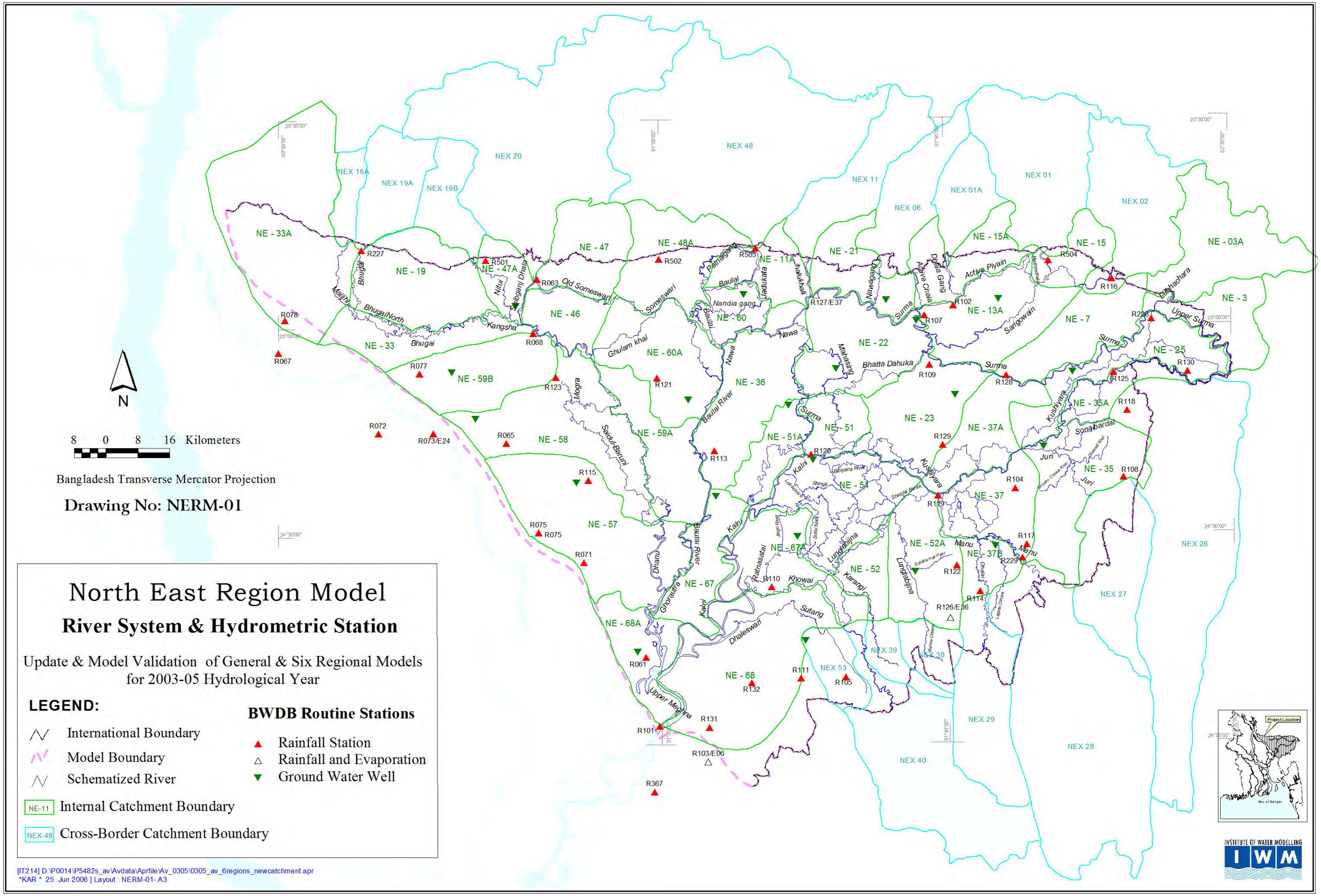
Annex 5-1

Division of Inland and Transboundafry Catchments of NERM


North East Region Model
River System & Hydrometric Station
Update & Model Validation of General & Six Regional Models
for 2003-05 Hydrological Year
LEGEND:
International Boundary
Model Boundary
Schematized River
NE-11 Internal Catchment Boundary
NEX-48 Cross-Border Catchment Boundary
BWDB Routine Stations
Rainfall Station
Rainfall and Evaporation
Ground Water Well
8 0 8 16 Kilometers
N
Bangladesh Transverse Mercator Projection
Drawing No: NERM-01
[IT214] D:\P0014\P5482s_av\Avdata\Aprfile\Av_0305\0305_av_6regions_newcatchment.apr
*KAR * 25 Jun 2006] Layout : NERM-01- A3
INSTITUTE OF WATER MODELLING
IWM
NEX 16A
NEX 19A
NEX 19B
NEX 20
NEX 48
NEX 11
NEX 06
NEX 01A
NEX 01
NEX 02
NEX 26
NEX 27
NEX 28
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NE - 57
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NE - 52
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NE - 68
Surma
Kushiyara
Upper Surma
Baulai River
Old Someswari
Kangsha
Bhugai
Dhaleswari
Upper Meghna
Khowai
Sutang
Manu
Juri
Kalni
Mogra
Dhanu
Nawa
Bhatta Dahuka
Sarigowain
Active Piyain
R227
R501
R063
R502
R503
R504
R116
R127/E37
R102
R107
R078
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R068
R077
R123
R121
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R128
R125
R130
R072
R073/E24
R065
R113
R120
R129
R118
R115
R104
R108
R119
R075
R071
R117
R229
R122
R110
R114
R126/E36
R061
R111
R105
R132
R131
R101
R103/E06
R367
Project Location

Annex 5-2

Study on Applicability of Frequency Analysis Using Simulated Water Levels

Study on Applicability of Frequency Analysis Using Simulated Water Levels

1. Availability of Observed Water Levels

Availability of observed water levels is examined by using water level data observed at 4 stations (Bhairab Bazar, Itna, Sunamganj and Sylhet), which are located along the Surma-Baulai Rivers. These data were provided for the Study by IWM.

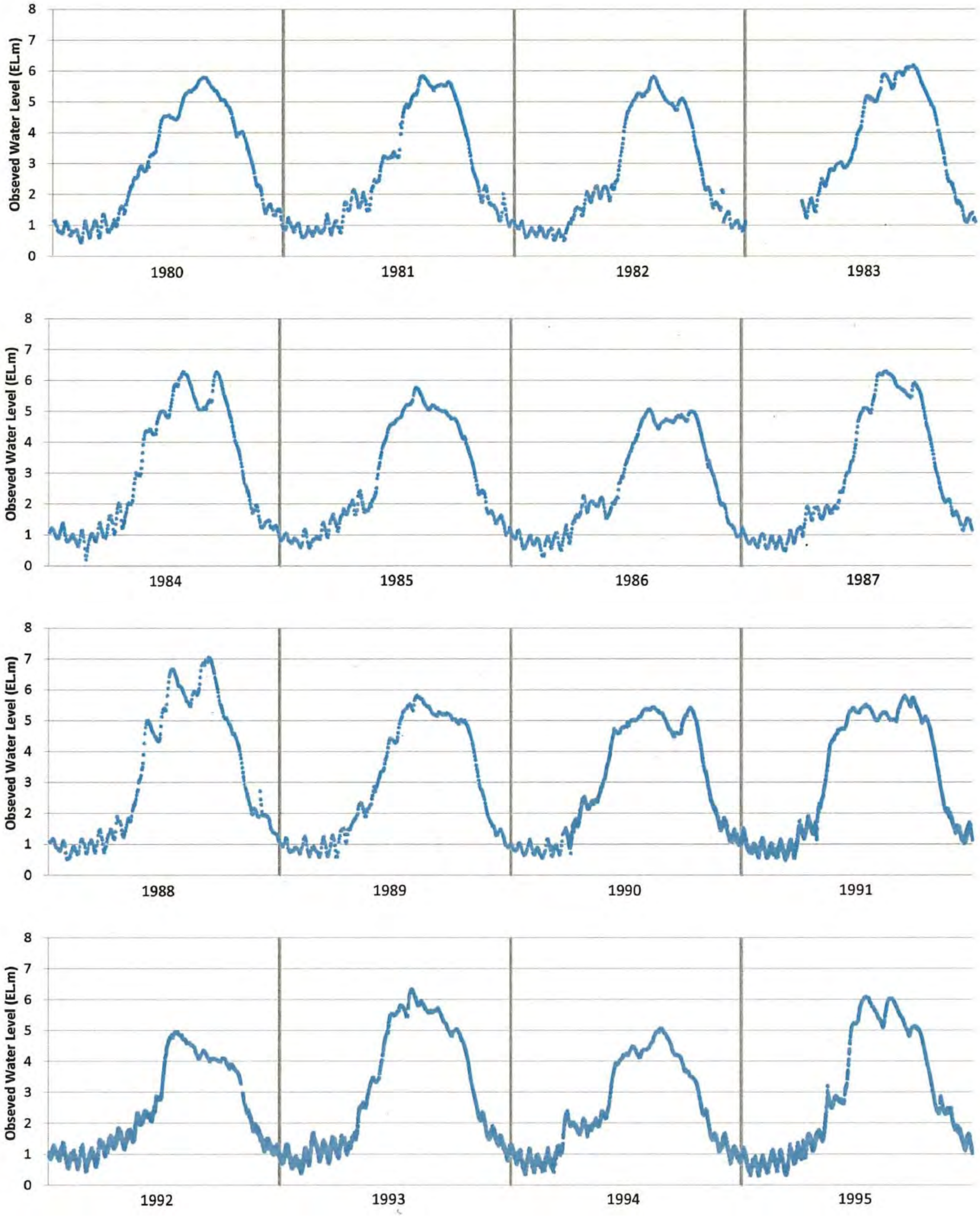
The observed data were used for the Study after correction due to river channel movement and land settlement in the haor area. Table 1 compiles the observed water level data after correction.

Table 1 Observed Water Level Data for the Study (after correction)

Station Name	Data Period	Correction value* (m)	Remarks
Bhairab Bazar	1980－2010	-0.62	Corrected data were provided for the Study in September 2013 by IWM.
Itna	2003－2010	-1.45	The data in and after 2003 were used for the Study, because no reliable correction value before 2003 had been obtained from IWM.
Sunamganj	1980－2010	-0.67	The correction value obtained from IWM was used for the 31 years (1980 to 2010).
Sylhet	1980－2010	-0.61	

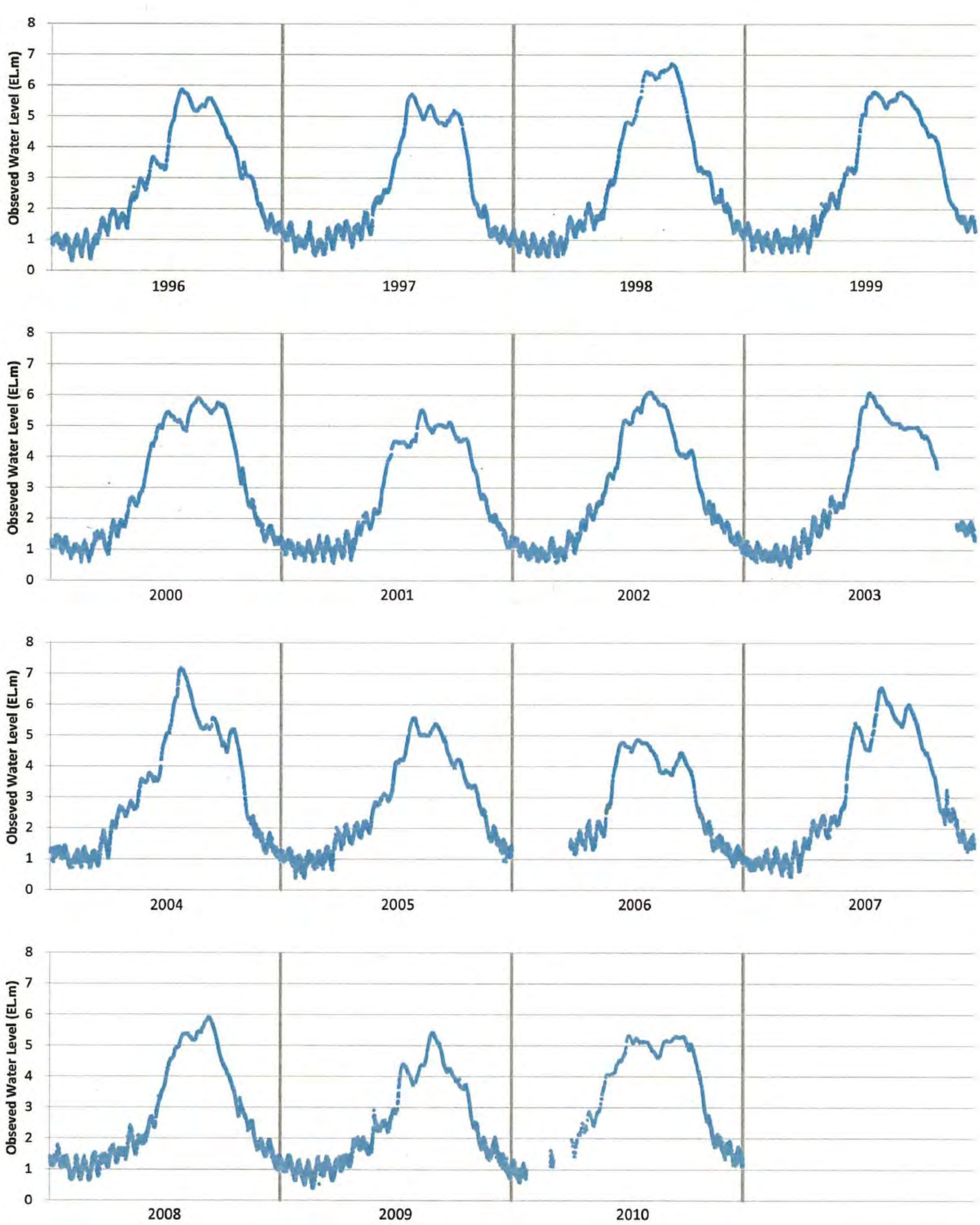
Note: * These values were added to the observed water levels for correction.

Figures 1 to 4 present the observed water levels after correction.



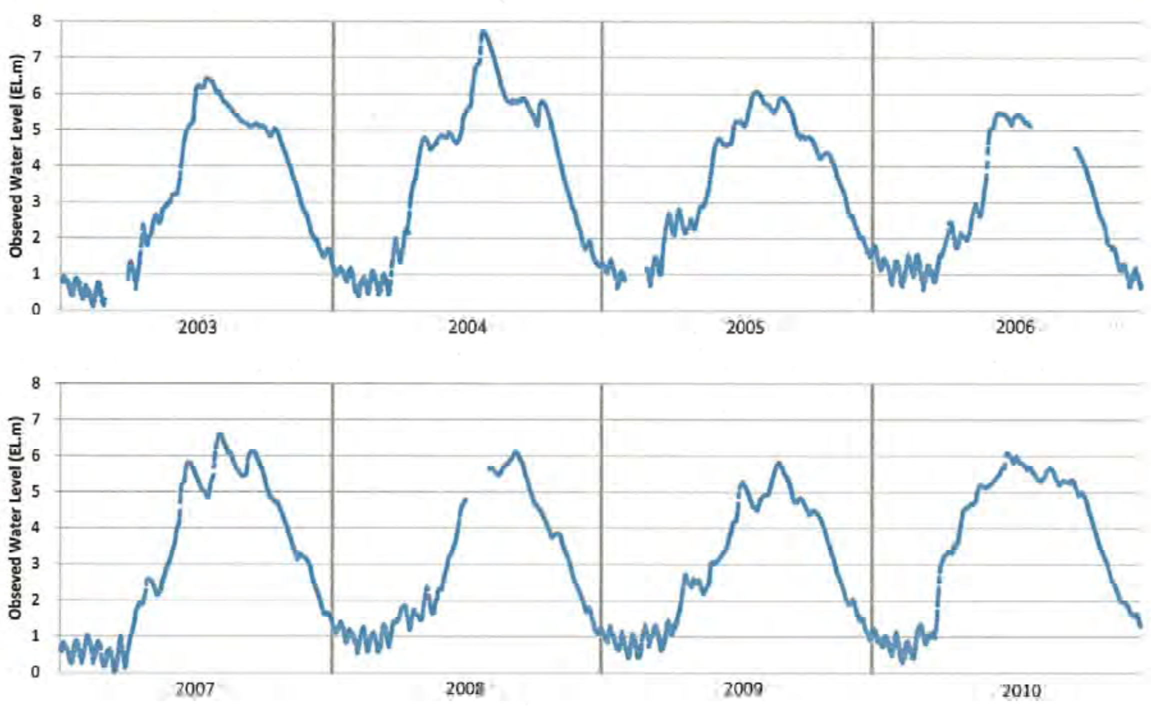
Source: JICA Study Team

Figure 1 Observed Water Levels at Bhairab Bazar Station（1/2: 1980－1995）



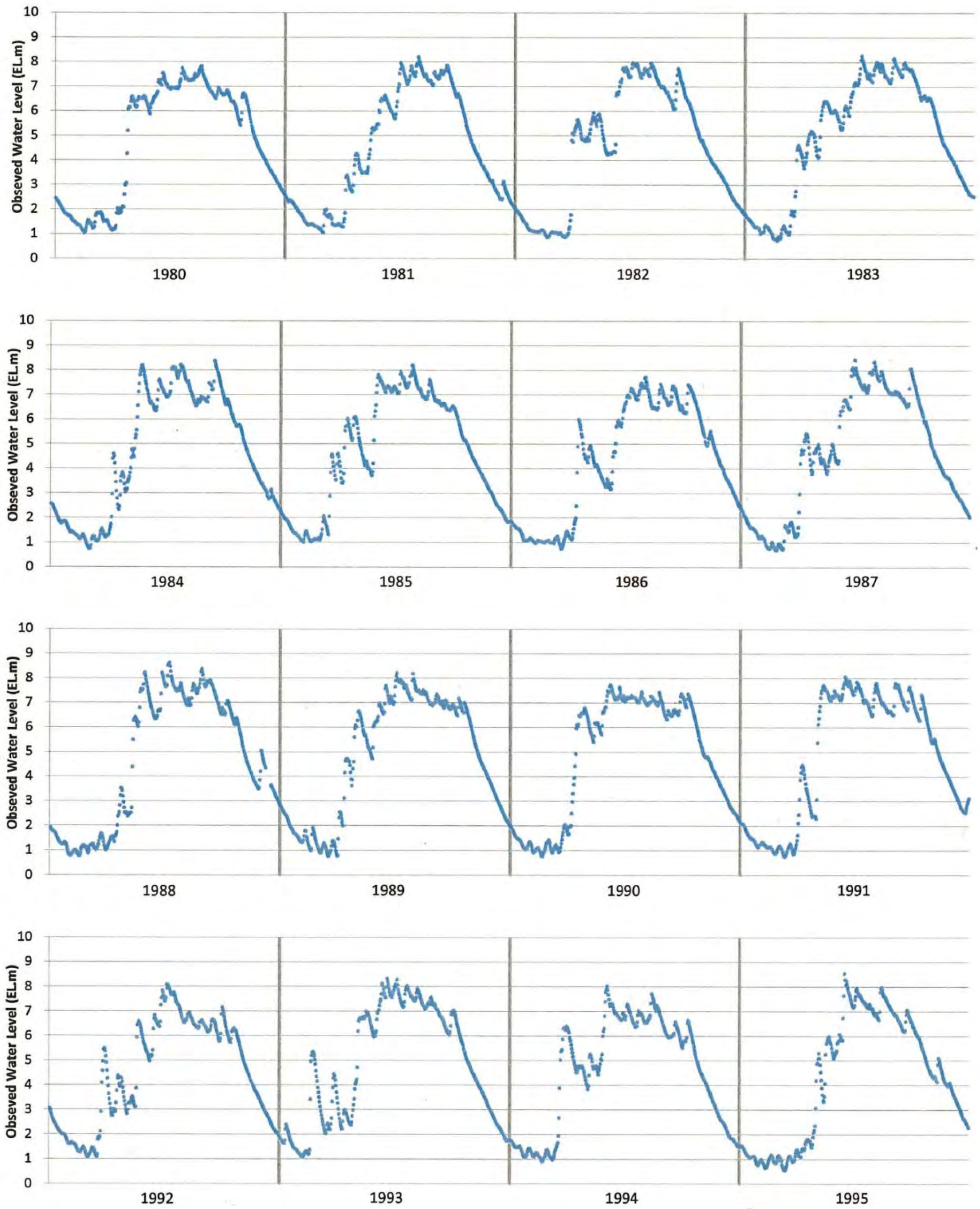
Source: JICA Study Team

Figure 1　Observed Water Levels at Bhairab Bazar Station（2/2: 1996－2010）



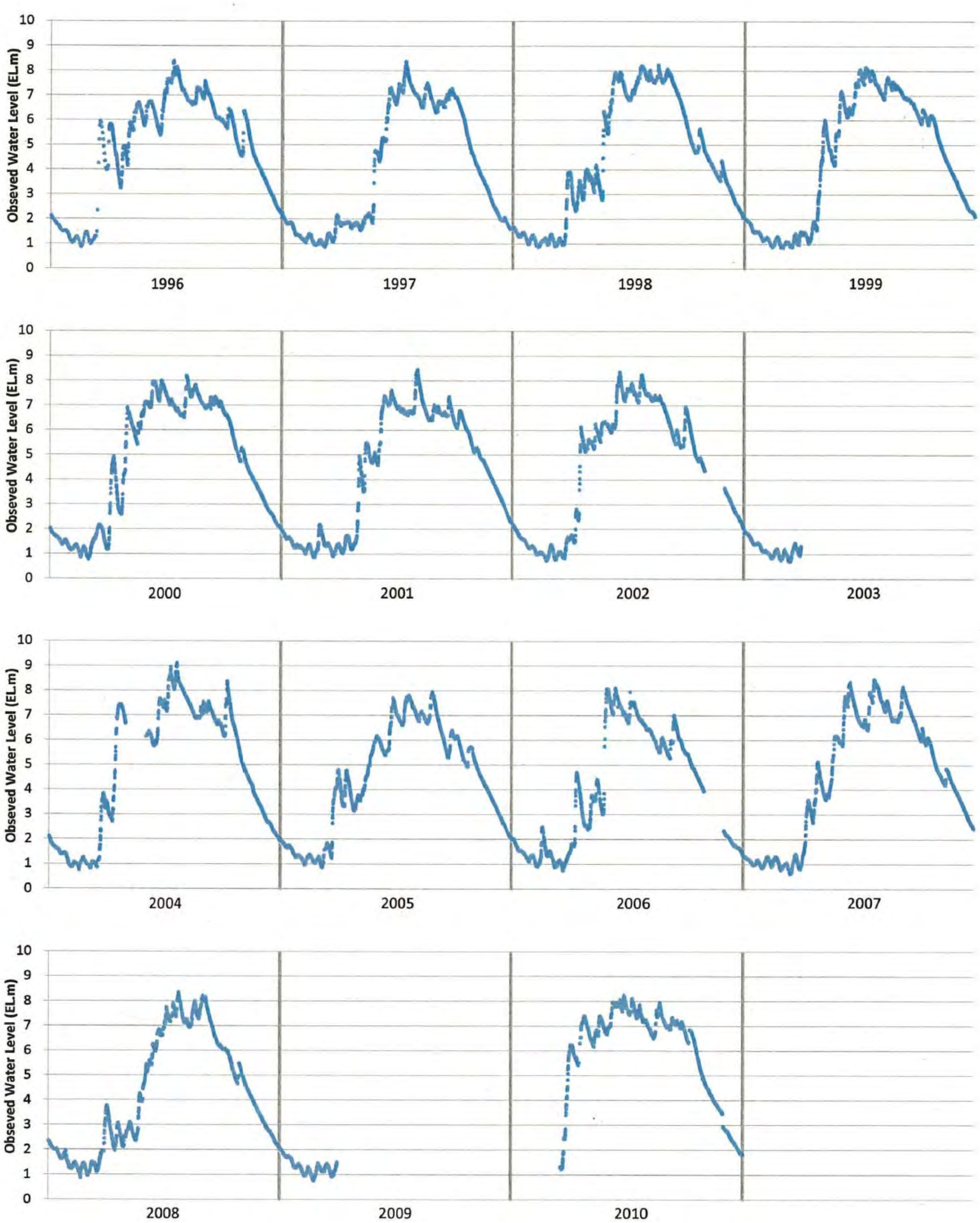
Source: JICA Study Team

Figure 2 Observed Water Levels at Itna Station（2003-2010）



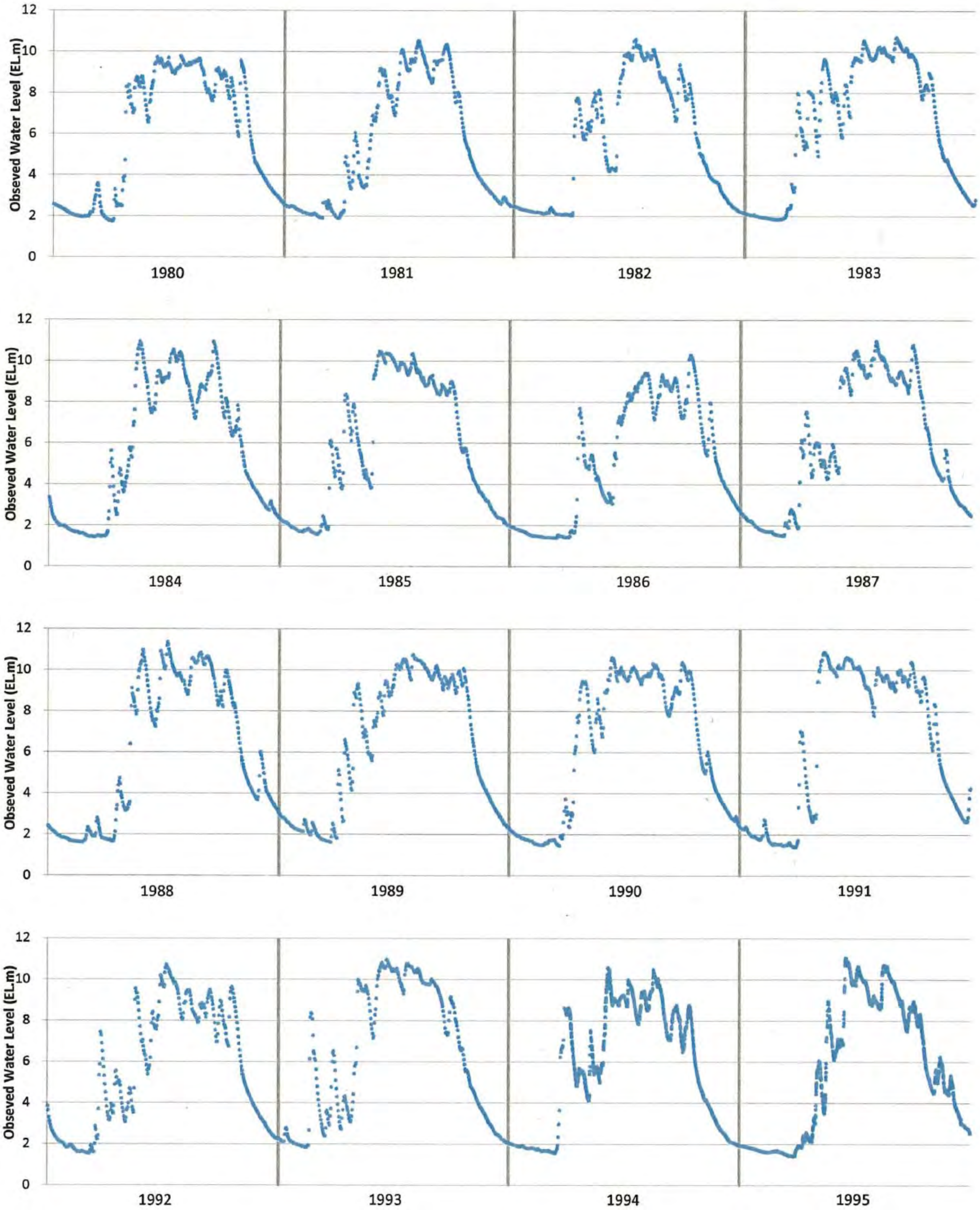
Source: JICA Study Team

Figure 3 Observed Water Levels at Sunamganj Station（1/2: 1980－1995）



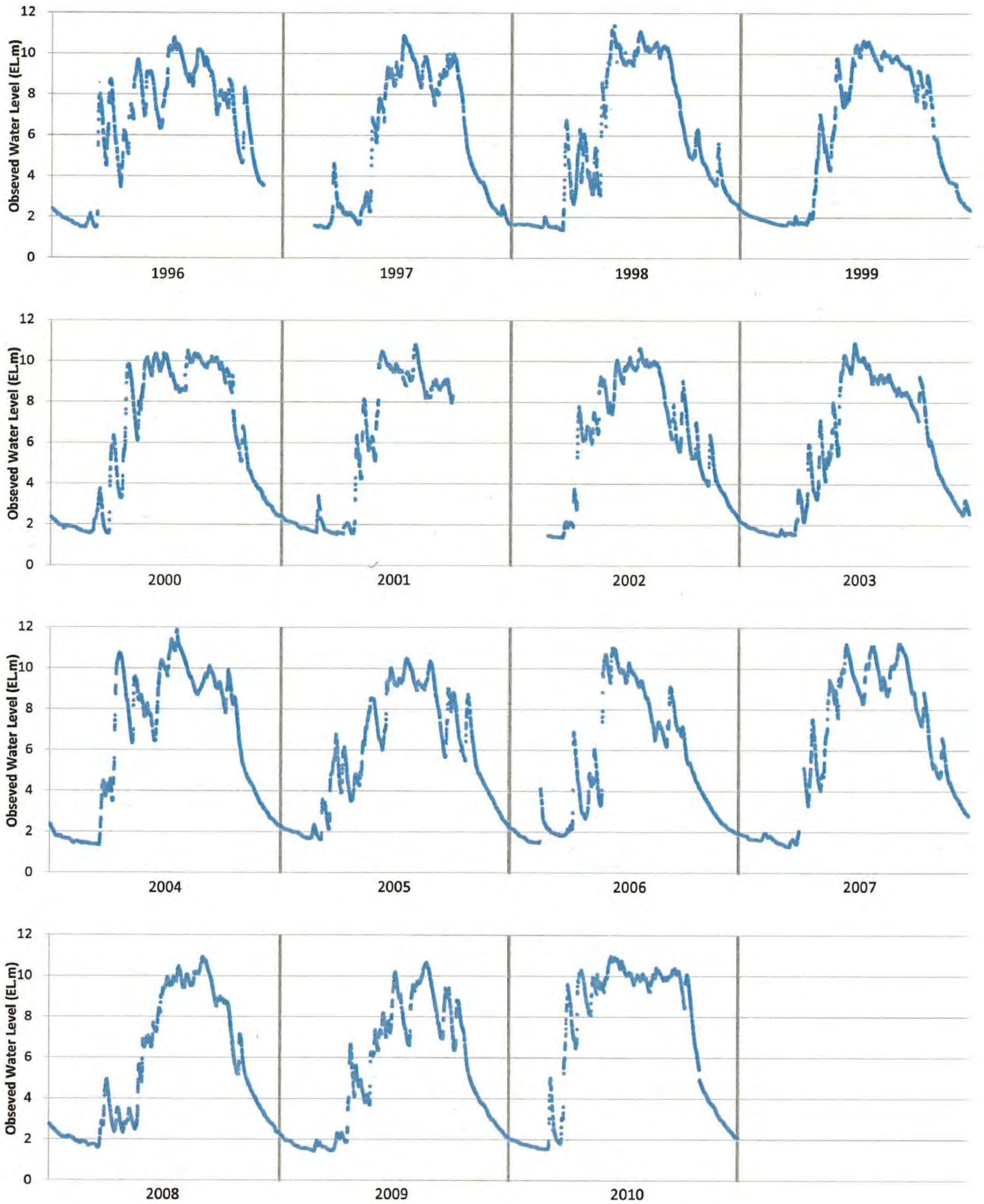
Source: JICA Study Team

Figure 3 Observed Water Levels at Sunamganj Station（2/2: 1996－2010）



Source: JICA Study Team

Figure 4 Observed Water Levels at Sylhet Station（1/2: 1980-1995）



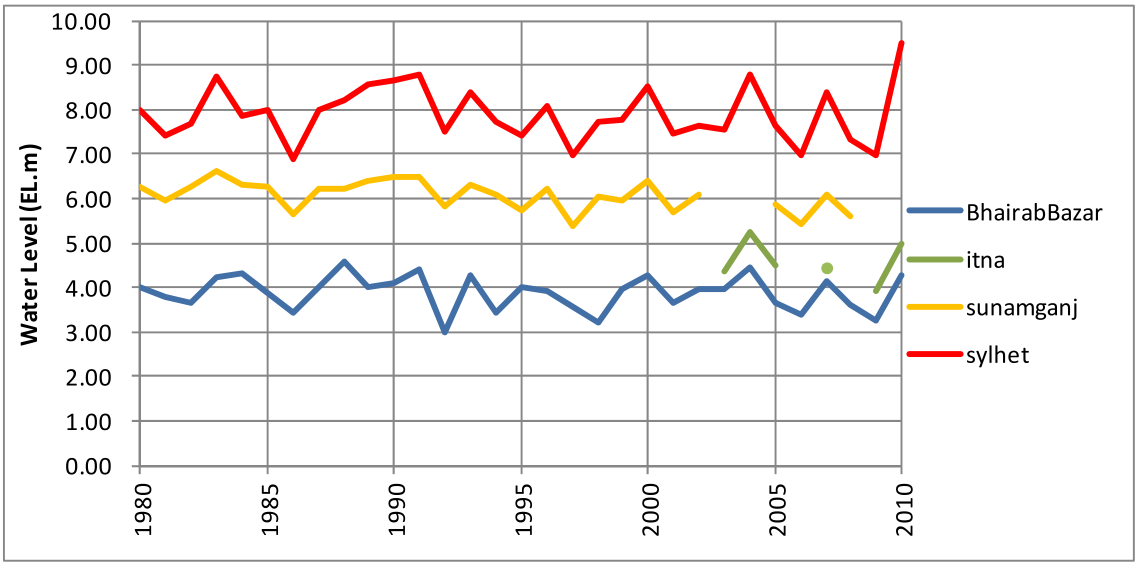
Source: JICA Study Team

Figure 4　Observed Water Levels at Sylhet Station（2/2: 1996－2010）

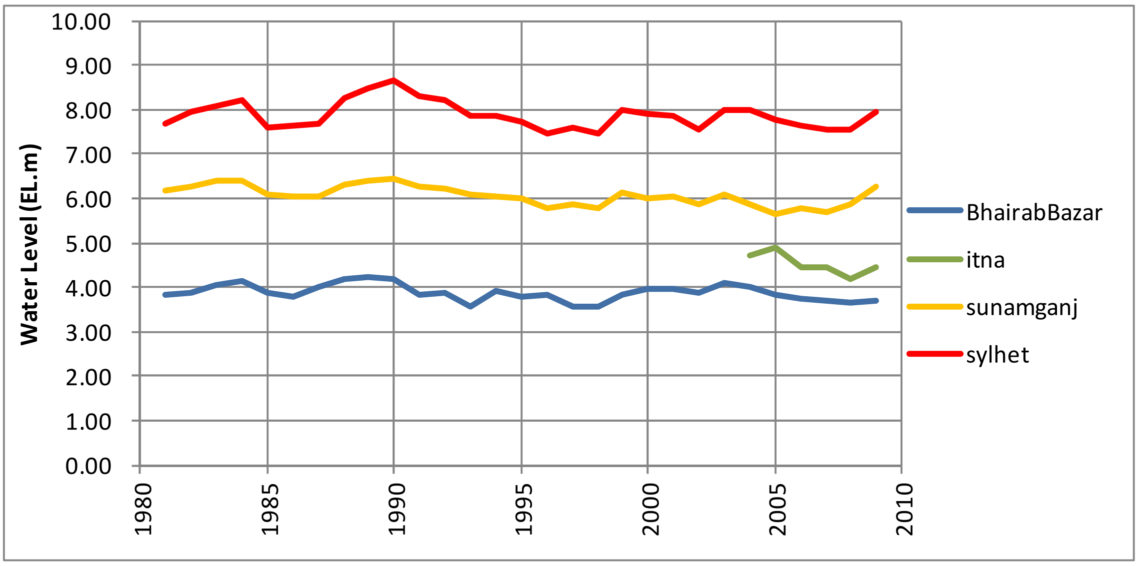
The annual average water levels during pre-monsoon and monsoon seasons, which were calculated using the corrected water levels in Table 1, and 3 year moving averages of the annual average water levels at the 4 stations are presented in Figure 5.

The observed water levels at Bhairab Bazar, Sunamganj and Sylhet after correction were used in the succeeding study, because unsteadiness of water levels such as change of long-term trend and jump (sudden change) is not found in Figure 5. The water level data at Itna were not used because of its short period data with data missing.

(a) Annual Average Water Level



(b) 3-year Moving Average of Annual Average Water Levels



Source: JICA Study Team

Figure 5 Chronological Change of Observed Water Levels during Pre-monsoon and Monsoon Seasons

2. Applicability of Flood Frequency Analysis Using Water Levels

Applicability of flood frequency analysis using not discharges but water levels was verified at the Sylhet station. The work flow of verification is as explained below (see Figure 6).

(1) Calculation of (a) probable water levels converted from probable discharges,
- Conversion of observed water levels (WLs) to observed discharges through H-Q curves prepared by the Study Team,
- Frequency analysis of the observed discharges, and
- Conversion of probable discharges to probable WLs through the H-Q curves.

(2) Calculation of (b) probable water levels estimated from observed water levels,
- Frequency analysis of observed WLs

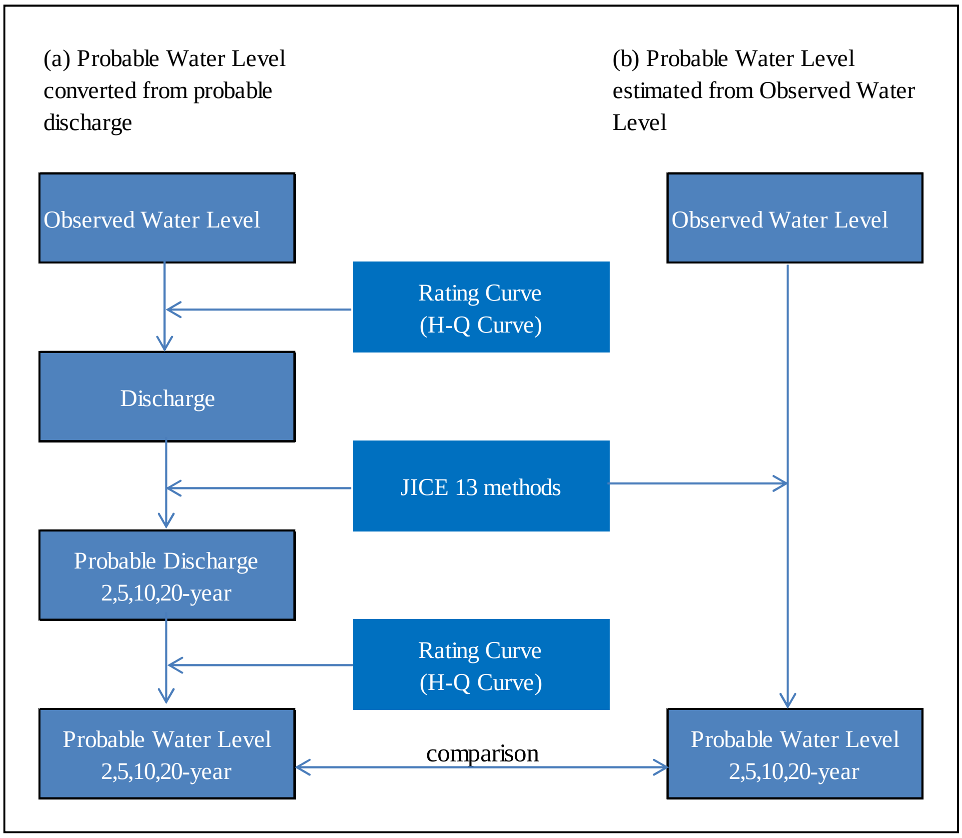
(3) Verification of applicability of frequency analysis using WLs through comparison between probable WLs (return periods: 2, 5, 10 and 20years) of the (a) and (b)

Selection criteria of probable distribution model in frequency analysis

The frequency analysis in the (1) and (2) was carried out for each of the pre-monsoon season (4/1-5/15) and monsoon season (5/16-10/31) by using annual maximum values during each season and the hydrological statistic utility program developed by Japan Institute of Country-ology and Engineering (JICE).

Out of 13 probable distribution models for annual events, the model which has an index of “Standard Least Square Criterion (SLSC)” of less than 0.04 and a comparatively smaller “Jackknife Estimation Error” was selected as an optimum one, referring to “Technical Criteria for River Works: Practical Guide (Investigation; Japanese Ministry of Land, Infrastructure, Transport and Tourism, June 2012)”

If each model has a SLSC index of more than 0.04, the model which has a comparatively smaller value as the index of “Akaike's Information Criterion (AIC)” was selected, after confirming its adaptability on a probability paper in 10 and 20 year return period cases.



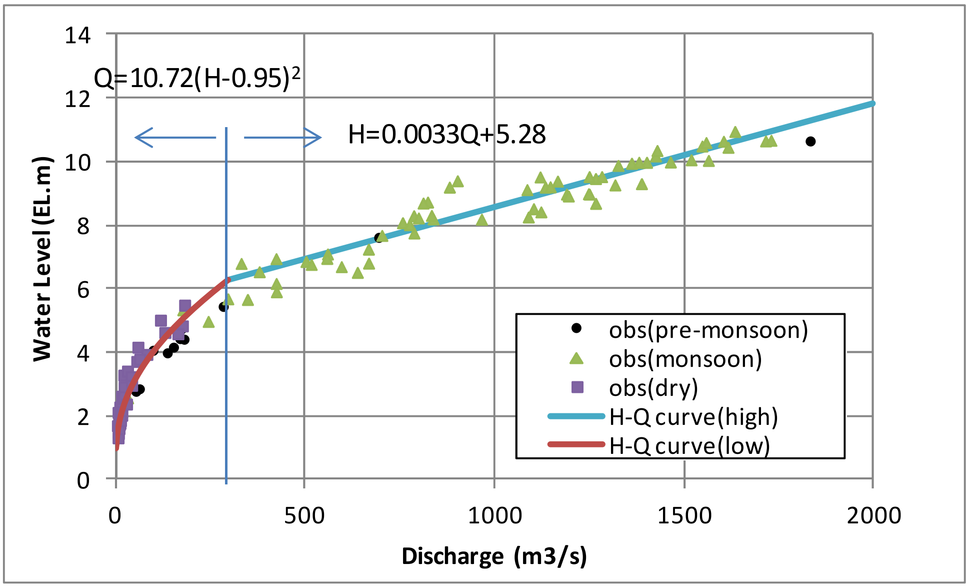
Source: JICA Study Team

Figure 2 Comparison between Frequency Analyses Using Water Levels and Discharges

Preparation of H-Q Curve

A H-Q curve was worked out based on discharge measurement data (2003－2009) at Sylhet. Taking into account the dates of discharge measurements, the measured discharges were divided into two flow conditions, namely low and flood flows, with a threshold of 300m^3/s, and H-Q formulas: $Q=a(H+b)^2$ and H=aQ+b were applied to low and flood flows, respectively, as shown in Figure 7. The coefficients of “a” and “b” were calculated by the “Least Squares Method”.

In this study, the correlation coefficient is employed as an index to assess adaptability of the H-Q curve. The correlation coefficients of the H-Q curve in Figure 7 have rather high values of 0.94 and 0.95 for low and flood flows, respectively.

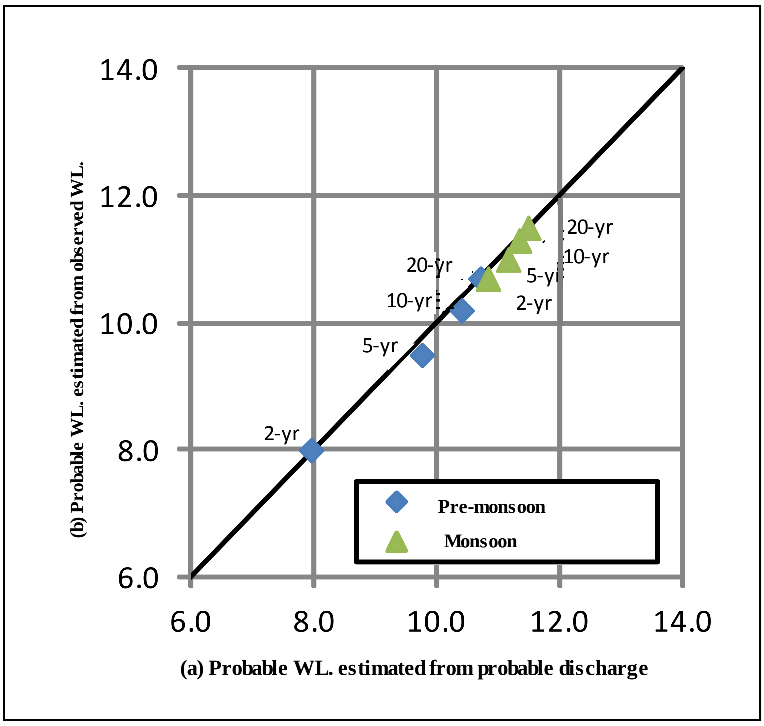


Source: JICA Study Team

Figure 7 H-Q Curve at Sylhet Station

Figure 8 presents comparison between probable WLs of the (a) and (b) above, wherein 2, 5, 10 and 20 year water levels during pre-monsoon and monsoon seasons are plotted. As the probable WLs of (a) and (b) show similar tendency in Figure 8, the applicability of frequency analysis using water levels was confirmed. Table 2 and Figures 9 to 12 present the results of the above mentioned frequency analyses.

It is noted that each probability distribution model has an SLSC index of more than 0.04 in selection optimum ones for probable discharges and probable water levels during the monsoon season. Therefore, probability distribution models were selected based on AIC indices and their adaptability on probability papers (see Figures 10 and 12 for the results on frequency analyses of observed discharge and observed water levels, respectively).



Source: JICA Study Team

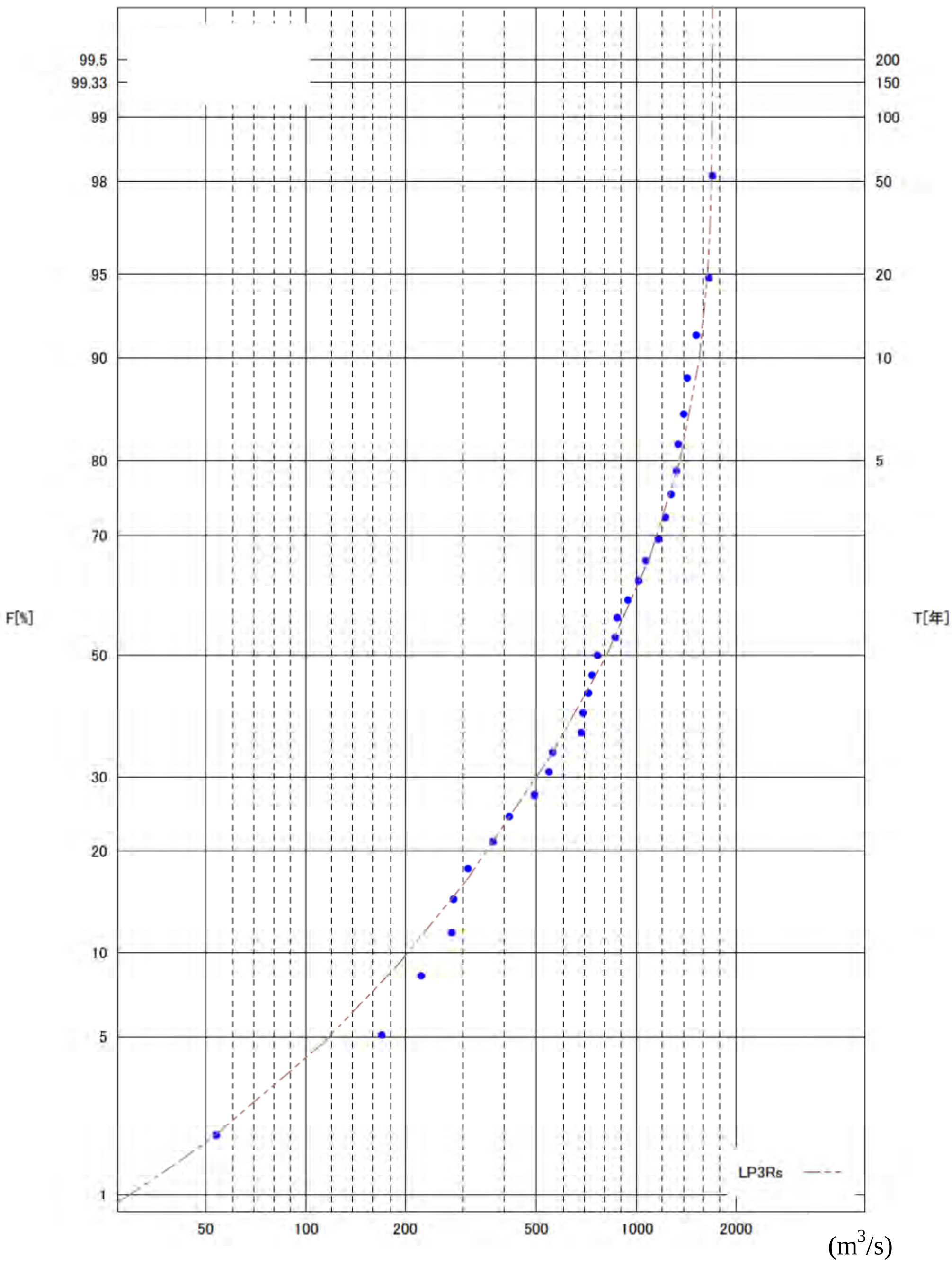
Figure 8 Comparison between Probable Water Levels Analyzed Using Observed Discharges and Observed Water Levels

Table 2 Probable Water Levels at Sylhet Estimated from Probable Discharges and Observed Water Levels

Sylhet Station		Pre-monsoon Season			Monsoon Season		
Estimation Method		(a) Probable Discharge		(b) Observed WL.	(a) Probable Discharge		(b) Observed WL.
		Discharge	Water Level	Water Level	Discharge	Water Level	Water Level
Probability Distribution Function		LP3Rs	-	GEV	LN2PM	-	Gumbel
Parameter Estimation Method			-	L-moment method	Moment method	-	L-moment method
Estimated value by Jackknife method	1/2	812	8.0	8.0	1,681	10.8	10.7
	1/5	1,356	9.8	9.5	1,780	11.2	11.0
	1/10	1,552	10.4	10.2	1,834	11.3	11.3
	1/20	1,644	10.7	10.7	1,879	11.5	11.5
Estimated Error by Jackkhife method	1/2	127	-	0.4	20	-	0.1
	1/5	87	-	0.3	28	-	0.1
	1/10	96	-	0.3	37	-	0.1
	1/20	129	-	0.4	46	-	0.2
SLSC		0.030	-	0.024	0.058	-	0.056
Correlation (X-COR)		0.984	-	0.994	0.964	-	0.963
pAIC		0.0	-	127.4	363.3	-	47.2
Number of sample		31	-	31	31	-	31

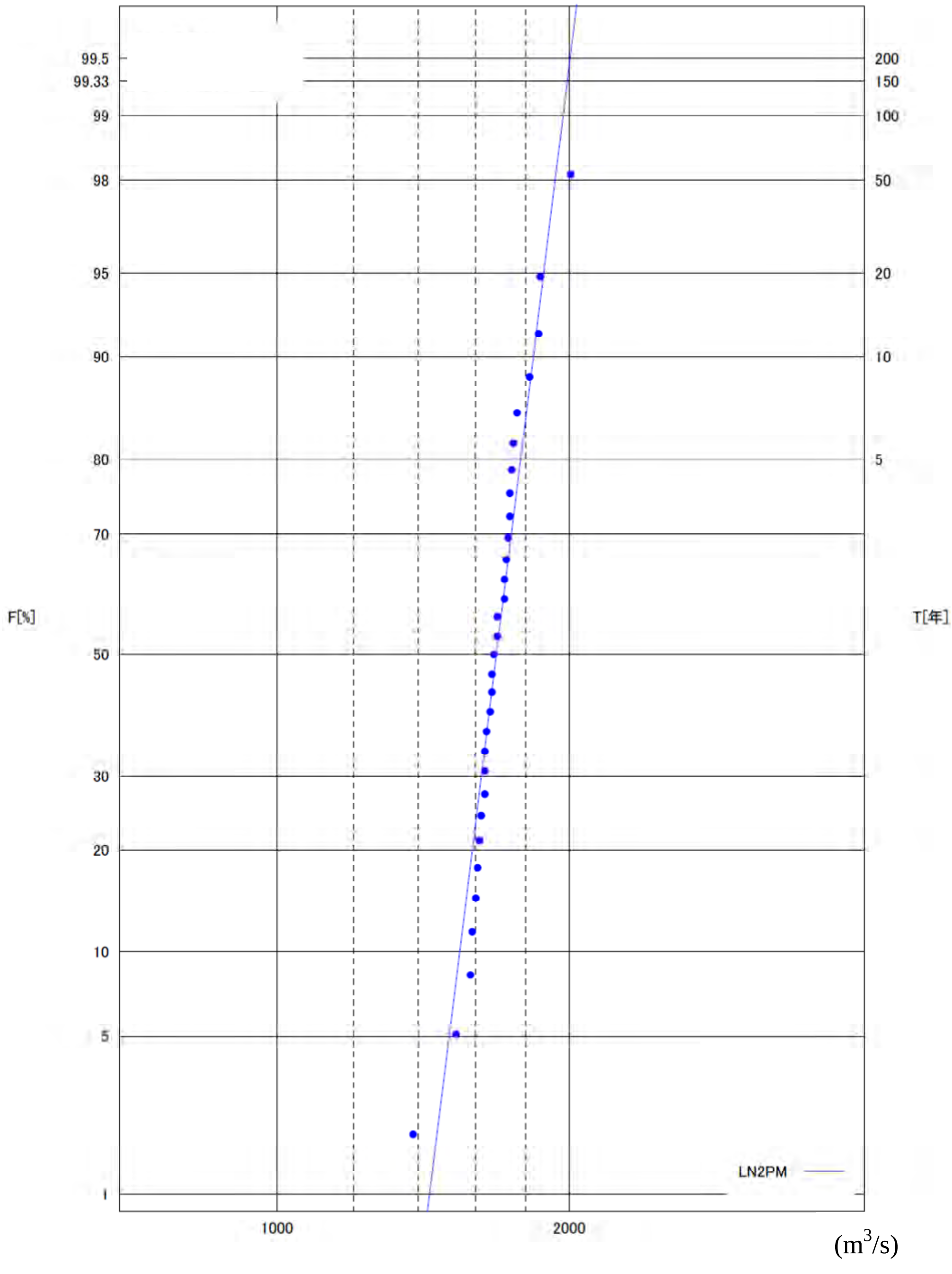
Note: LP3Re: Log Poison Type III Distribution (Real space method),
GEV: Generalized Extreme Value Distribution, LN2PM: Log Normal Distribution (2 parameter)
Gumbel: Gumbel Distribution

Source: JICA Study Team



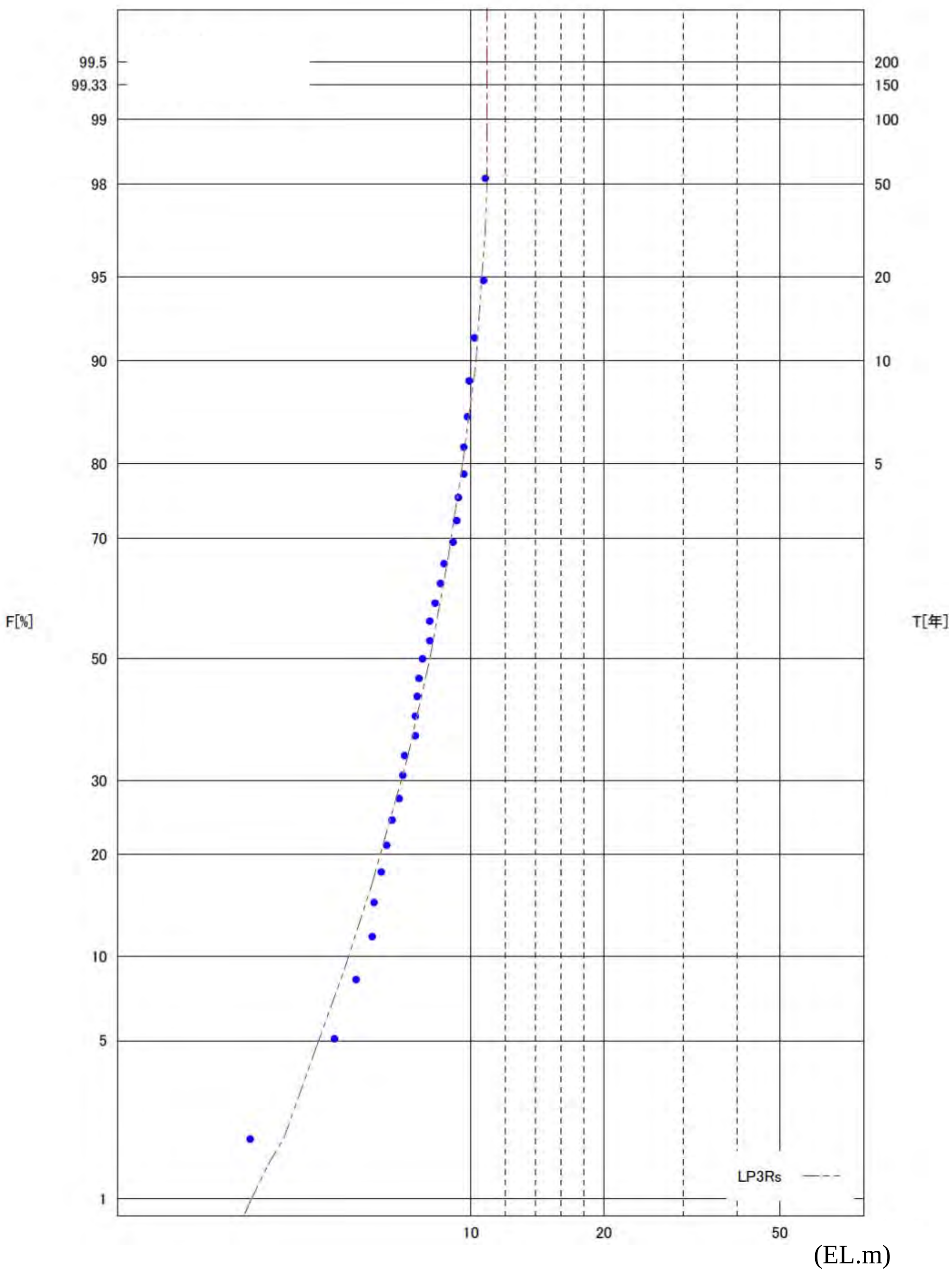
Source: JICA Study Team

Figure 9 Frequency Analysis of Discharge Data in Pre-monsoon Season at Sylhet Station



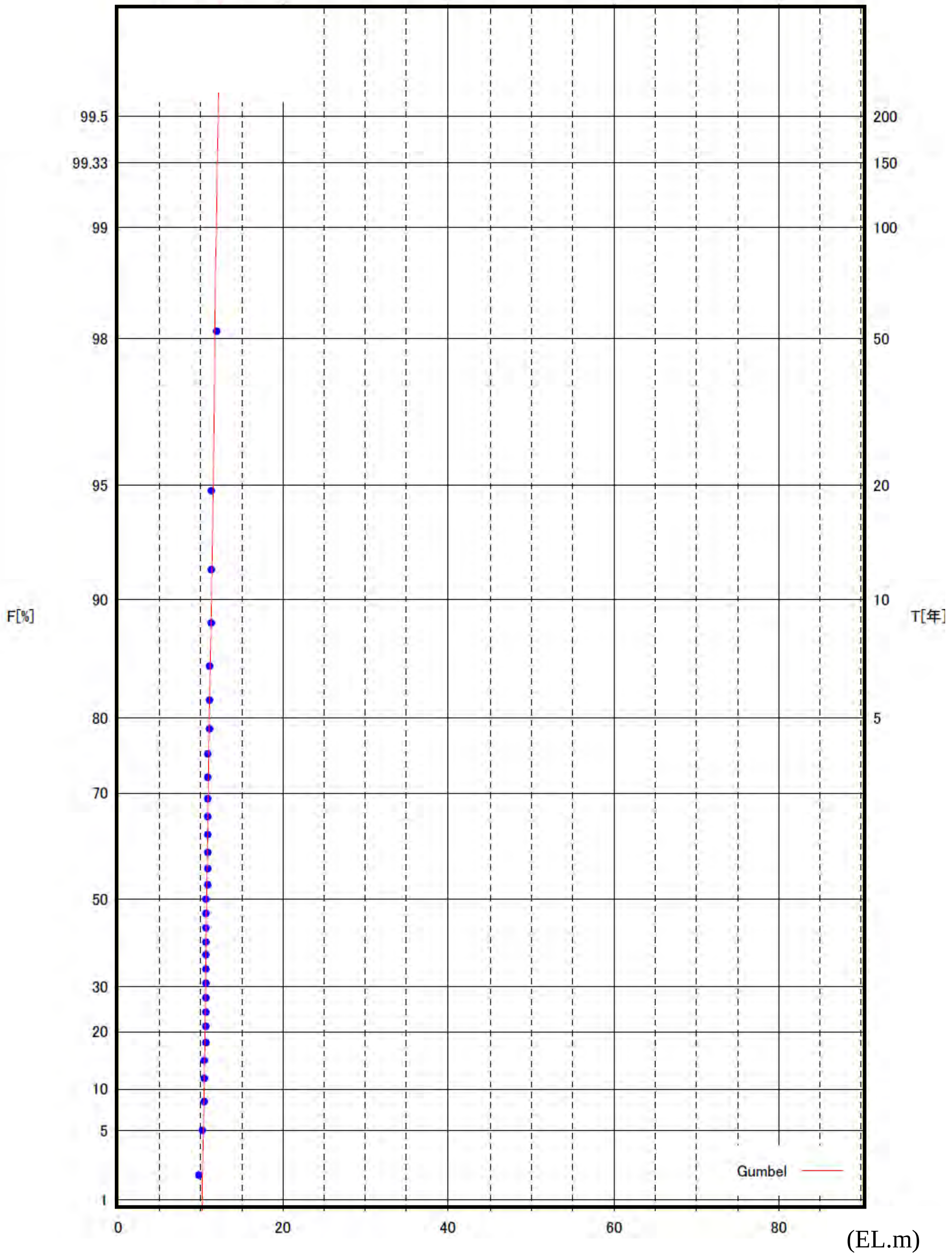
Source: JICA Study Team

Figure 10 Frequency Analysis of Discharge Data in Monsoon Season at Sylhet Station



Source: JICA Study Team

Figure 11 Frequency Analysis of Observed Water Level in Pre-monsoon Season at Sylhet Station



Source: JICA Study Team

Figure 12 Frequency Analysis of Observed Water Level in Monsoon Season at Sylhet Station

3. Applicability of Frequency Analysis Using Simulated Water Levels

The applicability of frequency analysis using simulated water levels has been verified at Bhairab Bazar, Sunamganj and Sylhe stations by comparing with the results of frequency analysis using observed water levels. The Itna station is excluded in this verification because the number of available observed water level data at this station is small.

In Figure 13, the annual maximum observed and simulated water levels are compared for pre-monsoon and monsoon seasons. As seen in Figure 13, the observed and simulated water levels at Bhairab Bazar are mostly the same, while there is a tendency that the observed water levels are higher than the simulated ones at Sunamganj and Sylhet. Thus, three stations have different tendency from one another. However, it is assessed that there is no data plotted extremely far from the bold lines at these stations.

In Figure 14, compared are 2, 5, 10 and 20 year water levels calculated for pre-monsoon and monsoon seasons using observed and simulated water levels.

There is no significant difference between them at Bhairab Bazar. On the other hand, at Sunamganj and Sylhe, though a similar tendency is seen in Figure 14, the probable water levels of observed ones are bigger: in the case of the 2 year water level at Sylhet during pre-monsoon season, the difference is 60 cm.

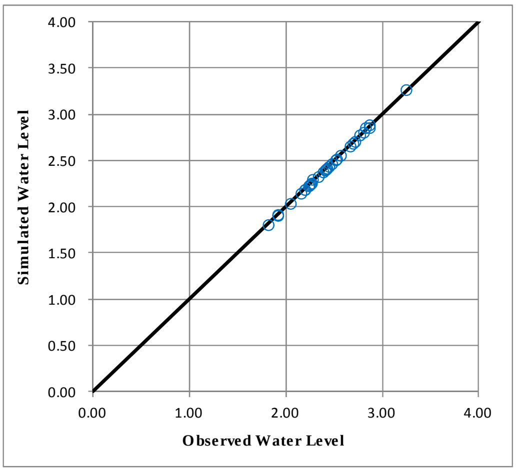
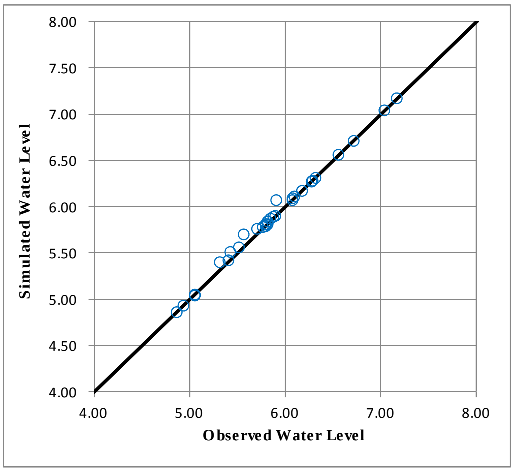
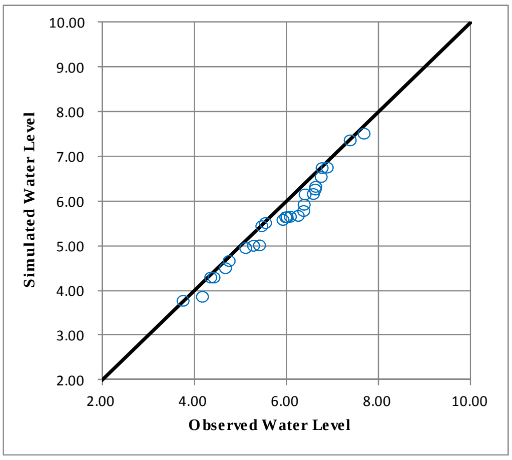
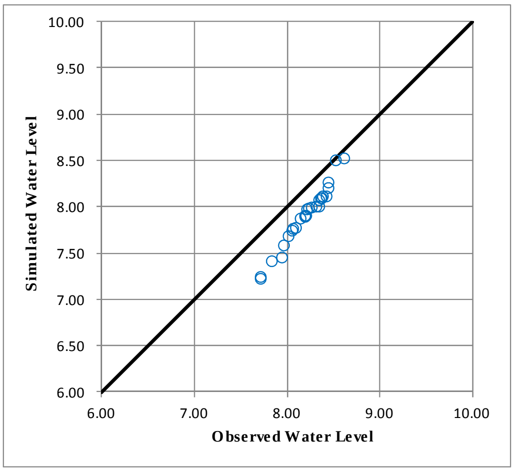
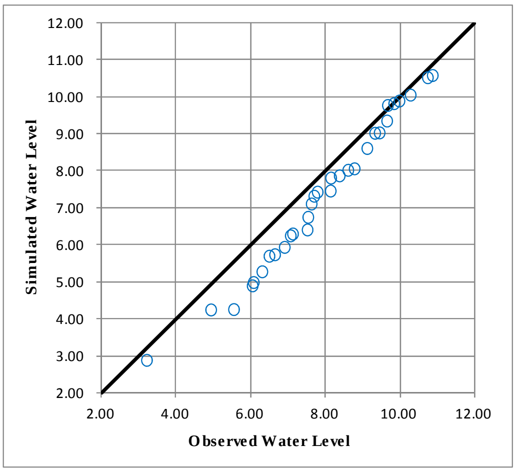
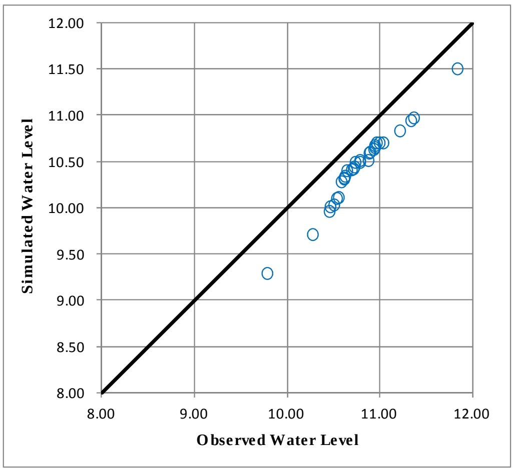
Furthermore, the pre-monsoon difference of the 10 year water levels is 30 cm at maximum at Sunmganj, and the monsoon difference of the 20 year waters is 40 cm at maximum at Sylhet. A 10 year pre-monsoon water level and a 20 year monsoon water level are used for design of submergible and full embankments, respectively. Tables 3 to 5 and Figures 15 to 26 present the results of frequency analyses at the 3 stations.

