

**MINISTRY OF FINANCE  
MINISTRY OF LOCAL GOVERNMENT, RURAL DEVELOPMENT AND  
CO-OPERATIVES  
KHULNA WATER SUPPLY AND SEWERAGE AUTHORITY (KWASA)  
THE PEOPLE'S REPUBLIC OF BANGLADESH**

**FEASIBILITY STUDY  
FOR  
KHULNA WATER SUPPLY  
IMPROVEMENT PROJECT  
IN  
THE PEOPLE'S REPUBLIC OF  
BANGLADESH  
  
FINAL REPORT  
  
VOLUME III  
SUPPORTING REPORT**

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SUPPORTING REPORT**

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### Supporting Report 3.3.1 KWASA’s Hand Pumps Investigation

JICA Study Team outsourced the flow measurement survey to a local consultant. The local consultant was conducted the survey for selected 30 numbers of KWASA’s hand pumps in November, 2009. This investigation is to cross check their results and to fix the flow rate of KWASA’s hand pumps.

#### Parameters to be measured

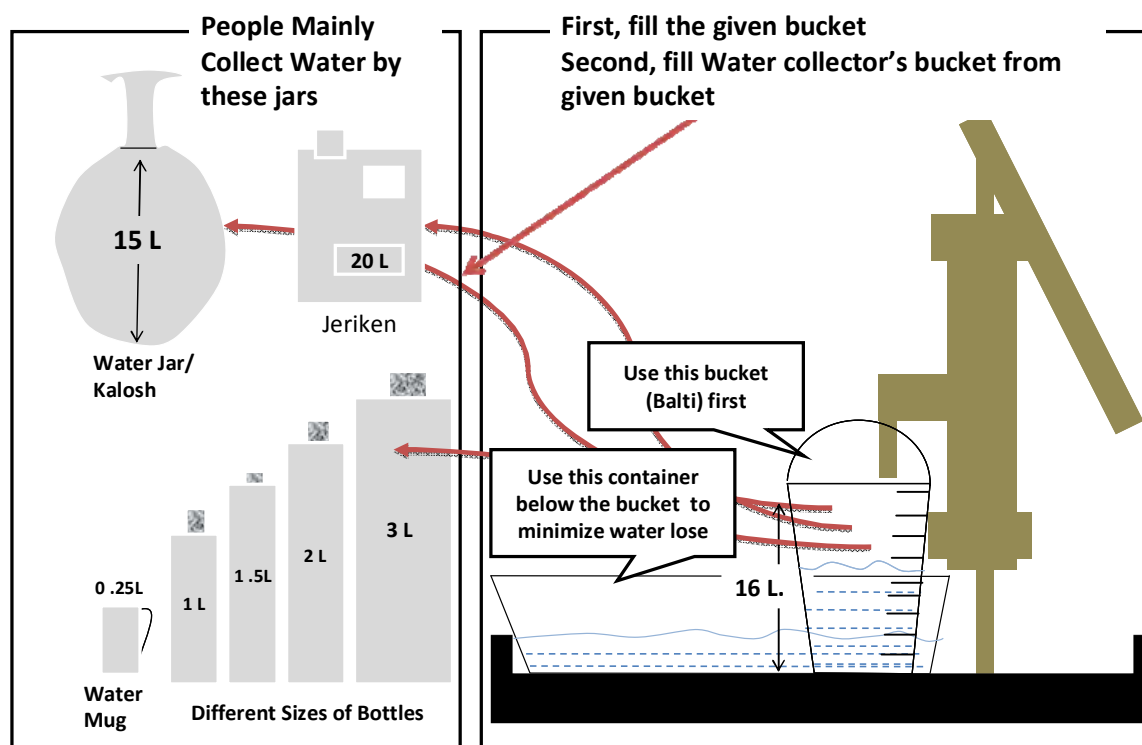
The investigation was conducted 24 hours for 20 numbers of each KWASA’s hand pumps. 10 of them are deep wells the depth around 275 to 300 m and 10 of them are shallow tube wells the depth around 60 to 77 m. Diameter of each wells are all 1.5 inches (=38 mm).

