.85	7.95

With Project

Return Period	No.1	No.2	No.3	No.4	No.5
25-year	7.01	7.1	7.33	7.34	7.47
100-year	7.55	7.66	7.87	7.88	8.01

Source: JICA Hydraulic Modeling Study

The above data show that there will be only some minor drainage congestion on the right bank due to the approach road.

Mitigation:

During Construction: Proper construction planning can eliminate local drainage congestion.

After Construction: Adequate waterway opening of the bridges/culverts are already provided for in the preliminary design on the approach road at appropriate locations to minimize the scope of drainage congestion. However, it is recommended that both mathematical and physical modelling be conducted to confirm the drainage congestion impact in the flood plain during the detail design stage.

(3) River Erosion and Siltation

Impact:

During Construction: Most of the river training related works will be carried out during dry season. Other construction will also cause minor impact on natural river erosion and siltation.

After Construction: Both left and right banks of the Padma River are prone to erosion to various degrees. In order to protect the bridge from erosion, RTW of about 6km at Mawa and 10km at Janjira site are planned. The JICA Hydraulic Modeling Study simulated the lowest river bed level for different design flood between 'without project' and 'with project' conditions. Comparison of the simulated results between 'without project' and 'with project' conditions indicate that no significant difference is visible for the main water course in view of macro-basis morphological developments. Details of the Hydraulic Modeling

Study can be found in other sections of this report (Main Report, Sec 4.3.3 Mathematical Modeling).

Mitigation:

During Construction: Careful construction planning is required not to disturb the natural condition.

After Construction: It is seen that the scour, erosion and siltation is not significant. However, it is recommended that both mathematical and physical modelling be conducted to confirm the river erosion and siltation impact during the detail design stage.

On the other hand, the RTW will protect the project site area from river erosion. This will have major beneficial impact on the local population. In order to enhance the benefits of RTW, it is suggested to include provision of fish landings and ghats in the design of the RTW. This will ensure access of the local population to the river water, which they use for a variety of purposes. Such provision was included in the design of Sariakandi hard point.

(4) Landscape

Impact:

During Construction: The construction activities will considerably degrade the local topography and landscape. Improper excavations of borrow pits for the construction of approach roads and other infrastructures may degrade the existing topography and landscape.

After Construction: Without monitoring, there is a chance that undesired structures will be erected at undesired locations. The project when completed will attract settlements near the bridge and along the connecting roads. A part of these will be industrial establishments and commercial facilities. Without proper control, unplanned establishment will deteriorate the pleasant landscape. There is also a possibility of growth of squatter settlements on those acquired lands that may become surplus and which have no specific use once the construction is over.

Mitigation:

During Construction: Regulatory measures should be undertaken to prevent uncontrolled land use adjacent to the approach roads and bridge. Input of a landscaping expert is required during construction and post construction stages.

After Construction: With proper landscape planning, the bridge site can be developed into attractive tourist spots. The maintenance staff at the bridge site need to be properly equipped to maintain the planned landscape.

7.9.3 Ecological Environment

(1) Agriculture

Impact:

During Construction: The project has potential negative impact on agriculture. The approach road, especially on the right bank (Janjira) passes mainly through agricultural land. Paddy including Aman and Aus, is the main crop in the project area. Other important crops are rabi crops such as onion, groundnut, pulses and garlic. As stated in Section 3.8.2 of

App-11, total crop loss is 2,396 MT. On the Mawa side, out of the total land lost, 12% is agricultural. On the other hand, on the Janjira side, 83% of the lost land is agricultural. Total agricultural land lost is 231 ha.

After Construction: There is no major ecology related agricultural impact after construction.

Mitigation:

During Construction: This is permanent ecological loss. Steps should be taken to convert the fallow lands in the vicinity into agricultural land.

After Construction: No impact is anticipated.

(2) Tree Cutting and Plantation

Impact:

During Construction: The trees that will need to be cut for construction of the project are of homestead and road plantation variety. These census on trees within the RoW of the project was carried out during September-October, 2004 which is presented in Volume X: Supporting Studies. It is understood that total 327,868 trees of various sizes and species are going to be affected, out of which, about 107,689 are large, 75,150 medium, 75,171 small and the rest are saplings.

After Construction: There is no major impact on tree cutting and plantation after construction.

Mitigation:

During Construction: In order to compensate for the loss of trees, the project provides opportunities for new plantation. A buffer strip of 20 meter width for RTW has been planned for tree plantation. There will be opportunities for plantation on the roadside slopes of the approach roads and in the service area. The total estimated area for tree plantation is about 300ha. It is recommended to plant fruit (40%), wood (50%) and fuel trees (10%). The estimated number of trees to be planted is 238,692 based on suitable spacing. Provision for more space for tree plantation can be considered but should not be at the expense of fertile agricultural land.

At the Jamuna, Bhairab and Paksey Bridge sites, a number of tree species were planted. The survival rate of some of the species, for example, Shishu is not satisfactory. Before selection of tree species for plantation at the Padma bridge site, it is recommended that the performance of plantation be studied at the other three major bridge sites. It is noted that Eucalyptus (Eucalypius Camaldulenisis) trees have been banned by GoB for road side plantation. Tree plantation should be carried preferably through engagement of NGOs and destitute women. Some of the suitable species for local conditions are shown in Table-7.9.6.

Table 7.9.6 Suitable Tree Species for the Project

Sl No	Fruit Trees	Wood Trees	Fuel Trees
1.	Jackfruit (*Artocarpus Heterophyllus Lamk*)	Raintree (*Albizia Spp*)	Jarul (*Lagerstroemia Speciosa*)
2.	Mango (*Mangifera Indica*)	Mehogini (*Swietenia Mahagoni*)	Debdaru (*Polyalthia Longifalia*)
3.	Jam (*Syzygium Cumini Skiel*)	Shilkoroi (*Abzia Procera*)	Kadam (*Anthocephalus chinensis*)
4.		Shegun (*Tectona Grandis*)	-
5.	-	Akasmoni (*Acacia Auricoliformis*)	-
6.	-	Neem (*Azadirachta Indica*)	-

Source: Field Survey, September-October, 2004 and UZ office.

After Construction: No impact is anticipated.

(3) Water Bodies and Fisheries

Impact:

During Construction: Construction on and by the river might create some disturbance to fish. However, this impact is minimal and reversible.

After Construction: The pattern of migration of riverine fish is controlled by the seasonal flooding following monsoon rains. Fish movement and migration longitudinally, upstream or downstream, occurs at various times of the year. Any barrier to the normal movement will affect their life and reproductive cycles. It has been observed that Hilsa (Tetraodontidae Hilsa) is a major species in the study area. Hilsa is the national fish and has a very special place in the Bangladesh diet. Hilsa of Padma is additionally famous for its taste, so any impact on Hilsa needs to be carefully scrutinized. This is especially true because there will be two large bridges in place on the Padma-Ganges river (Paksey and Mawa) and the cumulative impact on Hilsa may be significant.

The JICA Hydraulic Modeling Study simulated the river flow velocity for different design flood between 'without project' and 'with project' conditions. Comparison of the simulated results between 'without project' and 'with project' conditions indicate the increase in velocity due to the project is only marginal. So it can be said that Hilsa and other fish that seasonally migrate up and down the Padma River, are not expected to be affected by the project.

Fish which migrate laterally on to the floodplain may be impacted by the approach road on the left bank. The floodplain is an important fisheries ground. The natural khals especially the Naodoba khal maintain connectivity between Padma River and inland water bodies.

It was learnt through a FGD at the Paksey bridge site that fish resources were once declining in the Ganges river due to oil pollution from the ferry operation. After the stoppage of ferry services, the fish catch has improved. Therefore, it can be expected that stoppage of the ferry service between Mawa and Janjira after the opening of the bridge will be beneficial for fisheries. In the Jamuna Bridge Monitoring Report, no significant impact of the bridge on fisheries has been noted. However, it is to be noted that construction activities, especially the pile driving, will hamper fish migration, which is unavoidable but temporary in nature.

In case of culture fish production there will be some loss. The estimated loss of water bodies (58 ponds and 74 ditches) is 4.18ha (ponds) and 2.66ha (ditches). The types of fish that are cultivated in the water bodies are telapia, carp, pangas, migrigal, rui, aire, boal,

pabda, katla, tengra, chala, koi etc. The total losses of fish production within affected ponds and ditches are 2.62 MT/year and 8.92 MT/year valued at Tk. 235,800 and 739,380/year at Mawa and Janjira sites, respectively.

Mitigation:

During Construction: No disposal of waste products from construction site to the river during construction should be ensured.

After Construction: The loss of fish production can be compensated by strengthening the extension effect in the nearby villages (especially new borrow pit ponds). In the case of Jamuna Bridge, the borrow pits were designed for fish culture. Though it is inferred that there will be no adverse impact on Hilsa migration, considering its national interest, an independent study on Hilsa migration can be recommended. Adequate openings on five channels and on low depression on the Janjira side are recommended to mitigate the impact of lateral fish migration.

(4) Wildlife

Impact: Wildlife habitats in the project area are very limited. This is due to the natural environment in this area being already under stress from human habitation, agriculture, grazing, navigation and other human activities. There is no important habitat of migratory birds near the study area. There is no exclusive habitat of endangered species in the vicinity of the project area. However, The Padma River is a secondary habitat to two critically endangered species, namely Ganges River Dolphin (Plantanista Gangetica) and Gangetic Gharial. Their main habitat is the Ganges River upstream of confluence of the Ganges and Jamuna rivers at Paturia and seldom found at the project site Mawa – Janjira.

During Construction: The impact on the wildlife will be mainly during the construction activities arising from noise, vibration and human activities.

After Construction: After the construction, as there will be insignificant constricting effect, no impact on wildlife is anticipated. After construction, the wildlife living situation will actually improve with the closing of the Ferry Ghat which will stop oil pollution as has been observed in the case of Paksey Bridge.

Mitigation:

During Construction: The piling activities and the noise level will need to be managed so that these activities result in least disruption to the wildlife. Though it is anticipated that impact of the project on wildlife is very minimal, an independent study can be recommended.

After Construction: No negative impact is expected.

7.9.4 Environment Pollution

(1) Surface and Ground Water Quality

Impact: Water quality tests conducted give an indication of the surface and ground water quality (Chap-3, APP-11). It indicates that the surface water quality is acceptable. However, for the groundwater, it was found that though fecal coliform is not present, the concentration of ammonia is higher than the WHO standard of 1.5 mg/l. This indicates the possibility of sanitary contamination and any future plan to develop groundwater as a drinking water source requires extensive sampling and analysis. Concentrations of iron and

manganese are above the DOE drinking water standard, which is common in Bangladesh in naturally occurring arsenic areas.

During Construction: The quality of surface and ground water may be reduced by the discharge of liquid or solid wastes, sewage, dredged materials or by accidental spillage of fuels and chemicals during the construction. Groundwater pollution from liquid wastes can have serious effects on the quality of drinking water.

After Construction: Post construction rapid urbanization would put serious stress on water quality.

Mitigation:

During Construction: Handling and storage of the potential contaminants has to be organized under strict conditions to avoid water pollution during construction of the bridge.

After Construction: Planned future development can ascertain water quality maintenance.

(2) Air Pollution

Impact: Air quality tests conducted shows that SOx concentration is high at Mawa junction and Pachchar Bazar. The probable reason is the existence of brick fields in the vicinity.

During Construction: In and around the construction site, it is expected that air pollution will occur through the use of vehicles and machinery, the asphalt and aggregate plants, and burning of bituminous and other materials. Dust generated by construction vehicle movement, crushing and handling of aggregates, and earth works will also be sources of localized air pollution. Traffic using the road following construction may deteriorate air quality.

After Construction: It is rather difficult to predict the future air quality after the opening of the bridge. This is because the future ambient air quality not only depends on the future vehicle emissions, but also on the air pollution caused by future nearby traffic and surrounding industries. In addition, development of engine technology and change in government emission standards are also highly uncertain. As the ambient air quality also depends on flow velocity and direction, temperature and humidity, a complex, expensive and time consuming dynamic three dimensional mathematical model is required for future air quality prediction.

However, total pollution load from the future vehicle operation is provided below.

To estimate future air pollution load from the future vehicle operation, the following emission factors are considered.

Emission Factors for different vehicle types

Unit: gm/km

Category	CO	NOX	SO2	SPM
Light Vehicles	25.0	1.0	0.05	0.27
Diesel Trucks and Buses	12.7	21.0	1.5	3.0

Sources:

Light Vehicle: from VAPIS-Dhaka Model, World Bank SE Asia Unit, April, 1998

Diesel Trucks and Buses: from Faiz: Air Pollution from Motor Vehicles, World Bank, 1996

Based on the projected traffic assignment on Padma Bridge in 2025 (Chapter 3 of Main Report), the future air pollution is shown below.

Future Air Pollution from Traffic Movement in 2025

Unit: kg/km/day

Category	Traffic volume in 2025	CO	NOX	SO2	SPM
Light Vehicles	7,340	183.50	7.34	0.37	1.98
Diesel Trucks and Buses	34,210	434.47	718.41	51.32	102.63
Total	41,550	617.97	725.75	51.69	104.61

Mitigation:

During Construction: In order to keep the pollution level within an acceptable limit, construction related emissions should be regulated. Regular water spray on dry surfaces to reduce dust generation must be practiced. Air quality should be monitored regularly after the opening of the bridge.

After Construction: During the operation period, if the air quality deteriorates, a number of mitigation measures can be conceived. One idea is the modal shift, that is, diverting more passenger and goods to less polluting modes like railway. Other ideas include, imposing stricter vehicle emission standards (as adopted in California, USA); restricting number of vehicles (as adopted in Singapore); or enforcing time slots (for example, trucks should operate at night as adopted in India).

(3) Noise and Vibration

Impact:

During Construction: Due to construction activities, the noise and vibration levels are likely to be increased in the project area. Sources of noise include pile driving, rock crushing, dredging, electricity generation and transportation. As seen in noise tests, the ambient noise level already exceeds the DoE standards of 60 dB for some sampling points. Sources of existing noise pollution are passing vehicles using hydraulic horns, ferries and speed boats.

After Construction: To predict the future noise level after the opening of the bridge, an existing noise profile must be prepared during the detail design stage. The cumulative noise with the existing profile and the maximum expected noise from the future traffic must be compared with the standard and locations should be identified where the cumulative noise exceeds the standard.

The source of noise from a traffic stream can be divided into two components. The first is generated by the engines, exhaust system and transmission, and is the dominant noise source when traffic is not free flowing, particularly from heavy vehicles, which contribute most low frequency noise. Noise levels will vary according to engine speed rather than vehicle speed. The second noise source component is generated from the interaction of tyres with the road surface and is the dominant noise source under free flowing traffic conditions at moderate to high speeds and contributes a significant proportion of high frequency noise. Noise levels will vary dependent on vehicle speed, the road surface and whether the surface is wet or dry.

The noise from a stream of traffic at a reception point at any one instant is an aggregation of noise from each of many vehicles at various distances. Among factors which influence a basic traffic noise level are traffic flow, speed and composition (i.e., percentage of heavy vehicles), road gradient and road surface characteristics. The noise level at a particular reception point will also be affected by other factors among which are distance from the noise source, the nature of intervening surface and the presence of obstructions.

In Bangladesh, additional traffic noise is generated through the persistent use of horns.

An indication of the level of sound generated by traffic is shown below:

Car/light van traveling at 60 kph at 7 meters away	70 dB
Heavy diesel truck traveling at 40 kph at 7 meters away	86 dB

Source: Design Manual for Roads and Bridges, Volume 11-Environmental Assessment, Her Majesty's Stationery Office: UK legislation, 1993.

The index usually adopted to measure traffic noise is LA10,18h, which is the arithmetic mean of noise levels exceeded for 10% of the time in each of the 18 one hour periods between 6 am and midnight. To measure future noise pollution calculated as LA10,18h, complex models are available. For the SRNDP project (Dhaka Khulna Highway), 'Calculation of Road Traffic Noise' (CRTN, HMSO, 1988) was used. Thus, it is recommended to employ CRTN or similar type of model to predict future noise pollution during EMP study. Predictions should be made at distances of 10, 50, and 100 meters from the road edge for 'with project' and without Project' scenarios.

Mitigation:

During Construction: Since the noise pollution already exceeds the standard, strict measures for noise pollution control need to be undertaken during construction activities. Implementation of these measures may be expensive and difficult. The Contractor should be asked for consideration of these aspects and should apply optimum site activities and site layout so as not to exacerbate existing noise levels at sensitive receptor sites (e.g. mosques, schools etc.). The Bhariab Bridge is located in a relatively urban area, thus a number of noise pollution measures were taken. For example, a sound barrier was constructed to protect a nearby school from noise pollution. Also, the stream hammer method of pile driving was used, instead of the hydraulic hammers used in the Jamuna Bridge construction.

After Construction: The detail design stage will identify the sections of the approach road where cumulative noise would exceed the standard after the opening the bridge. Sound barriers should be placed at those locations. Continuous monitoring should be carried out in other locations also and whenever a section's noise level crosses the standard, JMBA should place noise barriers at that section.

(4) Soil Contamination

Impact:

During Construction: Deterioration of soil quality at the construction site is a possibility through accidental spillage of chemicals, bituminous materials, fuel and prolonged storage of such materials. Another potential source of soil contamination is through disposal of solid and liquid wastes.

Huge quantities of sand will be dredged and will be used for the construction of approach roads and other facilities at both sides of the bridge. An analysis of the dredged material has been carried out. The result shows that pollutant levels are not particularly high as there are no major polluting industries upstream of the bridge site.

After Construction: No major impact on soil contamination is expected after construction.

Mitigation:

During Construction: More detail analysis of dredge material is required during the EMP stage if the dredge material is to be used for road and service area construction. Adequate precautions should be taken in order to minimize scope for accidental spillage. Regular monitoring of dredged sand quality is recommended.

After Construction: No major impact is anticipated.

(5) Pollution due to Waste

Impact:

During Construction: During construction huge quantities of construction waste (such as dredged spoil, construction materials etc) and general waste will be generated and as a result, soil, air, water and project worker will be affected if no waste management plan is formulated.

After Construction: No major impact on waste pollution is expected after construction.

Mitigation:

During Construction: A waste management plan should be prepared and followed.

After Construction: No major impact is anticipated.

7.9.5 Social Environment

(1) Land Acquisition

Impact:

During Construction: Land acquisition has been kept to a minimum. The total area to be acquired stands at 616ha according to the SIA study. Most of the land to be acquired is on the right bank and mainly under agricultural practice. Details of land acquisition have been given in the SIA and Resettlement Report APP – 12.

After Construction: No major impact on land acquisition is expected after construction.

Mitigation:

During Construction: A Land Acquisition plan will have to be prepared for proper compensation for land loss and rehabilitation of the PAPs according to GoB rules and regulations as well as other relevant guidelines.

After Construction: No major impact is anticipated.

(2) Homestead/Resettlement

Impact:

During Construction: About 3000 households will require resettlement. Traditionally, Bangladeshi people are extremely emotionally attached to their homesteads. So eviction from the homesteads can be traumatic to the affected people. Details of resettlement have been given in the SIA and Resettlement Report APP – 12.

After Construction: Even after full compensation for the resettlement, the physiological impact will remain forever. It would be difficult to settle in a new place.

Mitigation:

During Construction: A resettlement action plan (RAP) will be needed for proper rehabilitation of the displaced persons. A RAP will be prepared for proper compensation

forland loss and rehabilitation of the PAPs according to GoB rules and regulations as well as "good practice" as adopted in the Jamuna Bridge and other projects.

After Construction: The RAP should include the rehabilitation plan even after the resettlement.

(3) Income Loss

Impact:

During Construction: As mentioned in Section 3.8.4, there will be a total loss of income of approximately Tk. 210 million. Out of this, agriculture related loss is around Tk. 45 million. In addition, the number of fishermen living in the RoW is 97 (21 at Mawa and 76 at Janjira sites), and most of them are poor (average income Tk. 40000/year). They will lose their income due to their loss of access to the river for fishing. Further, people associated with Ferry Ghat operation will also lose their income. These include about 200 boat operators, 100 hawkers, 1000 shopkeepers and 200 ferry operators. The total loss of ferry related income is estimated at Tk. 4,200,000/month. More detail can be found in SIA and Resettlement related sections of this Report.

After Construction: If there is no income restoration program, this loss will be repeated even after the construction.

Mitigation:

During Construction: All direct income loss must be adequately compensated within the RAP.

After Construction: Income loss can be mitigated by providing alternative job opportunities for PAPs. The compensation for income loss should be higher to women and poor. Due to the nature of their profession, the fishermen should be rehabilitated as near as possible to the riverbank. A fish landing site should be incorporated in the design of the RTW.

(4) Agricultural Production

Impact:

During Construction: The project has potential negative impact on agriculture. The approach road, especially on the right bank (Janjira) passes mainly through agricultural land. Paddy including Aman and Aus, is the main crop in the project area. Other important crops are rabi crops such as onion, groundnut, pulses and garlic. As stated in Section 3.8.2, the total crop loss is 2,396 MT with a price tag of around 45 million Taka.

After Construction: Besides paddy, which is the dominant crop, other crops like onion, chilli, sugarcane, jute, wheat, etc. are grown in the study area. After the construction of the bridge, which will improve transportation facilities, it is expected that the cultivation of these cash crops will increase. This will be beneficial for the local economy. The positive impact will be wide spread as seen in the case of Jamuna Bridge.

Mitigation:

During Construction: Proper compensation must be included in the RAP.

After Construction: Any loss in agricultural production due to land loss will be compensated by the expected increase of agricultural production on remaining land.

Farmers will be induced into production of more cash crops due to closeness of the study area to Dhaka city. The agricultural production can be further enhanced by constructing market facilities in the vicinity of the study area. Loan and training are also essential.

Market facilities (growth centers) need to be developed near the bridge site in order to facilitate the cash crop based economy. In addition, support in the form of loans and training should be provided. It may be mentioned here that the income generation program was not adequate in the Jamuna bridge project.

(5) Cultural Resources Loss

Impact:

During Construction: No historic establishment will be affected by to the construction of the approach road. Some cultural resources including schools (3), madrasha (1), mosques (19), eidgha (1), graveyards (16) and a Hindu burning yard (1) will be affected. More establishments will be affected in the Janjira site than in the Mawa site. All establishments can be relocated. More problematic are likely to be graveyard/family graves.

After Construction: No impact is expected regarding cultural resources loss after construction.

Mitigation:

During Construction: Alternative locations and facilities should be provided for the cultural infrastructure such as family graves/graveyards, educational institutes, mosques/temples, burning yard, eidgha etc. However, if the relocation takes place before the establishments are broken down, then this will help to reverse many negative impacts. As much as possible, graves/graveyards will need to be avoided by alternative design, but where this proves impossible then negotiations should be held to provide agreed relocation arrangements. This work should be included as part of the RAP.

After Construction: No impact is expected.

(6) Navigation/Water Transport

Impact: The Padma River is a Class-II navigation route. Large numbers of commercial and passenger steamers and barges ply in the Padma through the proposed bridge crossing. The right bank approach road crosses four khals and two small rivers. Among these khals and rivers, the Noadoba River is navigationally important. The left bank short approach road does not cross any active channel.

During Construction: During construction, considerable quantities of construction materials and equipment will have to be brought by river barges and may disrupt the regular riverine traffic. In addition, piling works, dredging and other construction activities will involve disruption to the navigational channel.

After Construction: Adequate navigational clearance has been kept in the design of the main bridge and the bridge over Noadoba River in consultation with BIWTA. As a result, no interruption is expected.

Mitigation:

During Construction: To avoid navigational problems during construction, adequate navigation lights and markings are to be provided to avoid accidents.

After Construction: No impact is expected.

(7) Health and Sanitation

Impact:

During Construction: About 3621 tubewells and 3267 latrines are likely to be affected (Table-3.8.10 & 3.8.11). People using these facilities will be relocated.

A labor camp/barrack will be constructed with temporary accommodation for about 5000 workers during the peak of construction activities in the contractor's working area. After the project is completed most of the family and bachelor quarters will be used by the O&M personnel and the rest of the facilities will be dismantled. Therefore, conditions should be set for the contractors to consider the above situation. Major health and sanitation concerns are drinking water, drainage and sewerage, solid waste and disease transmission. Lack of proper drainage and sewerage system is likely to cause waterborne diseases. Solid wastes (rubbish, garbage and construction wastes, etc) may pose additional health threat and nuisance. Risk of transmission of communicable diseases among the labor force is high.

After Construction: No negative impact is expected on health and sanitation after the construction. On the other hand, due to better access, health and sanitation situation of the area is expected to improve.

Mitigation:

During Construction: Soft loans should be provided to the relocated persons for construction of water supply and sanitation facilities. Adequate facilities should be provided for quality water supply, hygienic toilets etc in the construction camps and in the resettlement area of PAPs to ensure good health.

Drinking Water: Good quality drinking water is of paramount importance for maintaining good health of construction laborers. Drinking water should meet the WHO guideline values (1984) or Bangladesh Standards (DoE, 1997). As no public drinking water supply system is available at the project area, contractors have to provide their own facilities. It is to be remembered that the project area is located in one of the most arsenic prone areas. During construction, more tests should be carried out and if needed, an arsenic treatment plant should be constructed.

Drainage and Sewerage: Toilets for the construction workers must be fitted with water seals and connected to a septic tank. Care should be taken that the effluent from the septic tank is not discharged into open drains but is treated by subsurface infiltration through absorption trenches or soak pits without contaminating ground water. Septic tanks have to be inspected regularly and de-slugged, if necessary. Wastewater from washing, bathing, kitchen, etc. can be treated separately from excreta by infiltration in the sub-soil or direct discharge into the river via sewer pipe.

Solid Wastes: As a mitigation measure, regular collection of the solid wastes and proper disposal is essential.

Transmission of Diseases: Awareness building and education must be carried out regularly. Regular health inspection and a vaccination program is also necessary.

After Construction: No negative impact is expected. Local health and sanitation situation will be improved.

(8) Employment Opportunities

Impact:

During Construction: Due to relocation, a number of persons will lose their income as mentioned in Section 3.8.4. The total income loss of PAPs is approx. Tk. 210 million. However, the project will be able to generate considerable employment during construction period. The total employment to be generated during construction is estimated to be about 5000 laborers/day.

After Construction: After construction, a total of approx.imately 1000 positions will be generated for O&M works.

Mitigation:

During Construction: Alternative job opportunities should be arranged specially for the affected persons during the construction of the project. The increased employment opportunities should be utilized to the maximum benefit of the local populace. It is suggested that the priority in employment during the construction and operation stage should be given in the following order.

1) PAPs
2) Destitute women
3) Poor people in the project area
4) Local people
5) People from outside the project area

After Construction: Proper income restoration program should be included in RAP for the post construction period. It may be noted that the income restoration program for Jamuna bridge was not satisfactory.

(9) Women Empowerment

Impact:

During and After Construction: This project will provide direct and indirect opportunities for women empowerment in the form of increased employment during and after construction, trade prospects, better access to health and education, etc.

Mitigation:

During Construction: During construction, women should be engaged in different types of construction related jobs. This provision must be included in RAP.

After Construction: After the opening of the bridge, there are opportunities for women to be involve in various trades like handicraft, poultry, dairy, etc. With engagement of NGOs to facilitate the process, especially with loans, training and marketing, it will provide tremendous women empowerment.

(10) Social Infrastructure

Impact:

During Construction: Under the RAP, a number of social infrastructures were constructed in Jamuna Bridge like schools, health centers, community centers, etc. Similar approach can

be taken in the present case.

After Construction: After opening of the bridge, due to increased economic activities, it is expected that a number of new social infrastructure facilities, including schools, colleges, markets, recreation facilities, religious places, and tourism facilities will be developed in the vicinity of the bridge.

Mitigation:

During Construction: Construction of various social infrastructures should be included in the RAP for the affected as well as local peoples.

After Construction: A proper infrastructure development plan will enhance the benefits.

(11) Industry

Impact:

During Construction: No major impact is expected during construction.

After Construction: There is a tremendous potential for industrial development near the bridge site because of many factors, such as, proximity to Dhaka, a transportation link with the Southwest region including the third largest city of Khulna, and links with Benapole land port and Mongla seaport.

Mitigation:

During Construction: No major impact is expected.

After Construction: A master plan for industrial development should be prepared urgently to facilitate the development in a sustainable manner.

(12) Split of Communities

Impact:

During Construction: The approach road may split some of the communities. The psychological impact due to the split might be traumatic. In order to reduce the emotional stress, underpasses are included in the design at suitable locations in the approach roads.

After Construction: The split of communities due to relocation can not be avoided.

Mitigation:

During Construction: Underpasses are included in the design to reduce the split of communities.

After Construction: During the relocation process, extensive consultations with potentially affected communities need to be taken up, so that their concerns can be addressed as much as possible. In such cases, the experience of Jamuna Bridge will be especially relevant.

(13) Road Transport

Impact:

During Construction: During construction, movement of heavy vehicles will disrupt the

local traffic.

After Construction: The Bridge, once operational, will revolutionize the entire road network of the country. The south-west region, Benapole land port and Mongla port will particularly benefit.

Mitigation:

During Construction: Proper traffic management needs to be put in place in order to minimize the disruption during the construction stage.

After Construction: A national road transport master plan can best tap the benefits from this bridge.

(14) Road Accidents

Impact:

During Construction: Transportation of construction material, equipment and movement of the project personnel by road will increase road traffic during the construction phase. As a result, the risk of traffic accidents will increase.

After Construction: When the bridge opens for vehicle movement, increased speed of vehicles will again increase the risk of traffic accidents. Such a trend has been observed in the case of Jamuna Bridge.

Mitigation:

During and After Construction: BRTA rules and regulations will need to be strictly followed to minimize the risk of traffic accidents.

(15) Landuse

Impact:

During Construction: It is not expected that there will be major landuse change during the construction.

After Construction: The economy generated by the construction of the project will increase money supply in the area and will change the land use pattern. The land price will increase, particularly the price of roadside land which will be sought after for industrial, commercial and settlement purposes. Proximity to Dhaka will encourage rapid housing development. Other activities will also develop such as educational institutions, health facilities, recreation centers, tourism facilities, government institutions, etc. All these will provide employment to many people.

The short term significant social impact will be the transfer of the land from small farmers to big holders and land speculators. The land value will rapidly rise and this will be a real threat to small farmers living around the acquired area with respect to being displaced. They may eventually join the ranks of the landless.

There are 7 villages presently existing within 1 km of the road on the east side and 21 villages on the west side. These villages will experience both growth and transformation as a direct result of the opening up of the area to a greater market and opportunities and each will demand connection to the approach road.

The long term effect, unless regulatory measures are taken in time, will be uncontrolled settlement, environmental pollution from industries and innumerable places of access to the road leading to traffic congestion and hazard.

Mitigation:

During Construction: No major impact is expected.

After Construction: It is desirable to institutionalize some form of effective planning for and control of the development growth. While the demand for connections of local growth centers with the bridge approach road will be necessary and cannot be denied, their number and location can be controlled by a careful advance planning.

7.9.6 Prioritization of IECs

An attempt has been made to prioritize IECs. Such prioritization is helpful to formulate detailed EMP. The prioritization has been done on the basis of FGD/PRAs carried out for the Padma bridge. The priority of IECs is provided in Table-7.9.7. The major concern for the PAPs is social issues. The other concerns are for the natural environment, ecological environment and environmental pollution, in that order.

Table 7.9.7 Priority of IECs

Environmental Category	IECs
Social	• Homestead loss • Land acquisition • Split of communities • Employment opportunities
Natural	• Erosion • Drainage congestion
Ecological	• Tree cutting/plantation • Fisheries
Environmental pollution	• Noise and vibration

7.10 IMPACT EVALUATION

7.10.1 Procedure

In this section, impacts are evaluated on the basis of magnitude, immediacy, and sustainability / reversibility. The focus of each item is as follows:

- Magnitude
  - Type of impact (direct, indirect, cumulative)
- Immediacy
  - Temporal extent (during construction, after construction)
  - Spatial extent (local, widespread)
- Sustainability and Reversibility
  - Mitigability (fully, partially)
  - Monitoring possibility (fully, partially)

A 21-point scale has been adopted, for example: 1 to 10 for beneficial impacts, 0 for no impact, -1 to -10 for negative impacts. For the relative weight, magnitude is given higher value (40%) ahead of immediacy and sustainability/reversibility (30% each) because of its more direct and visual influence. The grading for each IEC can be found in Chap 3 of APP – 11.

7.10.2 Summary of Evaluation

The summary of impact evaluation is presented in Table 7.10.1. The relative weight values have been taken from the IEE study (Chap 2 of APP – 11). The weight values of the environmental parameters have been decided in the context of Padma bridge construction and their importance to the national development and environmental conservation. In the process of selecting the weighting, the values proposed in "Guidelines on Environmental Issues Related to Physical Planning" prepared by LGED and "Preliminary Activities related to Project Environmental Assessment" prepared by REB with WB assistance were consulted. It may be mentioned here that values proposed in the LGED guideline were prepared based upon an extensive exercise involving a number of national environmental experts. In addition, public consultation was held for prioritization of IECs (as explained in Sec 7.9.6), and that result is also incorporated in the weight selection.

The graded values are calculated for 'without mitigation measures' and 'with mitigation measures'. It is to be noted that though the rating method is widely practiced for EIA and accepted all over the world, it is subjective in nature. To eliminate this subjective dimension of the grading, a number of environmental experts do the rating independently and then combine. Also, EIA professionals usually don't look at the absolute numbers, rather the range of change. In the present case, the rating was done by 3 experts, namely, a member of the JICA Study Team, a professor of BUET and a leader of the local sub contract team. The range of the graded values shows that implementation of mitigation measures will considerably mitigate or enhance the impacts on IECs.