Each probability distribution model has an SLSC index of more than 0.04 in both observed and simulated water level cases at Sylhet during the monsoon season. Therefore, probability distribution models were selected based on AIC indices and also their adaptability on probability papers (see Figures 25 and 26 for frequency analyses of observed and simulated water levels, respectively)

The analysis results mentioned above are summarized as stated below:

(1) The probable WLs of observed ones are bigger than those of simulated WLs at Sunamganj and Sylhet.

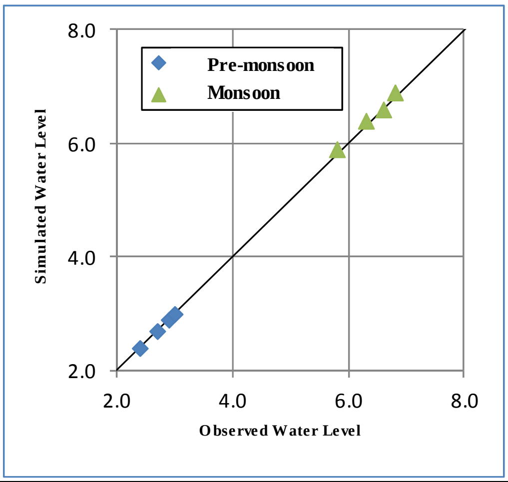
(2) The maximum difference of 10 year pre-monsoon water levels for design of submergible embankment is 30 cm and the maximum difference of 20 year monsoon water levels for design of full embankment is 40 cm.

Pre-monsoon Season	Monsoon Season
Bhairab Bazar	
	
Sunamganj	
	
Sylhet	
	

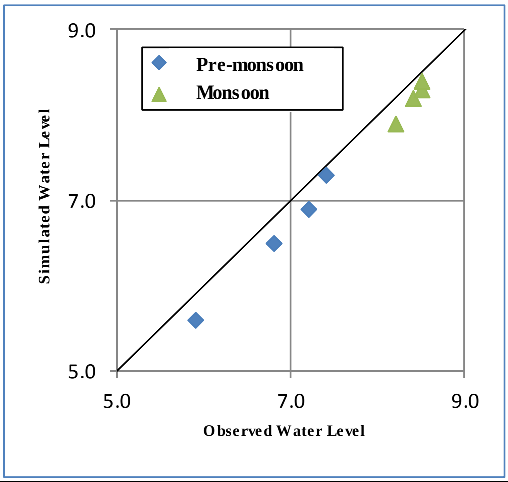
Source: JICA Study Team

Figure 13 Comparison of Maximum Water Levels between Observed and Simulated WLs in Pre-monsoon Season(4/1-5/15) and Monsoon Season(5/16-10/31)

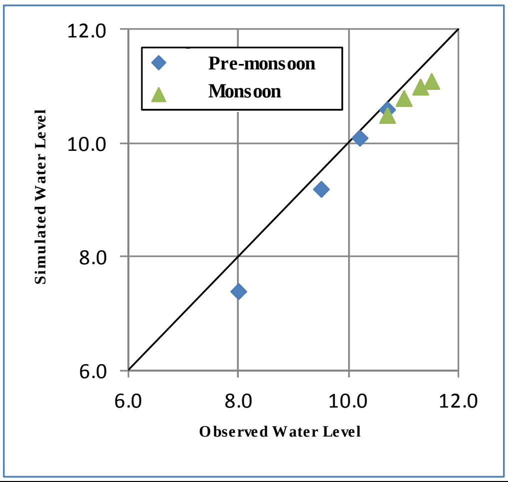
Bhairab Bazar



Sunamganj



Sylhet



Note: Probable water levels are estimated to 2, 5, 10 and 20-year return periods.

Source: JICA Study Team

Figure 14 Comparison of Probable Water Levels between Observed and Simulated Water Levels (Pre-monsoon and Monsoon Seasons)

Furthermore, it could be pointed out that the following are included in the causes of the (1) and (2) above :

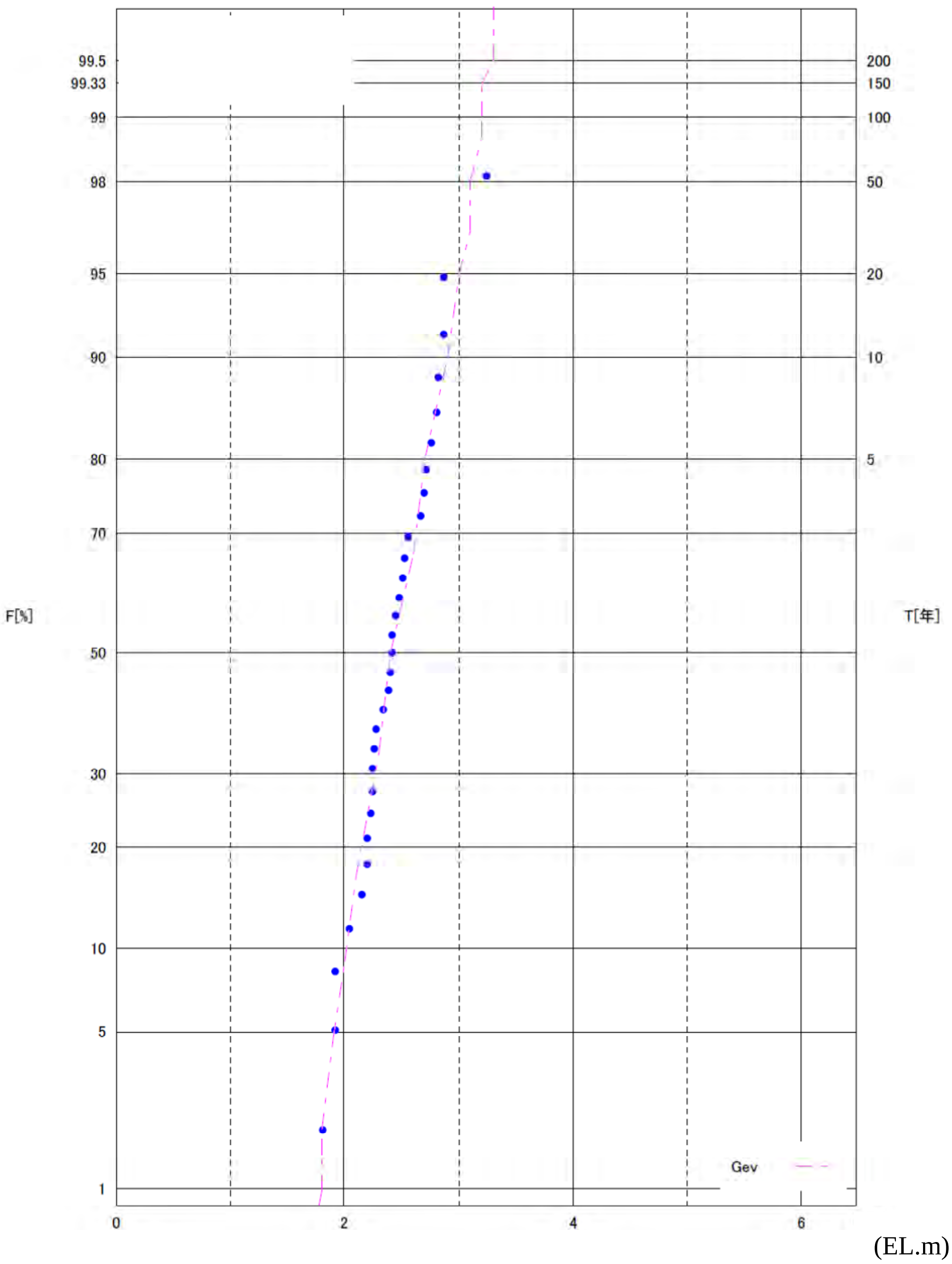
- Since the observed WLs for 31 years (1980-2010) are corrected with one constant correction value for each station, the WLs after correction fail to properly reflect the actual chronological changes due to river bed/channel movement, settlement, etc. in the haor area. And
- Since the simulation of water levels is carried out by using the meteoro-hydrologic data from 1980 to 2010 and current river cross sections, the reproducibility of water levels under past river conditions is not necessarily high.

Table 3 Probable Water Levels Estimated by Observed and Simulated Water Levels at Bhairab Bazar

Bhairab Bazar Station		Pre-monsoon Season			Monsoon Season		
		Observed WL.	Simulated WL.	Obs. - Sim.	Observed WL.	Simulated WL.	Obs. - Sim.
Probability Distribution Function		GEV	GEV		GEV	LN3PM	
Parameter Estimation Method		L-moment method	L-moment method		L-moment method	Ishihara-Takase	
Estimated value by Jackknife method	1/2	2.4	2.4	0.0	5.8	5.9	-0.1
	1/5	2.7	2.7	0.0	6.3	6.4	-0.1
	1/10	2.9	2.9	0.0	6.6	6.6	0.0
	1/20	3.0	3.0	0.0	6.8	6.9	-0.1
Estimated Error by Jackkhife method	1/2	0.1	0.1		0.1	0.1	
	1/5	0.1	0.1		0.1	0.1	
	1/10	0.1	0.1		0.2	0.2	
	1/20	0.1	0.1		0.2	0.2	
SLSC		0.036	0.033		0.036	0.039	
Correlation (X-COR)		0.991	0.992		0.987	0.984	
pAIC		22.2	23.2		55.7	55.4	
Number of sample		31	31		31	31	

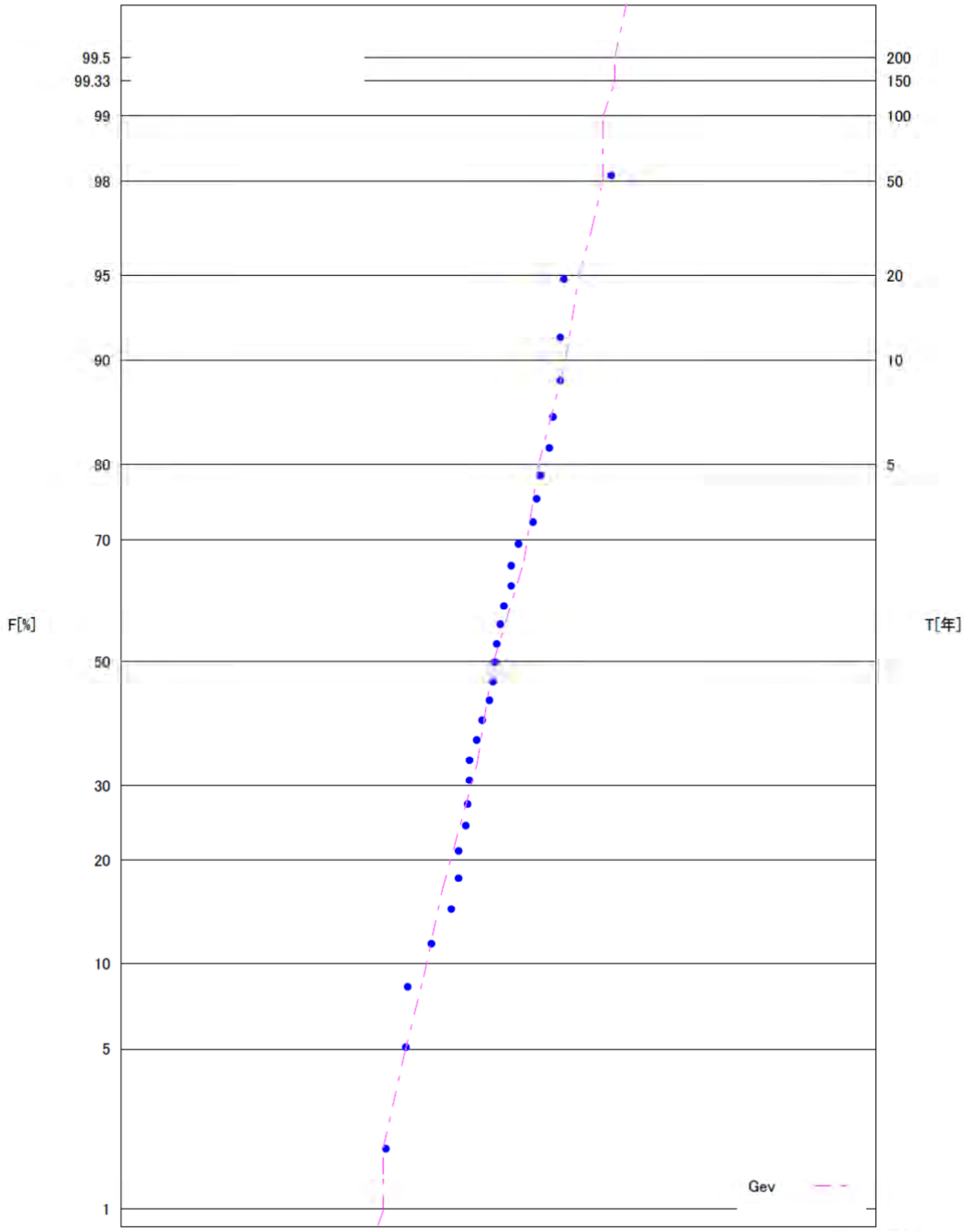
Note: GEV: Generalized Extreme Value Distribution, LN3PM: 3parameter Log normal Distribution

Source: JICA Study Team



Source: JICA Study Team

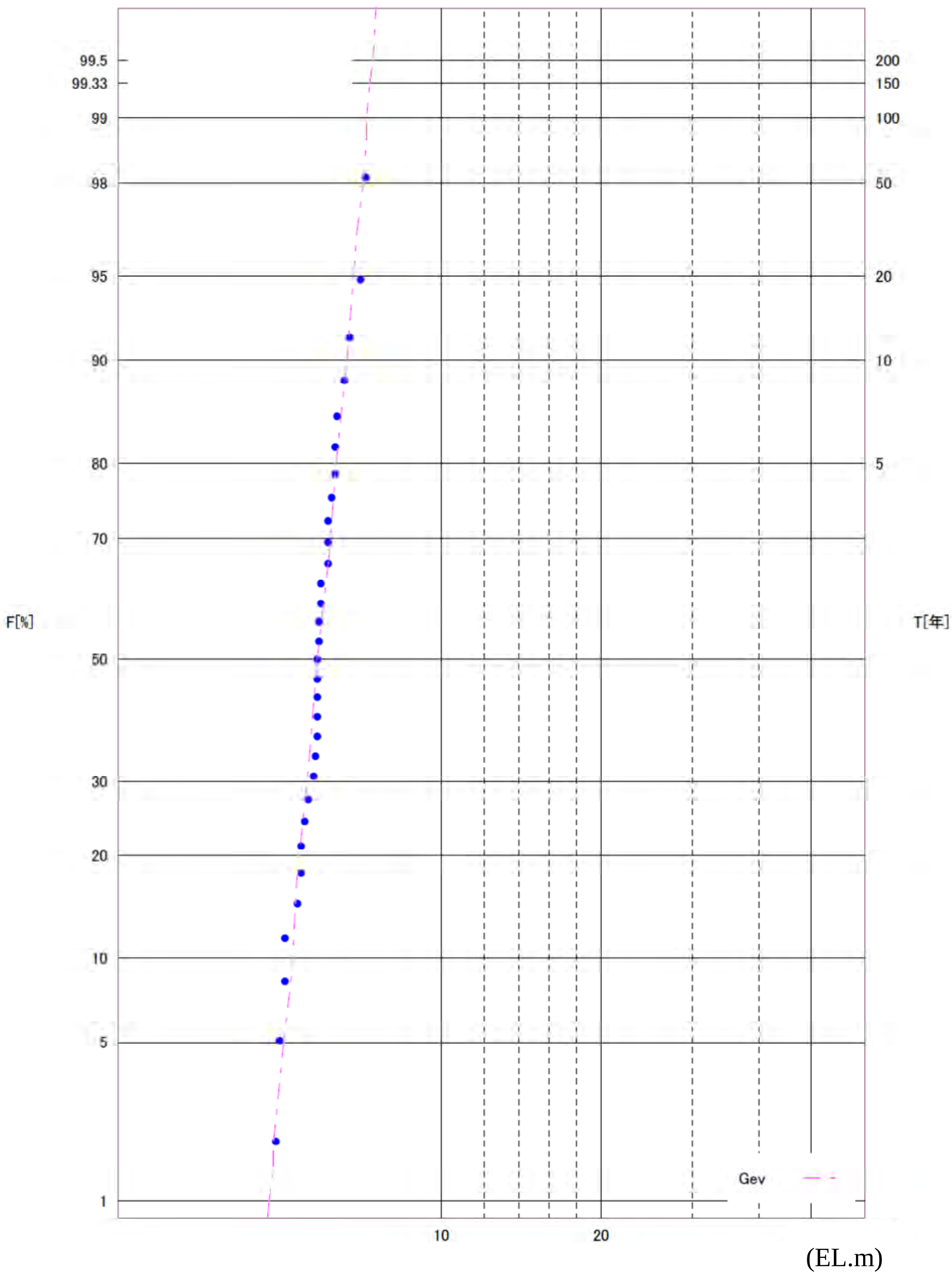
Figure 15 Frequency Analysis of Observed Water Level in Pre-monsoon Season at Bhairab Bazar Station



(EL.m)

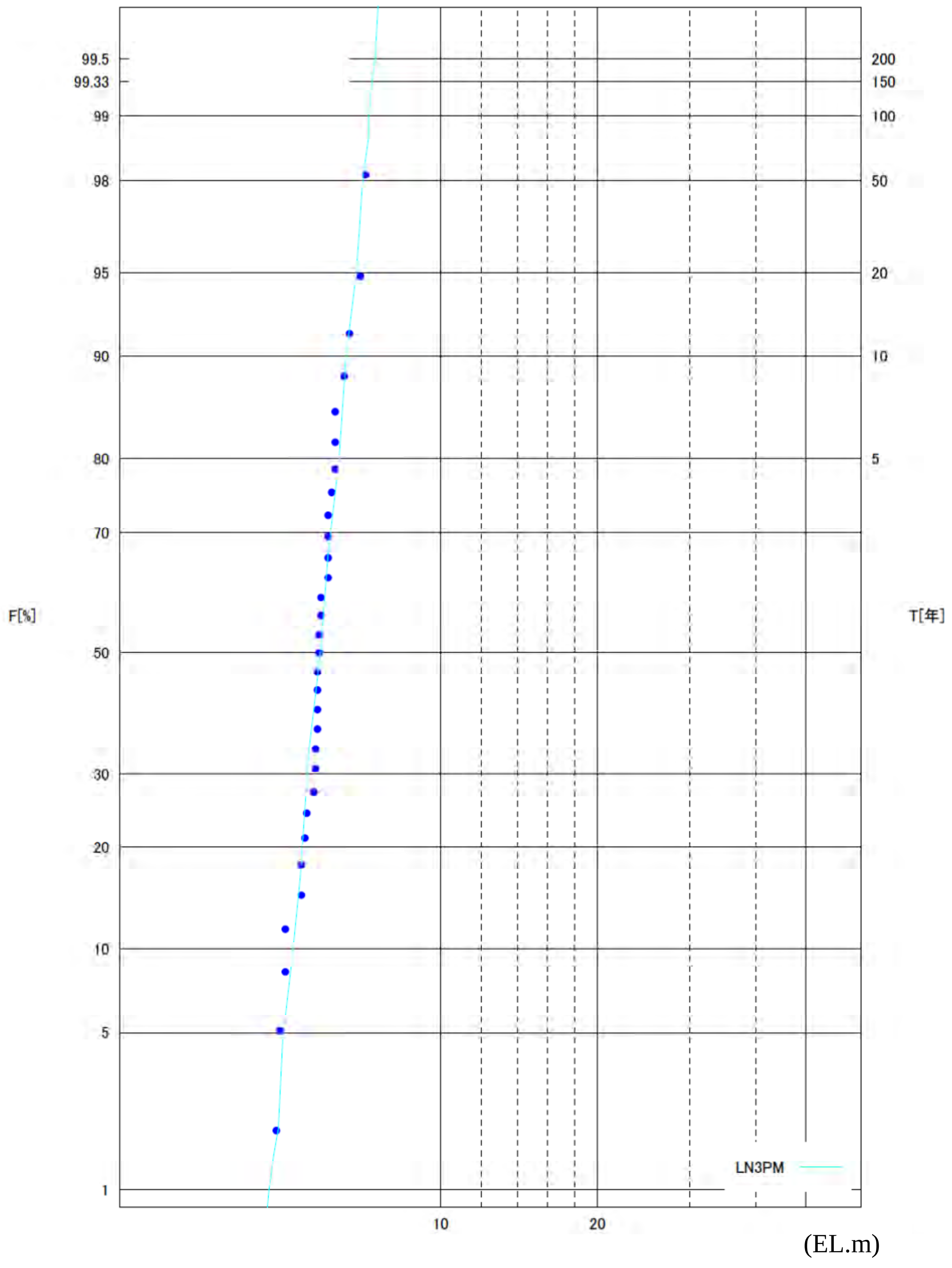
Source: JICA Study Team

Figure 16 Frequency Analysis of Simulated Water Level in Pre-monsoon Season at Bhairab Bazar Station



Source: JICA Study Team

Figure 17 Frequency Analysis of Observed Water Level in Monsoon Season at Bhairab Bazar Station



Source: JICA Study Team

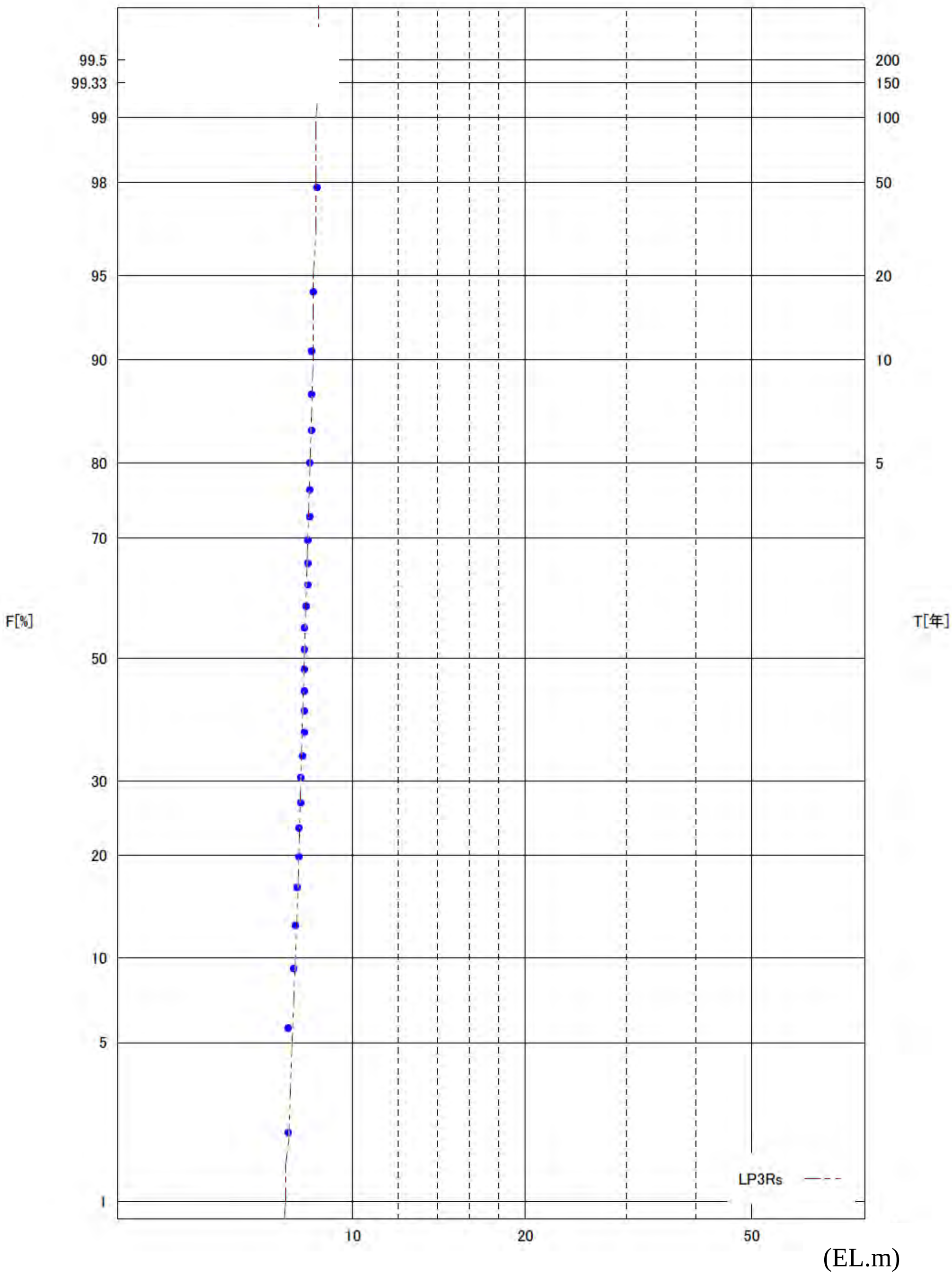
Figure 18 Frequency Analysis of Simulated Water Level in Monsoon Season at Bhairab Bazar Station

Table 4 Probable Water Levels Estimated by Observed and Simulated Water Levels at Sunamganj

Sunamganj Station		Pre-monsoon Season			Monsoon Season		
		Observed WL.	Simulated WL.	Obs. - Sim.	Observed WL.	Simulated WL.	Obs. - Sim.
Probability Distribution Function		LP3Rs	LP3Rs		LP3Rs	LP3Rs	
Parameter Estimation Method							
Estimated value by Jackknife method	1/2	5.9	5.6	0.3	8.2	7.9	0.3
	1/5	6.8	6.5	0.3	8.4	8.2	0.2
	1/10	7.2	6.9	0.3	8.5	8.3	0.2
	1/20	7.4	7.3	0.1	8.5	8.4	0.1
Estimated Error by Jackkhife method	1/2	0.2	0.2		0.0	0.1	
	1/5	0.2	0.2		0.0	0.1	
	1/10	0.2	0.2		0.0	0.1	
	1/20	0.3	0.3		0.1	0.1	
SLSC		0.030	0.029		0.027	0.039	
Correlation (X-COR)		0.991	0.992		0.993	0.983	
pAIC		81.3	80.3		0.1	20.1	
Number of sample		27	27		28	28	

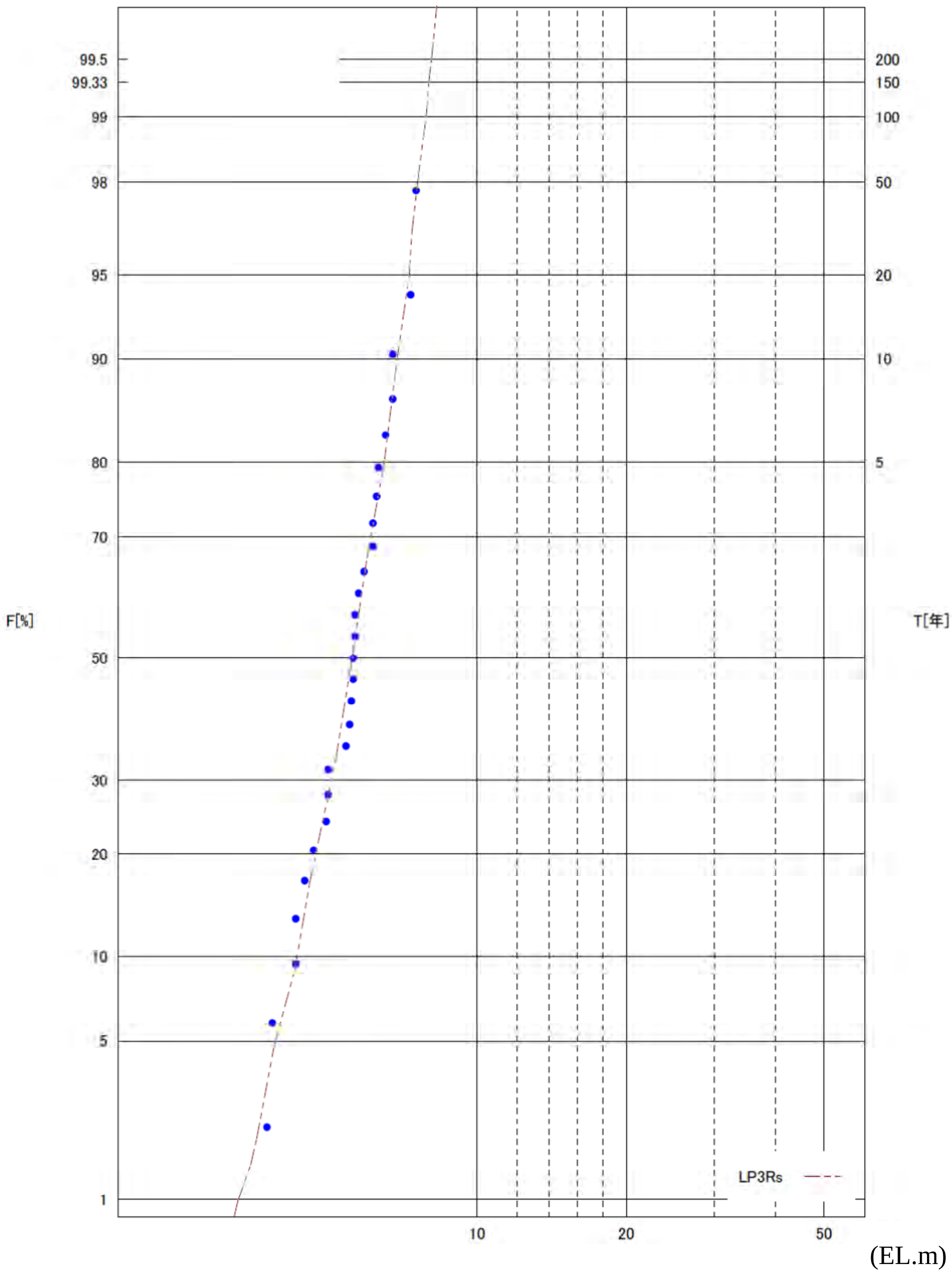
Note: LP3Rs: Log Poison Type III Distribution (Real space method)

Source: JICA Study Team



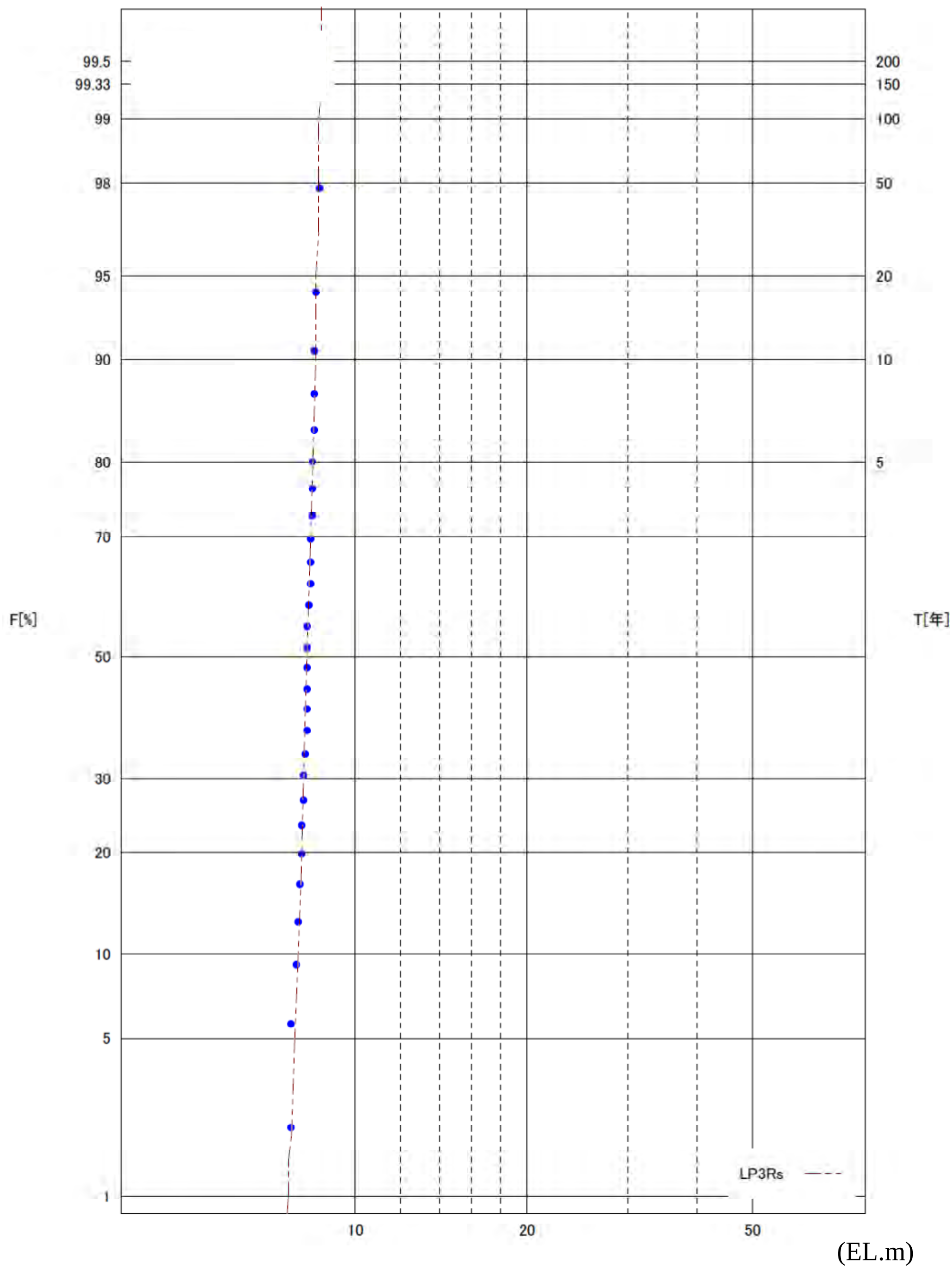
Source: JICA Study Team

Figure 19 Frequency Analysis of Observed Water Level in Pre-monsoon Season at Sunamganj Station



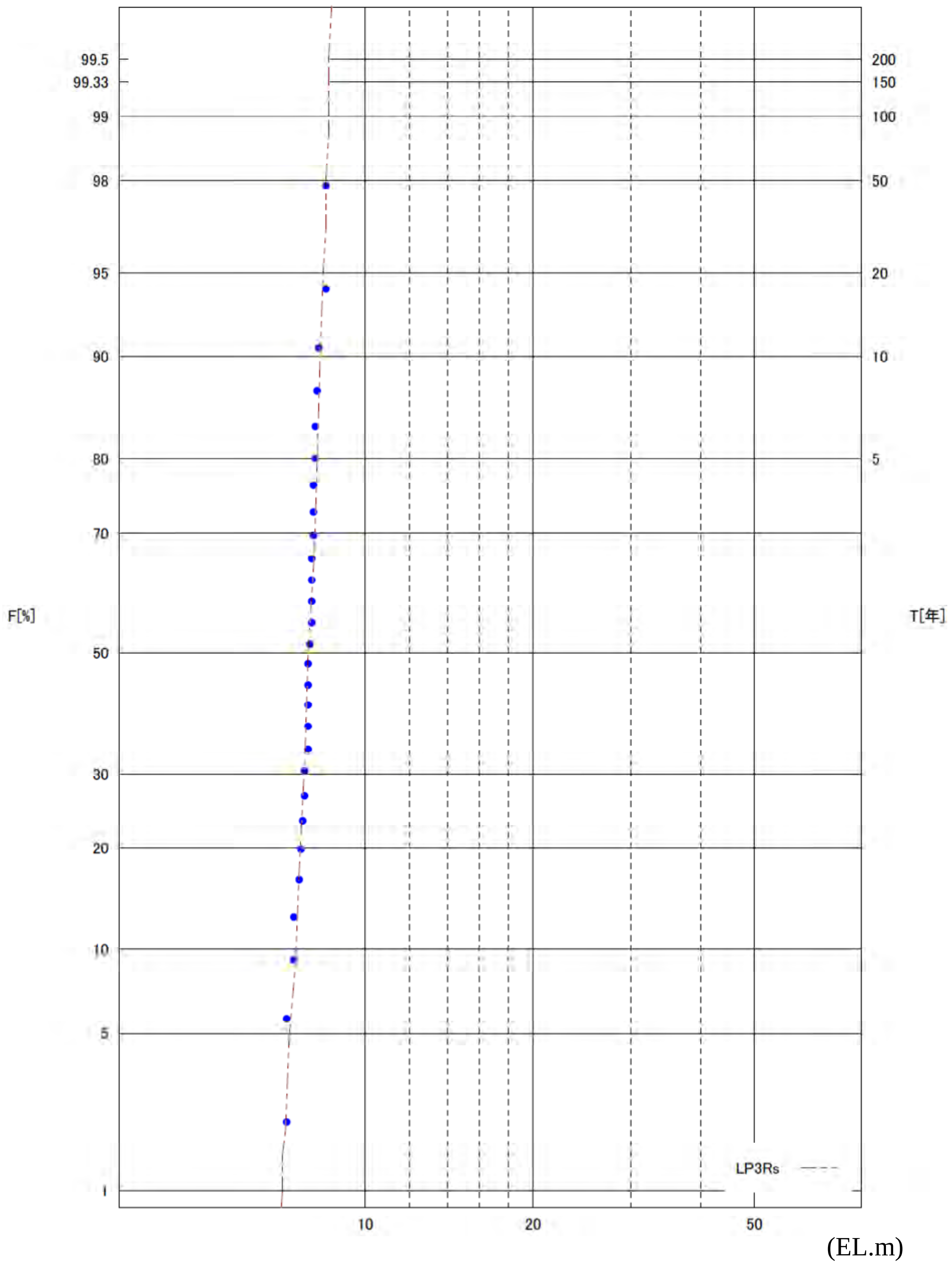
Source: JICA Study Team

Figure 20 Frequency Analysis of Simulated Water Level in Pre-monsoon Season at Sunamganj Station



Source: JICA Study Team

Figure 21 Frequency Analysis of Observed Water Level in Monsoon Season at Sunamganj Station



Source: JICA Study Team

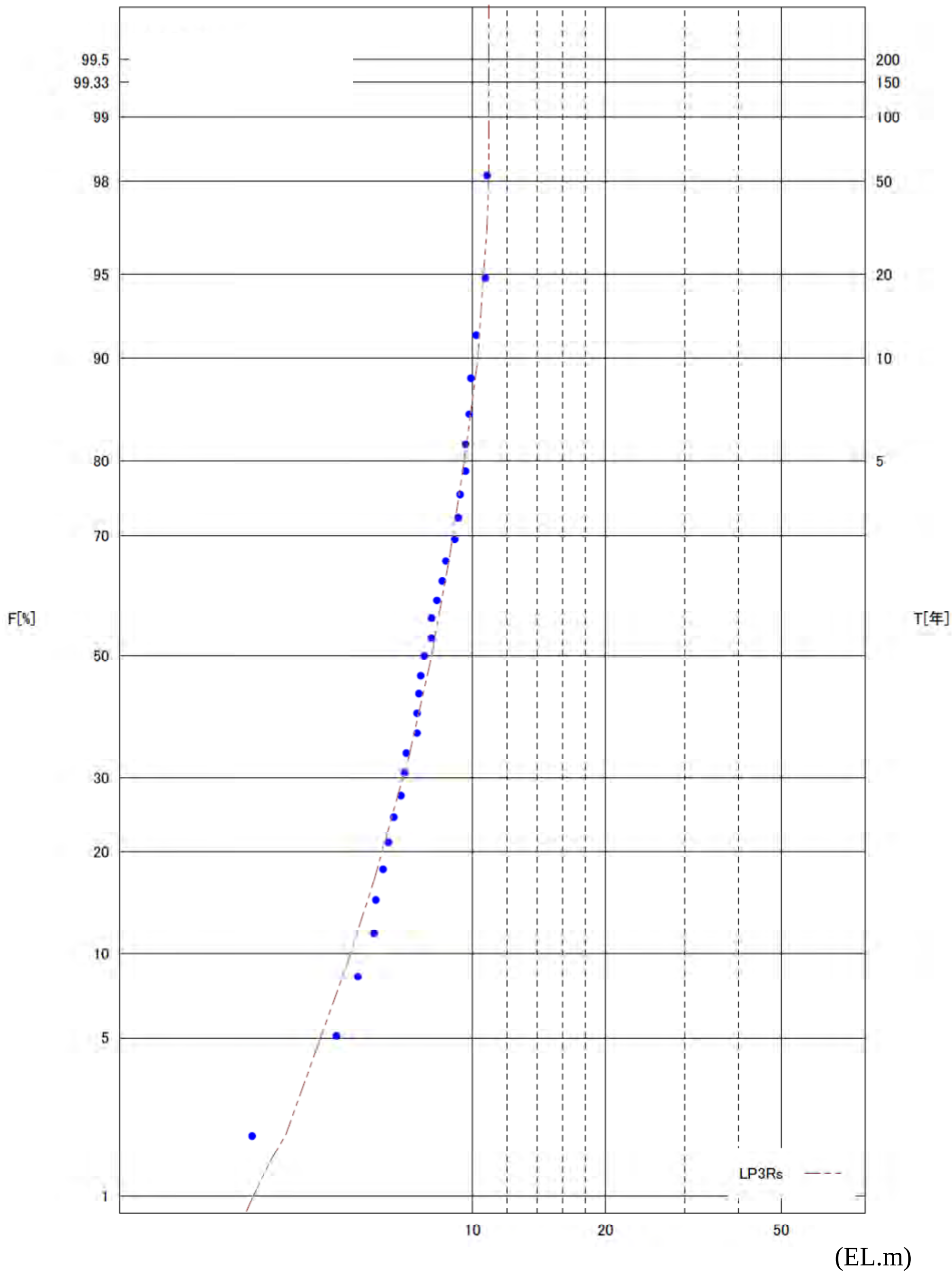
Figure 22 Frequency Analysis of Simulated Water Level in Monsoon Season at Sunamganj Station

Table 5 Probable Water Levels Estimated by Observed and Simulated Water Levels at Sylhet

Sylhet Station		Pre-monsoon Season			Monsoon Season		
		Observed WL.	Simulated WL.	Obs. - Sim.	Observed WL.	Simulated WL.	Obs. - Sim.
Probability Distribution Function		GEV	LP3Rs		Gumbel	LP3Rs	
Parameter Estimation Method		L-moment method			L-moment method	Moment method	
Estimated value by Jackknife method	1/2	8.0	7.4	0.6	10.7	10.5	0.2
	1/5	9.5	9.2	0.3	11.0	10.8	0.2
	1/10	10.2	10.1	0.1	11.3	11.0	0.3
	1/20	10.7	10.6	0.1	11.5	11.1	0.4
Estimated Error by Jackkhife method	1/2	0.4	0.5		0.1	0.1	
	1/5	0.3	0.4		0.1	0.1	
	1/10	0.3	0.3		0.1	0.2	
	1/20	0.4	0.4		0.2	0.2	
SLSC		0.024	0.024		0.056	0.049	
Correlation (X-COR)		0.994	0.994		0.963	0.972	
pAIC		127.4	134.0		47.2	40.6	
Number of sample		31	31		31	31	

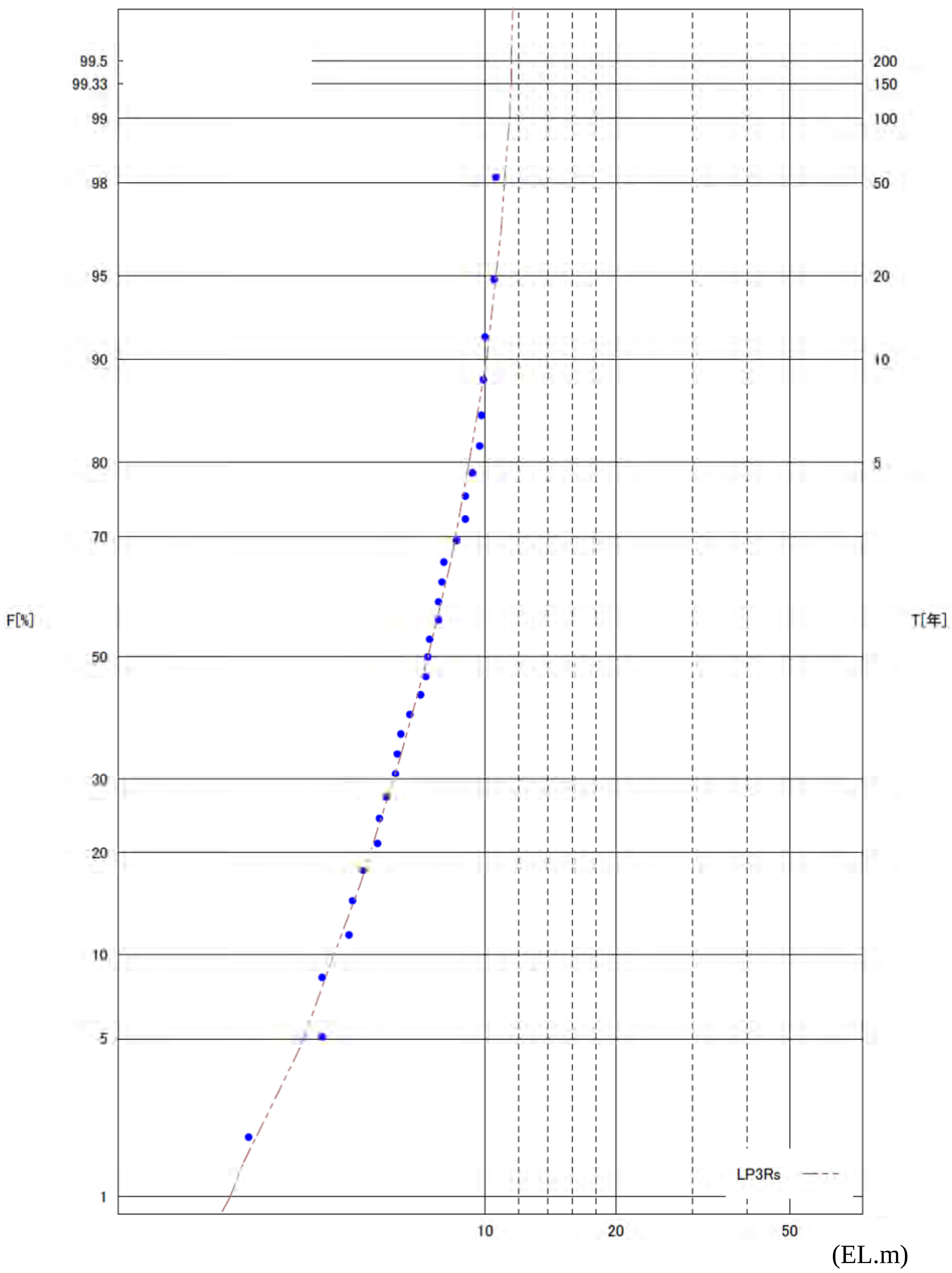
Note: GEV: Generalized Extreme Value Distribution,
LP3Rs: Log Poison Type III Distribution (Real space method)
Gumbel: Gumbel Distribution

Source: JICA Study Team



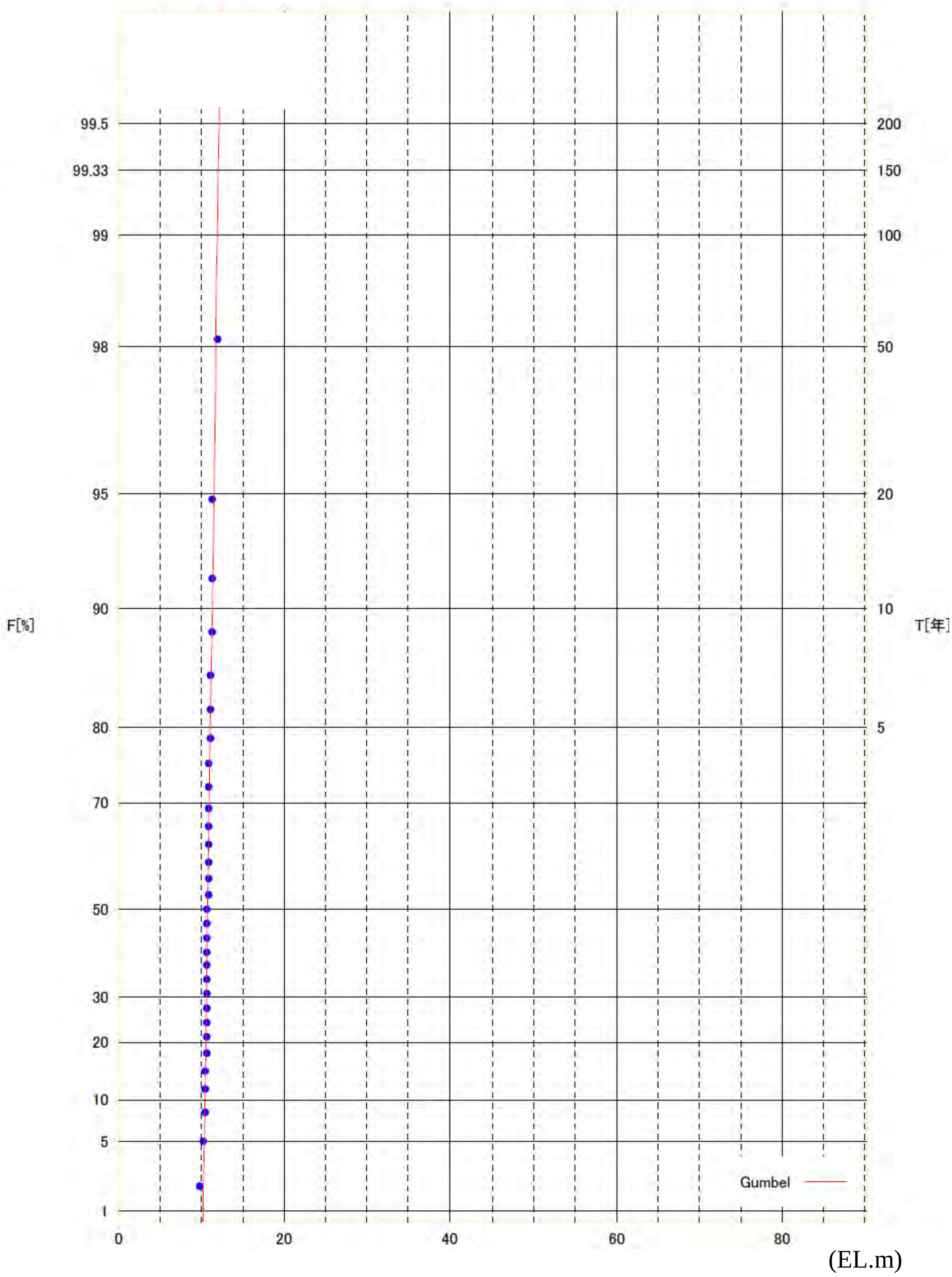
Source: JICA Study Team

Figure 23 Frequency Analysis of Observed Water Level in Pre-monsoon Season at Sylhet Station



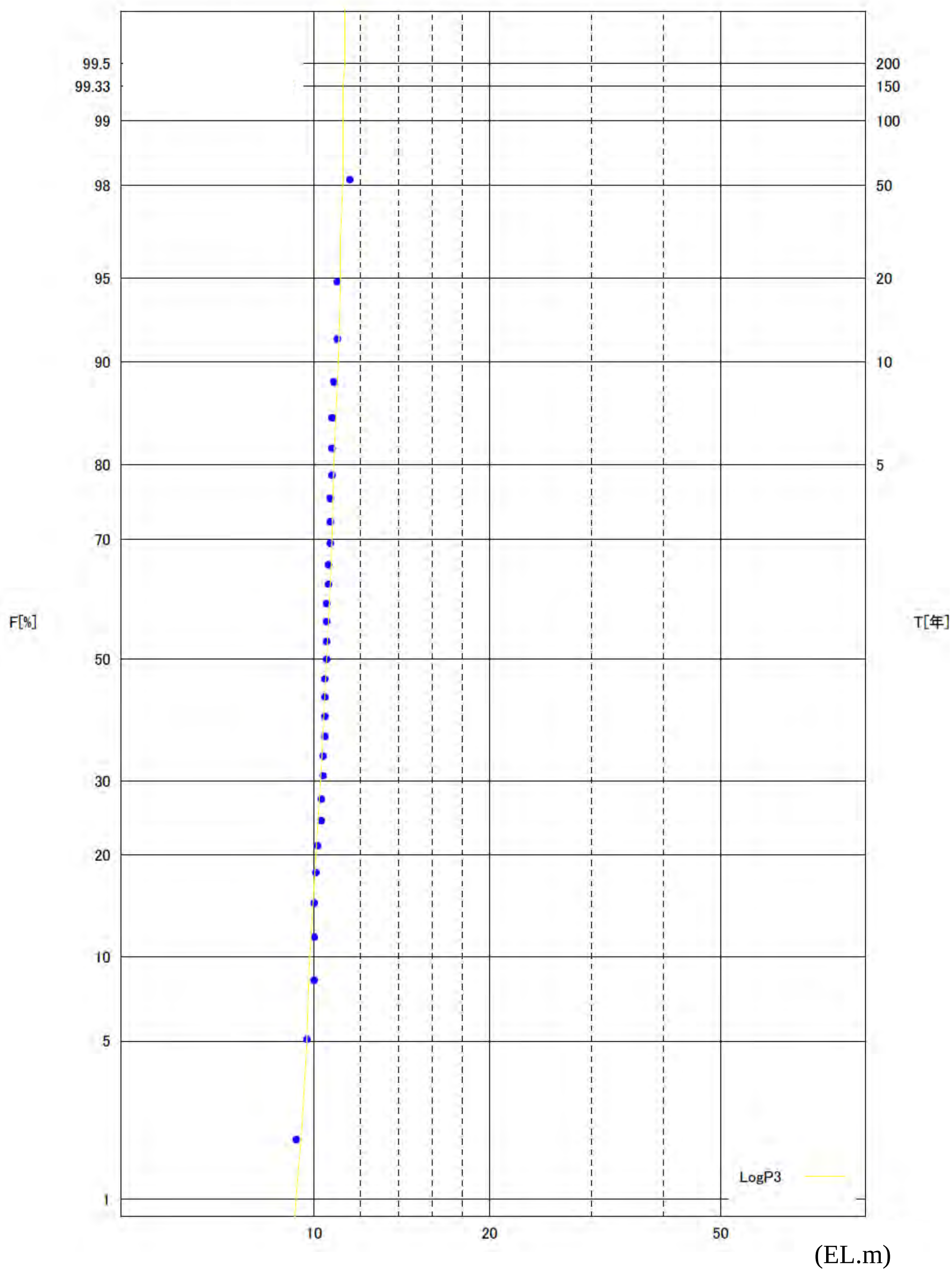
Source: JICA Study Team

Figure 24 Frequency Analysis of Simulated Water Level in Pre-monsoon Season at Sylhet Station



Source: JICA Study Team

Figure 25 Frequency Analysis of Observed Water Level in Monsoon Season at Sylhet Station



Source: JICA Study Team

Figure 26 Frequency Analysis of Simulated Water Level in Monsoon Season at Sylhet Station

Annex 7.1

Impact of New Haor Project

Study on the Impact to Upstream Area after Construction of New Haor Projects

1 Background

Many new haor projects are planned at downstream area along the Surma-Baulai River. If these projects affect to the upstream existing haor projects, heightening of existing submergible embankment in the existing haor projects are carried out or some new haor projects shall be rejected. And many rehabilitation projects decided by BWDB are on-going. Therefore, some new projects will be rejected. The hydraulic calculation by HEC-RAS is carried out to estimate the impact to upstream existing haor projects.

2 Simulation

The hydraulic simulation is carried out non-uniform flow calculation by using HEC-RAS. The assumptions of simulation are as follows;

- Water levels at Bhairab Bazar, Itna, Sunamganj are applied at 10-year pre-monsoon maximum water level for calibration of simulation model because the submergible embankment is considered to new and existing haor projects,
- Peak discharge is decided from 10-year pre-monsoon maximum water level. The peak discharge is estimated from the simulated discharge by NERM.
- Roughness coefficient is assumed at 0.03 in river and 0.09 at the flood plain area.

According to the simulated discharge by NERM model, there are several discharges at same water level due to impact from Padma River and other noise of the NERM. Therefore, maximum and mean discharges of the NERM result are used in the simulation.

2.1 Simulation Method

The simulation is carried out from following steps;

1st step: Calibration of present condition

Present condition is considered. The water levels at 3 points, Bhairab Bazar, Itna and Sunamganj, are fixed to the 10-year pre-monsoon maximum water level as shown below;

Water Level

Location	Water Level (EL.m)
Bhairab Bazar	2.86
Itna	4.52
Sunamganj	6.95

Source: JICA Study Team

The peak discharges at 3 points are applied to maximum and mean discharge cases.

Discharge Case

Location	Case 1(Max.) (m^3/s)	Case 2 (Mean) (m^3/s)
Bhairab Bazar	4,360	3,000
Itna	500	380
Sunamganj	3,700	2,400

Source: JICA Study Team

The water levels at 3 points are adjusted to same water level of 10-year pre-monsoon maximum water level.

2nd Step: Calculation of impact after completion of all proposed new projects

All proposed new projects are completed in this step. In this step, the submergible embankment is constructed along the new projects. Therefore, the upstream water level will be raised. The rising height and affected area are estimated. If the impact of the upstream existing haor area is small, the calculation is finished. Affected area is evaluated from difference between the present condition and the completion condition. The affected area is judged from 5cm difference of water level.

3rd Step: Calculation of impact after completion of selected proposed new projects

The bottle neck sections along the new projects area are checked, and its new projects are rejected. If the impact of the upstream existing haor area is small, the calculation is finished. Then, rejected new projects are fond out. Affected area is evaluated from difference between the present condition and the selected one. The affected area is judged from 5cm difference of water level.

2.2 Simulation Results

The simulation results are shown in following table and figure.

Location	Rising (cm)			
	Case 1		Case 2	
	All	Proposed	All	Proposed
Bhairab Bazar	0	0	0	0
Itna	14	6	16	7
Sunamganj	6	2	5	2

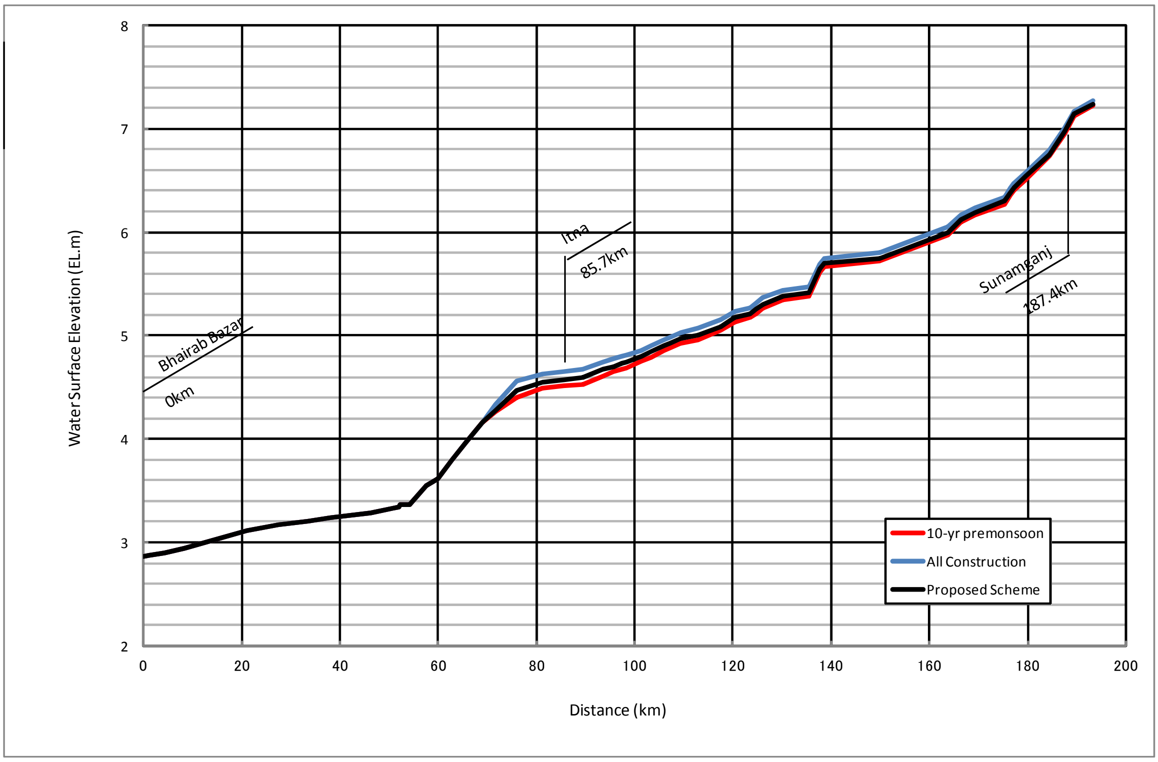
Note: Proposed scheme is not included Charigram Haor project.
Source: JICA Study Team

Location	Affected Area from Itna (km)			
	Case 1		Case 2	
	All	Proposed	All	Proposed
Itna	104	13	84	16

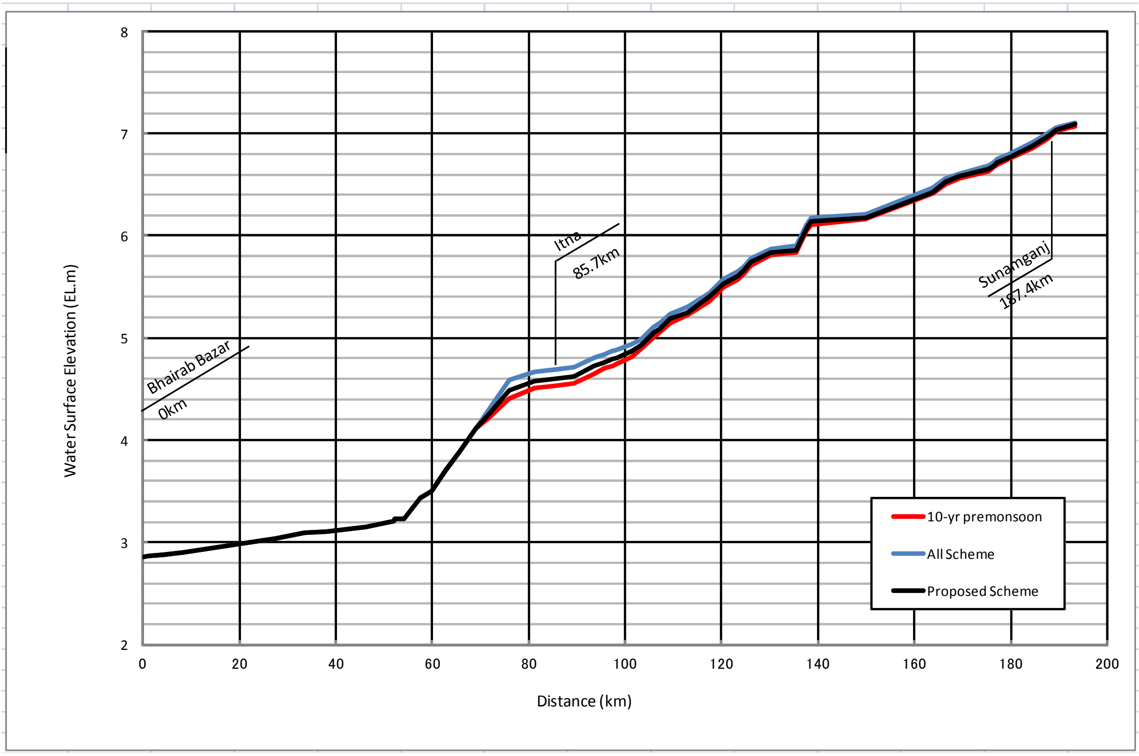
Note: Proposed scheme is not included Charigram Haor project.
Source: JICA Study Team

2.3 Recommendation

Charigram haor project shall be rejected from the hydraulic viewpoint.