**Table -1 Parameters to be measured**

Item	Time	Quantity (liter)	Name of Jars	Remarks or Calculations
Example) 1	9:00 am	45	Kalosh 15L	15 L x 3 = 45L
2	9:03 am	6	Bottle 3L	3L + 3L= 6L
3	9:07 am	3	Bottle 2L, 1L	2L + 1L = 3L

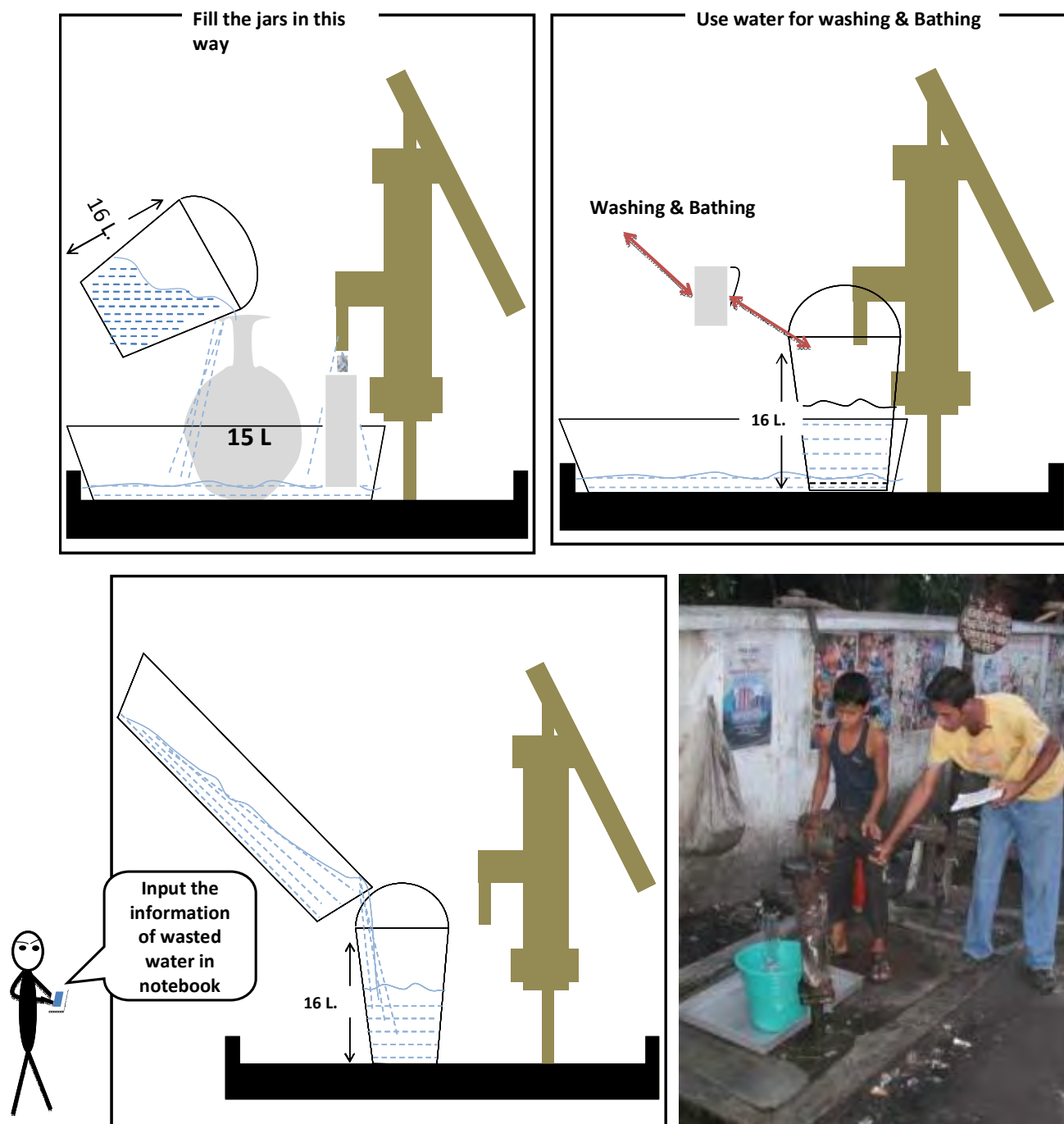
#### Measuring Method

Measuring methods are shown in **Figure -1**. At first, the bucket for measurement was marked scale of each one (1) liter to 16 liters. Basically, study team asked the water collectors to use our marked bucket.