Table 7.10.1 Summary of Evaluation of Impacts on IECs

Environmental parameters	Relative Weight	Environmental impact rating		Graded Value	
		Without mitigation	With mitigation	Without mitigation	With mitigation
	(i)	(ii)	(iii)	(iv)=(i)x(ii)	(v)=(i)x(iii)
Natural Environment					
Regional hydrology & flood pattern	10	-8	-6	-80	-60
Drainage congestion	7	-4	-1	-28	-7
River erosion, scour and siltation	2	7	8	14	16
Landscape	2	-4	6	-8	12
Ecological Parameters					
Fisheries and water bodies	8	-7	-4	-56	-32
Wildlife	4	-7	-4	-28	-16
Agriculture	8	-8	-5	-64	-40
Tree plantation/cutting	6	-9	5	-54	30
Environmental Pollution					
Surface and ground water pollution	7	-4	-1	-28	-7
Air pollution	5	-6	-1	-30	-5
Noise and vibration	3	-8	-4	-24	-12
Soil contamination	5	-6	-1	-30	-5
Waste	5	-6	-1	-30	-5
Social Environment					
Land acquisition	8	-8	-7	-64	-56
Homestead loss	10	-6	-3	-60	-30
Income loss	8	-3	0	-24	0
Agriculture production	8	-5	4	-40	32
Cultural loss	8	-7	-2	-56	-16
Navigation	3	-4	-2	-12	-6
Health and safety	5	-5	5	-25	25
Employment opportunities	7	7	9	49	63
Women empowerment	7	4	6	28	42
Infrastructure	5	4	7	20	35
Industry	5	3	5	15	25
Split of communities	6	-5	-2	-30	-12
Road transport	7	9	10	63	70
Road accidents	5	-3	-1	-15	-5
Land use	3	4	6	12	18
Total Graded Value				-585	54

7.11 PRELIMINARY ENVIRONMENTAL MANAGEMENT PLAN (EMP)

An Environmental Management Plan (EMP) should be prepared after the proponent JMBA gets environmental clearance from DOE. The procedure for getting environmental clearance is explained in Chap 1 of APP 11. It is a two step process. In the first step the proponent will apply in a prescribed form for site clearance attaching the IEE report. After getting DOE's site clearance, the next step is to apply for environmental clearance attaching the EIA report. The EMP should be prepared after that during the detail design stage. The JICA Study is outlining a preliminary EMP as a framework and guidance. The preliminary EMP is given in Chap 3 of APP – 11. The preliminary EMP consists of the following sections:

- Objectives of EMP
- Environmental Mitigation Measures (EMM) (given separately for pre-construction stage, construction stage, and post construction stage)

- Environmental Enhancement (tree plantation, recreation facility, landuse & landscape planning, income restoration / generation program and women empowerment)
- Institutional Arrangement to implement EMP
- Environmental Monitoring
- Implementation Schedule (which agencies are responsible for which stage for each item)

An indicative cost estimate has been made for the preliminary EMP and it was found to be around 3 million US$. It is to be noted that this is very indicative in nature and the actual cost should be estimated in the EMP preparation stage.

7.12 CONCLUSIONS AND RECOMMENDATIONS

7.12.1 Conclusions

The key conclusions of the EIA of the Padma River bridge project are as follows:

- The impact of the bridge on regional hydrology and flooding patterns will be minimal as the increase in the highest water level of the Padma River due to the bridge construction will be approximately 10cm.
- Adequate openings on the right bank approach road are planned to alleviate drainage congestion.
- Erosion and siltation are limited.
- A total of 327,868 trees will need to be cut for the project. This loss may be compensated by planting 238,692 trees.
- A total of 58 ponds (area=4.18ha) and 74 ditches (area=2.66ha) will be affected by the project. Fish production loss will be about 11 MT/year which may be compensated by fish culture in new borrow pit ponds.
- The project does not pass through any ecologically protected and sensitive area.
- There is no exclusive habitat of any endangered species near the Project site. However, Padma River is a secondary habitat of two critically endangered species, namely, Gangetic Gharial and Dolphin. Their main habitat is the Ganges River and they are seldom found in the project site.
- Padma River is an important migratory route for Hilsa fish.
- Due to land acquisition of 616ha, about 3,150 housing structures will be affected. An LA plan and RAP will be prepared to mitigate all these issues.
- Total income loss is 210 million taka of which agriculture production loss is about Tk. 45 million/ year
- A total of 41 cultural establishments including schools, madrasha, mosques, eidgha, graveyards and a Hindu burning-ghat will be directly affected.
- With the proposed mitigation measures, the overall impact will be limited.
- The indicative EMP cost is US$ 3 million.

7.12.2 Recommendations

Based on the findings of this study, various studies are recommended.

Within the EMP

Groundwater analysis: The project site is within the naturally occurring Arsenic area. Also, EIA test results indicate the possibility of sanitary pollution. Thus, detailed investigation is necessary. Test parameters should include pH, EC, hardness, COD, NH4-N, Nitrate, Nitrite, PO4-P, Total Coliform, Fecal Coliform, Cl, Fe, As, and Mn.

Surface water analysis: EIA tests show a generally good condition of surface water. Still, more analysis is desirable. Test parameters should include pH, EC, Cl, TSS, TDS, Total Coliform, Fecal Coliform, DO, BOD, COD, Ca, T-P, NH4-N, Nitrate, Nitrite, Fe, As, and oil and grease.

Noise pollution: Limited test results of the EIA show that, at some points, the noise level exceeds the standard. So, a detail noise level profile has to be determined along the route. Test parameters should include peak and average noise for both day and night time.

Air pollution: More sampling is required to evaluate the existing air quality. Test parameters should include SOx, NOx, CO, SPM and Pb.

Dredge material test: Since there is a possibility to use the dredge material excavated during river works for the construction of road, service area and toll plaza, a good number of samples from different depths should be analyzed in detail. Test parameters should include Zn, Cu, Hg, Mn, COD, Pb, CN, Cd, Cr, As, Se, and Volatile Solids.

Analysis of future air pollution level: Expected ambient air quality after the opening of the bridge should be estimated by utilizing mathematical modeling.

Analysis of future noise pollution level: Expected ambient noise quality after the opening of the bridge should be estimated.

From the parallel study

Hydrological investigation: In the detail design stage, physical and mathematical model tests will be executed for hydrological investigation. Information on flooding, drainage, erosion and sedimentation should be used in the EMP.

Social investigation: In the detail design stage, a Land Acquisition Plan and a Resettlement Action Plan will be prepared. Information on land acquisition, relocation and other indirect losses should be used in the EMP.

Independent Study

Further, some additional studies can be undertaken independently. These are as follows:

Hilsa Migration: As has been mentioned, Padma is an important migration route of Hilsa. The production of Hilsa in the country is in decline for various reasons. Further decline should be avoided to the extent possible. In the near future, there will be two bridges on the Ganges-Padma river, one at Paksey which has already been completed and another is the proposed Padma Bridge. It is desirable to study the cumulative impact of these bridges. A study of the migration pattern of Hilsa can recommend proper mitigation measures.

Landuse and Landscape (Regional Development): A land use plan around the proposed site is needed to maximize the benefits of the bridge. This will involve regional development planning including land use planning, landscape planning, industrial development, tourism development, urbanization, commercial and residential development. Such a plan should be based on the experiences of the land use development at other large bridge sites, namely Jamuna Bridge, Bhairab Bridge and Paksey Bridge.

Charland Study: There is a large char upstream of the bridge site. Mathematical study of this study estimated that there would be no impact on the char due to the bridge construction. However, inhabitants of the charlands are mainly marginal people and prone to environmental and social impact. Therefore, an independent study can be undertaken to

carefully evaluate the impact on the charland population.

Wildlife survey: There is no exclusive habitat of any endangered species near the project site. However, there will be some impact on wildlife, especially during the construction period. An independent study can elaborate such issues.

Chapter 8 Social Impact/Resettlement Studies

8.1 INTRODUCTION

This chapter examines the social impacts of the selected Mawa-Janjira site for the Padma Bridge construction and addresses the land acquisition and resettlement issues. It is based on the census/socioeconomic surveys of the potentially affected persons (APs) along the project corridors/right-of-way (ROW). A summary of the main study is presented here. The detailed report can be found in Appendix 12 – *Social Impact Assessment and Resettlement Framework.*

The chapter highlights a list of outstanding planning and implementation tasks to be completed by the project executing agency (EA) – the Jamuna Multipurpose Bridge Authority (JMBA) – during the detailed design and implementation periods. For example, the preparation of a resettlement action plan (RAP) will be critical to safeguarding the rights of the affected peoples such as replacement value of their assets, resettlement, livelihood restoration, and additional assistance to marginal and vulnerable groups. While the principles and the resettlement entitlements have been stipulated in this framework document, the compensation and rehabilitation packages for the affected households and shops, including the indicative budget, should be revised based on further detailed planning. JMBA should use this report only as a planning tool, prepare a full inventory of land acquisition and affected households/businesses during detailed project design, and prepare a RAP for the project. The RAP should benefit from the Jamuna Bridge resettlement experience and other "best practices" already established in various infrastructure projects in Bangladesh. The RAP thus prepared should be reviewed further as a condition for project processing by the donor agencies.

8.2 PROJECT DATA AND LA REQUIREMENTS

According to the Feasibility Study design, the proposed Padma Bridge Project consists of the following features:

1) A 5.58 km long 4-lane bridge over the Padma River connecting Mawa (left bank/east side) and Janjira (right bank/west side)
2) About 300m of existing N8 highway at the Mawa intersection to be widened into 4 lanes as the starting point of the bridge
3) 6 km of riverbank protection work in Mawa
4) 11 km of 4-lane approach roads from the bridge landing point at Mansur Mollar Kandi (Janjira) up to N8 near Panchchar Bazar (Sibchar)
5) The approach road in Janjira site will have a service area (near the landing site) for traveling public and a toll plaza
6) 10.5 km riverbank protection work in Janjira site

The project would require acquisition of 616.5 ha of land for the construction of the bridge and associated infrastructure listed above. In addition, 174 ha of land will be temporarily required during the construction period for facilities like construction yard. Most of the associated infrastructure is in Janjira site. Table 8.2.1 presents land acquisition by project components and locations. Over 35 percent of the acquired land will be used for river protection work followed by approach road (25%).

Table 8.2.1 Land Acquisition by Project Components

Location /Area	Land to be Acquired					Land to be Requisitioned		
	Component		Amount of land (ha)	% of Sub-total	% of Total	Component	Amount of Land (ha)	% of Total
	Name	Nature						
East End-Mawa	Approach Road	Widening of existing 300 m road	02.5	4.00	0.41	Construction Purpose	30.0	17.24
	River Protection Works	About 6 kmx100 m river bank protection work	60.0	96.00	9.73			
Sub-Total			*62.5*	*100*	*10.14*			
West End-Janjira	Approach Road	11 km long 4 lane approach road	147.0	26.53	23.84	Construction Purpose	144.0	82.76
	River Protection Works	10.5kmx100m river bank protection work	157.0	28.34	25.47			
	Service Area	1000mx1000m service near the bridge landing point	100.0	18.05	16.22			
	Toll Plaza	250mx200m toll plaza several kms from the bridge landing point	5.0	0.90	0.81			
	Borrow Area	25 ha area will be required on the west side	25.0	4.51	4.06			
	Reclamation Area	120 ha area will be required on the west side	120.0	21.66	19.46			
Sub-Total			*554.0*	*99.99*	*89.86*			
Grand Total			616.5		100		174.0	100

Ninety percent of the acquired land will be from the west end in Janjira site where 11 km long four lane approach road, 10.5 km long/100m wide river protection work, service area and toll plaza will be constructed. Therefore, the impact of land acquisition will be felt more on the Janjira site than Mawa.

8.3 IMPACT OF LA AND DISPLACEMENT

Table 8.3.1 contains the impact of land acquisition in terms of assets to be lost and households affected by the project.

Table 8.3.1 Project Impact – Displacement and Loss of Assets

Area/Location	Component	Land to be		HHs (Nos)	CBEs (Nos)	CRPs (Nos)	Families losing trees only
		Acquired (ha)	Requisitioned (ha)				
Ease End-Mawa	Approach Road	2.5		11	20	6	0
	River Protection	60.0		1332	131	19	51
Sub Total		***62.5***	***30.0***	***1343***	***151***	***25***	***51***
West End-Janjira	Approach Road	147.0		619	10	10	32
	River Protection Works	157.0		947	114	25	24
	Service Area	100		221	2	5	6
	Toll Plaza	5.0		20	0	0	1
	Borrow Area	25.0		-	-	-	-
	Reclamation Area	120		-	-	-	-
Sub Total		***554***	***144***	***1807***	***126***	***40***	***63***
Grand Total		**616.5**	**174.0**	**3150**	**277**	**65**	**114**

The total number of affected households who would lose homestead land/structure either partially or fully due to the project is 3150. The number is obviously higher on the Janjira side of the river (1807) than Mawa (1343) side of the river. This translates into 21.45 households/ha in Mawa and only 3.26 households/ha in Janjira. The number of affected common property resources (CPRs) is also higher in Mawa than Janjira. The number of households affected by land acquisition only (without being displaced) is estimated at 5,000; actual number affected will be available only after the Land Acquisition Plan (LAP) is prepared and notification under section 3 (u/s3) is processed by the concerned Deputy Commissioners (DCs). Furthermore, the study did not investigate the indirect or secondary impact of the project such as the impact on hotel/restaurant businesses at the three ferry *ghats* (Mawa on the left bank and Kathalbari and Charjanajat on the right bank), boat operators and ferry-related small business.[1]

The overall impacts reported here will, however, be lower, particularly with regard to impact caused by riverbank protection work. The survey had to adopt a wider ROW (i.e., 1 km and 1.5 km from the bankline to the floodplain in Mawa and Janjira, respectively) than the technical specification due to the flood season. The bankline at flood season was much closer to village settlements along the river, which recedes at PWD2 level during the winter season. The technical design considered PWD2 level as the "centre-line" for protection work along the bankline.[2] As a result, the impact on the bankline will be much lower than reported here. It is estimated that less than 30% of the households on the ROW for riverbank protection work will eventually be affected by the embankment. This, however, will be further studied through "dry-season" surveys during the detailed design period. The Study Team took efforts to minimize the project impacts through adjustments of the technical design. This should also continue during the detailed design period. However, it is important to note that the overall impact of the bridge project is much lower than the Jamuna Bridge Project.[3]

Among those likely to be affected, about 1500 households, mostly erosion displaced (*nadibashi*), live on land owned by others or under rental arrangements. Special attention needs to be given to these households, who are vulnerable and are already displaced by the natural process of erosion. Table 8.3.2 provides further details regarding their tenurial status and distribution.

Table 8.3.2 Tenurial Status of Erosion Displaced Households

Area	East End-Mawa						West End-Janjira						Grand Total	
District	Munshiganj				Sub Total		Shariatpur		Madaripur		Sub Total			
Upazila	Lauhajang		Sreenagar											
Status/owners hip of the land	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Relative/ Father/Brother	119	21.52	16	94.12	135	09.12	247	44.42	124	35.03	371	25.06	506	34.19
RHD	06	01.08	00	00.00	06	0.40	03	00.54	00	00.00	03	0.20	09	0.61
Lease/ Agreement	417	75.41	01	05.88	418	28.24	306	55.04	230	64.97	536	36.21	954	64.46
Vested Property	11	01.99	00	00.00	11	0.74	00	00.00	00	00.00	00	0.00	11	0.74
Grand Total	553	100	17	100	570	100	556	100	354	100	910	100	1480	100

[1] This will be carried out during the detailed design period.
[2] This means that the survey covered more areas and thus included households along the riverbanks, who eventually will be excluded from the inventory of affected households during detailed design and/or joint verification.
[3] The 4.48 km long Jamuna Bridge Project had acquired 3,000 ha of land. In all, 15,000 households were affected, out of which 4,000 required relocation.

8.4 PROFILE OF THE APS: AN OVERVIEW

In this section, an overview of some of the important socio-economic profiles of the APs is presented. Other details can be found in the main report in Appendix 12.

8.4.1 Demographic Characteristics

The distribution of population is shown in Table 8.4.1. Of the 19,000 people to be affected, 56% are males with a sex ratio (male per 100 female) 111 against national average of 104. It is very high (122) in Lauhajang *upazila* where the ferry ghat is located. Most of the workers of shops at the ferry ghat are male. However sex ratio is also very high on the Janjira side (113). During field study it was observed that because of limited job opportunities and regular shifting nature of the riverbank, male members migrate to the urban areas for their livelihoods. They often desert their families back home and continue living in urban areas. Eventually the family members remain in the locality run by deserted woman and become the most vulnerable segment of population.

Table 8.4.1 Population Distribution in the Affected Areas

Area	District	Upazila	Affected Population by Sex					
East Bank -Mawa			Male		Female		Total	
			No.	%	No	%	No	Sex Ratio
	Munshiganj	Lauhajang	3982	51.97	3680	48.03	7662	108
		Sreenagar	355	54.95	291	45.05	646	122
Sub Total			***4337***	***52.20***	***3971***	***47.80***	***8308***	***109***
West Bank-Janjira	Shariatpur	Janjira	2476	52.82	2212	47.18	4688	112
	Madaripur	Shibchar	3197	63.06	2828	46.94	6024	113
Sub Total			***5673***	***52.95***	***5040***	***47.05***	***10713***	***113***
Grand Total			**10010**	**56.32**	**9,011**	**43.68**	**19,021**	**111**

8.4.2 Female-headed Households

The incidence of female-headed households is quite significant in the project area. This is clearly demonstrated in Table 8.4.2. While national average is about 3 percent, 7.49% of the households are female-headed. This percentage is slightly higher in the Mawa than Janjira. Being already vulnerable, these female-headed household need special attention with regard to their relocation and resettlement.

Table 8.4.2 Incidence of Female-headed Household

Area	District	Upazila	Gender Distribution of the Affected Household Heads					
East Bank-Mawa			Male		Female		Total	
			No.	%	No	%	No	%
	Munshiganj	Lauhajang	1121	91.44	105	08.56	1226	100
		Sreenagar	105	89.74	12	10.26	117	100
Sub Total			***1226***	***91.40***	***117***	***8.71***	***1688***	***100***
West Bank-Janjira	Shariatpur	Janjira	774	95.91	33	4.09	807	100
	Madaripur	Shibchar	914	91.40	86	8.60	1000	100
Sub Total			***1688***	***93.41***	***119***	***6.59***	***1807***	***100***
Grand Total			**2914**	**92.51**	**236**	**7.49**	**3150**	**100**

8.4.3 Residual Homesteads Land

More than 55 percent of the households to be displaced by the project will not have any residual land to live on (Table 8.4.3). This includes nadibashi settlers, who live on land provided by relative or on rental arrangements. Twenty-one percent will have than 5

decimal and 13% between 6 and 10 decimal. Households having more than 25 decimal residual lands are all in Janjira site. Heads of these households are powerful landowners and "big men" who provide shelter to nadibashi settlers on their lands as a form of patronage to enhance local political power.

Table 8.4.3 Extent of Residual (Homestead) Land by the Affected Households

Area	East End-Mawa						West End-Janjira						Grand Total	
District	Munshiganj				Sub Total		Shariatpur		Madaripur		Sub Total			
Upazila	Lauhajang		Sreenagar				Janjira		Shibchar					
Amount of Land (Decimal)	No	%of Upazila	No	%of Upazila	No	%of GTotal	No	% of Upazila	No	% of Upazila	No	% of GTotal	No	%of G total
Nil	714	58.24	100	85.47	814	25.84	455	56.38	481	48.18	936	29.71	1750	55.56
Less than 5	406	33.12	17	14.53	423	13.42	49	6.07	195	19.50	244	7.74	667	21.17
6-10	100	8.16	0	0	100	3.17	93	11.52	204	20.40	297	9.42	397	12.60
11-15	4	0.33	0	0	4	0.12	45	5.58	49	4.90	94	2.98	98	3.11
16-20	1	0.08	0	0	1	0.03	97	12.02	40	4.00	137	4.34	138	4.38
21-25	1	0.08	0	0	1	0.03	4	0.50	8	0.80	12	0.38	13	0.41
26-30	0	0	0	0	0	0	4	0.50	8	0.80	12	0.38	12	0.38
31-35	0	0	0	0	0	0	48	5.95	6	0.60	54	1.71	54	1.71
36-40	0	0	0	0	0	0	6	0.74	2	0.20	8	0.25	8	0.25
41-45	0	0	0	0	0	0	0	0.00	0	0	0	00	0	00
46-50	0	0	0	0	0	0	1	0.12	3	0.30	4	0.12	4	0.13
51-55	0	0	0	0	0	0	0	0.00	1	0.10	1	0.03	1	0.03
56-60	0	0	0	0	0	0	1	0.12	1	0.10	2	0.06	2	0.06
60+	0	0	0	0	0	0	4	0.50	2	0.20	6	0.19	6	0.19
Grand Total	1226	100	117	100	1343	42.63	807	100	1000	100	1807	57.36	3160	100

8.4.4 Occupational Background of Heads of Households

Table 8.4.4 presents principal occupational pattern of the heads of the affected households. About 40 percent have business or service as their principal occupation. Their numbers are more in the east side in Mawa as compared to the west side of the river. On the other hand more than one quarter reported agriculture as principal occupation. Majority of them are from Janjira side. Very few depend on fishing (3%) as their principal occupation. More than 13 percent live on wage labor. Rickshaw/van pulling seems to be one of the prominent occupations of this project area. It is more prominent in the East side as compared to the West. About 6 percent of the head identified household work as their principal occupation. This percentage is similar to the percentage of female headed household as mentioned earlier. It is possible that despite earning a living, they identified themselves as just involved with household work. These households need special attention from the project during resettlement.

Table 8.4.4 Principal Occupation of the Head of the Affected Households

Area	East End-Mawa						West End-Janjira						Grand Total	
District	Munshiganj				Sub Total		Shariatpur		Madaripur		Sub Total			
Upazila	Lauhajang		Sreenagar				Janjira		Shibchar					
Principal Occupation	No	%of Upazila	No	%of Upazila	No	%of Total	No	% of Upazila	No	% of Upazila	No	% of Total	No	%of G total
Agriculture	180	14.68	11	9.40	191		294	36.43	306	30.60	600		791	25.11
Fishing	23	1.88	0	00	23		57	7.06	17	1.70	74		97	3.08
Business	450	36.70	66	56.41	516		165	20.45	266	26.60	431		947	30.06
Service	182	14.85	12	10.26	194		28	3.47	91	9.10	119		313	9.94
Household Work	82	6.69	10	8.55	92		26	3.22	68	6.80	94		196	5.90
Labor	101	8.24	6	5.13	107		183	22.68	124	12.40	307		414	13.14
Mistr/ Karigor	30	2.45	2	1.71	32		4	0.50	4	0.40	8		40	1.27
Driver	21	1.71	2	1.71	23		3	0.37	19	1.90	22		45	1.43
Rickshaw/ Van pullar	83	6.77	6	5.13	89		21	2.60	63	6.30	84		173	5.49
Hawker	2	0.16	0	00	2		1	0.12	7	0.70	8		10	0.32
Teacher	1	0.08	0	00	1		2	0.25	1	0.10	3		4	0.13
Tailor	29	2.37	1	0.85	30		6	0.74	4	0.40	10		40	1.27
Others	42	3.43	1	0.85	43		17	2.11	30	3.00	47		90	2.86
G Total	1226	100	117	100	1343		804	100	1000	100	1807		3150	100

8.4.5 Women and Work

Women in the area reported as being involved in household work, although 7 percent of the households are headed by females. Since there are several micro-credit programs run by NGOs, it is considered that a large number of women are involved in small business and marketing. Improved accessibility, particularly in Janjira site, will bring new economic and employment opportunities for women, particularly during construction and post-construction periods. There is a need for specific programs of information and training for women in this regard, and these are sorely lacking. One of the more positive impact of the project will be that women will be less isolated, better educated and more aware of the world beyond the village due to improved access provide by the new network of roads, particularly in Janjira site. This itself will go a long way in assisting women to make sure in the long run that receive an equitable share of the rewards of development.

8.4.6 Summary Project Impact – Losses and Risks

The impact of land acquisition of the project will be significant. The extent of land losses, particularly in Janjira, and displacement of households/businesses both in Mawa and Janjira are quite large. Many affected households will require relocation and assistance to resettle and re-establish them. The RAP should take into account the various losses, including the *nadibashi* settlers, to mitigate against negative impacts and associated risks such as loss of employment and livelihood sources. Further, the impacts of the project are likely to be different in Mawa and Janjira sites due to population density and loss of diversified resources such as land, business and access to river port and market. The RAP should address these issues carefully in resettlement planning and income restoration/social development programs.

8.5 DISCLOSURE AND STAKEHOLDERS CONSULTATION

Disclosure of potential project impacts and consultation with the affected communities and other stakeholders has been a key element of the Padma Bridge project preparation work. The major activities and outcome are presented separately in *Disclosure and Community*

Consultation Report.[4] A summary of the key activities and general response of the stakeholders to the project are presented in this section.

8.5.1 Disclosure and Consultation Meetings

The Study Team, assisted by sub-consultants, carried out disclosure and public consultation meetings during the social impact assessment phase. The Team conducted Information and Consultation Meetings (ICM), village-based Focus Group Discussion (FGD), and Participatory Rapid Appraisals (PRA). Table 8.5.1 presents a summary list of the various types of consultation meetings held at the project sites in Mawa and Janjira.

Table 8.5.1 Disclosure and Consultation Meetings

Type of Meeting	Site and Location	Number attended	Project Issues
Information and Consultation Meetings	Mawa – Kumar hog UP Office	37	✓ Scope of project impacts ✓ Impact assessment and identification of APs ✓ GOB laws and JICA/donors requirements ✓Compensation/resettlement issues &guidelines ✓ Reponses to the project
	Mawa – Medinimondal UP Office	44	
	Janjira – Matborerchar UP Office	50	
	Janjira – Naodoba UP at Diara	65	
	Janjira – Naodoba at Madrasah	70	
Participatory Rapid Appraisals	Mawa – South Medinimondal Village	48	✓ Discussion on project impacts ✓ Project impact assessment by the APs ✓ Local needs and concerns
	Janjira – Bakhorer Kandi Village	42	
	Janjira – Joyenuddin Matborer Kandi	52	
Focus Group Discussion	Mawa – Kandipara Village	35	✓ Extent of losses – land/houses – by the APs ✓ Impact of erosion disasters and displacement ✓ Resettlement of landless/informal settlers ✓Female-headed households and vulnerable groups ✓ Income and livelihoods ✓ Employment in project work
	Mawa – kumarbogh Village	44	
	Janjira - Bakhorer Kandi Village	71	
	Janjira – Sikderer Kandi Village	33	
	Janjira – Charjanajat ghat	40	
	Janjira – Diara/Naodoba Village	27	
Study Tour by APs	Visit to Jamuna Resettlement Sites in Bhuapur and Sirajganj	40	✓ The visit was aimed at explaining Jamuna resettlement "model" and to build up confidence among the APs for resettlement

The meetings were attended by various categories of potentially affected persons and stakeholders, including local upazila (sub-district) administration, Union Parishad (UP) chairmen/members, community leaders, political party members, school teachers, and representatives of local business communities. The Study Team members made initial presentations outlining the project and its impacts, with the help of drawings on the ground and maps so that affected people and communities could understand the scope of the impact and respond as desired. The participation by the villagers was very spontaneous, friendly, and interactive as well as informative. Figure 8.5.1 identifies project locations where ICM, FGDs and PRA were conducted. The outcomes were used to prepare policy framework to address various concerns and issues raised by the affected people.

[4] *Disclosure and Community Consultation Report*, Bangladesh Consultants Limited (November 2004). This report is annexed in Vol. X – *Supporting Studies*, JICA-Padma Feasibility Study Reports (January 2005).

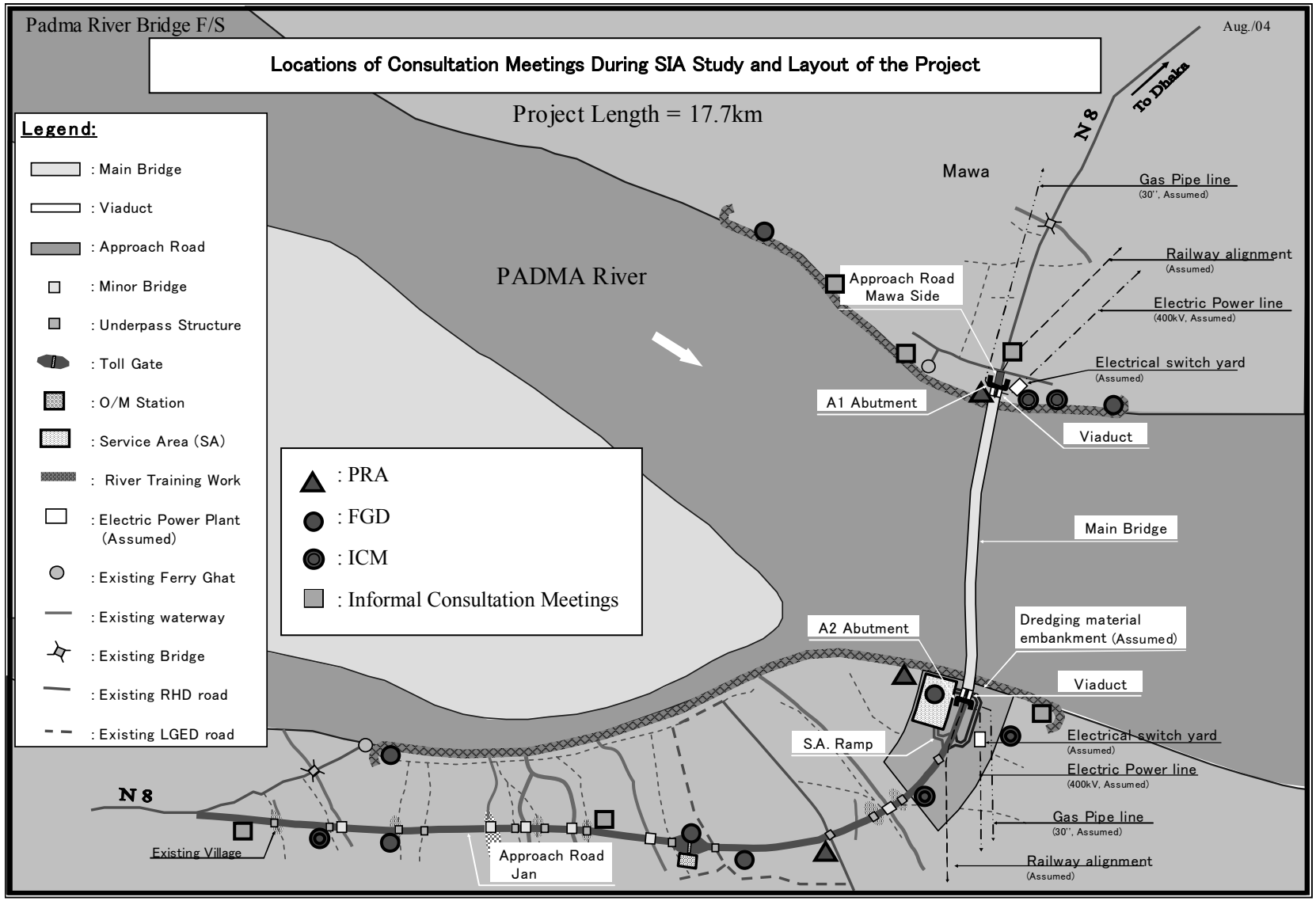


Figure 8.5.1 Locations of Consultation Meetings

8.5.2 Study Tour by APs to the Jamuna Resettlement Sites

A group of 40 persons consisting of locally elected officials (including women members of local union councils) and community leaders/opinion-makers from Mawa and Janjira were taken to the Jamuna Project resettlement sites on October 30 on a day-trip. The objectives of the trip were to explain on-site the Jamuna "model" of resettlement, which consisted of: (i) "self-managed" resettlement by the affected households with all eligible benefits; (ii) "cluster" resettlement assisted by the project; and (iii) resettlement in project-sponsored "resettlement sites." The study tour proved very effective, with the people able to see for themselves the extent of resettlement work including various civic amenities established by the project, as carried out in the case of the Jamuna. project. The trip also helped the Mawa/Janjira people in developing a "vision" of the project-sponsored resettlement sites in the Padma Project. Furthermore, those who visited the Jamuna resettlement site presented a positive view of the work done in Jamuna, which also mobilized the public responses favorably to the project.

8.5.3 Consultation Strategy and Activities

A disclosure consultation strategy was developed for consistency in the presentation of project briefs and materials for information and consultation meetings. The principle is presented in Table 8.5.2. The entire disclosure and consultation were guided by the tasks contained in the table.