Case 1



Case 2

Source: JICA Study Team

Figure 1 Water Level of with/without Scheme

Annex-7.2

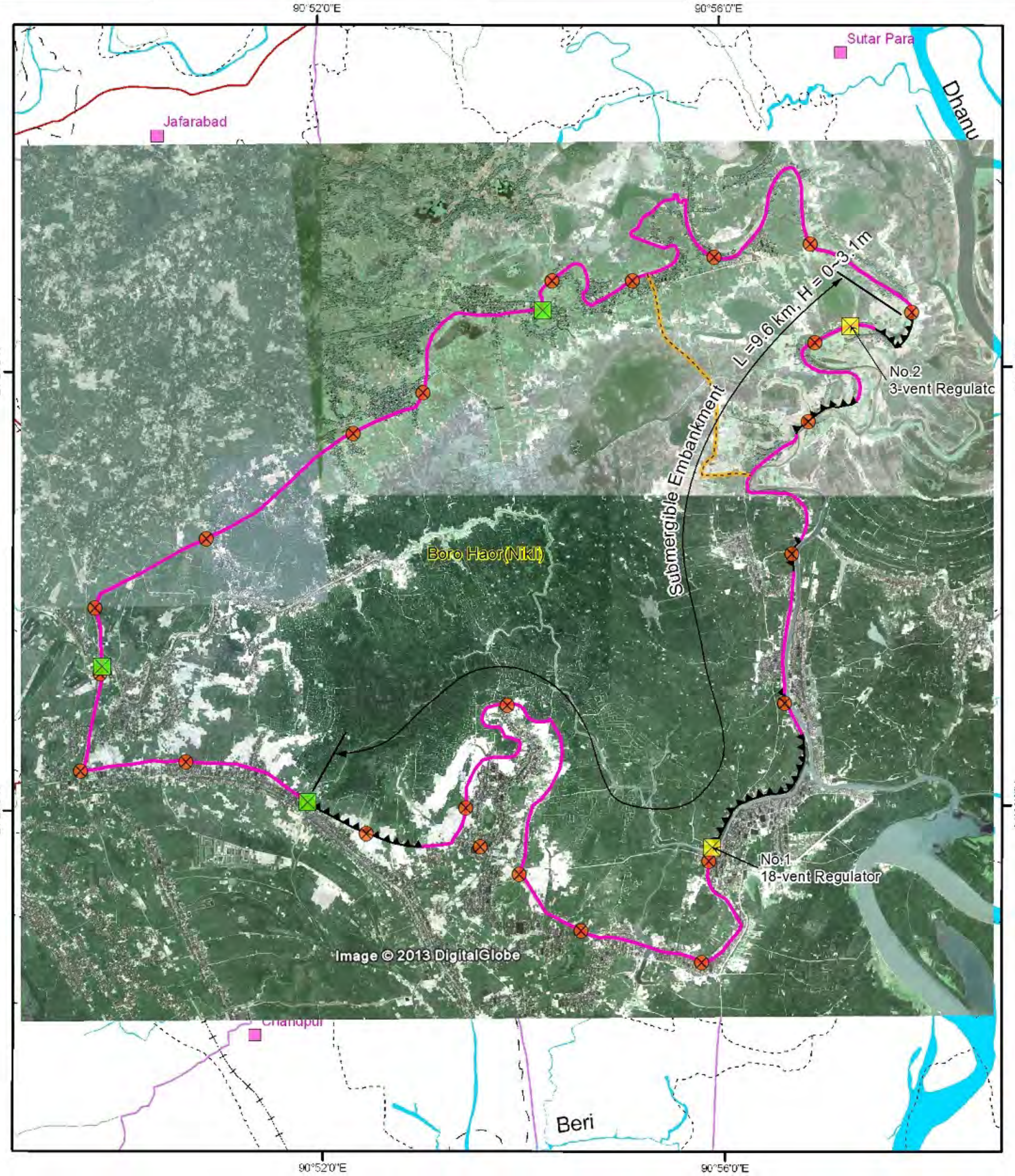
Project Map

New Project List

	Name of Haor Project	Crest Level (height) of embankment	Volume of Embankment	Re-excavation of Canal	Regulator
n-1	Boro Haor (Nikli)	5.4m (0 – 3.2 m)	9.6 km	10 km	9-vent: 2nos 3-vent: 1nos
n-2	Naogaon Haor	5.3m (0 – 1.7 m)	34.1 km	20 km	9-vent: 2nos 8-vent: 1nos 4-vent: 1nos
n-3	Jaliar Haor	7.6m (0 – 1.6 m)	6.8 km	8 km	2-vent: 1nos 2-vent: 1nos
n-4	Dharmapasha Rui Beel	6.4m (0 – 2.7m)	57.1 km	5 km	9-vent: 3nos 8-vent: 2nos 6-vent: 1nos 3-vent: 1nos
n-5	Chandpur Haor	5.2m (0 – 0.6 m)	2.1 km	5 km	4-vent: 1nos 1-vent: 1nos
n-6	Sunair Haor	5.9m (0 – 0.4 m)	16.2 km	25 km	4-vent: 1nos 1-vent: 1nos
n-7	Badla Project	5.2m (0 – 1.8m)	10.8 km	2 km	2-vent: 2nos
n-8	Nunnir Haor	4.7m (0 – 2.5 m)	25.5 km	20 km	5-vent: 1nos 2-vent: 2nos
n-9	Dakhshiner Haor	5.1m (0 – 2.3 m)	18.3 km	10 km	6-vent: 1nos 3-vent: 1nos
n-10	Chatal Haor	5.7m (0 – 2.3 m)	5.7 km	11 km	1-vent: 2nos
n-11	Ganesh Haor	6.4m (0 – 2.2 m)	22.5 km	3 km	3-vent: 1nos 2-vent: 1nos
n-12	Dhakua Haor	6.3m (0 – 3.2 m)	36.5 km	30 km	5-vent: 1nos 3-vent: 1nos 1-vent: 1nos
n-13	Mokhar Haor	5.5 – 6.2m (0 – 5.8 m)	68.8 km	110 km	5-vent: 1nos 4-vent: 2nos 3-vent: 2nos
n-14	Noapara Haor	4.9m (0 – 3.5 m)	28.3 km	7 km	3-vent: 1nos 2-vent:1nos 1-vent: 1nos
n-15	Dulalpur Haor	4.3m (0 – 2.9 m)	8.3 km	3 km	2-vent: 1nos
n-16	Bara Haor	6.3m (0 – 4.6 m)	27.0 km	40 km	5-vent: 1nos 1-vent: 1nos
n-17	Bansharir Haor	6.1m (0 – 2.8 m)	18.0 km		1-vent: 2nos
n-18	Korati Haor	5.2m (0 – 4.3 m)	40.4 km	4 km	4-vent: 1nos 1-vent: 1nos
n-19	Sarishapur Haor	4.6m (0 – 1.8 m)	7.1 km	5 km	1-vent: 1nos
n-20	Shelnir Haor	5.5m (0 – 1.6 m)	30.1 km	2 km	1-vent: 3nos
n-21	Kuniarbandh Haor	4.3m (0 – 3.0 m)	8.3 km		1-vent: 1nos
n-22	Ayner Gupi Haor	4.3m (0 – 3.0m)	13.7 km		3-vent: 1nos
	Charigram Project	4.9m (0 – 2.2m)	25.7 km	3 km	4-vent: 1nos 1-vent: 1nos
	Bara Haor (Austagram)	4.8m (0 – 2.2 m)	60.3 km	40 km	11-vent:2nos 4-vent: 1nos 3-vent: 1nos
	Golaimara Haor	4.2m (0 m)	-	-	-
	Joyariya Haor	4.2m (0 m)	-	-	-
	Total				

Rehabilitation Project List

No.	Name of Haor Project	Re-sectioning of Embankment	Replace of Gate and Regulator	Re-excavation of Canal
r-1	1. Dampara Water Management Scheme	Full 200 m Sub 400 m	Gate 15 nos	12km
r-2	2. Kangsa River Scheme	Full 40 m	Gate 16 nos	
r-3	3. Singer Beel Scheme	Full 100 m Sub 125 m	Gate 1 nos	2 km
r-4	4. Baraikhali Khal Sub-Project	Full 10 m	Gate 6 nos	24.5 km
r-5	5. Aladia-Bahadia Scheme		Gate 2 nos	8 km
r-6	6. Modkhola Bairagirchar Scheme	Full 500 m		
r-7	7. Ganakkahali Scheme		Gate 3 nos	
r-8	8. Kairdhala Ratna	Sub 60 m	Gate 9 nos	
r-9	9. Bashira River Re-excavation Schme	Sub 6,000 m	2vent Reg. 2 nos	20 km
r-10	10. Aralia Khal Scheme		Gate 4 nos	2.4 km
r-11	11. Chandal Beel Scheme	Full 100 m	2vent Reg. 1 nos	1.5 km
r-12	12. Satdona Beel Scheme		2vent Reg. 2 nos	
r-13	15. Gangajuri FCD	Full 600 m	Gate 20 nos	4.5 km
r-14	20. Kaliajuri Polder #02	Sub 810 m	Gate 19 nos	
r-15	21. Kaliajuri Polder #04	Sub 630 m	Gate 3 nos	



Government of The People's Republic of Bangladesh

Bangladesh Haor & Wetland Development Board

Development of Haor Master Plan

Boro Haor (Nikli) Scheme

Legend

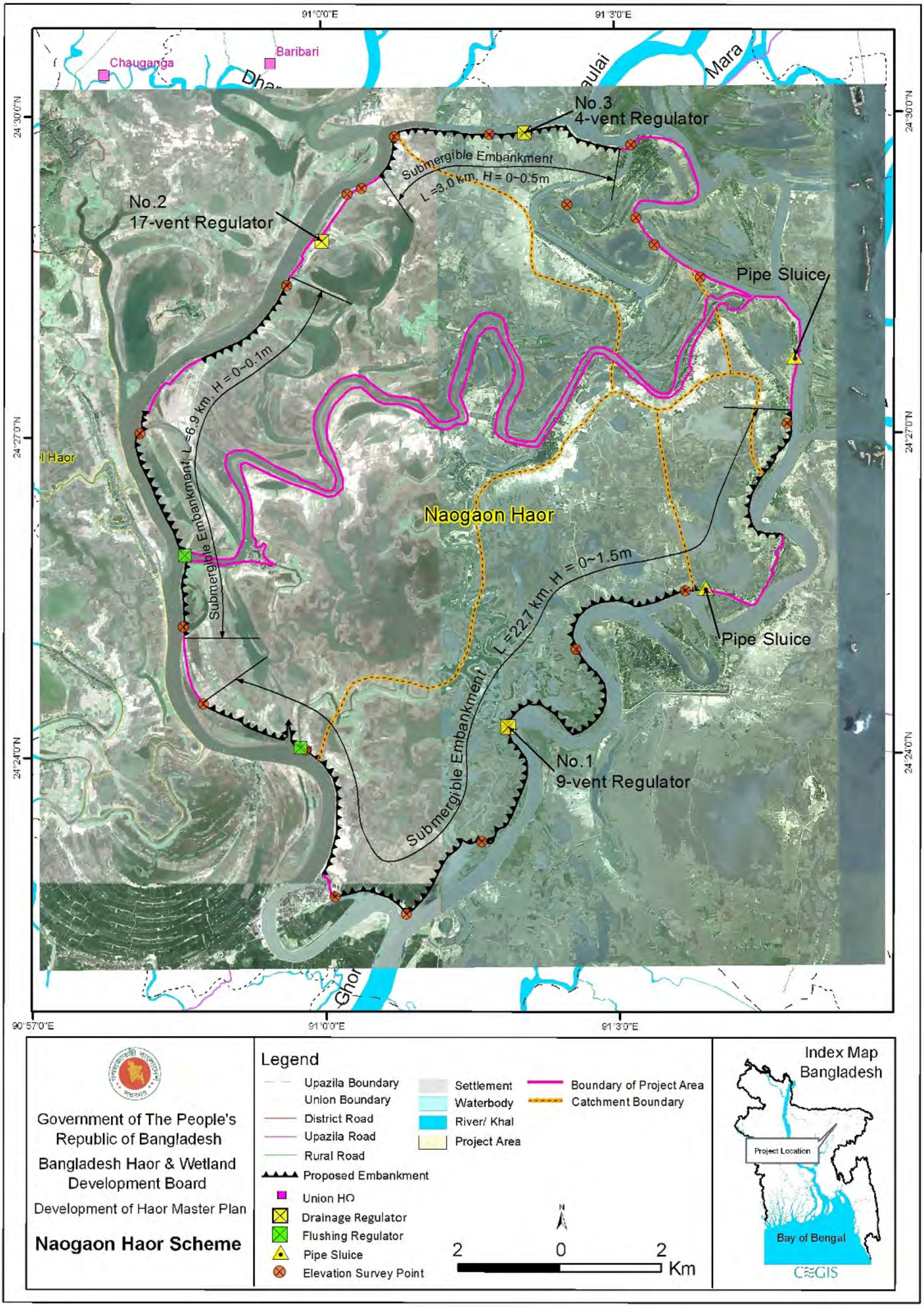
- Upazila Boundary
- Union Boundary
- District Road
- Upazila Road
- Rural Road
- Proposed Embankment
- Union HQ
- Drainage Regulator
- Flushing Regulator
- Elevation Survey Point
- Settlement
- Waterbody
- River/ Khal
- Project Area
- Catchment Boundary
- Boundary of Project Area

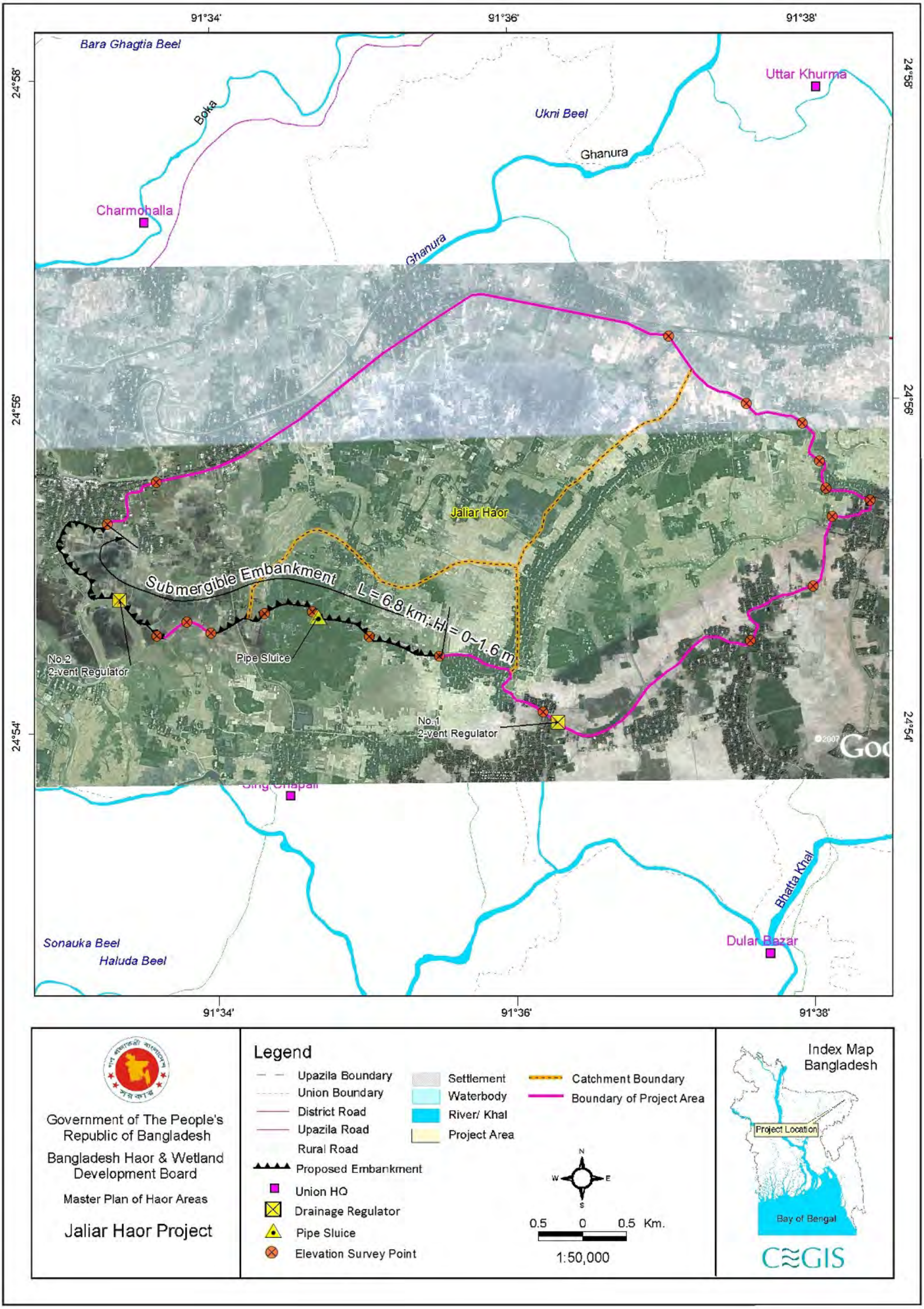
N

2 0 2 Km

Index Map Bangladesh

CEGIS


91°0'0"E
91°3'0"E
90°57'0"E
24°30'0"N
24°27'0"N
24°24'0"N
Chauganga
Baribari
Dhan
Baulai
Mara
Ghor
Haor
No.3
4-vent Regulator
Submergible Embankment
L =3.0 km, H = 0~0.5m
No.2
17-vent Regulator
Pipe Sluice
L =6.9 km, H = 0~0.1m
Submergible Embankment
Naogaon Haor
L =22.7 km, H = 0~1.5m
Submergible Embankment
Pipe Sluice
No.1
9-vent Regulator
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Naogaon Haor Scheme
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Flushing Regulator
Pipe Sluice
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Boundary of Project Area
Catchment Boundary
N
2 0 2 Km
Index Map
Bangladesh
Project Location
Bay of Bengal
CEGIS



91°34'
91°36'
91°38'
24°58'
24°56'
24°54'
Bara Ghagtia Beel
Boka
Uttar Khurma
Ukni Beel
Ghanura
Charmohalla
Ghanura
Jaliar Haor
Submergible Embankment
L = 6.8 km; H = 0~1.6 m
Pipe Sluice
No.2
2-vent Regulator
No.1
2-vent Regulator
Bhatta Khal
Sonauka Beel
Haluda Beel
Dular Bazar
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Master Plan of Haor Areas
Jaliar Haor Project
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Pipe Sluice
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Catchment Boundary
Boundary of Project Area
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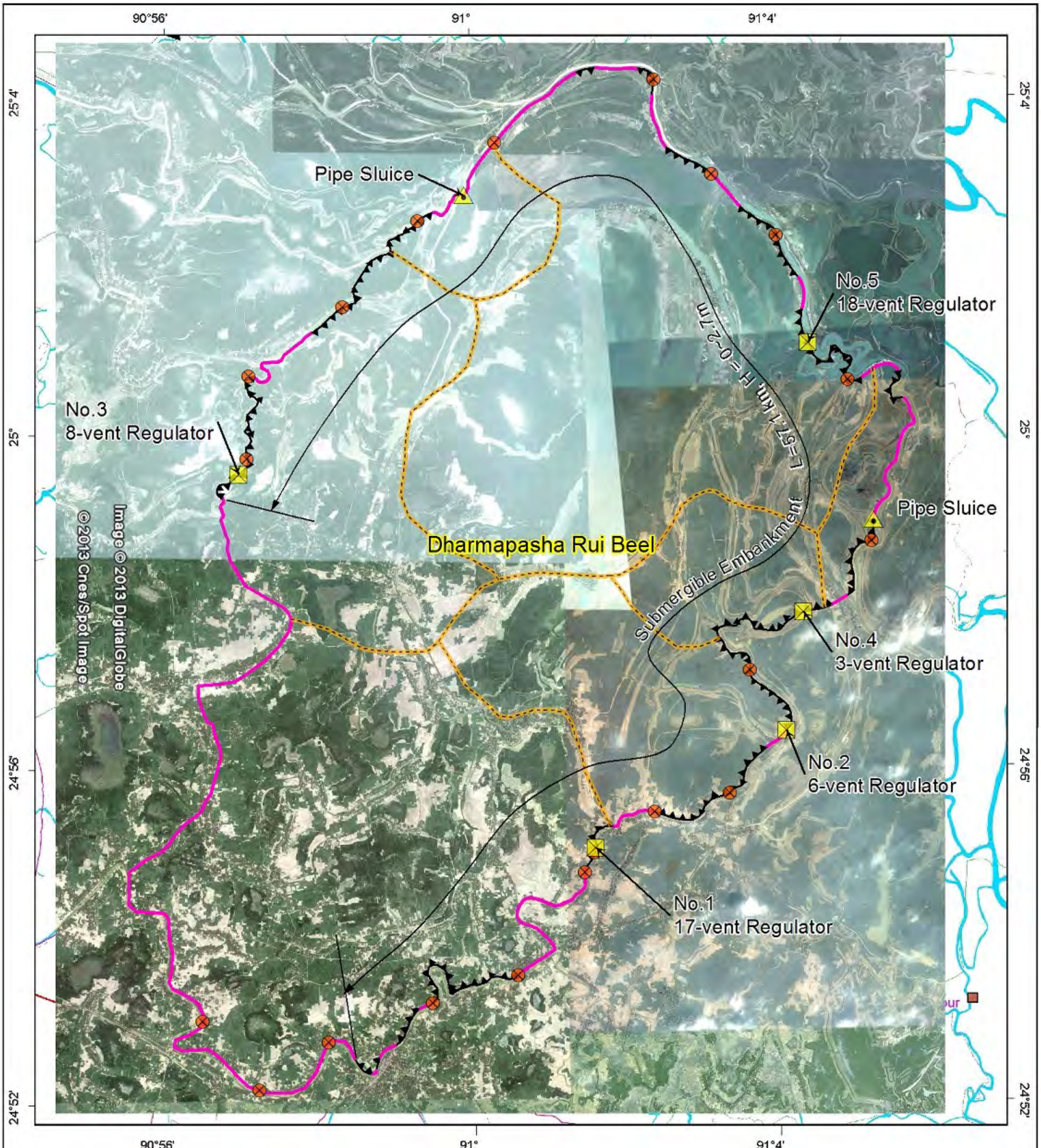
0.5 0 0.5 Km.
1:50,000
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS



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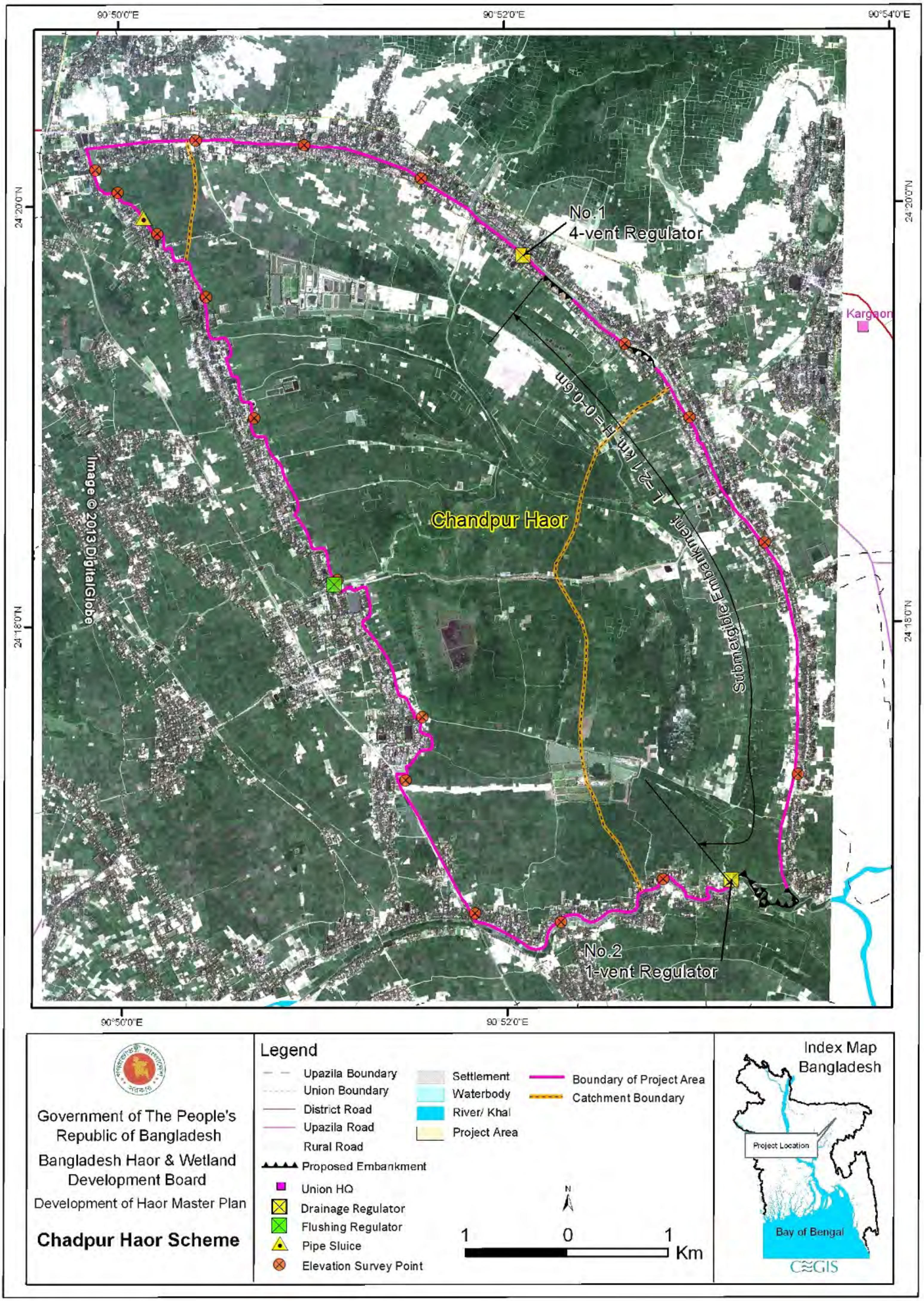
Bangladesh Haor & Wetland Development Board

Development of Haor Master Plan

Dharmapasha Rui Beel Project

CEGIS



90°50'0"E
90°52'0"E
90°54'0"E
24°20'0"N
24°18'0"N
No.1
4-vent Regulator
Kargaon
L = 2.1 km, H = 0-0.6m
Submergible Embankment
Chandpur Haor
Image © 2013 DigitalGlobe
No.2
1-vent Regulator
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Chadpur Haor Scheme
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Flushing Regulator
Pipe Sluice
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Boundary of Project Area
Catchment Boundary
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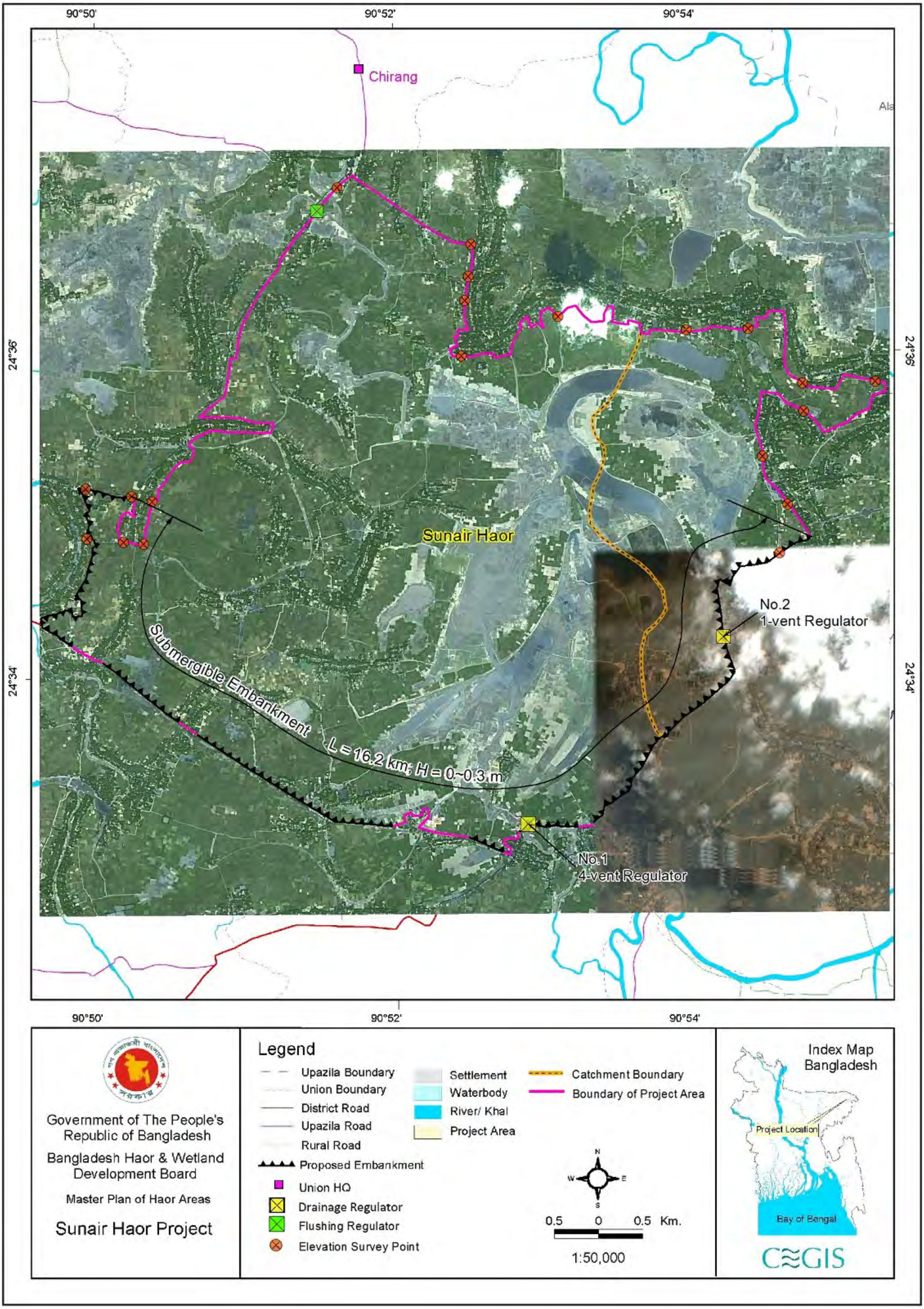
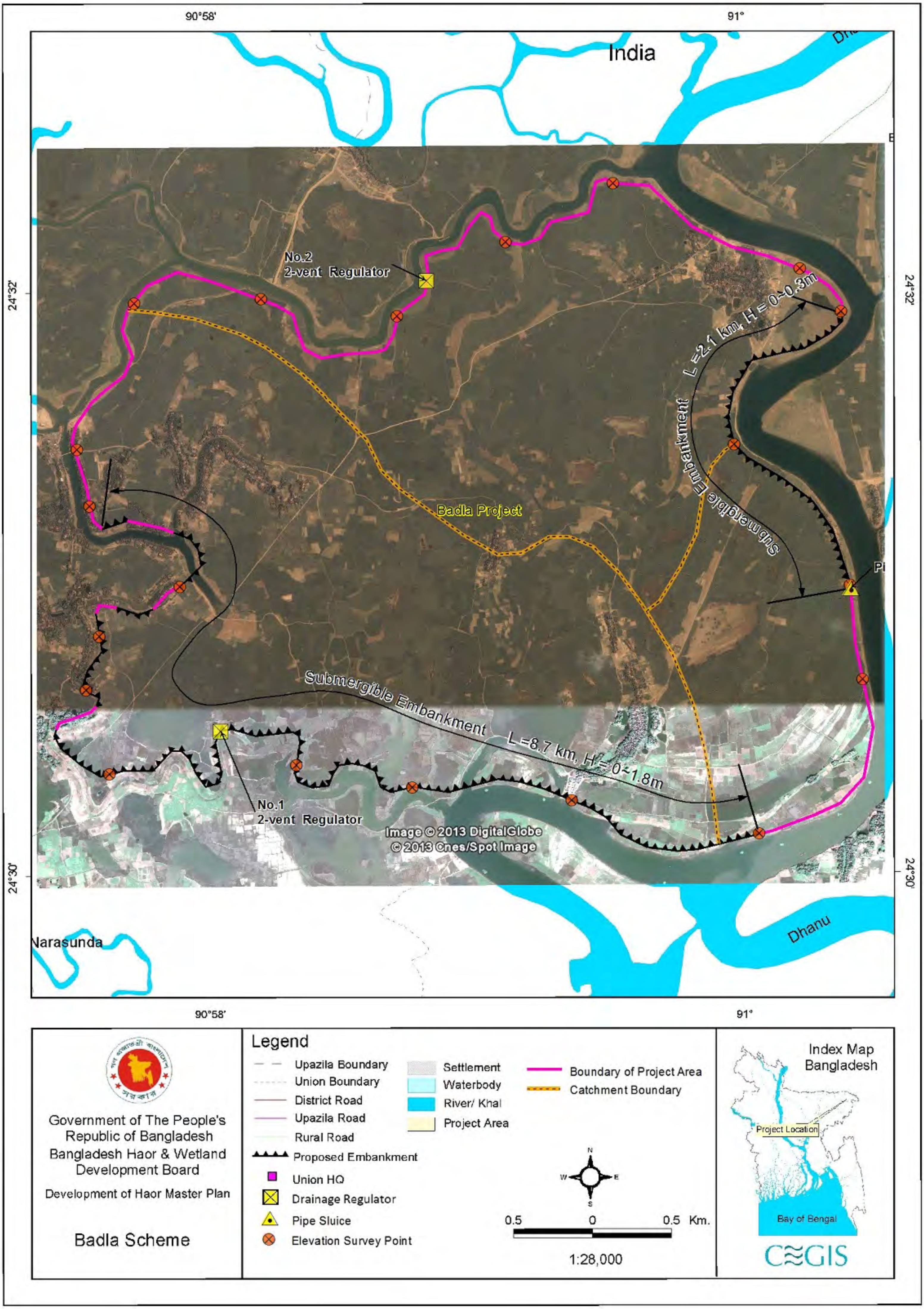
1
0
1
Km
Index Map
Bangladesh
Project Location
Bay of Bengal
CEGIS


90°50'
90°52'
90°54'
24°36'
24°34'
Chirang
Sunair Haor
No.2
1-vent Regulator
Submergible Embankment
L = 16.2 km; H = 0~0.3 m
No.1
4-vent Regulator
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Master Plan of Haor Areas
Sunair Haor Project
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Flushing Regulator
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Catchment Boundary
Boundary of Project Area
0.5 0 0.5 Km.
1:50,000
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS



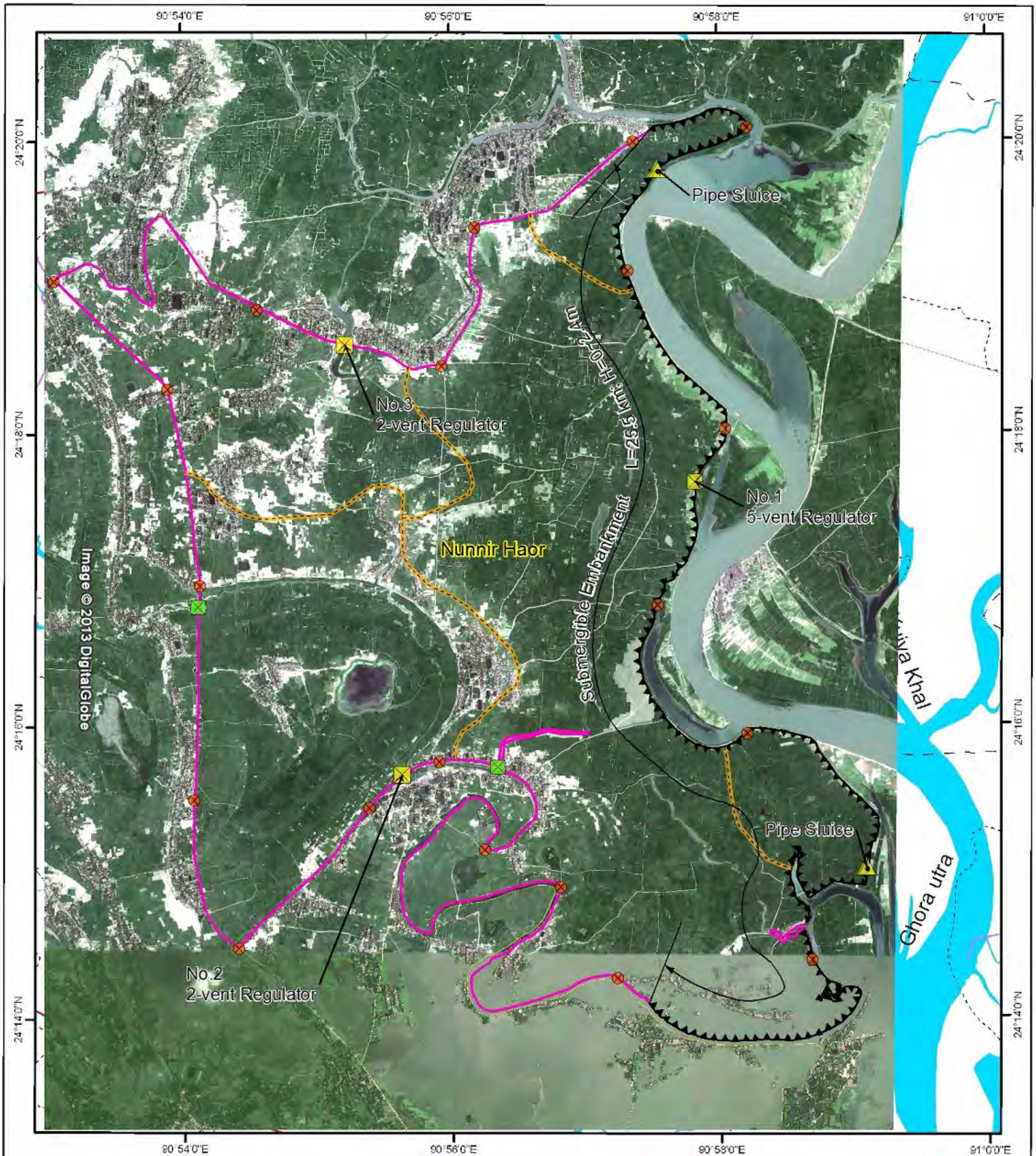
Government of The People's Republic of Bangladesh

Bangladesh Haor & Wetland Development Board

Development of Haor Master Plan

Badla Scheme

CEGIS



Government of The People's Republic of Bangladesh

Bangladesh Haor & Wetland Development Board

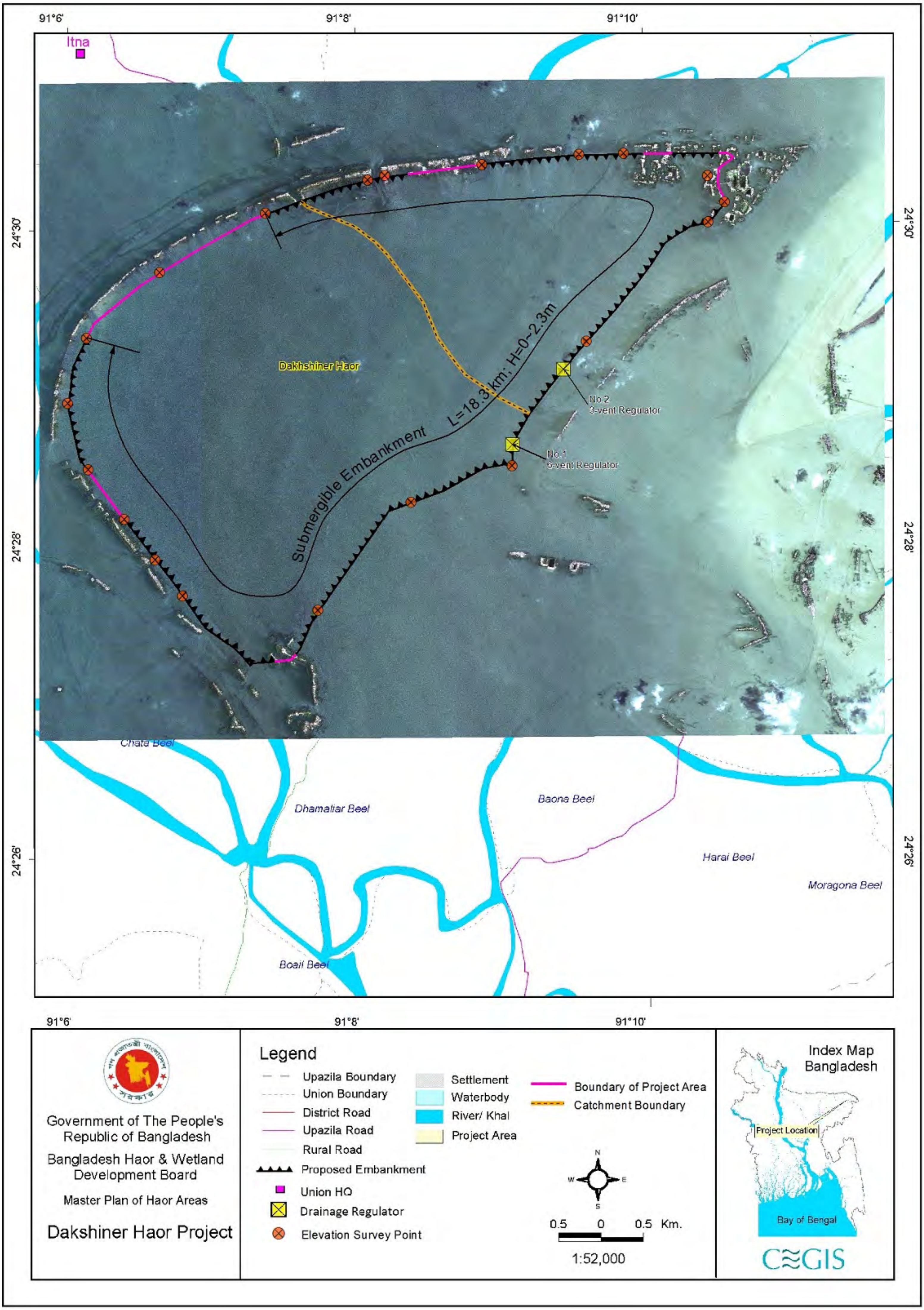
Development of Haor Master Plan

Nunnir Haor Scheme

Legend

- Upazila Boundary
- Union Boundary
- District Road
- Upazila Road
- Rural Road
- Proposed Embankment
- Elevation Survey Point
- Drainage Regulator
- Flushing Regulator
- Pipe Sluice
- Settlement
- Waterbody
- River/ Khal
- Project Area
- Catchment Boundary
- Boundary of Project Area

1 0 1 Km



91°6'
91°8'
91°10'
24°30'
24°28'
24°26'
Itna
Dakhshiner Haor
L=18.3 km; H=0~2.3m
Submergible Embankment
No.2
3-vent Regulator
No.1
6-vent Regulator
Chata Beel
Dhamaliar Beel
Baona Beel
Harai Beel
Moragona Beel
Boail Beel
Government of The People's Republic of Bangladesh
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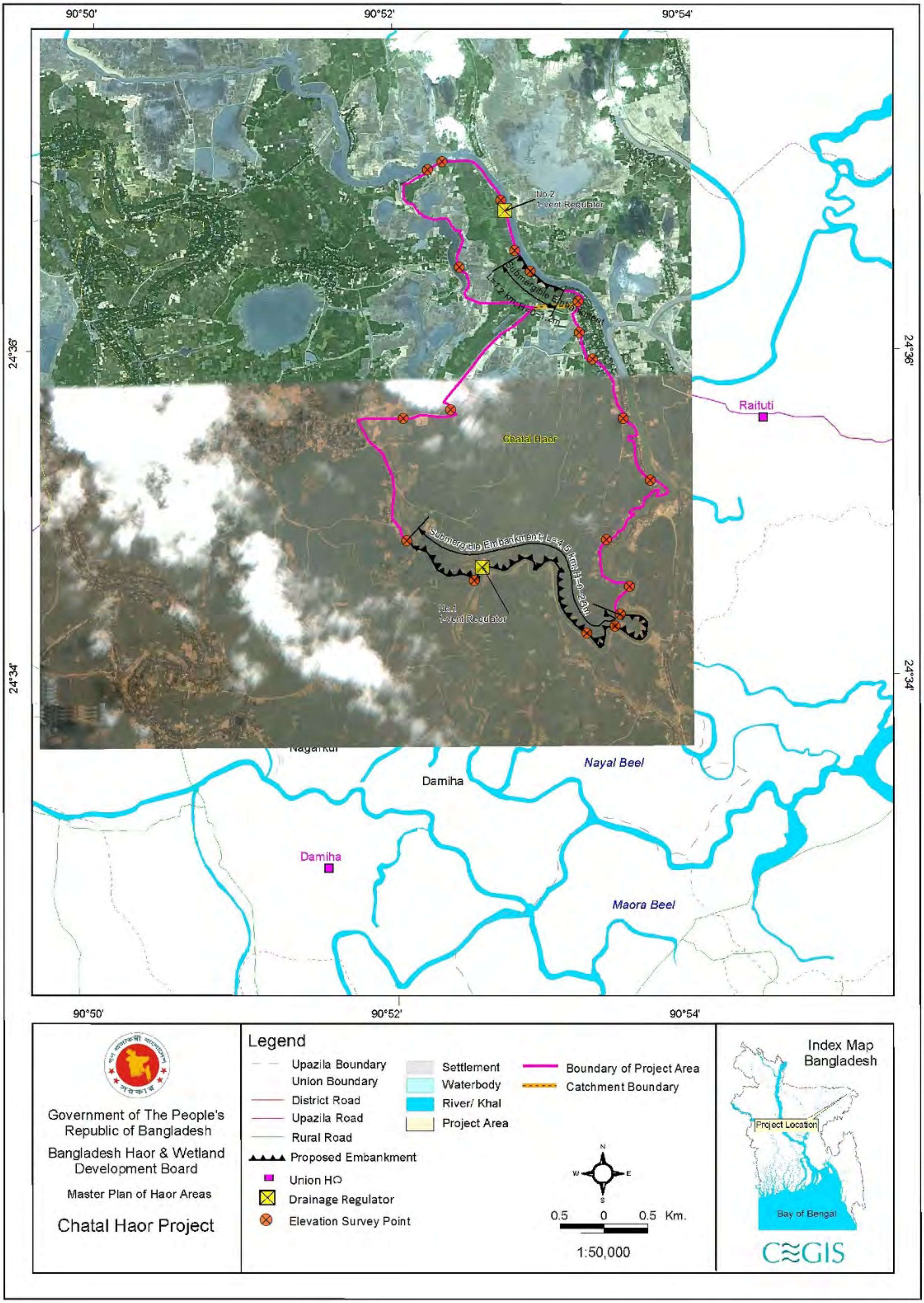
Master Plan of Haor Areas
Dakshiner Haor Project
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Boundary of Project Area
Catchment Boundary
N
W
E
S
0.5 0 0.5 Km.
1:52,000
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS



90°50'
90°52'
90°54'
24°36'
24°34'
No.2
1-vent Regulator
Submergible Embankment
L=1.2 km; H=0-1.2m
Raituti
Chatal Haor
Submergible Embankment; L=4.5 km; H=0-2.3m
No.1
1-vent Regulator
Nayal Beel
Damiha
Damiha
Maora Beel
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Chatal Haor Project
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Boundary of Project Area
Catchment Boundary
N
W
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0.5 0 0.5 Km.
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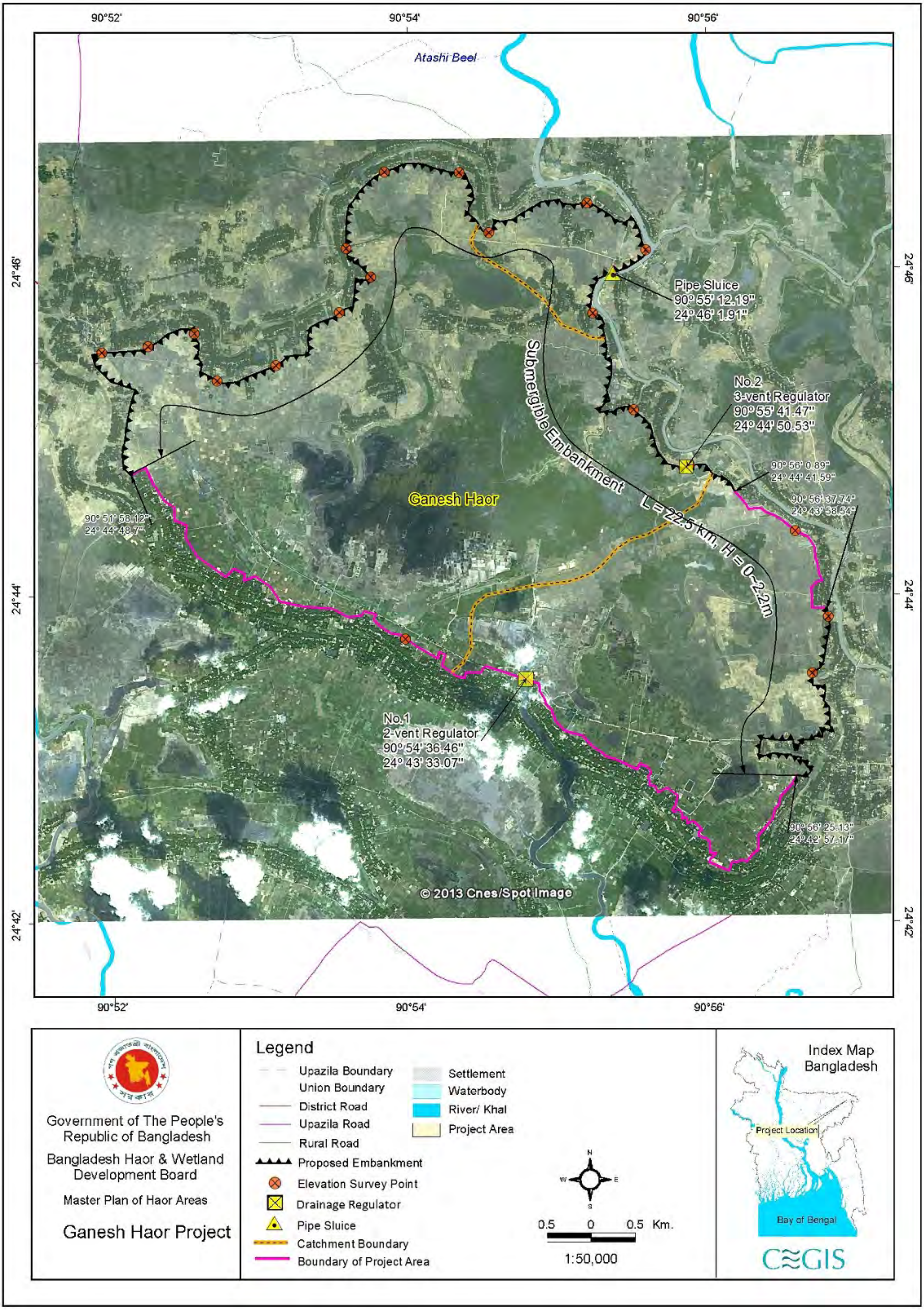
Index Map
Bangladesh
Project Location
Bay of Bengal
CEGIS


90°52'
90°54'
90°56'
24°46'
24°44'
24°42'
Atashi Beel
Pipe Sluice
90° 55' 12.19"
24° 46' 1.91"
Submergible Embankment
L = 22.5 km, H = 0~2.2m
No.2
3-vent Regulator
90° 55' 41.47"
24° 44' 50.53"
90° 56' 0.89"
24° 44' 41.59"
90° 56' 37.74"
24° 43' 58.54"
Ganesh Haor
90° 51' 58.12"
24° 44' 48.7"
No.1
2-vent Regulator
90° 54' 36.46"
24° 43' 33.07"
90° 56' 25.13"
24° 42' 57.17"
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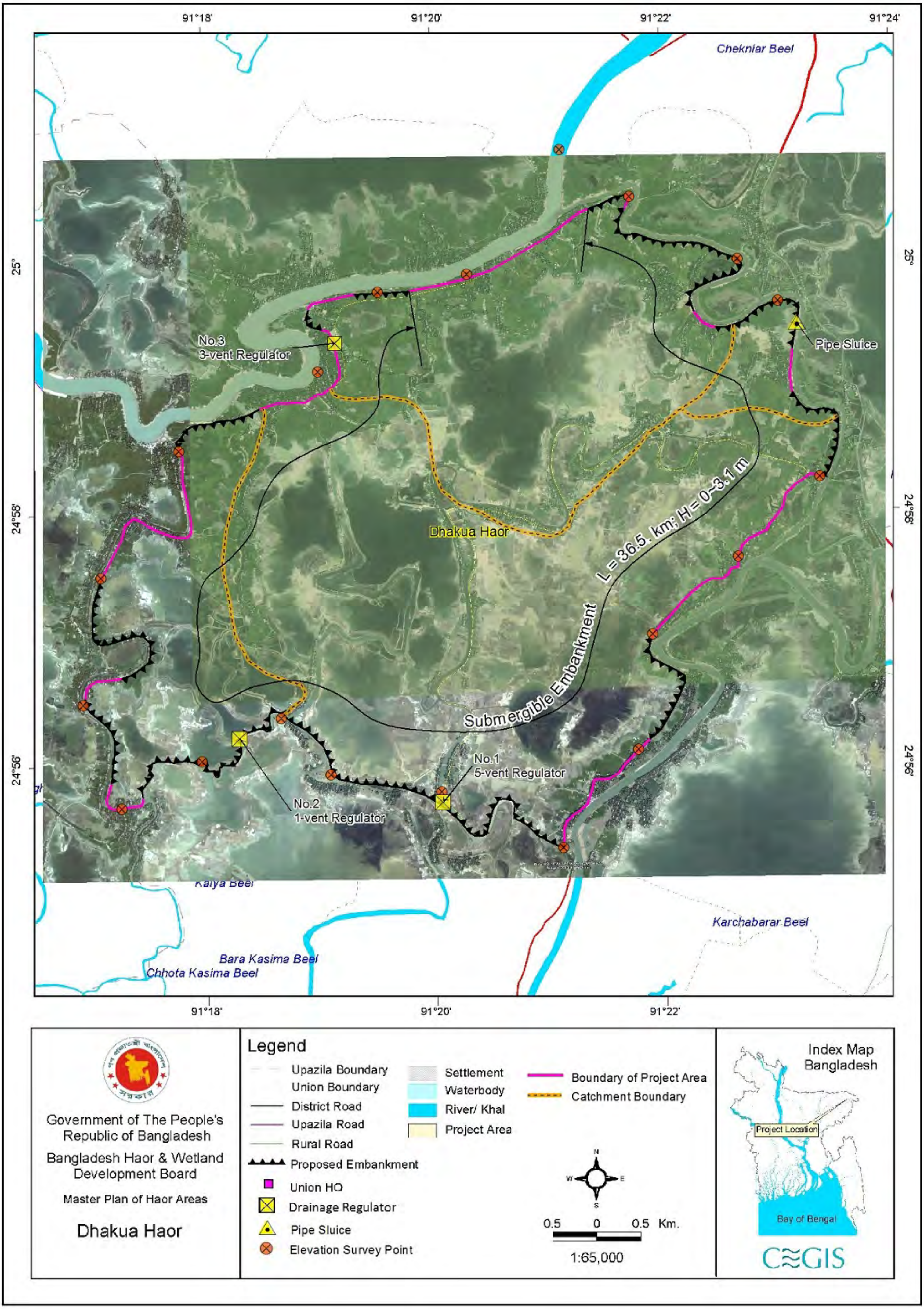
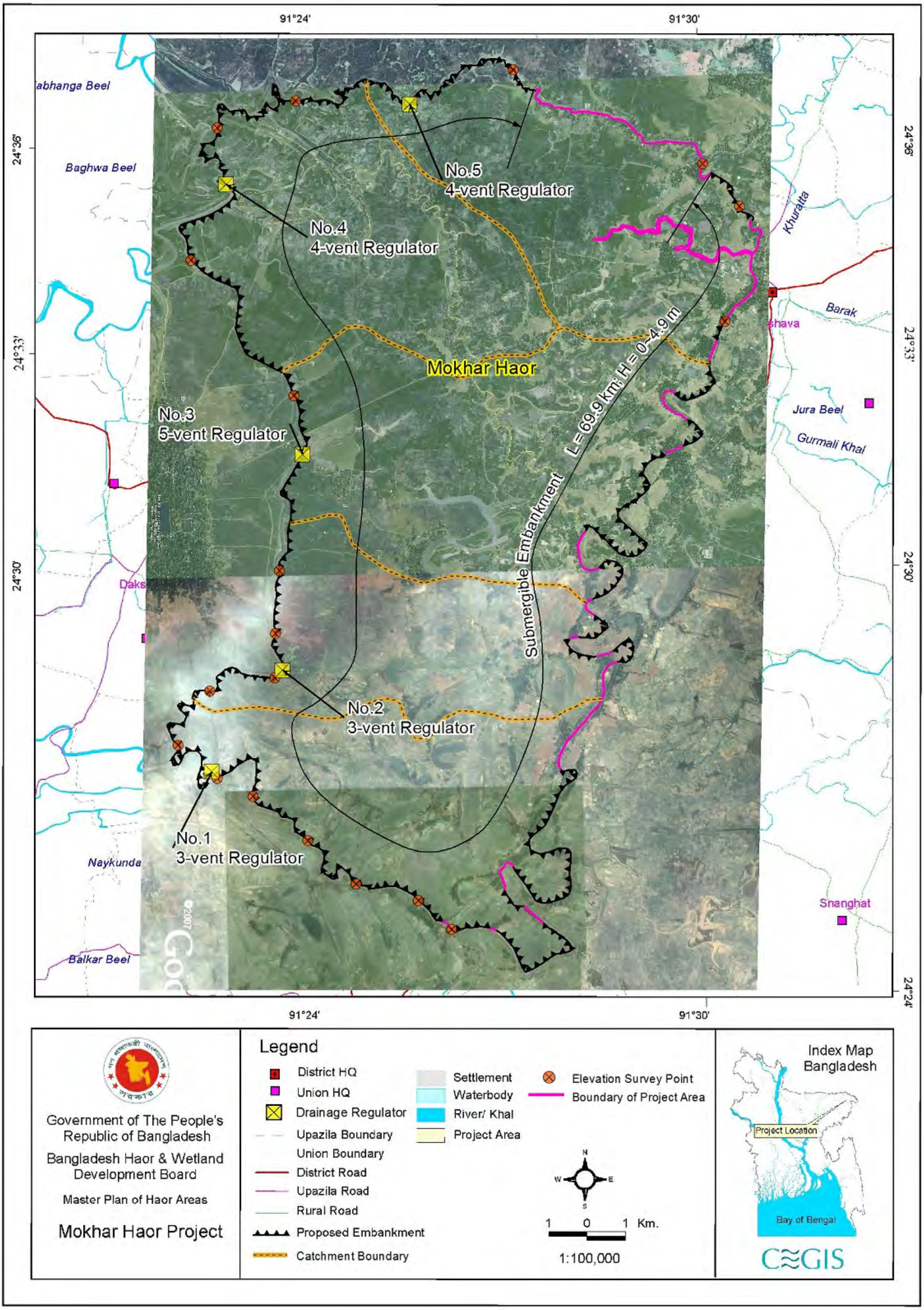
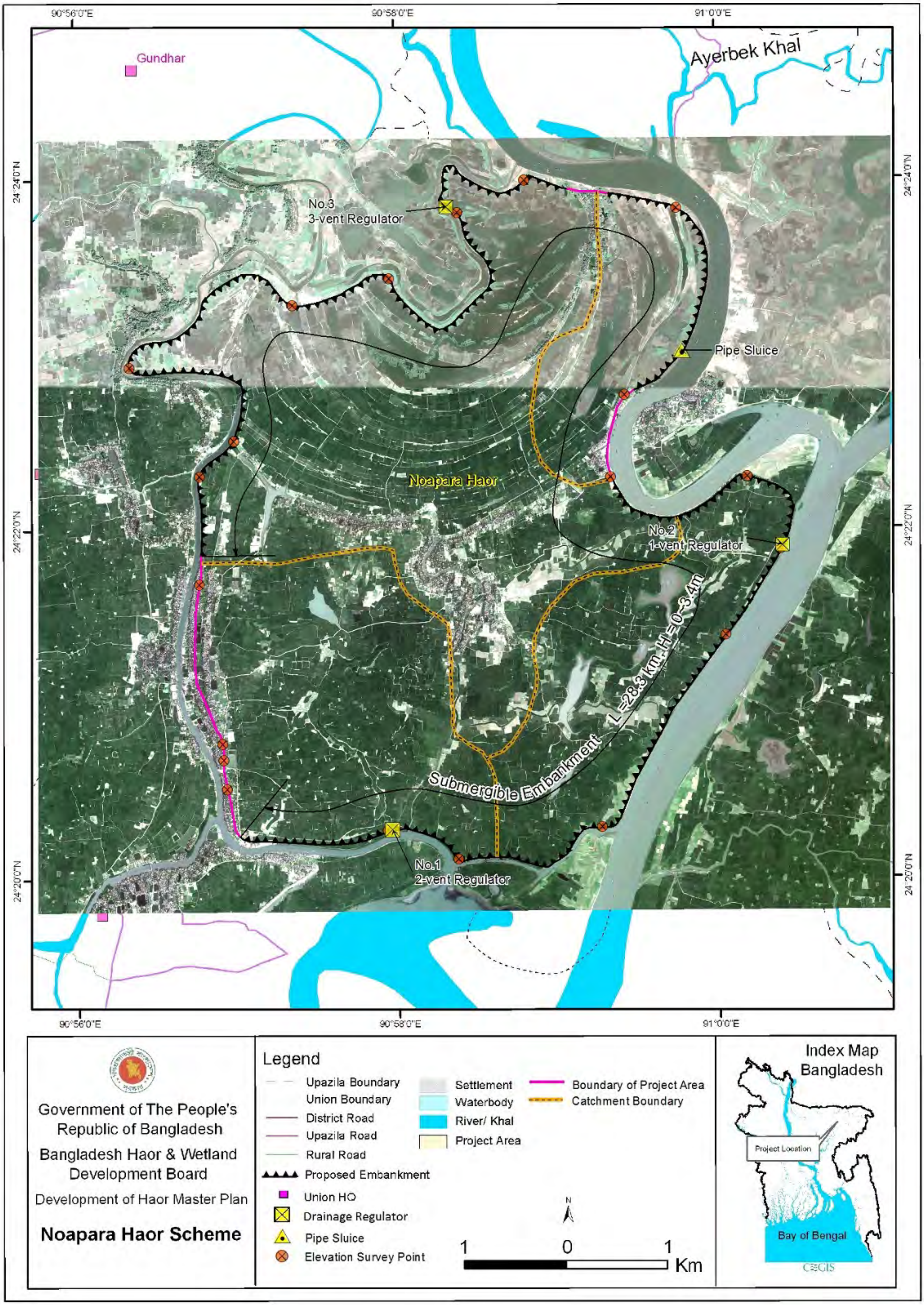
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Master Plan of Haor Areas
Ganesh Haor Project
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Elevation Survey Point
Drainage Regulator
Pipe Sluice
Catchment Boundary
Boundary of Project Area
Settlement
Waterbody
River/ Khal
Project Area
N
W
E
S
0.5 0 0.5 Km.
1:50,000
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS



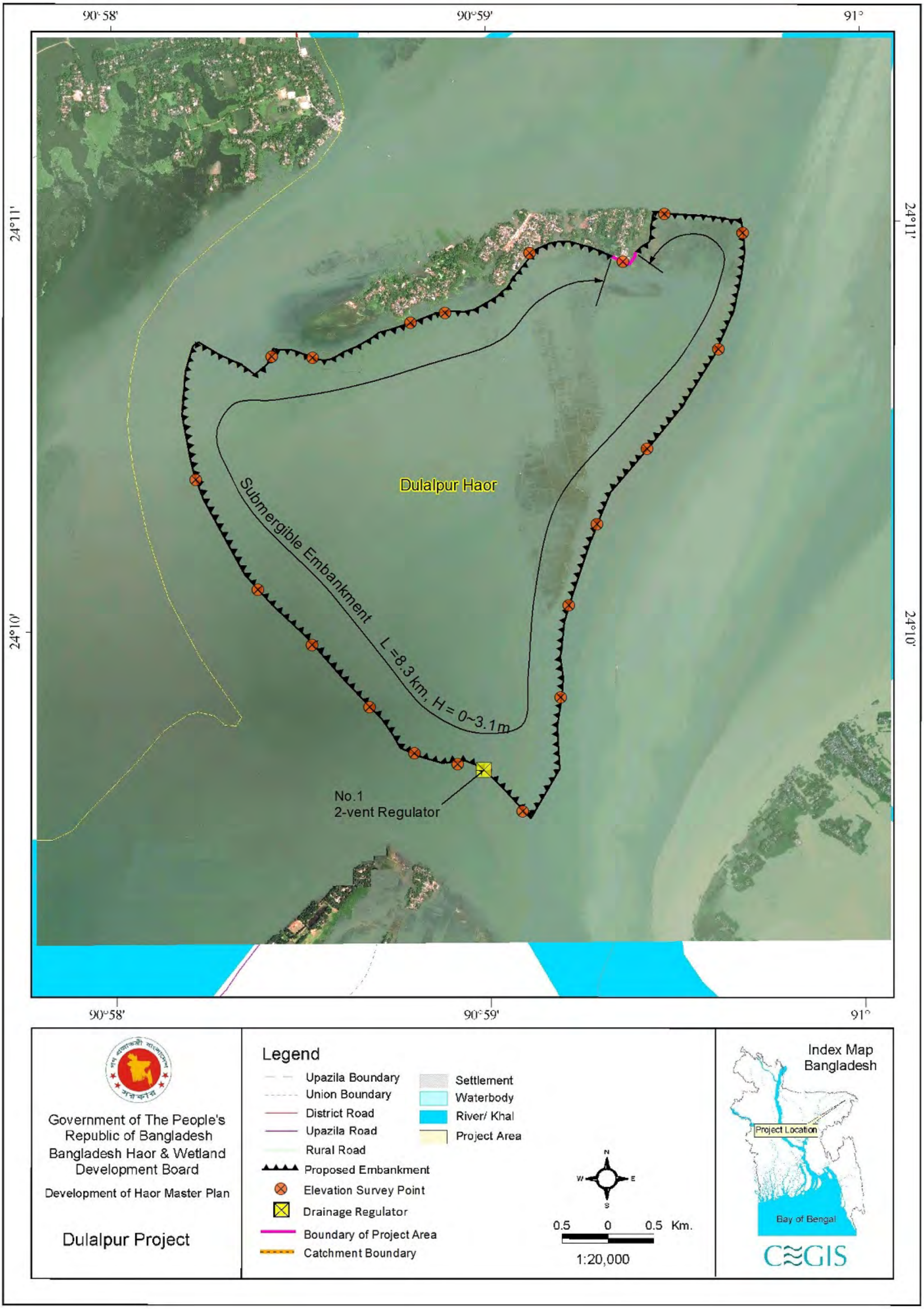
91°18'
91°20'
91°22'
91°24'
25°
24°58'
24°56'
Chekniar Beel
No.3
3-vent Regulator
Pipe Sluice
Dhakua Haor
L = 36.5. km; H= 0~3.1 m
Submergible Embankment
No.1
5-vent Regulator
No.2
1-vent Regulator
Kalya Beel
Karchabarar Beel
Bara Kasima Beel
Chhota Kasima Beel
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Master Plan of Haor Areas
Dhakua Haor
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Pipe Sluice
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Boundary of Project Area
Catchment Boundary
0.5 0 0.5 Km.
1:65,000
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS

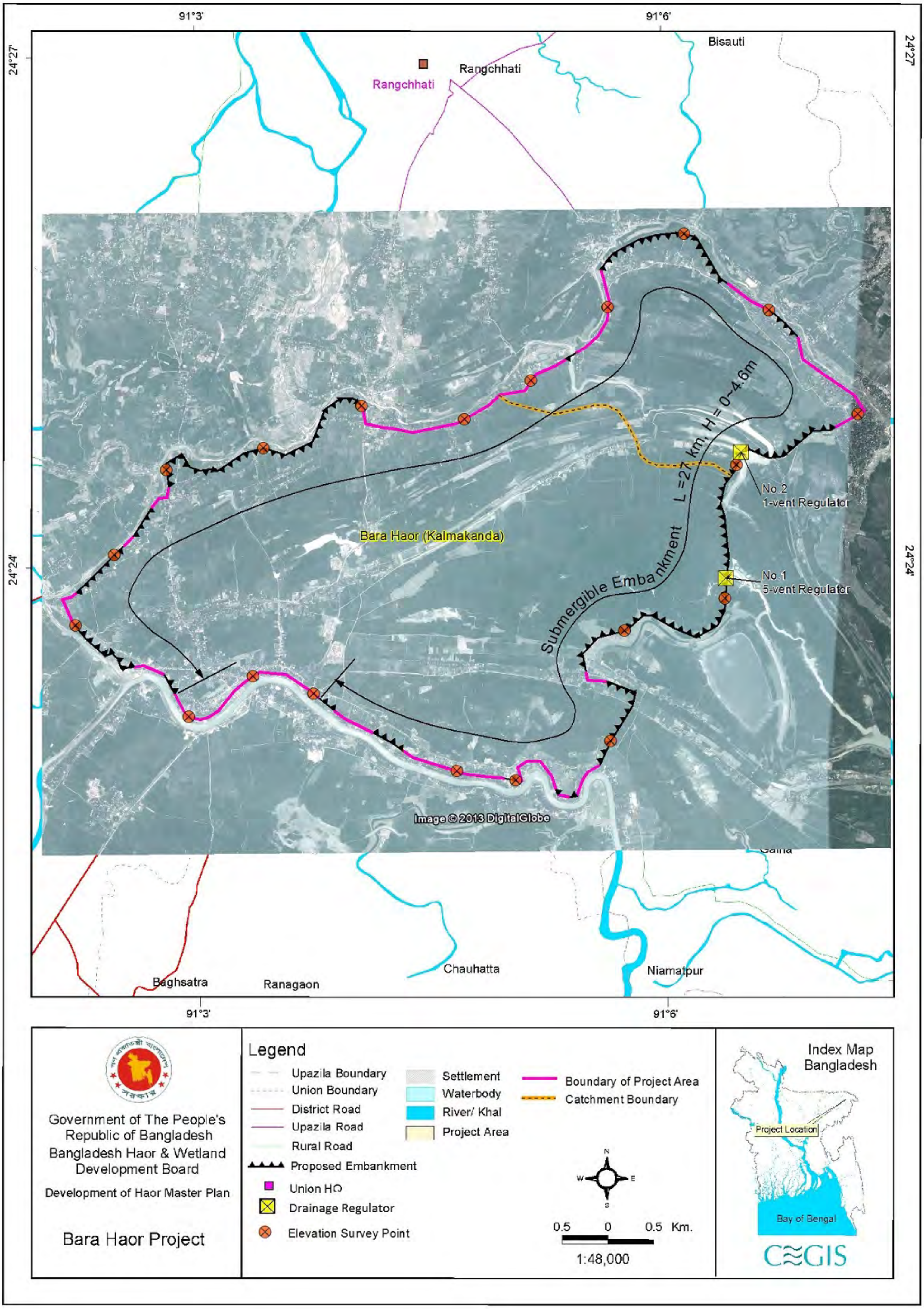


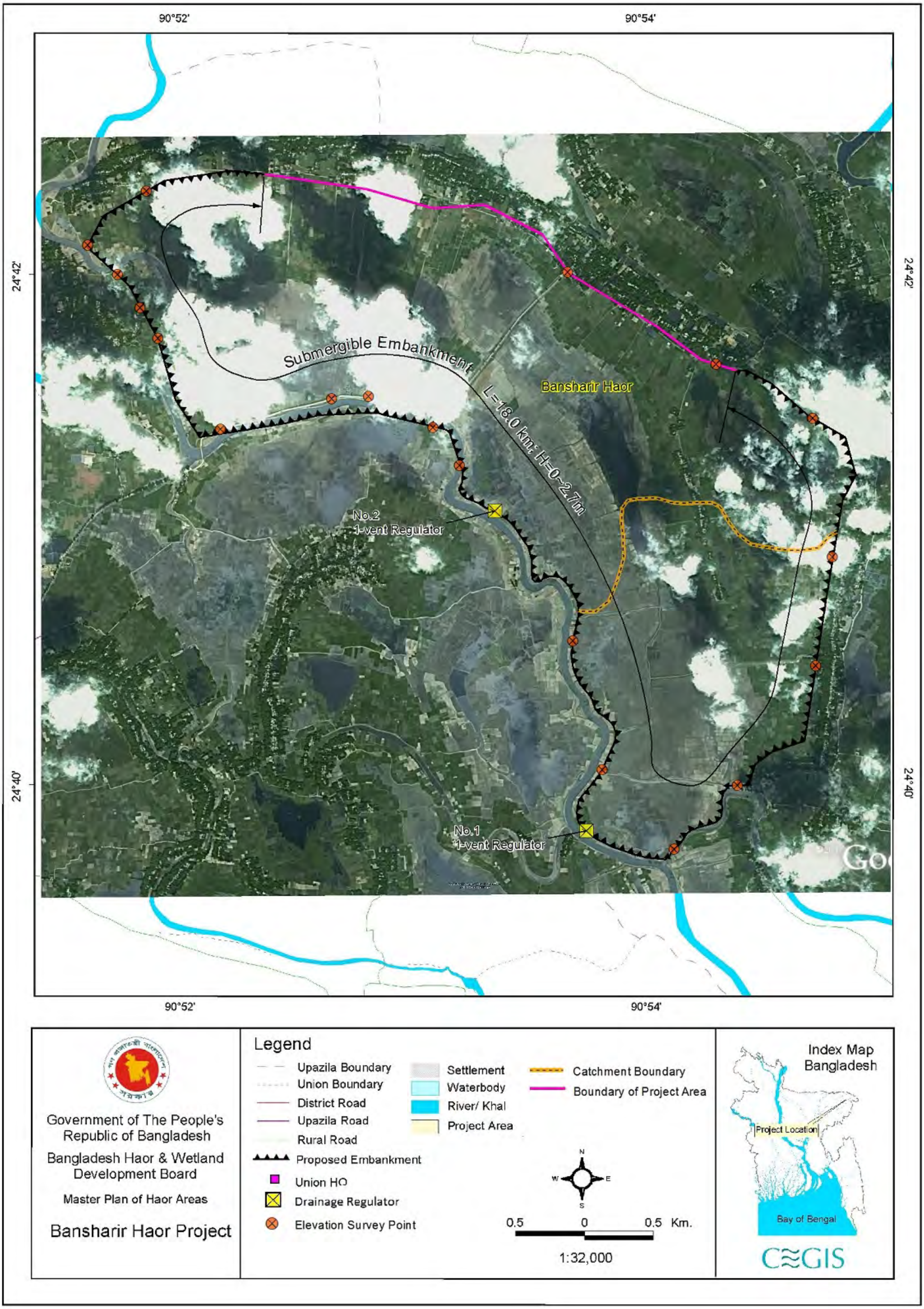
91°24'
91°30'
24°36'
24°33'
24°30'
24°24'
abhanga Beel
Baghwa Beel
Naykunda
Balkar Beel
Daks
Khuratta
Barak
shava
Jura Beel
Gurmali Khal
Snanghat
No.5
4-vent Regulator
No.4
4-vent Regulator
Mokhar Haor
No.3
5-vent Regulator
L = 69.9 km; H = 0-4.9 m
Submergible Embankment
No.2
3-vent Regulator
No.1
3-vent Regulator
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Master Plan of Haor Areas
Mokhar Haor Project
Legend
District HQ
Union HQ
Drainage Regulator
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Catchment Boundary
Settlement
Waterbody
River/ Khal
Project Area
Elevation Survey Point
Boundary of Project Area
N
S
E
W
1 0 1 Km.
1:100,000
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS



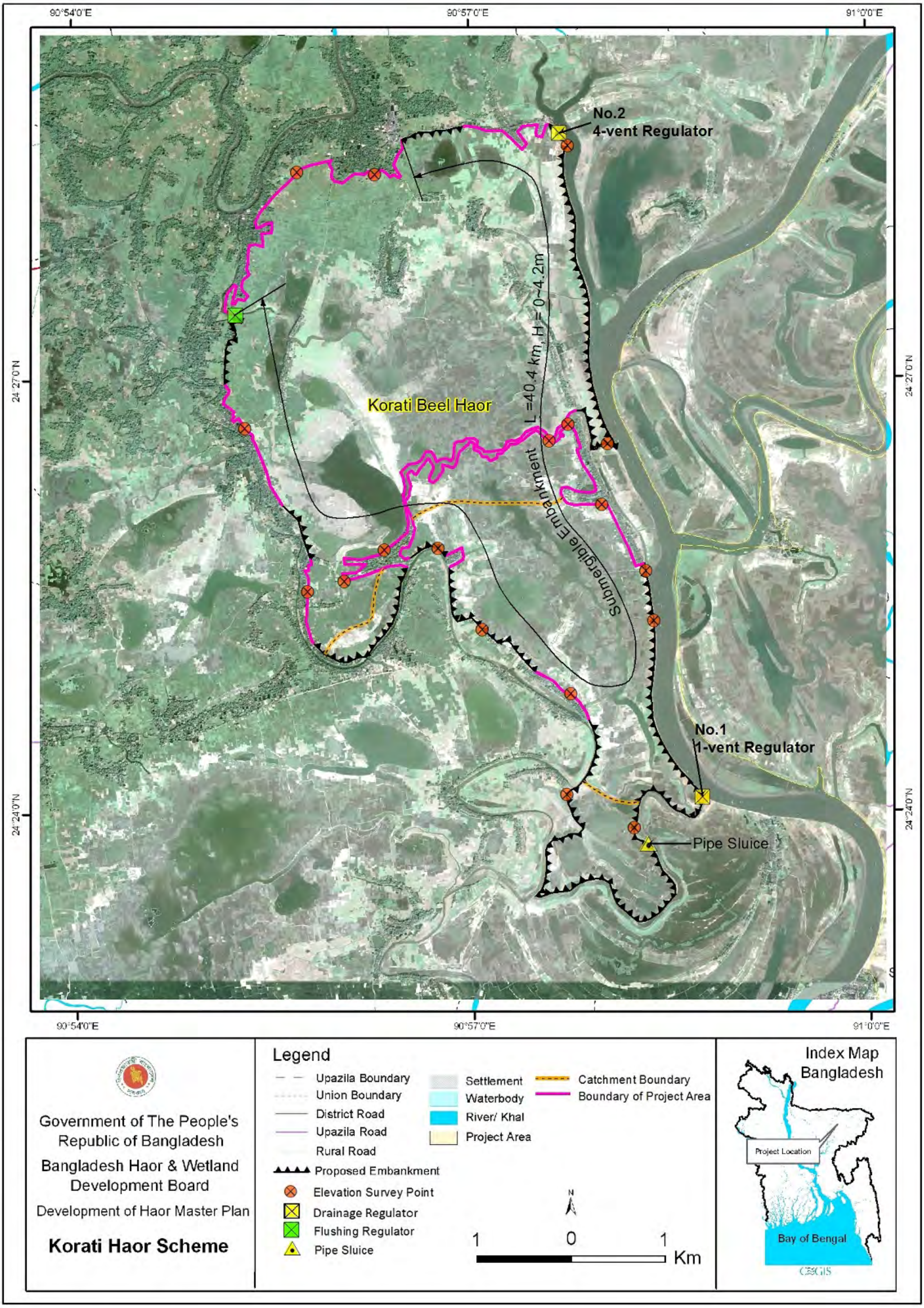
90°56'0"E
90°58'0"E
91°0'0"E
24°24'0"N
24°22'0"N
24°20'0"N
Gundhar
Ayerbek Khal
No.3
3-vent Regulator
Pipe Sluice
Noapara Haor
No.2
1-vent Regulator
Submergible Embankment L=28.3 km, H=0~3.4m
No.1
2-vent Regulator
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Noapara Haor Scheme
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Pipe Sluice
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Boundary of Project Area
Catchment Boundary
N
1 0 1 Km
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS


90°58'
90°59'
91°
24°11'
24°10'
Dulalpur Haor
Submergible Embankment
L =8.3 km, H= 0~3.1m
No.1
2-vent Regulator
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Dulalpur Project
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Elevation Survey Point
Drainage Regulator
Boundary of Project Area
Catchment Boundary
Settlement
Waterbody
River/ Khal
Project Area
N
S
W
E
0.5 0 0.5 Km.
1:20,000
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS

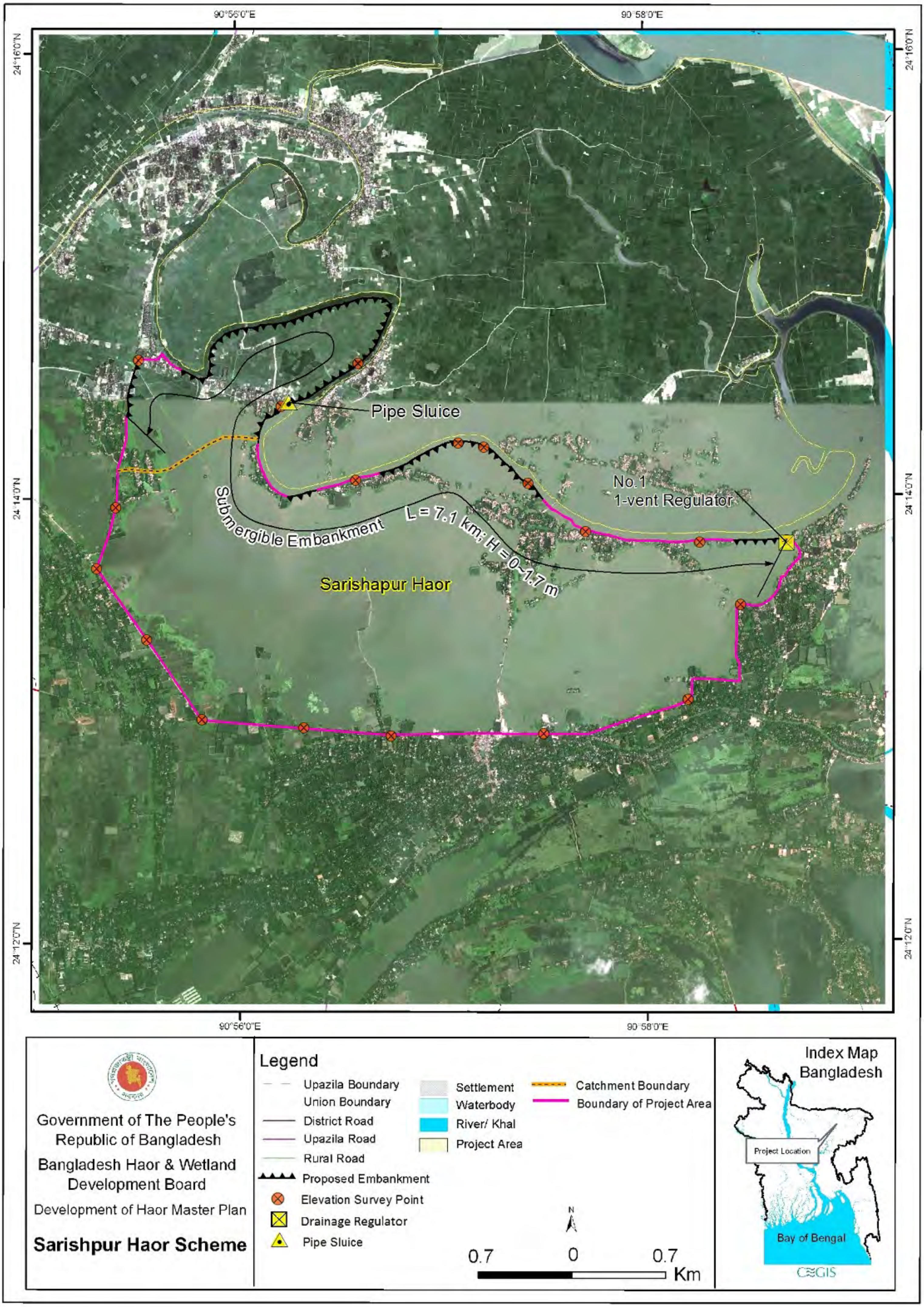

91°3'
91°6'
24°27'
24°24'
Bisauti
Rangchhati
Rangchhati
Bara Haor (Kalmakanda)
Submergible Embankment L =27 km, H = 0~4.6m
No.2
1-vent Regulator
No.1
5-vent Regulator
Image © 2013 DigitalGlobe
Baghsatra
Ranagaon
Chauhatta
Niamatpur
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Boundary of Project Area
Catchment Boundary
N
W
E
S
0.5 0 0.5 Km.
1:48,000
Index Map
Bangladesh
Project Location
Bay of Bengal
CEGIS
Government of The People's
Republic of Bangladesh
Bangladesh Haor & Wetland
Development Board
Development of Haor Master Plan
Bara Haor Project



90°52'
90°54'
24°42'
24°40'
Submergible Embankment
L=18.0 km; H=0~2.7m
Banshariri Haor
No.2
1-vent Regulator
No.1
1-vent Regulator
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Catchment Boundary
Boundary of Project Area
N
S
E
W
0.5
0
0.5 Km.
1:32,000
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Master Plan of Haor Areas
Bansharir Haor Project
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS



90°54'0"E
90°57'0"E
91°0'0"E
24°27'0"N
24°24'0"N
No.2
4-vent Regulator
Korati Beel Haor
L =40.4 km, H = 0~4.2m
Submergible Embankment
No.1
1-vent Regulator
Pipe Sluice
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Korati Haor Scheme
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Elevation Survey Point
Drainage Regulator
Flushing Regulator
Pipe Sluice
Settlement
Waterbody
River/ Khal
Project Area
Catchment Boundary
Boundary of Project Area
N
1
0
1
Km
Index Map
Bangladesh
Project Location
Bay of Bengal
CEGIS



90°56'0"E
90°58'0"E
24°16'0"N
24°14'0"N
24°12'0"N
Pipe Sluice
No.1
1-vent Regulator
Submergible Embankment
L = 7.1 km; H = 0-1.7 m
Sarishapur Haor
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Sarishpur Haor Scheme
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Elevation Survey Point
Drainage Regulator
Pipe Sluice
Settlement
Waterbody
River/ Khal
Project Area
Catchment Boundary
Boundary of Project Area
N
0.7
0
0.7
Km
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS

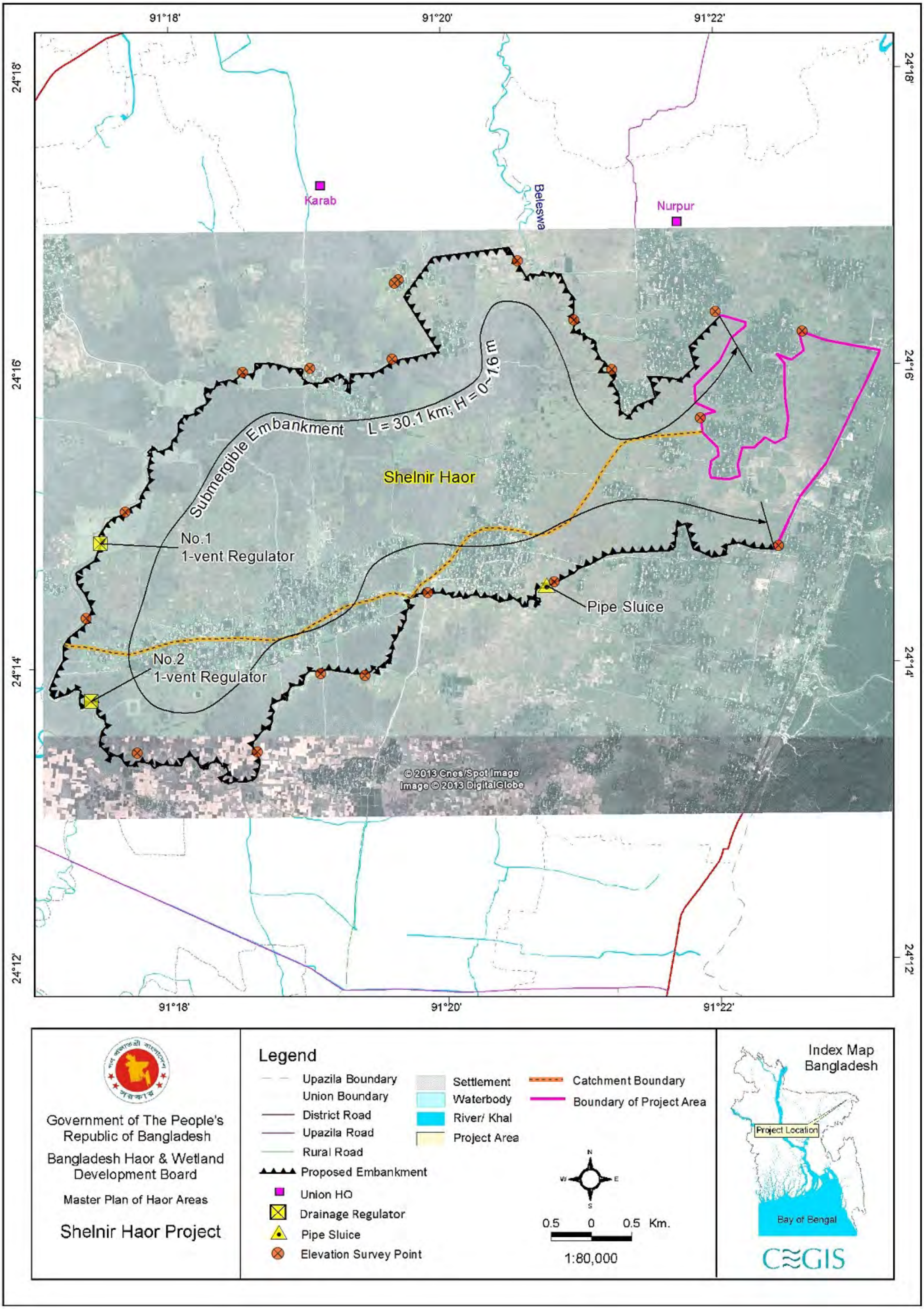

91°18'
91°20'
91°22'
24°18'
24°16'
24°14'
24°12'
Karab
Nurpur
Beleswa
Submergible Embankment L = 30.1 km; H = 0~1.6 m
Shelnir Haor
No.1
1-vent Regulator
No.2
1-vent Regulator
Pipe Sluice
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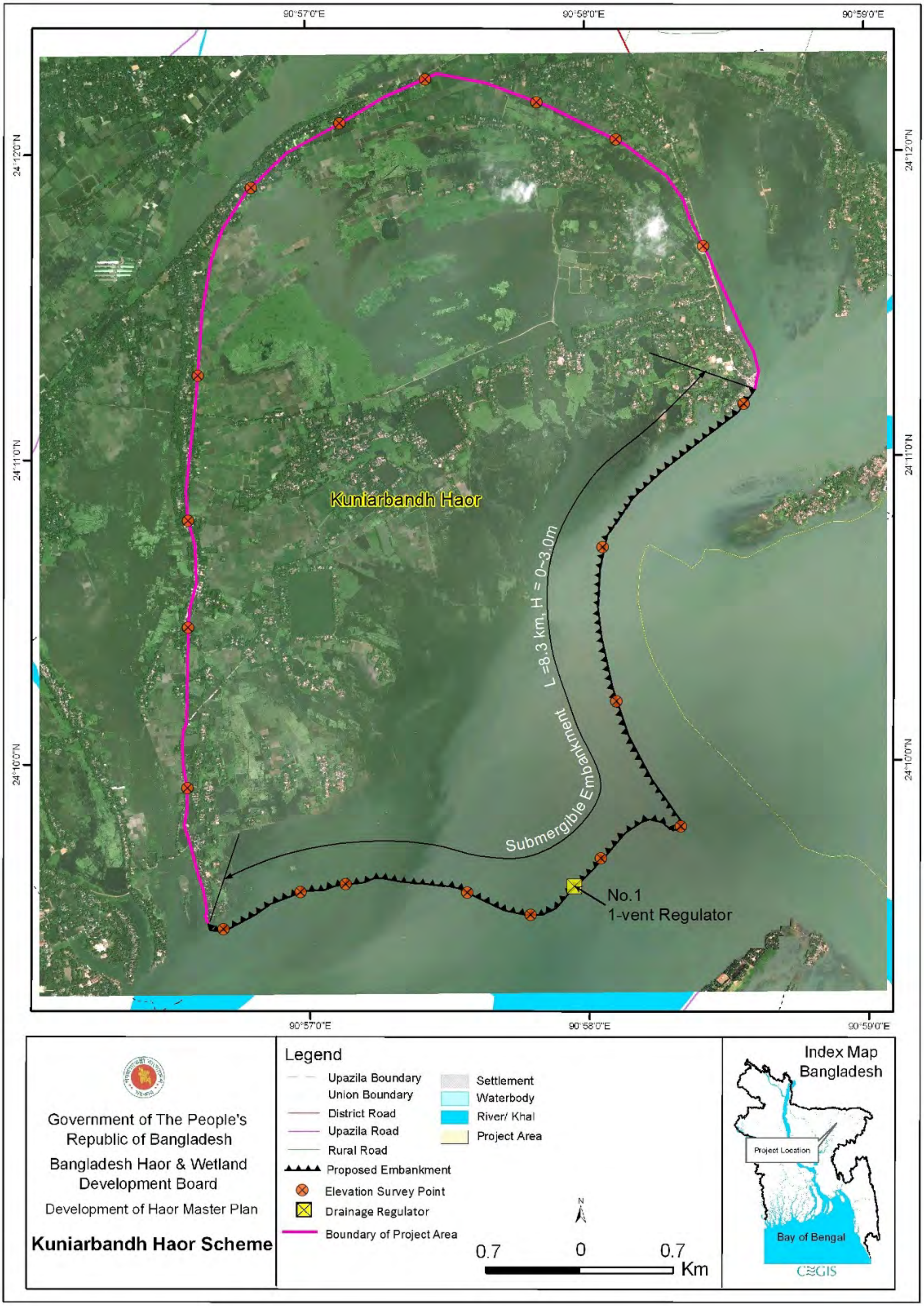
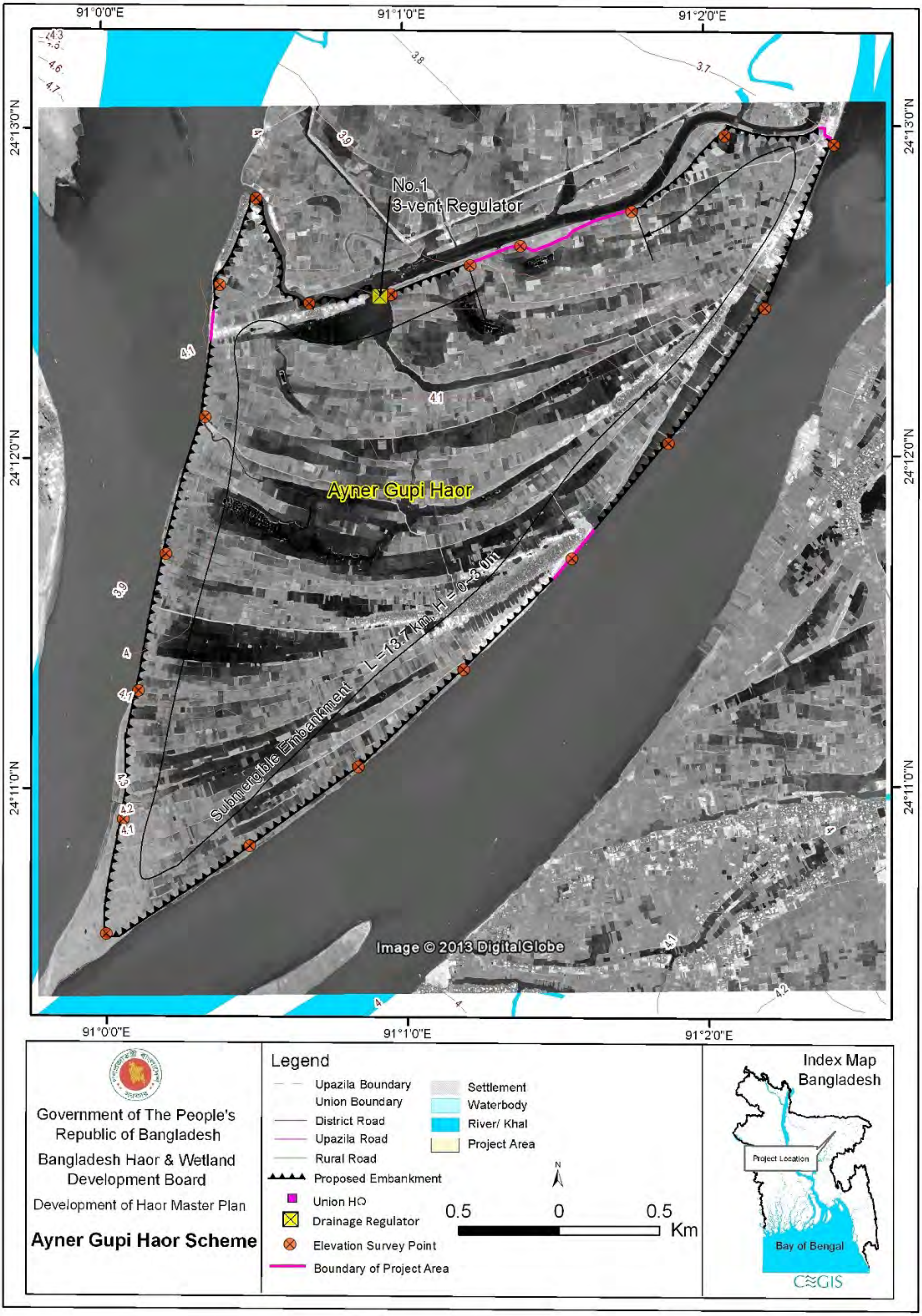
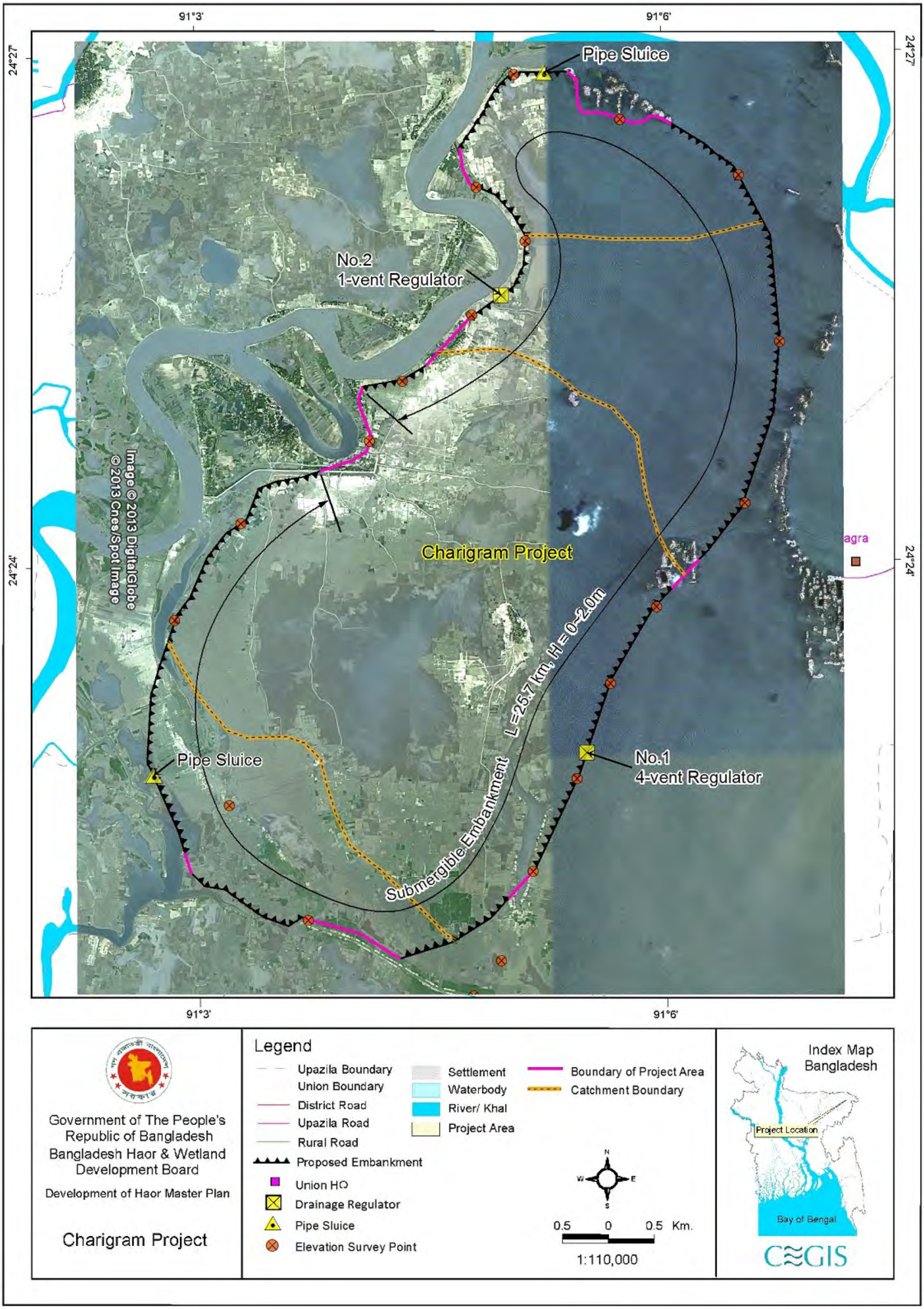
Image © 2013 DigitalGlobe
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Master Plan of Haor Areas
Shelnir Haor Project
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Pipe Sluice
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Catchment Boundary
Boundary of Project Area
N
W
E
S
0.5 0 0.5 Km.
1:80,000
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS

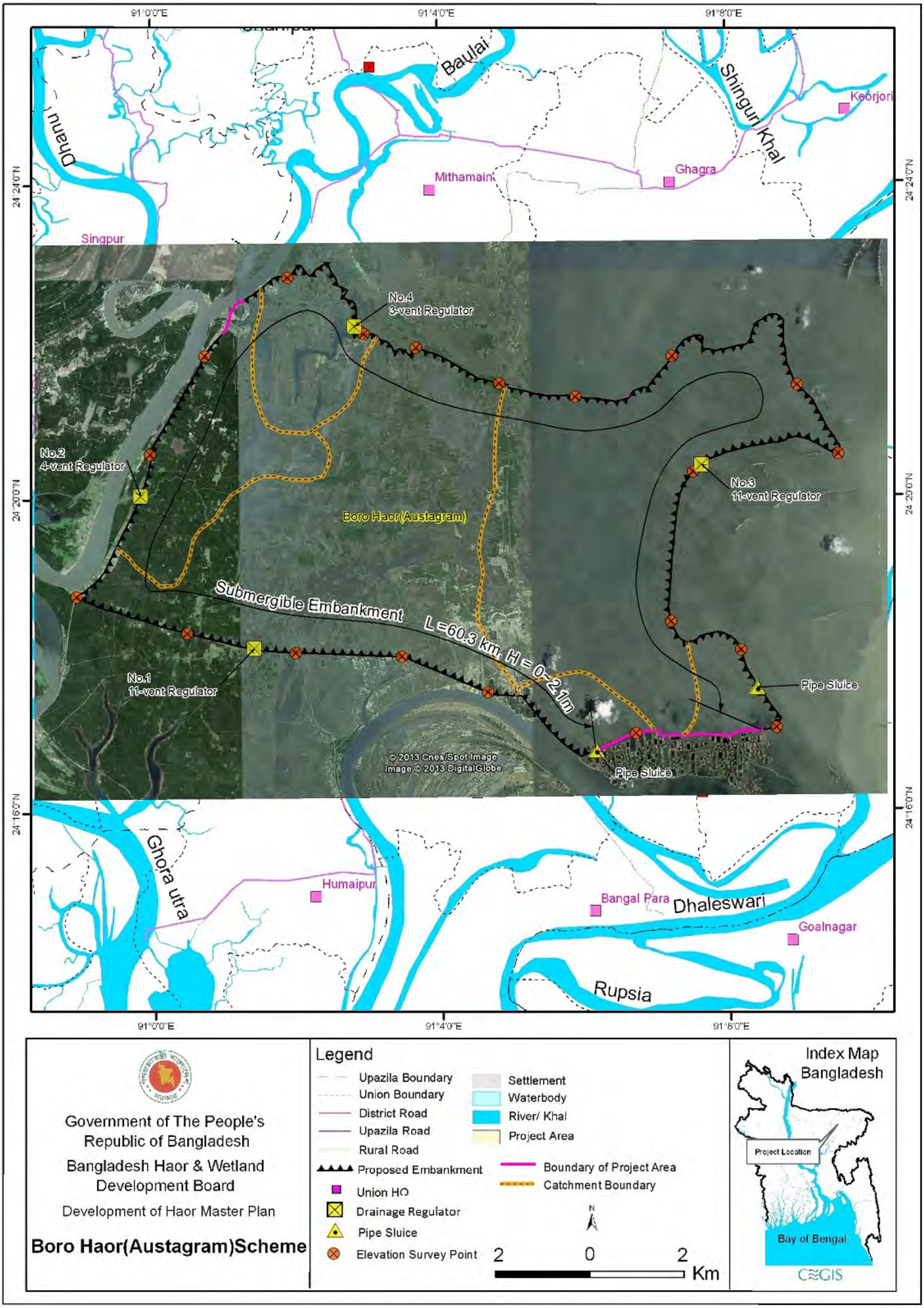

90°57'0"E
90°58'0"E
90°59'0"E
24°12'0"N
24°11'0"N
24°10'0"N
Kuniarbandh Haor
L =8.3 km, H = 0~3.0m
Submergible Embankment
No.1
1-vent Regulator
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Kuniarbandh Haor Scheme
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Elevation Survey Point
Drainage Regulator
Boundary of Project Area
Settlement
Waterbody
River/ Khal
Project Area
N
0.7
0
0.7
Km
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS



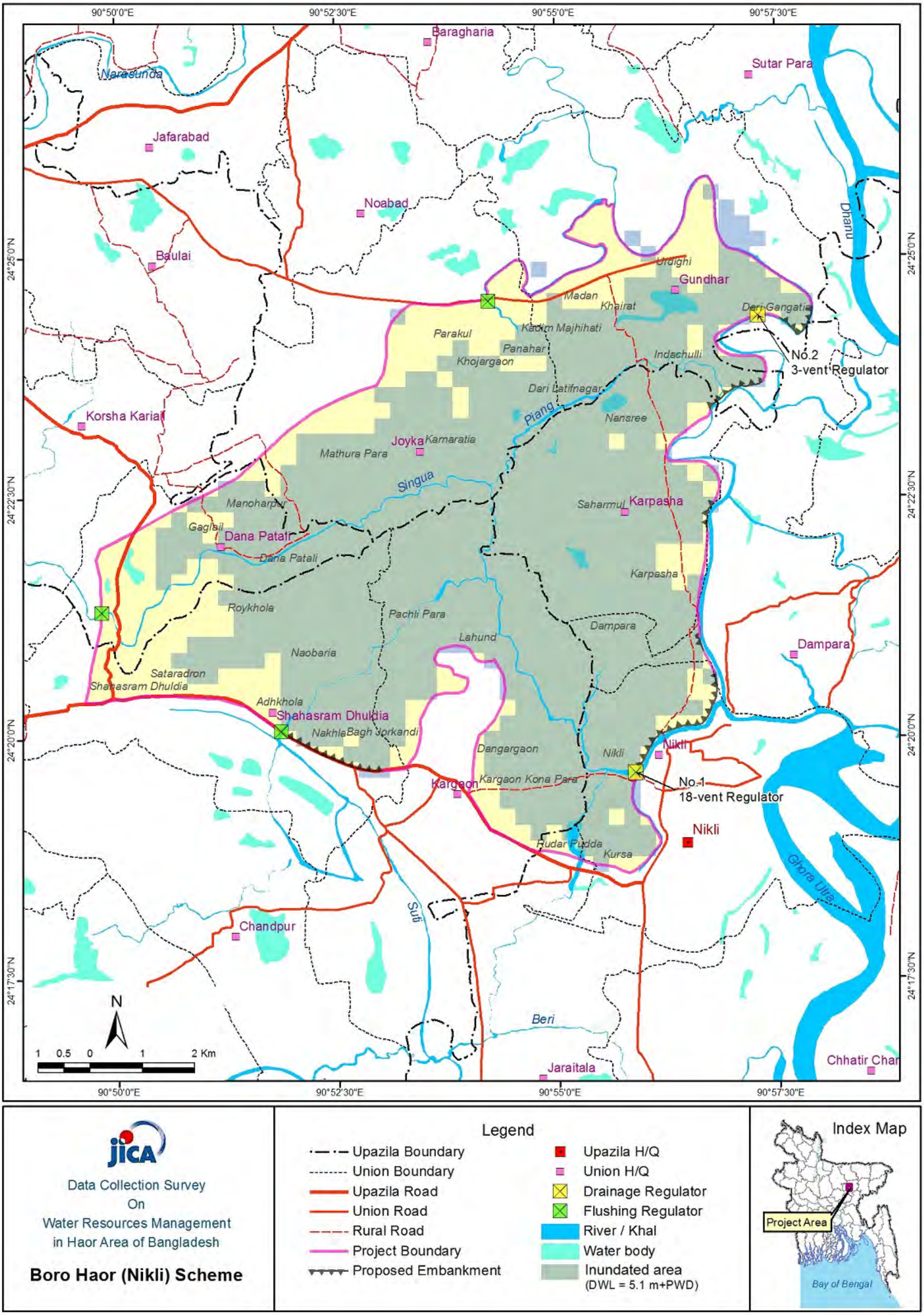
91°0'0"E
91°1'0"E
91°2'0"E
24°13'0"N
24°12'0"N
24°11'0"N
No.1
3-vent Regulator
Ayner Gupi Haor
Submergible Embankment L =13.7 km, H = 0 - 3.0m
Image © 2013 DigitalGlobe
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Ayner Gupi Haor Scheme
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Elevation Survey Point
Boundary of Project Area
Settlement
Waterbody
River/ Khal
Project Area
N
0.5 0 0.5
Km
Index Map
Bangladesh
Project Location
Bay of Bengal
CEGIS



91°3'
91°6'
24°27'
24°24'
Pipe Sluice
No.2
1-vent Regulator
Image © 2013 DigitalGlobe
© 2013 Cnes/Spot Image
Charigram Project
L =25.7 km, H = 0~2.0m
Submergible Embankment
Pipe Sluice
No.1
4-vent Regulator
agra
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Charigram Project
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Pipe Sluice
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Boundary of Project Area
Catchment Boundary
N
W
E
S
0.5 0 0.5 Km.
1:110,000
Index Map
Bangladesh
Project Location
Bay of Bengal
CEGIS



91°0'0"E
91°4'0"E
91°8'0"E
24°24'0"N
24°20'0"N
24°16'0"N
Baulai
Dhanu
Shingun Khal
Keorjori
Mithamain
Ghagra
Singpur
No.4
3-vent Regulator
No.2
4-vent Regulator
No.3
11-vent Regulator
Boro Haor(Austagram)
Submergible Embankment
L =60.3 km, H = 0~2.1m
No.1
11-vent Regulator
Pipe Sluice
Pipe Sluice
© 2013 Cnes/Spot Image
Image © 2013 DigitalGlobe
Ghora utra
Humaipur
Bangal Para
Dhaleswari
Goalnagar
Rupsia
Government of The People's Republic of Bangladesh
Bangladesh Haor & Wetland Development Board
Development of Haor Master Plan
Boro Haor(Austagram)Scheme
Legend
Upazila Boundary
Union Boundary
District Road
Upazila Road
Rural Road
Proposed Embankment
Union HQ
Drainage Regulator
Pipe Sluice
Elevation Survey Point
Settlement
Waterbody
River/ Khal
Project Area
Boundary of Project Area
Catchment Boundary
N
2 0 2 Km
Index Map Bangladesh
Project Location
Bay of Bengal
CEGIS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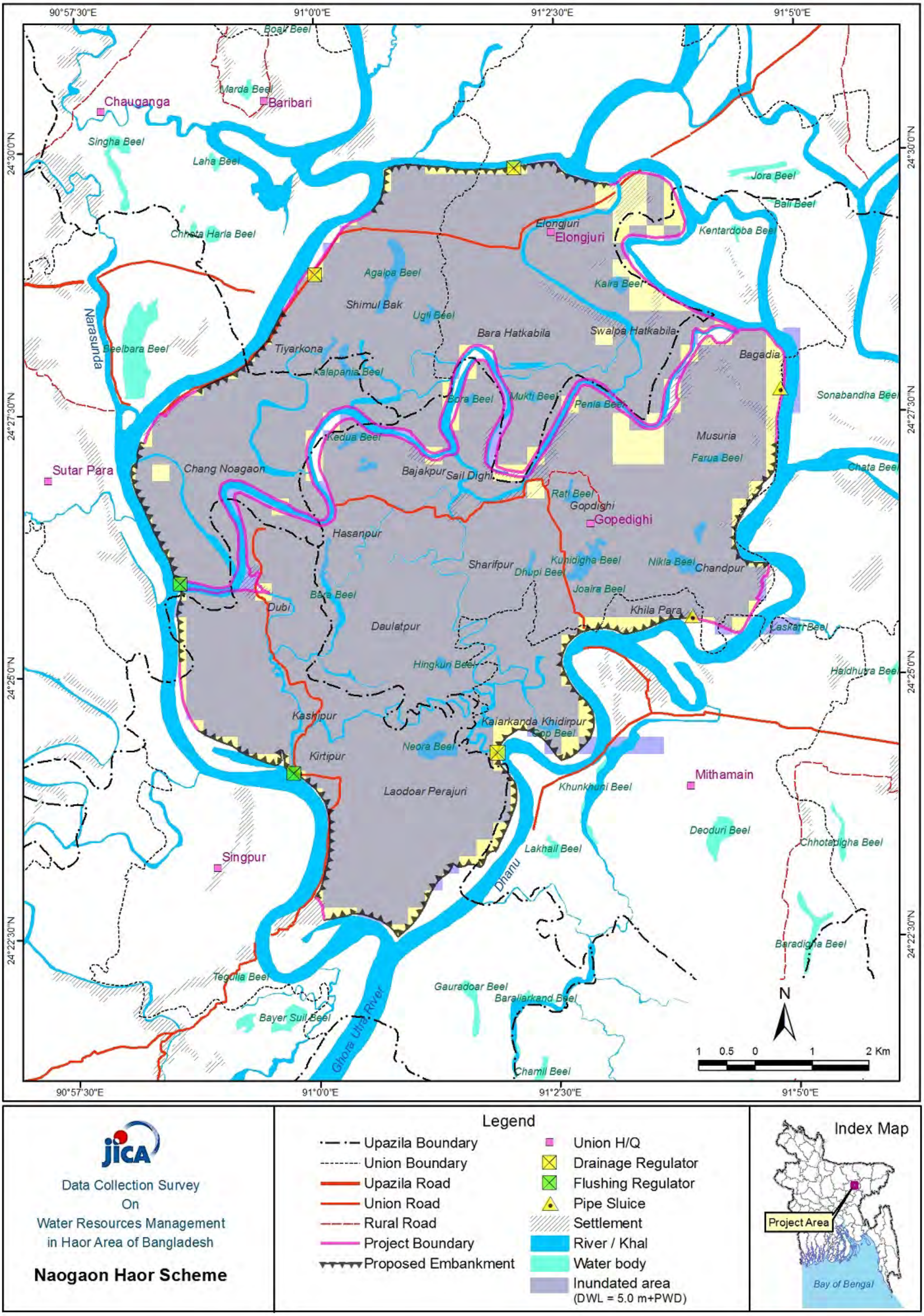
90°55'0"E
90°57'30"E
24°25'0"N
24°22'30"N
24°20'0"N
24°17'30"N
Baragharia
Narasunda
Sutar Para
Jafarabad
Noabad
Dhanu
Baulai
Urdighi
Gundhar
Madan
Khairat
Deri Gangatia
Kadim Majhihati
Parakul
Panahar
Khojargaon
Indachulli
No.2
3-vent Regulator
Dari Latifnagar
Korsha Kariail
Piang
Nansree
Joyka
Kamaratia
Mathura Para
Singua
Manoharpur
Saharmul
Karpasha
Gaglail
Dana Patali
Dana Patali
Karpasha
Roykhola
Pachli Para
Dampara
Lahund
Dampara
Naobaria
Sataradron
Shahasram Dhuldia
Adhkhola
Shahasram Dhuldia
Nakhla
Bagh Jorkandi
Dangargaon
Nikli
Nikli
No.1
18-vent Regulator
Kargaon
Kargaon Kona Para
Nikli
Rudar Pudda
Kursa
Ghora Utra
Suti
Chandpur
N
1 0.5 0 1 2 Km
Beri
Jaraitala
Chhatir Char
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh
Boro Haor (Nikli) Scheme
Legend
Upazila Boundary
Union Boundary
Upazila Road
Union Road
Rural Road
Project Boundary
Proposed Embankment
Upazila H/Q
Union H/Q
Drainage Regulator
Flushing Regulator
River / Khal
Water body
Inundated area
(DWL = 5.1 m+PWD)
Index Map
Project Area
Bay of Bengal



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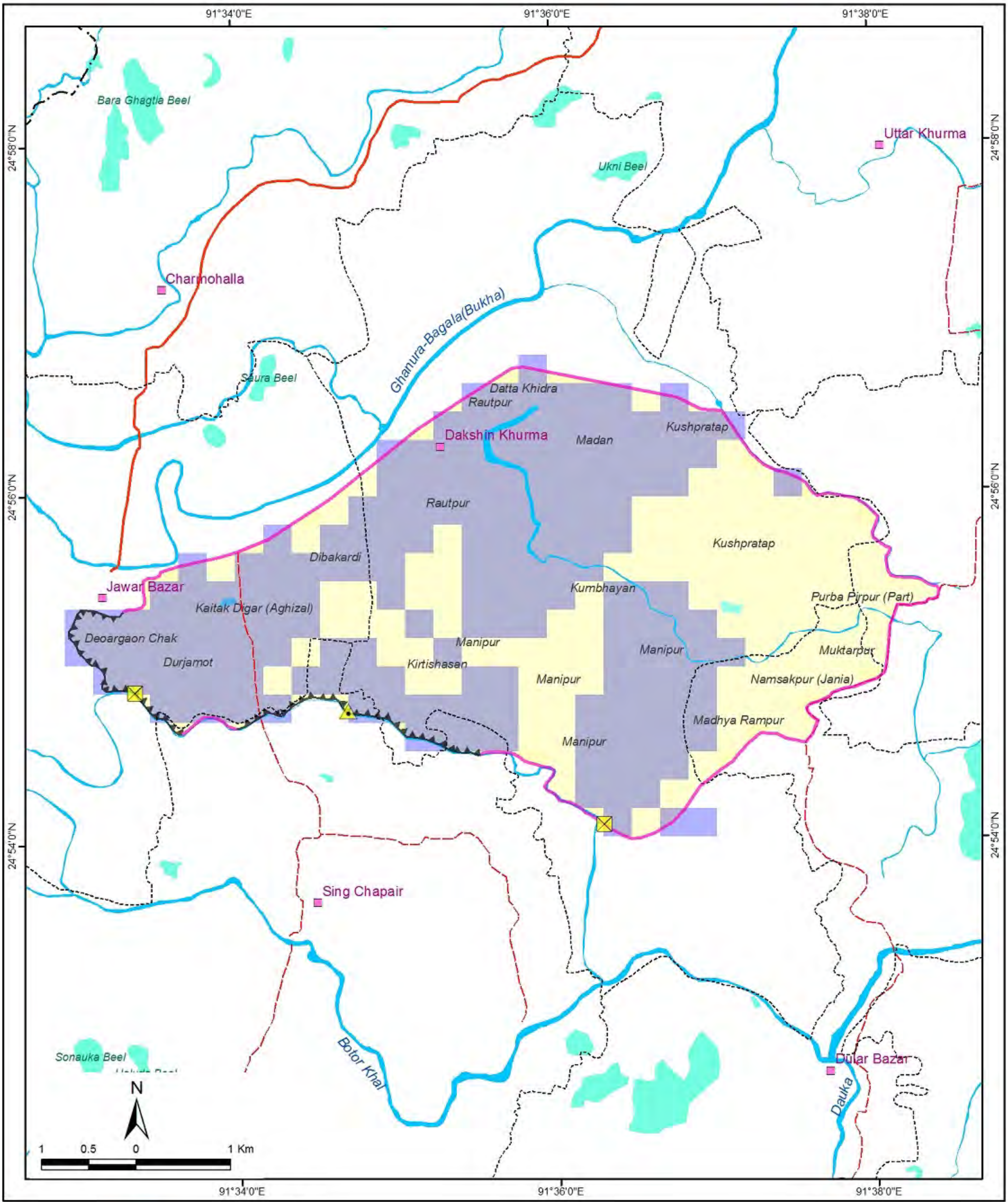
91°0'0"E
91°2'30"E
91°5'0"E
24°30'0"N
24°27'30"N
24°25'0"N
24°22'30"N
Boal Beel
Marda Beel
Chauganga
Baribari
Singha Beel
Laha Beel
Chhota Harla Beel
Jora Beel
Bali Beel
Elongjuri
Kentardoba Beel
Agalpa Beel
Kaira Beel
Shimul Bak
Ugli Beel
Bara Hatkabila
Swalpa Hatkabila
Narasunda
Beelbara Beel
Tiyarkona
Kalapania Beel
Bagadia
Sonabandha Beel
Bora Beel
Mukti Beel
Penla Beel
Kedua Beel
Musuria
Farua Beel
Sutar Para
Chang Noagaon
Bajakpur
Sail Dighi
Chata Beel
Rati Beel
Gopdighi
Gopedighi
Hasanpur
Sharifpur
Kunidigha Beel
Nikla Beel
Chandpur
Dhupi Beel
Joaira Beel
Bara Beel
Dubi
Khila Para
Daulatpur
Laskari Beel
Hingkuri Beel
Haldhura Beel
Kashipur
Kaiarkanda Khidirpur
Gop Beel
Neora Beel
Kirtipur
Khunkhuni Beel
Mithamain
Laodoar Perajuri
Deoduri Beel
Lakhail Beel
Chhotadigha Beel
Singpur
Dhanu
Baradigha Beel
Tegulia Beel
Gauradoar Beel
Baraliarkand Beel
Bayer Suil Beel
Ghora Utra River
Chamil Beel
N
1 0.5 0 1 2 Km
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh
Naogaon Haor Scheme
Legend
Upazila Boundary
Union Boundary
Upazila Road
Union Road
Rural Road
Project Boundary
Proposed Embankment
Union H/Q
Drainage Regulator
Flushing Regulator
Pipe Sluice
Settlement
River / Khal
Water body
Inundated area
(DWL = 5.0 m+PWD)
Index Map
Project Area
Bay of Bengal

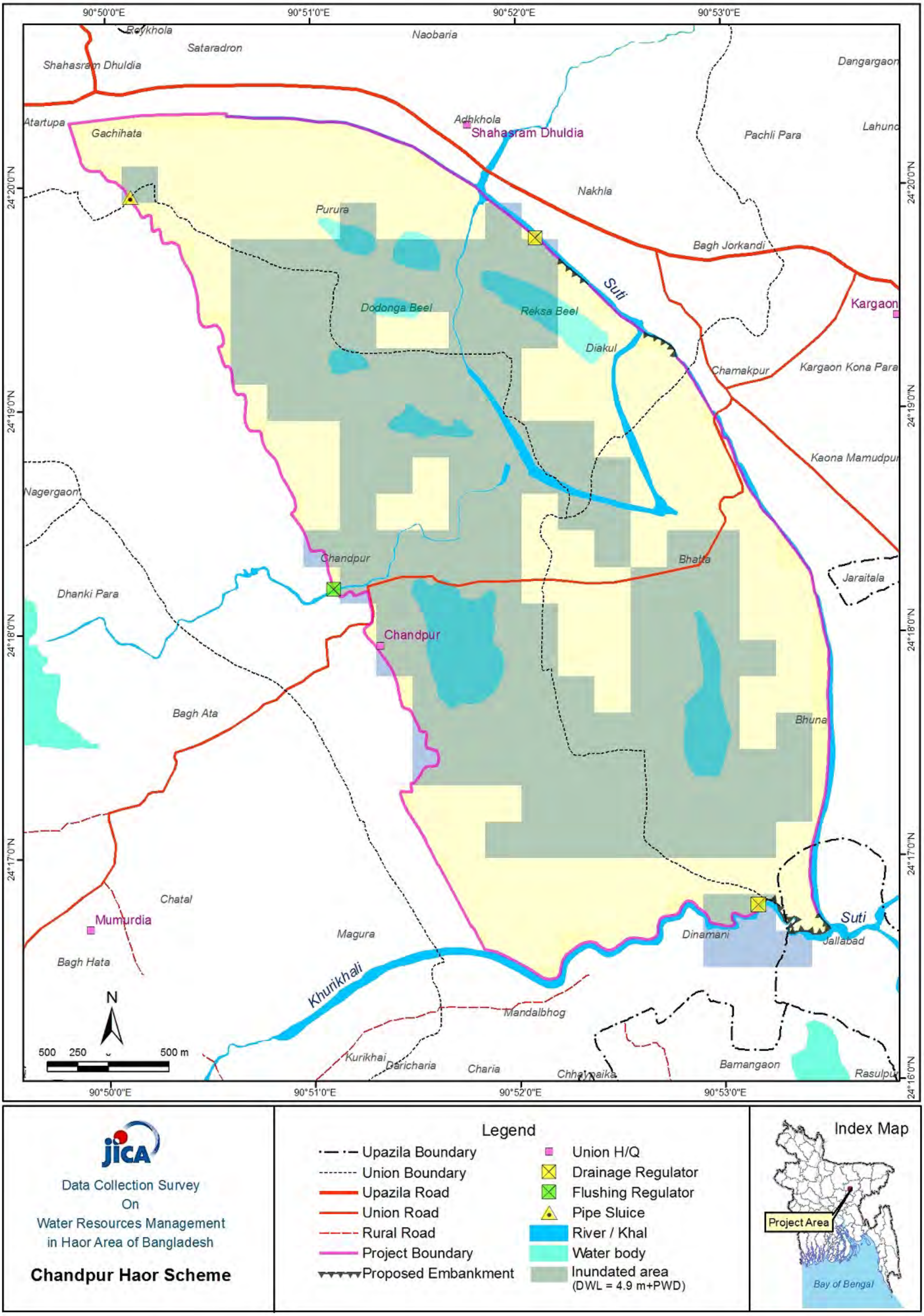


Data Collection Survey On Water Resources Management in Haor Area of Bangladesh

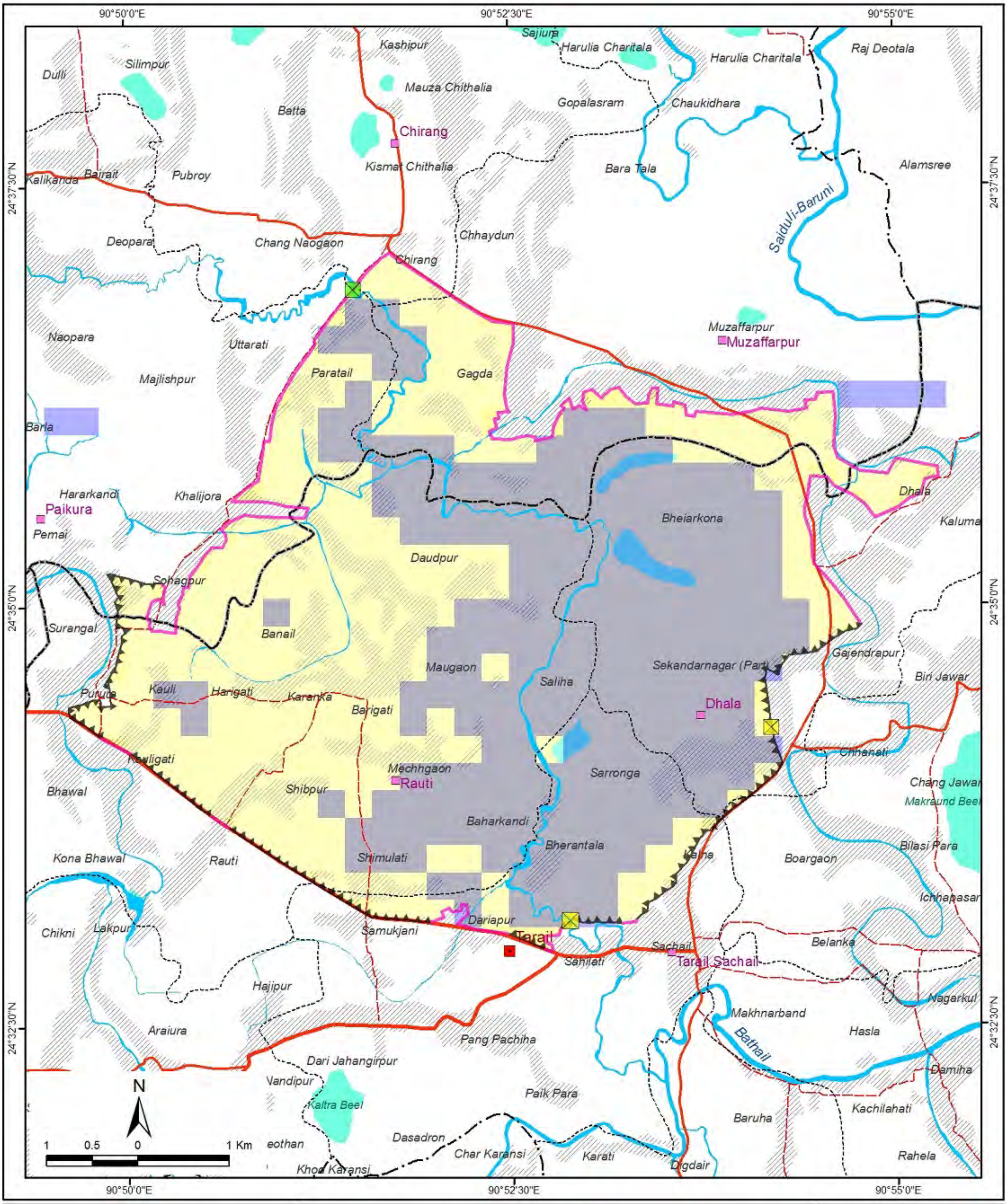
Jaliar Haor Project

Data Collection Survey On Water Resources Management in Haor Area of Bangladesh

Dharmapasha Rui Beel Project



90°50'0"E
90°51'0"E
90°52'0"E
90°53'0"E
24°20'0"N
24°19'0"N
24°18'0"N
24°17'0"N
24°16'0"N
Roykhola
Sataradron
Naobaria
Shahasram Dhuldia
Dangargaon
Atartupa
Gachihata
Adhkhola
Shahasram Dhuldia
Pachli Para
Lahuno
Nakhla
Purura
Bagh Jorkandi
Suti
Dodonga Beel
Reksa Beel
Kargaon
Diakul
Chamakpur
Kargaon Kona Para
Kaona Mamudpur
Nagergaon
Chandpur
Bhatta
Jaraitala
Dhanki Para
Chandpur
Bagh Ata
Bhuna
Chatal
Mumurdia
Magura
Dinamani
Suti
Jallabad
Bagh Hata
Khurikhali
Mandalbhog
N
500 250 0 500 m
Kurikhai
Daricharia
Charia
Chhatnaika
Bamangaon
Rasulpur
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh
Chandpur Haor Scheme
Legend
Upazila Boundary
Union Boundary
Upazila Road
Union Road
Rural Road
Project Boundary
Proposed Embankment
Union H/Q
Drainage Regulator
Flushing Regulator
Pipe Sluice
River / Khal
Water body
Inundated area
(DWL = 4.9 m+PWD)
Index Map
Project Area
Bay of Bengal

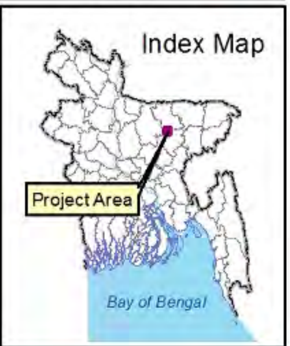


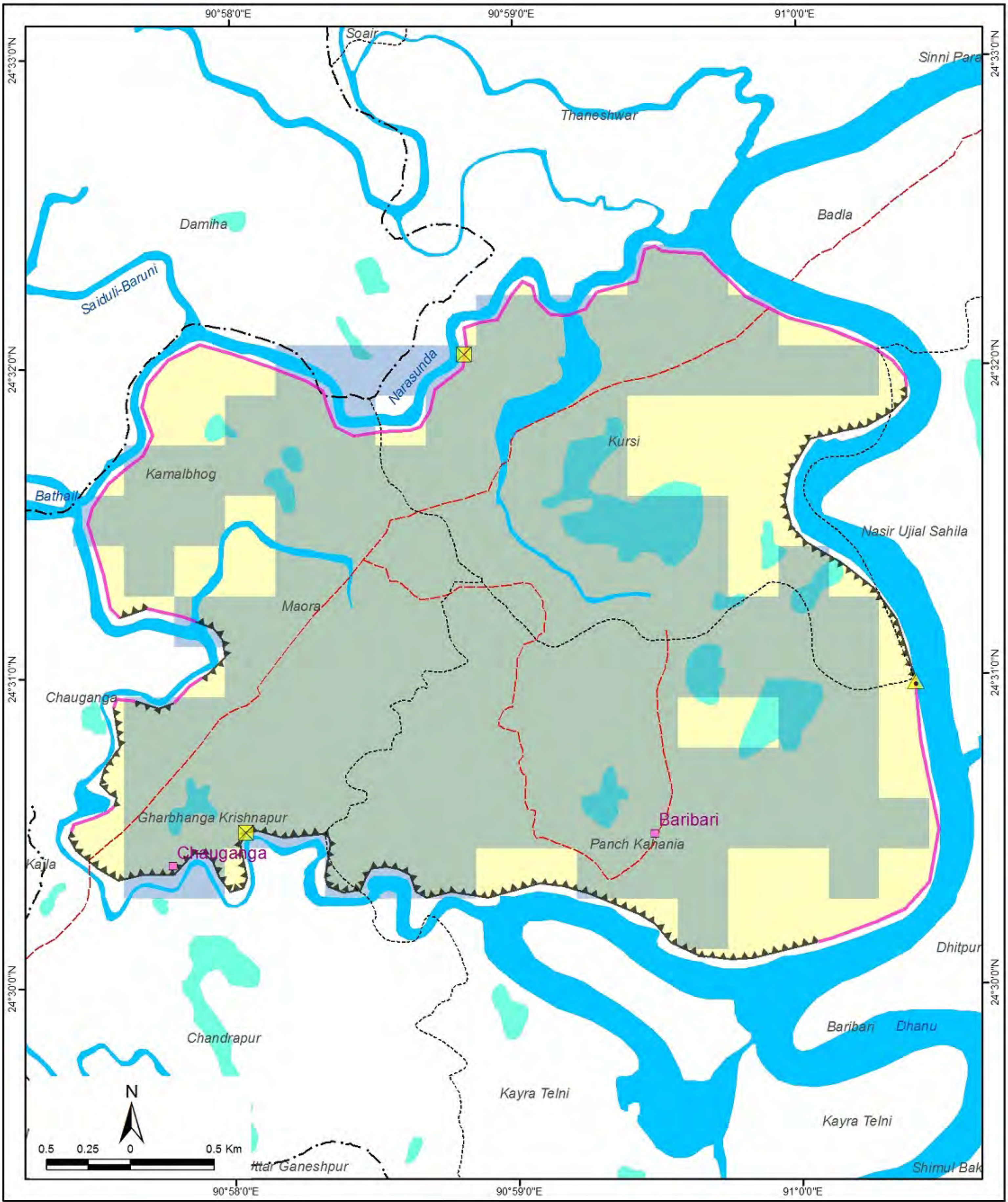
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh

Sunair Haor Project

Legend

- District Boundary
- Upazila Boundary
- Union Boundary
- Upazila Road
- Union Road
- Rural Road
- Project Boundary
- Proposed Embankment
- Upazila H/Q
- Union H/Q
- Drainage Regulator
- Flushing Regulator
- Settlement
- River / Khal
- Water body
- Inundated area (DWL = 5.7 m+PWD)