Table 8.5.2 Stakeholders Meetings and Major Activities

Sl. No	Major Activity	Description of Tasks
A. PLANNING PHASE		
1	Methodology Followed for effective DPC	
	Information gathering	• Review of JICA guidelines on disclosure and public consultation. • Review of other donors' guideline on disclosure and public consultation. • Review of other donors' guideline on disclosure and public consultation. • Review of available literature on disclosure and consultation method followed in other donor -funded infrastructure projects and good practices.
	Information Disclosure	• Dialogue with local people through public meetings. • Information and Consultation Meetings (ICM) in the locality. • Disclosure of the project component and related issues among stakeholders of all levels through conducting public meeting organized by prior notice. • Focus Group Discussion with local stakeholders, with primary focus being the project-affected people (directly and indirectly affected people irrespective of gender and social status). • Disclosure of the Land Acquisition and Resettlement Issues among the potential affected persons through NGO workers who would conduct the Socio-economic census survey on potential affected households, CBEs, and other organizations. • Guided tour by representatives of selected local people affected, elites, elected representatives and other local level stakeholders to Jamuna Bridge project Resettlement sites to observe resettlement activities undertaken by JMBA.
	Consultation	• Consultation of resettlement and rehabilitation issues with stakeholders at all levels and gathering feedback on potential risks and probable mitigation measures. • Review the project plan by the experts to accommodate the suggestions made by the respondents in the focus group discussion and give feedback and explanation about the status among stakeholders. • Encourage stakeholders at all levels to participate in the consultation by receiving views from representatives from different groups including directly and indirectly affected households, agriculture land loser, owners and employee of CBEs, fishermen, local traders, women and others.
	Participatory Decision Making	• Participatory Decisions were made through Participatory Rural Appraisal (PRA) method by involving 40-45 people in four locations with directly and indirectly affected people, local elites, women representatives of the affected households.
2	B. IDENTIFICATION OF STAKEHOLDERS	
	Primary Stakeholders	• Directly affected households, agriculture and other types of land owner, business and industry owners, other property owners along the RoW. • Indirectly affected persons including house and CBE renters, Uthulis, sharecroppers, wage labors/employees of firms/businesses affected by RoW. • Implementing agencies involved including local government, local administration, Deputy Commissioners office (DC land), JMBA, Ministry of Communication, GoB, donors, etc. • Department of Agriculture, Fisheries Department, Public Works Department, Forestry Department and other departments involved in assessing the value of the lost property .
	Secondary Stakeholders	• Local government/Community Leaders, Locally active NGOs, Women groups, Local level investors, Local elites. • Users of the affected community properties (mosque, school/madrasa, samitees, graveyards, etc.), local level travelers. • GOB laws and policy regulatory agencies, Consultants, implementing NGOs

8.5.4 General Responses and Feedback- Summary

The project-affected people overwhelmingly support the construction of the bridge. They expressed that it was the demand of their souls and would like to see the bridge a reality within their lifetime. The APs claimed that the project will (i) ease transportation and communication; (ii) save time and money to commute to Dhaka and other key destinations; (iii) create new jobs and increase economic activities; and (iv) encourage establishment of new industries with massive employment opportunities. A standing support to the project was on the ground of river training and protection work, which will save the localities from

future erosion endemic to the project area. This will further reduce the suffering of the erosion displaced (*nadibashi)* people.

However, some concerns were raised with respect to land, property and resource losses and consequent marginalization and income losses. The disclosure of the comprehensive resettlement process and compensation packages was welcomed by the people. Still then, concern over delays in compensation payment and harassment in receiving compensation payments from the government were expressed. The Study Team was requested to recommend measures to eliminate/reduce these delays/ harassments. Table 8.5.3 presents a summary of the project impacts, responses and findings. These findings have been considered in the development of resettlement framework and entitlement matrix for the project.

Table 8.5.3 Stakeholders' Responses and Findings

Type of Impact	Responses	Findings
Land Acquisition & Population Displacement	• Land acquisition is obvious • With land acquisition, population will be displaced • Compensation for land and all losses to structures, resources, business and trades and income generation for all APs to be provided	• Land acquisition should be minimized for all possible alternatives to be studied • Land acquisition should avoid settlements as far as possible • All compensation to be paid at replacement value • The difference between recorded price of land at Sub-Registrar's office and in the market should be reckoned • Tree resources felled should be compensated at market price and vigorous replanting effort should be in place at embankments and resettlement sites. • As land is scarce, assistance should be provided to find alternative land for purchase • Land development cost to be included in compensation package • Structures lost should be compensated at market price plus cost of transfer and reconstruction
Resettlement Strategies	• Multiple strategies will be adopted in resettlement management in the project	• Crops lost should be compensated • Businesses lost should be compensated plus transfer and reconstruction • Loss of trades, skills, change of profession should be considered, skill training provided and APs to be assisted in new IGAs. • Resettlement sites with utilities and services to be developed for marginal landowners and those landless and destitute • Land prices at resettlement sites to be minimum and land sizes proportional to family sizes should be allotted to the APs • Delays, harassments and corruption should be avoided in payment of compensation • There should be a way out for lands having unclear title/ownership but occupied/possessed by present owners • Sufficient time should be allowed between serving notice of acquisition, receiving compensation and moving out.
Impact on the Nadibhasi (erosion induced APs), Sheltered People	• Whether they will receive compensation for land which is not theirs, belongs to others and they are using by renting/leasing or free through mutual understanding • They prefer to live along the riverbanks because their livelihoods depends on activities centered around the river, fishing, carrying	• They now know they will not receive compensation for lands but other losses will be compensated • They would like to be resettled within close proximity of the river to retain their traditional trades and way of life • They should not be disturbed by the landowners until the lands are acquired and the existing understandings/ agreements should be honored • Change of profession, such as a boatman becoming a rickshaw puller, was very much disliked

Type of Impact	Responses	Findings
	passengers and commodities by boat, farming, cattle and goat-rearing in the shoals • The owners of the lands on which they live may be prompted to evict them in order to establish unencumbered possession on the lands	• They are not very interested in going to resettlement sites and leaving the openness and vast expanse of the rivers/shoals for limited space at resettlement sites • The flood season bankline and winter season bankline are different raising questions on whether land forebank protection works could be acquired along the winter banklines.
Impacts on the Women and Vulnerable Groups	• Women-headed households are disadvantaged compared to their male counterparts • Women widowed/divorced living with fathers' family/in-laws' family or singly fear becoming destitute • Their rights on ancestral/in-laws' properties may not be established and they may be deprived of due share of compensation moneys • They are now engaged in traditional homestead small trades like home poultry, cattle and goat rearing, backyard kitchen gardening, embroidery, serving in the homes of well-to-do neighbors. All these will be lost and they felt helpless • Vulnerable/ destitute felt encouraged at the disclosure of the fact that their interests will also be specially taken care of. Similar were the responses from families having disabled members	• The women APs should be resettled with compensation and assistance in all respects • Their rights/shares on land according to laws of the land and religious principles should be safeguarded • Their traditional homestead trades and IGAs should be recognized and appropriately compensated and rehabilitated. They should be assisted to re-establish their lost IGAs • They should be given appropriate employment in the bridge construction work without any wage discrimination • Destitutes/landless/disabled persons may be given shelters in the resettlement sites on a priority basis. They should be encouraged and assisted to form groups, given skills training and assisted in starting new IGAs and new trades including credit and supervision. • There should be sufficient protection and enforcement of social/religious principles to protect women APs and their families from gender discrimination and various abuses • The losses to hawkers and small businesses should be recognized and compensated

8.6 RESETTLEMENT GUIDELINES AND FRAMEWORK

8.6.1 GOB Legal Framework - A Review

The *Acquisition and Requisition of Immovable Property Ordinance II* (1982) governs all cases of acquisition and requisition by the government of immovable property for any public purpose or in the public interest. The owners affected by such acquisition are eligible to compensation for losses. The Ordinance requires that compensation be paid for (i) land and assets permanently acquired (including standing crops, trees, houses); and (ii) any other damages caused by such acquisition. In determining the compensation, the Deputy Commissioner (DC) considers the value of land transaction for the past 12 months in the project area, plus a 50 percent solatium on the assessed value of the property for compulsory acquisition.[5] The compensation thus paid does not constitute market or replacement value of the property acquired. The 1994 amendment made provisions for payment of crop compensation to tenant cultivators. However, the Ordinance neither covers project-affected persons without titles or ownership records such as informal settlers/squatters nor recognizes loss of income and livelihoods. Moreover, it does not take into account the adverse impact of dislocation. Furthermore, very little resettlement assistance is offered under the law. In summary, resettlement of affected persons (APs) is not an integral part of the land acquisition process in Bangladesh.

[5] The solatium was raised from 25 percent to 50 percent through an amendment in 1993.

8.6.2 JICA and Donors' Guidelines

JICA[6] and other donor agencies such as ADB[7] and the World Bank[8] have broad principles to minimize displacement, and require time-bound action plans with measures to restore or improve incomes of those unavoidably affected by project development. ADB's poverty reduction strategy[9] reinforces the importance of mitigating the risks of displacement, and taking steps to improve the conditions for the poor and vulnerable groups in particular. The guidelines require (i) avoiding involuntary resettlement where feasible, (ii) minimizing resettlement where population displacement is unavoidable, and (iii) ensuring that displaced people receive assistance under the project, so that they would be at least as well off as they would have been in the absence of the project. Involuntary or development-induced resettlement, therefore, needs to be an integral part of project design covering compensation for lost assets and loss of livelihood and income based on full replacement cost and paid in timely manner. The affected persons must receive assistance for relocation including provision for relocation sites with appropriate facilities and services. Finally, resettlement management should be perceived and executed as a development project.

8.6.3 Resettlement Experience in Bangladesh

Official statistics on project-related displacement are rarely available in Bangladesh. Through the 1970s and 1980s, many irrigation, flood control, hydropower, and urban/industrial development projects were completed, without any resettlement plan despite foreknowledge of large-scale land acquisition and population displacement. For instance, the Kaptai Hydroelectric Dam Project, completed in 1961, displaced close to 90,000 members of the indigenous/tribal in the Chittagong Hill Tracts.[10] The displaced people, mostly member of the Chakma tribe, were never adequately rehabilitated.[11]

To date, the Bangladesh government has no clearly formulated resettlement policy for persons affected by development projects. As indicated earlier, the 1982 Ordinance is the key legal instrument to acquire land for public sector projects. It delegates acquisition and/or requisition power to DCs, including valuation of property and payments of compensation for acquired assets. It is well known in Bangladesh that the registered value of land is only about half the market value because people devalue land in transactions to avoid, or pay, lower registration fees. As a result, compensation for land is always less than the market or replacement value of the property. As a result, when government acquires land for development purposes, it creates tension and uncertainties among the affected population due to absence of improved policy framework and lack of adequate assistance to the affected people, particularly the non-titled persons – the rural poor, landless, women and other disadvantaged groups. The Jamuna Bridge Project led to the first lengthy discussion and review of the issues related to development-induced displacement and established the "tradition" for a formal resettlement plan for project-affected persons. [12]

8.6.4 "Best Practices" Examples from Bangladesh

In recent years, due to donors' policy requirements and persistence to mitigate project-induced displacement, some improvements in the form of "best practices" are

[6] JICA, *Guidelines for Environmental and Social Considerations* (2004).
[7] ADB, *Involuntary Resettlement* (1995).
[8] World Bank, Operational Directive 4.12 *Involuntary Resettlement* (2002).
[9] ADB, *Fighting Poverty in Asia and Pacific - the Poverty Reduction Strategy*. 1999.
[10] An early account of the Kaptai Dam Project can be found in David Sopher, "Population Dislocation in the Hill Tracts," *Geographical Review*, Vol. 53(1963).
[11] For an analysis of the long-term impact and socio-political response to dislocation of the hill tribes, see M. Q. Zaman, "Crisis in the Chittagong Hill Tracts: Ethnicity and Integration," *Economic and Political Weekly*, Vol. 17:3(1982).
[12] For an overview of the issues, see M. Q. Zaman, "Development and Displacement in Bangladesh: Toward a Resettlement Policy," Asian Survey, Vol. 36(7), 1996.

noticeable in many projects funded by JBIC, DFID, ADB and WB (for example, Jamuna Multipurpose Bridge Project, Bhairab Bridge Project, Paksey Bridge Project, Rupsa Bridge Project, Riverbank Protection Project, and Southwest Road Network Project). The best practices include: (i) time-bound comprehensive resettlement plan for project-affected persons; (ii) consultation with stakeholders; (iii) entitlement matrix, based on types of losses by the affected people; (iii) provision for replacement value of assets (land and housing); (iv) shifting allowances for relocation; (v) involvement of APs in resettlement implementation; (vi) grievance redress provision for dispute resolution; (vii) training/income restoration program; (viii) special attention to women and vulnerable groups; and (ix) civic amenities in resettlement sites/host communities in resettlement management. The "best practices" are fairly rooted in the development scenario, particularly in the case of donor-funded projects and derived largely from the Jamuna resettlement project experience.

Despite project-specific and ad-hoc measures, findings from the *Evaluation of Resettlement Experience in Selected Projects*[13] indicate major problems in land acquisition and resettlement management in Bangladesh – for example, long delays in payment of compensation and resettlement assistance, lack of adequate consultation with APs, weak income restoration program, and weak coordination and monitoring of resettlement activities. The *Special Evaluation Study*[14] found that the ability to implement resettlement plan efficiently and effectively depends on clear policy guidelines and legal framework, as well as awareness, skill and experience of project staff, and strong institutional capacity for resettlement implementation.

8.6.5 Project Resettlement Guidelines and Framework

In the light of the types of losses and the past resettlement experience in Bangladesh, a project-specific land acquisition and resettlement that matches international donor requirements and standards is recommended for project implementation. The framework requires that: (i) detailed project design and implementation arrangements carefully consider alternative options to further minimize resettlement; (ii) land acquisition and resettlement action plans to mitigate adverse impacts be prepared, including replacement costs for all assets acquired and resettlement assistant; (iii) lost incomes of the affected people and businesses be restored; and (iv) the capacity of the executing agency for resettlement operations and managements be enhanced. Land acquisition and resettlement of the APs in the project will be carried out in accordance with the following guidelines:

(i) Land acquisition will be carried out in a way to minimize the adverse impacts on the APs. This will be done in consultation with the people to be affected.
(ii) Affected people will receive replacement value of the land and other assets. Likewise, loss of standing crops and productive trees will be compensated at market price.
(iii) Owners of residential/commercial units will be compensated at replacement costs. Renters/lease holders affected by loss of living quarters will receive compensation due to indirect impact of the project.
(iv) Affected community structures or common property resources will be re-built or replaced at market prices under project financing.
(v) The needs of women and other vulnerable groups will be identified and provisions made for social development support, employment, and means of subsistence to improve their status/livelihood.
(vi) JMBA/EA and implementing agency/NGO will assist APs and owners of businesses in all aspects regarding relocation and resettlement. The EA will involve all stakeholders in the decision-making process concerning relocation and resettlement.

[13] *Evaluation of Resettlement Experience in Selected Projects* (Draft Final Reports Vol. II), Asian Development Bank and Roads and Highways Department, Dhaka, December 2003.
[14] *Special Evaluation Study on the Impact of Involuntary Resettlement*, Asian Development Bank, Manila, September 2000.

(vii) JMBA/Project Management Consultants will guide, supervise and monitor the land acquisition, compensation payments, and resettlement of the APs, including addressing grievance and resolution of disputed claims for compensation.

The Resettlement Guidelines and Framework contains the following packages, which are designed to cover compensation for lost assets and restore or enhance the livelihoods of all categories (direct, indirect, title holders, and non-title holders) of affected people (Table 8.6.1).

Table 8.6.1 Compensation/Resettlement Framework and Beneficiaries

	Compensation Packages	Beneficiaries
1	• Replacement value of agricultural land to titled owners by DC office • Additional cash grant based on MARV to match market value of the land	• Households affected by loss of agricultural land • Households affected by loss of agricultural land
2	• Cash grant for loss of access to land by tenant/sharecroppers	• Tenant/sharecroppers affected by land acquisition for ROW
3	• Compensation for crops, trees and perennials	• Households affected by loss of crops/trees/pond-fish • Tenant farmers to receive 50% of the compensation for crop loss, if applicable
4	• Replacement house plots/cash for homestead land (by owners) at market value	• All homestead/house plot owners affected by the Project
5	• One-time cash grant for alternative housing to APs without titles to homestead land/structure	• Renters, leaseholders, squatters affected by the Project
6	• Cash compensation for residential/commercial structures at replacement cost • Cash compensation to renters/non-titled businesses for loss of business premise	• Households/business (owners only) affected by the Project • One-time cash grant to business establishments to re-establish business
7	• Transfer/shifting cost for relocation • Additional assistance to female-headed households	• All APs (rented, squatters included) to assist in the relocation • Female-headed households to hire hands for relocation
8	• Cash assistance for income restoration • Roadside plantation and Social Forestry Program	• All affected households/CBE employees and indirectly affected persons for loss of work, income, and business • Vulnerable groups such as women and landless people for alternative income generation program
9	• Reconstruction of community facilities or resources affected by the project	• All partially and fully affected community facilities will be reconstructed in consultation with affected communities
10	• Civic amenities in host areas to increase carrying capacity of the host villages	• Relocated areas/villages where APs will move in small groups
11	• Social Development Fund to assist restoration of income and livelihood in post-resettlement period	• Affected households with particular attention to female-headed households and other vulnerable groups and those under the official poverty line.

The APs will not only receive replacement land or cash for land and other assets at the market price. Many additional measures have also been taken - for example, shifting or moving allowances, assistance to owners of businesses, assistance to female-headed households, income restoration and social development program - to help the project-affected persons regain or improve their lives in the post-resettlement period. These entitlements are further listed and explained in the Entitlement Matrix (Annex I).

8.6.6 Resettlement Strategies and Options

(1) Extent of Displacement

The census identified the extent of displacement of households and other establishments due to acquisition of land for the project. According to current estimates, the project is likely to relocate 3,150 households, 277 CBEs and 65 CPRs partially or entirely from their current locations. Among them, a large majority are from Janjira site where many of the associated infrastructures (i.e., approach roads, toll plaza, service area, construction yard/project management office, river training and protection works, etc.) will be established.

(2) Relocation and the Local Samaj[15]

People of the project area mostly depend on agricultural land, especially in Janjira site. However, land is scare due to endemic erosion in the floodplain. Moreover, the distribution of land is very skewed and concentrated in some *gusthis* (patrilineage) in the *char* areas. The patrilineal groups are organized along kin and other social relationships and maintained through patronages such as providing "free land" and/or rental to *nadibashi* (displaced by erosion) relatives/fellow villagers for settlement within the *samaj*, which also maintains distinct social "boundaries." The *samaj* in effect is a mutual assistance group and is considered the primary political arena/field in Janjira site. The leadership is vested more often among a set of people variously called *matabbar*, *mondal, dhali, sikder* and *sarder*. These leaders are typically rich peasants who have abilities and networks to organize and mediate with the "outside" world. This was clearly evident during the field surveys and consultation meetings. Indeed, many local villages are named after leader(s) or the patron family – for example, Matoborer Char, Sikderkandi, and Matborkandi. Each *samaj* in char villages is identified with or named after its most powerful *matabbar* (for example, Khaleque Dhali's *samaj*). In summary, the *samaj* reflects local "brotherhood" of the landed "big men" who act as arbiters of local disputes and maintain solidarity as well as orderly life in the community.[16] Given the social conditions in Janjira, opportunities as well as preferences for relocation will most likely be influenced by the traditional *samaj* group and patronage systems. As a result, due attention must be paid to *samaj* in deciding resettlement sites and relocation. Therefore, the *samaj* leaders must be consulted during resettlement site identification/selection. A *samaj*-based resettlement strategy may be helpful in the case of Janjira site.

(3) Relocation Options and Strategies

The Study Team discussed various options and strategies with the affected people in PRAs and FGDs. The SES included specific question with regard to choice(s) for resettlement. Table 8.6.3 lists the responses and preferences.

[15] The *samaj* is a patron-based corporate social group widely found, particularly in the floodplain villages. It is often the largest intra and/or inter-village informal but important social organization of mutual reliance, organized primarily on the principle of patronage. For details, see M.Q. Zaman, *The Socioeconomic and Political Dynamics of Riverbank Erosion Hazard and Population Resettlement in Bangladesh*, Ph.D. Dissertation, University of Manitoba, Canada, 1988.

[16] M. Q. Zaman, "The Role of Social Relations in the Response to Riverbank Erosion Hazards and Population Resettlement in Bangladesh." In *Natural Disasters and Cultural Responses* (ed), A. Oliver-Smith, Studies in Third World Societies, Vol. 36; Williamsburg: College of William and Mary, 1986.

Table 8.6.2 Resettlement Preferences by Affected Persons

Location	Preferences for Resettlement								Total	
	Self –managed						Resettlement Sites			
	Owned land		Purchased land		Total					
	No	%	No	%	No	%	No	%	No	%
Mawa Site	22	1.64	1084	80.71	1106	*82.35*	237	*17.65*	1343	100
Janjira Site	93	5.15	1207	66.80	1300	*71.94*	507	*28.06*	1807	100
Total	115	3.65	2291	72.73	2406	*76.38*	744	*23.62*	3150	100

As in Table 8.6.2, over three-quarters (76%) of those requiring relocation prefer self-managed resettlement while the rest (24%) expressed views for relocation in project-sponsored resettlement sites. Only a few (3.6%) have plans to resettle on their own land but the majority desires to purchase land to re-build their houses and resettle independently. In the case of Jamuna also, three-fourth of the displaced families chose the "self-managed" resettlement option and re-established them in the existing villages.[17] Self-Managed resettlement allows affected households to make individual decisions and choices with regard to new house site or location for resettlement. This is usually influenced by availability of land for house construction, kinship, and other social relationships. The three options are discussed below.

(a) Self-Managed Resettlement by Affected Households

Affected households will self–relocate to their preferred places in the same or nearby villages having received all eligible benefits as per the policy framework and entitlement matrix. Self managed resettlement could be on their lands in the same *mouza*/village or in a nearby village through purchase of new land for housing and resettlement. In most instances, they would need to develop the land, as this area would predominantly be low-lying. So they would need time to develop the land prior to construction work. The self-managed strategy would reduce social disruption and allow the affected families to stay around their own social and kin groups according to their own choices. The affected households will need to be assisted in the relocation process by the INGO and pay all eligible compensation, transfer cost and income restoration allowances in advance so that relocation is completed prior to commencement of civil works.

(b) Small Group Resettlement

The affected households in groups of 10 to 15 families typically related my kin or other social ties will be encouraged to resettle in "clusters." This is another form of self-relocation enabling the affected families to remain together for mutual self-help. The project may provide additional support to host village in the form of civic amenities (for example, provision of tube-well for drinking water and sanitation and others). This will enhance the carrying capacity of the host village and improve settler-host relationship in the resettled village.

(c) Project Sponsored Resettlement Sites

APs are expected to receive adequate compensation for replacement agricultural and homestead land and some incentive in the form of salvageable materials, trees, house construction grant, transfer/relocation grant, transition allowances etc. As indicated earlier (Table 8.6.3), many would prefer and indeed be encouraged to go for self-resettlement. However, there would be others – about 25% according to the survey data – who would require assistance for resettlement. These include landless, marginal farmers, *nadibashi*, and members of vulnerable groups such as female-headed households who may not succeed in

[17] *Special Evaluation Study on the Impact of Involuntary Resettlement*, cited earlier (see Annex 13 – Jamuna Multipurpose Bridge Project).

resettling themselves on their own. As part of the safety net, the resettlement framework will keep provisions for "homestead-losers" at the resettlement sites. Given the project locations, at least 4 sites would be required (Mawa-1 and Janjira -3 sites). The sites should be selected in consultation with the affected people during the detailed design period. Each site will contain basic civic amenities like the resettlement sites at the Jamuna Bridge Project. Preference will be given to those most vulnerable families having 2.5 dec. homesteads and losing most of it by acquisition. As the APs are from different localities along the ROW, the resettlement sites should be identified in proximity to their place of origin as well "central" places with access to market and job opportunities.

(4) Resettlers-Host Relation

The resettlement strategies in this project preclude any resettlers-host conflict because the households will largely remain with the same general area of the existing villages and thus will maintain their pre-existing social ties and networks. Project will provide infrastructure facilities to enhance the carrying capacity of the villages where 30 or more families resettle. It is expected that these facilities will help to strengthen the mutual relations among the host villagers and resettlers. Therefore, no conflict or tension is anticipated. If necessary, JMBA and the implementing NGO will conduct meetings with host communities in the post-resettlement period to establish a congenial atmosphere among them.

8.6.7 Income Restoration Assistance

Affected households and business establishments requiring relocation may suffer temporarily due to loss of workdays/income and businesses caused by dislocation. This is especially true for the wage earners as well day laborers. The study observed that there are some women and minors directly or indirectly involved with fish business as well as informal employment for support services in the ferry ghat. Dislocation due to the project will affect these groups most adversely. Income Restoration Assistance (IRA) in the form of supervised grant should be paid to eligible APs. The primary objective of this additional assistance is to allow displaced APs and owners of business establishments to settle in their new place of residence and businesses, respectively. All income restoration programs should start in the post-resettlement period, based on fresh surveys and criteria for eligibility. The IRA program shall include (i) cash assistance to support lost income; (ii) assistance to re-establish business; (iii) special assistance for vulnerable groups; (iv) social development fund (SDF) for income-generation; (v) employment in project construction; and (vi) roadside plantation and social forestry.

8.6.8 Entitlement Matrix

The entitlement matrix (Annex I) is based on the LA&R Guidelines and Compensation/Resettlement Framework outlined earlier. It provides (i) entitlement provisions; (ii) eligibility; (iii) application guidelines; (iv) implementation issues; and (v) organization(s) responsible to carry out the tasks. The matrix includes 13 major categories, which are to be compensated under the project. These are:

(i) Loss of agricultural and commercial lands
(ii) Loss of homestead land
(iii) Loss of households/homestead and other physical structures
(iv) Loss of structures used for commercial and industrial activity
(v) Loss of timber, fruit-bearing trees, and bamboo and banana groves
(vi) Loss of standing crops
(vii) Loss of ponds and fish stock
(viii) Loss of usufruct rights in mortgaged-in/out and *khai-khalashi* lands
(ix) Loss of income from displaced commercial/industrial premises

(x) Temporary loss of income (wage earners – agriculture, commercial/industrial)
(xi) Loss of income from rented residential/commercial premises
(xii) Adverse impact on host population in post-resettlement period
(xiii) People adversely affected by the bridge (for example, change in water level up/downstream or in unforeseeable ways

8.6.9 Preliminary Cost Estimate and Budget

Table 8.6.3 contains a preliminary cost estimates for land acquisition and resettlement. A land market survey was conduct to assess the replacement value of land in the project area.[18] The estimated cost is Taka 4320 million or US$72 million (at Taka 60 for US$1). The cost estimate includes land acquisition and related costs, cost for structures, trees, income restoration/social development grants, NGO costs, monitoring and project administration costs. The preliminary cost has been included in the project cost estimates. The estimates and costs per unit and other related issues concerning costs are presented in the main report in Annex13.

Table 8.6.3 Preliminary Costs and Budget

Sl. No*	Item	Estimated Costs/ Taka in Million
A-G	Compensation for land acquisition (all types), stamp duty/registration, crop loss, payments for structures (all types), and trees at market rates	2897.47
H-V	Transition allowance, house construction grant, shifting allowance, land development cost, special assistance to female-headed households, resettlement site development, social development fund (SDF) for training/skill development and income restoration	889.18
W-X	Others (e.g. monitoring, hiring of NGO for RAP implementation, updating database through Joint Verification, allocation for indirectly affected persons and any unforeseen impacts)	533.36
Total		4320.01

* Corresponds to numbers (in alphabets) used in the cost estimates presented in Annex II. The table presents a summary of the cost estimates; for details, see Annex II. .

8.7 IMPLEMENTATION AND M&E ISSUES

8.7.1 Key Tasks

Land acquisition and resettlement management in the Padma Bridge Project would be a very challenging task. A successful implementation would require: (i) clear understanding of the tasks involved – their sequencing and linkages; (ii) a well-conceived organizational set-up with well-trained, efficient staff to carry out various tasks; and (iii) a carefully prepared work plan or activity schedule synchronizing resettlement with the construction schedules. The implementation should be based on the principle that all APs are paid their due compensation and assisted in resettlement of the project-affected people.

8.7.2 Capacity Building for Resettlement Management

There is a need for a dedicated organizational set-up for resettlement management. The key organizations/agencies responsible for implementation of RAP would involve:

- Establishment of a Resettlement Unit (RU) in JMBA with full responsibility for resettlement operations and management
- Deputy Commissioner(s) of the concerned Districts
- Local government Institution, such as Union *Parishad*, which represents the APs in all forums in connection with land acquisition and resettlement; and

[18] See *Padma Bridge Feasibility Study – Land Market Survey* (Bangladesh Consultants Ltd, Dhaka, October 2004).

Experienced NGOs, assisting the JMBA for implementing and monitoring the RAP.

These organizations/agencies will have critical roles to play in implementing a time-bound: (i) Land Acquisition Plan and (ii) Resettlement Action Plan. In order to achieve capacity building of these bodies, specific terms of reference, legal/administrative authority, and intensive training/workshop focusing on the tasks, processes and responsibilities are considered imperative. These aspects are discussed in greater detail in the main report.

8.7.3 Role of JMBA-Resettlement Unit

JMBA-RU, headed by the Project Director (PD), will be located at the HQ. Two Field Offices will be opened – one each at Mawa and Janjira sites. The main tasks of the Resettlement Unit under the responsibility of the PD are:

- Overall planning, management and monitoring of the resettlement program
- Synchronization of resettlement activity with JMBA construction schedule
- Hiring of NGOs/resettlement experts for RAP implementation
- Ensuring that all eligible APs are identified, provided with their respective entitlement according to the resettlement policy and are relocated as per the implementation schedule and with minimum hardship
- Liaising with the DC's office regarding timely acquisition of lands required for JMBA and payment of compensation and ensuring that these activities are completed as per schedule
- Ensuring that all APs are informed about their entitlement and provided with the necessary ID card as proof of their eligibility to resettlement benefits
- Forming Land Purchase Groups (LPGs) and ensuring their smooth functioning, including disposal of grievance through grievance redress mechanism
- Monitoring the effectiveness of entitlement packages and when necessary, proposing modification to JMBA management

The PD/RU will have full administrative and financial powers to manage the resettlement project in all matters including the following: (i) full powers to appoint work-charged staff up to certain levels with prior sanction of the post - in cases of recruitment, promotion, transfer and disciplinary action against staff, normal rules of the Government will be followed; (ii) administrative control over all officers and staff of the Resettlement Unit, and (iii) subject to availability of funding and within PCP/PP provision the PD will exercise the full financial powers in matters relating to the resettlement project:

- Regarding finalization of tenders of the resettlement project, the PD will form a tender evaluation in line with the GOB Procurement Policy and process the selection and award.
- All types of bills relating to the resettlement project will be finalized and approved by the PD and payments will be made through cash/cheque by JMBA accounts unit. The resettlement project accounts unit will assist PD in the process of finalization and approving of all types of bills. For reconciliation of accounts, a quarterly meeting will be held with resettlement accounts and JMBA accounts will be audited annually.

8.7.4 Role of Deputy Commissioner(s)

The Deputy Commissioner has a key role in the implementation process. He has the legal responsibility for acquiring land and paying compensation directly to the APs as envisaged under the Acquisition and Requisition of Immovable Property Ordinance, 1982 and subsequent amendments made there under. Furthermore, he has access to official land records and the Legal/ Administrative authority for determining updated title of land and

eligibility of APs for compensation under law (CCL) for land as well as several other assets covered by law. There is definite need to enhance the capacity of the offices of the concerned DCs with additional senior LA staff to process the LA requests speedily and smoothly. The EA and implementing NGO assisting the EA will work with the representatives of the Deputy Commissioners during Joint Verification of affected properties and the market survey of the properties for ascertaining current replacement value before budgeting for total compensation payable to the APs. The conduct of these joint verification and market surveys and reconciliation of the 'market value' and `replacement value' will require a great deal of mutual understanding among the DC's office, JMBA and the implementing NGO. It is, therefore, essential that the Deputy Commissioners accept the involvement of their representatives in Joint Verification and Market Surveys, budgeting of compensation, updating of land records of APs and in reconciliation of CCL with the additional compensation to be paid by the JMBA through the NGO.

The DC offices will receive funds for CCL from the JMBA and effect payment to the directly-affected persons immediately to facilitate quick disbursement of differentials, if any, by the JMBA through the NGO. Participation of the Deputy Commissioner will be necessary in host area meetings. Similarly DCs' intervention/assistance will be required in matters such as land registration, disposal of land ownership disputes, allotment of char land and other surplus land.

8.7.5 Role of Implementing NGO

It has now been generally recognized that the task of successfully implementing a RAP requires certain attitudes, experience and skills in dealing with grass roots people, which are best available among some reputable NGOs in the country. Therefore, it has been adopted as government policy to commission the services of such an NGO to assist in the implementation of a RAP. The principal task of the NGO is to identify the project-affected land, households/business enterprises and persons, estimate their losses and dislocations, work out their entitlement packages and prepare a compensation budget. The next main task is to assist the JMBA in disbursing entitlements, which are beyond the purview of CCL. Again NGOs also play an important role in ensuring that legitimate grievances of the APs are redressed and special attention is paid to the vulnerable. The NGO is also required to undertake efforts to mitigate some community-level dislocations caused by the project.

8.7.6 Important Bodies Assisting Implementation of RAP: JVT, PVAT, GRC and RAC

To arrive at a fair standard of compensation sufficient to cover present replacement value of the lost resources, formation of a Joint Verification Team (JVT) and, likewise, a Property Valuation Advisory Team (PVAT) is considered important for each district. Again, to devise a mechanism to dispose of the complaints as per LARP, setting up a Grievance Redress Committee (GRC) for each area is also felt to be indispensable. In order to ensure collective sharing of responsibilities, JVT and PVAT need to be formed with representatives drawn from the JMBA, District Administration, and implementing NGO and the GRC formed with representatives of the JMBA, NGO, APs including local UP Chairman and women members of UP under an administrative order of the Ministry of Communications with appropriate legal authority. During implementation of RAP, a Resettlement Advisory Committee (RAC) should also be established on both sides.