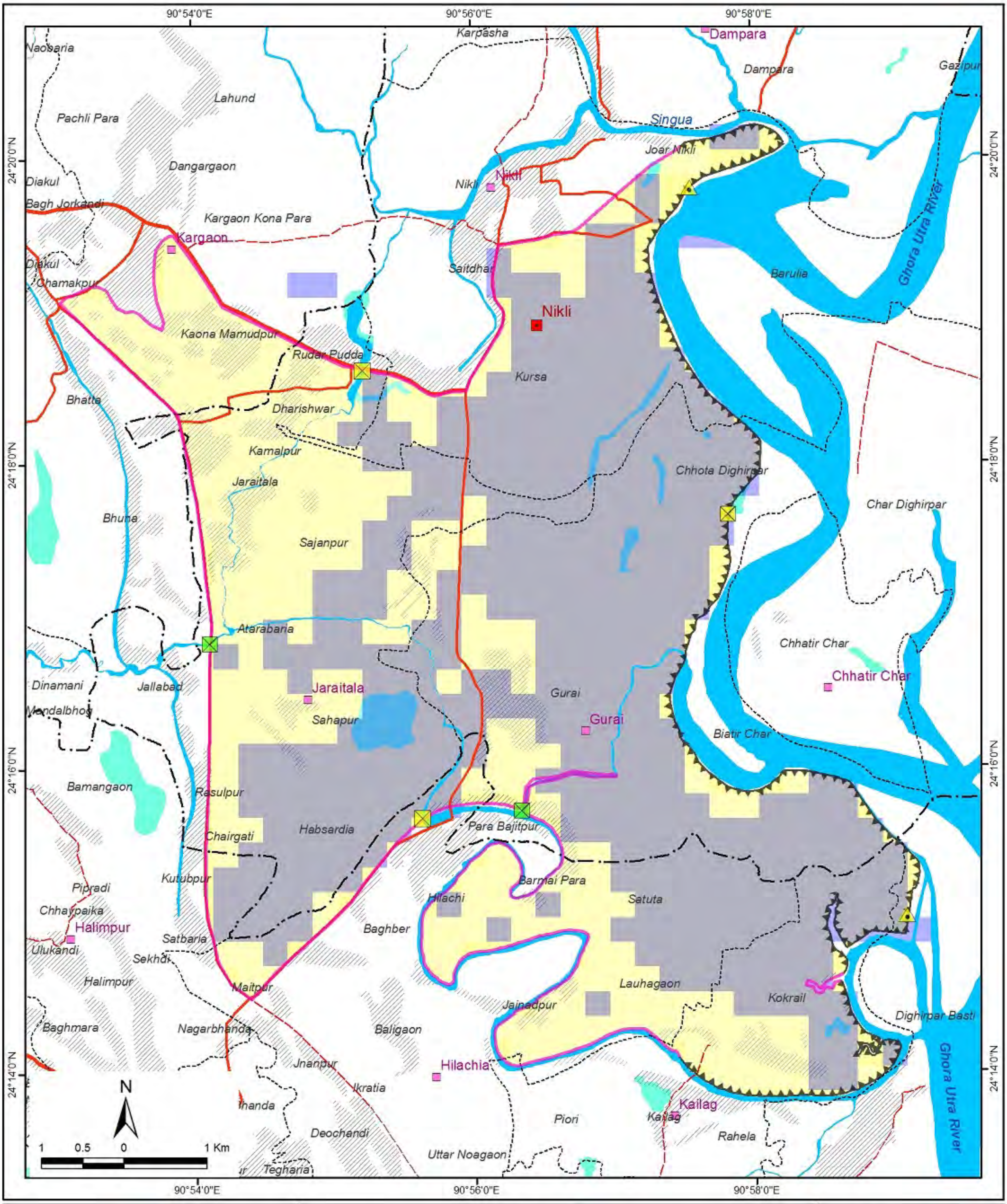
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh

Badla Scheme

Legend

- Upazila Boundary
- Union Boundary
- Rural Road
- Project Boundary
- Proposed Embankment
- Union H/Q
- Drainage Regulator
- Pipe Sluice
- River / Khal
- Water body
- Inundated area (DWL = 4.9 m+PWD)

Index Map

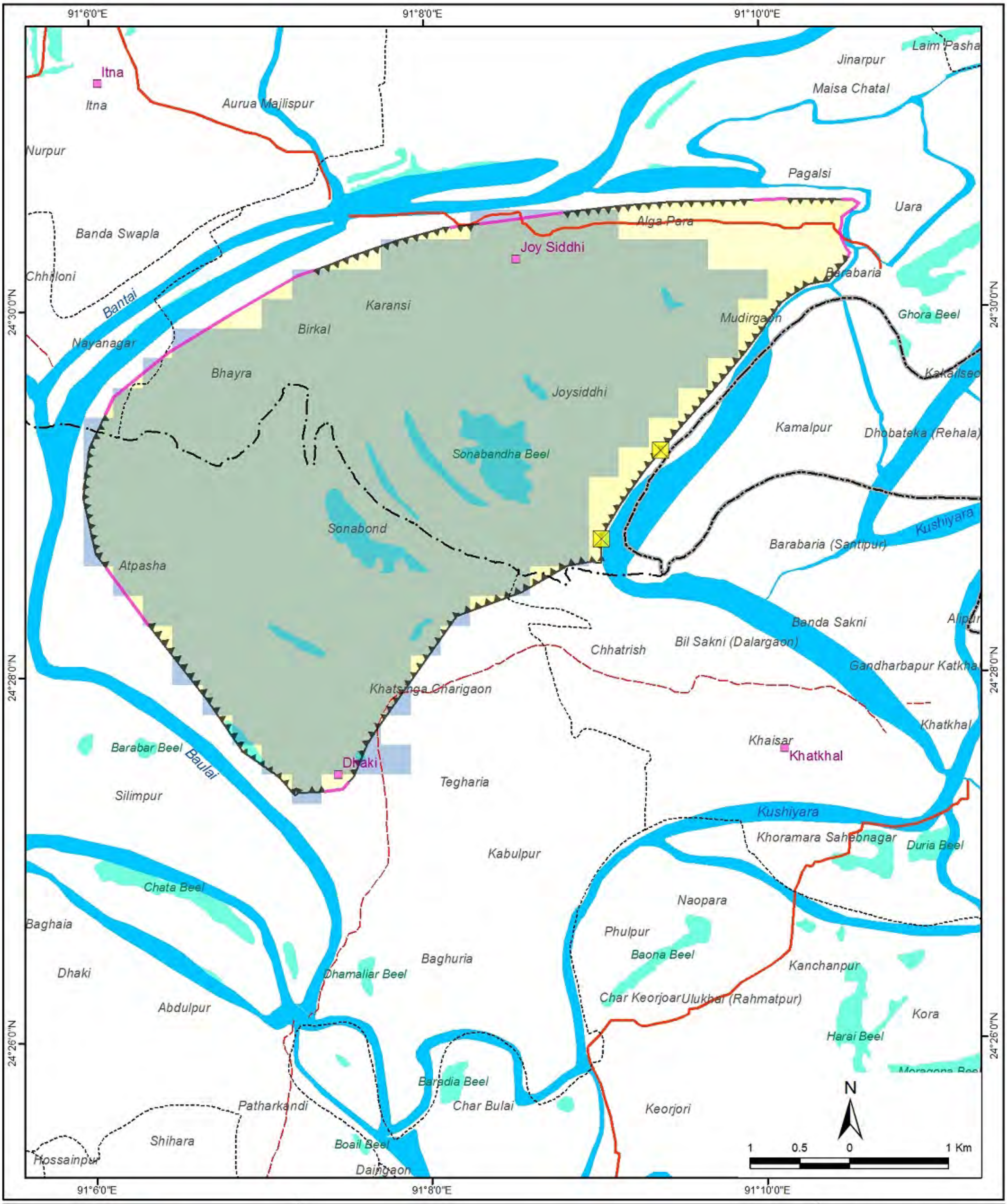


Data Collection Survey On Water Resources Management in Haor Area of Bangladesh

Nunnir Haor Scheme

Legend

Upazila Boundary	Upazila H/Q
Union Boundary	Union H/Q
Upazila Road	Drainage Regulator
Union Road	Flushing Regulator
Rural Road	Pipe Sluice
Project Boundary	River / Khal
Proposed Embankment	Water body
Settlement	Inundated area (DWL = 4.4 m+PWD)

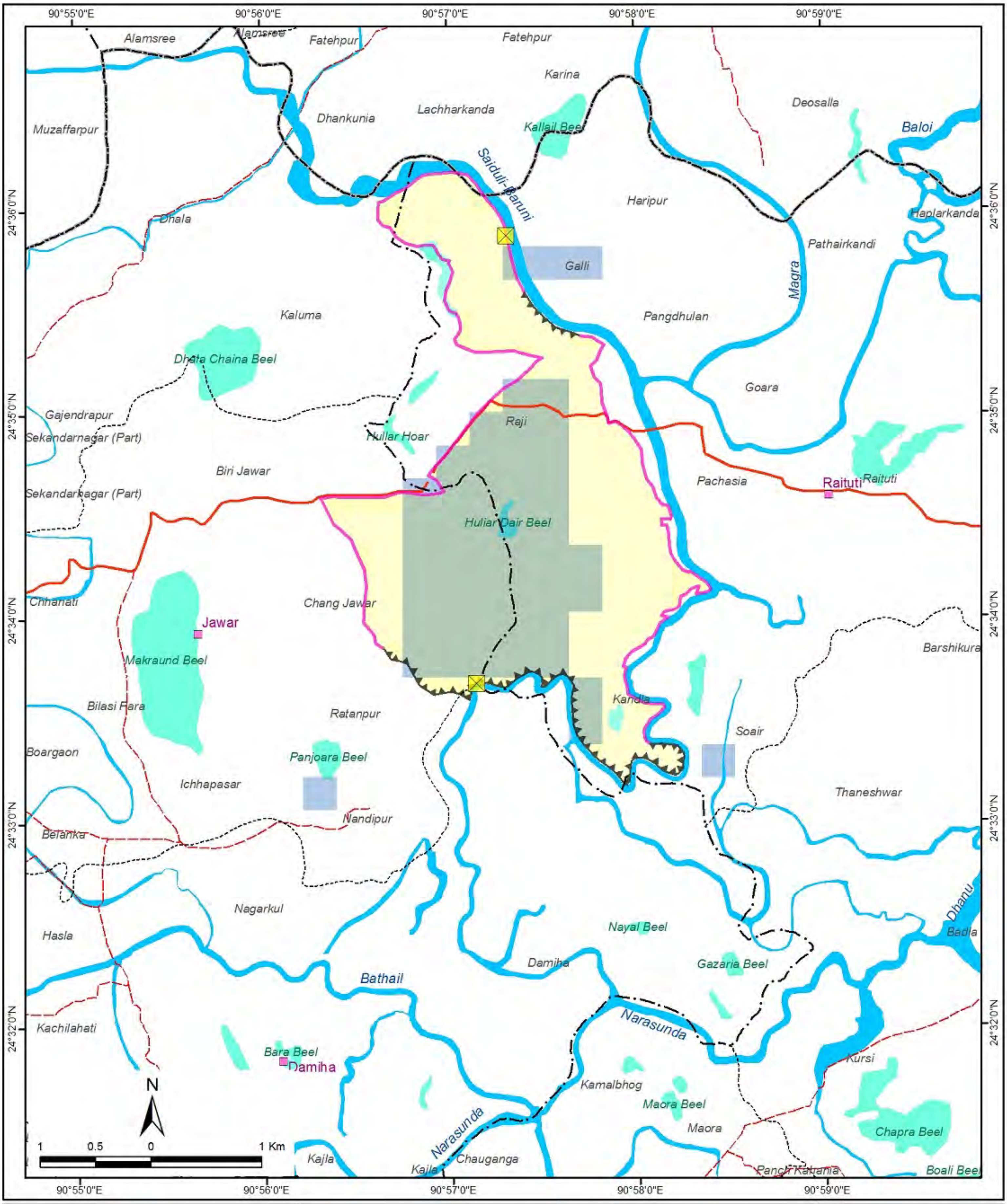


Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh

Dakhshiner Haor Project

Legend

- Division Boundary
- Upazila Boundary
- Union Boundary
- Union Road
- Rural Road
- Project Boundary
- Proposed Embankment
- Union H/Q
- Drainage Regulator
- River / Khal
- Water body
- Inundated area (DWL = 4.8 m+PWD)



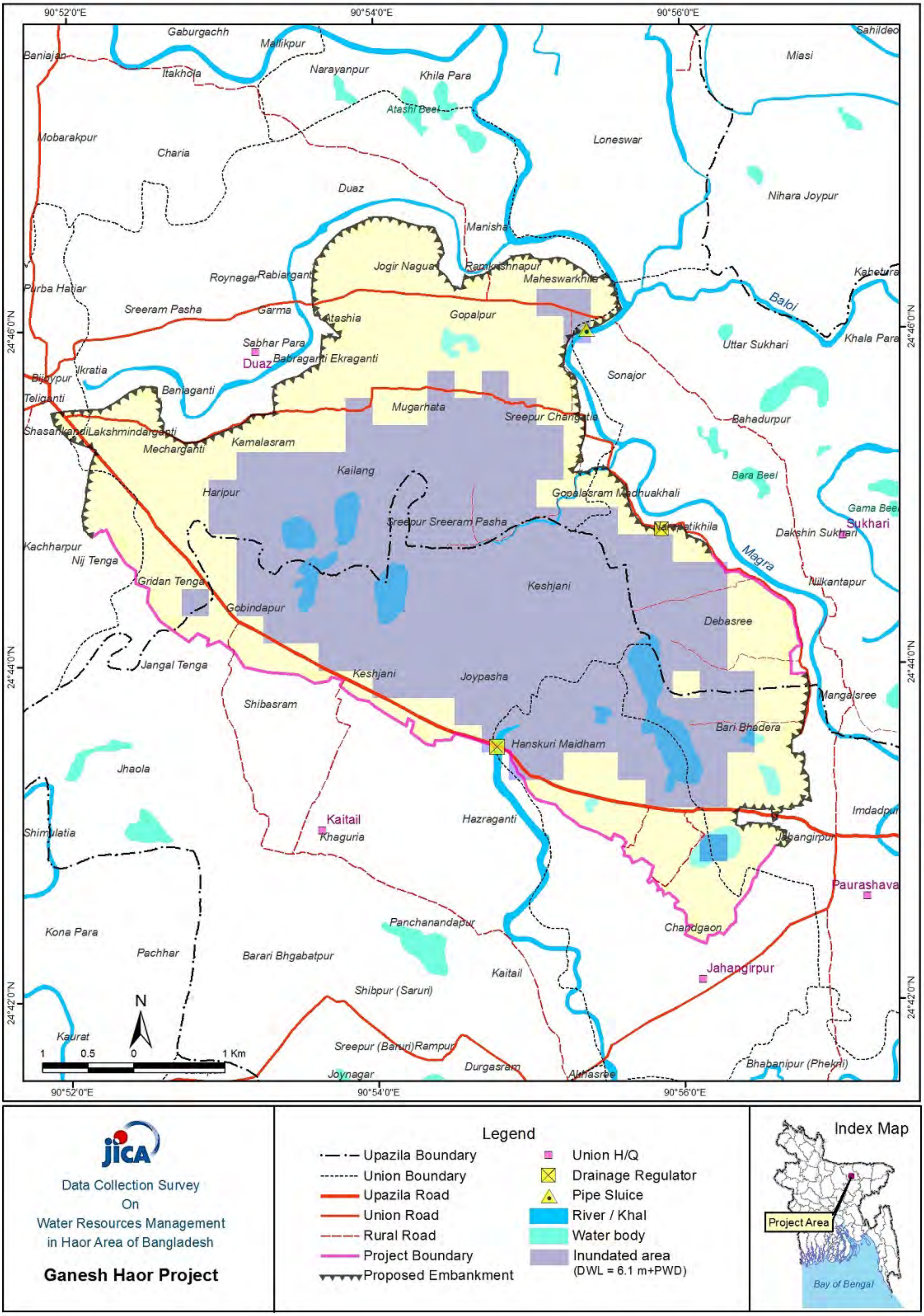
Data Collection Survey On Water Resources Management in Haor Area of Bangladesh

Chatal Haor Project

Legend

- District Boundary
- Upazila Boundary
- Union Boundary
- Union Road
- Rural Road
- Project Boundary
- Proposed Embankment
- Union H/Q
- Drainage Regulator
- River / Khal
- Water body
- Inundated area (DWL = 4.5 m+PWD)

Index Map



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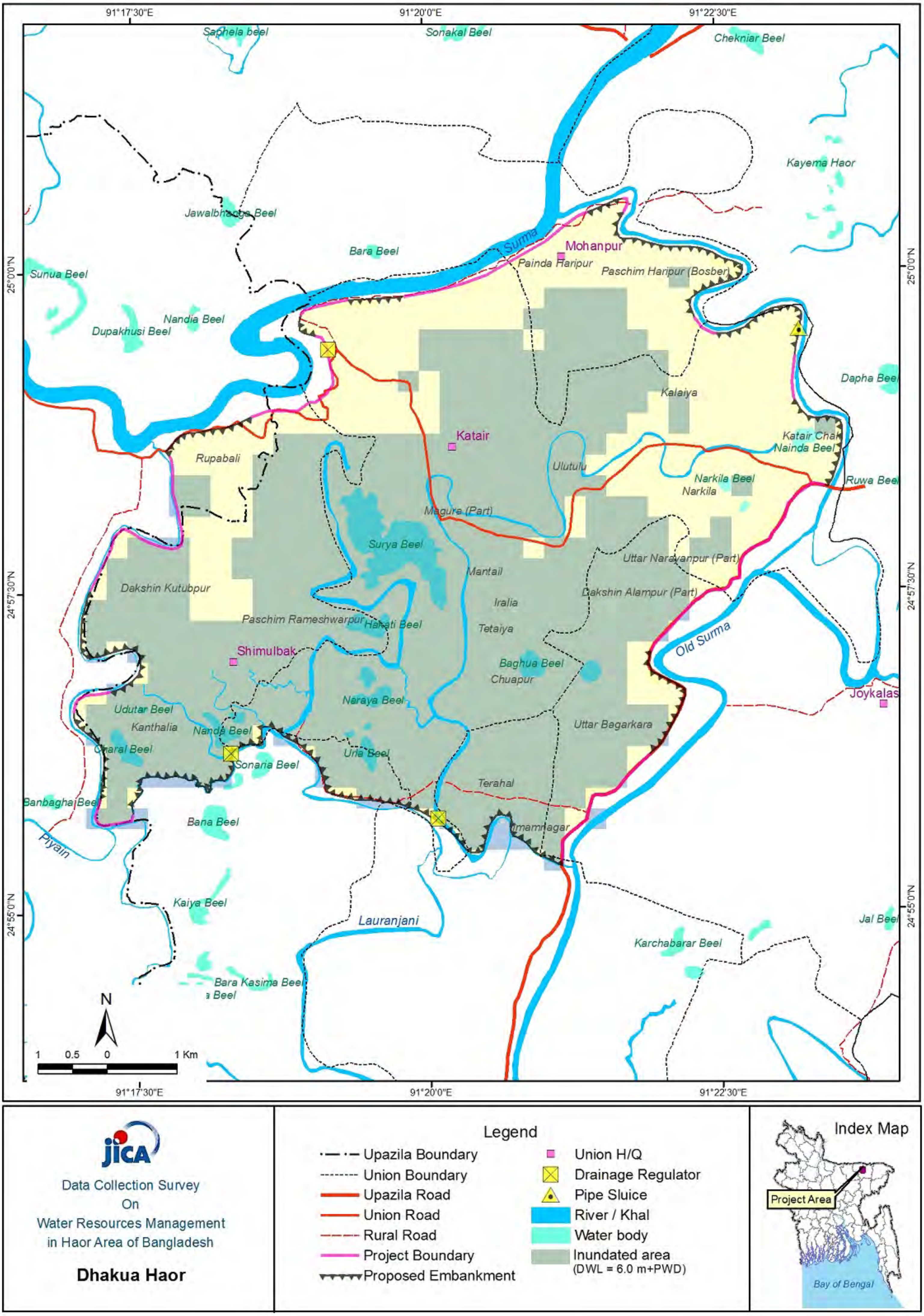
90°54'0"E
90°56'0"E
24°46'0"N
24°44'0"N
24°42'0"N
Gaburgachh
Mallikpur
Baniajan
Itakhola
Narayanpur
Khila Para
Atashi Beel
Sahildeo
Miasi
Mobarakpur
Charia
Loneswar
Duaz
Nihara Joypur
Manisha
Roynagar
Rabiargant
Jogir Nagua
Ramkrishnapur
Maheswarkhila
Kaheturi
Purba Hatiar
Sreeram Pasha
Garma
Atashia
Gopalpur
Baloi
Sabhar Para
Duaz
Babraganti Ekraganti
Uttar Sukhari
Khala Para
Ikratia
Bijoypur
Sonajor
Banlaganti
Teliganti
Mugarhata
Sreepur Changatia
Bahadurpur
Shasankandi
Lakshmindarganti
Mecharganti
Kamalasram
Kailang
Bara Beel
Haripur
Gopalasram
Madhuakhali
Gama Beel
Sreepur Sreeram Pasha
Sukhari
Dakshin Sukhari
Kachharpur
Nij Tenga
Magra
Gridan Tenga
Keshjani
Nilkantapur
Gobindapur
Debasree
Jangal Tenga
Keshjani
Joypasha
Mangalsree
Shibasram
Bari Bhadera
Hanskuri Maidham
Jhaola
Kaitail
Hazraganti
Imdadpur
Khaguria
Shimulatia
Jahangirpur
Paurashava
Panchanandapur
Chandgaon
Kona Para
Pachhar
Barari Bhgabatpur
Kaitail
Jahangirpur
Shibpur (Saruri)
Kaurat
Sreepur (Baruri)Rampur
Durgasram
Althasree
Bhabanipur (Phekni)
Joynagar
N
1 0.5 0 1 Km
JICA
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh
Ganesh Haor Project
Legend
Upazila Boundary
Union Boundary
Upazila Road
Union Road
Rural Road
Project Boundary
Proposed Embankment
Union H/Q
Drainage Regulator
Pipe Sluice
River / Khal
Water body
Inundated area
(DWL = 6.1 m+PWD)
Index Map
Project Area
Bay of Bengal



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Sonakal Beel
Chekniar Beel
Kayema Haor
Jawalbhanga Beel
Bara Beel
Surma
Mohanpur
Painda Haripur
Paschim Haripur (Bosber)
Sunua Beel
Nandia Beel
Dupakhusi Beel
Dapha Beel
Kalaiya
Katair
Rupabali
Ulutulu
Katair Char
Nainda Beel
Narkila Beel
Narkila
Ruwa Beel
Magura (Part)
Surya Beel
Mantail
Uttar Narayanpur (Part)
Dakshin Kutubpur
Iralia
Dakshin Alampur (Part)
Paschim Rameshwarpur
Hakati Beel
Tetaiya
Old Surma
Shimulbak
Baghua Beel
Chuapur
Joykalas
Udutar Beel
Naraya Beel
Kanthalia
Nanda Beel
Uttar Begarkara
Charal Beel
Sonaria Beel
Urla Beel
Terahal
Banbagha Beel
Bana Beel
Piyain
Kaiya Beel
Lauranjani
Jal Beel
Karchabarar Beel
Bara Kasima Beel
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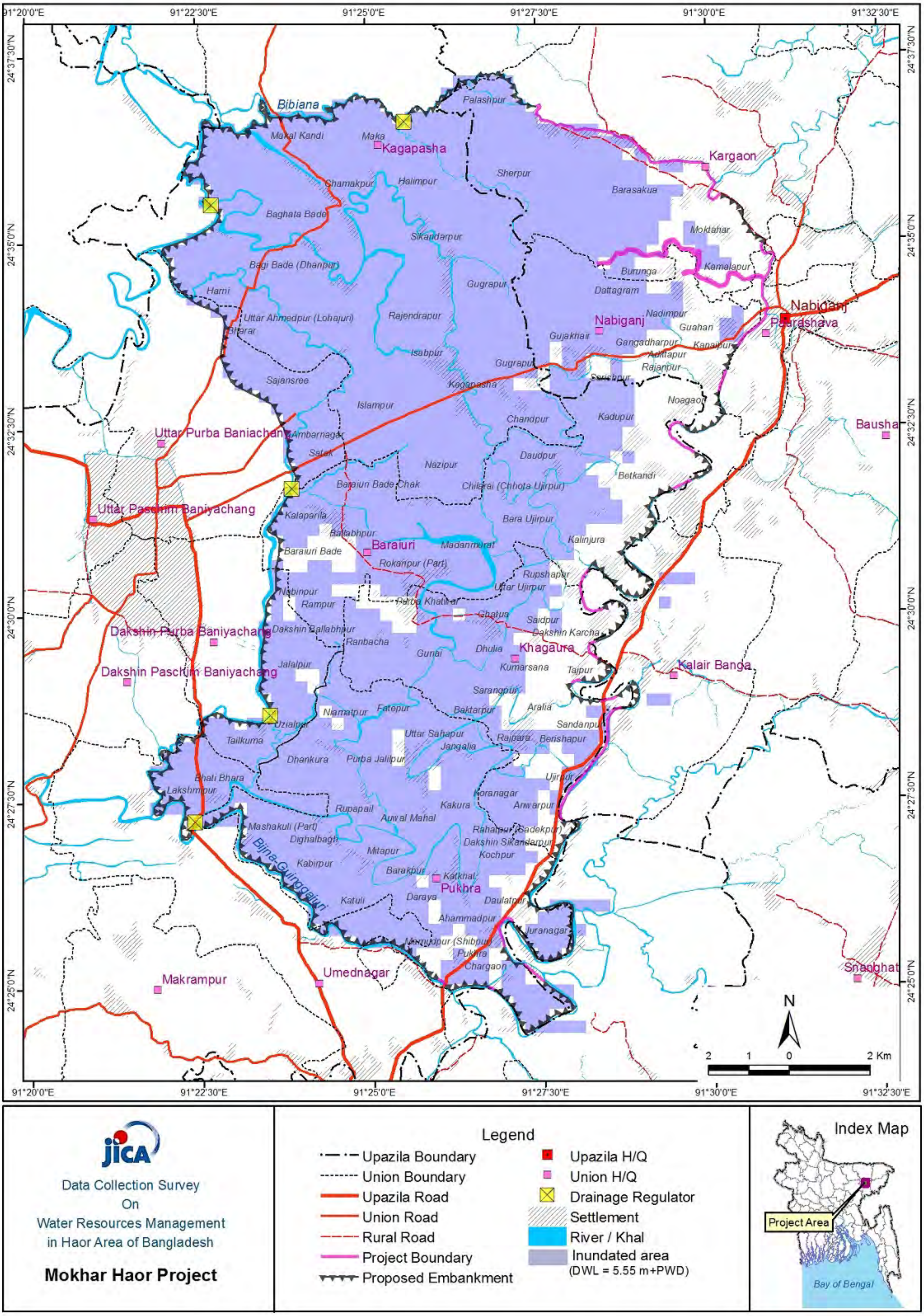
JICA
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh
Dhakua Haor
Legend
Upazila Boundary
Union Boundary
Upazila Road
Union Road
Rural Road
Project Boundary
Proposed Embankment
Union H/Q
Drainage Regulator
Pipe Sluice
River / Khal
Water body
Inundated area
(DWL = 6.0 m+PWD)
Index Map
Project Area
Bay of Bengal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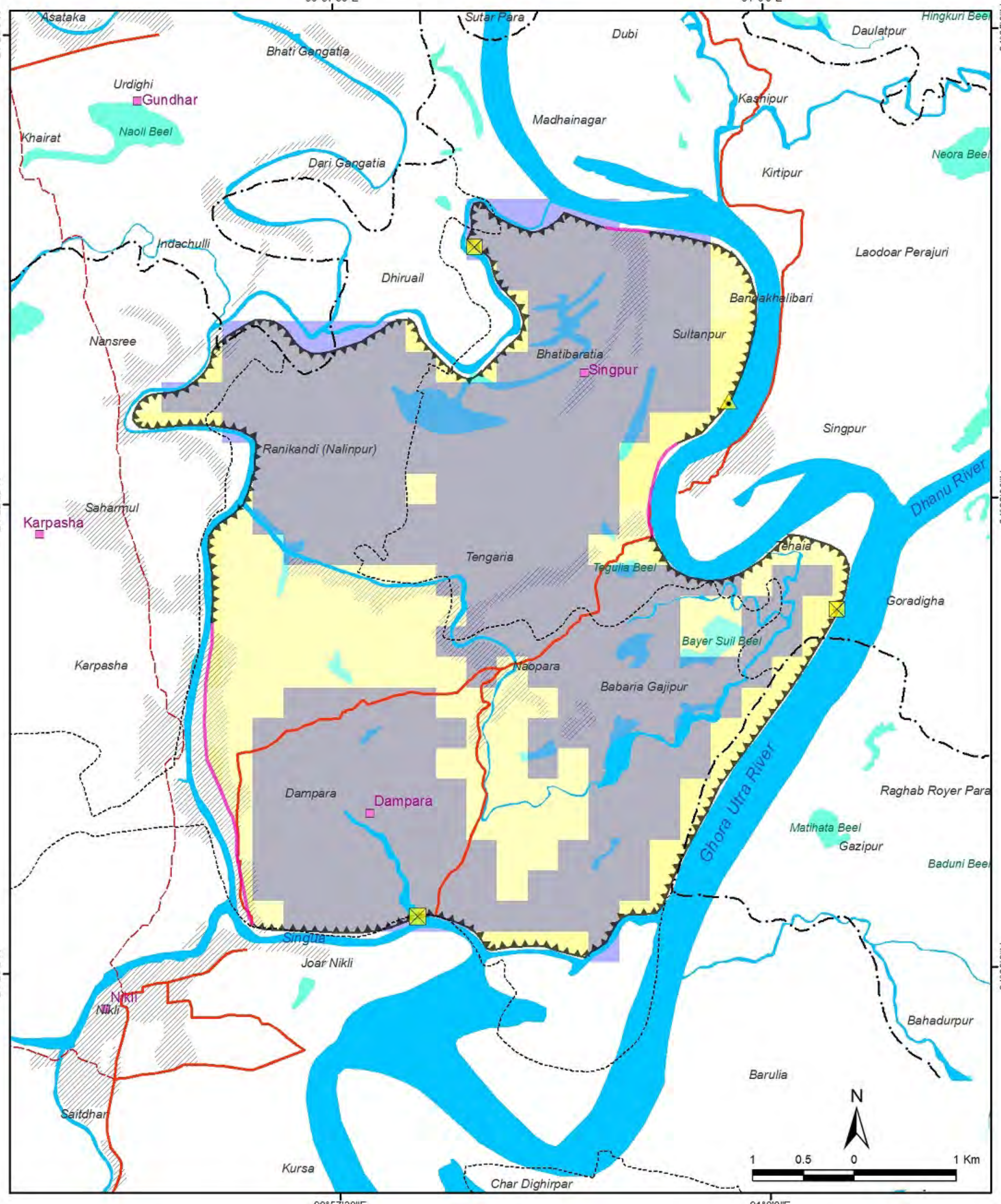
Bibiana
Palashpur
Makal Kandi
Maka
Kagapasha
Kargaon
Sherpur
Chamakpur
Halimpur
Barasakua
Baghata Bade
Sikandarpur
Moktahar
Bagi Bade (Dhanpur)
Burunga
Kamalapur
Gugrapur
Dattagram
Harni
Nabiganj
Paurashava
Uttar Ahmedpur (Lohajuri)
Rajendrapur
Nadimpur
Guahari
Bharar
Gujakhair
Gangadharpur
Kanaipur
Isabpur
Adittapur
Gugrapur
Rajanpur
Sajansree
Kagapasha
Noagaon
Islampur
Chandpur
Kadupur
Uttar Purba Baniachang
Ambarnagar
Bausha
Satak
Nazipur
Daudpur
Betkandi
Baraiun Bade Chak
Chilarai (Chhota Ujirpur)
Uttar Paschim Baniyachang
Kalaparila
Bara Ujirpur
Ballabhpur
Kalinjura
Baraiuri Bade
Baraiuri
Madanmurat
Rokanpur (Part)
Rupshapur
Nabinpur
Uttar Ujirpur
Rampur
Purba Khatirar
Ghatua
Saidpur
Dakshin Purba Baniyachang
Dakshin Ballabhpur
Dakshin Karcha
Ranbacha
Dhulia
Khagaura
Gunai
Dakshin Paschim Baniyachang
Jalalpur
Kumarsana
Tajpur
Kalair Banga
Sarangpur
Aralia
Niamatpur
Fatepur
Baktarpur
Uzialpur
Sandanpur
Uttar Sahapur
Tailkuma
Rajpara
Berishapur
Jangalia
Dhankura
Purba Jalilpur
Ujirpur
Bhati Bhara
Lakshmipur
Koranagar
Kakura
Anwarpur
Rupapail
Auwal Mahal
Mashakuli (Part)
Rahatpur (Sadekpur)
Dighalbagh
Dakshin Sikandarpur
Bijna-Guingajuri
Mitapur
Kochpur
Kabirpur
Barakpur
Katkhal
Pukhra
Katuli
Daraya
Daulatpur
Ahammadpur
Juranagar
Mamudpur (Shibpur)
Pukhra
Chargaon
Umednagar
Makrampur
Shanghat
N
2 1 0 2 Km
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh
Mokhar Haor Project
Legend
Upazila Boundary
Union Boundary
Upazila Road
Union Road
Rural Road
Project Boundary
Proposed Embankment
Upazila H/Q
Union H/Q
Drainage Regulator
Settlement
River / Khal
Inundated area
(DWL = 5.55 m+PWD)
Index Map
Project Area
Bay of Bengal



Data Collection Survey On Water Resources Management in Haor Area of Bangladesh

Noapara Haor Scheme

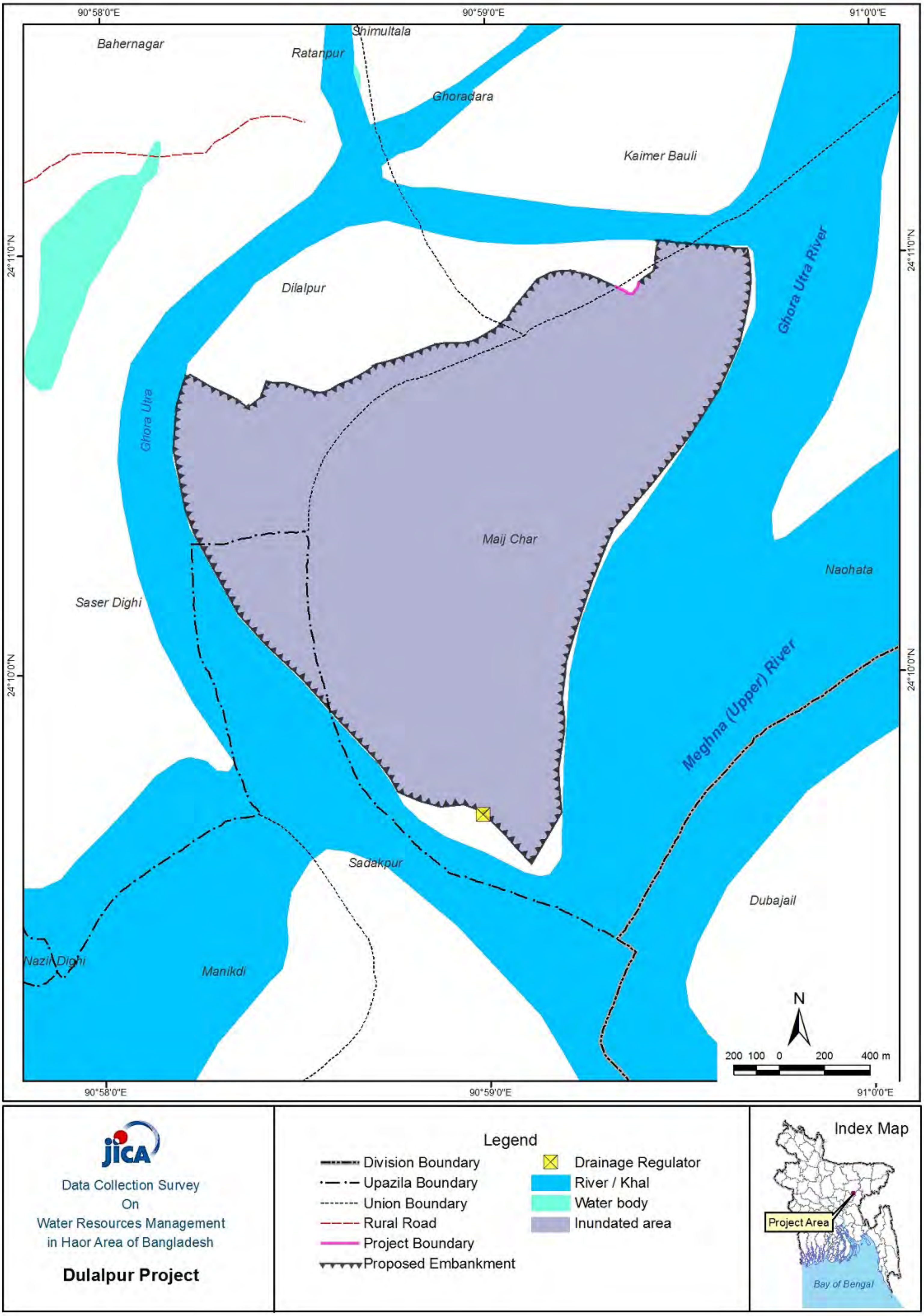
Legend

- Upazila Boundary
- Union Boundary
- Union Road
- Rural Road
- Project Boundary
- Proposed Embankment
- Union H/Q
- Drainage Regulator
- Pipe Sluice
- Settlement
- River / Khal
- Water body
- Inundated area (DWL = 4.6 m+PWD)

Index Map

Project Area

Bay of Bengal



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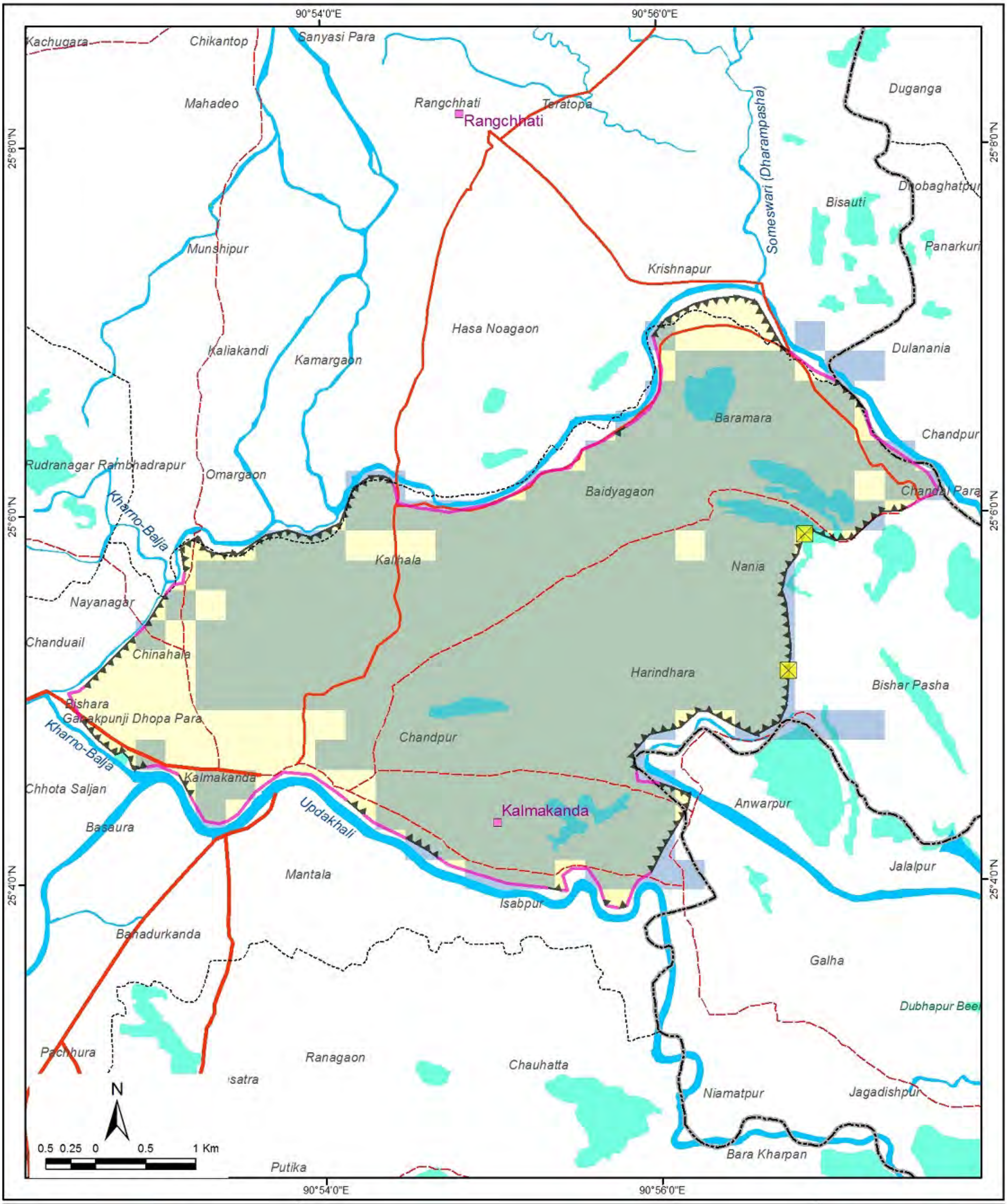
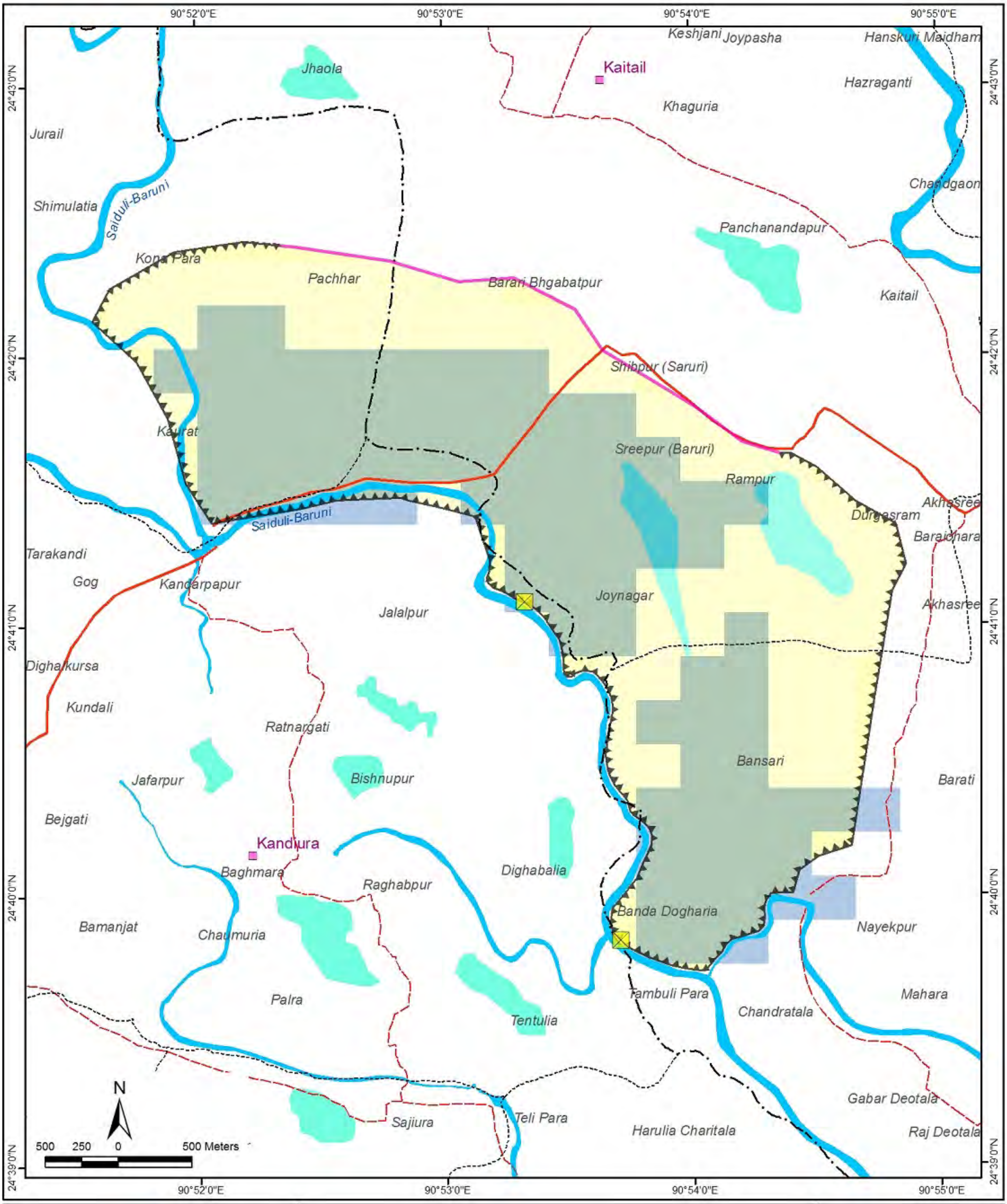
Bahernagar
Ratanpur
Shimultala
Ghoradara
Kaimer Bauli
Dilalpur
Ghora Utra
Ghora Utra River
Maij Char
Naohata
Saser Dighi
Meghna (Upper) River
Sadakpur
Dubajail
Nazir Dighi
Manikdi
N
200 100 0 200 400 m
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh
Dulalpur Project
Legend
Division Boundary
Upazila Boundary
Union Boundary
Rural Road
Project Boundary
Proposed Embankment
Drainage Regulator
River / Khal
Water body
Inundated area
Index Map
Project Area
Bay of Bengal



Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh

Boro Haor Project



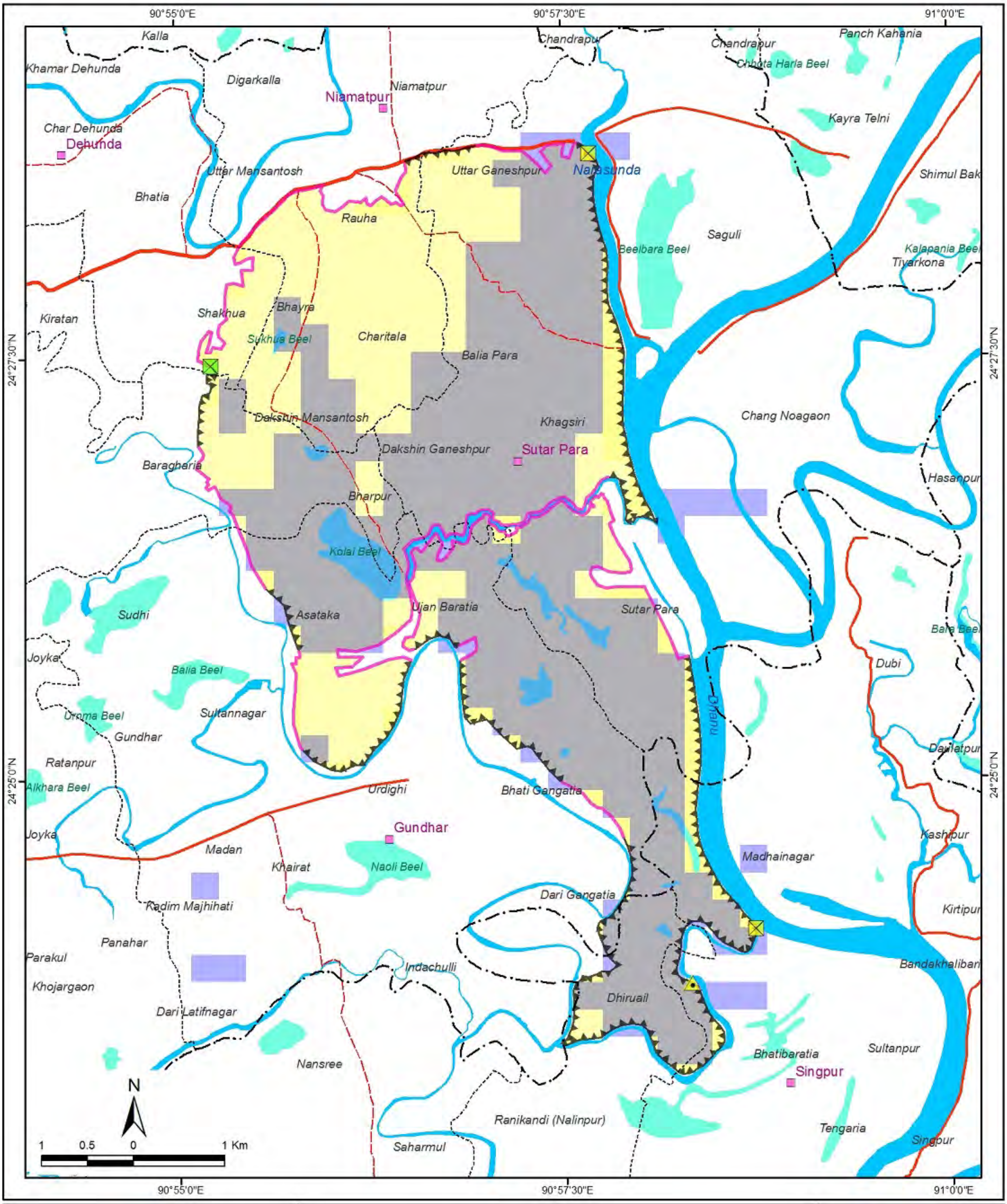
JICA

Data Collection Survey On Water Resources Management in Haor Area of Bangladesh

Bansharir Haor Project

Legend

- Upazila Boundary
- Union Boundary
- Union Road
- Rural Road
- Project Boundary
- Proposed Embankment
- Union H/Q
- Drainage Regulator
- River / Khal
- Water body
- Inundated area (DWL = 5.8 m+PWD)

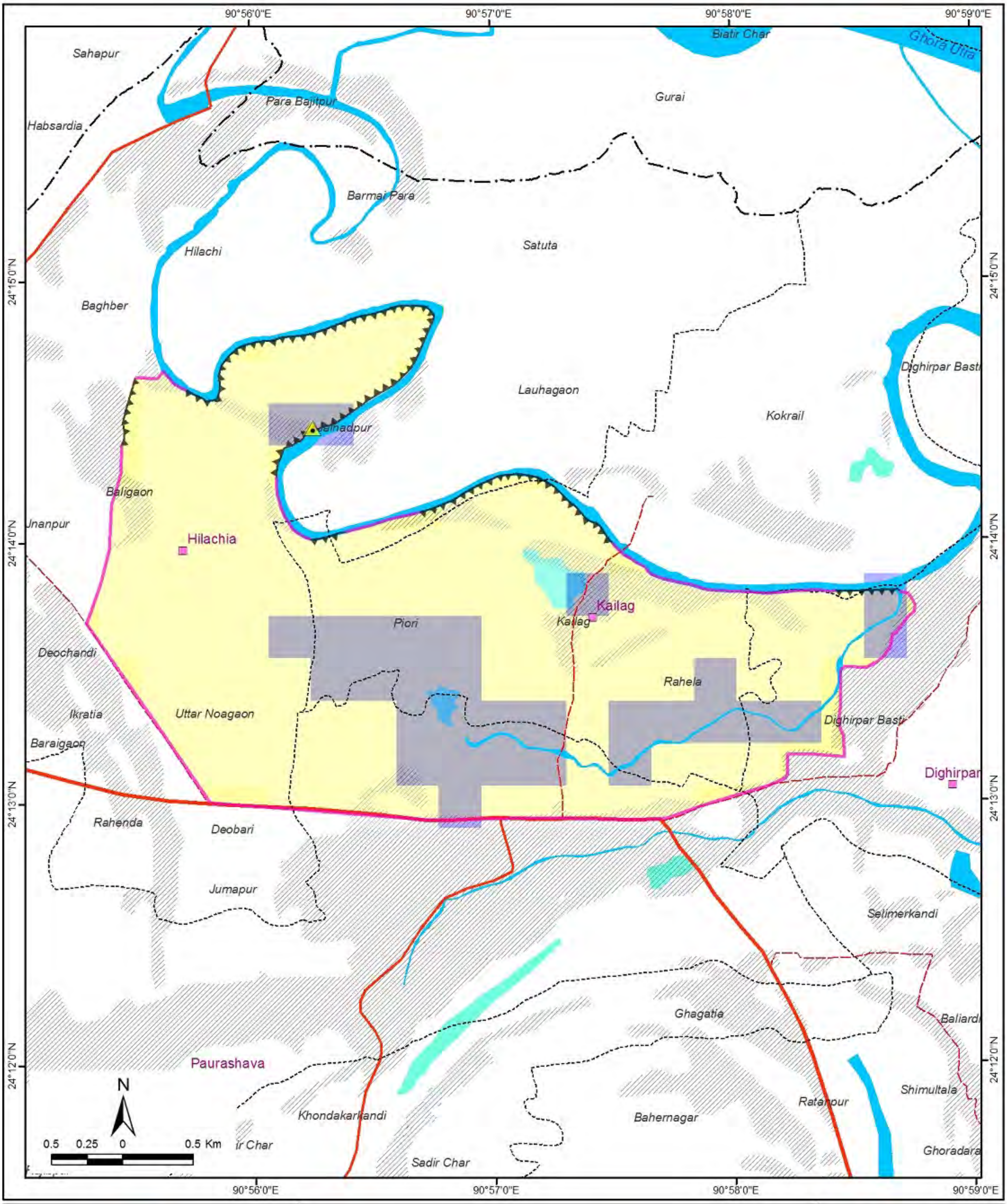


Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh

Korati Haor Scheme

Legend

- Upazila Boundary
- Union Boundary
- Upazila Road
- Union Road
- Rural Road
- Project Boundary
- Proposed Embankment
- Union H/Q
- Drainage Regulator
- Flushing Regulator
- Pipe Sluice
- River / Khal
- Water body
- Inundated area (DWL = 4.9 m+PWD)



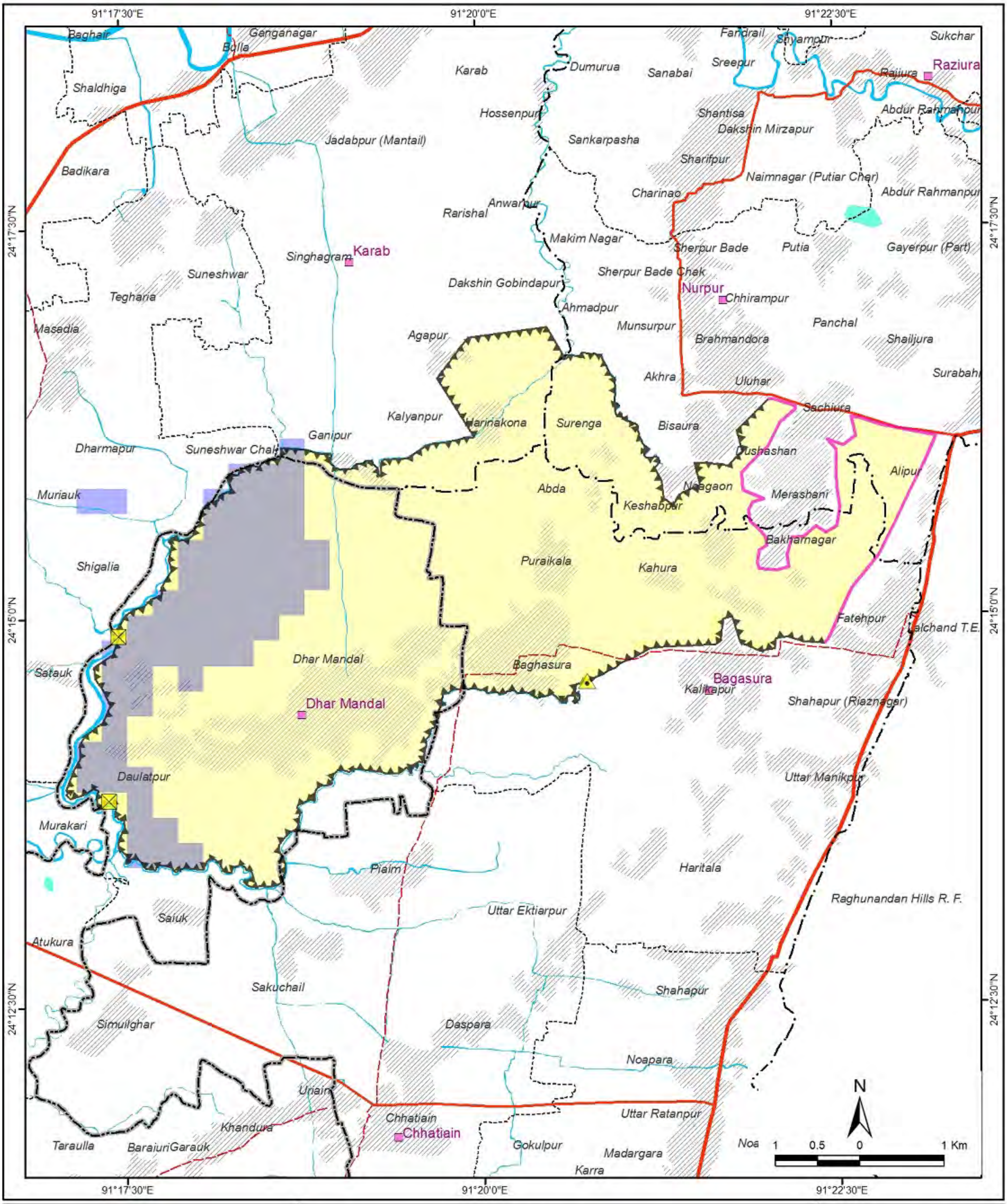
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh

Sarishapur Haor Scheme

Legend

- Upazila Boundary
- Union Boundary
- Upazila Road
- Union Road
- Rural Road
- Project Boundary
- Proposed Embankment
- Union H/Q
- Drainage Regulator
- Pipe Sluice
- Settlement
- River / Khal
- Water body
- Inundated area (DWL = 4.3 m+PWD)

Index Map



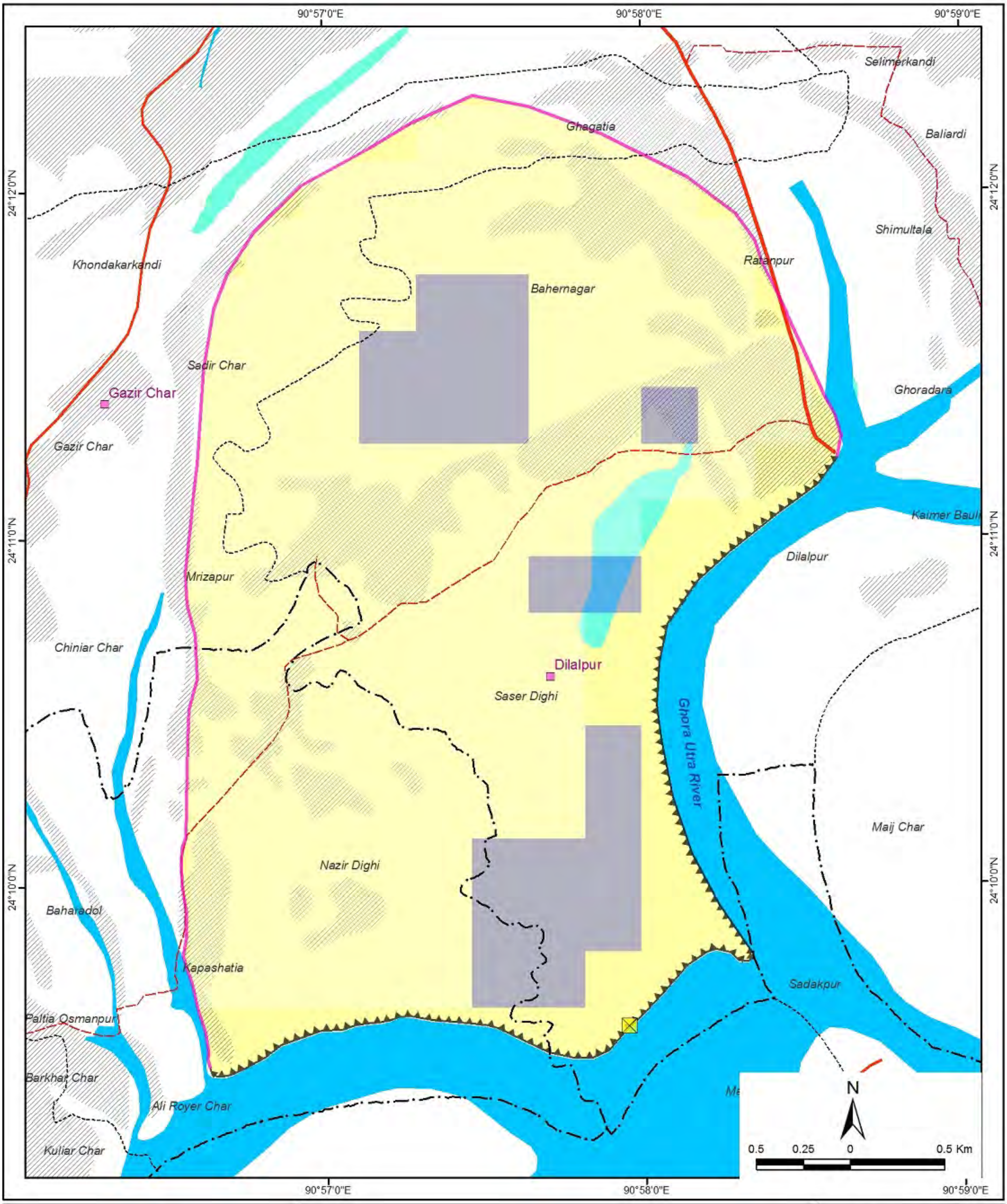
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh

Shelnir Haor Project

Legend

Division Boundary	Union H/Q
Upazila Boundary	Drainage Regulator
Union Boundary	Pipe Sluice
Upazila Road	Settlement
Union Road	River / Khal
Rural Road	Water body
Project Boundary	Inundated area (DWL = 5.2 m+PWD)
Proposed Embankment	

Index Map



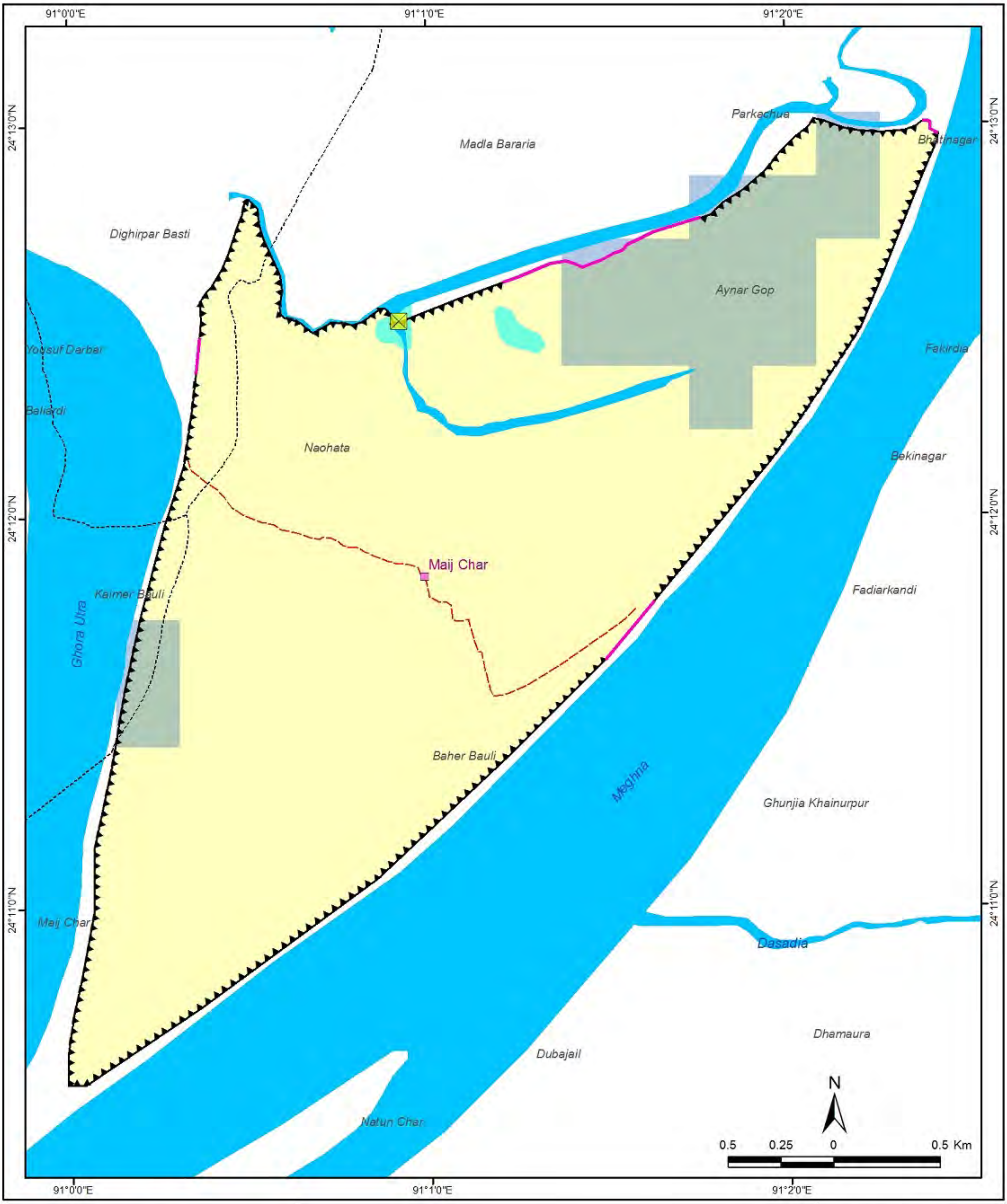
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh

Kuniarbandh Haor Scheme

Legend

- Upazila Boundary
- Union Boundary
- Upazila Road
- Union Road
- Rural Road
- Project Boundary
- Proposed Embankment
- Union H/Q
- Drainage Regulator
- Settlement
- River / Khal
- Water body
- Inundated area (DWL = 4.0 m+PWD)

Index Map

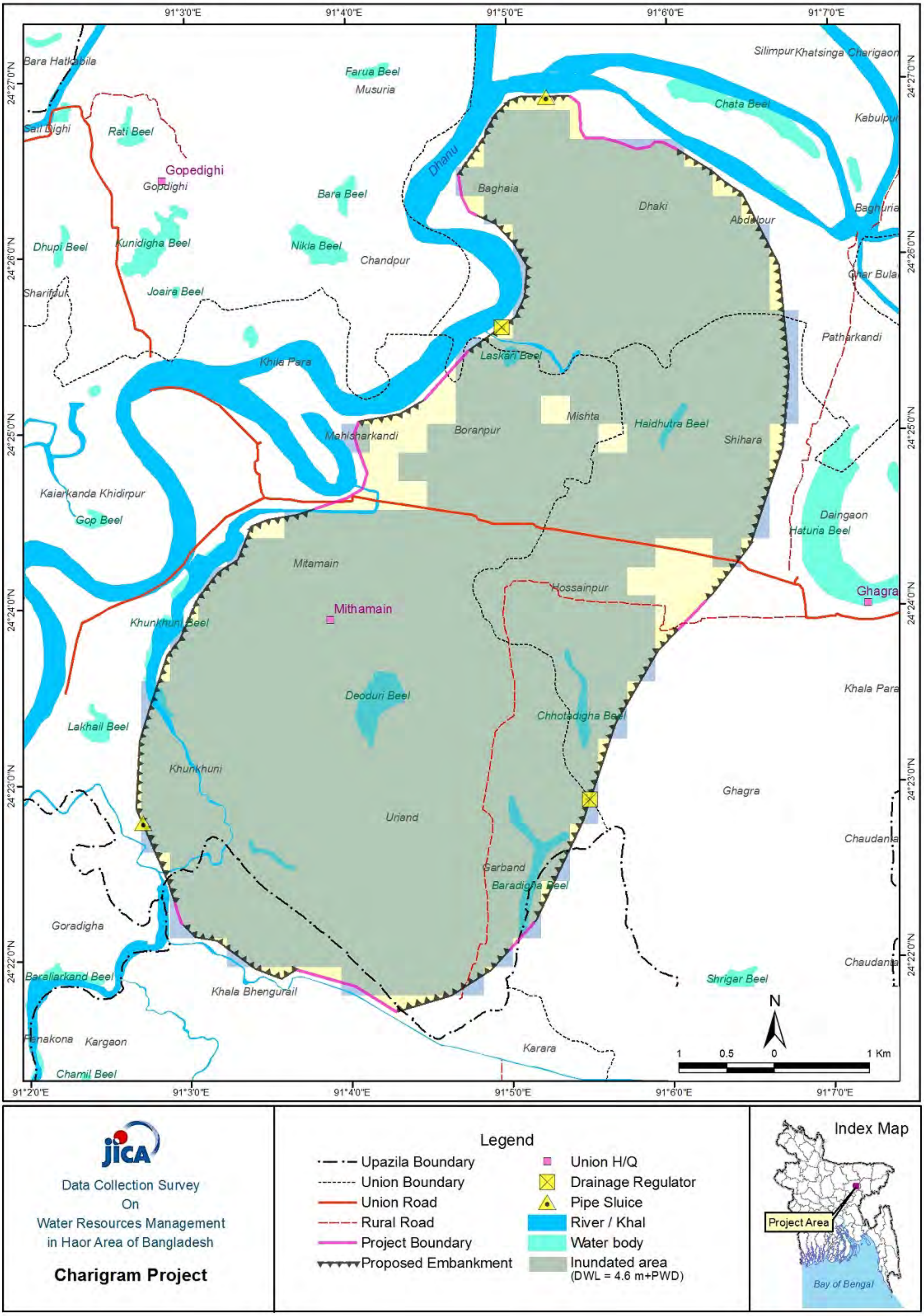


Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh

Ayner Gupi Haor Scheme

Legend

- Union Boundary
- Rural Road
- Project Boundary
- Proposed Embankment
- Union H/Q
- Drainage Regulator
- River / Khal
- Water body
- Inundated area (DWL = 4.0 m+PWD)