8.7.7 Role of Resettlement Management Consultants Team

The Management Consultants Team (MC) acting on behalf of the Project and JMBA will ensure that sound methodologies and practices are used in the implementation of RAP. The

consultants will advise on any changes in the modalities of the implementation work, participate in meetings with the contracted agency/NGO and JMBA, and monitor the work of the implementing agency in the field. The consultants will also review on behalf of PD-JMBA the implementation progress report submitted by the contracted agency/NGO on a regular basis.

8.7.8 Resettlement Supervision and M&E

Monitoring and supervision are an integral part of project implementation, which must be addressed if implementation has to proceed according to the projected plan and schedule. Evaluation (pre-, mid- or post-) on the other hand is needed to bring the implementation onto the right track towards attainment of project objectives and, if the situation demands, rectifying the policies and strategies originally outlined for the project.

Land Acquisition/Resettlement Plan implementation will be supervised and monitored by the Project Director, JMBA in coordination with the Deputy Project Director, Assistant Director, JMBA field officials and the staff of the implementing NGO. The monitoring will be done both internally and externally to provide feedback to the JMBA on implementation of the RAP and effectiveness of the resettlement Policy. The procedures for internal and external monitoring are discussed further in the main report, including reporting requirements. The MC will have it own resident resettlement specialist (international) to advise the EA and to conduct review and supervision missions on a monthly basis during the implementation stage and will report to JMBA and the donors on the progress of all aspects of land acquisition and resettlement activities.

8.7.9 Independent Monitoring Team

A separate independent monitoring team will be responsible for monitoring and evaluation of the land acquisition, payments of compensation and RAP implementation. The team will be made of both international and locally available resettlement experts/consultants or a firm with relevant experience. The modalities will be further streamlined during the preparation of RAP. A post-resettlement impact evaluation will be carried out by the independent team to assess whether adverse impacts of the projects have been mitigated and/or addressed adequately, and APs have been able to restore and/or improve their pre-project standard of living as a result of resettlement and development.

8.7.10 Resettlement Databank

All resettlement-related data, including land acquisition, will be computerized through MIS by the implementing NGO. The data bank will act as the key source of information for implementation and monitoring purposes. EP files on individual households will be prepared for checking and verification purposes. The file will contain detailed socio-demographic data on individual households, lost assets, compensation entitlements and payments, and relocation. The databank will enhance institutional capacity of both JMBA and the implementing NGO in managing resettlement for the Project.

8.7.11 Reporting Requirements

During the implementation phase, the Project Director will prepare quarterly reports on the progress of resettlement activities and forward copies of the report to the Donors. A format for resettlement implementation monitoring has to be devised for quarterly monitoring and data collection by field officials. The Resettlement Consultant of MCT will submit Monthly Resettlement Progress Monitoring Report to the JMBA and Donors.

8.8 TASKS FOR JMBA/DETAILED DESIGN CONSULTANTS

The scope of work and TOR for the study was limited to social impact assessment and formulation of a resettlement framework, including a preliminary cost estimate and a review of issues relevant to resettlement project implementation. In addition, the study concentrated on disclosure and community consultation and social analysis of the project affected and benefit areas. As a result, two important tasks remained at the completion of the present study. These include (i) preparation of a Land Acquisition Plan (LAP); and (ii) preparation of a Resettlement Action Plan (RAP). The preliminary technical design provides a framework, which will be further examined and finalized during the detailed design stage. Given this, it was deemed not appropriate to prepare the LAP and RAP. Instead, it was considered best to leave the tasks to JMBA and to the detailed design consultants. This section lists of some of the outstanding work to be completed for further processing of the bridge project.

8.8.1 Land Acquisition Plan

JMBA will require preparing a Draft Land Acquisition Plan (LAP) prior to start of the detailed design for the project. The LAP will be based on the feasibility study and ROW/alignment as available. The LAP updated further as per the detailed design and scope of land acquisition by the detailed design consultants. The requiring body (i.e., JMBA) will need to submit proposals for acquisition of land to the concerned DCs with the following papers and documents:

(i) Mouza maps showing the alignments of the project
(ii) Lay-out of the plan
(iii) Administrative approval of the Ministry of Communications
(iv) Minimum requirements certificate
(v) Schedule of land showing names of owners and class of land
(vi) Contract to abide by the decision of the acquiring authority (i.e. DC)
(vii) Project Proforma of the project

8.8.2 Preparation of Resettlement Action Plan

The present study has identified the losses and compensation packages, outlined the resettlement framework and derived an indicative budget on the basis of cost figures available at the present point of time. Based on the Social Impact and Resettlement Framework, JMBA shall prepare a Draft RAP prior to start of the detailed design work. The RAP should contain an inventory of assets, based on additional surveys/studies indicated in the Feasibility Study Report. To save time, both LAP and RAP should be prepared simultaneously. The Draft RAP will be updated by the detailed design consultants, based on the final project design.

8.8.3 Hiring of NGOs for Social Preparation/RAP Implementation

Engagement of NGOs early on for social preparation of the APs and RAP implementation would be useful as proven in several previous donor-funded projects in Bangladesh. Since RAP implementation will be a challenging task, competent and experienced NGOs should be hired by JMBA. The selected NGO should be mobilized immediately after the submission of the LA Plan to DC offices. The NGO must assist the DCs in the entire land acquisition to expedite the process. Further, the implementation NGO will work toward social preparation (e.g., consultation with APs, community meetings on relocation schedule, coordination with UP and JMBA field office on all resettlement matters) for relocation and resettlement.

8.8.4 Review of the Bankline/Charland Ownership Issues

About one-third of the land to be acquired is eroded and/or bankline. This will turn into a very critical issue regarding acquisition and compensation payments due to apparent lack of clarity on the ownership of eroded land and bankline. The bankline is considered as being the slope of the floodplain, affected by erosion. However, in the active floodplain it changes almost annually. The law requires that the concerned Assistant Collector (AC) office draws an alluvial and dilluvial line (AD Line) annually to demarcate the bankline in order to establish *khas* (or government) rights over land areas lost to the river (i.e. eroded lands). In reality, the AC office rarely does this. As a result, lands eroded – for example, in the last 10 years or more – are still cultivable land on government records. Owner(s) of such land normally continue to pay taxes to keep their title rights, at least for the first few years after erosion.

In the absence of an established AD line, the low water level (LWL) or PW2 is considered the AD line, because people cultivate land above the LWL during the dry season. In case this land is required for any public purpose and/or project construction, it should be acquired and affected owners should be compensated. However, in legal terms, eroded lands (*sikosti*) inside the AD line (i.e. underwater land towards the river) are considered *khas* land only after declaration by AC and following demarcation of the AD line. Legal owners of eroded lands are eligible to titles if the lands re-appear as a natural process within the 30 years of the date of erosion.[19] However, if the Government undertakes any development work such as bank protection, the owners will cease their potential claims. This added complexity is due to lack of up-to-date land records and maps, particularly for riverine areas. Therefore, the issues are not only complex, but require further investigations to address issues like (a) ownership rights and (b) compensation of khas land.

8.8.5 Study of Impacts on Char lands

Although the bridge construction will not constrict the river itself, there could be some unforeseen impacts on the shoals (chars). The Padma *chars* are quite densely populated and crops are produced during the *kharip* season. Any impact on these people and their assets/properties and crops will have to be identified and compensated in the case of negative impacts of the bridge construction. Therefore, a study of impact on charland needs to be carried out in coordination with the river engineers and modelers to assess to extent of flooding and erosion both up and down stream of the bridge location.

8.8.6 Training Needs for IGAs

From past experience in similar project implementation such as the Jamuna Bridge, nearly 50% of the APs did not buy land against lost lands; many decided to invest in business or changed profession. This means that APs may need assistance and guidance for investment choices. Some businesses and professions may be lost altogether and the people affected may need to change professions. These will involve identification of alternative jobs/skills, skills training needs assessment and training programs. The trained APs in new trades and professions may be in need of capital and equipment to start new businesses/trades. Additional assistance such as supervised grants may have to be extended and some vulnerable groups. This was very effectively done in the Bhairab Bridge Project under the Social Development Plan (SDP) in post-resettlement period.

[19] *The East Bengal State Acquisition and Tenancy Act* (1951, revised 1994). See A. K. M. Siddique, *Common Land Laws and Rules*, Dhaka, August 2001.

8.8.7 Development of Resettlement Site(s)

The landless, marginal landholders, vulnerable groups and squatters etc will have to be resettled in project sponsored resettlement sites with provision for employment/access to IGAs. The resettlement sites must be identified and cost estimates for RS sites must be included in the Draft RAP. Given the locations and distance covered by the approach road on the right bank, four resettlement sites (RS Site) would be required (1 in Mawa and 3 in Janjira). In Mawa, the northern-end of the market past the ferry ghat may be considered a potential site. In Janjira, three sites – one each at the bridge landing area in Naodoba, Kutubpur, and Mataborerchar – may be considered. For all RS sites, lands have to be acquired, developed, utilities and services developed and O&M issues addressed. These aspects will have to be planned and implemented.

8.8.8 Implementation of Key Outstanding Tasks

The feasibility study has recommended an implementation plan for further processing of the project, starting with some outstanding tasks (for example, draft LAP and RAP) to be completed by JMBA with its own resources. The detailed design work is likely to commence in the 4th quarter of 2005. The LAP and RAP will be updated during the detailed design period. Table 8.8.1 provides a schedule for completing the outstanding tasks, including those to be conducted by detailed design consultants as part of pre-construction work. Some of the activities can be conducted simultaneously to save time and to complete the project preparation work. Many resettlement-related works will continue through the construction and post construction period. The RAP to be prepared must contain a time-bound plan for resettlement/income restoration activities and monitoring work to be carried out during construction and post-construction period. Presently, the project construction work is targeted for 4th quarter of 2008 to be completed in March 2013.

Table 8.8.1 Bar Chart of Key Activities for Project Preparation

Tasks to be carried out by JMBA and Detailed Design Consultants (Pre-construction period) for project construction			2005			2006				2007				2008				2009	
			2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Main Task	Activity	Time Required																	
Preparation of LAP and RAP	・ Land Survey/ LA Plan and RAP	6 months																	
	・ Review and approval of LA P/RAP by MOC																		
	・ Updating and Finalization of LAP/RAP by DD Consultants	6 months																	
	・ Submission of revised LAP and RAP for approval by MOC/MOL and DCs for LA processing	3 months																	
	・ Establishment of RU in JMBA	3 months																	
	・ Notification u/s3 to land owners for acquisition	3 months																	
	・ Joint Verification of Acquired Assets	3 months																	
	・ Submission of LA costs estimates to JMBA/MOC by DCs	3 months																	
	・ Payments of compensation for acquisition	12 months																	
	・ Bid for construction of Resettlement sites – Public Notice to bid and other preparations – July 2006																		
	・ Bid open and evaluation – Sept 2006																		
	・ Negotiation and contracting – Dec 2006																		
	・ Construction work – Jan-December/07	12 months																	
	・ Relocation of Affected persons	6 months																	
	・ Supervision and monitoring by CS consultancy – Oct08-March 2013																		
	・ Construction of the bridge facilities – Oct/2008																		

Annex I Compensation Policy for Resettlement and Rehabilitation of Project Affected Person/Entitlement Matrix Padma Bridge Construction Project

CATEGORY 1: LOSS OF AGRICULTURAL AND COMMERCIAL LANDS

Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Replacement land or CCL which includes 50% premium plus the differential cost between MARV as determined by JVT and PVAT 2. Stamp duties and registration fees on purchase of replacement land by the APs, if purchase is made within 12 months of receiving CCL or during implementation period (whichever is longer) and will be upto the amount of land one can buy using the compensation money. 3. Transition allowance for loss of income from cultivated land. 4. For Homestead and Commercial Lands, Land Development Costs @ 30% of MARV	1. Legal owner(s) as determined by the DC during the process of CCL payment and / or determined by court in cases of legal disputes. 2. Transition allowance will be valid only for owner-cultivators as per project-specific policy (col 5).	1. Legal owners will be assisted by NGO/JMBA to establish appropriate legal evidence after notice under section 3 is served. 2. If acquisition begins more than 12 months after JVS, the replacement value will be updated @ 10% per annum. 3. If replacement value is greater than CCL, the difference will be paid by JMBA through NGO.	1. NGO will examine whether they have the required legal documents, and advise and assist with any issues that might delay receipt of CCL	1. Landowners (and others) will be informed of the details of the compensation policies payment procedures, stamp duty refund etc. 2. PVAT will determine the mouza-wise current market prices of the lands, considering land type in terms of number and types of crops produced a year, flooding, irrigation facilities, accessibility and other factors that might influence the market prices. 3. Current market prices of land determined by PVAT will be the basis for determining the replacement value 4. Title updating and determination of the usufractuary and other rights will be made before issuance of notice under section 6 (assisted by NGO). 5. For losses of upto 1 (one) acre of land entitlement as transition allowance will be Tk. 3,000/- and for loss of land above 1 (one) acre, it will be Tk. 6,000/=. 6. The implementing NGO shall strongly encourage and motivate the EPs to purchase land or invest the money in productive/income generating activities.	1. JMBA, through NGO, will carry out information dissemination on RAP policies, and assist the APs in updating their ownership & other records. 2. Difference between CCL and Replacement Value, if any, and the Transfer Allowance will be paid directly to the APs by JMBA through NGO. 3. Stamp duties will be paid directly to the APs (on production of receipt of buying stamps) by JMBA through NGO.

CATEGORY 2: LOSS OF HOMESTEAD LAND

Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Replacement land or CCL and the differential cost between MARV (as determined by JVT and PVAT) and CCL. 2. Stamp duties and Registration fees on purchase of replacement land by the APs, if purchase is made within 12 months of receiving CCL or during implementation period (whichever is longer) and will be upto the amount of land one can buy using the compensation money. 3. Land Development @ 30% of MARV at new locations	1. Legal owner(s) as determined during the process of making CCL payment by DC and/or determined by court in cases of legal disputes.	1. Legal owners will be assisted by NGO/ JMBA to establish appropriate legal evidence after notice under section 3 is served. 2. If replacement value is greater than CCL, the difference will be paid by JMBA through NGO subject to purchase/ arrangement of land for homestead. 3. If acquisition begins more than 12 months after JVS, the replacement value will be updated @ 10% per annum.	1. NGO will examine whether they have the required legal documents, and advise and assist with any issues that might delay receipt of CCL. 2. NGO will organize the APs into Land Purchase Groups (LPGs) and advise and assist them finding, negotiating and purchasing private lands for relocation.	1. Landowners (and others) will be informed of the details of the compensation policies, payment procedures, stamp duty refund 2. Current market prices of land determined by PVAT will be the basis for determining the replacement values. 3. Title updating and determination of the usufractuary and other rights will be made before issuance of notice under section 6 (assisted by NGO).	1. JMBA, through NGO, will carry out information dissemination on RAP policies, and assist the APs in updating their ownership & other records. 2. Difference between CCL and MARV will be paid directly to the APs by JMBA through NGO. 3. Stamp duties will be paid directly to the APs (on production of receipt of buying stamps) by JMBA through NGO.

CATEGORY 3: LOSS OF HOUSEHOLDS/HOMESTEAD AND OTHER PHYSICAL STRUCTURES
(Except Commercial or Industrial)

Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Replacement Value of Structures CCL and the MARV for legal owner 2. Transfer Grants (TG) @ Tk.2000/-, Tk. 5000/- and Tk. 10000/- over CCL for kutcha, semi pucca & pucca structures. 3. Owner will be allowed to take all salvageable materials (free of cost) without delaying the project works. 4. Construction Grant (CG) @ 15%, 20% and 30% over Replacement Value for kutcha, semi pucca & pucca structures. 5. Special assistance for female-headed households @ Tk. 2000, Tk. 3000 and Tk. 5000 for katcha, semi-pucca and pucca structures 6. Serial Nos 2 3 ,4 &5 will be applicable to squatter households (based on above parameters, rate to be calculated on Market Value of structures by JVT/PVAT). 7.Special Assistance of Tk. 5000/- for each disabled AP.	1. Legal owner as determined by the DC during the CCL payment process and/or determined by court in cases of legal disputes. 2. Socially recognized owners for structures built on public lands, as recognized by BSES and verified by JVT.	1. Applicable to all structures standing on the acquired lands at the time of issuance of notice under section 3, or on public lands to be vacated for the project. 2. Additional assistance of Tk 5,000/- for each of female headed HH and disabled to be paid at the time of moving. 3. JVT will distinguish between genuine and fraudulent structures and record the losses accordingly.	1. NGO will check whether or not the APs have the required legal documents, advise and assist APs with any issues that might delay receipt of CCL *2.* A plot at normal resettlement site for the most vulnerable EPs destitutes and squatters HH to be arranged by the project.	1. JVT will verify floor areas and materials based on BSES data and JVT & PAVT will assess the replacement value. 2. Compensation must be paid before EP dismantles and removes the structures. 3. HCG will be paid when EP has purchased/ arranged replacement homelot or structure within 12 months of receipt of CCL and is ready to start construction of new house. 4. If the entitlement is greater than the amount assessed by the DC, the additional amount will be paid by JMBA through NGO. 5. Notice under section 3 will establish the cut-off date for all structures not covered under CCL.	1. DC pays the CCL to all legal owners. 2. JMBA, through NGO, pay all owners recognized by BSES and verified by JVS.

CATEGORY 4: LOSS OF STRUCTURES USED FOR COMMERCIAL & INDUSTRIAL ACTIVITY

Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Replacement Value for legal owner. 2. Transfer Grants (TG) @ Tk.2000/- Tk.5000/- and Tk.10,000/- for katcha, semi pucca and pucca structures. 3. Owner will be allowed to take all salvageable materials (free of cost) without delaying project works. 4. Construction Grant (CG) @ 15%, 20% and 30% over Replacement Value for kutca, semi pucca and pucca structure. 5. Serial Nos 2, 3 & 4 will be applicable for squatter unit (Based on above parameter, rate to be calculated on Market Value of structures by JVT/PVAT).	1. Legal owner as determined by the DC during the CCL payment process. 2. Socially recognized owners for structures built on public lands, as recognized by BSES and visited by JVT.	1. Applicable to all structures standing on the acquired lands at the time of issuance of Notice 3, or on public lands to be vacated for the project. 2. JVT will distinguish between genuine and fraudulent structures and record losses accordingly.	1. CG will be paid when EPs have purchased/ arranged replacement land or structure within 12 months of receipt of CCL and is ready to start construction of new house. 2. NGO will examine whether they have the required legal documents, and advise and assist resolution of any issues that might delay receipt of CCL. 3. A business premise for each loser at a place near service area arranged by the project.	1. JVT will verify floor areas and materials based on BSES data and JVT & PAVT will assess the replacement value. 2. Compensation must be paid before EP dismantles and removes the materials. 3. If the entitlement is greater than the amount assessed by the DC, the additional amount will be paid by JMBA through NGO. 4. Notice under section 3 will establish the cut-off date for all structures not covered under CCL	1. DC pays the CCL to all legal owners. 2. JMBA, through NGO, pay all owners recognized by BSES and verified by JVT.

CATEGORY 5: LOSS OF TIMBER AND FRUIT BEARING TREES, AND BAMBOO AND BANANA GROVES

Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. *Timber trees and bamboo's:* Estimated current value of individual trees and bamboo's determined by PVAT and JVT. 2. *Fruit-bearing trees (without timber):* If the tree is at or near fruit-bearing stage estimated current value of the tree determined by PVAT and JVT. 3. *Fruit-bearing trees with timber:* If the tree is at or near fruit-bearing stage, value of timber + 30% of the timber value as compensation for fruits to be determined by PVAT and JVT. 4. *Banana groves:* Estimated current value of one-time crop of each grown-up tree determined by PVAT and JVT. 5. Owners will be allowed to fell and take the trees and fruits, after payment of compensation without delaying the project works.	1. Legal owner as determined by the DC during CCL payment process. 2. Socially recognized owners of trees grown on public lands, as recognized by BSES and verified by JVS.	1. Estimated market value of different species of trees as determined by PVAT and JVT based on categories: big, medium, small and plant (Saplings recently planted). 2. Value of perennial fruits to be determined as three years value of crop at harvest price.	1. NGO to explain the RAP policies regarding compensation for the trees of different species and size and make the EPs aware that they could take the trees and fruits. 2. JMBA will distribute sapling (fruit/ timber) through the implementing NGO @ 5 numbers per household.	1. Standard rates for trees of different species are available with the Department of Forestry. Valuation by BSES will also be available. 2. The implementing NGO will ensure plantation and post replantation care.	1. DC will pay the CCL to the legal owners. 2. JMBA, through NGO, will pay the difference if any, to the owners not covered CCL.

CATEGORY 6: LOSS OF STANDING CROPS

Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Compensation for standing crops, if any, affected at the time of property handover. 2. Owner will be allowed to take plants and crops, if any.	1. Cultivator (person who planted the crop) whether owner, leaseholder, tenant, sharecropper, etc. (on formal or informal arrangements) as determined by JVT.	1. Estimated market value at harvest, to be determined by PVAT and JVT.	None	1. Market value at harvest will be established by JVT and PVAT or on-site verification before handover, if the BSES is conducted during the non-agricultural season. 2. Verify whether or not crop is there in the field on the acquired properties at the time of handover.	1. The DC will pay the compensation to the legal owners. 2. JMBA, through NGO, will pay the difference to the owners if CCL and market value are different.

CATEGORY 7: LOSS OF PONDS AND FISH STOCK

Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Replacement Value of pond, including cost of land and digging, whichever is greater. 2. 25% of average value of fish stock per decimal of pond area, as compensation for loss of income. 3. The EP will be allowed to harvest and take away the fish.	Legal owner of the pond and fish as determined by the DC during CCL payment. or, Socially recognized owner of the fish, as determined by BSES and verified by JVS.	1. Legal owner will get the compensation if both pond and fish stock are owned by him/her. 2. If the fishpond is on public land and not under lease from GoB, the EP is entitled to compensation for 25% of the existing fish stock and is allowed to take the fish.	None	1. Magnitude of fish stock and value to be determined by PVAT and JVT. 2. Verify if the legal owner is also the owner of the fish-stock.	1. The DC will pay the CCL to the legal owners. 2. JMBA, through NGO, will pay the difference if any, not covered under CCL to the owners.

CATEGORY 8: LOSS OF USUFRUCT RIGHTS IN MORTGAGED-IN, LEASED-IN AND KHAI-KHALASHI LAND

Definition of Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. If Legal Agreement exists: CCL, plus difference between CCL and MARV determined by PVAT and JVT whichever is greater. 2. If no Legal Agreement exists: The legal owner collects compensation from DC and pays the mortgagee any amount outstanding on the acquired property. The implementing NGO will ensure that. 3. Transition Allowance for actual cultivator to cover the loss of income from the land.	1. Mortgagee/ lease holder holding the legal papers, 2. Socially recognized mortgagee or person holding lease or khai-khalashi rights, in cases of oral agreement.	1. With Legal Agreement: Legal owner and mortgagee / leaseholder will be paid CCL by DC as per the law. 2. With Verbal Agreement: Legal owner will be paid CCL by DC. The legal owner will pay the outstanding liabilities to the mortgagee/ leaseholder/holder of khai-khalashi right. 3. In cases, where CCL is smaller than the replacement value, legal owner will get the additional payment from JMBA if (i) all liabilities are already paid up; (ii) if not, the legal owner will get the residual payment after all liabilities are paid up. 4. Transition allowance will be paid to to the actual cultivator of the acquired land.	None	1. JVT will identify, by checking with each landowners and others, any persons who presently have interest in the acquired land due to mortgage, lease or khai-khalashi right. 2. Any disputes over status of present interest in the land will be resolved through grievance redress procedure. Once resolved, NGO will ensure payment of all outstanding liabilities on the land to the appropriate persons. 3. Transition allowance to cover loss of income will be paid to the present cultivator of the land (mortgagee or legal owner or leaseholder or the person with khai-khalashi right) as per project specific policy prescribed in Category: 1 col 5. sl. 5.	1. DC will pay the legal owner / mortgagee / leaseholder, if the contract is executed legally, OR to the legal owner if the agreement is verbal. 2. NGO will mediate payment of any outstanding liability to the mortgagee / leaseholder / person with khai-khalashi right. 3. JMBA, through NGO, will make the payment of Transition Allowance.

CATEGORY 9: LOSS OF INCOME FROM DISPLACED COMMERCIAL/INDUSTRIAL PREMISES

Definition of Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Compensation for loss of business for restoring income. 2. One-time moving assistance only for the tenants.	1. Any businessman or artisan operating in premises, at the time of issuance of Notice under Section 3. 2. One-time moving assistance only for tenants (business operators not receiving reconstruction grant)	1. Compensation is based on average annual turnover for three weeks (average value as determined by JVT and PVAT) 2. Moving assistance is equivalent to compensation for regular wage rate x 90 days, to be determined PVAT.	1. EPs will be brought under income generating program through the implementing NGO.	1. Primary eligibility to be based on shopkeepers and businessmen identified in the BSES and verified by JVT. Further claims and grievances, if any, will be settled by the grievance redress committee.	1. Cash grant will be paid by JMBA through NGO.

CATEGORY 10: TEMPORARY LOSS OF INCOME (WAGE EARNERS IN AGRICULTURE, COMMERCE & INDUSTRY)

Definition of Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Grant to cover temporary loss of regular wage income. 2. Income Restoration Assistance to vulnerable groups from Social Development Fund to be created by the Project.	1. Regular wage earners affected by the acquisition.	1. Grant for wage loss for farm labour @ of Tk.100/- for 90 days and that for non-farm labour @ Tk.120 for 60 days.	1. EPs will be brought under income generating program through the implementing NGO. 2. Involvement of APs in Construction Work. 3. Involvement of APs in tree plantation and social afforestation. 4. A plot at resettlement site for most vulnerable EPs distitutes and squatters to be arranged by the project.	1. EP must be employee of landowner or business located in the acquired lands for at least six months in the last twelve months, as determined by JVT. 2. Assessment of need of vulnerable group to be made before operation.	1. Grant to be paid by JMBA through NGO.

CATEGORY 11: LOSS OF INCOME FROM RENTED RESIDENTIAL / COMMERCIAL PREMISES

Definition of Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Rental Assistance of Tk.2500 for loss of income from leased/rented structures.	1. Owner of the rented premises.	1. Shifting allowance / moving assistance is meant for alternative housing.	EPs will be brought under income generating program through the implementing NGO.	1. Socio-economic survey to identify the owner of the business premises duly verified by JVT.	1. Grant to be paid by JMBA through NGO.

CATEGORY 12: ADVERSE IMPACT ON HOST POPULATION DUE TO DISLOCATION OF APs DURING AND AFTER IMPLEMENTATION OF PROJECT

Definition of Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Provision for Tubewell for pure drinking water and slab latrine for Sanitation. 2. Improvement of education and other public services.	1. Displaced relocated household /affected or host area/villages where displacees have resettled..	1. Investment in the host area to improve health, education, and other public services.	Afforstation programme in host area.	1. Assessment of community needs 2. Implementation of mitigation measures.	1. JMBA-Resettlement Unit (RU), NGO 2. Trust fund of GoB

Category 13: PEOPLE ADVERSELY AFFECTED BY BRIDGE e.g. CHANGE IN WATER LEVELS UPSTREAM, OR DOWNSTREAM, OR IN UNFORESEEABLE WAYS

Definition of Entitlement	*Definition of Entitled Person (EP)*	*Application Guidelines*	*Additional Services*	*Implementation Issues*	*Responsible Organization*
1	2	3	4	5	6
1. Assistance to mitigate impacts.	1. Person affected adversely by the bridge, other than the above categories.	1. Assistance will be made available to EPs as soon as they might be affected.	1. Additional assistance will be identified as per the nature of the impact (s).	1. The mitigation measure are proposed under the EAP, RU and Environmental unit will closely coordinate its activities and monitor and mitigate adverse impacts. 2. Plan for mitigation will be developed by the JMBA.	1. JMBA-RU, NGO and other relevant agencies. 2. JMBA-Environmental Unit (EU).

Annex II Cost Estimates

Area : ALL (East End & West End)

Sl. No.	Category of loss		Quantity in ha/sft/No.	Rate in Tk.	Amount in Million Tk.
A	***Land with Types (Land to be Acquired)***				
1	(a) Settlements (Homestead), East (ha)	(ha)	40.88	11,115,000	454.40
	(b) Settlements (Homestead), West (ha)	(ha)	91.24	7,410,000	676.12
2	(a) Agriculture, East	(ha)	8.91	5,804,500	51.70
	(b) Agriculture, West	(ha)	418.33	1,482,000	619.96
3	(a) Commercial, East	(ha)	5.12	11,115,000	56.89
	(b) Commercial, West	(ha)	0.83	7,410,000	6.16
4	(a) Waterbodies, East	(ha)	7.59	5,804,500	44.08
	(b) Waterbodies, West	(ha)	43.60	2,593,500	113.08
	Sub Total Land Acquisition, East		***62.50***		***607.06***
	Sub Total Land Acquisition, West		***554.00***		***1415.31***
B	Stamp duty and Registration fees (@ 15% for 50% of land acquired), East				45.53
	Stamp duty and Registration fees (@ 15% for 50% of land acquired), West				106.15
C	Crop, East @ of Tk. 61,750/ha		8.91	61,750	0.55
	Crop, West @ of Tk. 61,750/ha		418.33	61,750	25.83
D	Fishstock, East @ of Tk. 74,100/ha Water area		7.59	74,100	0.56
	Fishstock, West @ of Tk. 74,100/ha Water area		43.60	74,100	3.23
E	***Structures***				
1	(a) Katcha, East	(Sft)	105,809	200	21.16
	(b) Katcha, West	(Sft)	110,688	200	22.14
2	(a) Semi Pucca , East	(Sft)	31,629	300	9.49
	(b) Semi Pucca, West	(Sft)	8,927	300	2.68
3	(a) Pucca, East	(Sft)	179,741	600	107.84
	(b) Pucca, West	(Sft)	5,569	600	3.34
4	(a) Thatched, East	(Sft)	50,702	90	4.56
	(b) Thatched, West	(Sft)	229,951	90	20.70
5	(a) Tin, East	(Sft)	777,520	240	186.60
	(b) Tin, West	(Sft)	643,150	240	154.36
	Other Stuctures :				
6	Latrin (Katcha), East	(Sft)	165	1,200	0.20
	Latrin (Katcha), West	(Sft)	1,147	1,200	1.38
7	Latrin (Slab), East	(Sft)	3,934	2,000	7.87
	Latrin (Slab), West	(Sft)	1,637	2,000	3.27
8	Latrin (Pucca), East	(Sft)	871	24,000	20.90
	Latrin (Pucca), West	(Sft)	191	24,000	4.58
9	Tubewell, East	(No)	661	10,500	6.94
	Tubewell, West	(No)	1,599	10,500	16.79
10	Chatal, East	(No)	4,800	26	0.12
	Chatal, West	(No)		26	
11	Boundary Wall (Tin), East	(Sft)	1,590	50	0.08
	Boundary Wall (Tin), West	(Sft)	853	50	0.04
12	Boundary Wall (Pucca), East	(Sft)	1,332	350	0.47
	Boundary Wall (Pucca), West	(Sft)	5,518	350	0.19
13	RCC Pillar, East	(No)	74	350	0.03
	RCC Pillar, West	(No)	-	350	-
	Sub Total of Structue, East				***366.27***

Sl. No.	Category of loss		Quantity in ha/sft/No.	Rate in Tk.	Amount in Million Tk.
	Sub Total of Structue, West				***229.47***
F	***Trees (Calculation made on average rate)***				
1	Large, East	(No)	18,992	250	4.75
	Large, West	(No)	155,644	230	35.80
2	Medium, East	(No)	12,563	240	3.02
	Medium, West	(No)	111,436	225	25.07
3	Small, East	(No)	27,312	180	4.92
	Small, West	(No)	93,453	170	15.89
4	Sapling, East	(No)	25,062	10	0.25
	Sapling, West	(No)	89,084	10	0.89
	Sub Total of Trees, East		***83,929***		***12.93***
	Sub Total of Trees, West		***449,617***		***77.65***
G	(a) Fruits (@ of 30% Big & Medium Fruits Tree Values: Tk. 6,568,500/- for 1 Years), East				1.97
	(b) Fruits (@ of 30% Big & Medium Fruits Tree Values: Tk. 16,507,010/- for 1 Years), West				4.95
	Sub Total (A-G), East				***1034.88***
	Sub Total (A-G), West				***1862.59***
H	Transition Allowances loss of income from cultivated land, East	(No)	220	3,000	0.66
	Transition Allowances loss of income from cultivated land, West	(No)	10,332	3,000	31.00
I	***House Construction Grant (HCG)***				
1	(a) Katcha (15% of Structure Value: Tk. 21,161,930/-), East				3.17
	(b) Katcha(15% of Structure Value: Tk. 22,137,600/-), West				3.32
2	(a) Semi Pucca (20% of Structure Value: Tk. 9,488,850/-), East				1.90
	(b) Semi Pucca (20% of Structure Value: Tk. 2,678,100/-), West				0.54
3	(a) Pucca (30% of Structure Value: Tk. 107,844,750/-), East				32.35
	(b) Pucca (30% of Structure Value: Tk. 3,341,400/-), West				1.00
	Sub Total of HCG, East				***37.43***
	Sub Total of HCG, West				***4.86***
J	***House Transfer Grant (HTG) for structure***				
1	(a) Katcha, East	(No)	960	2,000	1.92
	(b) Katcha, West	(No)	815	2,000	1.63
2	(a) Semi Pucca , East	(No)	135	5,000	0.68
	(b) Semi Pucca, West	(No)	44	5,000	0.22
3	(a) Pucca, East	(No)	113	10,000	1.13
	(b) Pucca, West	(No)	28	10,000	0.28
	Sub Total of HTG, East				***3.73***
	Sub Total of HTG, West				***2.13***
K	Land Development Grant (30% of Settlement & Commercial Land Value of Tk. 511,290,000/-), East				153.39
	Land Development Grant (30% of Settlement & Commercial Land Value of Tk. 682,274,268/-), West				204.68
L	Special Assistance for Female Headed Household, East	(No)	123	5,000	0.62
	Special Assistance for Female Headed Household, West	(No)	122	5,000	0.61
M	Special Assistance for Disabled, East	(No)	128	5,000	0.64

Sl. No.	Category of loss		Quantity in ha/sft/No.	Rate in Tk.	Amount in Million Tk.
	Special Assistance for Disabled, West	(No)	76	5,000	0.38
N	Rental Assistance for rented/leased Commercial & Residential Premises, East	(No)	246	2,500	0.62
	Rental Assistance for rented/leased Commercial & Residential Premises, West	(No)	25	2,500	0.06
O	Moving Assistance for tenant (Business Operator) [wage for 90 days], East	(No)	381	120	4.11
	Moving Assistance for tenant (Business Operator) [wage for 90 days], West	(No)	212	120	2.29
P	Income Restoration Grant for businessman or Artisan (3 weeks value of average annual turnover), East	(No)	381	L.S	4.97
	Income Restoration Grant for businessman or Artisan (3 weeks value of average annual turnover), West	(No)	212	L.S	1.59
Q	***Income Restoration Grant for wage loser***				
1	Non-farm Labour (for 60 days), East	(No)	487	120/per day	4.38
	Non-farm Labour (for 60 days), West	(No)	288	120/per day	2.59
2	Farm Labour (for 90 days), East	(No)	156	100/per day	1.40
	Farm Labour (for 90 days), West	(No)	367	100/per day	3.30
R	Cost of saplings (5 mango seedlings for each HH), East	(No)	1345	10	0.07
	Cost of saplings (5 mango seedlings for each HH), West	(No)	1805	10	0.09
S	Slab-Latrine for Relocated Household displaced by project, East	(No)	1352	2000	2.70
	Slab-Latrine for Relocated Household displaced by project, West	(No)	1789	2000	3.58
T	Hand Tube-well for host areas/villages where diplacees resettled, East	(No)	136	10500	1.43
	Hand Tube-well for host areas/villages where diplacees resettled, West	(No)	179	10500	1.88
U	Social Development Fund (skill training, credit operation, etc.), East			LS	50.00
	Social Development Fund (skill training, credit operation, etc.), West			LS	50.00
V	Cost for Resettlement sites and their development (2 sites), East			LS	134.00
	Cost for Resettlement sites and their development (2 sites), West			LS	180.00
	Sub Total (I-W), East				***400.14***
	Sub Total (I-W), West				***489.04***
W	***Others***				
1	External Monitoring, East			LS	10.00
	External Monitoring, West			LS	10.00
2	NGO operation for 10 years, East			LS	40.00
	NGO operation for 10 years, West			LS	50.00
3	Updating replacement value of land if acquisition begins 12 months after JVS, East			LS	85.22
	Updating replacement value of land if acquisition begins 12 months after JVS, West			LS	198.67
	Sub Total of Others (W.1-W.3), East				***135.22***
	Sub Total of Others (W.1-W.3), West				***258.67***
X	Block Allocation for Indirectly Affected Persons, interests and structures, East			LS	65.00
	Block Allocation for Indirectly Affected Persons, interests and structures, West			LS	74.47

Sl. No.	Category of loss	Quantity in ha/sft/No.	Rate in Tk.	Amount in Million Tk.
	Total, East =			***1635.23***
	Total, West =			***2684.77***
	Grand Total Tk. =			**4320.01**
	Grand Total US$ = (1US$ = Tk. 60.00)			**$72.00**

Y *	**Land to be requisitioned, East**	**30**	**370,500**	**11.12**
	Land to be requisitioned, West	**144**	**370,500**	**53.35**

* The lands requisitioned will be handed over to the contractor and the contractor will pay the amounts to the Executing Agency. Hence, this cost is kept out of Resettlement Budget.

Chapter 9 Economic and Financial Evaluation

9.1 ECONOMIC EVALUATION

9.1.1 General

In general, economic evaluation aims at confirming economic viability of proposed infrastructure development projects in the national economy in which they will be carried out. The magnitude of the benefits from the project is estimated and compared based on project cost required for their realization. The viability of certain projects is usually measured using evaluation tools such as Economic Internal Rate of Return (EIRR), Benefit Cost Ratio (B/C), and Net Present Value (NPV). The degree of project viability is evaluated and interpreted in relation to such economic terms as official discount rate or opportunity cost of the national economy.

The aim of the study presented in this Chapter is to evaluate the economic viability of the captioned project and to obtain basic information for the selection of the optimal bridge development scheme. The evaluation was carried out mainly in relation to estimated benefits and/or revenue from the Project and estimated costs for its implementation based on alternative development scenarios proposed in Chapter 6.

9.1.2 Methodology of Economic Evaluation

An indicative economic evaluation was presented in Chapter 3 to provide information for the selection of the bridge location. The economic study in this Chapter is a detailed assessment of the Project in the context of the analyses in Chapter 3.

The economic evaluation was carried out based on conventional evaluation methods in which the project costs, expressed in terms of economic price and economic benefits from the Project, are two of the most important variables. Project cash flows, which consist of the flow of annual project costs to be disbursed and annual benefits after opening to the public, were prepared as the base tool for the evaluation.

The type and size of economic benefits accruing to the Project were defined and estimated in conjunction with the future traffic volume forecast in Chapter 3.

The evaluation period for the project was set as 30 years after opening to the public. The opportunity cost of capital or discount rate, which is a basic criteria for the calculation and evaluation of such indicators as B/C and NPV, was adopted as 12%. This took into account recent the macro-economy in Bangladesh and similar transport infrastructure development projects in the other parts of the world.

9.1.3 Economic Project Cost and Cost Disbursement Schedule

Project costs estimated in Chapter 6 were converted into economic prices by extracting transfer factors such as tax and customs, as shown in Table 9.1.1. The cost disbursement schedules in terms of economic price were prepared corresponding to the project implementation and construction schedules proposed in Chapter 9 and as shown in Table 9.1.2.

Table 9.1.1 Economic Project Cost for Alternative Development Schemes

Unit mil. TK

Work Item	Alt. H-1	Alt.H-2	Alt.H-3
Construction Cost	51170.4	52466.4	46197.7
Detailed Design Cost	855.3	1317.7	855.3
Construction Supervision Cost	1710.5	1756.9	1710.5
Administration Cost	256.6	307.5	229.9
Land Compensation Cost	3847.5	3847.5	3847.5
Total (Economic cost)	57840.3	59695.8	52840.9

Table 9.1.2 Economic Cost Disbursement Schedule

Unit: mil.TK

Year	Alt. H-1	Alt. H-2	Alt. H-3
2004	0.0	0.0	0.0
2005	0.0	0.0	0.0
2006	0.0	0.0	0.0
2007	1697.3	1928.5	1697.3
2008	1697.3	1928.5	1697.3
2009	1315.2	1315.2	1315.2
2010	7470.0	7679.0	6720.1
2011	20418.0	20989.2	18368.2
2012	11952.0	12286.3	10752.1
2013	7968.0	8190.9	7168.1
2014	5322.5	5378.2	5122.5
Total	57840.3	59695.8	52840.9

Economic Costs resulting from the Closing of Ferry Operations

The existing ferry operations at Mawa – Charjanajat site will be stopped after opening of Padma Bridge at Mawa. In that case, workers of the existing ferry operations are usually compensated for losing their jobs or transfer to other ferry sites and those costs are necessary to be included in the project costs. However, existing ferries at Padma River are operated by Bangladesh Inland Water Transport Corporation (BIWTC), a public sector responsible for ferry operation under the Ministry of Shipping.

According to BIWTC, there is no private company operating ferry services in the Mawa and Paturia ferry sectors. It is also told that there are many candidate ferry crossings in the country and they can continue their operations. Therefore, no compensations are necessary for BIWTC. In addition, launch boat operations and ferry terminals are managed by Bangladesh Inland Water Transport Authority (BIWTA).

Only exception to be compensated related to the stopping of the ferry operation is income loss of small shops along the approaches to the ferry ghats at Mawa – Charjanajat. Owners and workers of these shops have to close their shops or have to move to other sites under operations. Therefore, compensation costs for them were necessary and already included in the project costs as resettlement cost.

9.1.4 Definition of Benefits from the Project and Estimation

(1) Definition of Project Benefits

The benefits from the Project to be quantified are defined as below, taking into account the characteristics of the

Project and relevant study reports including the Jamuna Bridge F/S report and the Pre-F/S report for the current study. The benefits from the Project are defined and categorized below, where road user-related benefits are dominant elements.

(a) Road User Benefit

This category of benefits consists of those accruing to the innovated transport network of the Project. The following are included in this benefit category:

1) Vehicle Operation Cost (VOC) Saving Benefit
2) Travel Time Cost (TTC) Saving Benefit
3) Ferry Waiting Time (FWT) Saving Benefit
4) Freight Value Deterioration (FVD) Saving Benefit

(b) Non-Road User Benefit

The benefit in this category consists of the following:

1) Ferry Operation Cost (FOC) Saving Benefit
2) Benefit from Installation of Utility Facilities
3) Benefit by installation of Power Transmission (UPT)
4) Benefit by installation of telecommunication cables (UTC)
5) Benefit by installation of gas pipelines (UGP)
6) Land Enhancement (LE) Benefits

(2) Estimation of Benefits

In accordance with the above definition, the benefits from the Project were estimated through the standard procedure of benefit estimation in transport infrastructure projects. Most benefits were derived as the balance between the two costs, namely "without-project" and "with project" cases. Road use-related benefits were estimated in line with the results of traffic simulation. Such indicators as simulated vehicle-km, vehicle-hours and simulated waiting times at ferry terminals provide basic information for the estimation of benefits. The benefits from normal traffic and from induced traffic were estimated separately. The classification of traffic type is defined in Chapter 2. The benefits from induced traffic were halved according to the "Road users' Surplus Theory in transport economics". The target years of the estimation were set at 2015 and 2025. The flows of benefits throughout the 30 years of the evaluation horizon were estimated based on interpolation and extrapolation of the forecast values in 2015 and 2025. All estimated benefits were expressed in economic prices at 2004 price levels.

(a) Estimation of Road User Benefit

i) Vehicle Operation Cost (VOC) Saving Benefit

VOC saving benefit was estimated applying unit vehicle operation cost. It was defined by speed level and vehicle type with corresponding vehicle-km simulated in the traffic study in Chapter 2. VOC savings benefits were obtained on the basis of the balance of two of the total vehicle operation costs, namely Vehicle-Km in "without the project scenario", and "with the Project scenario". Input data for the calculation are shown in Tables 9.1.3 and 9.1.4, while the estimated results are shown in Table 9.1.5.

Table 9.1.3 Simulated Vehicle Km

2015 With Project

Speed	Normal Traffic			Induced Traffic		
Level	LV	Bus	Truck	LV	Bus	Truck
Over 60km	527578	2175202	2113931	176495	681871	254841
50-60km	56433	229765	199142	14729	57600	25935
40-50km	256	67	924	80	29	227
30-40km	31755	122488	68698	13091	72295	11630
25-30km	6248	34574	31215	237	291	282
20-25km	0	0	0	0	0	0
15-20km	3135	14260	10840	601	2223	470
Under 15km	480	2163	1909	80	419	306
Total	625885	2578519	2426659	205313	814728	293691

2015 Without Project

Speed	Normal Traffic		
Level	LV	Bus	Truck
Over 60km	419414	1944132	1938228
55-60km	102098	174119	130017
50-55km	50456	208184	198377
35-50km	12886	23097	16484
30-35km	19130	92114	62052
25-30km	66104	147409	108837
15-25km	7677	21186	13478
Under 15km	12416	45461	15250
Total	690181	2655702	2482723

2025 With Project

Speed	Normal Traffic			Induced Traffic		
Level	LV	Bus	Truck	LV	Bus	Truck
Over 60km	392363	2109369	2224178	128252	561853	241106
50-60km	659027	2727133	1921487	242289	981706	227755
40-50km	9693	58244	52086	2911	12842	3317
30-40km	12690	84985	62059	3006	49312	4402
25-30km	49753	169923	78726	20756	85423	14425
20-25km	6467	53246	44039	161	198	192
15-20km	5698	28635	18210	1568	6488	1057
Under 15km	1788	5442	3723	416	1404	590
Total	1137479	5236977	4404508	399359	1699226	492844

2025 Without Project

Speed	Normal Traffic		
Level	LV	Bus	Truck
Over 60km	564880	2785587	2361591
55-60km	162310	949602	928845
50-55km	319387	1002961	823468
35-50km	20956	72169	61851
30-35km	44938	206737	121479
25-30km	106740	260184	136686
20-25km	11641	56773	40576
15-20km	13405	50703	30892
Under 15km	24672	93664	27959
Total	1268929	5478380	4533347

Source: Traffic Study, Study Team

Table 9.1.4 Unit VOC by Speed Level

Unit: TK/km

Speed Level	LV	Bus	Truck
60km/h	8.16	10.79	13.44
55km/h	8.31	10.97	13.52
50km/h	8.50	11.23	13.78
45km/h	8.77	11.59	14.13
40km/h	9.08	12.00	14.79
35km/h	9.56	12.62	15.41
30km/h	10.16	13.42	16.60
25km/h	11.08	14.64	17.90
20km/h	12.38	16.35	20.01
15km/h	14.27	18.86	23.17
10km/h	17.48	23.09	28.56
5km/h	25.01	33.04	41.36

Source: RHD Road User Cost, Feb 2003、Study Team

Table 9.1.5 Estimated VOC Saving Benefits

Unit: mil. TK

Year	Benefit from Normal Traffic	Benefit from Induced Traffic		Total Daily Benefit	Total Yearly Benefit
	Daily Benefit	Induced/Normal Ratio	Daily Benefit		
2015	4.7	56.5(%)	1.3	6.1	2210.9
2025	9.3	58.1(%)	2.7	12.0	4381.5

ii) Travel Time Cost (TTC) Saving Benefit

In the same manner, TTC saving benefits were estimated by applying unit time costs as defined by the type of vehicle to vehicle-hours to be saved by the Project simulated in the traffic study. Unit time values were determined using a modification of the values made public in the RHD Road User Cost Annual Report for 2002-2003. The key input data applied for the estimation are shown in Table 9.1.6 and 7.The results are shown in Table 9.1.8.

Table 9.1.6 Simulated Vehicle-hours

Unit: Hours/day

Traffic Type	Vehicle Type	2015		2025	
		With	Without	With	Without
Normal Traffic	LV	11,481	16,148	21,577	31,304
	Bus	47,902	60,483	99,749	130,032
	Truck	43,682	48,903	81,123	92,250
	Total	103,065	125,534	202,449	253,586
Induced Traffic	LV	3,735		7,493	
	Bus	15,246		32,615	
	Truck	5,254		9,014	
	Total	24,235		49,122	

Source: Study team

Table 9.1.7 Unit Time Values

Vehicle Type	Gross Time Value Unit: Tk/hour	Opportunity for Productive Activity	Net Time Value Unit: TK/hour
LV	124.1	0.3	37.2
Bus	423.8	0.3	127.1
Truck	186.2	0.3	55.9

Source: RHD Road User Cost, Feb.2003, Study Team

Table 9.1.8 Estimated TTC Saving Benefit

2015

Vehicle Type	For Normal Traffic			Induced Traffic		Total	
	Vehicle x hour to be Saved	Unit Time Value (04 Price)	TTC Saved by Normal Traffic (mil.TK/ day)	Induced/ Normal Traffic Ratio	TTC Saved by Induced Traffic (mil.TK/ day)	TTC Saved by Total Traffic (mil.TK/ day)	TTC Saved by Total Traffic (mil.TK/ year)
LV	4667	37.2	0.2	0.565	0.6	2.6	966.4
Bus	12581	127.1	1.6				
Truck	5221	55.9	0.3				
Total			2.1				

2025

Vehicle Type	For Normal Traffic			Induced Traffic		Total	
	Vehicle x hour to be Saved	Unit Time Value (04 Price)	TTC Saved by Normal Traffic (mil.TK/ day)	Induce/ Normal Traffic Ratio	TTC Saved by Induced Traffic (mil.TK/ day)	TTC Saved by Total Traffic (mil.TK/ day)	TTC Saved by Total Traffic (mil.TK/ year)
LV	9727	37.2	0.4	0.581	1.4	6.2	2276.4
Bus	30283	127.1	3.8				
Truck	11127	55.9	0.6				
Total			4.8				

iii) Ferry Waiting Time (FWT) Savings Benefit

FWT savings benefits were estimated on the basis of simulated future ferry waiting time of normal traffic

under "without project scenario" and unit time values of vehicles.

Estimation of Ferry Waiting Time (FWT)

The daily FWT was simulated based on the following processes:

Step 1: Simulation of hourly vehicle arrivals at ferry terminals at Janjira and Mawa.
Numbers of vehicles arriving at two of the ferry terminals were estimated in terms of passenger car unit (PCU) by time band, based on forecast daily traffic volume and information of hourly traffic variation obtained in the traffic survey in 2003.

Step 2: Simulation of hourly vehicle departures on ferries at terminals.
Numbers of vehicles departing from each terminal carried by the ferry boats were estimated based on capacities of available ferry boats expressed in PCU and maximum frequency of ferry services to be provided within an hour.

Step 3: Estimation of hourly ferry waiting time at terminals
Hourly ferry waiting time was estimated on the basis of arrival and departure of traffic at each ferry terminal simulated in the above steps, on the assumption that vehicles which cannot be processed by the ferry service within an hour have to wait for the next hour's services in order of arrival. However, it is assumed that traffic not processed within a day are likely to detour to other routes such as the Jamuna Bridge-Paksey Bridge route and/or Paturia-Goalundo ferry.

Step 4: Estimation of daily ferry waiting time at terminals by type of vehicles
Daily waiting time in terms of PCU was obtained by summing the hourly waiting times at both terminals of Janjira and Mawa, and converting to those of actual vehicle numbers applying the information about the composition of vehicle type.

Details of the above are shown in Table 9.1.9.

Estimation of Ferry Waiting Time Benefit

Ferry waiting time savings, that is the time cost to be nullified with the opening of the bridge and termination of ferry service, were estimated applying unit time values of vehicles, as shown in Table 9.1.7 to the above estimated ferry waiting time. The results are also presented in Table 9.1.10.

Table 9.1.9 (a) Ferry Waiting Time Estimation (2015) (1/2)

.Janjira→Mawa

Time	Projected Traffic Volume in 2015 (Vehicle/h, One way)				Average Service Ratio by Ferry Operation (PCU/hr)	Waiting Time (hr)
	LV	Bus	Truck	PCU converted		
07.00-08.00	15	68	18	272	160	247.73
08.00-09.00	18	85	11	306	160	508.26
09.00-10.00	23	83	8	298	160	756.82
10.00-11.00	25	125	6	420	160	1,573.33
11.00-12.00	29	166	11	559	160	3,278.67
12.00-13.00	22	172	11	572	160	4,782.15
13.00-14.00	19	160	2	505	160	5,427.28
14.00-15.00	15	169	6	540	160	7,027.30
15.00-16.00	15	131	5	423	160	6,358.71
16.00-17.00	18	109	5	363	160	5,974.99
17.00-18.00	15	77	3	258	160	4,478.94
18.00-19.00	16	82	28	344	160	6,290.69
19.00-20.00	12	77	10	275	160	5,276.94
20.00-21.00	9	42	15	180	160	3,547.07
21.00-22.00	7	25	17	133	160	2,599.36
22.00-23.00	4	38	24	190	160	3,747.92
23.00-24.00	6	56	27	256	160	5,119.89
00.00-01.00	2	41	17	177	160	3,591.01
01.00-02.00	4	50	16	199	160	4,099.00
02.00-03.00	2	30	20	153	160	3,159.75
03.00-04.00	3	60	32	279	160	5,865.41
04.00-.05.00	3	40	16	173	160	3,689.64
05.00-06.00	8	35	19	171	160	3,673.66
06.00-07.00	11	39	28	210	160	4,406.37
Total	302	1963	355	7254	3840	95,480.91

Table 9.1.9 (b) Ferry Waiting Time Estimation (2015) (2/2)

Mawa→Janjira

Time	Projected Traffic Volume in 2015 (Vehicle/h, One way)				Average Service Ratio by Ferry Operation (PCU/hr)	Waiting Time (hr)
	LV	Bus	Truck	PCU converted		
07.00-08.00	10	54	17	223	160	174.26
08.00-09.00	15	86	19	331	160	473.97
09.00-10.00	21	106	4	349	160	891.07
10.00-11.00	23	124	5	410	160	1,603.00
11.00-12.00	31	132	8	451	160	2,518.43
12.00-13.00	24	151	4	489	160	3,699.24
13.00-14.00	20	106	6	355	160	3,271.56
14.00-15.00	15	129	2	408	160	4,305.20
15.00-16.00	17	130	11	442	160	5,410.85
16.00-17.00	13	122	7	399	160	5,516.84
17.00-18.00	16	118	9	399	160	6,131.05
18.00-19.00	21	99	2	326	160	5,407.15
19.00-20.00	14	62	19	254	160	4,426.67
20.00-21.00	11	59	13	227	160	4,072.99
21.00-22.00	8	34	22	176	160	3,206.29
22.00-23.00	6	67	17	259	160	4,801.73
23.00-24.00	5	67	24	280	160	5,370.56
00.00-01.00	4	54	19	225	160	4,478.83
01.00-02.00	5	53	19	221	160	4,458.77
02.00-03.00	3	47	26	220	160	4,531.81
03.00-04.00	6	58	24	252	160	5,303.91
04.00-.05.00	3	47	31	238	160	5,137.16
05.00-06.00	5	34	34	208	160	4,581.25
06.00-07.00	7	25	10	113	160	2,473.63
Total	302	1963	355	7254	3840	92,246.22

Total Waiting Time (PCU converted, hr/day)	187,727.13		
Total Waiting Time (vehicle converted, hr/day)	67,777.41		
	LV	Bus	Truck
By Vehicle Type (hr/day)	7,802.55	50,800.71	9,174.15
Waiting Time per Vehicle (hr/day)	12.94	12.94	12.94

Table 9.1.10 Ferry Waiting Time (FWT) Saving Benefit

Year	Vehicle Type	Normal Traffic				Induced Traffic		Total
		Waiting Time Hours/day	Net Economic Time Value (TK/h)	Daily FWTCS Benefit (mil.TK)	Yearly FWTCS Benefit (mil.TK)	Ratio Induced /Normal Traffic	Yearly FWTCS Benefit (mil.TK)	Yearly FWTCS Benefit (mil.TK)
2015	LV	7802.6	37.2	0.290	105.9	0.49	26.0	132.0
	Bus	50800.7	127.1	6.457	2356.7	0.66	781.8	3138.5
	Truck	9174.2	55.9	0.513	187.2	0.37	34.9	222.1
	Total	67777.4		7.260	2649.8		842.7	3492.6
2025	LV	15206.0	37.2	0.566	206.5	0.49	50.6	257.1
	Bus	99002.6	127.1	12.583	4592.9	0.66	1515.7	6108.5
	Truck	17879.1	55.9	0.999	364.8	0.37	67.5	432.3
	Total	132087.7		14.148	5164.1		1633.7	6797.9

iv) Freight Value Deterioration (FVD) Saving Benefit

It is expected that the damages on the freight shall be reduced due to reduced transport time by the Project. These benefits were calculated for the following two categories of reduced time:

Category A: FVD saving due to reduced transport time by improved road network

Category B: FVD saving due to reduced ferry waiting time at ferry terminals

Preceding the benefit estimation, average hourly freight values of perishable goods such as fish, meats and fresh vegetables and so on were estimated according to the formula described below:

Freight Time Value=Freight Value(per ton) x (Short Term Interest Rate)/(365day x 24 hours)

Where, "freight values per ton were set out at market values", and as to "short term interest rate", 10.0% was adopted taking into account substantial short time interest rate in Bangladesh. The above calculated freight values were converted into that of freight vehicles, adopting information about loading condition of vehicles obtained in the traffic survey in 2003. FVD saving benefit was estimated applying these values to both vehicle-hours to be saved in driving and to waiting time to be saved at ferry terminals. Definition of perishable cargoes, time values of vehicles carrying these cargoes are shown in Table 9.1.11 and 9.1.12.

FVD saving benefits were estimated applying the above unit values to the amount of time to be saved by the Project as shown in Table 9.1.13 and 9.1.14

Table 9.1.11 Loading Condition of Perishable Goods

Category (A)	Category (B)	Commodity	Share in Category (B)	Number of Daily Trucks
Fish	Fish (4% of Total Truck)	Hilsa Fish	0.50	15
		Ruhi Fish	0.50	15
		Sub total	1.00	30
Meat	Meat (3% of Total Truck)	Cow	0.25	6
		Goat	0.25	5
		Chicken	0.50	11
		Sub total	1.00	22
Dairy	Dairy (3% of Total Truck)	Milk	0.50	6
		Egg	0.75	16
		Sub total	1.00	22
Agricultural Product (36% of Total Truck)	Vegetable (2% of Agri. Product)	Lal/data	0.33	2
		Bitter Gourd	0.34	2
		Ladies Finger	0.33	2
		Sub total	1.00	6
	Fruit (4% of Agri. Product)	Banana	0.75	9
		Papaya	0.25	3
		Sub total	1.00	12
	Bean (10% of Agri. Product)	Barbati	0.50	14
		Bean	0.50	14
		Sub total	1.00	28
	Grain (15% of Agri. Product)	Rice	0.60	26
		Wheat	0.10	4
		Corn	0.30	12
		Sub total	1.00	42
	Agri.Total			280
Total Number of Trucks				779

Source: Traffic Survey Results and Study Team

Table 9.1.12 Unit Time Value for Trucks Loaded with Perishable Goods

Large category	Commodity	Share in large category	Price/ 100kg in 1997 Price (TK)	Price in 2004 Unit: TK/100kg	Average Price in 2004 Price Unit: TK/00kg	Average Price in 2004 Unit: TK/ton	Short Term Interest Rate (%)	Term 365day x 24h	Unit Time Value of Goods	Unit Time Value of Truck (8ton Truck)	Unit Time Value of Utility Vehicle (1ton)
Fish	Hilsa	0.50	9375	11928	5964						
	Ruhi Fish	0.50	12334	15692	7846						
	Sub total	1.00			13810	138100	10	8760	1.576	12.612	1.576
Meat	Cow	0.25	6500	8270	2067						
	Goat	0.25	11600	14758	3690						
	Chicken	0.50	4727	6014	3007						
	Sub total	1.00			8764	87641	10	8760	1	8.004	1.000
Dairy	Milk	0.50	1829	2327	1163						
	Egg	0.75	5900	7506	5630						
	Sub total	1.00			6793	67933	10	8760	0.775	6.204	0.775
Vegetable	Lal/data	0.33	464	590	195						
	Bitter Gourd	0.34	1360	1730	588						
	Ladies Finger	0.33	700	891	294						
	Sub total	1.00			1077	10770	10	8760	0.123	0.984	0.123
Fruit	Banana	0.75	772	982	737						
	Papaya	0.25	2400	3053	763						
	Sub total	1.00			1500	15000	10	8760	0.171	1.37	0.171
Bean	Barbati	0.50	704	896	448						
	Bean	0.50	756	962	481						
	Sub total	1.00			929	9288	10	8760	0.106	0.848	0.106
Grain	Rice	0.60	1087	1383	830						
	Wheat	0.10	1010	1285	129						
	Potato	0.30	680	865	260						
	Sub total	1.00			1218	12178	10	8760	0.139	1.112	0.139

Source: Study Team

Table 9.1.13 Estimation of FVD Savings Benefit

Category 1:FVD Savings Due to Driving Time Reduction by Improved Network due to Project

2015

Vehicle Type	Daily Vehicle Hours to be Saved	Time Value of Loaded Vehicle Unit: TK	Daily FVDS Benefit Normal Traffic (TK)	Yearly FVDS Benefit Normal Traffic (mil.TK)
Normal Truck	5221	1.111	5800.5	2.1
Normal Utility	2334	0.139	324.4	0.1

Vehicle Type	Induced/Normal Ratio (%)	Discount Factor of Induced Traffic	Yearly Ind. FVDS Benefit (mil.TK)	Normal & Induced FVDS Benefit (milTK)
Induced Truck	0.565	0.5	0.7	2.9
Induced Utility	0.565	0.5	0.0	

2025

Vehicle Type	Saved Vehicle Hours/day (1)	Time Value of Loaded Vehicle Unit: TK	Daily FVDS Benefit Normal Traffic (TK)	Yearly FVDS Benefit Normal Traffic (mil.TK)
Normal Truck	11127	1.111	12362.1	4.5
Normal Utility	4864	0.139	676.0	0.2

Vehicle Type	Induced/Normal Ratio (%)	Discount Factor of Induced Traffic	Yearly Ind. FVDS Benefit (mil.TK)	Normal & Induced FVDS Benefit (miiTK)
Induced Truck	0.581	0.5	1.3	6.1
Induced Utility	0.581	0.5	0.1	

Table 9.1.14 Unit Time Value for Vehicles Loaded with Perishable Goods

Kind of Goods Loaded	Share in Total Cargo Loaded on Freight Vehicles (%)	Unit Time Value of Truck Loaded with Corresponding Goods (TK)	Unit Time Value per Utility Vehicle loaded with Corresponding Goods (TK)	Unit Time Value per All Truck Including Unloaded Vehicle (TK)	Unit Time Value per All Utility Vehicle including Unloaded Vehicle (TK)
Fish	0.04	12.612	1.576	0.504	0.063
Meat	0.03	8.004	1.000	0.240	0.030
Dairy	0.03	6.204	0.775	0.186	0.023
Vegetable	0.07	0.984	0.123	0.071	0.009
Fruit	0.01	1.370	0.171	0.019	0.002
Bean	0.04	0.848	0.106	0.031	0.004
Grain	0.05	1.112	0.139	0.060	0.008
Average				1.111	0.139

Table 9.1.15 Estimation of FVD Savings Benefit

Category 2: FVD Saving due to Ferry Waiting Time Reduction

2015

Vehicle Type	Daily Vehicle Hours to be Saved	Time Value of Loaded Vehicle Unit: TK`	Daily FVDS Benefit: Normal Traffic (TK)	Yearly FVDS Benefit Normal Traffic (mil.TK)
Normal Truck	9174	1.111	10192.5	3.7
Normal Utility	3901	0.139	542.2	0.2

Vehicle Type	Induced/Normal Ratio (%)	Discount Factor of Induced Traffic	Yearly Ind. FVDS Benefit (mil.TK)	Normal + Induced FVDS Benefit (miiTK)
Induced Truck	0.565	0.5	0.7	4.7
Induced Utility	0.565	0.5	0.0	

2025

Vehicle Type	Saved Vehicle Hours/day (1)	Time Value of Loaded Vehicle Unit: TK	Daily FVDS Benefit Normal Traffic (TK)	With normal Yearly FVDS Benefit Normal Traffic (mil.TK)
Normal Truck	17879	1.111	19863.2	7.3
Normal Utility	7602	0.139	1056.7	0.4

Vehicle Type	Induced/Normal Ratio (%)	Discount Factor of Induced Traffic	Yearly Ind. FVDS Benefit (mil.TK)	Normal & Induced FVDS Benefit (milTK)
Induced Truck	0.581	0.5	2.2	10.0
Induced Utility	0.581	0.5	0.1	

Table 9.1.16 Results of FVD Saving Benefit

Unit: mil.TK

Year	FVDS due to Reduced Driving Time by improved Road Network	FVDS due to Reduced Ferry Waiting Time	Total
2015	2.9	4.7	7.6
2025	6.1	10	16.1

(b) Estimation of Non Road User Benefit

i) Ferry Operation Cost Saving Benefit

The present ferry service on the Mawa-Janjira route will be terminated with the opening of the proposed bridge. The ferry operation cost to be saved by terminating the service is reckoned as one of the benefits of the Project. The benefit was estimated based on future ferry tariff revenue calculated under the "no project scenario", because that revenue is approximately equal to the expenditure cost for operation and

maintenance of the existing ferry, should the service be maintained under financially sound conditions of the ferry operator, with no excessive profit or loss from the service. As such, tariff revenue at Mawa-Janjira ferry operation was estimated on the basis of future traffic volume at Mawa-Jinjira ferry simulated under the "without the bridge scenario". In the estimation the tariff rates to be charged are set out at the present level as shown in Table 9.1.17. The process of estimation of revenues from ferry service is shown in Table 9.1.18-21.