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91°6'0"E
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91°2'0"E
24°27'0"N
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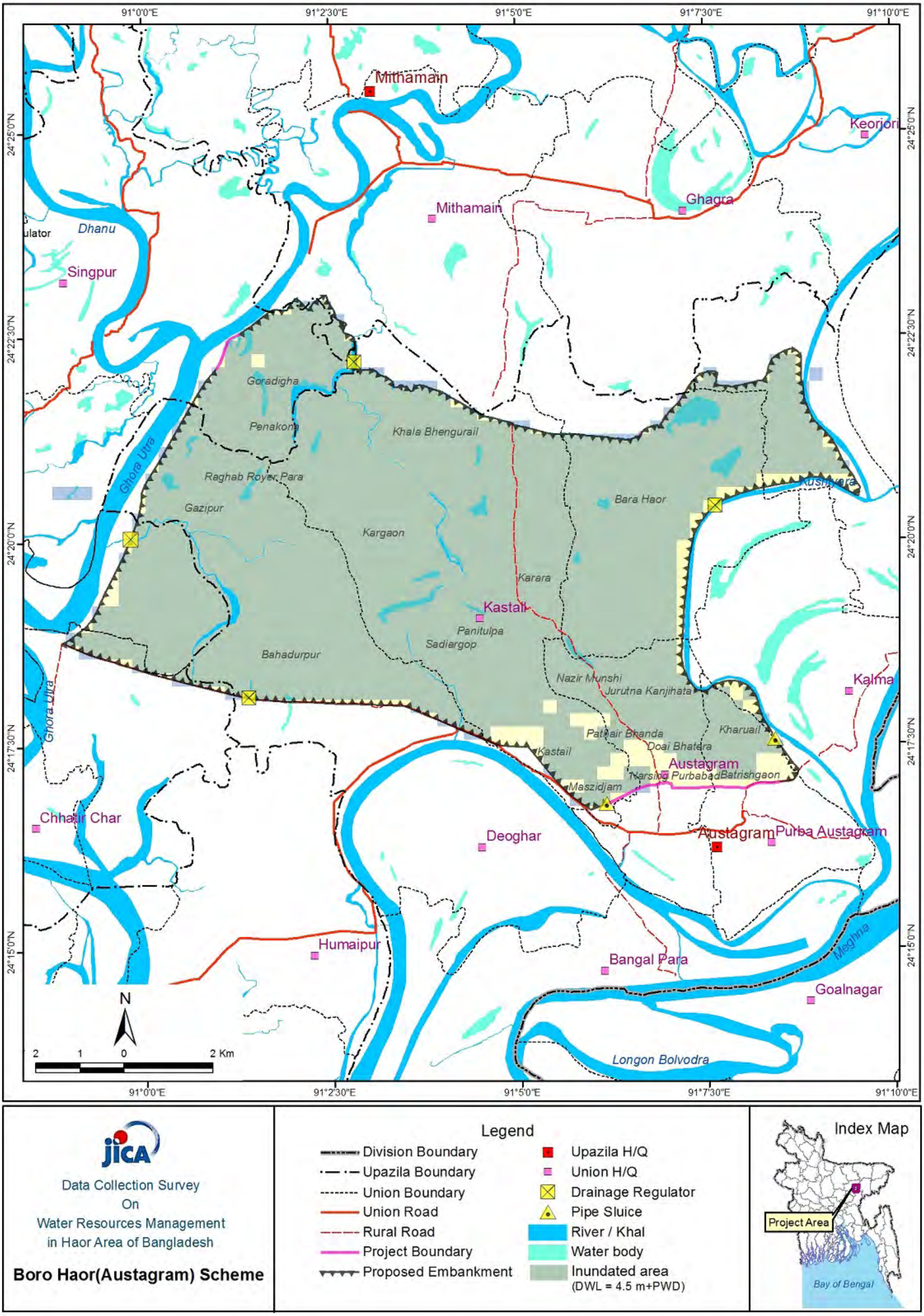
24°25'0"N
24°24'0"N
24°23'0"N
24°22'0"N
Bara Hatkabila
Farua Beel
Musuria
Silimpur
Khatsinga
Charigaon
Chata Beel
Kabulpur
Sail Dighi
Rati Beel
Gopedighi
Gopdighi
Dhanu
Baghaia
Dhaki
Bara Beel
Abdulpur
Baghuria
Dhupi Beel
Kunidigha Beel
Nikla Beel
Chandpur
Char Bulai
Sharifpur
Joaira Beel
Patharkandi
Khila Para
Laskari Beel
Mishta
Haidhutra Beel
Mahisharkandi
Boranpur
Shihara
Kaiarkanda Khidirpur
Gop Beel
Daingaon
Haturia Beel
Mitamain
Hossainpur
Ghagra
Mithamain
Khunkhuni Beel
Khala Para
Deoduri Beel
Chhotadigha Beel
Lakhail Beel
Khunkhuni
Ghagra
Uriand
Chaudania
Garband
Baradigha Beel
Goradigha
Chaudania
Baraliarkand Beel
Shrigar Beel
Khala Bhengurail
Panakona
Kargaon
Karara
Chamil Beel
N
1 0.5 0 1 Km
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh
Charigram Project
Legend
Upazila Boundary
Union Boundary
Union Road
Rural Road
Project Boundary
Proposed Embankment
Union H/Q
Drainage Regulator
Pipe Sluice
River / Khal
Water body
Inundated area
(DWL = 4.6 m+PWD)
Index Map
Project Area
Bay of Bengal


Mithamain
Mithamain
Keorjori
Ghagra
Dhanu
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Singpur
Goradigha
Penakona
Khala Bhengurail
Raghab Royer Para
Gazipur
Ghora Utra
Bara Haor
Kushiyara
Kargaon
Karara
Kastail
Panitulpa
Sadiargop
Bahadurpur
Nazir Munshi
Jurutna Kanjihata
Kharuail
Kalma
Pathair Bhanda
Doai Bhatera
Kastail
Austagram
Narsing
Purbabad
Batrishgaon
Maszidjam
Ghora Utra
Chhatir Char
Deoghar
Austagram
Purba Austagram
Humaipur
Bangal Para
Meghna
Goalnagar
Longon Bolvodra
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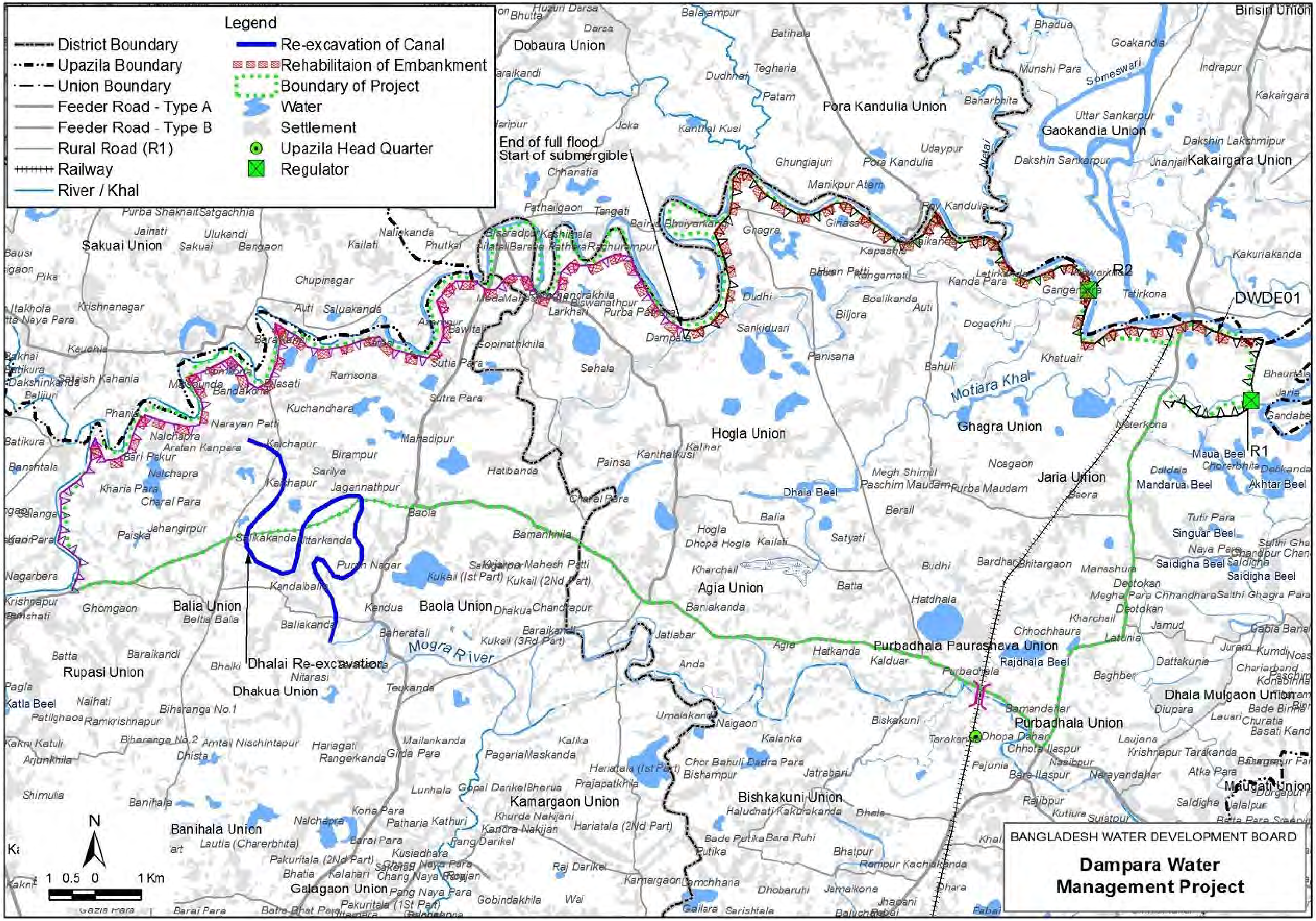
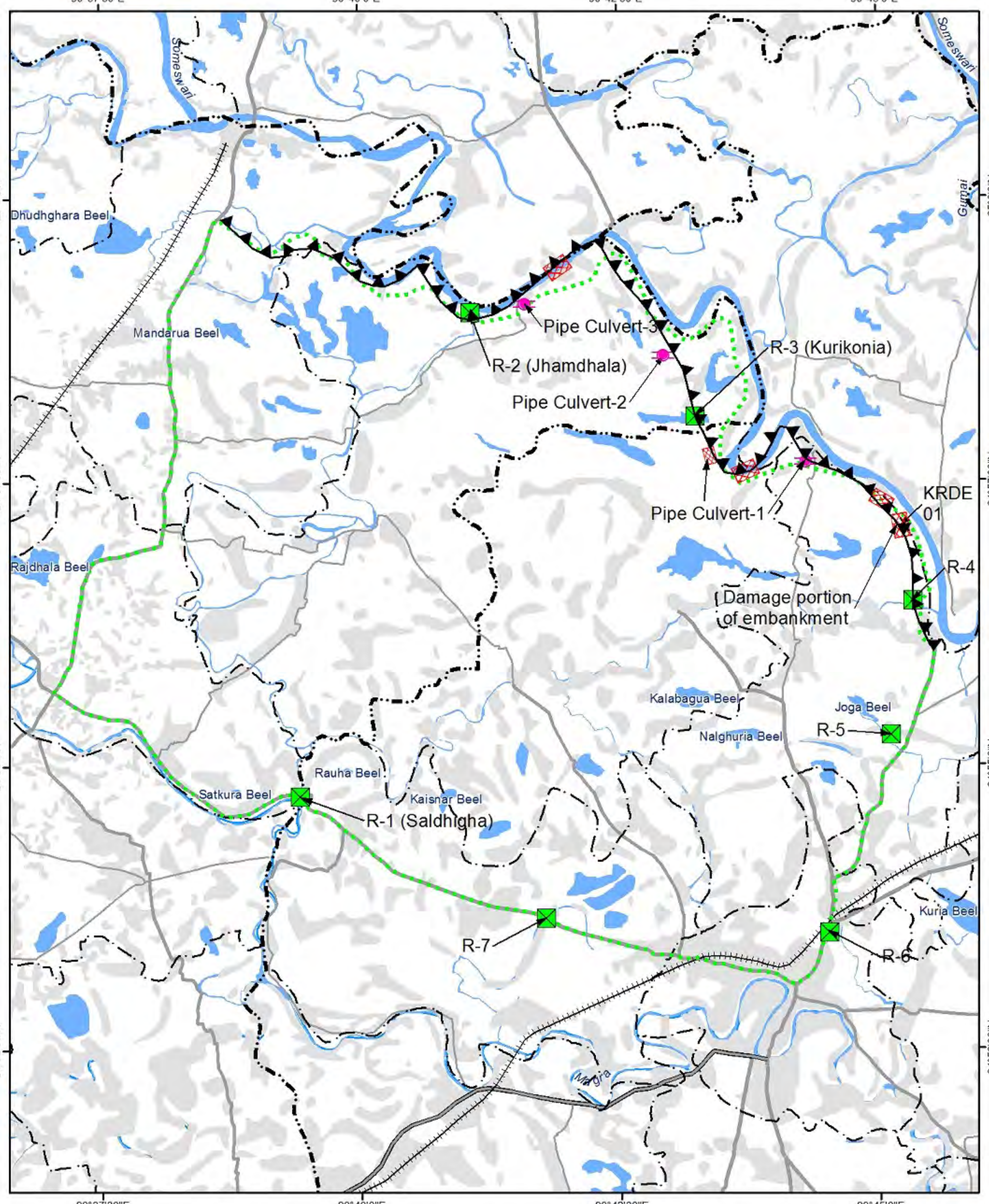
JICA
Data Collection Survey
On
Water Resources Management
in Haor Area of Bangladesh
Boro Haor(Austagram) Scheme
Legend
Division Boundary
Upazila Boundary
Union Boundary
Union Road
Rural Road
Project Boundary
Proposed Embankment
Upazila H/Q
Union H/Q
Drainage Regulator
Pipe Sluice
River / Khal
Water body
Inundated area
(DWL = 4.5 m+PWD)
Index Map
Project Area
Bay of Bengal


Legend
District Boundary
Upazila Boundary
Union Boundary
Feeder Road - Type A
Feeder Road - Type B
Rural Road (R1)
Railway
River / Khal
Re-excavation of Canal
Rehabilitaion of Embankment
Boundary of Project
Water
Settlement
Upazila Head Quarter
Regulator
End of full flood
Start of submergible
Dhalai Re-excavation
DWDE01
R1
R2
Mogra River
Motiara Khal
Sakuai Union
Dobaura Union
Pora Kandulia Union
Gaokandia Union
Kakairgara Union
Birisiri Union
Hogla Union
Ghagra Union
Jaria Union
Agia Union
Baola Union
Balia Union
Rupasi Union
Dhakua Union
Banihala Union
Galagaon Union
Kamargaon Union
Bishkakuni Union
Purbadhala Paurashava Union
Purbadhala Union
Dhala Mulgaon Union
N
1 0.5 0 1 Km
BANGLADESH WATER DEVELOPMENT BOARD
Dampara Water Management Project



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

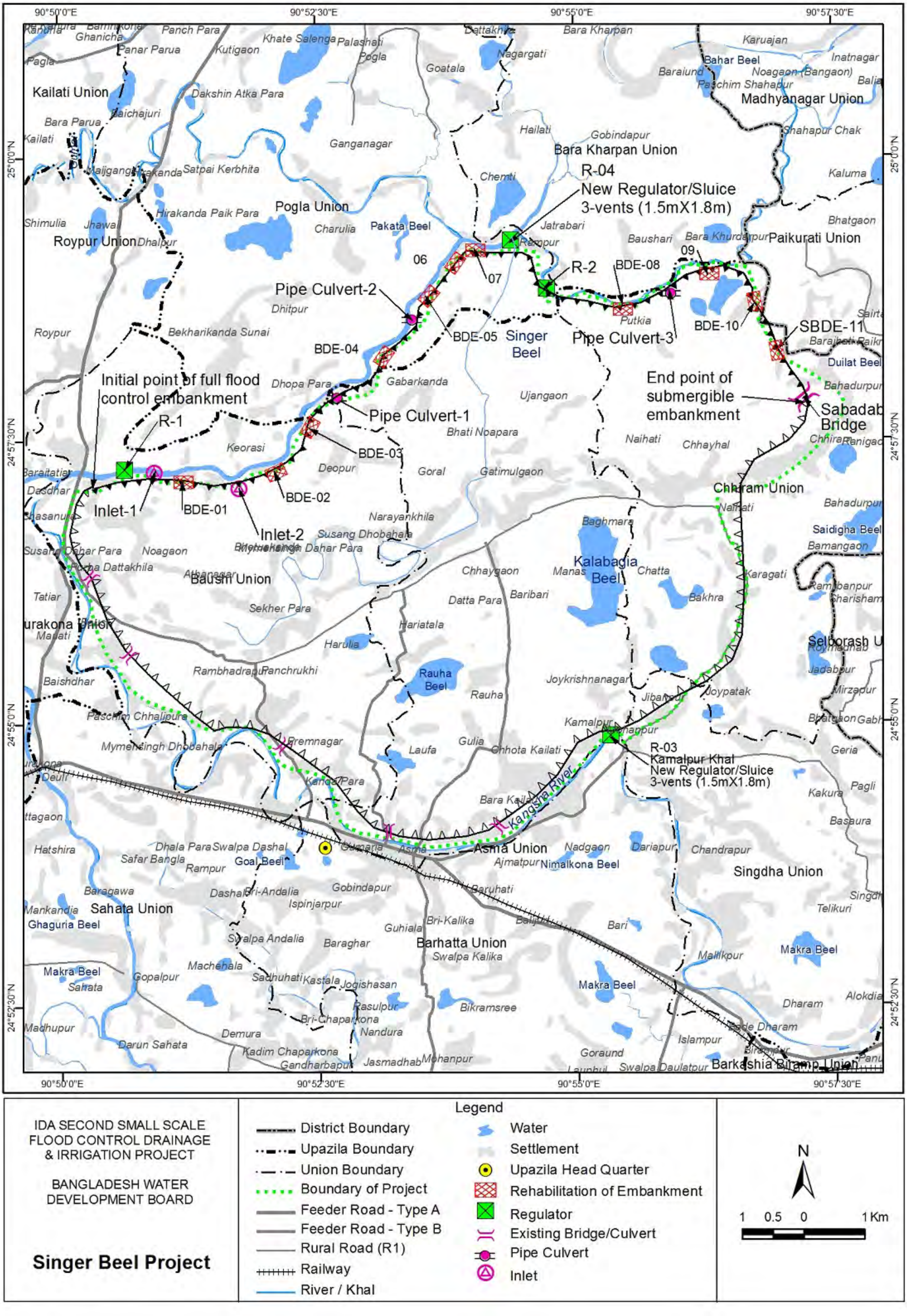
Kangsha River Scheme

Legend

- Upazila Boundary
- Union Boundary
- Boundary of Project
- Regional Road
- Feeder Road - Type A
- Feeder Road - Type B
- Rural Road (R1)
- Railway
- River / Khal
- Water
- Settlement
- Rehabilitation of Embankment
- Regulator
- Pipe Culvert

N

1 0.5 0 1 Km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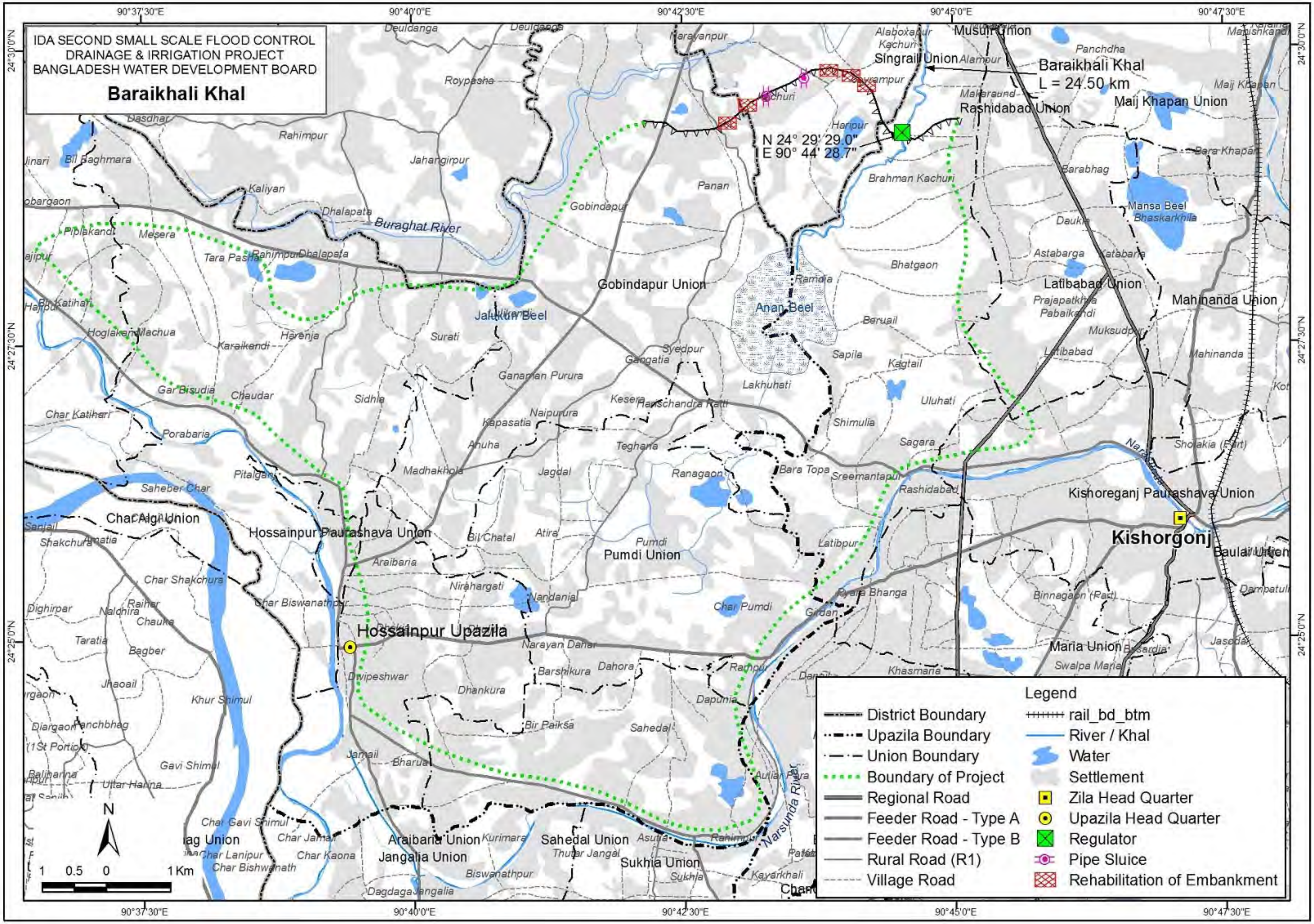
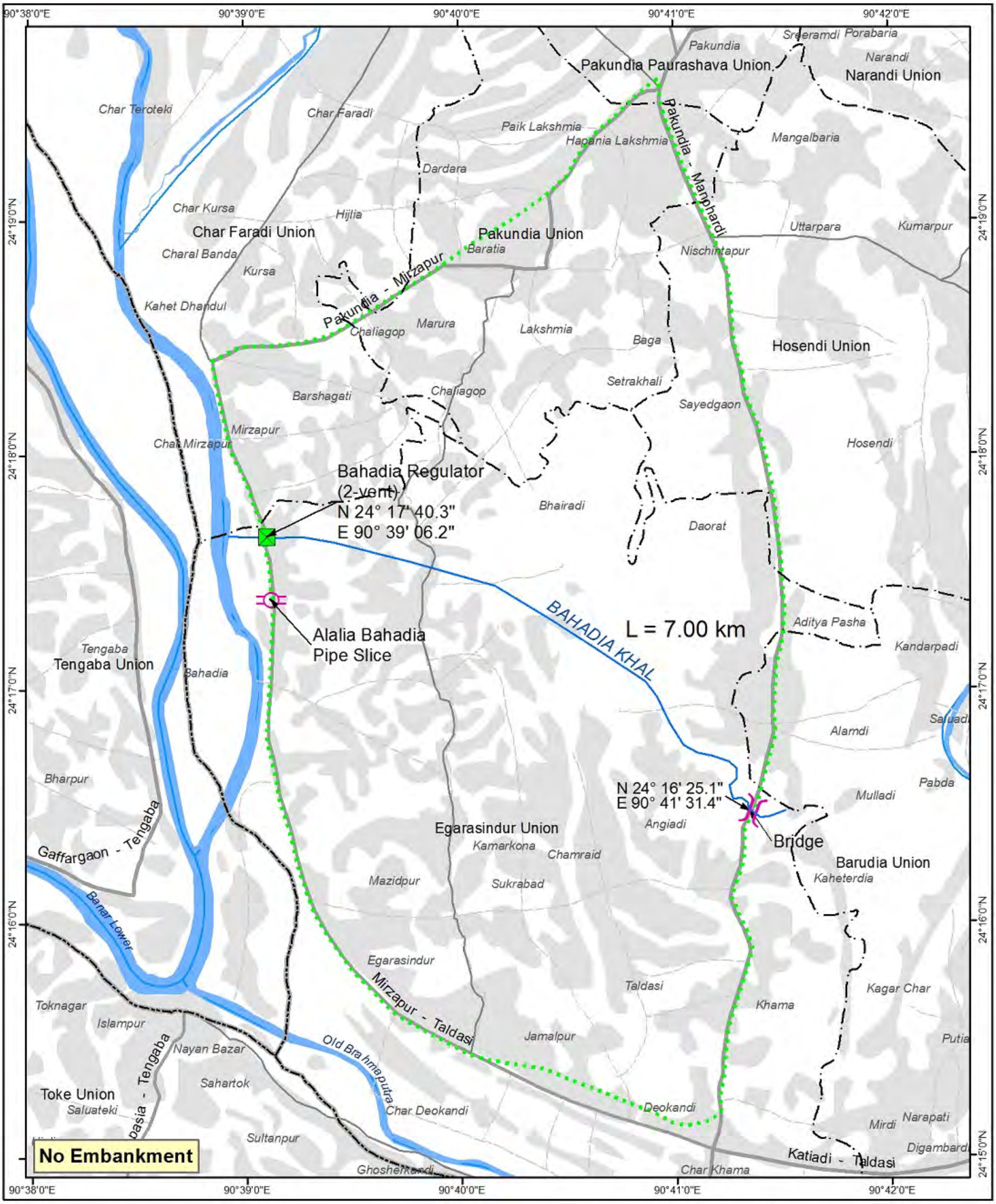
Kailati Union
Pogla Union
Roypur Union
Bara Kharpan Union
Madhyanagar Union
Paikurati Union
Baushi Union
Chhiram Union
Sahata Union
Barhatta Union
Asma Union
Singdha Union
Selborash Union
R-04
New Regulator/Sluice
3-vents (1.5mX1.8m)
R-2
R-1
R-03
Kamalpur Khal
New Regulator/Sluice
3-vents (1.5mX1.8m)
Pipe Culvert-1
Pipe Culvert-2
Pipe Culvert-3
Inlet-1
Inlet-2
BDE-01
BDE-02
BDE-03
BDE-04
BDE-05
06
07
BDE-08
09
BDE-10
SBDE-11
Initial point of full flood
control embankment
End point of
submergible
embankment
Sabadab
Bridge
Singer
Beel
Kalabagia
Beel
Rauha
Beel
Pakata Beel
Bahar Beel
Duilat Beel
Saidigha Beel
Goal Beel
Nimalkona Beel
Ghaguria Beel
Makra Beel
Kangsha River
Legend
District Boundary
Upazila Boundary
Union Boundary
Boundary of Project
Feeder Road - Type A
Feeder Road - Type B
Rural Road (R1)
Railway
River / Khal
Water
Settlement
Upazila Head Quarter
Rehabilitation of Embankment
Regulator
Existing Bridge/Culvert
Pipe Culvert
Inlet
N
1 0.5 0 1 Km
IDA SECOND SMALL SCALE
FLOOD CONTROL DRAINAGE
& IRRIGATION PROJECT
BANGLADESH WATER
DEVELOPMENT BOARD
Singer Beel Project



IDA SECOND SMALL SCALE FLOOD CONTROL
DRAINAGE & IRRIGATION PROJECT
BANGLADESH WATER DEVELOPMENT BOARD
Baraikhali Khal
Baraikhali Khal
L = 24.50 km
N 24° 29' 29.0"
E 90° 44' 28.7"
Gobindapur Union
Pumdi Union
Hossainpur Upazila
Hossainpur Paurashava Union
Char Algi Union
Kishorgonj
Kishoreganj Paurashava Union
Latibabad Union
Mahinanda Union
Maij Khapan Union
Rashidabad Union
Singrail Union
Maria Union
Sahedal Union
Sukhia Union
Araibaria Union
Jangalia Union
Anan Beel
Jalkuri Beel
Mansa Beel
Buraghat River
Narsunda River
Legend
District Boundary
Upazila Boundary
Union Boundary
Boundary of Project
Regional Road
Feeder Road - Type A
Feeder Road - Type B
Rural Road (R1)
Village Road
rail_bd_btm
River / Khal
Water
Settlement
Zila Head Quarter
Upazila Head Quarter
Regulator
Pipe Sluice
Rehabilitation of Embankment
1 0.5 0 1 Km
N



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

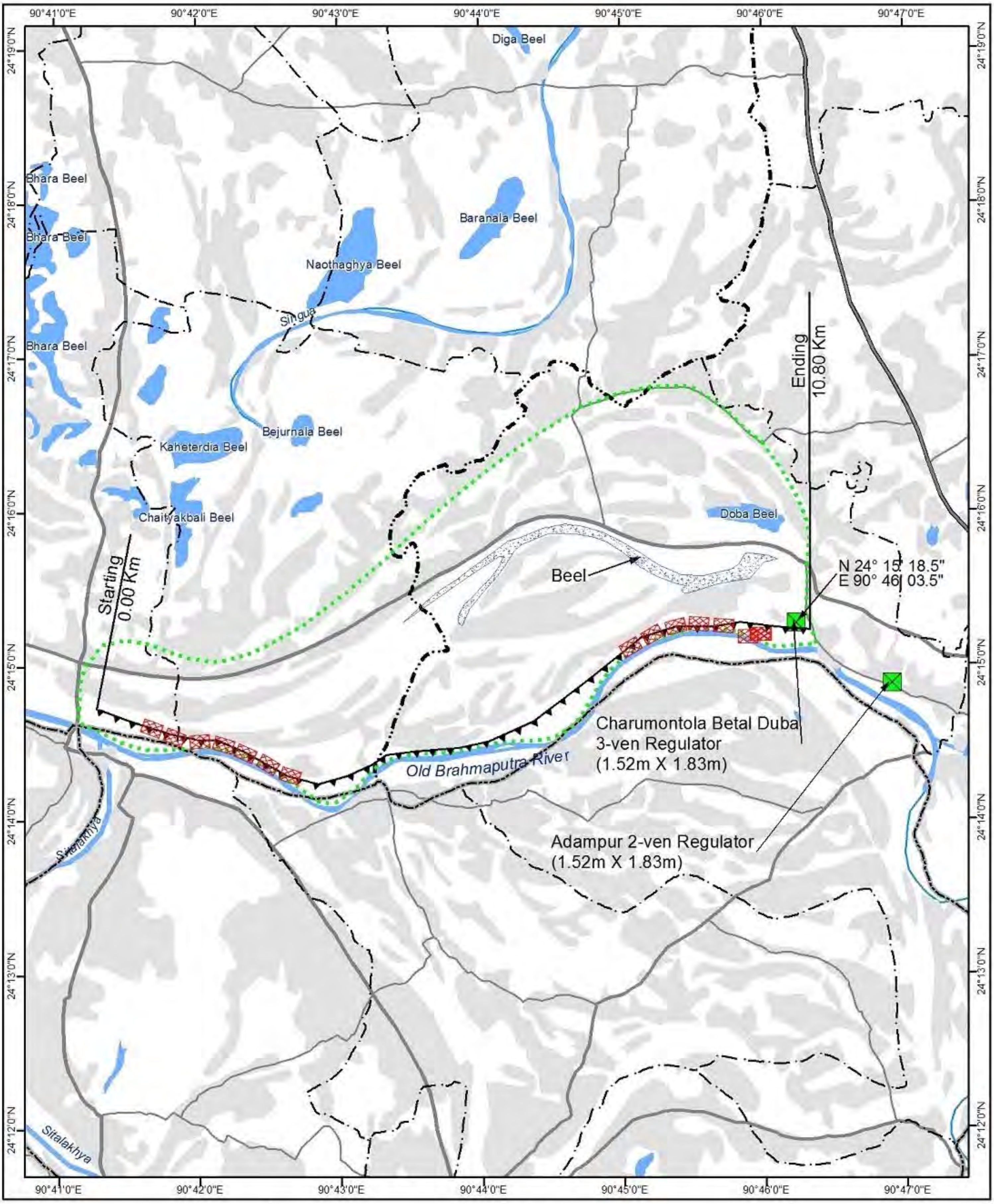
Aladia Bahadia Sub-Project

Legend

- District Boundary
- Union Boundary
- Boundary of Project
- Regional Road
- Feeder Road - Type A
- Feeder Road - Type B
- Rural Road (R1)
- Khal / canal
- River
- Settlement
- Regulator
- Bridge
- Pipe Sluice

N

0.5 0.25 0 0.5 Km



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

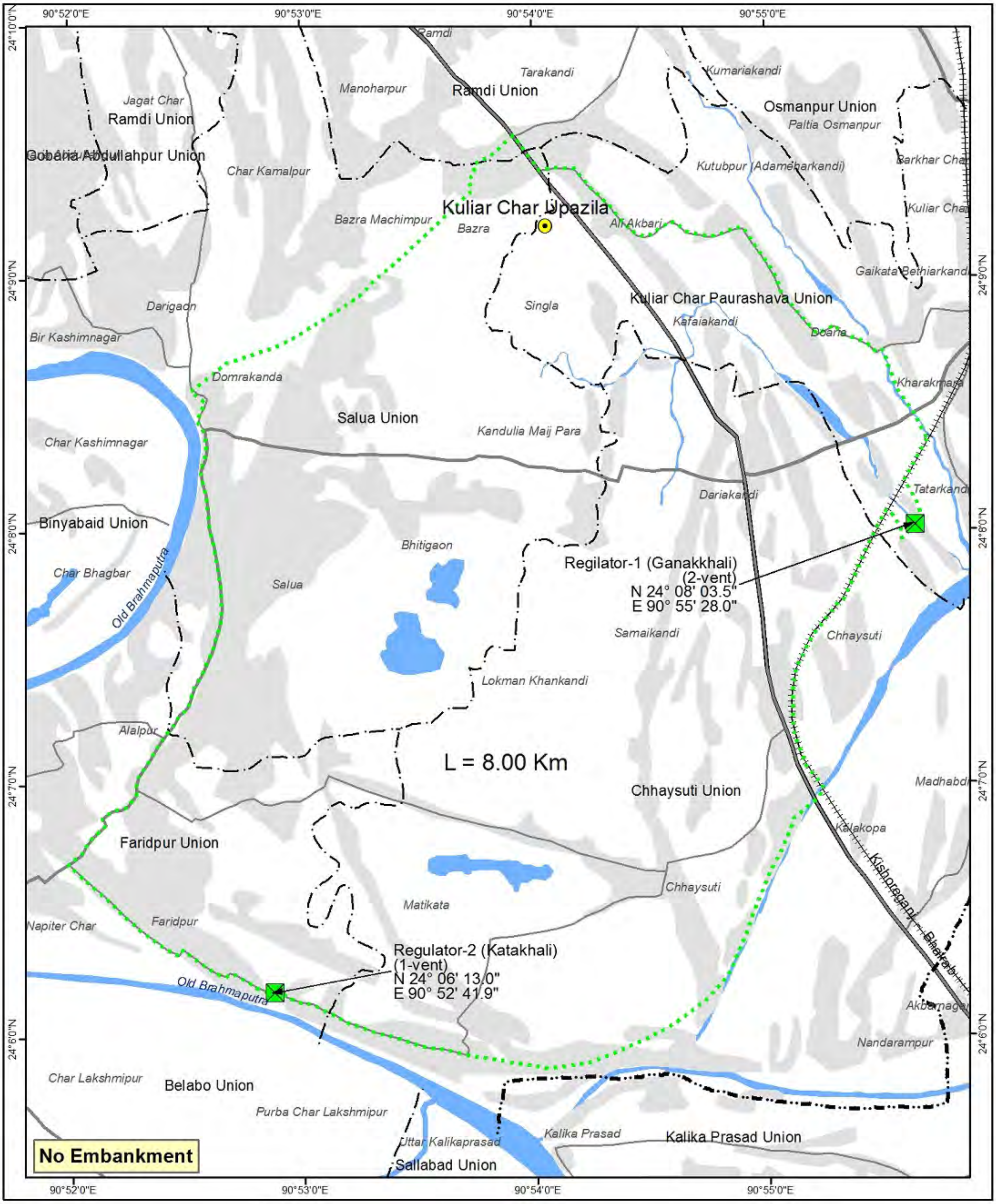
Modkhola Bhairagirchar Scheme

Legend

- District Boundary
- Upazila Boundary
- Union Boundary
- Boundary of Project
- Regional Road
- Feeder Road - Type A
- Feeder Road - Type B
- Rural Road (R1)
- River / Khal
- Water
- Settlement
- Upazila Head Quarter
- Regulator
- Rehabilitaion of Embankment

N

0.5 0.25 0 0.5 1 Km



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

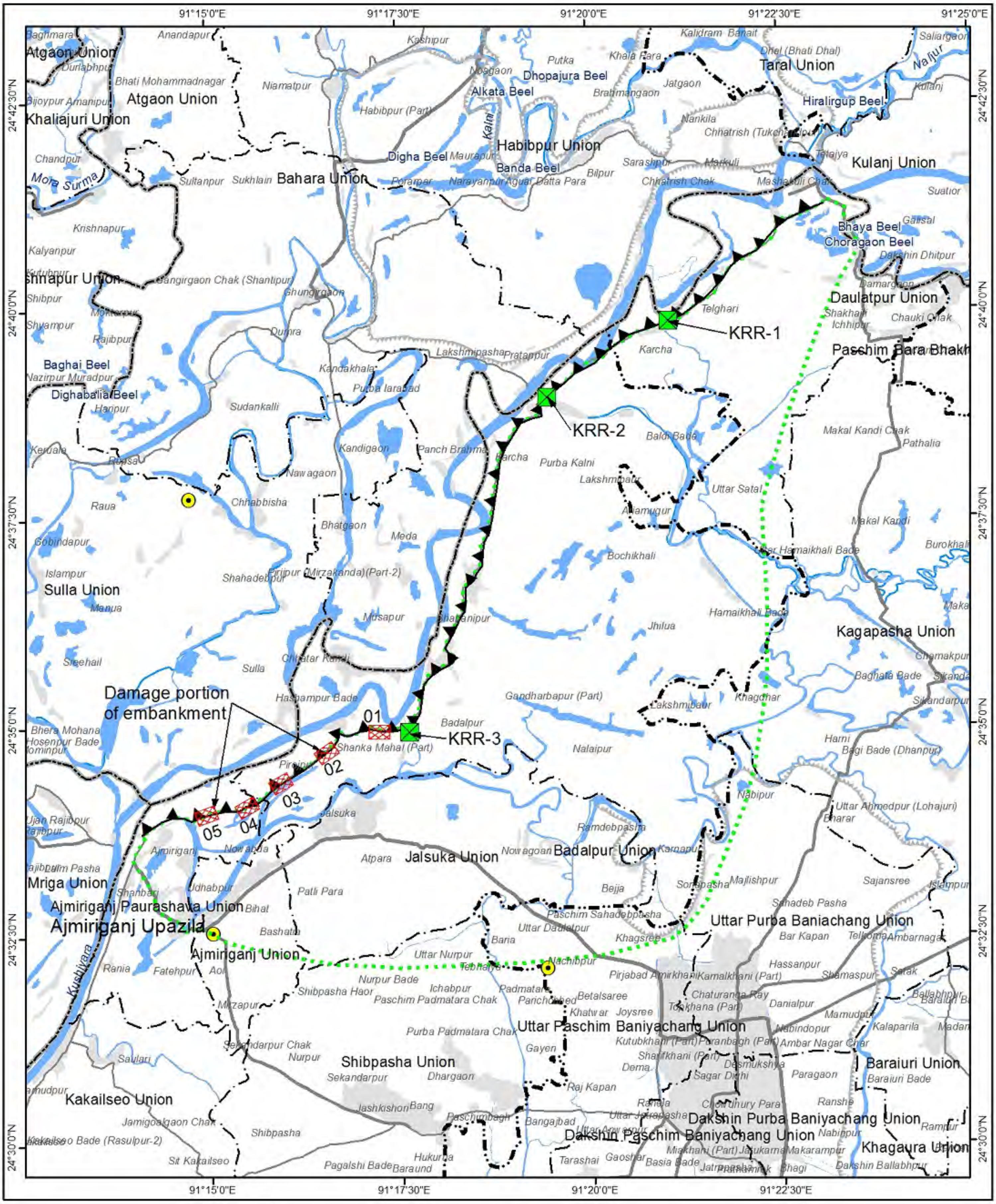
Ganakkhali Sub-Project

Legend

- Upazila Boundary
- Union Boundary
- Boundary of Project
- Regional Road
- Feeder Road - Type A
- Feeder Road - Type B
- Rural Road (R1)
- Railway
- River / Khal
- Water
- Settlement
- Upazila Head Quarter
- Regulator

N

500 250 0 500 m



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

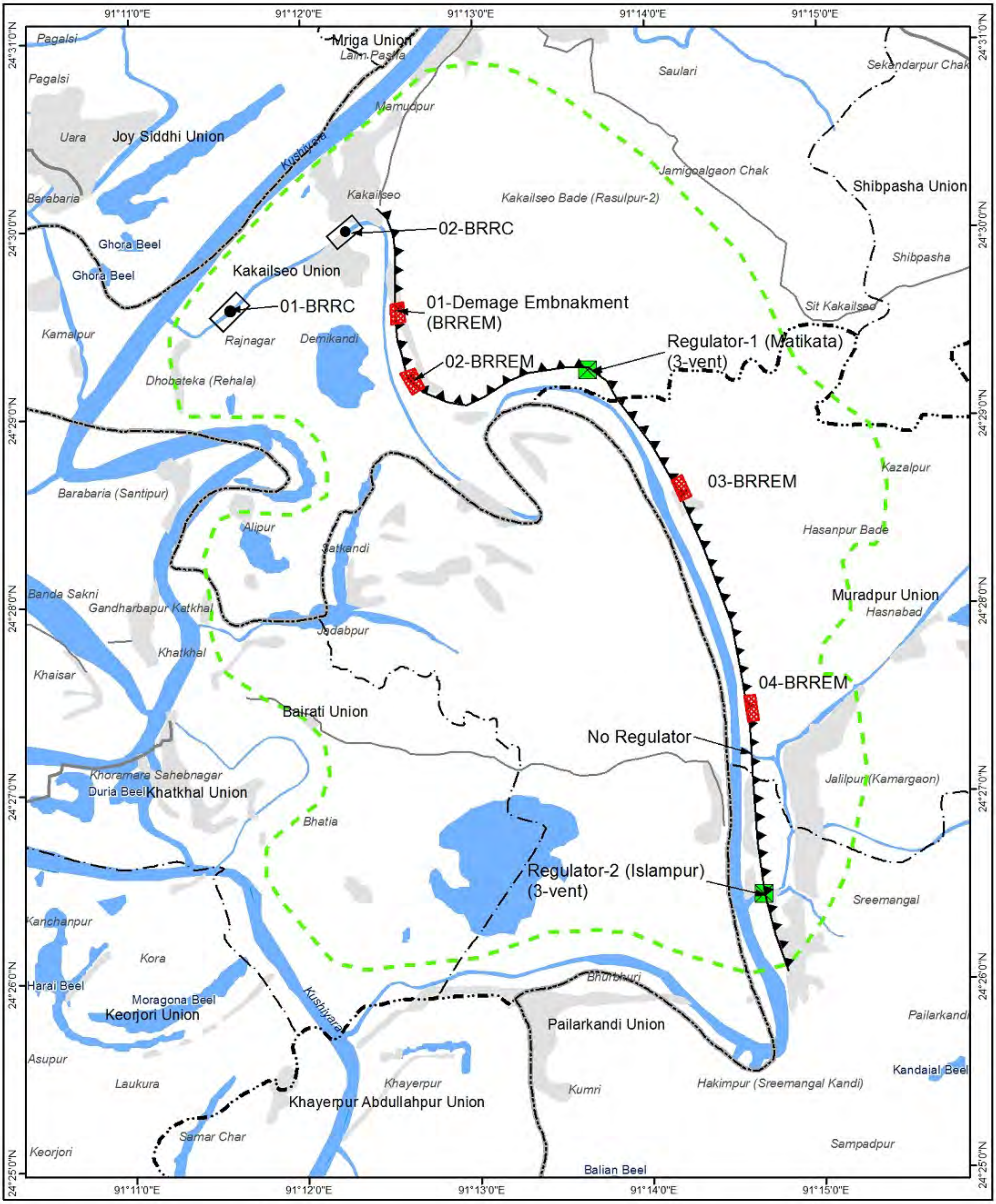
Kairdhala-Ratna Scheme

Legend

- District Boundary
- Upazila Boundary
- Union Boundary
- Boundary of Project
- Feeder Road - Type A
- Feeder Road - Type B
- Rural Road (R1)
- Railway
- Embankment
- River / Khal
- Water
- Settlement
- Upazila Head Quarter
- Regulator
- Rehabilitation of Embankment

N

1 0.5 0 1 2 Km



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

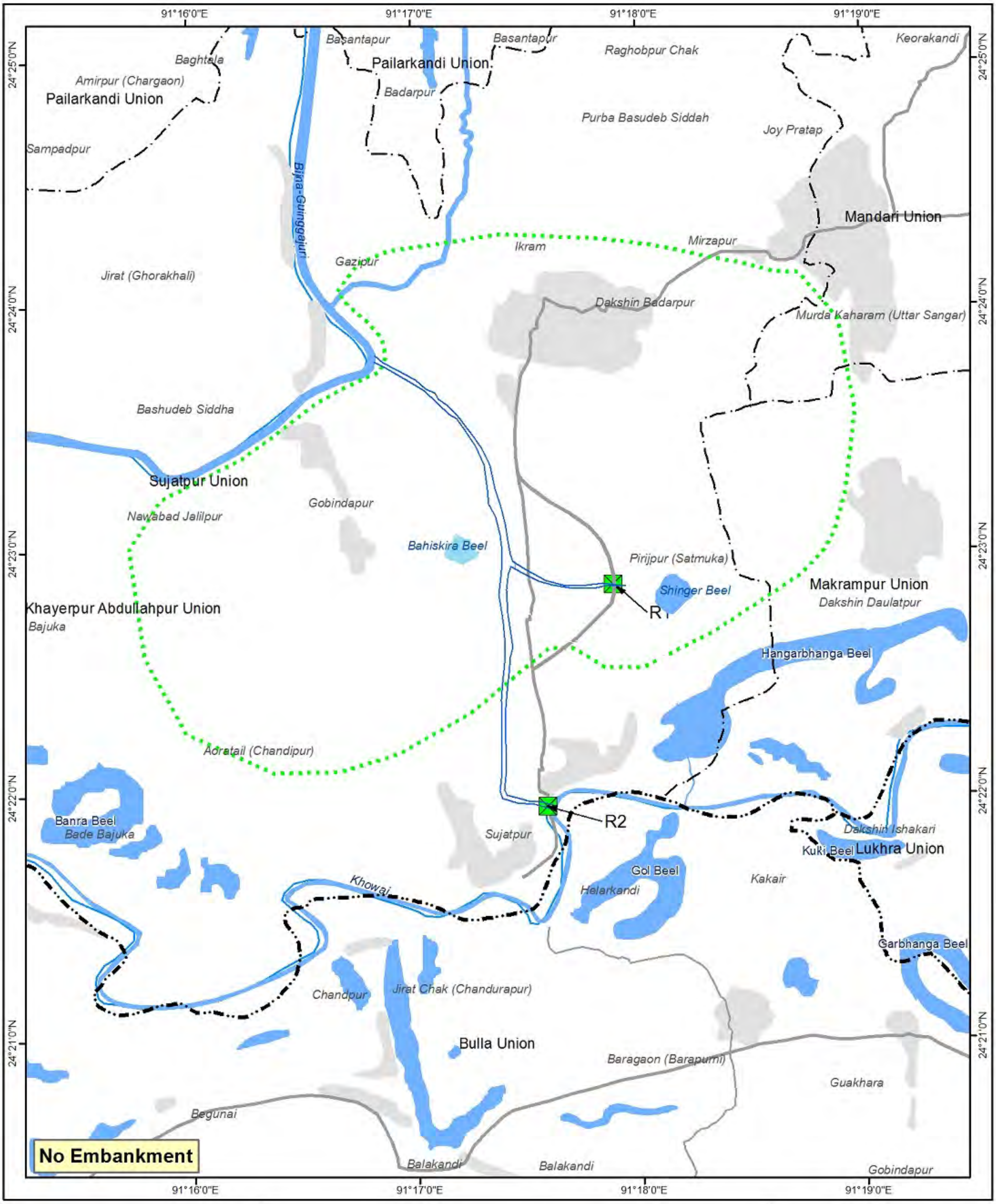
Bashira River Re-excavation

Legend

- District Boundary
- Upazila Boundary
- Union Boundary
- Boundary of Project
- Feeder Road - Type B
- Rural Road (R1)
- Embankment
- River / Khal
- Water
- Settlement
- <all other values>
- Regulator
- Rehabilitation of Embankment

N

500 250 0 500 m



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

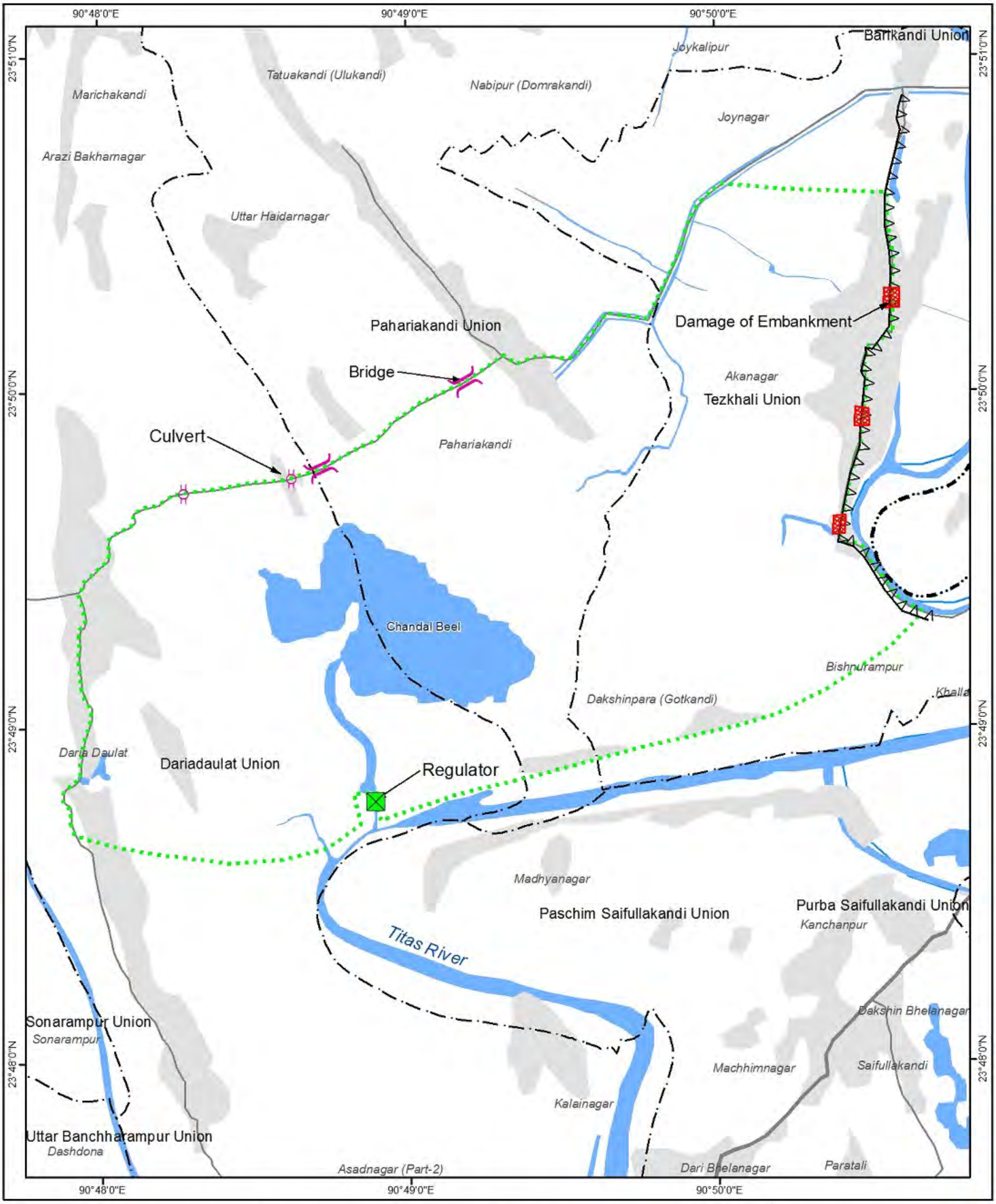
Aralia Khal Scheme

Legend

- Upazila Boundary
- Union Boundary
- Boundary of Project
- Feeder Road - Type A
- Feeder Road - Type B
- Rural Road (R1)
- River / Khal
- Water
- Settlement
- Regulator

N

500 250 0 500 m



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

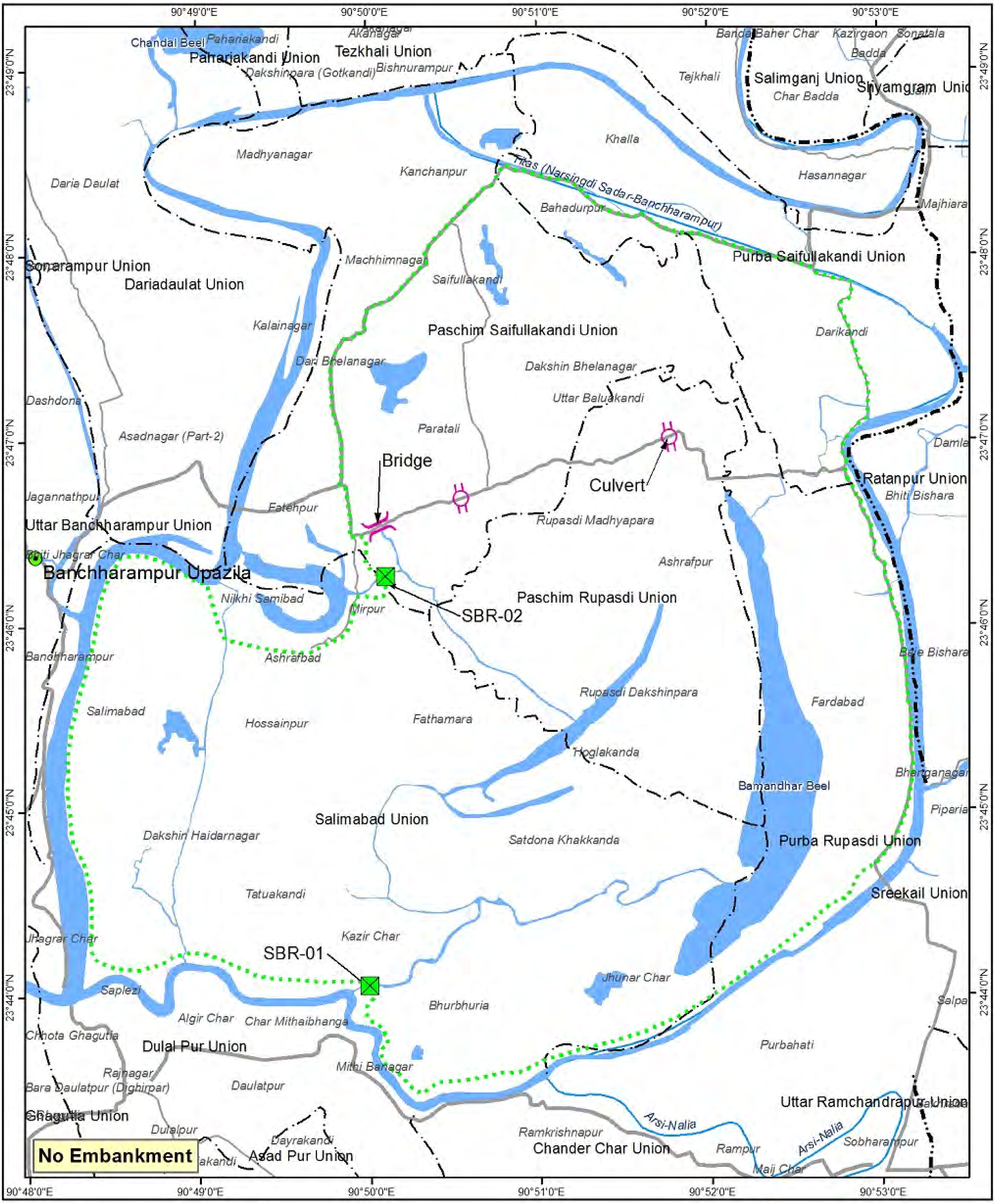
Chandal Beel Scheme

Legend

- Upazila Boundary
- Union Boundary
- Boundary of Project
- Feeder Road - Type A
- Feeder Road - Type B
- Rural Road (R1)
- River / Khal
- Water
- Settlement
- Rehabilitation of Embankment
- Regulator
- Bridge
- Culvert

N

400 200 0 400 m



IDA SECOND SMALL SCALE
FLOOD CONTROL DRAINAGE
& IRRIGATION PROJECT

BANGLADESH WATER
DEVELOPMENT BOARD

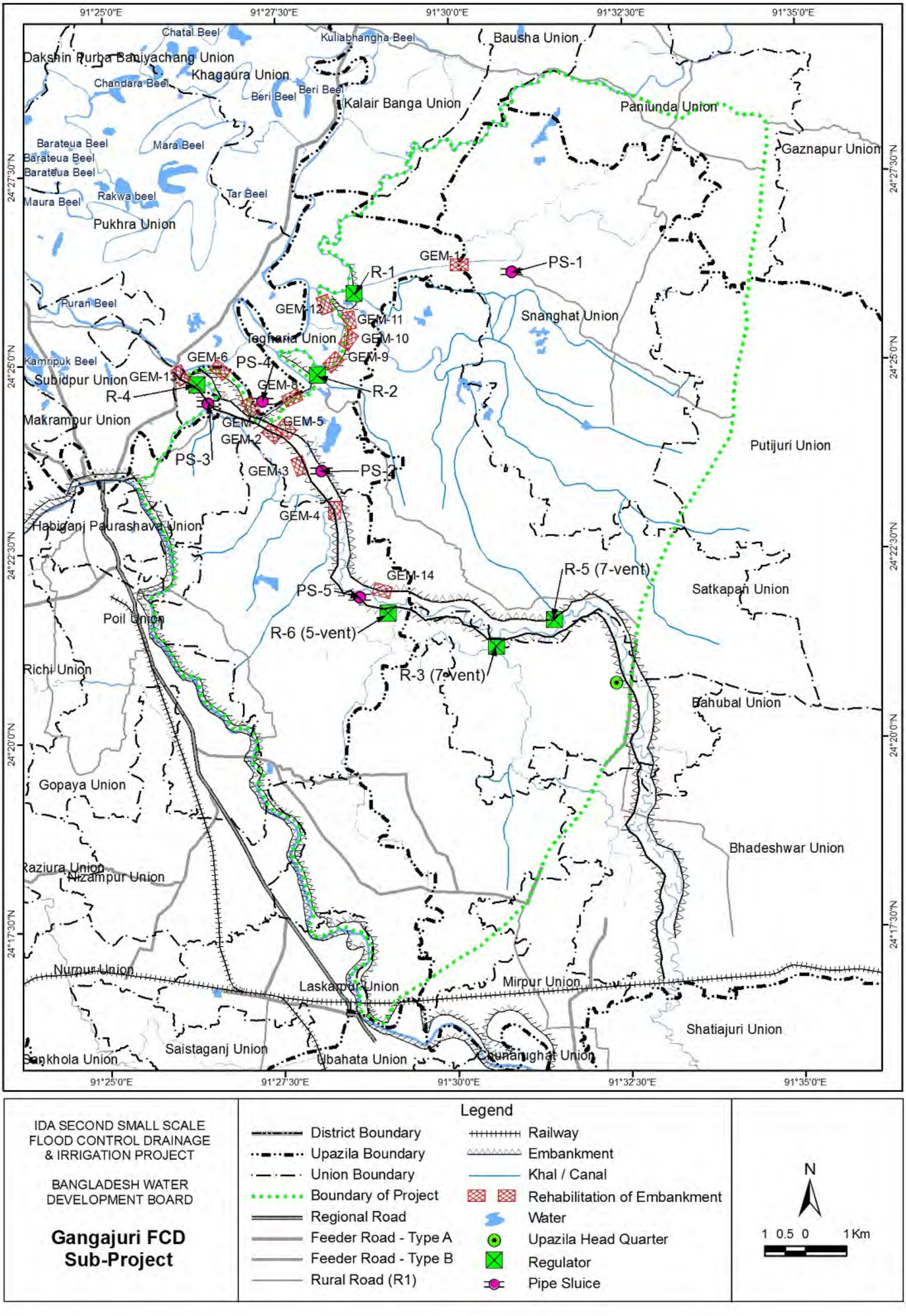
Satdona Beel Scheme

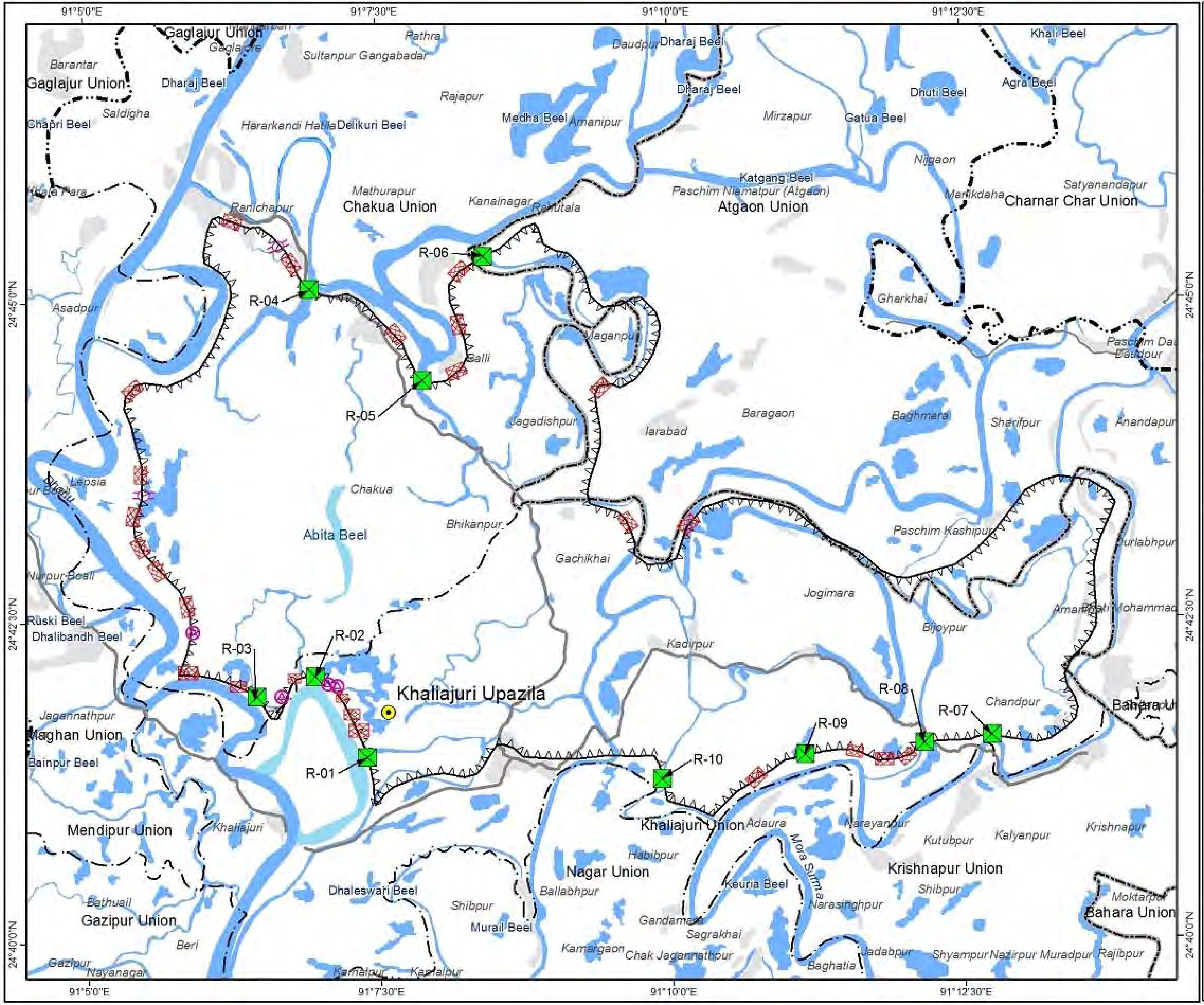
Legend

- Upazila Boundary
- Union Boundary
- Boundary of Project
- Feeder Road - Type A
- Feeder Road - Type B
- Rural Road (R1)
- River / Khal
- Water
- Settlement
- Upazila Head Quarter
- Regulator
- Bridge
- Culvert

N

500 250 0 500 m


91°25'0"E
91°27'30"E
91°30'0"E
91°32'30"E
91°35'0"E
24°27'30"N
24°25'0"N
24°22'30"N
24°20'0"N
24°17'30"N
Chatal Beel
Kuliabhangha Beel
Bausha Union
Dakshin Purba Baniyachang Union
Khagaura Union
Chandara Beel
Beri Beel
Beri Beel
Kalair Banga Union
Paniunda Union
Barateua Beel
Barateua Beel
Barateua Beel
Mara Beel
Gaznapur Union
Maura Beel
Rakwa beel
Tar Beel
Pukhra Union
GEM-1
PS-1
R-1
Puran Beel
GEM-12
GEM-11
Snanghat Union
Tegharia Union
GEM-10
GEM-9
Kamripuk Beel
GEM-6
PS-4
Subidpur Union
GEM-13
GEM-8
R-2
R-4
Makrampur Union
GEM-7
GEM-5
GEM-2
PS-3
GEM-3
PS-2
Putijuri Union
GEM-4
Habiganj Paurashava Union
GEM-14
R-5 (7-vent)
PS-5
Satkapan Union
Poil Union
R-6 (5-vent)
R-3 (7-vent)
Richi Union
Bahubal Union
Gopaya Union
Bhadeshwar Union
Raziura Union
Nizampur Union
Nurpur Union
Laskarpur Union
Mirpur Union
Shatiajuri Union
Saistaganj Union
Sankhola Union
Ubahata Union
Chunarughat Union
IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT
BANGLADESH WATER DEVELOPMENT BOARD
Gangajuri FCD Sub-Project
Legend
District Boundary
Upazila Boundary
Union Boundary
Boundary of Project
Regional Road
Feeder Road - Type A
Feeder Road - Type B
Rural Road (R1)
Railway
Embankment
Khal / Canal
Rehabilitation of Embankment
Water
Upazila Head Quarter
Regulator
Pipe Sluice
N
1 0.5 0 1 Km



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

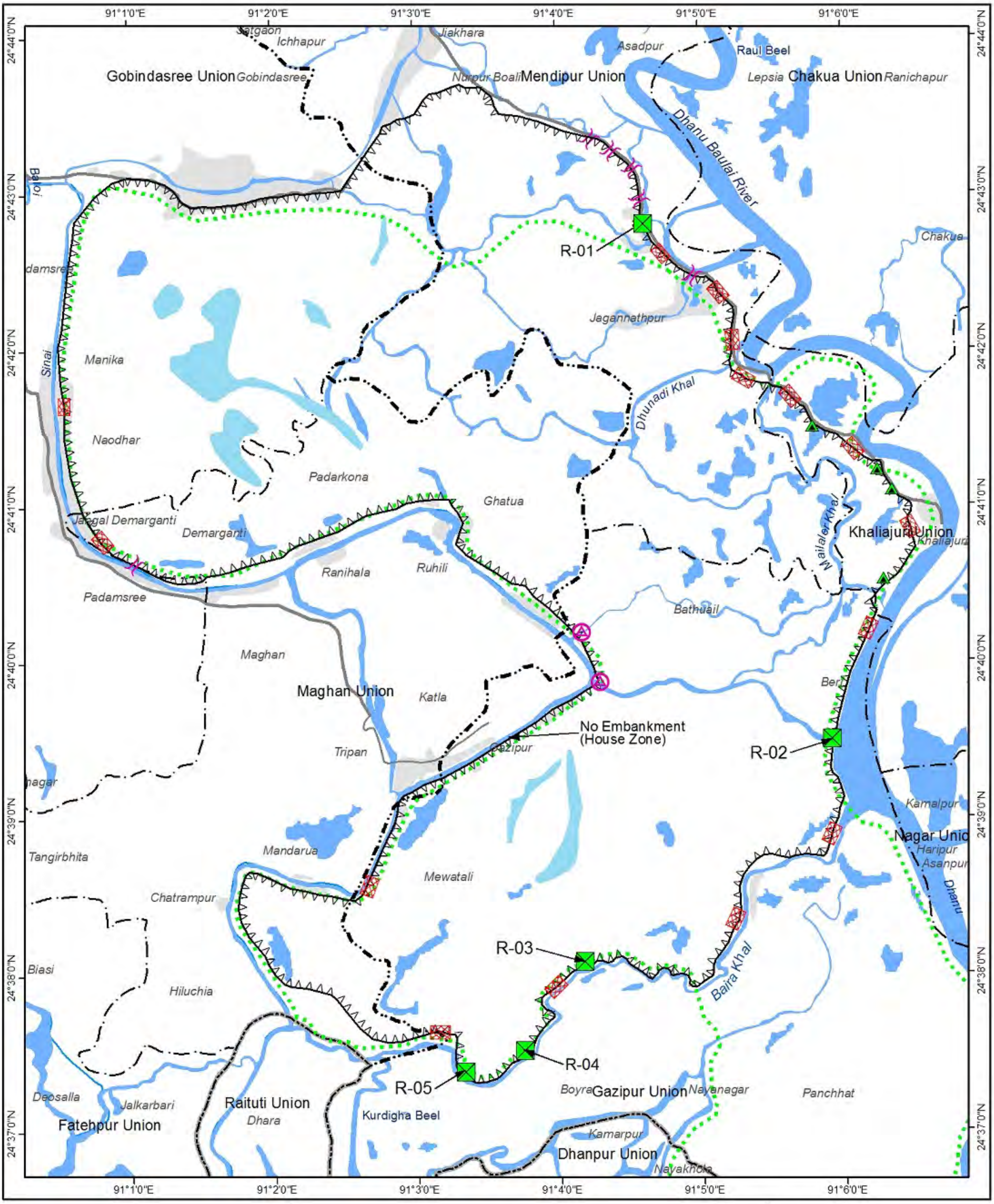
Khaliajuri FCD Project (Polder No. 2)

Legend

- District Boundary
- Upazila Boundary
- Union Boundary
- Boundary of Project
- Feeder Road - Type B
- Rural Road (R1)
- River / Khal
- Water
- Settlement
- Upazila Head Quarter
- Regulator
- Inlet
- Culvert
- Rehabilitation of Embankment

N

1 0.5 0 1 Km



IDA SECOND SMALL SCALE FLOOD CONTROL DRAINAGE & IRRIGATION PROJECT

BANGLADESH WATER DEVELOPMENT BOARD

Khaliajuri FCD Project (Polder-4)

Legend

- District Boundary
- Upazila Boundary
- Union Boundary
- Boundary of Project
- Feeder Road - Type B
- Rural Road (R1)
- River / Khal
- Water
- Settlement
- Upazila Head Quarter
- Regulator
- Inlet
- Causeway
- Culvert
- Rehabilitation of Embankment

N

1 0.5 0 1 Km

Annex-7.3

Calculation of Damage Rate of Rice

The estimation method of damaged rate of rice was followed from the Preparatory Survey on Upper Meghna River Basin Watershed Management Improvement Project. The detailed information of the estimation method was explained at “Appendix 13.14 Calculation of Damage Ratio of Rice” in the draft final report of Preparatory Survey on Upper Meghna River Basin Watershed Management Improvement Project as shown below:

Appendix 13.14 Calculation of Damage Ration of Rice
Damage rate was calculated from the estimated rice production influenced by probable floods which was calculated in the feasibility study report of the Kalni-Kushiyara River Management Project (KKRPMP, 1998). The same flooded rice production was applied in this survey, since the study area of the KKRMP had been also extended in the haor area. The F/S of KKRMP determined the yield of rice in the damage free land (inundation depth > 0.3 m) and flood damaged land (inundation depth > 0.3 m), referring to past surveys such as NERP Farm Household Survey (1996), NERP Land Use Survey (1995 – 1996), K-K Farm Monitoring Survey (1995 – 1996), Kalni-Kushiyara Pre-F/S (1994), National Minor Development Project (1994) and information of Bangladesh Bureau of Statistics published in 1991 and 1993. The rice production was calculated from these yields of rice and inundation areas for the floods of 2, 5 and 10-year probabilities as shown in the table below.