Table 9.1.17 Ferry Tariff Rate

Vehicle Type (1)	Vehicle Type (2)	Tariff 2004	Vehicle Share	Average Tariff
	Car/Jeep	180	0.960	172.8
LV	Micro Bus	330	0.040	13.2
	Sub total		1.000	186.0
	Large Bus	1155	0.504	582.1
Bus	5ton Bus	990	0.248	245.5
	3ton Bus	550	0.248	136.4
	Sub total		1.000	964.0
	3-8 ton truck	935	0.990	925.7
Truck	8ton Truck	1265	0.010	12.7
	Sub total		1.000	938.3

Source: Traffic Survey

Table 9.1.18 Average Number of Passengers by Vehicle Type

Vehicle Type (1)	Vehicle Type (2)	Occupancy	Vehicle Share	Average Occupancy
LV	Car/Jeep	4	0.96	3.84
	Micro Bus	8	0.04	0.32
	Sub total			4.16
Bus	Large Bus	40.7	0.504	20.51
	5ton Bus	16	0.248	3.97
	3ton Bus	8	0.248	1.98
	Sub total			26.46
Truck	3-8 ton truck	2	0.99	1.98
	8ton Truck	2	0.01	0.02
	Sub total			2.00

Source: Traffic Survey

Table 9.1.19 Ferry Tariff Revenue from Passengers

Year	Vehicle Type	Vehicle Number (Vehicles/day)	Average Occupancy	Tariff on Person* (TK/person)	Daily Tariff Revenue (mil.TK)	Yearly Tariff Revenue (mil.TK)
2015	LV	603	4.16	25	0.063	22.9
	Bus	3926	26.46	8	0.831	303.3
	Truck	709	2.00	8	0.011	4.1
	Total	5238			0.905	330.4
2025	LV	1254	4.16	25	0.130	47.6
	Bus	7870	26.46	8	1.666	608.1
	Truck	1467	2.00	8	0.023	8.6
	Total	10591			1.820	664.2

* LV users are assumed to use upper class deck

Table 9.1.20 Tariff Revenue at Mawa-Janjira Ferry

Year	Vehicle Type	Yearly Ferry Tariff Revenue (mil.TK)		
		Vehicle	Passenger	Total
2015	LV	40.9	22.9	63.8
	Bus	1381.4	303.3	1684.7
	Truck	242.8	4.1	246.9
	Total	1665.2	330.4	1995.6
2025	LV	85.1	72.0	157.1
	Bus	2769.1	246.7	3015.8
	Truck	502.4	13.7	516.1
	Total	3356.7	332.4	3689.1

Source: Traffic Survey

Table 9.1.21 Estimation of Ferry Operation Cost

Unit mil. TK

Year	Vehicle Type	Ferry Tariff Revenue	Economic O/M Cost to be Saved
2015	LV	63.8	54.6
	Bus	1684.7	1440.4
	Truck	246.9	211.1
	Total	1995.6	1706.2
2025	LV	157.1	134.3
	Bus	3015.8	2578.5
	Truck	516.1	441.3
	Total	3689.1	3154.2

ii) Benefit from Provision of Utility Facilities

Basic Concept

The benefits from the proposed utility facilities to be accommodated on the bridge were estimated based on "Cost Approach". This approach asserts that the provision cost of utility facilities shall be reduced if they are accommodated on the bridge compared with their independent construction across the river. The balance of the two of the costs, one is the cost of independent construction of river crossing utility facilities, and the other is the reduced construction cost utilizing existing structure of bridge, is deemed "benefit" from the provision of utility facilities.

The other analysis, termed "Beneficiary Approach", stands to the side of beneficiaries of utilities. However, this approach is inclined to incur many uncertain factors in the enumeration. For these reasons, the estimation was proceeded standing on the aforementioned "Cost Approach" as explained below.

Estimation of Benefit from Power Transmission (UPT) and Telecommunication Cable (UTC)

The magnitude of benefits or balance of two of the construction costs was estimated through updating available costs of independent construction of power transmission. These were undertaken in "The East-West Interconnection (400 kv) Project" in 1982 and accommodation costs of these facilities into the Project Bridge were described in Chapter 5 of this Report.

Description of the East-West Interconnection (400 kV) Project in 1982

- Size of power cable: 400KV equivalent
- Total length: 13.65km
- Total cost of the project: $161.59 mil. (in 1982 prices)
- Unit construction cost: $11.84 mil./km (in 1982 prices)

The above costs expressed in 1982 prices were converted to 2004 price levels using the following index of the Bangladesh economy:

- Exchange Rate: $1=25TK (1982), $1=60TK (2004)
- Average GNP implicit deflator (1982-2004): 3.5% per annum

The unit construction cost of East-West Interconnection was estimated to be 628.8 mill. TK/km (at 2004 price levels), if it were implemented now. Therefore, independent construction costs of power transmission across the Padma River were estimated to be 3772.8 mill. TK based on applying the unit construction cost of the 37.5 mill. TK in the East-West Inter-connection Project to a 6 km-long section of Padma River. Corresponding accommodation costs of the utility for the bridge are estimated at 3666.0 mill. TK, as shown in Chapter 5 of this report. The benefit from power transmission, as the balance of two of the construction costs, was estimated to be 91.3 mil. TK, as shown in Table 9.1.22.

Table 9.1.22 Estimation of Benefits from Power Transmission Installation

Item	Length (km)	Unit Construction Cost In 04 Price, mil.TK	Construction Cost In 04 Price, mil.TK
Accommodation on Padma Bridge (mil TK)	6.0	611.0	3666.0
Independent Construction (mil.TK)	6.0	628.8	3772.8
Balance in Construction Costs (mil.TK)			106.8
Benefit in Economic Price 85.5 % of Cost Balance	91.3mil TK		

The benefit from telecommunications (UTC) was assumed to be approximately equivalent to that of power transmission (UPI) due to its similarity in structure and function.

Benefit from Installation of Gas Pipeline (UGP)

The benefit from accommodating a gas pipeline onto the bridge was estimated as explained below:

Future proposal of pipeline construction envisaged by BP

The Bangladesh Government envisages construction of a pipeline at the western and southern parts of Bangladesh and has a plan to construct it on the section between the western end of Jamuna Bridge to the eastern bank of Padma River near Paksey Bridge, which is now under construction. Furthermore, it has a

long- term development plan for extension to the city of Khulna, should the ongoing plan of Padma Bridge at Mawa-Janjira site not be realized.

Length of pipelines

The routes of pipelines to Khulna have not be determined in detail at present, but the shortcut distance from Paksey Bridge to the city of Khulana is approximately 180km. The corresponding distance from Dhaka to Khulna via the proposed Padma Bridge at Mawa is approximately 150km. That means the expected construction section of gas pipeline along the route by way of Padma Bridge is shorter by about 30km.

Estimation of savings in construction costs

Savings in construction cost was estimated applying bench mark unit construction cost, available at the Power Board of Bangladesh (PB), to the distance for the construction section to be saved, as shown in Table 9.2.23.

Table 9.1.23 Estimation of Benefits from Gas Pipeline

Bench Mark Value of: Unit Construction Cost Pipeline (Φ30cm), Mil. TK/km	Distance to be Shortened by Padma Bridge Route (Km)	Saving in Construction Cost by Padma Bridge Route (Mil. TK)	Benefit of Gas Pipeline Accommodation onto Padma Bridge, Economic Price (mil. TK)
37.5	30.0	1125.0	962.0

Estimated benefits from accommodation are outlined below in Table 9.1.24.

Table 9.1.24 Summary of Estimated Benefits from Utilities

Unit: mil. TK

Utility Facility	Benefit
Power Transmission	91.3
Telecommunication	91.3
Gas Pipeline	962.0
Total	1144.6

iii) Land Enhancement Benefit

Land enhancement benefits at the lands to be reclaimed or protected by river training works to protect bridge foundations are defined as one of the benefits of the Project. The benefits were estimated as the balance of two of the land values, namely the present and future land values. The estimating procedure is explained below:

Estimation of area of lands to be affected

Firstly, the area of land to be reclaimed or protected by the river training works was defined with reference to the results of the river training study in Chapter 3 of this Report.

Areas of Land to be Improved

Reclaimed	Protected	Total
9.7 km^2	17.1km^2	26.8km^2

Future Land Use Proposal

Secondly, future land use plans of the areas to be improved were proposed as shown in Table 9.1.25, taking the existing land use characteristics in the vicinity of the project site and present land use pattern of the nearby Jamuna Bridge into consideration.

Table 9.1.25 Proposed Land Use

Land Use Pattern	Future		Present	
	Reclaimed Area (km^2)	Protected Area (km^2)	Reclaimed Area (km^2)	Protected Area (km^2)
Paddy (1-clop)	1.213	4.275		
Paddy (2-clop)	1.213	4.275		
High Land	7.275	8.55		
Plantation	0	0		
Fallow Land	0	0	9.7	
Water Body	0	0		17.1
Total	9.7	17.1	9.7	17.1

Set out of land price by usage

Thirdly, unit prices based on land usage were set out with reference to the results of a study of "Command Area Development Project" by the Bangladesh Water Development Board in 2000. These unit land values were updated to 2004 price levels as shown in Table 9.1.26.

Table 9.1.26 Unit Land Price by Usage of Land (in 2004 Prices)

Unit: mil. TK/km^2

Usage	Paddy (1-clop)	Paddy (2-clop)	High Land	Plantation	Fallow Land	Water Body
Price	226.8	283.4	340.1	340.1	42.5	0.0

Source: Command Area Development Project, BWDB

Estimation of gains in land value or land enhancement benefit

The gains in land value were estimated as the difference between enhanced and existing land values. The results are presented in Table 9.1.27.

Table 9.1.27 Estimation of Land Enhancement Benefit

Land Use	Future						Present				Land Enhancement Benefit in Economic Prices (2004) (Unit: Mil TK) *Factored by 0.855 to Remove Tax
	Reclaimed	Protected	Unit Land Price TK Mil./km^2	Value of Reclaimed Land (mil.TK)	Value of Protected Land (mil.TK)	Total Value of Land (mil.TK)	To be reclaimed	To be Protected	Total	Total Value of Land (mil.TK)	
	Area (km^2)	Area (km^2)					Area (km^2)	Area (km^2)	Area (km^2)		
Paddy (1-clop)	1.213	4.275	226.8	275.1	969.6	1244.7					
Paddy (2-clop)	1.213	4.275	283.4	343.8	1211.5	1555.3					
High Land	7.275	8.550	340.1	2474.2	2907.9	5382.1					
Plantation	0.000	0.000	340.1	0.0	0.0	0.0					
Fallow Land	0.000	0.000	42.5	0.0	0.0	0.0		17.1	17.1	726.8	
Water Body	0.000	0.000	0.0	0.0	0.0	0.0	9.7		9.7	0.0	
Total	9.701	17.100		3093.1	5089.0	8182.1	9.7	17.1	26.8	726.8	6374.3

iii) Summary of Estimated Benefit from the Project

Benefits estimated in the above process are summarized in Table 9.1.28.

Table 9.1.28 Summary of Estimated Benefit (in economic prices in 2004)

Unit: mil. TK

Item of Benefit	2015	2025
Vehicle Operation Cost (VOC) Saving Benefit	2210.5	4381.5
Travel Time Cost Saving (TTC) Saving Benefit	966.4	2276.4
Ferry Waiting Time (FWT) Saving Benefit	3492.6	6797.9
Freight Value Deterioration (FVD) Saving Benefit	7.6	16.1
(a) FVD Saving due to Reduced Driving Time	2.9	6.1
(b) FVD Saving due to Reduced Waiting Time	4.7	10.3
Ferry Operation Cost (FOC) Saving Benefit	1706.2	3154.2
Benefit from Utility Installation (* Only in Initial Year)	1145.6	Initial Year Only
(a) Power Transmission Cable Installation (UPT)	91.3	do
(b) Telecommunication Cable Installation (UTC)	91.3	do
(c) Gas Pipeline Installation (UGP)	963.0	do
Land Enhancement (LE) Benefit (*Only in Initial Year)	6374.3	Initial Year Only
Total	15903.2	16626.1

9.1.5 Economic Evaluation

(1) Premise of Economic Evaluation

In order to confirm economic feasibility of the Project, economic evaluation was carried out. Economic viabilities of alternative bridge development proposals were evaluated on the basis of associated economic flows of project costs and benefits. The economic viability of the Project to the national economy of Bangladesh was evaluated in terms of Internal Rates of Return (EIRR), Benefit Cost Ratio (B/C) and Net Present Value (NPV). Premises for the economic evaluation were set out as follows:

a. Evaluation period was set as 30 years after commencement of operation of the Project
b. Annual cost flows were prepared for alternative development scenarios, corresponding to the project implementation and cost disbursement schedules.
c. Item-wise annual benefits were assigned throughout the evaluation period on the basis of the estimated economic benefits in 2015 and 2025, except for benefits from utility provision and enhanced land that are reckoned only in the year of commencement of operations.
d. The ceiling of benefit growth was set as 2033, when the daily traffic volume on the bridge is expected to reach 75,000, corresponding to 1.5 times the daily highway capacity of 48,000 vehicles per 4-lane highway*.
e. Economic residual values were estimated as shown in Table 9.1.29 for each of the development alternatives under the assumption of 50 years of project life. They were reckoned at the final year of evaluation (2044).
f. Annual maintenance costs were set out by development alternatives. They are expressed in economic prices as shown in Table 9.1.30.
g. Economic discount rate or opportunity cost of capital in Bangladesh, necessary for the calculation of B/C and NPV and for the evaluation of EIRR, was set at 12% per annum.

* In terms of the Vehicle Speed-Traffic Volume relation, vehicle speed becomes less than 10km/h as vehicle numbers per lane approach 1000 vehicles/hr. Peak traffic volume in the case of 76,000 vehicles/day is estimated to be 5.5km/hr. that is the speed level that obliges detours to other routes to drivers, such as Dhaka-Jamuna Bridge-Paksey Bridge-southern parts of Bangladesh. Speed level on these routes is simulated to be 55km/h-60km/hr. on average in 2025.

Table 9.1.29 Economic Residual Values by Alternative Development Schemes

Unit :mil.TK

Development Alternative	Economic Price
Alt. H-1	18320
Alt. H-2	18810
Alt. H-3	19570

Table 9.1.30 Annual Maintenance Cost

Unit: mil TK

Alternative	Financial Price			Economic Price		
	1-5 Year	6-30 Year	Total	1-5 Year	6-30 Year	Total
Alt. H-1	625.2	375.1	12503.5	598.0	358.8	11960.0
Alt. H-2	642.1	385.3	12843.0	614.2	368.5	12283.5
Alt. H-3	560.2	336.1	11203.5	535.8	321.5	10716.5

(2) Results of Economic Evaluation

Values of evaluating indicators for the alternative bridge development plans are summarized in Table 9.1.31. From these, the project is concluded to be economically feasible to the national economy of Bangladesh, as all calculated EIRRs are higher than the discount rate of 12%, B/Cs are higher than 1.0, and they have positive NPVs. Maximum return is obtained in Alternative H-3, and the minimum in Alternative H-2. However, among three of the highway bridge development schemes, only Alt. H-3 with a bridge width of 16.5m is substandard in terms of the Asian Highway Standard. Asian Highway Standards regulate the bridge width must be more than 21.5m at least to satisfy its condition. Therefore, Alt. H-1 is concluded to be more economically viable than Alt. H-2 as the former has higher indicator values.

Table 9.1.31 Results of Calculated Evaluating Indicators

Alternative	IRR(%)	B/C	NPV (Mil. TK)	NPV (mil. $)
Alt. H-1	15.35	1.46	12404.2	206.7
Alt. H-2	15.01	1.41	11432.4	190.5
Alt. H-3	16.18	1.61	14652.2	244.2

(3) Sensitivity Analysis

Sensitivity analysis was carried out for the case of Alt. H-1, which was concluded to be the most recommended development alternative. In the analysis, EIRR, B/C and NPV were calculated as shown in Table 9.1.32, assuming project costs and benefits were varied within a range of +/-20% and with a discount rate of 12%. As a result, the economic viability was found to be robust, with all calculated values of EIRR higher than 12 %, B/C ratios greater than 1.0, and a positive NPV except for the case of “costs 20% up and benefits 20% down”. A maximum return of 19.48% was expected with a combination of “costs 20% down and benefits 20% up” of those calculated.

Table 9.1.32(a) Results of Sensitivity Analysis-EIRR

Case:Alt.H-1 Unit: %

Cost \ Benefit	20% Down	10% Down	Original	10% Up	20% Up
20% down	15.35	16.48	17.54	18.54	19.48
10% down	14.26	15.35	16.36	17.31	18.21
0riginal	13.33	14.38	15.35	16.26	17.12
10% up	12.52	13.53	14.47	15.35	16.18
20% up	11.81	12.78	13.69	14.54	15.35

Table 9.1.32(b) Results of Sensitivity Analysis -B/C

Case:Alt.H-1

Cost \ Benefit	20% Down	10% Down	Original	10% Up	20% Up
20% down	1.46	1.65	1.83	2.01	2.20
10% down	1.30	1.46	1.63	1.79	1.95
0riginal	1.17	1.32	1.46	1.61	1.76
10% Up	1.07	1.20	1.33	1.46	1.60
20% Up	0.98	1.10	1.22	1.34	1.46

Table 9.1.32(c) Results of Sensitivity Analysis -NPV

Case:Alt.H-1 Unit: mil. TK

Cost \ Benefit	20% Down	10% Down	Original	10% Up	20% Up
20% down	9923.3	13831.4	17739.4	21647.5	2555.5
10% down	7255.7	11163.7	15071.8	18979.8	22887.9
0riginal	4588.1	8496.1	12404.2	16312.2	20220.3
10% Up	1920.4	5828.5	9736.5	13644.6	17552.6
20% Up	-747.2	3160.8	7068.9	10976.9	14885.0

9.2 FINANCIAL EVALUATION

9.2.1 General

In order to obtain information relating to the financial aspects of the Project, financial analysis of the toll system, optimal toll rate, evaluation of financial viability of the Project, procurement plan of finance and analysis of probable financing methods including those of private financing methods as well as conventional methods of project financing by ODA were studied. Revenues from the bridge were estimated in conjunction with the analysis of toll rates. Cash flows or cost-revenue flows of the Project were prepared. The financial viability of the Project was evaluated in terms of Financial Internal Rate of Return (FIRR), Revenue Cost Ratio (R/C) and Investment Limit (IL) assuming 12% Cost of Capital in Bangladesh. Costs and revenues from the Project were estimated and expressed in financial prices including tax and customs that were excluded in the economic analysis. Cash flows consisting of cost disbursement during the construction period and operation after opening and revenues during the 30-year redemption period were prepared as the basis of the analysis.

9.2.2 Analysis of Toll Rate

(1) Toll System

The results of the traffic study and economic evaluation reveal that the Bridge will be used significantly by traffic across the Padma River and produce a huge level of benefits to users. From this fact only the bridge is recommended to be operated under a toll system. The revenues from a toll bridge might be one of the resources for the repayment of a portion of project funds released by international /domestic financers and other potential financial participants. At present Jamuna Bridge is being operated under the toll system and the future Paksey Bridge is proposed to be operated under the same system. From these facts it seems very reasonable that the Project be operated under the toll scheme.

(2) Toll Rate and Traffic Volume

In general, there exists a negative relation between traffic volume and toll rate. Traffic volume tends to decrease as toll rate increases, as the toll functions as an impedance for vehicle users. In order to trace the relation between toll rate and traffic volume, traffic simulations were carried out under different toll rate levels, adopting the same traffic simulation model that was used in the traffic demand forecast discussed in Chapter 3. The cases simulated were set out to follow the pivoting original toll rate adopted in the traffic assignment, as explained below:

Case 1: 0.5 times the original rate
Case 2: Original rate (equivalent to present rate at Jamuna Bridge)
Case 3: 1.5 times the original rate

The results of the simulated traffic volume by type of traffic and vehicle type are shown in Table 9.2.1.

Table 9.2.1 Toll Rate and Traffic Volume Relation (2015)

Unit: Vehicle/day

Toll rate: Times Present Jamuna Rate		0.5 times Present Rate	Present Rate	1.5 times Present Rate
Toll Rate (TK)	Light Vehicle	200	400	600
	Bus	400	800	1200
	Truck	500	1000	1500
Normal Traffic	Light Vehicle	4,920	4,450	2,430
	Bus	14,360	12,880	9,580
	Truck	5,800	4,690	2,780
	Total	25,080	22,020	14,790
Induced Traffic by Other Projects	Light Vehicle	490	460	320
	Bus	2,530	2,470	2,130
	Truck	670	610	400
	Total	3,690	3,540	2,850
Induced Traffic by Padma Bridge	Light Vehicle	2,520	2,430	1,380
	Bus	10,940	10,820	8,400
	Truck	2,160	2,020	1,230
	Total	15,620	15,270	11,010
Diverted Traffic	Bus	430	580	430
	Truck	120	140	120
	Total	550	720	550
Total	Light Vehicle	7,930	7,340	4,120
	Bus	28,410	26,750	20,690
	Truck	8,760	7,460	4,560
	Total	45,100	41,550	29,370

(3) Relation Between Toll Rate and Toll Revenue

(a) Mathematical Relation

The magnitude of the toll revenues was estimated by simulating traffic volume and assumed toll rates as shown in Table 9.2.2. From this, it was found that the relation between magnitude of toll revenue and level of toll rate could be explained by the following convex curve:

Light Vehicle (LV):
$R = -427.4 + 4.7778r - 0.00576r^2$
Bus:
$R = -1443.6 + 10.7578r - 0.00517r^2$
Truck:
$R = -662.4 + 4.0381r - 0.00184r^2$

Where,
R: Annual Toll Revenue (mil. TK) r: Toll rate (TK)

Table 9.2.2 Relation between Toll Rate and Toll Revenue (2015)

Vehicle Type	Toll Rate (TK/vehicle)			Traffic Volume (Vehicles/day)			Toll Revenue (mil TK/year)		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
LV	200	400	600	4079	3850	1670	297.8	562.1	365.7
Bus	400	800	1200	13920	13210	9180	2032.3	3857.3	4020.8
Truck	500	1000	1500	4910	4200	2280	896.1	1533.0	1248.3

The toll rates that maximize the revenues are obtained as the first differential values of the above equations as shown below:

LV: 415 TK (400TK)
Bus: 1040 TK (800TK)

Truck: 1095TK (1000TK)
(Figures in brackets are present toll rates at Jamuna Bridge.)

Putting the above values into the above mathematical relations, maximum annual toll revenues in 2015 were obtained by vehicle type as follows:

LV: 563.4 mil. TK
Bus: 4152.6 mil. TK
Truck: 1549.7 mil. TK

Toll revenues in 2015 and 2025 were estimated as shown in Table 9.2.3 under two toll alternatives (Alt. 1 and Alt. 2).

Alt. 1: Present rate at Jamuna Bridge
Alt. 2: Toll rates that maximize revenue

Table 9.2.3 Estimation of Toll Revenue

Alt. Rate 1: Toll Rate at Present Jamuna Bridge

Year	Vehicle Type	Traffic per day	Toll Rate (TK)	Toll Revenue day (mil TK)	Toll Revenue year (mil TK)
2015	LV	3850	400	1.5	562.1
	Bus	13210	800	10.6	3857.3
	Truck	4200	1000	4.2	1533.0
	Total	21260		16.3	5952.4
2025	LV	7340	400	2.9	1071.6
	Bus	26750	800	21.4	7811.0
	Truck	7460	1000	7.5	2722.9
	Total	41550		31.8	11605.5

Alt. Rate 2: Toll Rate Maximizing Toll Revenue

Year	Vehicle Type	Traffic per day	Toll Rate (TK)	Toll Revenue day (mil TK)	Toll Revenue year (mil TK)
2015	LV	3719	415	1.5	563.3
	Bus	10940	1040	11.4	4152.8
	Truck	3877	1095	4.2	1549.5
	Total	18536		17.0	6266.0
2025	LV	7113	415	3.0	1077.5
	Bus	22132	1040	23.0	8401.2
	Truck	6878	1095	7.5	2748.9
	Total	36123		33.5	12227.6

9.2.3 Analysis of Utility Charge

Fee revenue from utility facilities is another source of revenues for the proposed Bridge. Chargeable rates of these fees were analyzed and set out referring to those at Jamuna Bridge and relevant information as shown in Table 9.2.4.

Table 9.2.4 Determination of Tariff Rates for Utility Facilities

Item	Power Transmission	Gas Pipe Line	Telecommunication Cable
Authority	BPDB	GTCL	BTTB
Operating Condition in 2004	Non operating	Non operating	Non operating
Annual Fee (mil TK per annum)	-	3.0	3.0
Unit Fee Rate at Jamuna Bridge, applied to Padma Length 4.8 km (mil TK)	- 0.11 mil TK	0.63mil TK	0.63mil TK
Application: Unit Rate at Jamuna per km (Padma Bridge 5.6 km)	Set out based on average of rates (power, gas and telecom.) at Jamuna*** 0.5. mil TK/km x 5.6Km= 2.8 mil TK	Unit Rate at Jamuna 0.63mil TK/km x 5.6Km=3.5 mil TK	Unit Rate at Jamuna 0.63 mil TK/km x 5.6Km=3.5 mil TK
Increased rate: under the assumption of full operation 15 times present level* mil. TK/annum	15 times of present rate 42.0 mil TK	15 times of present rate 52.5 mil TK	15 times of present rate 52.5 mil TK

*** Modification to correct imbalance in tariff rates at Jamuna Bridge

****Application of increased fee on railway in 2004. In this case initial fee level was increased 1500% with its full operation.

*****Tariffs in this context are deemed charges on bridge structure usage fee.

9.2.4 Financial Project Cost and Operation and Maintenance Cost

Costs for the financial analysis were prepared in real terms including contingency of the Project and transfer factors for tax and customs that were excluded in the costs in the economic analysis, as shown in Table 9.2.5. Financial cost disbursement schedules were prepared for alternative bridge development proposals as shown in Table 9.2.6, whilst annual operation and maintenance costs during the 30-year evaluation period are shown in Table 9.1.2.

Table 9.2.5 Financial Project Cost for Alternative Schemes

Unit: mil TK

Work Item	Alt.H-1	Alt.H-2	Alt.H-3
Construction Cost	53915.6	55270.5	48716.7
Detailed Design Cost	1000.3	1541.1	1000.3
Construction Supervision Cost	2000.6	2054.8	2000.6
Administration Cost	300.1	359.6	268.9
Land Compensation Cost	4500.0	4500.0	4500.0
Contingency	7502.3	7705.6	6722.5
VAT for Imported Tax	5381.2	5579.1	4853.5
Total (in financial price)	74600.2	77010.7	68062.5

Table 9.2.6 Financial Cost Disbursement Schedule

Unit: Mil TK

Year	Alt.H-1	Alt.H-2	Alt.H-3
2004	0.0	0.0	0.0
2005	0.0	0.0	0.0
2006	0.0	0.0	0.0
2007	1985.2	2255.6	1985.2
2008	1985.2	2255.6	1985.2
2009	1538.2	1538.2	1538.2
2010	9778.8	10059.2	8798.1
2011	26728.6	27495.2	24048.1
2012	15646.0	16094.7	14077.0
2013	10430.7	10729.8	9384.6
2014	6507.7	6582.5	6246.2
Total	74600.2	77010.7	68062.5

9.2.5 Financial Evaluation

(1) Premise of Financial Evaluation

Financial evaluation was carried out on the basis of financial cost and revenue flows established through the above process. The cases for evaluation were set out as below:

Alt. Rate 1:Revenue based on toll rate of Jamuna Bridge (LV, 400TK, Bus, 800TK, Truck, 1000TK)

Alt. Rate 2:Revenue under maximum chargeable toll rate (LV, 415TK, Bus, 1040TK, Truck, 1095TK)

Main premises for financial evaluation were set out as follows:

a. Redemption period was set as 30 years after Project opening.
b. Annual flow costs in financial terms were prepared for alternative development scenarios, corresponding to the project implementation and cost disbursement schedules.
c. Annual flow of revenues from the Project were prepared for 30-year redemption period.
d. The ceiling of the benefit growth was set as year 2033, when the daily traffic volume on the bridge is expected to reach 75,000, corresponding to 1.5 times the daily bridge capacity.
e Annual maintenance cost in terms of financial price was prepared by development alternative.
f. Cost of Capital of 12% per annum was introduced as the thresh hold value of evaluation on the basis of long-term interest rate in Bangladesh.
g. Neither cost escalation nor increases in tariffs were considered in the evaluation.

(2) Calculated Indicators

The results of calculated indicators are shown in Table 9.2.7.

Table 9.2.7 Summary of FIRR and R/C Ratio Calculated

Alt. Rate 1: Under Jamuna Bridge Toll Rate
(LV: 400TK, Bus: 800TK, Truck: 1000 TK

Alternative	FIRR	R/C Ratio
Alt . H-1	10.16	0.79
Alt. H-2	9.90	0.76
Alt. H-3	10.85	0.87

Alt. Rate 2 Under Maximum Chargeable Toll Rate
(LV: 415TK, Bus:1040TK, Truck: 1095TK)

Alternative	FIRR	R/C Ratio
Alt H-1	10.74	0.85
Alt H-2	10.48	0.82
Alt H-3	11.44	0.93

(3) Sensitivity Tests

Sensitivity tests were carried out for Alt. H-1 under the toll rate that maximizes toll revenue (Alt Rate 2) assuming a combination of probable variations of financial project cost and revenue, where costs and revenues were assumed to vary by +/-20% of the original. Results are shown in Table 9.2.9.

(4) Investment Limit on the Basis of Revenue from the Project and O&M Cost

In order to ascertain the investment limit corresponding to the revenue from the Project, investment limit in terms of the relation between revenues from the Project and O&M costs was calculated for the case of Alt H-1 under maximum toll rate. Investment Limit in this context is defined by the following formula:

Investment Limit= [Sum of the Present Value of Revenues] - [Sum of the Present Value of O&M Cost]

= 28969.7 mil TK – 1263.1 mil TK
= 27706.6 mil TK (=$461.8 mil)

For the calculation of the above, a discount rate of 12% was adopted. As a result, Investment Limit in this context was calculated at 27706.6 mil TK or $461.8 mil, which corresponds to 37.1% of the original project cost of 74600.2 mil TK (=$1243.3 mil).

The above result suggest the portions of the project or subprojects less than 27706.6 mil TK or $461.8 mil are financially viable and manageable with the revenue of the project itself.

(5) Financial Evaluation under the Assumption that Utility Construction Costs are borne by Private Sector

For the purpose of confirm the impact on financial indicators in the case that utility construction costs are borne by private sector, financial evaluation excluding the utility construction costs was carried out in the cases of maximum chargeable toll rate for the Alt. H-1 of the development scheme. The utility construction costs are estimated as 3900 mil TK or $64.9 mil in total as detailed below:

Power Transmission: 3666.0 mil TK ($61.0 mil)

Gas Pipeline: 225 mil TK ($3.75 mil)

Telecommunication Cable: 9 mil TK ($0.15 mil)

The results suggest that there is no great changes in the indicators so as to enhance the levels of the indicators beyond the criteria of financial viability of FIRR of 12% and R/C ration greater than unity. This is due to very small portion of utility facility construction cost as compared to tremendous amount of construction cost of bridge itself. The results are shown in Table 9.2.8.

Table 9.2.8 FIRR and R/C Ratio in the Case of Utility Construction is done by Private Sector

(LV: 415TK, Bus:1040TK, Truck: 1095TK)

Alternative	FIRR	R/C Ratio
Alt H-1	11.04	0.88

(6) Results of Financial Evaluation

The results of the financial evaluation are described below:

- It could be concluded that the Project as a total is financially not viable, as all FIRRs are below the 12% Cost of Capital in Bangladesh, the R/C ratio is less than unity.
- However, unlike the opportunity cost of capital applied in the economic evaluation, 12 % of capital cost in the financial evaluation is easily affected by the conditions of financial markets and also easily changeable by the government financial policies. Therefore, the project is still maintains the possibility of falling in the range of financially viable with FIRR of 10% to 11.4%.
- The results of sensitivity analysis show that in the cases of increased revenue of 120% and more of the original case, an FIRR above 12 %, R/C higher than unity. This fact suggests a possibility of financial viability of the project under proper policy of tariff increases during the redemption period under a concerted effort of reducing the Project cost.
- Calculated Investment Limit in terms of the relation between revenues from the Project and O&M costs suggests that the portions of the project or subprojects with a scale of less than 27706.6 mil TK or $461.8 mil are financially viable and manageable based solely on the revenue of the project.
- However, as far as the total project is concerned, it could be recommended project financing by Bangladesh Government itself, with the assistance by international organization and/or by foreign governments, seems to be most practical method of financing.

Table 9.2.9 (a) Results of Sensitivity Analysis-FIRR

Case:Alt.H-1, max rate Unit: %

Revenue / Cost	20% Down	10% Down	Original	10% Up	20% Up
20% Down	10.74	11.66	12.50	13.30	14.05
10% Down	9.86	10.74	11.56	12.32	13.04
Original	9.10	9.95	10.74	11.48	12.17
10% Up	8.44	9.26	10.03	10.74	11.41
20% Up	7.84	8.65	9.39	10.09	10.74

Table 9.2.9 (b) Results of Sensitivity Analysis -R/C

Case:Alt.H-1, max rate Unit: %

Revenue / Cost	20% Down	10% Down	Original	10% Up	20% Up
20% Down	0.85	0.96	1.06	1.17	1.28
10% Down	0.76	0.85	0.96	1.04	1.14
Original	0.68	0.77	0.85	0.94	1.02
10% Up	0.62	0.70	0.77	0.85	0.93
20% Up	0.57	0.64	0.71	0.78	0.85

9.3 QUALITATIVE CONSIDERATIONS FOR PRIVATE SECTOR PARTICIPATION

(1) Objectives and Methodology

In order to support and elaborate the preliminary considerations for investment limit and private financing in the previous section, the possibility of private sector participation and use of a private financing scheme for the Project will be discussed with reference to the observed facts from the field survey and literature review. First, key success factors of BOT (Build, Operate and Transfer) or PPP (Public Private Partnership) schemes applied to transport projects are extracted from the literature, and then the relevancy of these extracted factors to the Project in the context of Bangladesh are discussed for the possibility of private sector participation.

(2) Key Success Factors of BOT (PPP) Projects

The BOT or PPP method has been used worldwide to promote the provision of infrastructure. For private enterprises to develop or participate into such schemes, public agencies need to provide various types of institutional support, including incentives as to share the risks and facilitate the participation.

Especially in the transport sector, better business conditions, including stable demand and public support, must be provided since any project will fail without an adequate business environment and not all BOT (PPP) transportation projects have been successful so far. The following three issues were identified in a literature review[1] as critical factors for ensuring the successful implementation of BOT (PPP) in transport sector projects.

Factor 1: Consistent Demand and Appropriate Toll Level

Ensuring stable profitability is the greatest factor in the success of transportation projects. BOT (PPP) road projects are relatively profitable from the beginning when there is active transportation demand. In a number of cases, profitability improved when a project was implemented in the vicinity of a congested road.

Demand and toll level are inextricably linked, and an appropriate toll level shall be set for ensuring a certain level of demand. The toll level has a large influence on transportation demand, which substantially affects the profitability of BOT (PPP) projects. To recover heavy investments, high tolls must be charged; however, traffic demand, the revenue generator, is highly sensitive to the toll level. Conversely, low tolls will cause low profitability and result in no participation of private investors.

Factor 2: Adequate Size and Limited Scope of Participation

[1] Ministry of Land, Infrastructure and Transport of Japan [2002] *Guidelines for BOT Road Project Development under Public-Private Partnership*, http://www.mlit.go.jp/sogoseisaku/inter/tech/tech_trans-3_j.html (as of Dec. 12, 2004)

Many BOT (PPP) projects are successful when their scope is limited to a certain part of a network, such as a bridge or a tunnel, and are implemented in an area lacking alternative routes. When a BOT (PPP) project is initiated in an area with alternative routes, the project may suffer from lower-than-projected traffic volume, depending on the convenience of such alternatives. Additionally, it is also important that the scale of the project should be manageable among private investors.

Factor 3: Substantial Public Support including Risk Sharing

In the past, transportation infrastructures were developed by the public sector because such projects involve a variety of risks, including high market risk, and require a large sum of money. Private enterprises must accept considerable risks when they decide to take charge of a project.

However, it becomes controversial that the public sector tends to depend too much on the BOT (PPP) method, generally leaving the business risk to private enterprises. Some BOT (PPP) projects are intrinsically unprofitable, even when the government supports them. Private enterprises will not participate in a project if it is highly risky or fails to guarantee adequate revenues. Even if they declare their intention to undertake a highly risky project, private businesses may quit negotiations in the planning phase or suspend the project just after it is started.

Given this, substantial support by the government or public agencies, especially in risk sharing, should be deemed as essential in order to facilitate the participation of private enterprises.

(3) Possibility of Private Sector Participation to the Project

Assimilating three success factors extracted in the above as a benchmark, the relevancy of each factor to the Project was qualitatively discussed in the context of Bangladesh.

Factor 1: Consistent Demand and Appropriate Toll Level

In this study, under the condition of ensuring the traffic demand, the toll rates that maximize revenues were obtained from a numerical equation shown in Section 9.2. Calculated level of tolls was found to be similar to existing toll rates at Jamuna Bridge and considered to be an appropriate level, as Jamuna Bridge is currently attracting more traffic than predicted.

However, even if the above rates that can guarantee a certain level of demand will be applied to the Project, the profitability of the Project as a whole is considered as miserable[2].

Factor 2: Adequate Size and Limited Scope of Participation

In terms of the road network, the scope of the Project is limited to a part of N8 national highway and will be implemented in an area lacking alternative routes. It is hard to consider that the Project would suffer from a lower-than-projected traffic volume, depending on the convenience of alternative routes. The Project, therefore, meets the requirement of Factor-2 from the viewpoint of limited scope (meaning there are no alternative routes that will harm the profitability of the Project).

However, looking at the financial scale of the Project, the total scale may not be manageable by private companies. As shown in Chapter 6, the total cost of the Project will exceed US$ 1,200 million, and BOT or PPP has never been applied to a project of such

[2] See Section 9.2 for more detail.

scale in Bangladesh[3]. This is a background that asserts project implementation under BOT (PPP) be of limited scale and/or sub projects. As shown in Section 9.2.5, the investment limit was calculated as 27,706.6 mil TK or $461.8 mil, which corresponds to 37.1% of the original project cost of 74,600.2. mil TK (=$1243.3 mil). This suggests that the portions of the project or subprojects for BOT (PPP) should be of a scale less than 27,706.6 mil TK or $1,178.3 mil.

Factor 3: Substantial Public Support including Risk Sharing

The literature review reported that there are four types of risks that are critical for BOT (PPP) projects[4]: country risk, market risk, credit risk and financing risk,. For each risk, the possibility of risk sharing between private companies and the government will be discussed in the following:

Country risk (Political risk)

Country risks, including political risk such as institutional change risk, stem from adverse effects of a change in economic policies or laws of the government. It is, by nature, entirely beyond the control of the private sector. To avoid or mitigate the risk and encourage private participation, substantial public support for risk sharing is necessary and the public sector needs to clarify its own responsibilities in the contract to be concluded with private companies.

In particular, changes in the transport policy, including setting tolls for transport facilities and introducing competing transportation systems, will significantly affect transportation demand around the project site. The government must clearly define the responsibilities to be assumed when policy changes result in a loss of revenue.

In the case of the Padma Bridge, firstly, the country risks may be deemed as the most critical on the grounds that they will be much higher in Bangladesh than in developed countries, due to high frequency of political power shift compared with the project duration and undeveloped legal framework in this field[5]. Second, experience with private infrastructure projects in the road sector are very limited on the government side[6]. Third, the uncertainty in the resettlement of affected persons living in the vicinity of the construction area is usually affecting the successful completion of bridge projects, and Padma is no exception in this regard. For these reasons, risk minimizing with this context is quite important and some ideas for risk mitigation are shown in Table 9.3.2.

Market risk

Transportation infrastructure is characterized by a comparatively high market risk. As explained, demand for transportation fluctuates widely with socio-economic changes in the nation and the level of services provided by the transportation facility. This makes private companies extremely cautious toward participation in a BOT (PPP) project.

In principle, market risk should be assumed by the private sector. Nonetheless, fluctuations in demand are partly caused by public policies such as a change in toll rates

[3] Meghnaghat Power Plant Project is considered as a successful BOT (PPP) case in Bangladesh. Total cost of the project is US$ 300 million (US$ 80 million by private investment). Regarding the road BOT(PPP) project in Bangladesh, Jatrabari Flyover Project is now under implementing with the financial scale of approx. US$ 100 million.

[4] Ministry of Land, Infrastructure and Transport of Japan [2002] *Guidelines for BOT Road Project Development under Public-Private Partnership*, http://www.mlit.go.jp/sogoseisaku/inter/tech/tech_trans-3_j.html (as of Dec. 12, 2004)

[5] In December 2003, Prime Minister's Office of Bangladesh prepared the *Bangladesh Private Sector Infrastructure Guideline*. It explains, however, merely a procedure of how to implement a private infrastructure project. It didn't provide, unfortunately, any practical legal frameworks ensuring such a project.

[6] The only example is Jatrabari Flyover Project with total project cost of US$ 100 million.

and road construction in the vicinity of a project site. Particularly in developing countries, where there are intrinsically existing higher market risks than in developed countries, governments need to provide risk hedges, such as guaranteeing a certain amount of revenue based on minimum traffic volume.

In Padma's case, it is projected that the daily traffic volume will reach around 20,000 vehicles in 2015 and then will increase at an annual rate of about 7% till 2034[7]. Generally speaking, in a BOT (PPP) project in developed countries, practical risk sharing for demand fluctuation is a partial revenue guarantee by the public sector, which is normally stipulated in the concession contract. In this sense, this type of risk hedge is expected to be applied to the Project (See Table 9.3.2 for risk mitigation methods).

Credit risk

Credit risk is the risk that the private-sector partner will withdraw from the project. Some BOT (PPP) cases in developed countries unfairly punish such withdrawals. A disproportionate burden on private companies discourages them from taking part in BOT (PPP) projects. If the government provides appropriate risk hedges, however, private businesses will not make excessive demands to offset such burdens. In practice, to hedge credit risks the public sector generally asks a third party to be a joint guarantor or to contribute to a trust fund for the project (See Table 9.3.2 for more detail).

Financing risk

Financing risk is the risk that the private-sector participant will fail to acquire the necessary funds, forcing the enterprise to discontinue operations. This kind of risk is generally assumed by the private companies. However, in developing countries where projects may lack financing certainty, financial support from the government, not only during operation but also at the commencement of a project, is necessary to facilitate private participation.

In Bangladesh, a non-bank financial institution called Infrastructure Development Company Limited (IDCOL) was established in 1997, through collaboration with the World Bank[8], for the purpose of promoting and facilitating private sector participation in infrastructure development projects. Nevertheless, i) only a few BOT projects, especially in the power sector, have been implemented under financing by IDCOL at the moment, ii) one of the conditions for financing is that at least 40 percent of equity or investment from private investors should be secured[9], and iii) the scale of financing is at most around US$80 million. Given these facts, it would be hard to apply an IDCOL scheme to Padma's main construction work. Besides, it has to be taken into account that foreign exchange risk would be extremely high in Bangladesh, and profits from the project may significantly deteriorate. Some ideas for risk mitigation are shown in Table 9.3.2.

The country, market, credit and financing risks would become critical should the Project be implemented under the schemes of BOT (PPP).

(5) Summary of Evaluation and Possible PPP Scheme

In conclusion, a variety of constraints exist for the project implementation under private participation methods. Focusing on the Operations and Maintenance (O&M), as is the case with the Jamuna Bridge where the O&M have been implemented on a contract-basis with a private operator, the same scheme is applicable to the Project. Additionally, it would be

[7] See Chapter 2 for more detail.
[8] See http://www.idcol.org/index.htm (As of Dec.15, 2004) for more detail.
[9] Ibid.

beneficial that the JMBA, a governmental agency to be in charge of the O&M of the Padma Bridge, has already accumulated experiences in this field. Otherwise, a kind of concession contracting for the O&M for a certain period could be applied under the international competitive bidding.

Furthermore, although the scale is extremely limited and project cost saving is not much expected, there would be room to maneuver for private sector participation in the areas such as follows :

1) Development and operation of the service area:
The cost for construction of the service area (US$ 6.43 million out of US$ 1,256.82 million of the total project cost) and the facilities (restaurants, shops, gas stations, toilets and other facilities such as hotel, observatory, picnic area, sports area, etc.) to be accommodated in it is invested by a private investor, and the rights to plan, design and operate these facilities for business purposes are granted to the investor.

2) Construction of the approach road and use of the reclaimed land:
The cost for construction of the entire approach road of the Padma Bridge (US$ 68.87 million out of US$ 1,256.82 million of the total project cost) is invested by a private investor, and the right to use the reclaimed land of about 1.3 km^2 excluding the service area of 0.5 km^2, which will be formed by the earth of about 7.0 million m^3 dredged from the river training work of the Padma Bridge Project, for business purposes are granted to the investor with the guarantee to access directly to the Project highway.

3) Installation and operation of gas pipeline and telephone line:
It is not unreasonable to demand the utility companies to share the initial construction cost of the Padma Bridge due to the cost increase caused by accommodation of the gas pipeline, telecommunication cables and power transmission, instead of charging the accommodation fees as described in 9.2.3.

Table 9.3.1 Analysis of Private Sector Participation in Main Construction Work

Requirements for BOT (PPP) Project	Issues and Constraints
Consistent Demand and Appropriate Toll Level	Even if toll rates that could guarantee a certain level of demand were applied to the Project, the profitability as a whole is predicted to be miserable compared to the profitability expected by the private sector.
Adequate Size and Limited Scope of Participation	The financial scale of the Project may be to large for private companies. The total project cost will exceed US$ 1,200 million, and such a scale has never been applied to BOT or PPP project implemented in Bangladesh. The investment limit was calculated as 27,706.6 mil TK or $461.8 mil, which corresponds to 37.1% of the original project cost.
Substantial Public Support including Risk Sharing	It would be hard to expect to obtain substantial public support and appropriate risk sharing may not be realized when applying PPP scheme to bridge construction works. However, there would be room to maneuver for private sector participation for a limited scope, and possible risk mitigation methods are summarized in the next table.

Table 9.3.2 Risks of the Project and Methods of Risk Mitigation

Category of Risk	Description of Risk	Example of Risk Hedge
Market Risk	Traffic demand for roads or bridges fluctuates widely with socio-economic changes in the country. Toll rates may be decided on the basis of socio-economic effects such as poverty alleviation and taxation issues, not based on the financial profitability.	Guaranteeing a certain amount of revenue based on minimum traffic volume Giving authority for change of toll rates to a private company
Credit Risk (Nonperformance or Contractual default risk)	A private sector partner may withdraw from the project.	Specifying punishment clause for such withdrawals on a concession contract
Financing Risk	A private sector participant may fail to acquire the necessary funds, forcing the enterprise to discontinue operations.	Obtaining bank's guarantee for unpaid equity
Country (Political) Risk	Due to institutional change, including a change of economic policies or laws of the government, the project may be abandoned.	Stipulating on the concession contract that the public sector will cover the additional cost caused by institutional changes. Utilizing insurance or risk guarantee scheme developed by international financial agencies. Ideally, parliamentary resolution for project implementation is necessary.
Inflation and Foreign Exchange Risk	Due to sharp inflation, the profitability of the project may deteriorate. Restriction on foreign exchange transactions may discourage private sectors interest.	Applying toll rate adjustment mechanism linked with inflation indexes Guaranteeing a private partner's discretion in foreign exchange

(6) Conclusions

Three issues were identifed as critical factors for the successful implementation of BOT or PPP schemes in transport sector projects. These are i) whether consistent demand will be secured throughout the project period, (ii) whether the project is planned or designed with proper size (including financial aspects) and limited scope of participation, and (iii) whether the project is fully supported by the government and potential risks are appropriately shared among stakeholders, including government and private investors. According to the result of discussions, private financing could probably be introduced for a limited part of the Project and/or sub project with concerted efforts to minimize the risks among all stake holders. As is the case with the Jamuna Bridge, where operations and maintenance (O&M) has been implemented on a contract-basis with a private operator[10], the same scheme could also be applied to the Project. This method will be endorsed by the fact that the JMBA, a government agency in charge of the O&M of the Padma Bridge has already accumulated experiences in this field. Moreover, (i) construction and operation of the toll plaza by a private company and (ii) installation of gas pipeline and telephone line with private sector participation would be possible, although the scale is extremely limited and not much project cost saving is expected.

[10] See Chapter 11 for more detail.

Chapter 10 Alternative with Railway Provision

10.1 OBJECTIVES AND SCOPE

10.1.1 Objectives

The economic feasibility of Padma Bridge as a road bridge was confirmed in the previous chapter and alternative-1 (extra-dosed girder type) was selected as an optimum plan. Based on these results, the possibility of including the provision of broad gauge railway link on the road bridge has been examined as an alternative design. The purpose of preparing an alternative railway provision is to maintain the possibility of railway installation on Padma Bridge as a future option when sound financial conditions of the government and Bangladesh Railway (BR) and other relevant circumstances are realized.

10.1.2 Scope of Provision

It should be noted that this provision is still based on a road bridge but is designed with sufficient space to accommodate a broad gauge track (1,676 mm) with structures based on a standard that can accept additional loads even as large as Indian railway freight wagons.

It is also noted that new railway links to connect Padma Bridge with the exiting railway network from both sides of the Padma River are outside the scope of this provision. Those new railway links are treated as other railway projects and are not within the Padma Bridge Project.

10.1.3 Future Roles and Functions of Railway Provision

When this railway provision is realized in the future, it will result in significant impacts on domestic and international transport as a multi-modal facility. Connected with the Trans-Asian Railway system, it will contribute to promote economic cooperation in the Eastern Region of the Indian Sub-continent. It will integrate not only the divided Southwest Region with the rest of the country but also integrate the landlocked states of the northeastern parts of India with the central areas of India. These impacts, especially on international transport between surrounding countries, are presented in detail in the next Chapter.

10.2 ENGINEERING AND COST STUDIES ON RAILWAY PROVISION

In Section 5.2 Preliminary Design of Padma Highway Bridge, Alternative-H1 PC Extra-dosed Girder Bridge was selected as the favorable bridge type for the highway bridge through a comparison of three alternatives: Alternative-H1 PC Extra-dosed Girder Bridge, Alternative-H2 PC Extra-dosed Girder Bridge and PC Cable Stayed Girder Bridge, and Alternative-H3 PC Extra-dosed Girder Bridge with Minimum Width.

Accordingly, the engineering and cost studies in this Section are based on the PC Extra-dosed Girder Bridge.

10.2.1 Bridge Width for Railway Provision

The Padma Bridge would be built on Asian Highway (AH) Route No. A-1 planned under UNESCAP. The Study Team has examined the standard bridge widths with those

stipulated in the AH standard by UNESCAP and the Bangladesh highway standard by RHD. The Study Team proposes the width composition shown in Figure 10.2.1 for the initial stage prior to incorporating the railway; this meets the AH standard for a 2-lane dual carriageway with median strip. When the railway is incorporated, the width composition will be changed as shown in Figure 10.2.2. This meets the RHD standard for 2-lane dual carriageway and Bangladesh Railway standard for a single broad gauge track.

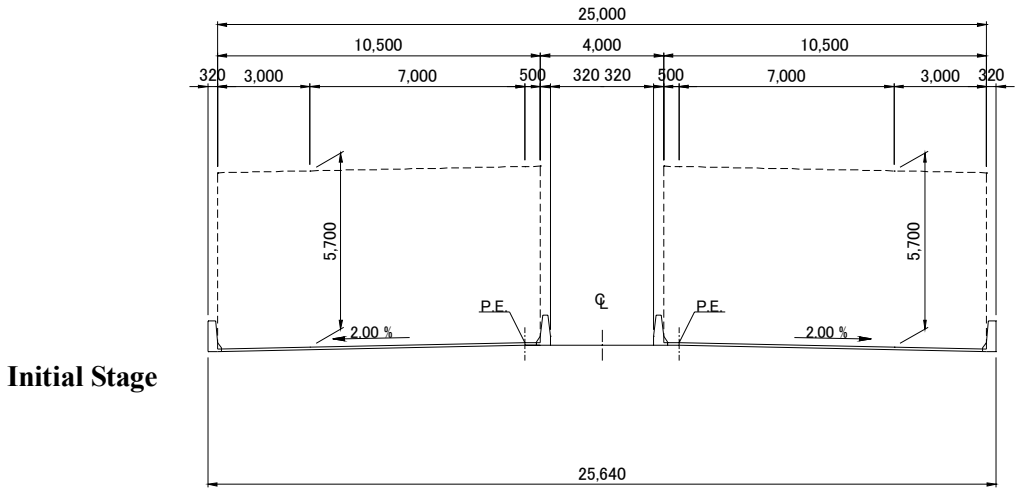


Figure 10.2.1 AH Standard (Initial Stage with Railway Provision)

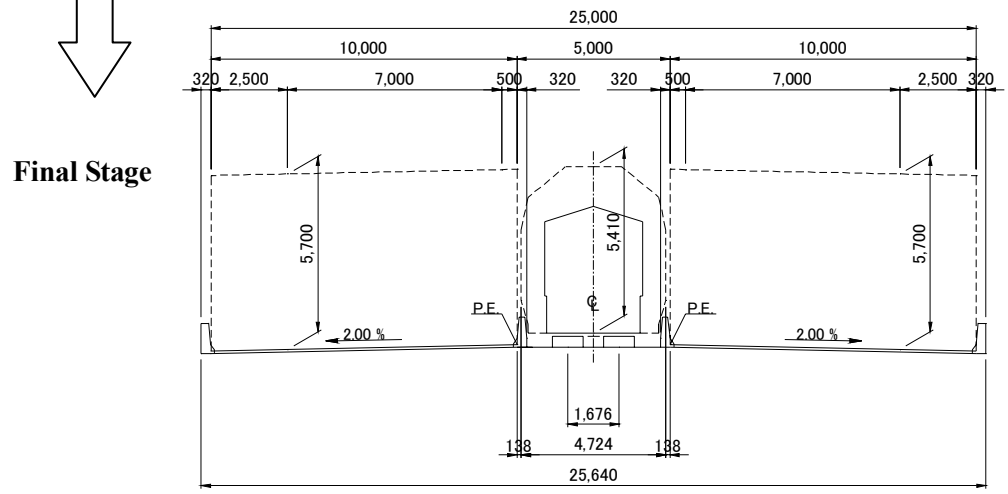


Figure 10.2.2 RHD Standard (Final Stage with Railway Provision)

10.2.2 Design Criteria and Standards for Railway Provision

(1) Design Criteria

These design standards and criteria were confirmed through discussions with officials of Bangladesh Railways.

Main important assumptions are described hereunder:

1) Broad gauge (1,676mm) trains will be operated on the bridge;
2) Non-electrified single track will be installed; and

3) The Indian Railways standards and criteria are considered partly because of the future possibility of operation of freight wagons owned by Indian Railways.

Railway design criteria applied to the Project are shown in the following Table.

Table 10.2.1 Design Criteria Adopted to Railway Provision

Proposed speed on the bridge	50 km/hr
Maximum gradient	10 ‰ (on and around bridge)
Minimum curve radius	340m (on and around bridge)
Construction gauge	Shown in Figure 5.3.1
Track structure	Shown in Figure 5.3.2
Limit of train length and weight	528m and 19,570 kN

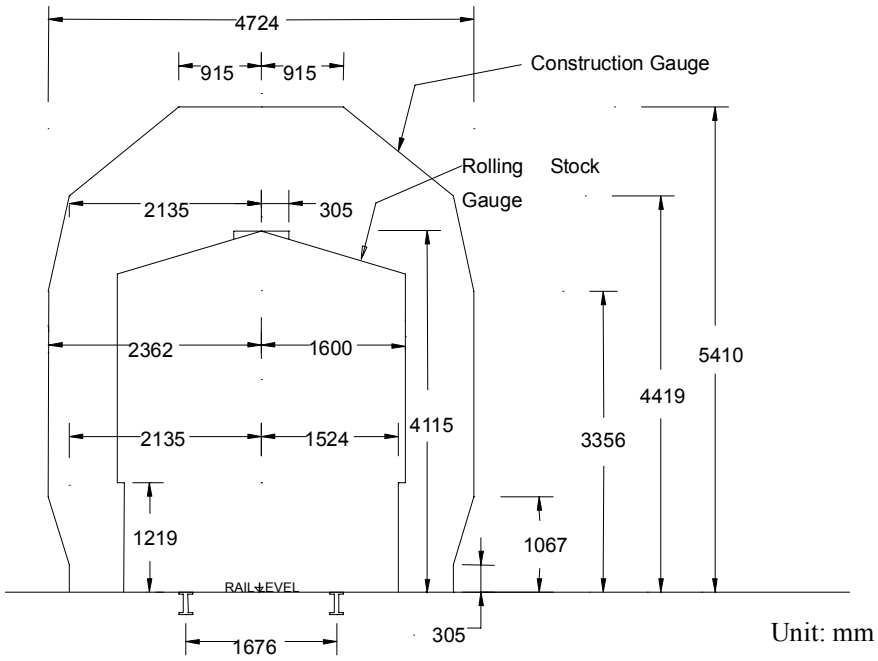


Figure 10.2.3 Construction Gauge

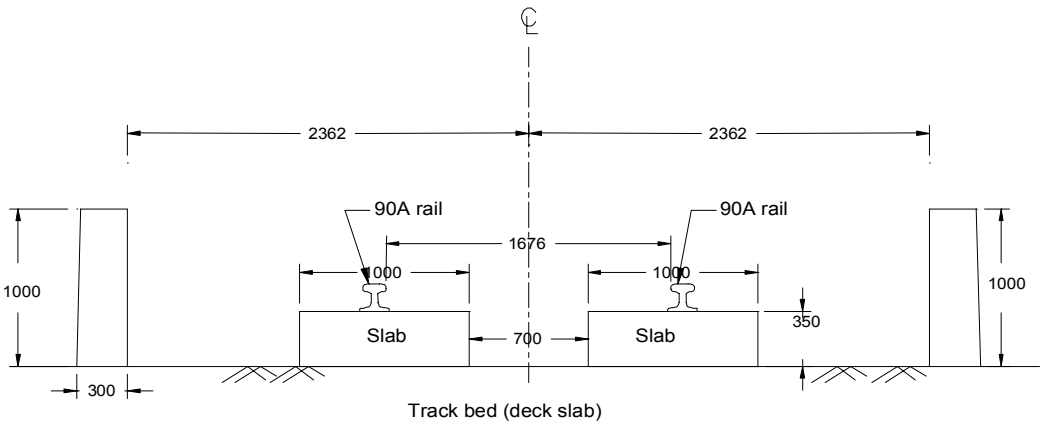


Figure 10.2.4 Typical Section of Railway Portion

(2) Rail Loads

In Bangladesh Railway standards, the following are considered as railway-related loads:

- Live Load
- Impact
- Centrifugal Load
- Longitudinal Load (Traction and Breaking)
- Wind Pressure Load

(a) Live Load

The proposed design load for the railway is shown in Figure 5.3.3. Regarding the trailing load, the Indian Railways standard is applied in consideration of trailers from/to India. For the locomotive load, the Bangladesh Railways standard is adopted because Bangladesh Railway locomotives will tow trailers not only for Bangladesh Railway but also for the Indian Railways.

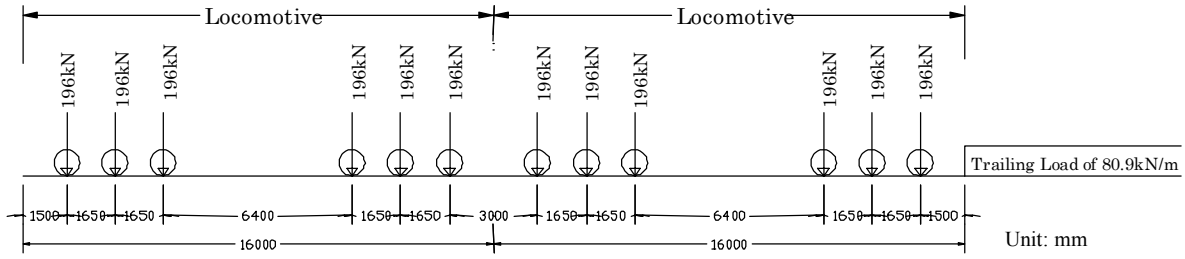


Figure 10.2.5 Rail Loads to be Considered for Railway Provision

(b) Impact

The impact load shall be taken as equal to the live load giving the maximum stress in the member under consideration multiplied by an impact coefficient 'I ' obtained from the following formula:

$$I = \frac{19.8}{13.7 + L}$$

(Subject to a maximum of 1.00)
where L(m) = Effective span length

(c) Centrifugal Load

The horizontal centrifugal force, which may be assumed to act at a height of 1,830 mm above rail level, is calculated from the following formula:

$$C = \frac{WV^2}{12.95R}$$

where C= horizontal effect (kN/m),
W=equivalent distributed live load (kN/m),
V= maximum speed (km/hr), and
R= radius of curve (m)

(d) Longitudinal Load

Although Bangladesh Railway has a standard for longitudinal load, it can not be adopted because it does not deal with long-spanned bridges. The Japanese standard, however, refer to all bridge types. Therefore the Japanese standard , which is outlined below, is applied.

- Breaking Load: 25% of the design load

- Traction Load: 25% of the design locomotive load

(e) Wind Pressure Load

For loaded spans, the net exposed area is computed as the horizontal projected area of the moving train.

- Maximum Train Height: 4.115m
- Maximum Train Length: 528m

(f) Dead Load (track load only)

According to the typical cross-section shown in Figure 5.3.2, the dead load for railway track per meter will be estimated as follows:

- 18.03 kN/m
  (Slab: 24.5 kN/m^3 @ 0.7m^3 = 17.15 kN/m, Rail (90A): 0.44 kN/m @ 2 = 0.88 kN/m)

10.2.3 Alternative-HR: PC Extra-dosed Girder Bridge with Railway Provision

(1) Superstructure

Figure 10.2.4 shows a general arrangement of spans for the Alternative-HR with railway provision, while Figure 10.2.5 and Figure 10.2.6 show the elevation and cross-sectional views in more detail.

The main bridge portion, 5400 m in length and the same as the other highway bridge alternatives, is mainly composed of PC extra-dosed structures, with PC continuous box girder structures added on both banks. It comprises 7 modules of 720 meters, 2 modules of 360 meters in extra-dosed structure, and also 2 continuous box structures of 180 meters long.

As this alternative accommodates a railway, the deck is wider by 3.5 meters. Furthermore, the difference of slope limit between the highway and railway has to be considered in the span arrangement. In other words, where the highway goes up or down at a slope steeper than 1%, the railway can not go together with the highway on the same deck, and thus they have to be on separate decks. On both ends of the bridge the railway slopes at a gentler gradient away from the highway, as shown in the cross-sectional view of Figure 10.2.6.

As the deck of this alternative is wider than that of the highway bridge Alternative-H1, and the live load of the railway is much heavier than that of the highway, the construction cost is higher.

The same number of navigation routes is to be provided as for the highway bridge Alternative-H1.

(2) Substructure

Figures 10.2.7 and 10.2.8 show the general arrangements of the river edge and mid-river substructures, respectively. The addition of railway live load and associated increased superstructure width requires a more substantial substructure when compared to Alternative-1.

In order to minimize the effect of river flow, pile caps are provided with rounded corners. The 3150mm diameter hollow steel tubular piles have a maximum rake of 1 in 6 to the vertical, and are to be infilled with a mass concrete toe plug to generate additional end bearing.

The four edge river piers comprise a 17.5m x 37.0m x 7.1m deep pile cap supported on 12 piles with an average maximum wall thickness of 66mm. Average toe elevation is -93.0mPWD, providing an approximate embedded depth of 48m below the design river bed level.

The twenty-six mid-river piers comprise a 17.5m x 31.5m x 7.1m deep pile cap supported on 10 piles with an average maximum wall thickness of 62mm. Average toe elevation is -80.0mPWD, providing an approximate embedded depth of 49m below design river bed level.

The twin pier columns forming the base of the extra-dosed cable towers are each 6.0m x 7.0m in overall cross- sectional area with minimum wall thickness of 1.25m, with a similar connecting cross-beam 5.5m deep. This cross-beam may be alternatively hidden within the superstructure.