Damage Rate for 2-year flood

Crop		Flood Year (2-year) Cultivated area (ha)	Yield (ton/ha)	Production (ton)		No Flood Year Cultivated area (ha)	Yield (ton/ha)	Production (ton)
HYV Boro	Damage Free	169,239	4.69	793,731		193,752	4.69	908,697
	Damaged	24,513	2.9	71,088				
Local Boro	Damage Free	25,710	3.11	79,958		43,010	3.11	133,761
	Damaged	17,300	1.6	27,680				
B. Aus	Damage Free	7,384	1.1	8,122		7,446	1.10	8,191
	Damaged	62	1.04	64				
DW Aman	Damage Free	21,245	1.93	41,003		25,297	1.93	48,823
	Damaged	4,052	1.5	6,078				
Loc T. Aman	Damage Free	36	2.15	77		36	2.15	77
	Damaged	0	1.75	0				
HYV T. Aman	Damage Free	7,430	3.2	23,776		7,518	3.20	24,058
	Damaged	88	2.24	197				
Total Production				**1,051,774**				**1,123,607**

Loss due to Flood	1,123,607	-	1,051,774	=	71,833 ton
Damage Rate	71,833	/	1,051,774.0	=	**6.4 %**

Damage Rate for 5-year flood

Crop		Flood Year (5-year) Cultivated area (ha)	Yield (ton/ha)	Production (ton)		No Flood Year Cultivated area (ha)	Yield (ton/ha)	Production (ton)
HYV Boro	Damage Free	61,411	4.69	288,018		193,752	4.69	908,697
	Damaged	132,341	2.9	387,759				
Local Boro	Damage Free	9,329	3.11	29,013		43,010	3.11	133,761
	Damaged	33,681	1.6	53,890				
B. Aus	Damage Free	2,679	1.1	2,947		7,446	1.10	8,191
	Damaged	4,767	1.04	4,958				
DW Aman	Damage Free	7,709	1.93	14,878		25,297	1.93	48,823
	Damaged	17,588	1.5	26,382				
Loc T. Aman	Damage Free	13	2.15	28		36	2.15	77
	Damaged	23	1.75	40				
HYV T. Aman	Damage Free	2,696	3.2	8,627		7,518	3.20	24,058
	Damaged	4,822	2.24	10,801				
Total Production				**827,341**				**1,123,607**

Loss due to Flood	1,123,607	-	827,341	=	296,266 ton
Damage Rate	296,266	/	827,341.0	=	**26.4 %**

Damage Rate for 10-year flood

Crop		Flood Year (10-year) Cultivated area (ha)	Yield (ton/ha)	Production (ton)		No Flood Year Cultivated area (ha)	Yield (ton/ha)	Production (ton)
HYV Boro	Damage Free	9,217	4.69	43,228		193,752	4.69	908,697
	Damaged	184,535	2.9	540,688				
Local Boro	Damage Free	1,400	3.11	4,354		43,010	3.11	133,761
	Damaged	41,610	1.6	66,576				
B. Aus	Damage Free	402	1.1	442		7,446	1.10	8,191
	Damaged	7,044	1.04	7,326				
DW Aman	Damage Free	1,157	1.93	2,233		25,297	1.93	48,823
	Damaged	24,140	1.5	36,210				
Loc T. Aman	Damage Free	2	2.15	4		36	2.15	77
	Damaged	34	1.75	60				
HYV T. Aman	Damage Free	405	3.2	1,296		7,518	3.20	24,058
	Damaged	7,113	2.24	15,933				
Total Production				**718,350**				**1,123,607**

Loss due to Flood	1,123,607	-	718,350	=	405,257 ton
Damage Rate	405,257	/	718,350.0	=	**36.1 %**

Annex-8.1

Cost Estimation

Preliminary Cost Summery

Poject				Submergible Embankment				re-excavation		Direct Cost (mil. BDT)					
Name	DWL (m +PWD)	Crest Level (m +PWD)	Area (ha)	Length (km)	Ave. height (m)	Volume (m3)	Land acquisition (m2)	Length (km)	Amount (mil. BDT)	Embankement	Regulator	Re-excavation	**Total**	Land acquis.	**Total incl. land aquis.**
Badla	4.9m	5.2m	1504	10.8	0.9	61,000	104,760	2.0	3.5	32.3	33	3.5	**68.8**	63.0	**131.8**
Dharmapasha	6.1m	6.4m	21563	57.1	1.5	780,500	759,430	5.0	8.8	412.9	210.5	8.8	**632.2**	456.0	**1,088.2**
Charigram	4.6m	4.9m	3634	25.7	1.1	213,524	280,130	3.0	5.3	113.0	35.5	5.3	**153.8**	168.0	**321.8**
Bara	6.0m	6.3m	2468	27	2.7	1,001,200	553,500	40.0	70.0	529.6	38	70.0	**637.6**	332.0	**969.6**
Ayner Gupi	4.0m	4.3m	809	13.7	2.1	305,500	231,530	0.0	0.0	161.6	19	0.0	**180.6**	139.0	**319.6**
Bara (Austagram)	4.5m	4.8m	11013	60.3	1.3	658,643	729,630	40.0	70.0	348.4	141.5	70.0	**559.9**	438.0	**997.9**
Boro (Nikli)	5.1m	5.4m	9147	9.6	1.7	78,596	139,200	10.0	17.5	41.6	87	17.5	**146.1**	84.0	**230.1**
Chandpur	4.9m	5.2m	2311	2.1	0.6	3,600	16,590	5.0	8.8	1.9	35.5	8.8	**46.2**	10.0	**56.2**
Dulalpur	4.0m	4.3m	355	8.3	2.0	168,900	135,290	3.0	5.3	89.3	16.5	5.3	**111.1**	81.0	**192.1**
Golaimara	3.9m	4.2m	610			0	0	0.0	0.0	0.0	0	0.0	**0.0**	0.0	**0.0**
Joyariya	3.9m	4.2m	1434			0	0	8.0	14.0	0.0	0		**0.0**	0.0	**0.0**
Korati	4.9m	5.2m	2948	40.4	2.1	914,817	682,760	4.0	7.0	483.9	35.5	7.0	**526.4**	410.0	**936.4**
Kuniarbandh	4.0m	4.3m	1327	8.3	2.4	196,600	155,210	0.0	0.0	104.0	14	0.0	**118.0**	93.0	**211.0**
Naogaon	5.0m	5.3m	9104	34.1	0.6	98,755	269,390	20.0	35.0	52.2	121	35.0	**208.2**	162.0	**370.2**
Noapara	4.6m	4.9m	3179	28.3	1.7	458,438	410,350	7.0	12.3	242.5	49.5	12.3	**304.3**	246.0	**550.3**
Nunnir	4.4m	4.7m	5809	25.5	1.0	172,196	262,650	20.0	35.0	91.1	57	35.0	**183.1**	158.0	**341.1**
Sarishapur	4.3m	4.6m	1161	7.1	1.1	55,264	77,390	5.0	8.8	29.2	14	8.8	**52.0**	46.0	**98.0**
Bansharir	5.8m	6.1m	1172	18	1.1	163,000	196,200	0.0	0.0	86.2	28	0.0	**114.2**	118.0	**232.2**
Chatal	5.4m	5.7m	816	5.7	1.0	47,200	58,710	11.0	19.3	25.0	28	19.3	**72.3**	35.0	**107.3**
Dakshiner	4.8m	5.1m	2482	18.3	1.1	185,000	199,470	10.0	17.5	97.9	45.5	17.5	**160.9**	120.0	**280.9**
Dhakua	6.0m	6.3m	6143	36.5	1.4	409,100	463,550	30.0	52.5	216.4	57	52.5	**325.9**	278.0	**603.9**
Ganesh	6.1m	6.4m	3090	22.5	1.1	219,600	245,250	3.0	5.3	116.2	35.5	5.3	**157.0**	147.0	**304.0**
Jaliar	7.3m	7.6m	2466	6.8	0.6	23,400	53,720	8.0	14.8	12.4	33	14.8	**60.2**	32.0	**92.2**
Mokhar	5.2 to 5.9m	5.5 to 6.2m	12341	68.8	1.7	960,100	997,600	110.0	192.5	507.9	105	192.5	**805.4**	599.0	**1,404.4**
Shelnir	5.2m	5.5m	3030	30.1	1.0	162,200	310,030	2.0	3.5	85.8	42	3.5	**131.3**	186.0	**317.3**
Sunair	5.7m	6.0m	3894	16.2	0.3	10,800	98,820	25.0	43.8	5.7	35.5	43.8	**85.0**	59.0	**144.0**
Total										3,887	1,317	637	**5,841**	4,460	**10,301**

1) unit price of embankment: 529BDT/m3 (see estimation table of unit price)
2) cost of regulator (see cost estimation of regulator)
3) cost of re-excavation (see Haor M/P)
4) unit price of land acquisition is 600 BDT/m2 (see preparatory survey disaster prevention program)

Preliminary Cost Estimation of Embankment and Regulator

- Submergible Embankament Unit Price per cum

Supposing 1.2m height (1:3 slope for both side), crest width 4.3m

Item	Unit	Quantity	Unit Price	Amount
Land acquisition	sqm	11.5		0.0
Earth work (300m to 1km)	cum	9.48	263.92	2,502.0
Transportation (1km to 5km) for 50% ave	cum	4.74	30.15	142.9
Base stripping (t=15cm)	cum	1.73	107.96	186.8
Compaction 90%	cum	9.48	35.48	336.4
Compaction 90% => 95%	cum	9.48	20	189.6
Slopeprotection (turfing)	sqm	7.59	20.46	155.3
Turfing pavement	sqm	3.5	20.46	71.6
others (toe protection, geo-textile etc)	sqm	15.8		716.9
Total volume	cum			9.5
Total amount	BDT			4,301.4
Preparatory work (0%)				0.0
Unit price per volume	BDT/cum			454.0

Unit price of land acquisition : 600BDT/sqm

80 %

- Submergible Embankament Unit Price per cum

Supposing 1.2m height (1:3 slope for both side), crest width 4.3m

Item	Unit	Quantity	Unit Price	Amount
Land acquisition	sqm	11.5		0.0
Earth work (300m to 1km)	cum	9.48	263.92	2,502.0
Transportation (1km to 5km) for 50% ave	cum	4.74	30.15	142.9
Base stripping (t=15cm)	cum	1.73	107.96	186.8
Compaction 90%	cum	9.48	35.48	336.4
Compaction 90% => 95%	cum	9.48	20	189.6
Slopeprotection (turfing)	sqm	7.59	20.46	155.3
Compacting brick chipe pavement	cum	0.875	4138.53	3,621.2
others (toe protection, geo-textile etc)	sqm	15.8		702.6
Total volume	cum			9.5
Total amount	BDT			7,836.7
Preparatory work (0%)				0.0
Unit price per volume	BDT/cum			827.0

・Compacting brick chipe
Ref : LGED Schedule of rate/July 2012
Item Code 3.2.03.04 : 4,138.53 BDT/m3
0.875 m3

20 %

- Submergible Embankament Unit Price per cum
(Brick pavement 20% and Turfing pavement 80%) **529**

- Regulator (concrete structure and gate)

Number of vents (gates)	al Price (mil.BDT) A	B
1	10.5	**14.0**
2	14.7	**16.5**
3	16.8	19.0
4	18.9	21.5
5		24.0
6	23.1	26.5
7		29.0
8	27.3	31.5
9		34.0

A: refering DPP (2011 Study), hearing from BWDB Design Circle 1 and Example of Detail Cost Estimation

B: hearing from PD on 2013/10/07 for vent no. of 1 and 2
linear extrapolation for vent no. of more than 3
=> B is applied.

Preliminary Cost Estimation of Regulator

Project	Regulator	Catchment	number of vents	invert level	Price (mil. BDT)	Total Price
1 Badla Project	No.1	763	2	3.5	16.5	
1 Badla Project	No.2	513	2	3.5	16.5	
1 Badla Project	PS	228				33.0
2 Dharmapasha Rui Beel	No.1	6860	17	2	65.5	
2 Dharmapasha Rui Beel	No.2	2404	6	2	26.5	
Dharmapasha Rui Beel	No.3	3184	8	2	31.5	
2 Dharmapasha Rui Beel	No.4	1033	3	2	19.0	
Dharmapasha Rui Beel	No.5	6923	18	2	68.0	210.5
2 Dharmapasha Rui Beel	PS	457				
2 Dharmapasha Rui Beel	PS	702				
3 Charigram Project	No.1	2089	4	3	21.5	
Charigram Project	No.2	708	1	3	14.0	35.5
3 Charigram Project	PS	450				
3 Charigram Project	PS	387				
4 Bara Haor	No.1	1961	5	3	24.0	
4 Bara Haor	No.2	507	1	3	14.0	38.0
5 Ayner Gupi Haor	No.1	809	3	2.5	19.0	19.0
6 Boro Haor(Austagram)	No.1	4167	11	2.5	50.5	
6 Boro Haor(Austagram)	No.2	1291	4	2.5	21.5	
6 Boro Haor(Austagram)	No.3	4028	11	2.5	50.5	
6 Boro Haor(Austagram)	No.4	823	3	2.5	19.0	141.5
6 Boro Haor(Austagram)	PS	358				
6 Boro Haor(Austagram)	PS	347				
7 Boro Haor(Nikli)	No.1	8053	18	3	68.0	
7 Boro Haor(Nikli)	No.2	1096	3	3	19.0	87.0
8 Chandpur Haor	No.1	1573	4	4	21.5	
8 Chandpur Haor	No.2	677	1	4	14.0	35.5
8 Chandpur Haor	PS	61				
9 Dulalpur	No.1	355	2	1.5	16.5	16.5
10 GolaimaraHaor	No.1	610	0			
11 Joyariya Haor	No.1	1434	0			
12 Korati Beel Haor	No.1	726	1	2.75	14.0	
12 Korati Beel Haor	No.2	2061	4	2.75	21.5	35.5
12 Korati Beel Haor	PS	160				
13 Kuniarbandh Haor	No.1	1327	1	3.5	14.0	14.0
14 Naogaon Haor	No.1	2394	9	2	34.0	
14 Naogaon Haor	No.2	4760	17	2	65.5	
14 Naogaon Haor	No.3	1125	4	2	21.5	121.0
14 Naogaon Haor	PS	555				
14 Naogaon Haor	PS	270				
15 Noapara Haor	No.1	783	2	2.75	16.5	
15 Noapara Haor	No.2	586	1	2.75	14.0	
15 Noapara Haor	No.3	1496	3	2.75	19.0	49.5
15 Noapara Haor	PS	314				
16 Nunnir Haor	No.1	2993	5	2.75	24.0	
16 Nunnir Haor	No.2	1460	2	2.75	16.5	
16 Nunnir Haor	No.3	894	2	2.75	16.5	57.0
16 Nunnir Haor	PS	264				
16 Nunnir Haor	PS	199				
17 Sarishapur Haor	No.1	1004	1	3.5	14.0	14.0
17 Sarishapur Haor	PS	157				
18 Bansharir Haor	No.1	333	1	4.5	14.0	
18 Bansharir Haor	No.2	844	1	4.5	14.0	28.0
19 Chatal Haor	No.1	680	1	2.75	14.0	
19 Chatal Haor	No.2	137	1	2.75	14.0	28.0
20 Dakhshiner Haor	No.1	1694	6	2.25	26.5	
20 Dakhshiner Haor	No.2	789	3	2.25	19.0	45.5
21 Dhakua Haor	No.1	3430	5	3.75	24.0	
21 Dhakua Haor	No.2	877	1	3.75	14.0	
21 Dhakua Haor	No.3	1655	3	3.75	19.0	57.0
21 Dhakua Haor	PS	181				
22 Ganesh Haor	No.1	984	2	3.75	16.5	
22 Ganesh Haor	No.2	1944	3	3.75	19.0	35.5
22 Ganesh Haor	PS	162				
23 Jaliar Haor	No.1	914	2	6	16.5	
23 Jaliar Haor	No.2	1297	2	6	16.5	33.0
23 Jaliar Haor	PS	254				
24 Mokhar Haor	No.1	3983	3	3.5	19.0	
24 Mokhar Haor	No.2	3388	3	3.5	19.0	
24 Mokhar Haor	No.3	5473	5	3.5	24.0	
24 Mokhar Haor	No.4	4496	4	3.5	21.5	
24 Mokhar Haor	No.5	4087	4	3.5	21.5	105.0
25 Shelnir Haor	No.1	1972	1	4.75	14.0	
25 Shelnir Haor	No.2	469	1	4.75	14.0	
25 Shelnir Haor	No.3	589	1	4.75	14.0	42.0
26 Sunair Haor	No.1	3197	4	4	21.5	
26 Sunair Haor	No.2	697	1	4	14.0	35.5

Preliminary Cost Estimation of Rehabilitation Project

Projects	Item	Qnt.	Unit	Unit Price	Amount	Note
Dampara	Resection of Embankment (Full)	200	m	16,500	3,300,000	
	Resection of Embankment (Submergible)	460	m	3,600	1,656,000	
	Replacement of Gates	15	nos	99,000	1,485,000	Schedule of rate 76-240-40, 76-260-20
	Re-excavation of Canal	12	km	2,000,000	24,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				30,441,000	
Kangsa River	Resection of Embankment (Full)	40	m	70,600	2,824,000	
	Replacement of Gates	16	nos	99,000	1,584,000	Schedule of rate 76-240-40, 76-260-20
	others	1	LoS		0	0% of above
	Sub-total				4,408,000	
Singer Beel	Resection of Embankment (Full)	100	m	34,300	3,430,000	
	Resection of Embankment (Submergible)	125	m	3,600	450,000	
	Replacement of Gates	1	nos	99,000	99,000	Schedule of rate 76-240-40, 76-260-20
	Re-excavation of Canal	2	km	1,750,000	3,500,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				7,479,000	
Baraikhali Khal	Resection of Embankment (Full)	10	m	41,100	411,000	
	Replacement of Gates	6	nos	99,000	594,000	Schedule of rate 76-240-40, 76-260-20
	Re-excavation of Canal	24.5	km	200,000	4,900,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				5,905,000	
Alaria Bahadia	Replacement of Gates	2	nos	99,000	198,000	Schedule of rate 76-240-40, 76-260-20
	Re-excavation of Canal	8	km	2,000,000	16,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				16,198,000	
Modkhola Bhairagirchar	Resection of Embankment (Full)	500	m	31,000	15,500,000	
	others	1	LoS		0	0% of above
	Sub-total				15,500,000	
Ganakkhali	Replacement of Gates	3	nos	99,000	297,000	Schedule of rate 76-240-40, 76-260-20
	others	1	LoS		0	0% of above
	Sub-total				297,000	
Kairdhala Ratna	Resection of Embankment (Submergible)	60	m	2,900	174,000	
	Replacement of Gates	9	nos	99,000	891,000	Schedule of rate 76-240-40, 76-260-20
	others	1	LoS		0	0% of above
	Sub-total				1,065,000	

Bashira River	Resection of Embankment (Submergible)	6000	m	4,200	25,200,000	
	2-vent Regulator	2	nos	16,500,000	33,000,000	Schedule of rate 76-240-40, 76-260-20
	Re-excavation of Canal	20	km	2,500,000	50,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				108,200,000	
Aralia Khal	Replacement of Gates	4	nos	99,000	396,000	Schedule of rate 76-240-40, 76-260-20
	Re-excavation of Canal	2.4	km	2,000,000	4,800,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				5,196,000	
Chandal Beel	Resection of Embankment (Full)	100	m	41,100	4,110,000	
	2-vent Regulator	1	nos	16,500,000	16,500,000	Schedule of rate 76-240-40, 76-260-20
	Re-excavation of Canal	2	km	2,000,000	4,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				24,610,000	
Satdona Beel	2-vent Regulator	2	nos	16,500,000	33,000,000	Schedule of rate 76-240-40, 76-260-20
	others	1	LoS		0	0% of above
	Sub-total				33,000,000	
Datta Khola and Adjoing Bee	Re-excavation of Canal	73.5	km	2,000,000	147,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				147,000,000	
Chegaia Khal	Resection of Embankment (Full)	130	m	39,100	5,083,000	
	Replacement of Gates	1	nos	99,000	99,000	Schedule of rate 76-240-40, 76-260-20
	Re-excavation of Canal	4.5	km	2,000,000	9,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				14,182,000	
Gangajuri FCD	Resection of Embankment (Full)	600	m	39,100	23,460,000	
	Replacement of Gates	20	nos	99,000	1,980,000	Schedule of rate 76-240-40, 76-260-20
	Re-excavation of Canal	4.5	km	2,000,000	9,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				34,440,000	
Sukti River Embankment	Re-excavation of Canal	11.5	km	2,000,000	23,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				23,000,000	

Madhapur	Resection of Embankment (Full)	1260	m	39,100	49,266,000	
	Re-excavation of Canal	38	km	2,000,000	76,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				125,266,000	
Akashi and Shapla Beel	Resection of Embankment (Full)	150	m	39,100	5,865,000	
	Re-excavation of Canal	6.5	km	2,000,000	13,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				18,865,000	
Mohadao Nodi Embankment	Resection of Embankment (Full)	420	m	39,100	16,422,000	
	Resection of Embankment (Submergible)	120	m	3,600	432,000	
	others	1	LoS		0	0% of above
	Sub-total				16,854,000	
Kaliajuri Polder #2	Resection of Embankment (Submergible)	810	m	3,600	2,916,000	
	Replacement of Gates	19	nos	99,000	1,881,000	Schedule of rate 76-240-40, 76-260-20
	others	1	LoS		0	0% of above
	Sub-total				4,797,000	
Kaliajuri Polder #4	Resection of Embankment (Submergible)	630	m	3,600	2,268,000	
	Replacement of Gates	3	nos	99,000	297,000	Schedule of rate 76-240-40, 76-260-20
	others	1	LoS		0	0% of above
	Sub-total				2,565,000	
Sukaijuri Bathai	Resection of Embankment (Full)	70	m	39,100	2,737,000	
	Replacement of Gates	1	nos	99,000	99,000	Schedule of rate 76-240-40, 76-260-20
	others	1	LoS		0	0% of above
	Sub-total				2,836,000	
Singua River	Re-excavation of Canal	55	km	2,000,000	110,000,000	Haor M/P
	others	1	LoS		0	0% of above
	Sub-total				110,000,000	
Someswari River Embankmer	Resection of Embankment (Full)	1970	m	39,100	77,027,000	
	Replacement of Gates	1	nos	99,000	99,000	Schedule of rate 76-240-40, 76-260-20
	others	1	LoS		0	0% of above
	Sub-total				77,126,000	

Required Section Area of Re-embankment for Rehabilitation Project based on the Cross-section Survey

Section no.	Dampara (F)			Kangsa (F)			Singer (F)			Baraikhali (F)			Modkhola (F)			Kairdhala (S)			Bashira (S)			Chandal (F)		
	A1	A2	L	A1	A2	L	A1	A2	L	A1	A2	L	A1	A2	L	A1	A2	L	A1	A2	L	A1	A2	L
1	57.6	29.7	29.8	78.1	41.9	34.5	64.7	4.3	27.1	79.8	7.4	40.0	56.5	5.4	24.7	2.9	0.0	9.5	8.3	0.0	11.4	34.5	0.0	16.6
2	31.9	3.8	19.5	52.0	38.1	27.1	48.8	7.4	23.3	99.9	7.3	39.1	69.5	43.4	33.7	2.9	0.0	9.5	3.3	0.0	7.5	40.7	0.0	19.8
3	15.8	13.4	11.5	60.0	24.5	30.6	46.5	3.6	21.6	48.5	9.7	29.9	33.6	36.3	26.0	2.9	0.0	9.5	7.0	0.0	10.7	74.7	0.0	24.6
4	25.7	8.4	18.6	82.4	25.0	35.9	76.7	23.8	31.3	52.8	1.3	22.5	25.8	27.7	22.6	3.4	0.0	8.3	3.5	0.0	8.6	84.4	0.0	25.9
5	25.3	16.5	19.2	64.7	26.5	32.9	45.5	2.6	21.1	60.9	5.9	25.6	29.3	21.8	23.1				3.1	0.0	7.3	38.4	0.0	19.2
6	10.7	2.9	11.2	63.1	9.3	26.1	48.6	0.0	21.1	66.2	6.4	25.1	34.4	26.0	24.3				3.5	0.0	8.0	39.5	0.0	18.9
7	18.0	2.5	13.8	90.6	54.0	38.7	43.6	3.2	20.8	72.4	12.8	29.1	27.6	25.5	21.5				2.8	0.0	7.5	36.1	0.0	24.0
8	22.8	8.1	17.7	98.6	50.4	39.4	43.7	0.0	19.6	93.2	6.0	32.7	31.2	20.7	22.6				3.3	0.0	7.8	88.7	0.0	25.5
9	18.1	12.1	16.2	114.4	64.3	43.4	50.6	4.8	26.0	53.7	4.7	26.6	27.0	31.0	22.7				2.2	0.0	7.4	93.3	0.0	25.7
10	20.8	3.9	15.0	94.7	55.4	40.6	41.6	34.7	27.9	32.5	1.7	16.6	24.1	21.9	19.1				4.5	0.0	8.9	95.2	0.0	26.8
11	10.0	0.0	9.1										27.0	16.5	20.6				4.6	0.0	8.9	48.0	0.0	21.5
12	8.4	0.0	9.5										23.7	17.5	19.7				13.7	0.0	11.0	92.2	0.0	27.1
13	11.2	0.0	10.4										24.3	6.4	19.8				8.5	0.0	11.7	90.8	0.0	27.1
14	9.4	0.0	8.2										23.1	4.1	18.0				5.7	3.9	11.4	106.1	0.0	29.1
15	8.4	0.0	8.5										23.8	3.3	18.2							104.1	0.0	28.9
16	17.7	4.1	13.5										23.4	5.6	19.0							125.4	0.0	30.6
17	33.2	14.8	22.4										18.7	2.8	14.9									
18													30.0	36.5	25.0									
19													75.4	3.7	29.8									
20													30.8	4.2	23.0									
21																								
Average	20.3	7.1	14.9	79.9	38.9	34.9	51.0	8.4	24.0	66.0	6.3	28.7	33.0	18.0	22.4	3.0	0.0	9.2	5.3	0.3	9.2	74.5	0.0	24.5
Unit Cost	14,476	976	1,026	62,845	5,374	2,396	31,460	1,165	1,645	38,252	872	1,970	26,966	2,486	1,538	1,600	0	1,262	2,944	38	1,256	39,414	0	1,678
(BDT/m)	16,500			70,600			34,300			41,100			31,000			2,900			4,200			41,100		

A1: section area of re-embankment (m2) from AutoCAD
A2: section area of excavation and re-embankment (m2) from AutoCAD
L: length of surface treatment (m)
Unit cost: unit cost for rehabilitation of embankment (BDT/m)

- left side cell: re-embankment from unit price of embankment 529 BDT/m3
- middle cell: excavation of existing embankment 138 BDT/m3
- right side cell: foundation treatment by removing surface soil 0.5m (refer to schedule of rate 16-150)
- below: sum of re-embankment and foundation treatment

Average unit cost of full embankment 39,100 BDT/m
Average unit cost of submergible embankment 3,600 BDT/m

Spot Ground Elevation along Embankment					Calculation of Embankment Volume and Length				
Point No.	Latitude	Longitude	Elevation (m)	Distance (m)		Height (m)	Section A (m2)	Volume (m3)	Length (m)
Badla Project					Crest Elev.	5.200			
1	24.505	90.986	4.279	1,150		0.921	6.505	7,210	1,150
2	24.504	90.998	6.225	1,246		0.000	0.000	4,054	1,246
3	24.512	91.005	6.188	926		0.000	0.000	0	0
4	24.517	91.004	5.368	1,354		0.000	0.000	0	0
5	24.525	90.997	4.925	1,133		0.275	1.409	798	1,133
6	24.533	91.004	5.466	946		0.000	0.000	666	946
7	24.536	91.004	5.504	684		0.000	0.000	0	0
8	24.540	90.989	6.254	1,116		0.000	0.000	0	0
9	24.537	90.983	6.285	1,087		0.000	0.000	0	0
10	24.533	90.975	5.819	1,332		0.000	0.000	0	0
11	24.534	90.967	5.599	736		0.000	0.000	0	0
12	24.533	90.962	6.303	1,106		0.000	0.000	0	0
13	24.525	90.956	7.137	597		0.000	0.000	0	0
14	24.522	90.957	6.330	777		0.000	0.000	0	0
15	24.517	90.965	3.401	1,067		1.799	17.445	9,309	1,067
16	24.514	90.959	4.237	787		0.963	6.923	9,593	787
17	24.511	90.959	4.270	806		0.930	6.594	5,445	806
18	24.509	90.959	3.969	1,379		1.231	9.839	11,330	1,379
19	24.507	90.968	4.671	1,217		0.529	3.114	7,879	1,217
20	24.505	90.976	4.328	1,028		0.872	6.031	4,701	1,028
Total			5.328	20,476				60,985	10,759
Dharmapasha Haor					Crest Elev.	6.400			
1	24.884	90.937	9.494	16,787		0.000	0.000		
2	24.870	90.950	6.715	3,942		0.000	0.000	0	0
3	24.880	90.965	7.898	1,919		0.000	0.000	0	0
4	24.887	90.988	6.146	3,222		0.254	1.286	2,071	3,222
5	24.892	91.007	6.557	3,863		0.000	0.000	2,483	3,863
6	24.913	91.022	5.666	4,182		0.734	4.772	9,978	4,182
7	24.918	91.024	4.118	462		2.282	25.435	6,978	462
8	24.924	91.036	5.208	2,329		1.192	9.388	40,552	2,329
9	24.929	91.053	5.896	1,899		0.504	2.929	11,694	1,899
10	24.953	91.052	3.731	7,513		2.669	32.847	134,397	7,513
11	24.979	91.085	3.906	5,192		2.494	29.384	161,562	5,192
12	25.012	91.080	4.910	5,849		1.490	13.067	124,150	5,849
13	25.040	91.063	6.753	4,747		0.000	0.000	31,017	4,747
14	25.053	91.050	6.735	1,990		0.000	0.000	0	0
15	25.071	91.038	4.280	2,671		2.120	22.599	30,180	2,671
16	25.059	91.003	4.495	3,946		1.905	19.079	82,239	3,946
17	25.043	90.986	6.190	3,076		0.210	1.035	30,937	3,076
18	25.026	90.969	4.683	2,507		1.717	16.227	21,641	2,507
19	25.013	90.948	4.534	3,647		1.866	18.470	63,264	3,647
20	24.996	90.948	5.252	1,995		1.148	8.890	27,291	1,995
Total			5.658	81,739				780,435	57,100
Charigram Project						4.900			
1	24.405	91.052	3.612	1,787		1.288	10.515	14,540	1,787
2	24.395	91.045	3.292	1,289		1.608	14.671	16,230	1,289
3	24.377	91.050	2.772	1,652		2.128	22.736	30,901	1,652
4	24.366	91.059	3.336	1,285		1.564	14.063	23,649	1,285
6	24.359	91.076	3.047	1,459		1.853	18.269	23,586	1,459
5	24.362	91.079	3.545	620		1.355	11.335	9,177	620
7	24.370	91.083	3.359	779		1.541	13.750	9,771	779
8	24.380	91.088	3.174	1,141		1.726	16.359	17,175	1,141
9	24.389	91.091	3.529	1,081		1.371	11.534	15,077	1,081
10	24.397	91.096	4.392	879		0.508	2.959	6,367	879
11	24.406	91.106	5.303	1,477		0.000	0.000	2,186	1,477
12	24.422	91.110	3.932	1,945		0.968	6.973	6,782	1,945
13	24.439	91.106	4.462	1,906		0.438	2.459	8,988	1,906
14	24.444	91.093	4.667	1,500		0.233	1.165	2,718	1,500
15	24.449	91.082	4.259	1,508		0.641	3.989	3,886	1,508
16	24.438	91.077	4.408	1,356		0.492	2.842	4,631	1,356
17	24.432	91.083	4.028	849		0.872	6.031	3,766	849
18	24.425	91.077	4.193	1,170		0.707	4.540	6,182	1,170
19	24.419	91.069	4.428	995		0.472	2.698	3,599	995
20	24.413	91.067	4.057	1,020		0.843	5.757	4,313	1,020
Total			3.890	25,698				213,524	25,698

Bara Haor (Kalmakanda)					Crest Elev.	6.300			
1	25.075	90.898	5.562	647		0.738	4.807	10,870	647
2	25.067	90.914	4.141	1,780		2.159	23.268	24,983	1,780
3	25.067	90.920	3.986	1,217		2.314	26.014	29,981	1,217
4	25.071	90.930	2.826	1,285		3.474	51.144	49,588	1,285
5	25.080	90.933	3.031	2,002		3.269	46.116	97,334	2,002
6	25.067	90.944	1.738	1,324		4.562	82.052	84,839	1,324
7	25.097	90.945	2.799	1,791		3.501	51.825	119,906	1,791
8	25.102	90.961	3.482	1,520		2.818	35.941	66,715	1,520
9	25.112	90.948	3.237	1,527		3.063	41.317	58,992	1,527
10	25.119	90.939	2.891	1,180		3.409	49.523	53,608	1,180
11	25.113	90.931	3.298	1,741		3.002	39.945	77,888	1,741
12	25.106	90.923	3.657	1,209		2.643	32.321	43,684	1,209
13	25.101	90.913	3.454	837		2.846	36.537	28,821	837
14	25.104	90.904	3.551	1,255		2.749	34.492	44,587	1,255
15	25.100	90.893	4.366	1,358		1.934	19.537	36,675	1,358
16	25.097	90.883	3.804	1,263		2.496	29.423	30,906	1,263
17	25.089	90.877	2.704	1,246		3.596	54.256	52,142	1,246
18	25.082	90.873	3.764	1,056		2.536	30.199	44,588	1,056
19	25.077	90.892	5.879	1,924		0.421	2.342	31,309	1,924
20	25.073	90.885	3.838	886		2.462	28.771	13,783	886
Total			3.600	27,049				1,001,200	27,049

Ayner Gupi					Crest Elev.	4.300			
1	24.210	91.003	2.280	752		2.020	20.927	19,011	752
2	24.214	91.005	1.674	541		2.626	31.979	14,311	541
3	24.208	91.008	3.473	768		0.827	5.608	14,434	768
4	24.209	91.013	2.478	547		1.822	17.794	6,400	547
5	24.210	91.017	4.326	479		0.000	0.000	4,262	479
6	24.211	91.020	4.470	342		0.000	0.000	0	0
7	24.213	91.026	4.741	642		0.000	0.000	0	0
8	24.217	91.032	3.373	678		0.927	6.564	2,225	678
9	24.217	91.037	3.101	740		1.199	9.469	5,932	740
10	24.208	91.034	2.027	979		2.273	25.273	17,006	979
11	24.202	91.028	1.991	941		2.309	25.923	24,088	941
12	24.196	91.023	1.935	845		2.365	26.949	22,339	845
13	24.190	91.017	2.129	873		2.171	23.475	22,010	873
14	24.185	91.011	1.640	806		2.660	32.665	22,624	806
15	24.181	91.005	1.863	759		2.437	28.296	23,135	759
16	24.176	90.996	1.949	980		2.351	26.691	26,944	980
17	24.182	90.998	1.302	675		2.998	39.855	22,459	675
18	24.189	90.998	2.347	721		1.953	19.841	21,520	721
19	24.196	91.000	2.286	796		2.014	20.829	16,186	796
20	24.203	91.002	1.793	818		2.507	29.635	20,640	818
Total			2.559	14,682				305,527	13,698

Boro Haor (Austagram)					Crest Elev.	4.800			
1	24.381	91.029	3.833	4,566		0.967	6.963	44,292	4,566
2	24.364	91.010	3.297	2,782		1.503	13.240	28,101	2,782
3	24.344	90.997	3.869	2,640		0.931	6.604	26,193	2,640
4	24.313	90.979	3.925	3,948		0.875	6.059	24,996	3,948
5	24.306	91.005	2.613	2,752		2.187	23.753	41,028	2,752
6	24.301	91.030	2.895	2,609		1.905	19.079	55,872	2,609
7	24.300	91.055	3.468	2,490		1.332	11.050	37,510	2,490
8	24.308	91.082	4.185	3,016		0.615	3.779	22,363	3,016
9	24.283	91.109	4.717	3,365		0.083	0.378	6,993	3,365
10	24.284	91.142	3.625	3,483		1.175	9.194	16,671	3,483
11	24.301	91.133	3.767	2,233		1.033	7.643	18,802	2,233
12	24.307	91.117	3.062	2,094		1.738	16.535	25,311	2,094
13	24.339	91.123	2.689	3,600		2.111	22.446	70,171	3,600
14	24.342	91.157	3.767	3,732		1.033	7.643	56,145	3,732
15	24.358	91.146	3.799	2,053		1.001	7.310	15,353	2,053
16	24.363	91.118	3.592	5,057		1.208	9.572	42,691	5,057
17	24.355	91.095	3.109	2,903		1.691	15.850	36,897	2,903
18	24.358	91.077	3.171	1,869		1.629	14.966	28,793	1,869
19	24.366	91.058	3.526	2,073		1.274	10.347	26,237	2,073
20	24.371	91.046	3.358	3,004		1.442	12.439	34,225	3,004
Total			3.513	60,269				658,643	60,269

Boro Haor (Nikli)					Crest Elev.	5.400			
1	24.310	90.927	5.778	3,638		0.000	0.000	0	0
2	24.326	90.928	5.405	2,221		0.000	0.000	0	0
3	24.350	90.941	6.222	3,570		0.000	0.000	0	0
4	24.372	90.942	5.124	2,705		0.276	1.415	1,914	2,705
5	24.393	90.945	6.378	3,512		0.000	0.000	2,485	3,512
6	24.404	90.946	5.519	2,759		0.000	0.000	0	0
7	24.409	90.962	5.958	2,250		0.000	0.000	0	0
8	24.419	90.945	5.827	2,117		0.000	0.000	0	0
9	24.418	90.929	6.773	3,575		0.000	0.000	0	0
10	24.414	90.916	7.238	4,384		0.000	0.000	0	0
11	24.411	90.904	9.884	3,303		0.000	0.000	0	0
12	24.397	90.881	8.178	2,494		0.000	0.000	0	0
13	24.391	90.870	8.023	1,406		0.000	0.000	0	0
14	24.375	90.845	9.228	3,063		0.000	0.000	0	0
15	24.365	90.827	9.202	2,253		0.000	0.000	0	0
16	24.355	90.827	13.966	1,135		0.000	0.000	0	0
17	24.340	90.824	8.269	1,657		0.000	0.000	0	0
18	24.341	90.841	7.666	1,723		0.000	0.000	0	0
19	24.335	90.862	2.214	2,253		3.186	44.152	49,737	2,253
20	24.330	90.871	8.405	1,108		0.000	0.000	24,460	1,108
21	24.328	90.890	8.694	2,006		0.000	0.000	0	0
22	24.334	90.888	7.912	1,106		0.000	0.000	0	0
23	24.350	90.895	7.052	3,093		0.000	0.000	0	0
24	24.324	90.897	8.447	3,612		0.000	0.000	0	0
25	24.315	90.907	8.183	1,500		0.000	0.000	0	0
Total			7.422	62,443				78,596	9,578

Chandpur Haor					Crest Elev.	5.200			
1	24.317	90.880	9.494	1,612		0.000	0.000	0	0
2	24.323	90.874	4.620	784		0.580	3.503	1,373	784
3	24.330	90.865	9.043	1,290		0.000	0.000	2,259	1,290
4	24.336	90.856	7.824	1,078		0.000	0.000	0	0
5	24.338	90.846	8.367	1,075		0.000	0.000	0	0
6	24.339	90.837	8.426	1,040		0.000	0.000	0	0
7	24.337	90.828	8.550	936		0.000	0.000	0	0
8	24.335	90.830	7.925	527		0.000	0.000	0	0
9	24.332	90.833	8.301	531		0.000	0.000	0	0
10	24.327	90.836	8.823	845		0.000	0.000	0	0
11	24.317	90.841	8.693	1,367		0.000	0.000	0	0
12	24.303	90.847	8.916	1,766		0.000	0.000	0	0
13	24.294	90.856	7.015	1,712		0.000	0.000	0	0
14	24.289	90.854	9.018	795		0.000	0.000	0	0
15	24.278	90.861	9.433	1,397		0.000	0.000	0	0
16	24.277	90.868	8.009	1,018		0.000	0.000	0	0
17	24.281	90.877	7.895	1,147		0.000	0.000	0	0
18	24.289	90.890	8.193	3,047		0.000	0.000	0	0
19	24.307	90.886	6.877	2,077		0.000	0.000	0	0
Total			8.180	24,043				3,632	2,074

Dulalpur Haor					Crest Elev.	4.300			
1	24.179	90.971	1.200	440		3.100	42.160	11,782	440
2	24.178	90.973	1.300	235		3.000	39.900	9,650	235
3	24.180	90.978	1.460	611		2.840	36.409	23,306	611
4	24.180	90.978	1.433	165		2.867	36.987	6,055	165
5	24.183	90.982	2.885	516		1.415	12.091	12,665	516
6	24.182	90.986	4.783	451		0.000	0.000	2,729	451
7	24.184	90.988	2.316	279		1.984	20.340	2,834	279
8	24.184	90.991	1.731	397		2.569	30.846	10,160	397
9	24.179	90.991	3.817	589		0.483	2.777	9,908	589
10	24.175	90.987	2.061	542		2.239	24.667	7,439	542
11	24.172	90.984	3.063	432		1.237	9.910	7,473	432
12	24.169	90.983	3.166	404		1.134	8.734	3,764	404
13	24.165	90.983	2.975	426		1.325	10.964	4,198	426
14	24.160	90.982	2.186	573		2.114	22.497	9,590	573
15	24.162	90.979	2.428	401		1.872	18.563	8,223	401
16	24.163	90.977	2.180	306		2.120	22.599	6,294	306
17	24.165	90.975	1.530	251		2.770	34.930	7,230	251
18	24.167	90.973	2.086	409		2.214	24.226	12,103	409
19	24.169	90.970	2.687	352		1.613	14.741	6,856	352
20	24.174	90.969	2.941	508		1.359	11.384	6,636	508
Total			2.411	8,288				168,897	8,288

Korati Haor					Crest Elev.	5.200			
1	24.402	90.976	5.337	1,594		0.000	0.000	20,043	1,594
2	24.423	90.970	4.257	2,446		0.943	6.723	8,222	2,446
3	24.429	90.969	3.746	650		1.454	12.595	6,278	650
4	24.436	90.964	4.344	1,148		0.856	5.879	10,604	1,148
6	24.445	90.959	4.457	2,102		0.743	4.851	11,277	2,102
5	24.442	90.965	4.944	1,057		0.256	1.297	3,249	1,057
8	24.478	90.960	3.099	3,991		2.101	22.277	47,043	3,991
9	24.475	90.935	5.627	3,948		0.000	0.000	43,975	3,948
10	24.474	90.926	6.574	1,449		0.000	0.000	0	0
11	24.446	90.921	2.085	5,453		3.115	42.504	115,882	5,453
12	24.426	90.926	4.773	2,564		0.427	2.383	57,550	2,564
13	24.427	90.931	2.854	3,487		2.346	26.599	50,536	3,487
14	24.431	90.936	4.038	1,346		1.162	9.047	23,990	1,346
15	24.431	90.943	1.277	775		3.923	63.039	27,933	775
16	24.422	90.948	0.932	1,855		4.268	73.000	126,176	1,855
17	24.414	90.960	1.342	1,464		3.858	61.242	98,265	1,464
18	24.403	90.958	1.879	1,532		3.321	47.367	83,195	1,532
19	24.399	90.966	2.934	4,981		2.266	25.148	180,600	4,981
Total			3.583	41,842				914,817	40,393

Kuniarbandh Haor					Crest Elev.	4.300			
1	24.187	90.974	2.665	961		1.635	15.050	7,235	961
2	24.179	90.965	1.439	1,270		2.861	36.858	32,954	1,270
3	24.171	90.966	2.443	938		1.857	18.330	25,876	938
4	24.163	90.970	2.114	964		2.186	23.736	20,280	964
5	24.162	90.964	2.261	531		2.039	21.240	11,936	531
6	24.159	90.960	2.057	716		2.243	24.738	16,451	716
7	24.160	90.956	1.802	459		2.498	29.461	12,450	459
8	24.160	90.949	1.742	711		2.558	30.629	21,355	711
9	24.160	90.947	1.392	271		2.908	37.874	9,279	271
10	24.158	90.942	1.316	544		2.984	39.544	21,061	544
11	24.166	90.940	7.086	896		0.000	0.000	17,713	896
12	24.175	90.941	7.316	1,003		0.000	0.000	0	0
13	24.181	90.940	7.030	685		0.000	0.000	0	0
14	24.189	90.941	7.683	940		0.000	0.000	0	0
15	24.199	90.944	7.430	1,192		0.000	0.000	0	0
16	24.202	90.949	7.181	715		0.000	0.000	0	0
17	24.205	90.954	7.689	546		0.000	0.000	0	0
18	24.203	90.961	7.315	633		0.000	0.000	0	0
19	24.213	90.966	5.307	679		0.000	0.000	0	0
20	24.196	90.971	6.137	712		0.000	0.000	0	0
Total			4.470	15,365				196,590	8,260

Naogaon Haor					Crest Elev.	6.500			
1	24.402	90.994	6.329	2,720		0.171	0.823	8,571	2,720
2	24.408	90.975	7.274	2,592		0.000	0.000	1,067	2,592
3	24.421	90.973	6.493	1,582		0.007	0.030	24	1,582
4	24.451	90.965	6.391	3,356		0.109	0.504	897	3,356
5	24.474	90.991	7.005	3,506		0.000	0.000	884	3,506
6	24.488	91.002	6.852	1,946		0.000	0.000	0	0
7	24.489	91.004	6.623	617		0.000	0.000	0	0
8	24.498	91.009	6.525	1,440		0.000	0.000	0	0
9	24.498	91.026	5.856	1,635		0.644	4.013	3,282	1,635
10	24.487	91.039	6.671	1,326		0.000	0.000	2,660	1,326
11	24.496	91.050	7.417	1,318		0.000	0.000	0	0
12	24.485	91.051	7.259	3,040		0.000	0.000	0	0
15	24.452	91.077	6.750	4,516		0.000	0.000	0	0
16	24.425	91.059	6.214	4,563		0.286	1.475	3,366	4,563
17	24.417	91.040	6.339	3,584		0.161	0.770	4,023	3,584
18	24.405	91.028	5.572	3,696		0.928	6.574	13,571	3,696
19	24.387	91.024	5.172	1,748		1.328	11.001	15,361	1,748
20	24.376	91.011	4.885	2,350		1.615	14.769	30,278	2,350
21	24.379	90.999	5.687	1,459		0.813	5.479	14,771	1,459
Total			6.385	46,995				98,755	34,117

Noapara Haor					Crest Elev.	4.900			
1	24.347	90.948	1.960	1,845		2.940	38.573	35,583	1,845
2	24.339	90.963	1.684	2,396		3.216	44.857	99,950	2,396
3	24.336	90.970	1.450	957		3.450	50.543	32,211	957
4	24.339	90.985	3.145	1,546		1.755	16.787	28,630	1,546
5	24.357	90.998	2.921	2,712		1.979	20.259	62,010	2,712
6	24.365	91.004	2.616	1,090		2.284	25.471	15,915	1,090
7	24.373	91.000	4.291	1,269		0.609	3.731	12,369	1,269
8	24.372	90.986	3.215	1,570		1.685	15.763	25,950	1,570
9	24.380	90.988	3.111	832		1.789	17.294	7,262	832
10	24.398	90.993	4.865	2,541		0.035	0.154	2,600	2,541
11	24.402	90.977	4.547	1,637		0.353	1.892	6,810	1,637
12	24.398	90.970	3.987	1,608		0.913	6.427	6,334	1,608
13	24.392	90.963	4.618	2,479		0.282	1.451	17,715	2,479
14	24.390	90.953	3.427	1,294		1.473	12.843	26,710	1,294
15	24.383	90.936	2.455	2,105		2.445	28.448	48,438	2,105
16	24.376	90.947	3.092	1,752		1.808	17.581	26,008	1,752
17	24.373	90.943	3.484	652		1.416	12.104	3,943	652
18	24.362	90.943	6.616	1,133		0.000	0.000	0	0
19	24.345	90.947	6.476	474		0.000	0.000	0	0
Total			3.577	29,892				458,438	28,285

Nunnir Haor					Crest Elev.	4.700			
1	24.240	90.975	3.809	5,447		0.891	6.213	16,921	5,447
2	24.266	90.967	4.120	7,199		0.580	3.503	34,971	7,199
3	24.281	90.956	4.686	2,845		0.014	0.061	5,070	2,845
4	24.303	90.975	2.956	2,750		1.744	16.624	22,937	2,750
5	24.319	90.953	4.598	2,242		0.102	0.470	19,166	2,242
6	24.335	90.967	2.241	2,688		2.459	28.714	39,219	2,688
7	24.320	90.962	9.017	2,362		0.000	0.000	33,912	2,362
8	24.324	90.934	8.950	1,610		0.000	0.000	0	0
9	24.308	90.929	8.757	1,946		0.000	0.000	0	0
10	24.315	90.906	8.933	2,500		0.000	0.000	0	0
11	24.318	90.881	8.724	4,479		0.000	0.000	0	0
12	24.306	90.895	9.204	1,980		0.000	0.000	0	0
13	24.283	90.899	8.893	2,522		0.000	0.000	0	0
14	24.259	90.898	8.882	2,699		0.000	0.000	0	0
15	24.242	90.904	9.419	2,061		0.000	0.000	0	0
16	24.258	90.920	9.145	2,435		0.000	0.000	0	0
17	24.263	90.929	7.923	1,078		0.000	0.000	0	0
18	24.253	90.934	5.392	2,450		0.000	0.000	0	0
19	24.249	90.944	5.675	5,113		0.000	0.000	0	0
20	24.238	90.951	5.757	3,918		0.000	0.000	0	0
Total			6.854	60,325				172,196	25,533

Sarishapur Haor					Crest Elev.	4.600			
1	24.216	90.955	6.456	1,270		0.000	0.000	0	0
2	24.216	90.943	6.858	1,257		0.000	0.000	0	0
3	24.217	90.936	6.901	762		0.000	0.000	0	0
4	24.217	90.927	7.003	822		0.000	0.000	0	0
5	24.223	90.923	6.926	838		0.000	0.000	0	0
6	24.229	90.919	7.136	699		0.000	0.000	0	0
7	24.233	90.920	6.560	562		0.000	0.000	0	0
8	24.244	90.922	5.789	1,225		0.000	0.000	0	0
9	24.243	90.945	3.286	2,519		1.314	10.830	13,640	2,519
10	24.241	90.933	3.916	1,356		0.684	4.345	10,287	1,356
11	24.235	90.940	2.850	1,483		1.750	16.713	15,616	1,483
12	24.238	90.949	3.406	1,012		1.194	9.411	13,219	1,012
13	24.238	90.951	3.940	222		0.660	4.145	1,505	222
14	24.235	90.954	5.073	481		0.000	0.000	997	481
15	24.231	90.959	5.371	633		0.000	0.000	0	0
16	24.230	90.968	4.965	947		0.000	0.000	0	0
17	24.231	90.975	4.683	754		0.000	0.000	0	0
18	24.226	90.972	6.407	877		0.000	0.000	0	0
19	24.219	90.967	8.884	1,233		0.000	0.000	0	0
Total			5.601	18,951				55,264	7,073

Bansharir					Crest Elev.	6.100			
1	24.667	90.903	3.390	1,014		2.710	33.685	18,753	1,014
2	24.663	90.899	3.210	740		2.890	37.483	26,343	740
3	24.669	90.893	4.965	1,333		1.135	8.745	30,816	1,333
4	24.677	90.891	4.648	1,013		1.452	12.569	10,793	1,013
5	24.685	90.886	5.101	1,264		0.999	7.290	12,554	1,264
6	24.688	90.884	5.203	460		0.897	6.271	3,119	460
7	24.693	90.884	4.151	524		1.949	19.777	6,831	524
8	24.693	90.877	3.763	361		2.337	26.434	8,351	361
9	24.693	90.875	3.573	294		2.527	30.023	8,299	294
10	24.691	90.866	5.023	1,072		1.077	8.111	20,433	1,072
11	24.698	90.864	5.613	656		0.487	2.806	3,583	656
12	24.699	90.861	5.963	414		0.137	0.645	715	414
13	24.703	90.861	5.858	255		0.242	1.216	238	255
14	24.703	90.857	5.738	357		0.362	1.950	565	357
15	24.707	90.861	5.863	461		0.237	1.188	723	461
16	24.675	90.909	5.975	3,425		0.125	0.584	3,035	3,425
17	24.682	90.910	5.860	1,249		0.240	1.205	1,117	1,249
18	24.691	90.909	6.005	964		0.095	0.436	791	964
19	24.695	90.902	5.510	945		0.590	3.581	1,898	945
20	24.701	90.891	5.545	1,196		0.555	3.311	4,121	1,196
Total			5.048	17,999				163,078	17,999
Chatal Haor					Crest Elev.	5.700			
1	24.555	90.961	5.215	2,005		0.485	2.791	27,813	2,005
2	24.556	90.964	5.568	821		0.132	0.620	1,400	821
3	24.557	90.965	6.349	652		0.000	0.000	202	652
4	24.560	90.966	7.290	526		0.000	0.000	0	0
5	24.565	90.963	6.605	1,031		0.000	0.000	0	0
6	24.571	90.968	7.977	1,221		0.000	0.000	0	0
7	24.577	90.965	8.192	1,022		0.000	0.000	0	0
8	24.583	90.962	6.845	814		0.000	0.000	0	0
9	24.586	90.961	6.296	430		0.000	0.000	0	0
10	24.589	90.960	4.548	455		1.152	8.935	2,033	455
11	24.592	90.955	6.907	782		0.000	0.000	3,494	782
12	24.595	90.954	7.024	383		0.000	0.000	0	0
13	24.600	90.952	6.151	445		0.000	0.000	0	0
14	24.604	90.945	6.364	835		0.000	0.000	0	0
15	24.603	90.944	6.386	498		0.000	0.000	0	0
16	24.593	90.947	6.169	1,419		0.000	0.000	0	0
17	24.578	90.946	6.168	2,836		0.000	0.000	0	0
18	24.577	90.941	7.026	679		0.000	0.000	0	0
19	24.565	90.941	6.100	2,093		0.000	0.000	0	0
20	24.560	90.949	3.445	986		2.255	24.952	12,301	986
Total			6.331	19,932				47,243	5,701
Dakshiner Haor					Crest Elev.	5.100			
1	24.464	91.108	4.312	1,804		0.788	5.251	11,783	1,804
2	24.468	91.106	4.920	364		0.180	0.871	1,114	364
3	24.472	91.103	5.516	605		0.000	0.000	264	605
4	24.478	91.099	5.593	1,179		0.000	0.000	0	0
5	24.484	91.096	4.936	582		0.164	0.786	229	582
6	24.492	91.097	6.057	1,078		0.000	0.000	424	1,078
7	24.499	91.106	6.023	1,479		0.000	0.000	0	0
8	24.505	91.119	5.793	1,044		0.000	0.000	0	0
9	24.508	91.132	4.796	1,122		0.304	1.584	889	1,122
10	24.508	91.133	4.526	253		0.574	3.457	637	253
11	24.510	91.144	3.701	1,304		1.399	11.887	10,003	1,304
12	24.510	91.156	4.170	1,128		0.930	6.594	10,422	1,128
13	24.512	91.160	3.737	684		1.363	11.434	6,170	684
14	24.508	91.171	3.422	905		1.678	15.662	12,256	905
15	24.505	91.173	4.842	681		0.258	1.309	5,780	681
16	24.503	91.171	3.400	359		1.700	15.980	3,106	359
17	24.490	91.157	3.417	2,199		1.683	15.734	34,875	2,199
18	24.477	91.148	3.645	1,586		1.455	12.608	22,476	1,586
19	24.474	91.136	2.828	1,580		2.272	25.256	29,904	1,580
20	24.458	91.151	4.051	2,097		1.049	7.812	34,671	2,097
Total			4.484	22,034				185,002	18,332

Dhakua					Crest Elev.	6.300			
1	24.972	91.387	6.369	3,479		0.000	0.000	12,539	3,479
2	24.962	91.375	4.637	1,592		1.663	15.448	12,294	1,592
3	24.952	91.362	4.943	1,686		1.357	11.359	22,596	1,686
4	24.936	91.360	6.028	2,791		0.272	1.392	17,793	2,791
5	24.923	91.349	4.271	1,836		2.029	21.075	20,622	1,836
6	24.931	91.332	4.550	2,589		1.750	16.713	48,908	2,589
7	24.933	91.315	3.411	1,836		2.889	37.462	49,723	1,836
8	24.941	91.308	4.636	1,187		1.664	15.462	31,423	1,187
9	24.935	91.297	3.175	2,168		3.125	42.734	63,085	2,168
10	24.929	91.285	4.335	1,883		1.965	20.033	59,096	1,883
11	24.943	91.280	5.323	2,013		0.977	7.065	27,277	2,013
12	24.960	91.282	6.468	3,525		0.000	0.000	12,453	3,525
13	24.976	91.294	7.249	2,664		0.000	0.000	0	0
14	24.987	91.314	5.223	2,557		1.077	8.111	10,371	2,557
15	24.996	91.381	6.399	2,705		0.000	0.000	10,971	2,705
16	25.001	91.376	7.022	2,309		0.000	0.000	0	0
17	25.010	91.360	7.041	1,545		0.000	0.000	0	0
18	25.016	91.350	5.925	1,536		0.375	2.034	1,562	1,536
19	25.000	91.336	6.148	1,500		0.152	0.723	2,068	1,500
20	24.998	91.323	5.309	1,582		0.991	7.208	6,273	1,582
Total			5.423	42,983				409,052	36,465

Ganesh Haor					Crest Elev.	6.400			
1	24.726	90.944	4.566	2,998		1.834	17.977	41,072	2,998
2	24.732	90.944	5.218	1,082		1.182	9.274	14,740	1,082
3	24.740	90.939	4.958	1,087		1.442	12.439	11,804	1,087
4	24.748	90.929	4.212	1,492		2.188	23.770	27,011	1,492
5	24.753	90.922	5.072	1,234		1.328	11.001	21,456	1,234
6	24.763	90.918	5.308	1,750		1.092	8.273	16,867	1,750
7	24.770	90.924	5.013	1,030		1.387	11.735	10,303	1,030
8	24.774	90.917	4.673	1,025		1.727	16.374	14,408	1,025
9	24.772	90.906	5.568	1,285		0.832	5.654	14,155	1,285
10	24.778	90.903	6.131	857		0.269	1.374	3,010	857
11	24.777	90.895	5.006	938		1.394	11.824	6,187	938
12	24.770	90.891	5.901	1,054		0.499	2.893	7,758	1,054
13	24.767	90.893	5.602	537		0.798	5.342	2,212	537
14	24.765	90.889	6.317	1,018		0.083	0.378	2,913	1,018
15	24.758	90.882	5.897	795		0.503	2.922	1,311	795
16	24.757	90.876	5.952	626		0.448	2.529	1,705	626
17	24.761	90.873	6.466	799		0.000	0.000	1,010	799
18	24.760	90.868	5.745	656		0.655	4.104	1,345	656
19	24.759	90.864	5.170	488		1.230	9.828	3,397	488
20	24.719	90.885	5.205	1,763		1.195	9.423	16,969	1,763
Total			5.399	22,513				219,632	22,513

Jaliar Haor					Crest Elev.	7.600			
1	24.927	91.557	8.630	6,629		0.000	0.000	0	0
2	24.922	91.555	7.590	786		0.010	0.043	17	786
3	24.915	91.553	6.984	1,884		0.616	3.787	3,608	1,884
4	24.911	91.557	7.857	716		0.000	0.000	1,357	716
5	24.913	91.560	7.720	269		0.000	0.000	0	0
6	24.912	91.563	7.639	252		0.000	0.000	0	0
7	24.914	91.569	7.357	754		0.243	1.222	461	754
8	24.914	91.575	6.024	647		1.576	14.228	4,998	647
9	24.911	91.581	7.092	1,400		0.508	2.959	12,029	1,400
10	24.909	91.589	8.113	601		0.000	0.000	889	601
11	24.904	91.600	7.770	2,097		0.000	0.000	0	0
12	24.910	91.624	7.911	2,667		0.000	0.000	0	0
13	24.916	91.631	8.637	1,337		0.000	0.000	0	0
14	24.923	91.633	8.271	735		0.000	0.000	0	0
15	24.925	91.638	8.216	546		0.000	0.000	0	0
16	24.926	91.632	9.134	555		0.000	0.000	0	0
17	24.929	91.632	8.409	539		0.000	0.000	0	0
18	24.932	91.630	8.054	530		0.000	0.000	0	0
19	24.935	91.624	7.924	594		0.000	0.000	0	0
20	24.942	91.615	7.831	1,208		0.000	0.000	0	0
Total			7.858	24,745				23,357	6,787

Mokhar Haor					Crest Elev.	5.850			
1	24.560	91.502	5.456	3,274		0.394	2.160	35,827	1,637
2	24.417	91.431	6.733	38,312		0.000	0.000	20,688	19,156
3	24.428	91.407	6.061	1,134		0.000	0.000	0	0
4	24.449	91.381	3.172	1,801		2.678	33.030	29,744	1,801
5	24.461	91.362	4.168	2,309		1.682	15.720	56,282	2,309
6	24.477	91.387	5.095	2,073		0.755	4.957	21,431	2,073
7	24.417	91.431	4.917	1,019		0.933	6.623	5,900	1,019
8	24.428	91.407	3.223	1,022		2.627	31.999	19,736	1,022
9	24.449	91.381	3.274	5,335		2.576	30.984	168,009	5,335
10	24.461	91.362	4.205	2,104		1.645	15.192	48,577	2,104
11	24.477	91.387	4.918	1,589		0.932	6.613	17,324	1,589
12	24.502	91.389	5.343	1,533		0.507	2.951	7,331	1,533
13	24.543	91.394	4.530	5,144		1.320	10.903	35,634	5,144
14	24.586	91.508	3.272	5,033		2.578	31.024	105,509	5,033
15	24.596	91.499	5.276	5,194		0.574	3.457	89,545	5,194
16	24.619	91.450	4.094	2,801		1.756	16.801	28,371	2,801
17	24.612	91.394	3.747	7,077		2.103	22.311	138,398	7,077
18	24.606	91.371	2.881	6,023		2.969	39.212	92,637	3,012
19	24.578	91.376	2.774	1,939		3.076	41.612	39,179	970
Total			4.376	94,716				960,124	68,808
Shelnir Haor					Crest Elev.	5.500			
1	24.248	91.371	7.769	3,834		0.000	0.000	0	0
2	24.244	91.344	5.140	3,289		0.360	1.937	3,185	3,289
3	24.243	91.328	5.731	2,063		0.000	0.000	1,998	2,063
4	24.234	91.320	4.580	1,637		0.920	6.495	5,316	1,637
5	24.225	91.307	4.689	1,574		0.811	5.460	9,406	1,574
6	24.225	91.292	4.578	3,161		0.922	6.515	18,927	3,161
7	24.240	91.286	4.501	2,800		0.999	7.290	19,328	2,800
8	24.252	91.291	3.940	1,658		1.560	14.009	17,652	1,658
9	24.268	91.306	4.520	2,354		0.980	7.095	24,835	2,354
10	24.268	91.314	4.490	1,244		1.010	7.403	9,018	1,244
16	24.278	91.324	4.604	1,196		0.896	6.261	8,170	1,196
15	24.280	91.340	4.162	1,169		1.338	11.124	10,162	1,169
13	24.273	91.346	4.970	1,477		0.530	3.122	10,519	1,477
12	24.268	91.351	5.596	1,483		0.000	0.000	2,315	1,483
17	24.269	91.324	4.387	2,002		1.113	8.502	8,510	2,002
19	24.274	91.364	6.846	3,031		0.000	0.000	12,885	3,031
11	24.262	91.362	6.708	1,660		0.000	0.000	0	0
18	24.272	91.374	7.616	2,920		0.000	0.000	0	0
Total			5.268	38,551				162,227	30,136
Sunair Haor						6.000			
1	24.590	90.905	5.742	14,032		0.258	1.309	9,185	14,032
2	24.585	90.907	7.627	866		0.000	0.000	567	866
3	24.580	90.907	6.847	825		0.000	0.000	0	0
4	24.595	90.909	6.653	1,114		0.000	0.000	0	0
5	24.597	90.917	7.318	1,316		0.000	0.000	0	0
6	24.597	90.909	7.512	828		0.000	0.000	0	0
7	24.603	90.903	6.793	1,511		0.000	0.000	0	0
8	24.603	90.896	6.964	853		0.000	0.000	0	0
9	24.604	90.882	6.684	2,135		0.000	0.000	0	0
10	24.609	90.877	6.704	1,258		0.000	0.000	0	0
11	24.601	90.871	6.137	712		0.000	0.000	0	0
12	24.606	90.872	7.773	729		0.000	0.000	0	0
13	24.612	90.872	6.763	792		0.000	0.000	0	0
14	24.586	90.837	6.867	1,914		0.000	0.000	0	0
15	24.586	90.834	6.879	5,926		0.000	0.000	0	0
16	24.587	90.829	6.888	518		0.000	0.000	0	0
17	24.582	90.829	6.965	266		0.000	0.000	0	0
18	24.582	90.833	6.557	707		0.000	0.000	0	0
19	24.582	90.836	5.690	667		0.310	1.621	540	667
20	24.618	90.857	6.059	624		0.000	0.000	506	624
			6.771	37,594				10,798	16,189

ANNEX 9-1

Assessment of Present Situation and Appropriateness regarding Existing Non-structural Flood Measures

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1.0 Introduction

The haor area in the north-eastern region of Bangladesh is subject to very peculiar hydrological and hydraulic conditions and suffers from extensive annual flooding. This makes the livelihood in the area extremely vulnerable and limits the potential for agriculture production and general economic growth. For 6 to 7 months of the year, the cropped land is completely inundated. Strong wave action adds to the vulnerability as it can potentially wash away the land and poses a major threat to many villages in the haor area. Although the lifestyle of the haor people is well adapted to flood phenomena, damage due to drainage related inundation, pre-monsoon flash floods, severe monsoon floods, river bank erosion, failure of river structures, etc. still occurs. Due to monsoon inundation, in most haor areas, only simple harvesting of rice is possible. Boro rice and other winter crops cultivation is the major agricultural activity in this area.