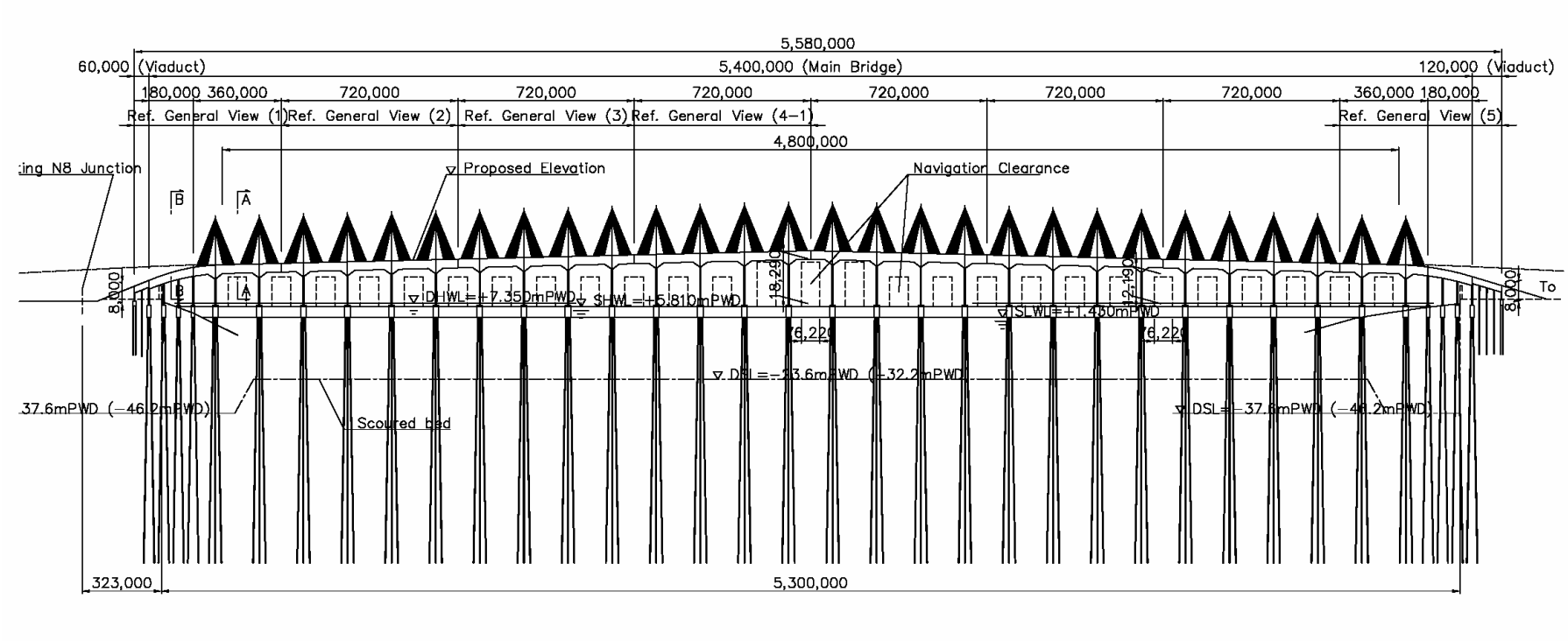


Figure 10.2.6 General View

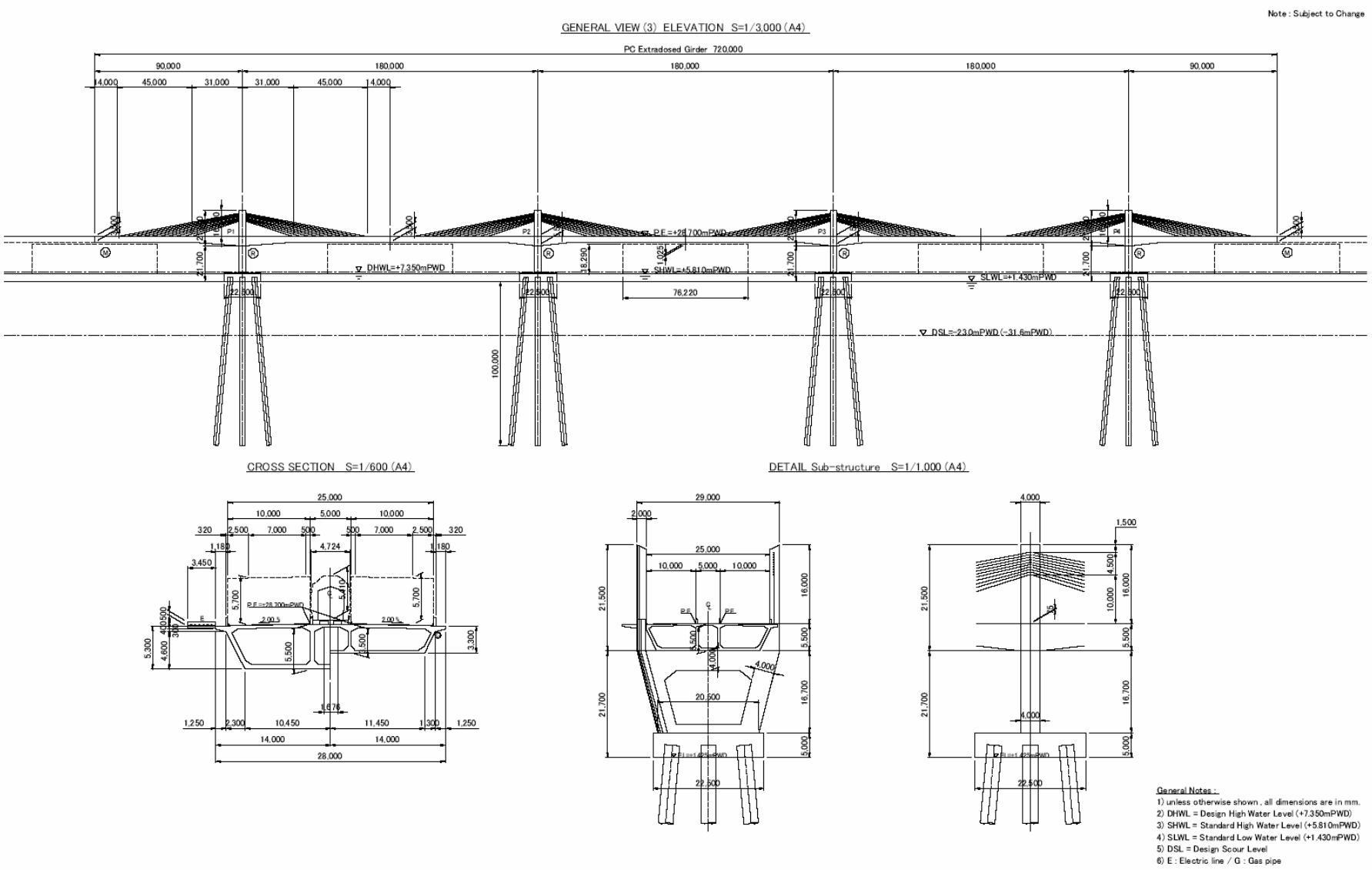


Figure 10.2.7 Main Bridge Portion

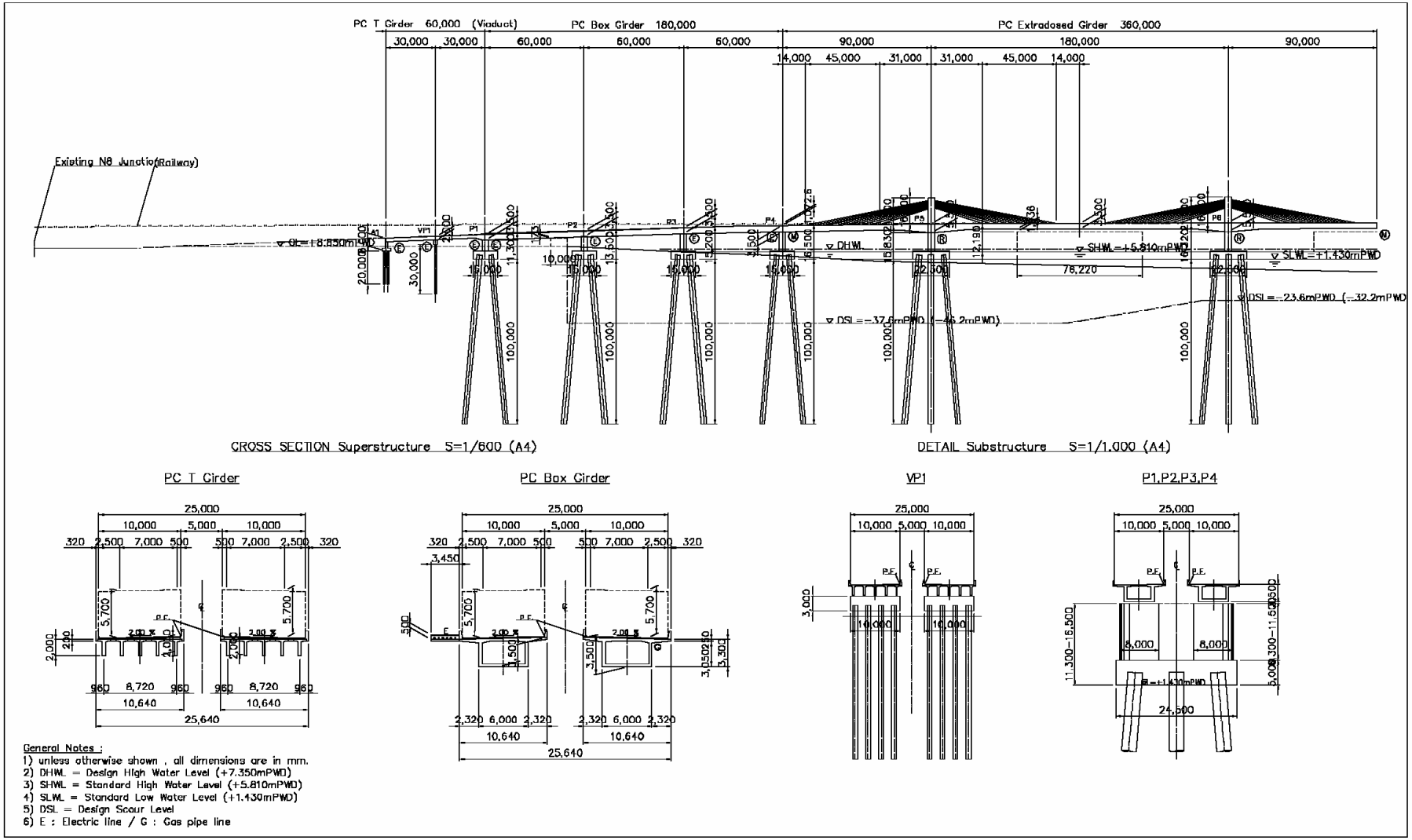


Figure 10.2.8 Viaduct Portion

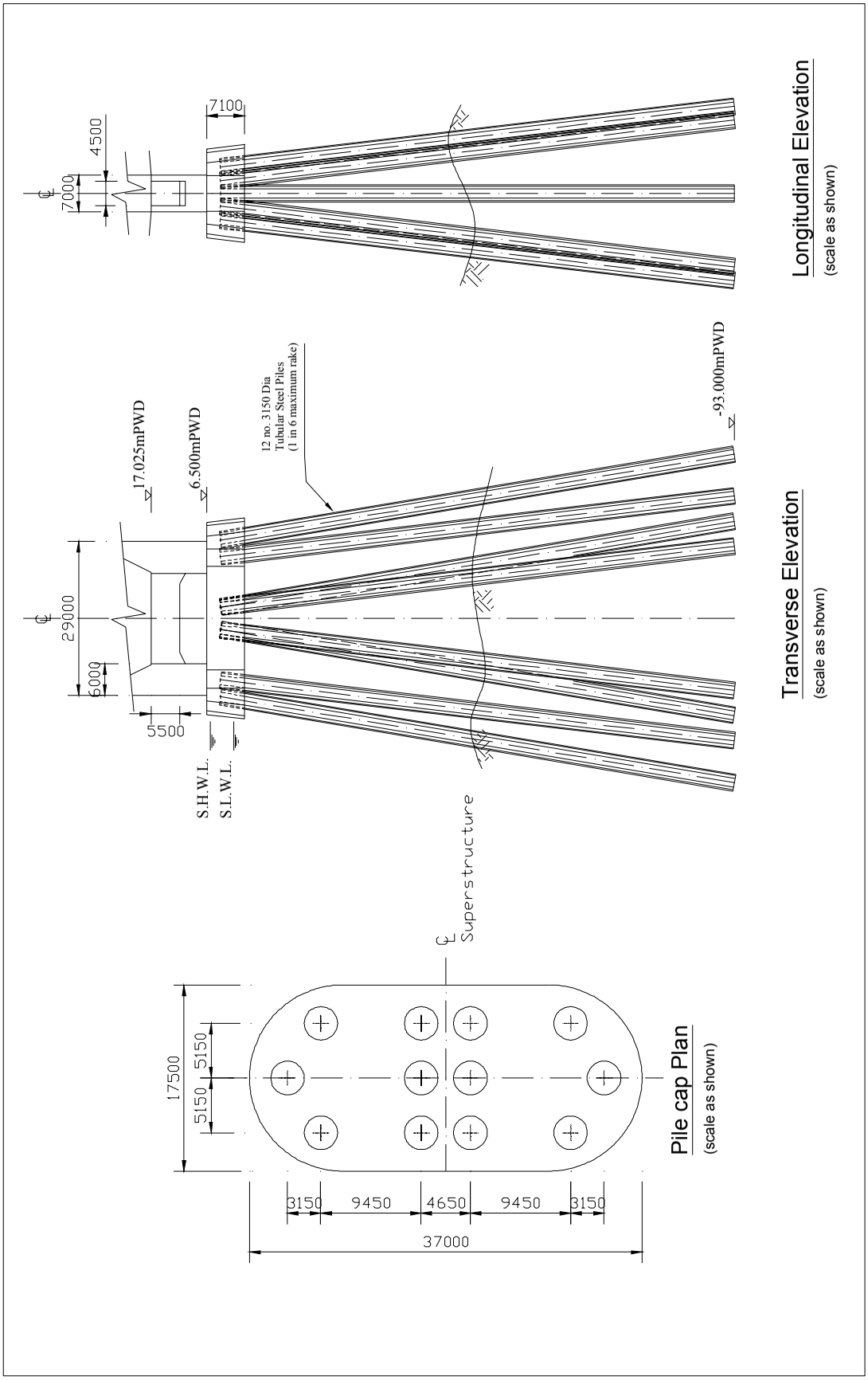


Figure 10.2.9 Edge River Pier

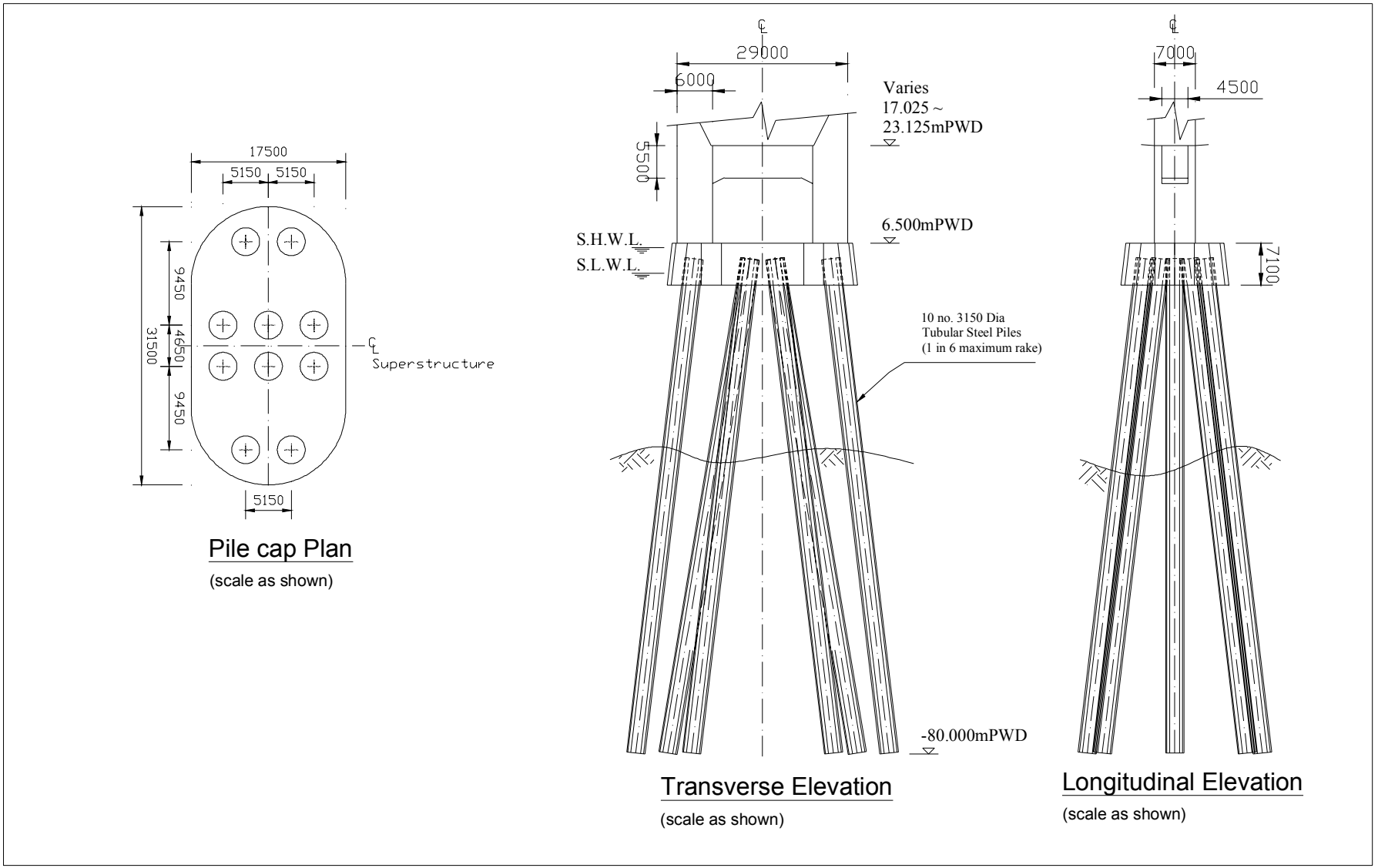


Figure 10.2.10 Mid-River Pier

10.2.4 Project Cost of Alternative for Railway Provision

The same items shown in Chapter 6 are also presented in the summary table in Table 10.2.2.

Table 10.2.2 Project Cost Summary for Alternative-HR: Railway Provision

Name of Bridge Alternative	**Alternative-HR**
Bridge type	Extra-dosed girder
Carriage purpose of bridge	with Railway Provision
Bridge width	25.0m
Project cost items	Unit: USD
1. Construction cost	892,891,870
1) Bridge	482,694,470
2) Approach roads/Toll gate/S.A	49,193,790
3) River works	361,003,610
2. Engineering cost	53,573,500
1) Detailed design (2~3% of item-1)	17,857,830
2) Construction supervision (4% of item-1)	35,715,670
3. Administration cost	5,357,340
1) Details design stage (10% of item-2 1))	1,785,780
2) Construction supervision stage (10% of item-2 2))	3,571,560
4. Land acquisition and resettlement, and EMP cost	75,000,000
5. Physical contingency (15% of item-1)	133,933,780
6. Duty tax (VAT etc) (14.5% for importation of item-1+2)	96,066,230
Total project cost	**1,256,822,720**

Remarks : Utility construction cost was independently estimated as below;

Item	Cost (USD million)
Power Transmission	61.06
Gas Pipeline	3.75
Telecommunication	1.50

10.3 ECONOMIC AND FINANCIAL EVALUATION

10.3.1 Introduction

In order to confirm economic viability of the development scheme of highway with railway provision, economic and financial evaluation was carried out. In conjunction with the conclusion in Chapter 9, a scheme for railway provision was prepared on the basis of Alt. H-1 of the highway bridge development scheme. Alt. H-1 is the most economically viable bridge development scheme with PC extra-dosed girder bridge, also satisfying the Asian Highway Standard. The analysis was carried out based on the same procedures and same premise of evaluation as those outlined Chapter 9. The magnitudes of benefit and revenue from the highway with railway provision are deemed to be equivalent to those of Alt. H-1 except for the annual fee revenue to be paid by Bangladesh Railway (BR) authority. In line with three of the highway bridge development alternatives (Alt. H-1, Alt. H-2 and Alt. H-3), this alternative scheme with rail provision was defined as Alt. HR.

10.3.2 Economic and Financial Aspects of Highway Bridge with Railway Provision

(1) Project Cost

Economic and financial costs of the alternative highway with railway provision (Alt. HR) were estimated as shown in Table 10.3.1

Table 10.3.1 Project Cost of Alt. HR

Unit mil. TK

Work Item	Financial Cost	Economic Cost
Construction Cost	57473.5	54573.6
Detailed Design Cost	1071.5	916.1
Construction Supervision Cost	2142.9	1832.2
Administration Cost	321.4	274.8
Land Compensation Cost	4500.0	3847.5
Contingency	8036.0	0.0
VAT for Imported Tax	5764.0	0.0
Total	79309.4	61444.2

The corresponding cost disbursement schedule was prepared in accordance with the project implementation plan as shown in Table 10.3.2.

Table 10.3.2 Cost Disbursement Schedule of Alt. HR

Unit: mil. TK

Year	Financial Cost	Economic Cost
2007	2020.8	1727.7
2008	2020.8	1727.7
2009	1538.2	1315.2
2010	10474.4	8001.5
2011	28630.2	21870.7
2012	16759.1	12802.3
2013	11172.8	8534.9
2014	6693.2	5464.2
Total	79309.4	61444.2

(2) Annual Operation and Maintenance (O&M) Cost

Annual maintenance cost was prepared on the basis of the operation and maintenance plan shown in Chapter13 where 1.25% of construction cost was appropriated to the first 5 years and 0.75% of construction cost years 6-30. This method is the same as that adopted for

highway bridge alternatives. The results are shown in Table 10.3.3.

Table 10.3.3 Annual O&M Cost of Alt. HR

Unit: mil. TK

Term	1-5 Years after Opening	6-30 Years after Opening	Total
O&M in Financial Cost	669.7	401.8	13393.5
O&M in Economic Cost	640.5	384.3	12810.0

(3) Benefit

The benefits of Alt. HR are the same as those for the highway bridge alternatives adopted as shown in Table 9.1.7 in Chapter 7, where benefits in 2015 and 2025 were estimated to be 15903.2 mil. TK and 16626.1 mil. TK, respectively.

(4) Residual Value

Residual value after the 30-year evaluation period (year 2044) was estimated at 19570 mil TK under the assumption of a 50 year project life.

(5) Revenue

Tariff revenues from toll bridges, fee revenue for accommodation of utility facilities (power transmission, telecommunications cable and gas pipeline) and fee revenue for provision of railway constitute the total revenue in the case of Alt. HR. Revenue from the railway facility was set at 87.5 mil. TK/year. This was based on applying the present unit tariff on rail at Jamuna Bridge and is shown in Table 10.3.4.

Table 10.3.4 Set out of Tariff Rate on Rail at Padma Bridge

Length of Jamuna Bridge	4.8 km
Tariff on Railway at Jamuna (2004)	75 mil.TK/year
Unit Tariff	15.625 mil.TK/year
Length of Padma Bridge	5.6 km
Estimated Tariff for Railway on Padma	87.5 mil.TK(=15.625mil.TK x 5.6 km

Revenues from the toll bridge and tariffs charged on utility facilities are the same as those in Alt. H-1, where toll revenue was estimated based on the toll rates that maximize the toll revenue: LV: 415 TK, Bus: 1040 TK, and Truck: 1095 TK, as shown in Table 9.2.2. The process of estimating revenues from utilities is detailed in Table 9.2.3. Table 10.3.5 summarizes estimated revenues for the case of Alt. H-1.

Table 10.3.5 Summary of Revenues for Alt. HR

Unit: mil. TK/year

Year	Tariff on Traffic				Tariff on Utility Facility				Railway	Total
	LV	Bus	Truck	Subtotal	Power Cable	Gas Pipeline	Telcom.	Subtotal		
2015	563.3	4152.8	1549.5	6265.6	42.0	52.5	52.5	147.0	87.5	6500.1
2025	1077.5	8401.1	2748.9	12227.5	42.0	52.5	52.5	147.0	87.5	12462.0

*Tariff on traffic is estimated at rates that maximize total revenue:
LV: 400TK, Bus: 800TK, Truck: 1095 TK

10.3.3 Economic Evaluation

(1) Premise of Evaluation

In order to evaluate the economic viability of the case of the highway bridge with railway provision, an economic study was carried out in the same manner as that outlined in Chapter 9. The major premise is reiterated below:

1) Evaluation period was set at 30 years after the opening of the Project
2) The ceiling of benefit growth was set at year 2033, when the daily traffic volume on the bridge is expected to reach 75,000; this corresponds to 1.5 times the daily highway capacity of 48,000 vehicles per 4-lane highway. This is the level that vehicle speed during peak hours reaches 10km/hr.
3) Economic discount rate or opportunity cost of capital in Bangladesh necessary for the calculation for B/C and NPV and for the evaluation of EIRR was set at 12% per annum.

(2) Results of Economic Evaluation

The calculated evaluation indicators are shown in Table 10.3.6. As a result, it could be concluded that the scheme of bridge with railway facility is economically viable; the EIRR results in a higher value than the official discount rate of 12%, the B/C ratio exceeds 1.0, and there is a positive NPV.

Table 10.3.6 Results of Evaluation Indicators for Alt. HR

Alternative	EIRR(%)	B/C	NPV (Mil. TK)	NPV (mil. $)
Alt. HR	14.80	1.38	10771.1	179.5

When compared to the results for Alt.H-1, the most recommended alternative among the three highway bridge development schemes (with an EIRR of 15.35%, B/C, 1.46, and NPV 12404.2 mil. TK), it could be concluded that no significant difference exists between them in economic terms. In this context, it is concluded that the proposed bridge should include the railway provision. The analysis in the following section further reviews this point.

(3) Economic Consideration on the Timing of Provision of Railway Facility

The extra project cost for the railway provision with the highway bridge is estimated at US$ 67.1 million or 4026 million TK in terms of 2004 economic prices. On the other hand, if a railway bridge is constructed independently of the highway bridge, the cost is roughly estimated to be as high as $181.7 million, or about 10800 million TK in 2004 price, as shown in Table 10.3.7. The results of the economic evaluation reveal that the bridge exclusively designed as a highway (Alt. H-1) shows slightly higher returns compared with that with railway provision (Alt. HR). This is the background to the opinion that asserts the proposed bridge should be a highway bridge only and a railway bridge should be constructed independently at a later time, when the railway extension plan from Dhaka and so on becomes a more realistic option.

Table 10.3.7 Construction Cost of Independent Railway Bridge

Item	Dimension
Unit Construction Cost (in financial price)	$4725/m^2
Length	5580 m
Width	8m
Cost (mil.$ in financial price)	210.9
Cost (mil. TK in financial price) 2004	12654.0
Cost (mil.$ in economic price)	180.0
Cost (mil. TK in economic price 2004)	10819.1

However, simple economic calculations reveal that inclusion of the railway function into the highway bridge is more economic than constructing an independent rail bridge later. Disbursement of the extra project cost (4026.0 mil. TK) associated with construction of the highway bridge with railway provision is more economic than constructing an independent railway bridge at a later time. It is suggested that the value of extra investment of 4026 mil. TK is worth 36705.9 mil. TK in 2023, even after including accumulated annual O&M cost up to that year. The value in 2023 is almost equivalent to the independent construction cost of the railway bridge at current 2015 prices, that is 36705 mil. TK assuming a discount rate of 12% per annum. Thus, construction of the railway function at an earlier time is far better than constructing an expensive independent railway almost 10 years after the opening of the bridge, as suggested in simple economic analysis in Table 10.3.8. It is recommended that the bridge structure should incorporate both a highway and railway.

Table 10.3.8 Future Value of Extra Cost for Rail Facility

Unit: mil. TK

Year	Cost Disbursement Schedule (2004 price)			Current Value of Extra Rail Facility Cost			
	Extra Rail Facility Cost	Annual O&M Cost	Total	Extra Rail Facility Cost	Annual O&M Cost	Accumulated O&M Cost	Total Value
2015	4026.0	51.2	4077.2	14004.6	178.1	178.1	14182.7
2016		51.2	51.2	15685.2	199.5	377.6	16062.8
2017		51.2	51.2	17567.4	223.4	601.0	18168.4
2018		51.2	51.2	19675.5	250.2	851.2	20526.7
2019		51.2	51.2	22036.6	280.2	1131.5	23168.0
2020		30.7	30.7	24681.0	188.2	1319.7	26000.6
2021		30.7	30.7	27642.7	210.8	1530.4	29173.1
2022		30.7	30.7	30959.8	236.1	1766.5	32726.3
2023		30.7	30.7	34675.0	264.4	2030.9	**36705.9**
2024		30.7	30.7	38836.0	296.1	2327.1	41163.1
2025		30.7	30.7	43496.3	331.7	2658.8	46155.0

* Independent railway bridge construction cost in 2004 prices:10819,1 mil. TK

** Independent railway bridge construction cost in current prices: of 2015 (Opening Year37634.8 mil. TK、under 12% discount rate. Value in 2023 is the nearest value to 37634.8 mil. TK.

10.3.4 Financial Evaluation

(1) Premise of Evaluation

Financial analysis was conducted to confirm the extent of redemption of cost to be invested with revenues from vehicle tolls and tariffs on utility facilities and railway. Therefore, the analysis carried out was limited to maximum conceivable toll revenues as discussed in Section 9.2.2 (b) in Chapter 9. The analysis was undertaken in line with the financial analysis in Chapter 9, where the evaluation period was set at 30 years and a discount rate of 12% per annum was adopted. The analysis was carried out based on financial cost disbursement, maintenance cost and revenues for the case of Alt. HR, bridge development scheme including the railway. Financial aspects of the case are summarized in Table 10.3.2. In the analysis neither cost escalation nor price increases in tariffs are assumed.

(2) Results

The calculated evaluation indicators are shown in Table 10.3.9. FIRR in this case is 10.28% and Revenue Cost Ratio (R/C) is 0.81. Both are relatively good values for such a large infrastructure development project, but alone are not satisfactory to conclude that the scheme is financially viable. However, the huge amount of revenue, as shown in Table 10.3.6, suggests a sufficiency in affordability of recovery of investment costs at an early time, as will be discussed in Section 6, Chapter 11.

Table 10.3.9 Results of Financial Evaluation

Case	FIRR	R/C Ratio
Case Alt. H-R (Highway & Rail Bridge)	10.28%	0.81

10.3.5 Conclusion

It could be concluded that a highway bridge with railway provision is economically feasible. Furthermore, simple economic analysis suggests that early provision of the railway function is more economical than its provision well into the future. Additional project cost of highway and railway is about 4,700 mil. TK ($78 mil.) in financial prices, which is less than 7% of total project cost of just the highway bridge (Alt. H-1).

Although the bridge is not financially viable, as is also the case for all exclusive highway bridge alternatives (Alt. H-1, Alt. H-2, and Alt.H-3), the massive amount of revenues from traffic tolls and tariff revenues from utilities and the railway guarantee early redemption of construction costs.

It is also noted that, although the cost of capital (interest rate) is set at 12% in this study, this capital cost in a financial evaluation is variable depending on the conditions of domestic and international financial markets. Therefore, the alternative HR is still maintaining the possibility to be financially viable with a value of over 10% of FIRR. Under the situation, it is not correct to easily judge that the Alternative HR is not financially viable.

10.4 CONCLUSION OF RAILWAY PROVISION ALTERNATIVE

10.4.1 Introduction

The Padma Bridge will generate remarkable impacts for the whole country and contribute to the economic development of the Southwest Region of Bangladesh. At the same time, the Padma Bridge is situated at the best location to form an international transport corridor as part of Asian Highway A-1. If a rail provision on the Padma Bridge is effectively connected with the existing railway network, the Padma Bridge can contribute to the formation of a multi-modal international transport corridor for the Eastern Region of the Indian Sub-continent. It will also have the possibility of providing a transit route for India to its eastern states (seven sisters).

10.4.2 Present Railway Situation

At present, there is no “Trans-Padma Corridor” on the railway network in Bangladesh, as occurs for Asian Highway A-1. However, Bangladesh Railway (BR) has prepared a conceptual plan for the short- and long- terms showing the new railway alignment for rail provision on the Padma Bridge (refer to Figure 11.4.5).

According to the information from BR, “the origin and destination points in the short-term

will be Dhaka-Darsana international route, which will connect the northeastern part of India-Dhaka-Padma Bridge-Pukaria-Faridpur-Rajbari-Poradaha-Ranaghat-Kolkata. It will require construction of only 70km of railway line. Land for a substantial portion of this line has already been acquired for construction of this 70km length.

In the long-term, the origin and destination points via Padma Bridge will be Dhaka-Jessore. This is an international route, which will connect the northeastern part of India - Dhaka – Padma Bridge – Jessore – Benapole - Kolkata. About 160km of railway line has to be constructed to connect Dhaka and Jessore.

In order to realize the above plan, BR has to implement ADB's "Rail Recovery Project (RRP)" on a continuous basis and with no problems and must improve its financial condition through restructuring/reforming the organization.

10.4.3 Impacts of Padma Bridge on Railway Transport

1) Cargo volumes imported from India via road and rail are each around 2 million ton/year. Import volume by land ports is illustrated in Figure 11.4.8. Judging from the recent trend of cross-border traffic demand, the corridor of Benapole- Padma Bridge- Dhaka is the most important one from the aspect of international trade between India and Bangladesh.

2) A new railway link which connects Dhaka-Padma Bridge-Jessor-Benapole is 200km in length. (The existing railway link from Dhaka to Benapole is 518 km in length.) Movement of freight traffic from Benapole will be quicker and economical and at the same time, this line will open up a new era in the surface transport sector between Dhaka and southwest part of Bangladesh, including Mongla Port.

3) Earnings from cross-border traffic will greatly contribute to the improvement of the financial condition of BR when the Padma Bridge route proposed by BR is constructed. At the same time, Indian traders will also gain benefits due to the lower transport costs and from time savings.

4) India appears to want to transport cargo to its northeastern states across Bangladesh. By transiting through Bangladesh, Indian traffic can save a distance of 350 to 400 km and travel time and costs will be significantly lower. If the Indian traffic from Kolkata to Agartala can pass through the "Trans –Padma Corridor", more savings will be realized. These benefits will be enjoyed not only by India but also by Bangladesh, as a result of increased business opportunities for BR and other related business fields.

Expected concrete benefits for Bangladesh from the Indian transit traffic explained above are summarized below:

1) Earnings of foreign exchange (Transit Fee charges)
2) New business opportunities (Services such as selling fuel, water and foods and supply services of rest houses, shopping, repair, maintenance works and others for trucks and buses, for example).
3) New job opportunities (depending on the bilateral negotiations. Trucks and bus drivers can be limited to Bangladesh nationals)

However, necessary conditions to realize the benefits listed above are as follows:

1) Services are not for domestic transport. If the railway provision is limited to domestic use, traffic will not be enough to justify the provision.
2) Commodities/ cargos must be containerized (if general cargo or bulk) or tanked (if

liquid) and must be securely locked up to final destinations.
3) Containers or tanks may be opened only outside of Bangladesh territory.
4) Trains should be operated by Bangladesh Railway (BR) and railways/ truck drivers may be Bangladeshis (depending on bilateral negotiations).
5) Expansion of broad gauge links in Bangladesh for smooth transit of Indian Railway wagons.

10.4.4 Recommendation

Preliminary design and cost estimates for Alternative-HR (highway with railway provision) was conducted. Alternative-HR requires the additional cost of about 80 million US$ compared with the project cost of the most recommended highway Alternative H-1.

An economic evaluation of Alternative-HR was undertaken. As a result, it could be concluded that Alternative-HR is economically viable with an EIRR of 15.13%. When compared with the result of Alternative H-1, with an EIRR of 15.7%, no significant differences exist.

To make clear this difference of EIRR values, simple economic calculation based on two cases was compared. One case is to construct Alternative-HR and the other case is to construct Alternative H-1 and a railway bridge independently at a later stage, when the railway extension plan from Dhaka becomes more realistic. Based on a discount rate of 12% per annum, it is better to construct Alternative-HR than to construct a railway bridge some 10 years after the opening of the road bridge, as suggested by the simple economic analysis.

No one can forecast a construction timing of “Trans-Padma Corridor”, however, construction of Alternative H-R will accelerate the realization of a railway crossing the Padma.

Taking the importance on forming an international transport corridor into consideration, it is recommended that Alternative-HR should be constructed.

It is necessary to carry out a further study including new railway links to connect Padma Bridge with the existing railway network.