Overwhelming majority of the population is dependent upon rice for food and other basic necessities of life. The harvest time varies with the rice/ crop types but is encompassed within late April to mid May.

Sometimes flash flood occurs in the pre-monsoon period, during April and May, before the harvesting. As a result, once in 3 or 4 years, the crops have been damaged due to pre-monsoon flash floods.

Among many natural hazards, flash floods or pre-monsoon floods are particularly challenging for the communities of the haor area. Flash floods are severe flood events that occur with little or no warning. They can be triggered by intense local or upstream rainfalls, failure of dams, and outbursts of glacial lakes from upstream hilly areas. Flash floods tend to carry with them much higher amounts of sands and debris compared to monsoon floods and, as a result, cause more damage to roads, culverts, embankments, bridges and other water management infrastructure, silt up the canals and rivers, and cause sand carpeting over the cultivable land. Though the main tools of the damage reduction revolve around structural measures like embankment, river dredging, etc., non-structural flood measures are also considered as useful means of damage reduction. This study paper tends to assess the present non-structural measures practiced in the haor area and to evaluate their appropriateness.

2.0 Relevance of Flood Damage Pattern with Non-structural Measures

2.1 Relevance

Analysis of area specific flood damage pattern is relevant as not all types of non-structural measures are effective for all types of flood damage. For example, where the flash flood can cause a life threatening situation, early warning and evacuation is most important. On the other hand, where major threat is crop damage, crop diversification and alternate livelihood can be also effective measures.

2.2 Flood Damage Type in the haor Area

The major damage experienced in the Haor area include:

- Crop damage,
- Sediment deposition in the rivers and canals, thus reducing their conveyance capacities,
- Sediment deposition in haors (sand carpeting), which may adversely affect the fertility,

- Sediment deposition in beels (the lowest part of haor), which may adversely affect fisheries,
- Water logging and drainage congestion,
- Damage of embankment,
- Damage of social infrastructure like schools, roads, markets, etc.,
- Damage of houses, and
- River bank erosion.

Threat to human life is not common in the haor area, because there is no habitat in the low lying areas and most habitats are raised above normal monsoon flood levels. However, in some extreme flood events, there are some incidences of life loss. On the other hand, among the various types of flood damage experienced in the haor area, crop damage is the main issue of concern. In some years, the extent of crop damage may exceed more than 75%. Thus, more focus is given on asset loss reduction by government and non-government organizations.

2.3 Impact of Flood Damage and Importance of Non-structural Measures

Since the pre-monsoon cultivation is the only major economic activity for the vast majority of the people in the haor area, any damage can have serious consequences. Damage of standing crops can push people in hunger, indebtedness, distress sale of property and seasonal migration.

During the period from 1993 to 2010, about 2.44 million tons of rice, 64,000 tons of jute, 40,000 tons of other crops could not be harvested because of flood damage (Haor MP, CEGIS, 2012, Annex 2 – Agricultural Sector Report).

Though within the haor area, there are perennial and seasonal water bodies which are the abodes of fishes, and though monsoon inundation provides a favorable ground for fish spawning and growth, the common people in the area have no access to the huge aquatic resources. Rather it is controlled by a small powerful group of people through fishing right lease obtained from the local government. Therefore, pre-monsoon crop failure has serious implication on livelihood of poor and extreme poor people.

To ensure flood damage reduction, thus, non-structural measures should also be considered in addition to and in parallel with structural measures.

3.0 Typical Non-structural Flood Measures

Non-structural flood measures refer to any measure that does not involve physical construction (like retention basins, embankment, dredging river channel, diversions, etc.) but instead uses knowledge, practices, and/or agreements to reduce the potential impacts of floods. Non-structural approaches can be cost-effective alternatives to traditional engineering and ecological solutions. Typical approaches include policies and laws, raising public awareness, and training and education. Such measures offer a variety of possibilities including the installation of early warning systems, soil and land use management, insurance, awareness building and public information actions, emergency systems, and post-catastrophe recovery, all of which can help mitigate flood related damage. Nonetheless, not all non-structural measures are effective in all situations and it is always better to adopt multiple non-structural measures along with some structural measures for better flood risk management. Non-structural measures are generally less expensive than structural measures, easy to roll out and they are more sustainable because they include active involvement of the community.

The need for non-structural measures becomes very important for the haor area for several reasons, which are:

- high cost of structural measures,
- lack of capacity to build and operate structural measures,
- low involvement of local community into structural measures,
- lack of feeling of ownership toward structural measures, and
- adverse environmental impacts of structural measures.

The various types of typical non-structural measures can be grouped as flows:

Table 3.1 Groups of Non-structural Flood Measures

Risk Acceptance	Tolerance strategy	Toleration (flood proofing)
		Emergency response system
		Insurance
Risk Reduction	Prevention strategy	Watershed management
		Delimitation of flood areas and securing flood plains (development control)
		Implementation of flood area regulations
		Application of financial measures (an economic contribution or the waiver of a financial burden such as: taxes, loan interest, or the liquidation of a loan)
	Mitigation strategy	Reduction of discharge through natural retention
		Forecasting and early warning
		Emergency action based on monitoring, warning, and response system (MWRS)
		Public information and education

Source: Modified by JICA Study Team, adapted from "Resource Manual on Flash Flood Risk Management, Icimod, 2008, originally based on "Colombo, A.G.; Hevas, J.; Arllam, A.L.V. (2002), Guidelines on Flash Floods Prevention and Mitigations. Ipsra (Italy): NEIDES

Different types of non-structural measures are practiced in the haor area. In the following sections, each measure is analyzed briefly covering present situation, on-going and planned activities, and potential for further interventions.

4.0 Regulation of Development in River Areas

Through field visit, physical verification and consultation with different stakeholders and local communalities, it is known that development in river bank sides of the haors is not regulated in the study area. Part of the river side areas are relatively high land compared to the low lying haors, and thus these areas are less prone to flooding. People use those lands for housing, shops, duck farming, etc.

There are two main reasons for not having any development control in the river side establishments. First, the people usually construct these establishments at relatively flood free areas, so these are less susceptible to flood loss; and second, the local administration has no legal framework and resources to ensure any development control.

It may be proposed that local authorities can be given legal authorities for development control in consultation with all stakeholders concerned including BWDB. However, considering the effectiveness and necessity, this has a low priority.

The local residents, farmers, fishermen and development workers claimed that some groups of people sometimes had made cross dams over the rivers for fish culture/capture, which are barriers for smooth flow of water and navigation. The JICA Study Team found that local BWDB has no such record regarding activities in either the side of the river bank or within the river itself.

It is also important to mention that, unplanned rural road development, often supported by the Food for Work Programme, has resulted in blockage to flood waters and fish movements on floodplains. To reduce the adverse impacts of rural road construction, there is a need for institutional changes in the form of inter-sectoral planning process and a practical change to ensure greater provision of fish-friendly culverts through roads wherever they cross existing canals and also traverse extensive areas of open floodplains.

The process of installing culverts requires the consideration of several important issues, including fish passage requirements and the hydrological and physical characteristics of the sites. The various fish species present in the haor area have different swimming and climbing abilities. It is therefore possible to “custom build” in-stream structures to cater for the fish species present in a particular catchment, although it is important to ensure that there are suitable habitats for the species upstream of the culverts.

Watershed management can also reduce flood hazards by controlling the quantity and velocity of flash floods. Proper uses of land, forest, and water resources are primary acts of watershed management. However, since the major watershed of the haor area lies outside the boundary of the country, integrated watershed management is difficult to achieve.

5.0 Flood Forecasting and Warning System

Flood forecasting and warning, as one of significant non-structural measures, can reduce the flood damage by enabling and persuading people and organizations to be prepared for the flood and take actions to increase safety and reduce damage. Its goal is to alert the agencies/departments to enhance their preparedness and to motivate vulnerable communities to undertake protective measures.

5.1 Model Based Forecast

(1) Flood Forecasting and Warning Center (FFWC)

As stated in the BWDB Act-2000, Flood Forecasting in Bangladesh is the mandate and responsibility of Bangladesh Water Development Board (BWDB) and Flood Forecasting and Warning Center (FFWC) of the BWDB has been carrying out this activity. FFWC was established in 1972 and is functioning as directed by the Standing Orders for Disaster (SOD) of the Government of Bangladesh. FFWC is acting as the focal point in co-ordination with other ministries and agencies like BMD, DMB, DAE, etc. during the monsoon season for flood disaster mitigation and management. The center is fully operative working in the flood season, from April to October every year.

The forecasting analysis system of FFWC has been developed and improved through the technical and financial assistance of DANIDA (Danish International Development Agency). However, since the hydro-meteorological records utilized for the forecasting analysis are obtained by manual operation, transmitted through wireless voice communication, and manual input to the model, problems related to reliability, accuracy and immediacy of the input data have occurred. Further, one of the main struggle and demand is to increase the warning lead time.

An ADB project is about to start as a pilot study on satellite based weather forecast incorporating flood forecast. This will be implemented by JAXA.

Data Collection

According to interview with the executive engineer (FFWC) by the JICA Study Team, the FFWC model incorporates 86 representative water level stations and 56 rainfall stations distributed throughout the country. Out of those, 20 water level stations and 15 rainfall stations are in the NE region. (The total numbers of BWDB water level and rainfall stations are 343 and 269, respectively). The real time hydrological data is collected by the single sideband (SSB) wireless, fixed & mobile telephone system through the BWDB hydrological network. WLs for non-tidal stations are collected daily five times at 3 hour intervals during the day time from 6:00 AM to 6:00 PM, and for tidal stations collected hourly. Rainfall is collected daily at 9 AM. Some limited WLs, rainfalls and forecasts of upper catchments from Indian stations are also collected through Internet, e-mail and BMD.

In 2012, 3 automated WL stations were established; one of them is in the NE region, at Bhairab. However, these are not incorporated in the FFWC model yet. It may be mentioned here that, JICA established 14 automated telemetric stations in 1996. However, now all of them are broken.

For the rainfall estimation, satellite images from National Oceanic and Atmospheric Administration (NOAA, USA) and India Meteorological Department (IMD) are used. For the flow data from the Indian territory, they are using the Weather Research and Forecasting (WRF) weather model developed by NOAA, which can convert the rainfall data into flow data.

The JICA funded Maulvibazar Doppler radar data, never used by FFWC as the station is not calibrated yet. A separate JICA project is now doing the calibration and it is expected to be completed in 2013. That project will also establish a link with FFWC for smooth incorporation of radar data into the model. The radar has a 200 km coverage in diameter. This radar gives information on rainfall intensity, cloud height, wind, etc. A cloud height is very important to estimate rainfall amount.

Currently, multi donor funded CDMP II (Comprehensive Disaster Management Project, 2nd Phase) is working with FFWC to improve the lead time, to install new gauging stations, to improve the warning dissemination and to set up new local FF model.

Info Box --- CDMP II

CDMP is an umbrella program executed by United Nations Development Program (UNDP) together with Department of Disaster Management and Relief (DDMR). It is funded jointly by UKAid, EU, Norad, SIDA, AusAID and UNDP. CDMP I was carried out from 2004 to 2009, while CDMP II started in 2010 and is expected to continue till 2014. CDMP II covers 1,780 unions in 200 Upazillas in 40 districts.

Data Processing

FFWC uses the simulation model MIKE11 developed by Danish Hydraulic Institute (DHI) and a special version of MIKE11 FF (flood forecasting) conceptual hydrodynamic model is in operation for forecast formulation.

FFWC developed 'General Model (GM)' in cooperation with DHI and IWM by adopting MIKE11 to real time operation in which the boundary is extended near the Indian borders on all main rivers. This covers the entire flood affected area of Bangladesh, except the coastal southern part (Annual Flood Report, FFWC, 2012). However, the model cannot run in a dry season if the water level is below a certain level, hence, it is not possible to operate this model during the flash flood period.

Output

The principal outputs of FFWC are the daily statistical bulletin of floods, river situation, a descriptive flood bulletin, forecast for 24, 48 & 72 hours at 52 monitoring points, production of Upazilla/Thana Status Map, Satellite Imageries, special flood report along with different graphical and statistical presentation during the monsoon season. Under the CDMP II, there is a plan to increase the lead time from current 3 days to 5 days.

(2) Local Flash Flood Forecasting for NE region

Until recently, FFWC could not forecast for the pre monsoon period because the GM cannot operate in a dry season. In CDMP II, a local FF model for the Northeast (NE) region is under preparation through IWM. The new NE FF model is now operated as a trial basis and experimental flash flood warning has started since 2013 for 8 stations, namely, 3 on Kushiyara, 3 on Surma, 1 on Kalni and 1 on Kangsha. The lead time is 48 hours.

In addition, CDMP II has a plan to increase the number of water gage stations to 400 and to 600 in 2013 and 2014, respectively (Early Warning System: A Briefing for the DER Meeting, 11 February 2013). CDMP II also has a plan of installing 40 automatic water level gauging stations. The locations are not finalized yet, but some of them will be in the NE region. Automatic gauging stations with telemetry will certainly improve the warning reliability.

5.2 Warning Dissemination System

Under the present institutional mandate, the warning is provided by FFWC to all BWDB divisional offices and relevant government and non government organizations, and also posted on FFWC's website (http://www.ffwc.gov.bd). In addition, the bulletins are disseminated to more than 600 recipients including different ministries, offices (central & district levels), individuals, print & electronic news media, development partners, research organizations, NGOs, etc. as well as President's & Prime Minister's Secretariats. Whenever the forecasted river stage crosses the Danger Level, the concerned field offices and limited key officials are informed through the mobile SMS. Warning dissemination to the people is the responsibility of local government.

With support from the Department of Disaster Management and Relief (DDMR) under CDMP II, mobile phone Cell Broadcasting (CB) has been started from July-2011 for flood warning message dissemination. Instant Voice Response (IVR) method is also introduced, and anyone can call 10941 from a 'Teletalk' mobile (a government owned service provider) and hear a recorded Bangla Voice Message regarding the day's flood situation. As a normal call charge is applicable, the voice message is given within one minute duration.

Below the district level, the responsibility of forecast dissemination and response action belongs to Disaster Management Committees (DMC) set up at district, upazilla and union levels. BWDB divisional officials are the members of the District DMC.

Dissemination of flood forecasts and warnings is weak because one organization does not have overall responsibility for disseminating flood forecasts and warnings to potential users. Also, there is no monitoring to confirm whether recipients can understand or use the flood warnings provided. (Bangladesh: Early Warning Systems Study, ADB TA 4562, December 2006).

Currently, FFWC issues warnings on water level at some fixed river locations, which local people cannot correlate with their local areas. As a trial basis, FFWC has been currently producing a national level inundation map. But local level inundation maps cannot be produced unless the new DEM data are available to FFWC. It is recommended that new DEM data for the NE region now being prepared by a JICA project should be incorporated into the FFWC model so that local inundation maps can be produced.

5.3 Simplified Warning System

Simplified flood warning denotes the system that does not use a computational mathematical model. There can be various types of simplified warning systems:

(a) By using historical data employing statistical calculation

(b) Co-relating upstream water gauge levels and downstream floods

(c) Simple visual inspection of upstream river, either physically or through CCTV

Some NGOs tried to apply such system in the haor area, but without much success. A systematic formal arrangements are highly recommended.

Example of Type (a): In 2009, CNRS, an NGO, developed a simplified warning system called "People-centered flood early warning systems" based on rainfall-runoff relationship (Adopting Early Warning System to Address Flash Flood in the Deeply Flooded Haor (Wetland) Basin in Northeast Bangladesh, Center for Natural Resources Studies (CNRS), December 2009). The target area covered the haors in Tahirpur Upazila. However, it was not successful because of lack of availability of rainfall information in the Meghalaya catchment.

Example of Type (b): Another NGO (Oxfam) had some activities on early warning based on upstream water level information. But the flood damage reduction was not achieved well. Though they could issue an early warning, the lead time was short. That could not reduce the damage as enough labor force was not available for harvesting at short notice. It is generally considered that a 7 day lead time is required for effective crop damage reduction (ADB, 2006).

Example of Type (c): A simple visual tower method used in Nepal is shown below. A red flag is hoisted to warn the local people.

<Photo of Simple Visual Observation based Flood Warning in Nepal>

	
Photo 5.1 Community based early warning system in Nepal	Photo 5.2 Automated simplified warning system in Nepal

Source: Resource Manual on Flash Flood Risk Management, Module 2: Non-structural Measures, ICIMOD-USAID, July, 2008

6.0 Local Disaster Management Planning

6.1 Response System/ Evacuation Planning

The response aspects of flood warning are much neglected. This can be attributed to lack of proper warning and dissemination. Also, no response system can function properly as no single organization is responsible for ensuring flood response. (Bangladesh: Early Warning Systems Study, ADB TA 4562, December 2006). One of the reasons for such weak situation could be linked to the fact that the life loss is not a concern in the haor area.

Info Box --- Main lessons learnt from ADB TA of 2006

- A 2-day lead time for flood warning is sufficient to save household assets and small livestock, but a 7-day lead time is required for saving agriculture and properties;
- More infrastructures such as flood or cyclone shelters are required so that villagers may have more choices about the actions they can take in response to warnings;
- Infrastructures such as roads, water supplies, and sanitation facilities need to be designed and maintained in such a way that they may continue to function properly during floods; and
- A systematic way for assessing flood damage needs to be developed.

In 2012, Bangladesh enacted the Disaster Management Act 2012 from a draft that was developed by CDMP I in 2006, and later reviewed by CDMP II. Under the Act, Department of Disaster Management and Relief (DDMR) has been established, and establishment of National Disaster Management Training and Research Centre and National Disaster Management Volunteer Corps is underway. Disaster Management in Bangladesh is guided by National Disaster Management Council headed by the Prime Minister. Similarly, each district has a District Disaster management Committee (DMC) and each Upazilla has a Upazilla DMC.

CDMP II utilizes a simplified Community Risk Assessment (CRA) tool as a bottom-up method to identify risks at the community level and a newly innovated Fast Tracked Risk Assessment (FTRA) as the complementary top-down coordination at the local administration level to produce the Risk Reduction Action Plans (RRAPs). Most of the measures are long term interventions and community-led initiatives, while some agreed priorities for community level, small scale, and quick yielding interventions are to be financed by the Local Disaster Risk Reduction Fund (LDRRF, see the next Info Box).

Info Box --- Local Disaster Risk Reduction Fund (LDRRF)

The Local Disaster Risk Reduction Fund (LDRRF) is a funding mechanism established jointly by Government and the donors in the Comprehensive Disaster Management Programme (CDMP) to provide resources and financial supports for the most vulnerable communities in the form of grants to broaden and strengthen their coping capacities against disaster and climate change.

Governed by a Technical Committee and the Approval Committee, the grant is awarded to small/medium projects that are developed based on the Risk Reduction Action Plans (RRAPs) developed through Community Risk Assessment (CRA) methodology; aligned with other community needs; and being endorsed by the Union Disaster Management Committees (DMCs).

During 2005-2009 LDRRF supported more than 560 small / medium scale projects in more than 380 Unions in 11 districts benefitting over 600,000 vulnerable people.

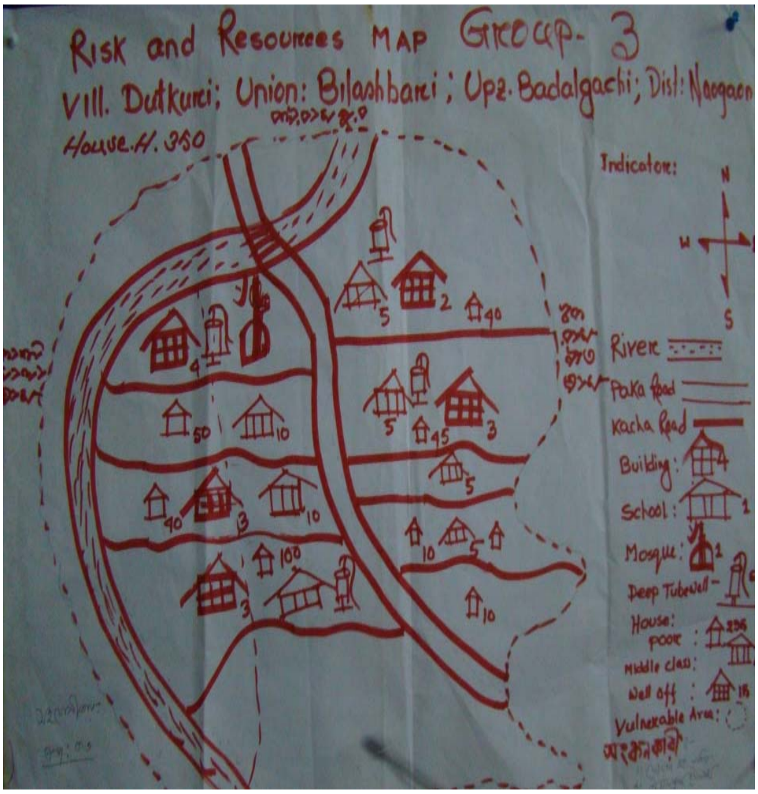
Source: CDMP Leaflet on LDRRF

In 2012, a total of 242 unions have gone through the FTRA/Review of RRAP process facilitated by CDMP II. Moreover during this period, 23 CRAs were conducted to develop RRAPs, bringing a total of 900 unions so far (including 644 CRAs completed during the CDMP Phase I). Among the recommended risk reduction and adaptation measures, some of the community level /small scale interventions are financed by the LDRRF's 1,088 schemes under 206 contracts at a value of around USD 14.4 million. (Annual Progress Report, CDMP II, 2012)

6.2 Hazard Mapping

The local communities in the haor area have no clear understanding about existing flash flood management programs. Even with the current flood warning which gives the expected river water levels at some specific locations, the community cannot correlate that information with their localities.

Many organizations are now working with the local communities to prepare local hazard maps. CDMP II is also doing this on a country wide basis. Some of NGOs are working exclusively in the haor area like POPI. Under their 'Participatory Capacity and Vulnerability Assessment Program', they are preparing local hazard maps as exemplified below.



Source: POPI

Fig. 6.1 Simple Local Level Hazard Map

Asian Disaster Preparedness Center (ADPC) is now implementing a project named "Multi-Hazard Risk and Vulnerability Assessments, Modeling and Mapping in Bangladesh". It is a 30 month project started from Jan 2011 and expected to end in May 2014. This project is under DDMR and funded by Norway. It looks into 7 types of hazards, namely, flood, cyclone, earthquake, drought, tsunami, landslide and industrial disaster. Its final target is to prepare union level multi hazard maps considering exposure of people, infrastructures, roads, etc.

6.3 Flood Shelter

There are few flood shelters in the haor area. They have been used for multi purposes. In normal times, these are used as schools or hospitals. Since human loss is not a serious issue in the haor area flooding, the government and NGOs pay less importance on the flood shelter. DDMR is the government agency which is in charge of construction of the flood shelter. Sometimes they implement this through LGED.

Since there is no formal evacuation plan, the people use their common sense to evacuate. Some NGOs like POPI, CONCERN and Polli Bikas Kendro have been working with the local communities for evacuation planning.

It was learned from the community that they do not prefer to evacuate until it becomes impossible to stay in their houses during floods. The common reasons not to evacuete to the flood shelter are,

- They have to accept the risk of looting of valuable assets and resources from their houses,

- The shelters are not suitable for women as in many cases separate female toilet facilities are not available, and
- The shelters lack facilities for cattle head evacuation.

6.4 Disaster Prevention Edification and Awareness Building

Many organizations are carrying out disaster prevention education and awareness building programs. Among them, CDMP is the leading peoject.

CDMP II launched several initiatives to raise awareness, and promote household preparedness to disasters by providing life jackets, solar lanterns and radio sets. In addition, disaster management education is provided during the preparation of local Community Risk Assessment (CRA). Further, CDMP II now introduces disaster management topics in school text books. Bangla and English versions of two learning modules namely, the Introduction to Disaster Management (IDM) and the Comprehensive Disaster Management (CDM) modules are now accessible at http://elearning.cdmp.org.bd. Communication materials like 1 million posters, 50 thousand leaflets and other materials were published and distributed to schools countrywide.

CDMP II is now forming flood management volunteer corps involving Ansar and VDP (Community Police). CDMP II will also provide training to them.

6.5 Seed Bank and Food Bank

A community Food Bank (CFB) is an idea where buffer stock of food grains is built up at a community level to provide food against seasonal deficits in the lean months (mid-September to mid-November) or during disaster periods. The CFB will keep deposit of food from the beneficiaries and return back it during the crisis period. The depositors may withdraw their food in terms of cash and have the provision in getting interest. Branches can be set up in villages and a central storage is required which may be set up at the upazilla level. Though some NGOs are promoting this idea, it is not widely practiced in the haor districts.

At present, the required seeds for different crops are available mostly by the public sector (BADC). Some private firms also supply some small amount of seeds. After a major flood, usually there is a scarcity of seeds. To overcome this problem, there should be some facility to maintain seed security stock. Public private partnership can be promoted in establishing seed banks, preferably at the upazilla level. Though some NGOs are promoting this idea, it is not widely practiced in the haor districts.

6.6 Flood Damage Insurance/ Crop Insurance

Small scale farmers with few resources are typically unable to insure their crops against extreme weather events and can lose their entire income every time a flood hits. Although flood damage insurance and crop insurance are widely practiced ideas in many flood prone developing countries, it is not yet adopted in the haor area. BRAC, one of the leading NGOs, once tried to introduce crop insurance but it was not very effective.

Now, a new project is going to be implemented soon to develop an ‘affordable’ crop insurance system to natural calamities for the Bangladeshy small farmers who lose crops.

The project titled "Pilot Project on Weather Index-Based Crop Insurance TA - 46284" will be implemented by Asian Development Bank (ADB) under a grant of $2 million from Japan.

The system of weather index-based crop insurance, that incorporates historical weather and crop production data, is considered to be more cost-effective and efficient than traditional agriculture insurance. It reduces farm-level monitoring and transaction costs. Several countries in Asia, including India, Indonesia, Mongolia, the Philippines, Sri Lanka, and Thailand, have begun piloting or providing these products but this is the first time it will be trialed in Bangladesh. The project will design and pilot the insurance over a three years period in selected districts, targeting to cover at least 12,000 farm households. It will collaborate with agricultural banks, multilateral financial institutions and farmer cooperatives and try various models to make the business sustainable. Along with reduced premiums and improved distribution networks, ADB says that the new insurance scheme will provide other benefits to farmers like income support during lean periods, access to credit and a buffer against loan defaults.

The project will also support developing 'a regulatory and legal framework' to accommodate the new concept. Under the project, at least 20 weather stations will be upgraded and at least 400 staff from government and meteorological agencies, insurance companies, agricultural institutions, and civil society groups will be trained up on 'weather-indexed insurance' to improve the accuracy of weather data.

7.0 Livelihood Diversification

Livelihood of the haor people is extremely vulnerable and the combined effect of flash floods, monsoon floods and strong wave action limits the potential for agriculture production. Rural poor households in the haor area have to depend upon fisheries and off-farm labor to supplement the meager farm income. The common property nature of the water bodies (Jalmohals) and the unfavorable lease arrangements inhibit the full growth potential of the fishery sector. This forces many people to opt seasonal migration to find work.

To maintain the livelihood of the vulnerable haor community, paddy variety diversification, non rice crop diversification and job diversification is essential to coping with the situation. All the haor farmers are not fully motivated to such switchover yet.

7.1 Paddy Variety Diversification

The seven haor districts comprising 39 Upazillas accounts for 13.5% of the Bangladeshy area, 12% of the population, and 11% of the agricultural households. About 5.25 million metric ton of rice is produced in the haor area, which is 18% of the total rice production in Bangladesh on an area of 1.74 million ha (16% of total rice production area). Considering Boro rice is the only rice crop in the haor area, it can be said that the production yield of the haor area is above the country average.

The haor farmers grow both local and hybrid varieties of boro rice. Most hybrid varieties are developed by Bangladesh Rice Research Institute (BRRI). The most common varieties are BR-28 and BR-29. The present status of Boro rice cultivation in seven haor districts is as follows.

Table 7.1 Distribution of Paddy Varieties (2012-2013 season)

Districts	**Percent of Boro rice varieties out of total Boro rice production (%)**				
	BR-28	BR-29	BR-19/ other BR	Non BR hybrid	Local/ Others
Kishoreganj	35	45	-	19	1
Netrokona	55	35	-	-	10
Sylhet	47	31	4	5	13
Moulavibazar	36	35	18	7	4
Habiganj	16	42	-	34	8
Sunamganj	23	52	5	10	10
Brahammanbaria	47	44	-	8	1

Source: Compiled by JICA Study Team through interview survey of head office and 7 district offices of Department of Agricultural Extension (DAE) during May 2013.

The haor farmers select the varieties based on soil conditions, grain yield, seed availability, cost of inputs, and maturity duration. The apparent popularity of BR-28 and BR-29 has its roots on the fact that BR-28 is a short maturation variety (140 days) and BR-29 has a rather high yield (7.5 t/ha). BR-28 can offset the risk of crop damage due to flash floods to some extent. In addition, with BR-28, farmers can produce other short life crops (garlic, onion, etc.). Following table shows the salient features of 5 popular BR rice varieties in the haor area.

Table 7.2 Salient Features of BR Rice Varieties Farmed in Haor Area

Rice variety	**Seed sowing time**	**Harvesting time**	**Grain yield (Ton/ha)**	**Days of maturity**
BR 14	15 Nov-20 Dec	1 May-31 May	6.5	160 days
BR 19	15 Nov-15 Dec	18 April-4 May	6.0	170 days
BR 28	15 Dec-7 Jan	1 May-25 May	6.0	140 days
BR 29	30 Oct-15 Nov	19 April-2 May	7.5	160 days
BR 45	15 -30 Nov	1 April-7 April	6.5	145 days

References:

1. BRRI-Bangladesh Rice Research Institute-Fact sheet (Web based Fact Sheet-Training Module)

2. Crop Production in the Haor Areas of Bangladesh: M. Shahe Alam et. al., Journal of Agriculturalist (Krishi Foundation, 2011)

3. Plant Varieties Developed by the NARS Institutes and Agricultural Universities (BARC Publication, June 2011)

From the above table, it can be seen that BR-45 is the earliest harvesting type with a reasonable yield. However, its stem is very weak against wind and also shattering (falling off the grains during harvesting) is a big problem. Thus, it is not much popular and only practiced in the most vulnerable areas. BRRI is now trying to solve these problems. Though BR-29 is very popular, it cannot withstand if temperature is less than 13 ºC, so in years of severe cold, its yield drops drastically.

The above discussion concludes that though the best scenario has not been achieved yet, paddy variety diversification is well practiced in the haor area as one of non-structural measures for flash flood damage reduction. Until now, no single rice seed has been found without any limitation. So there is a need to continue rice research / crop diversification research. Many suitable technologies have been demonstrated, however, these technologies have not been properly promoted yet. So, there is a need to enhance farmer awareness about them. Farmers are also constrained by the availability of improved seeds. There is a need to enable farmers to use market opportunities and create linkage with markets for small holder producers.

7.2 Crop Diversification

The major problems of the haor area in an agricultural sector are associated with flood damage, drainage congestion, difficulty in timely transplantation, seedlings scarcity, land ownership and tenancy, access to inputs and credit, man power shortage and transportation during harvesting and post harvesting activities, lack of storage facilities and marketing, etc. To cope with such adverse situations, the haor farmers have been trying to diversify crops.

Some of crops are cultivated during the Robi (winter period) period, usually before the Boro cultivation; and the others are cultivated during Kharif (summer period). The cultivation areas of major crops in the study area are given in the following table.

Table 7.3 Cultivation Areas of Major crops in the Study Area

Crop Group	Crop Area ('000' ha)							
	Sunamganj	Kishoreganj	Netrokona	Sylhet	Habiganj	Moulvibazar	Brahmanbaria	Study Area
Aus	3.9	23.0	1.8	45.9	33.6	32.4	3.8	144.4
T Aman	67.8	76.7	139.2	162.9	67.2	102.5	47.5	663.6
B Aman	-	-	-	6.3	26.1	4.1	24.1	60.5
Boro	193.8	166.3	176.3	77.2	108.0	40.4	109.3	871.3
Total Rice	***265.5***	***266.0***	***317.3***	***292.2***	***234.9***	***179.4***	***184.7***	***1,739.8***
Wheat	0.6	1.7	1.0	3.2	0.7	0.1	2.3	9.6
Maize	-	2.5	-	2.0	0.0	-	0.0	4.5
Oilseeds	2.9	6.5	3.1	4.8	1.4	0.2	5.3	24.2
Pulses	0.4	1.8	0.6	3.8	0.5	0.3	4.8	12.2
Spices and Condiments	1.4	4.2	2.4	2.8	1.7	1.1	5.5	18.9
Potato	1.9	6.5	2.5	5.5	2.2	1.9	3.6	24.0
Vegetables	8.5	9.8	6.1	18.8	9.0	11.6	9.4	73.2
Jute	0.5	8.5	7.7	-	0.5	-	5.0	22.0
Sugarcane	-	-	-	-	0.3	-	-	0.3
Total Non Rice	***16.1***	***41.5***	***23.3***	***40.7***	***16.3***	***15.2***	***35.9***	***189.0***
Total Crop Area	**281.5**	**307.5**	**340.6**	**332.9**	**251.1**	**194.6**	**220.6**	**1,928.8**
Net Crop Area	**254.0**	**196.9**	**211.1**	**208.7**	**162.9**	**126.9**	**150.4**	**1,310.9**
Cropping Intensity (%)	***111***	***156***	***161***	***160***	***154***	***153***	***147***	***147***

Source: Department of Agriculture Extension (DAE), 2010

It can be seen from the above table that vegetables, potatoes and oil seeds are the major non rice crops in the study area. CONCERN is promoting cultivation of a special potato. This special potato can be planted in late November and requires only 40 days to harvest. So the people can cultivate Boro rice after harvesting the special potato.

Another important aspect is that the cropping intensity is more than 1 in all the districts. Though there is a room for improvement, it can be said that crop diversification is well practiced in the haor area as one of non-structural flood measures to reduce the flood related damage.

The yield levels of different crops are closely associated with soil conditions, input usage (fertilizer, etc.) and cultural practices. The yields of different crops cultivated in the haor area are given in the following table.

Table 7.4 Yield Rates of Different Crops in the Study Area

Crop Name	Yield rate (ton/ha)						
	Brahmonbaria	Hobigonj	Kishoregonj	Moulovibazar	Netrakona	Sunamganj	Sylhet
Aus	1.99	2.46	2.50	2.61	2.21	2.18	2.46
T Aman	2.43	2.68	2.56	2.53	2.40	2.07	2.60
B Aman	1.18	1.39	-	1.01	-	-	1.34
Boro (all types)	3.83	3.64	4.08	3.24	3.25	3.37	4.10
Average Rice	3.09	2.95	3.51	2.67	2.87	3.02	2.95
Wheat	1.94	2.26	2.02	1.80	2.46	2.22	2.20
Maize	2.00	6.00	4.40	-	-	-	5.19
Oil seeds	1.20	1.13	1.06	0.86	0.87	1.19	1.14
Pulses	0.92	1.17	0.95	0.80	1.06	1.31	1.17
Spices and Condiments	2.23	3.66	3.00	4.15	3.72	1.99	2.25
Potato	11.11	9.05	15.85	12.05	12.83	16.49	11.66
Vegetables	14.00	15.45	5.68	14.48	19.95	16.23	15.00
Jute	1.50	1.80	1.70	-	1.50	1.29	-
Sugarcane	-	44.42	-	-	-	-	-

Source: Department of Agriculture Extension (DAE), 2010

Notes:

1. Rice yields are average of all types of hybrid and local varieties.
2. Pulses include Arhar, Gram, Kheshari, Maskhalai, Motor, Mung, Mushur, other pulses.
3. Oilseeds include Groundnut, Mustard, Till.
4. Vegetables include Beans, Brinjal, Cabbage, Cauliflower, other winter vegetables, Spinach, Pumpkin, Radish, Sweet Potato, Tomato, Water Guard, Arum, Long Beans, Brinjal_kharif, Chalkumra, Chichinga, Cucumber, Danta, Jhinga, Kakrol, Karala, Lady's Finger, Patal, Puisak, other kharif Vegetables. The yield level of vegetables has been calculated on the basis of average yield values of vegetables both in summer as well as winter.
5. Spices include Chilli_Kharif, Chilli_Rabi, Coriander, Garlic, Ginger, Onion, and Turmeric.

Other potential crops are shrubs such as bamboo and mustaq. These plants can provide vegetative protection against wave erosion, and are also raw materials for mat and basket making.

Case Studies

To tap the potential of crop diversification, many NGOs and agencies have been carrying out various activities. Three case studies are explained briefly in the following.

(1) CNRS

CNRS, NGO working in the haor area, undertook a pilot project with the assistance from Bangladesh Agriculture Research Institute (BARI) and Bangladesh Rice Research Institute

(BRRI): the two are national research institutions. The main target was to assist the farmers to adjust with their improved cropping patterns.

The pilot project, funded by Oxfam Hong Kong, tested 126 demonstration plots with 18 different crops together with local farmers from ten villages in Sunamganj District. Several techniques were tested to shorten crop maturity (by varying transplanting of seedlings), change in seedling and harvesting periods, and find optimum fertilizer use. Results of the pilot project are given below. Out of 18 crops, only tomato and Bate shak returned poor conclusion.

Table 5.5 Results of CNRS Pilot Project on 18 Crops in Sunamganj

	Observed Yield (ton/Ha)	**Optimal yield (t/Ha)**	**Conclusion**
BRRI 45 Rice	7.14	6	Recommended
BRRI 29 Rice	9.88	7.5	Recommended
Wheat	4.01	3.5 - 4.6	Recommended
Potato	29.64	25 - 30	Recommended
Garlic	9.88	10 - 12	Recommended
Onion	11.12	12 - 15	Recommended
Bitter gourd	24.70	25 -28	Recommended
Sweet gourd	69.34	60 - 70	Recommended
Bate shak	14.82	45 - 55	not recommended
China shak	25.35	25 -30	Recommended
Red amaranth	12.84	12 - 14	Recommended
Stem amaranth	12.35	13 - 15	Recommended
Garden pea	9.88	12 - 14	needs further trials
Eggplant	49.40	45 - 50	Recommended
French bean	13.59	13 - 14	Recommended
Tomato	25.94	80 - 85	not recommended
Radish	41.17	55 - 60	needs further trials
Mung bean	0.98	1.2 - 1.5	needs further trials
Black gram	1.23	1.4 - 1.6	needs further trials

Source: CNRS Publication on results of Pilot research, written by M. Anisul Islam and Mokhlesur Rahman Suman, retrived from CNRS website,

(2) Climate Change Cell

Climate Change Cell under Ministry of Environment, in collaboration with BRRI and BARI tested adaptive cropping at the farmers' fields between 2006 and 2008, which demonstrated encouraging results. The research was conducted in Sunamganj District by employing CNRS. Research findings have opened up avenues for the farmers to adapt to the risks of flashfloods. However, more social and institutional work is needed to sensitize farmers to the shift from their traditional preference over rice to other non-rice crops as well as to provide an enabling institutional mechanism that could facilitate extension of adaptive cropping to wider communities exposed to flashflood hazards.

The comparative analysis of different crops is summarized in the following table. Apart from the 3 Boro varieties, all other crops shown in the table can be harvested well before flash flood occurrence. It can also be seen that some of crops returned much more profit than conventional Boro crop, like Radish, Sweet gourd, Bitter gourd and Garlic.

Table 7.6 Comparative Analysis of Different Crops

Name of crops	Flash Flood Impact			Economic Aspects				Type of land that can be used
	Maturation days	Harvesting time	Safe from Flash Flood?	Production cost (Taka/Ha)	Production (Ton/Ha)	Market price (Taka/Ha)	Gross profit (Taka/ Ha)	
BR-28	145	Early Apr	No	41,310	5.37	64,440	23,130	Winter rice land
BR-29	150	Mid Apr	No	40,333	6.18	80,340	40,007	Winter rice land
Habiganj Boro 6	145	Early Apr	No	41,310	4.56	52,440	11,130	Winter rice land
BR-45	140	End Mar	Yes	41,310	5.98	74,450	33,440	Winter rice land
CH 45	140	End Mar	Yes	41,310	5.55	66,600	25,290	Winter rice land
French bean	70	Early Jan	Yes	63,726	7.41	74,100	10,374	Fallow land, adjacent homestead and front yard
Radish	65	Early Feb	Yes	69,024	37.05	370,500	301,476	Adjacent homestead and front yard
Spinach	40	Early Jan	Yes	34,083	5.56	55,600	21,517	Adjacent homestead and front yard
Garden pea	95	Early Mar	Yes	33,094	9.98	149,700	116,606	Adjacent homestead and front yard
Sweet gourd	130	Early Feb	Yes	85,026	68.13	340,650	255,624	Fallow land, adjacent homestead and front yard
Red amaranth	45	Early Jan	Yes	36,513	8.98	53,880	17,367	Adjacent homestead and front yard
Stem amaranth	65	Mid Jan	Yes	46,728	47.01	235,050	188,332	Adjacent homestead and front yard
Bitter gourd	120	End Feb	Yes	117,633	28.4	340,800	223,167	Fallow land, adjacent homestead and front yard
Potato	75	Mid Feb	Yes	156,063	19.06	285,900	129,837	Winter rice land, Fallow land, adjacent homestead and front yard
Ash gourd	85	End Jan	Yes	47,542	17.90	89,500	41,958	Adjacent homestead and front yard
Onion	120	End Mar	Yes	64,343	11.36	227,200	162,857	Winter rice land, Fallow land, adjacent homestead and front yard
Garlic	130	End Mar	Yes	120,528	9.92	496,000	375,472	Winter rice land, Fallow land, adjacent homestead and front yard

Source: Climate Change Adaptation Research: Adaptive Crop Agriculture Including Innovative Farming Practices in Haor Basin, Dec, 2008, Climate Change Cell, DoE, MoEF; Component 4B of CDMP, MoFDM

(3) CDMP II

DCRMA (Disaster and Climate Risk Management in Agriculture) is a component of CDMP-II, having been implemented since 2011 by Department of Agricultural Extension (DAE). DCRMA has project activities on crop diversification, integrated farming, adaptive farming, farmers' capacity building, etc. in 4 haor districts (Habiganj, Netrokona, Sunamganj and Moulovibazar).

One of the DCRMA activities is Field Demonstrations in Kharif-II, 2011 and Rabi, 2011. Followings are the recommendations from the demonstration activities for the haor area: (Present Status of Established Field Demonstrations in Kharif-II 2011 and Rabi 2011, published March, 2012, Implemented By: DCRMA Project under CDMP-II/ DAE Part)

- Development of late T. Aman variety
- Introduction of submergence tolerant rice (BRRI 51, 52)
- Use of early variety of BRRI 45
- Introduction of pulse, maize, mustard, etc.
- Establishment of fruit garden
- Vegetables cultivation
- Swamp tree plantation
- Green manuring like dhaincha cultivation
- Supplementary irrigation in Aman and Aus
- Short duration variety (for Boro 120-130 days)
- Storage of surface water
- Mechanical cultivation introduction
- More use of surface water
- Increase of homestead activities
- Establishment of appropriate crop demonstration (short duration variety coconut, dhaincha, betel nut, orhor, drum stick, quickly growing vegetable and fruits, mushroom)
- Motivational and Training program for farmers

In another activity of DCRMA, it has demonstrated the effectiveness of floating garden on hyacinth beds (for aroid, okra, red amaranth, stem amaranth, cucumber, Indian spinach, turmeric and seedlings production in floating beds), boro seed production in dry bed, community based cultivation and community based seed storage for higher viability in the haor area (Report on Floating Vegetable Cultivation, February, 2013, by DCRMA/ DAE).

During the monsoon season when otherwise agriculture is not possible, the floating agriculture has several advantages: (1) the waterlogged area can be cultivated and the total cultivable area can be increased, (2) an area under floating cultivation is more fertile compared with the traditional land, (3) no additional fertilize and manure is required unlike the conventional agricultural system, (4) after cultivation, the biomass generated could be used as organic fertilizer in the field, (5) it conserves the environment, (6) during the floods it can be used as a shelter for the poultry and cattle, and (7) a farmer can harvest crops and fish at the same time. All the activities of the practice are environmentally friendly and can prove to be an alternative livelihood option.

7.3 Job Diversification

Flash flood damage is directly associated with agricultural activities. To reduce the damage of flash floods, nonagricultural income generation activities are promoted. There are scope and opportunities for undertaking some innovative income earning initiatives such as floating cage fish culture, beel nursery, pen culture, etc. Some of these are well known technologies in the country although they may not be well known in the haor area.

To improve livelihood of the haor community, there are many NGOs working on fish and fisheries resources management and conservation in Bangladesh. Their main activities include but not limited to (i) Mono- and poly-culture of different species; (ii) Nursery management programme; (iii) Baor fisheries development and management; (iv) Credit programs; and (v) Extension Programmes. NGOs working on a fishery sector includes Bangladesh Rural Advancement Committee (BARC), Proshika Mannobik Unnayan Kendra, Rangpur Dinajpur Rural Service (RDRS), Care International Bangladesh (CARE), Caritas Bangladesh, Association for Social Advancement (ASA), Gano Shahajya Sangstha (GSS), Association of Development Agencies in Bangladesh (ADAB), World Fish Bangladesh, IUCN, Christian Commission for Development in Bangladesh (CCDB), Friends in Village Development, Manabik Sahajaya Sangstha, Technical Assistance for Rural Development (TARD), POPI, CNRS, Chetona, etc.

It can be said that though there is further room for improvement, job diversification is currently used widely as a tool of non-structural flood measures to reduce flood related damages.

(1) Capture Fisheries

The contribution of haor capture fisheries to the livelihood of rural poor in the haor area is historically very significant. Many of the people, particularly the poor, often depend on fishing in the floodplain for living. Although 2.59% of the study area population are full-time fishermen, over 65% of the households engage in fishing as part-time or as subsistence fishing. Rapid population growth has caused increased fishing leading to reduction of fish stocks, which in turn has adversely impacted on the livelihood of those directly dependent on the capture fisheries.

(2) Beel Nursery

Beel is generally defined as the deepest parts of a haor, where water remains even in the dry season. Beel nursery is a good and fruitful way of increasing biodiversity and production of pure strain and native fish species. In this scheme, government owned beels are made available to fishery groups through lease agreement. The groups then maintain sustainable fishing after getting proper training. This activity ensured higher production of fish and improved the livelihood of the local fishermen community.

To boost up haor fisheries production and increase fish biodiversity and thus, in turn to improve livelihood of the haor fishermen community, beel nursery activities were undertaken by LGED under financial assistance from a UN agency International Fund for Agricultural Development (IFAD) (See Case Study below).

Some of successful examples of job diversification are the two IFAD financed LGED projects. First, Sunamganj Community Based Resource Management Project (SCBRMP) implemented promotion of beel nursery development in one haor district (Sunamganj) and based on its very positive results it is replicated in Haor Infrastructure and Livelihood Improvement Project (HILIP).

Info Box --- two IFAD funded LGED projects

SCBRMP started from 2002 and is expected to end in 2014. The estimated cost is US$ 50 million and the target beneficiaries are 90,000 farmers (SCBRMP leaflet, 2010). The HILIP started from 2012 and is expected to run until 2019. The estimated cost is US$ 118 million and the target beneficiaries are 688,000 households (HILIP leaflet, undated).

Case Study

Under the Community Resource Management component of these two Projects, a total of 500 beels are to be brought under Beel User Groups (BUG). The BUG is a community management institutional arrangement for the Beel re-excavation to improve their productivity and biodiversity. The objective of this component is to improve the livelihood of poor rural households engaged in fishing by improving their access to fish resources, increase in fish production and the fish species in the beels of the haor area.

With agreement from the Ministry of Land (as owner of the beels), the BUG is to gain access to public water bodies. The combined impact of beel development and improved management of this resource has helped to increase fish production and fish species in the Beels. It is estimated that around 20,000 members of the BUGs will benefit from this component of which at least 20% will be women. (HILIP Project Design Report, May 2011). HILIP project thus opens up new income source of the people to compensate agricultural flood damage.

Water of some beels is drained out and may become dry. As a result, beel fisheries cannot be practiced. To address this issue, establishment of a spillway on a drainage canal is considered. The spillway can retain water in the beels at a certain height during the flood recession period.

The Department of Fisheries (DoF) has also conducted beel nursery activities through Second Aquaculture Development Project. DoF had implemented around 75 beel nursery in the haor area from 2009-10.

Because of the success of these projects, now IFAD is forming a new project called CALIP to expand the coverage. The scope of CALIP is expected to be finalized within 2013.

(3) Pen Culture

The pen culture of fish farming is a method of growing fish by holding them captive within an enclosed space in rivers, floodplains or lakes whilst maintaining a free exchange of water. This pen culture is an alternative open system of commercial breeding that allows interaction with the immediate environment, yet prevents the entry of undesirable animals and fish that may harm the cultured stock. This kind of practice is highly suitable for the community based approach and its popularity has been increasing.

(4) Floating Cage Culture

Cage culture is an aquaculture system where fishes are held in floating net pens. Cages are widely used in overseas commercial aquaculture and individual cage units come in all shapes and sizes and can be tailored to suit individual farmer’s needs. One popular size of the cage is 20´X10´X6´. Cage units can be purchased through commercial outlets, but can also be made from readily available construction materials such as poly pipe, bamboo or wood or/and steel. Cages are mostly used in open freshwater bodies where gentle current of water prevails. In the study area, such examples are found in South Sunamganj (22 nos.), Mithamain (12 nos.) and Jamalganj (10 nos.), (Source: Upazila Fisheries Officer). However, it is not suitable where the wave actions are high. The main problems of cage fishing are cage dislocation and fish food washing away due to wave action. Thus, further trial is recommended.

(5) Poultry/ Livestock

In the case of poultry/ livestock, the principal threat is from disease. There limited is the access to vaccination and improved feed preparation technologies which can help to build the resistance against disease as well as improve animal productivity. There also limited is the knowledge about preventive disease measures. The strategies required are to build linkage with private sector service providers, ensure market access, enhance capacity of local para-vets, and access to improved inputs such as day-old chicks and improved feed.

For livestock and poultry, the focus should be on developing the linked elements within a value chain. One of the keys for improvement is access to health services and breed upgrading. To do this, it requires establishment of sustainable support services. Similarly the introduction of improved breeds of chicken and duck through breeding services (mini hatcheries) are important.

(6) Agro Industry

For the synchronization effect, cottage industries based on agro-products are most recommendable. For example, fish processing (dried fish) can be improved through updating processing and packaging techniques and establishing linkage with buyers. Another practice can be value addition to bamboo and mustaq (local aquatic plants). These plants can provide vegetative protection against wave erosion, and also raw materials for mat and basket making.

Quality improvement of handicrafts and access to new markets can be an important initiative. The IFAD funded HILIP proposed to provide training and capital support for such income generating activities mainly for women. The project will closely work with the smallholder producers and other market actors along the value chain.

It is also possible to establish alternate use of agro product and by-product. For example, it is possible to make ethanol (bio-fuel) from straw of paddy. Japan’s Kawasaki Heavy Industries installed such plants in Japan. The largest plant can produce 22,500 l/year of ethanol at a cost of JPY 40/liter. The US market price of ethanol in May 2013 was about JPY 55/ liter. It is a viable option but needs further investigation on availability of straw, transportation to plant, plant location and marketing strategy.

7.4 Improved Market Access

The agricultural production system is closely linked with storage and marketing facilities. The storage facilities for crops in the haor area are very poor. The inaccessibility of the haor area makes it difficult for farmers to get the reasonable prices for their produce. Most of the farmers sell their products in village markets immediately after harvest when prices are typically low. The reason for farmers' inability to store their crops are (i) need of cash, (ii) lack of proper storage facilities, (iii) crop loan obligations, and (iv) tenure crop division arrangements. The producers are then frequently obliged to replace this food grain at higher prices to meet daily consumption requirements during the off-season. The marketing system is traditional. In order to improve the socio-economic conditions, the marketing system needs to be strengthened through establishment of regulated markets, construction of warehouses, provision for grading of crop quality, standardization of produce, standardization of weight and measures, daily broadcasting of market prices of agricultural crops on Radio, TV, daily news paper, and improvement of transport facilities, etc. The agriculture marketing system should be developed for improvement of the haor area. Producers should be linked with markets and may be organized into market-based farmer’s associations, with interventions aimed to improve links with buyers and input suppliers.

Case Study

Under the Livelihood Protection Component of HILIP, the livelihood is to be improved by adopting a value chain approach for crop cultivation particularly rice, horticulture and livestock such as ducks, poultry, etc. The broad objective of this component is to enhance production, diversification and marketing of crop and livestock produce. This component will develop the capacity of smallholder producers to participate in selected market-based value chains and establish and support market-based institutions. A total of 94,000 persons are expected to directly benefit from this component in the 26 project Upazilas. (HILIP Project Design Report, May, 2011)

8.0 Flood Proofing of Living Environment

This includes raising of houses, tube-wells, latrines, stock yards, and construction of new platforms above the flood levels to be used for housing purpose (new villages) and markets.

Though it involves physical construction, flood proofing is widely recognized as one of non-structural measures. According to UNESCO Guideline, (Guidelines on Non-Structural Measures in Urban Flood Management, International Hydrological Programme -V | Technical Documents in Hydrology | No. 50, UNESCO, Paris, 2001), “Flood proofing is the use of permanent, contingent or emergency techniques to either prevent flood waters from reaching buildings and infrastructure facilities, or to minimize the damage from water that does get in.

8.1 Raising of Habitat Area

People are living for many generations in the haor area and thus, they adopted their living style with the normal monsoon flood. In most cases, their houses, tube wells, stock yards, cattle houses, latrines, etc. are constructed above a normal flooding level. In this way, they can reduce the flood damage. However, in some years of extreme flooding events, their habitats go under water.

Many NGOs help poor people in raising habitats, either by providing materials or by cash. Some NGOs integrate these activities with their micro-credit scheme or health safety scheme.

8.2 Raising of Villages and New Platform Construction

In this approach, part or an entire area of a village is raised above a normal flood level or a new platform is constructed above a normal flood level to be used as a village or market area. POPI is leading in this approach and constructed 4 platforms from 2011 to 2013. All four platforms are constructed in Chatirchar Union, Nikli Upazilla in Kishoreganj District. The layout and photos are as shown in the following. The layout photo shows their sizes and construction years. One of them is used as a market area and the rest are used as living villages. The height of the platforms was 11 feet.

The land is given under a lease agreement to the homeless people for 10 years without any ownership right. The Union Council and local community together decide who gets the land lease.

The priority was given to those who had lost their home due to erosion, female headed family, family with no agricultural land, and very poor. In the 3 living villages, a total of 250 families have get land. Each family got a land parcel of 25 ft X 15 ft.

The construction was done using dredged materials extracted from the nearby river. Layers of soil was placed and then compacted manually. All cost was borne by POPI but periodic maintenance is expected to be done by the beneficiaries. The actual construction cost of one of the platform with a size of 150 feet long, 120 feet wide and 11 feet high (198,000 cu. ft) was 4.9 million BDT, which is equivalent to BDT 2.45 per cu. ft, or BDT 87 per m3 (Contract award document, POPI, 2012).

With the success of POPI, now BWDB is planning to replicate the new platform construction in their Kalni-Kushiara dredging project.

Source: JICA Study Team Field Investigation

Photo 8.1 The Locations of newly raised villages at Chatirchar, Nikli

Source: POPI

Photo 8.2 A newly raised village named Sunaulla hati, Chatirchar, Nikli where community people has manage 70 decimal land for the land owners without any interest

Photo 8.3 Constructed platform Side View

Photo 8.4 Stair to Constructed Market

Photo 8.5 The Newly Constructed Village

9.0 Participatory Water Resources Management

There are many structural water resources management facilities in the haor area: namely, submergible embankment, culverts, regulators, protective dykes, etc. In a traditional way, these are managed by public sector agencies. However, due to lack of proper O&M, sometimes these structures may not function properly and lead to flood related damage. It is now considered that stakeholders participation in operation and management of such structural facilities can ensure proper O&M and reduce the flood damage. Thus, water resources management through a participatory approach is sometimes considered as one of non-structural measures of flood damage reduction.

Ministry of Water Resources (MoWR) prepared a Guideline for Participatory Water Management in the light of participatory water management as provided in NWP (National Water Policy). The stakeholders of such participatory water management are:

- Local stakeholders,
- Water management organizations,
- Local government institutions,
- Ngo/community level self help groups,
- Private sector service providers,
- Implementing agencies, and
- Other public sector agencies.

The guideline also stipulates the scope and function of three tier entities on the basis of size and complexity of the project/scheme (see the next Info Box), namely, Water management group, Water management associations and Water management federation.

Info Box --- Water Management Organizations

Three types of water management organizations are proposed, namely, Water Management Group (WMG), Water Management Associations (WMA) and Water Management Federation (WMF). For each project/ scheme, there will be at least one level of WMO. The number and level of WMO to be formed in any project/ scheme will be decided by the stakeholders on the basis of their preference and in consideration of the size and complexity of the project/ scheme.

- WMG at the lowest level for each smallest hydrological unit or social unit (village)
- WMA at the apex level of project/ scheme up to 1,000 ha; or at mid level of project/ scheme more than 1,000 ha
- WMF at the apex level of project/ scheme more than 5,000 ha, and sometimes at the apex level of project/ scheme between 1,000 and 5,000 ha.

Source: Guidelines for Participatory Water Management, Ministry of Water Resources

Case Studies

Four case studies are given below.

(1) WMIP Project

Water Management Improvement Project (WMIP) is an on-going project of BWDB funded by World Bank and the Netherlands government, expected to be completed by 2015. The project is basically designed to expand the role of communities in water resources management, to empower them to manage the infrastructure and to provide a framework for participation of beneficiaries and stakeholders in rehabilitation and operation of the water management (Inception Report of Component 1 and 2, WMIP, November, 2010).

The view of participatory water management was successfully tested in a previous project called Integrated Planning for Sustainable Water Resources Management (IPSWRM) involving 9 polders. WMIP is intended to improve, modify and apply the IPSWRM model in a broader scale.

In the WMIP project, a 10 step Participatory Scheme Management (PSM) is applied, where the steps are, (1) Identification, (2) Scheme assessment, (3) Screening, (4) Mobilization, (5) Planning, (6) Design, (7) Implementation, (8) Management plan preparation, (9) One year trail operation and maintenance period and (10) Evaluation and management transfer. In this way, it is expected that the people will develop a sense of ownership of the project.

The core component of the participatory approach is formation of water management organizations. In WMIP, 2 tiers of such organizations have been considered, Water Management Group (WMG) at the lowest level and Water Management Association (WMA) by combining a number of WMGs. The WMA has at least a 30% representation of women and should consist of one male and one female representatives elected by each WMG. In addition, representatives of landless people, fishermen and destitute women are to be included in the WMA.

The O&M activities are divided into three groups under the WMIP, namely (1) preventive maintenance, (2) periodic maintenance and (3) emergency maintenance. It is proposed in WMIP that WMA will be responsible for preventive maintenance while BWDB will provide both periodic and emergency maintenance.

In the WMIP project, 67 schemes are under execution and first results of management transfer will start to emerge from 2014. However, no schemes are included in the haor area.

(2) Local Government Engineering Department (LGED) Practice

The Small Scale Water Resources Development Projects of LGED (funded by ADB and JICA) organized Water Management Cooperative Association (WMCA) for the operation and management of the facilities. The implementation started from mid 2000 and currently is expected to be continued till 2017. Under SSW-I and II, about 570 sub projects were developed and handed over to Water Management Cooperative Associations (WMCAs) for O&M, and by 2017, a further 260 and 200 sub projects will be developed under ADB and JICA assistance, respectively.

The LGED small scale project revolves around the concept of Water Management Cooperative Association (WMCA). In a typical sub project, the WMCA has to make an upfront contribution and the subproject is constructed by the LGED. After management transfer, the WMCA is responsible for operation and also for routine maintenance. The periodic maintenance is done by LGED. However, in most cases, WMCA also contributes a matching fund for the periodic maintenance.

This LGED model is generally considered to be very successful. However, there are further room for improvement. The "O&M Strategy Development for Small Scale Water Resources Subprojects" (ADB, May, 2009), mentions that "……additional targeted post handover support for maximum and sustainable benefits is required……”.

(3) “Concern” Practice

Concern, an international NGO based in Ireland, carried out 21 sub projects in the haor area for village protection from wave action with financial assistance from Irish Aid and European Commission under the project name “Haor Initiatives for Sustainable Alternative Livelihood (Hisal)”. The project was implemented between October 2006 and December 2011.

In this project, Concern organized a cooperative society in the target village and the society created a maintenance fund upfront. The beneficiaries also contributed all labor required for the construction. After the completion, the ownership was transferred to the village cooperative society and they took over responsibilities for all kinds of maintenance.

According to Concern, in the past 5 years, there were 2 cases of collapse out of the 21 sub projects; however, the villagers successfully reconstructed those without any assistance from Concern. Thus, the model is generally considered to be successful.

(4) CNRS-CARE Practice

Under the CNRS-CARE project “Flood Risk Reduction Activities in Sunamganj, FRRAS, Phase –II, December 2006 –March 2010”, a number of activities were undertaken to protect agricultural crops from flash floods by making natural barriers through planting of swamp trees, i.e. Hijol and Koroch saplings as one of non-structural flood measures. They planted 30,000 saplings of these species in the haor areas of Sunamganj District. They also develop and put in place community-based systems and mechanisms involving communities and Union Parishads to ensure regular maintenance and durability of submergible embankment and tree plantation activities.