**\*In case hand pump, it is very busy, we only can allow to use above jars directly.**

**Figure -1 Measuring Method of Water Consumption Investigation (1/2)**



**Figure -1 Measuring Method of Water Consumption Investigation (2/2)**

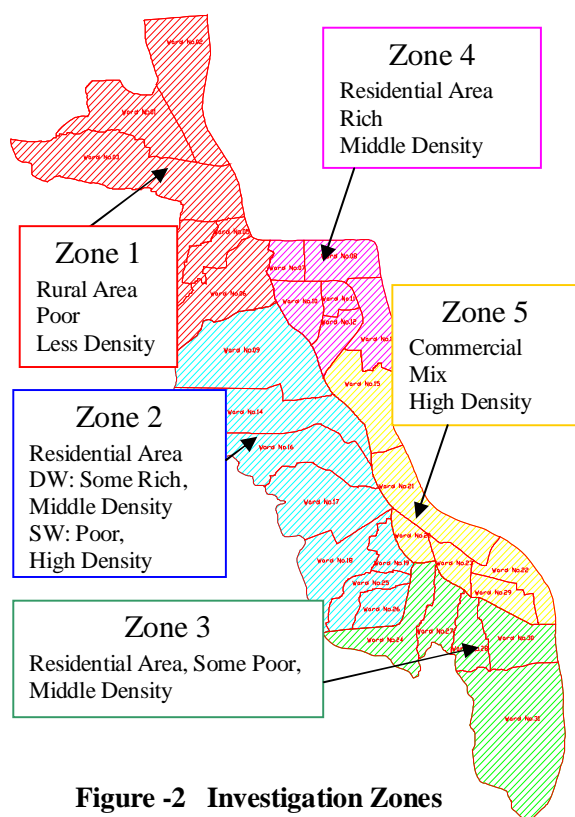
People who pray God use water for purge themselves before they pray. In that case, people concentrate to the wells. Even though, investigator asked them to use our bucket as much as they could. Scattered water and wasted water were also collected in shallow container set below the bucket and measured (refer to above figure). Additionally, study team assumed 10 % of margin for scattered water and measurement errors.

### Locations of KWASA'S Hand Pumps for the Investigation

Total 20 numbers of hand pump tube-wells were measured the water consumption. The lists of hand pumps location are shown in **Table -2**.

**Table -2 List of 20 Hand Pump Locations for the Investigation**

Block	Code	Word	Location
1	1S-1	5	Rightside from entrance of protapadittya road, Daulatpur bus satnd
	1S-2	5	Near Temple, protapadittya road, Daulatpur bus satnd
	1D-1	5	Right street from entrance of protapadittya road, Daulatpur bus satnd
	1D-2	5	Aiub Ali Road, Daulatpur bas stand
2	2S-1	19	Near mosque, goborchaka cross road
	2S-2	19	Near mosque, goborchaka cross road
	2D-1	14	Palpara road, mujgunni R/A
	2D-2	14	Opposite of boyra Bus stand, mujgunni moha sarak
3	3S-1	30	Azizur rahman road, daroga para
	3S-2	30	Right street from Taltala Hospital
	3D-1	30	Shipyards road, Labanchara, Rupsha
	3D-2	31	Zinnah para road, Labanchara, Rupsha
4	4S-1	10	Near mosque, nayabatir moor, Khalishpur
	4S-2	12	Bihari Refugee colony moor, Khalishpur
	4D-1	10	Near mosque, nayabatir moor, Khalishpur
	4D-2	12	Near Old KWASA, Khalishpur Housing state, khalishpur
5	5S-1	21	Near KWASA, Lower jessore road
	5S-2	21	Opposite street from Castle Salam Hotel
	5D-1	21	Near Shonkho Market, Lower Jessore road
	5D-2	21	Near Circuit House, K.D. Ghosh Road



**Figure -2 Investigation Zones**

Study team suggested that KCC area should be separated five (5) zones for their steady distribution network in submitted Interim report. Each zone has each characteristics and different types of water use. Therefore, study team decided to choose four (4) KWASA's hand pumps (2 deep wells and 2 shallow wells) for the investigation.

Impressions of the site for each zone are described as follows;

- Zone 1: Rural Area (less density, poor)
- Zone 2: Residential Area (Deep well site: less density, some rich, Shallow well site: high density, poor)
- Zone 3: Residential Area (middle density, some poor)
- Zone 4: Residential Area (middle density, rich)
- Zone 5: Commercial Area (high density, mixed)

Locations of KWASA's hand pumps to be measured and their photos are shown in **Figure-3**.

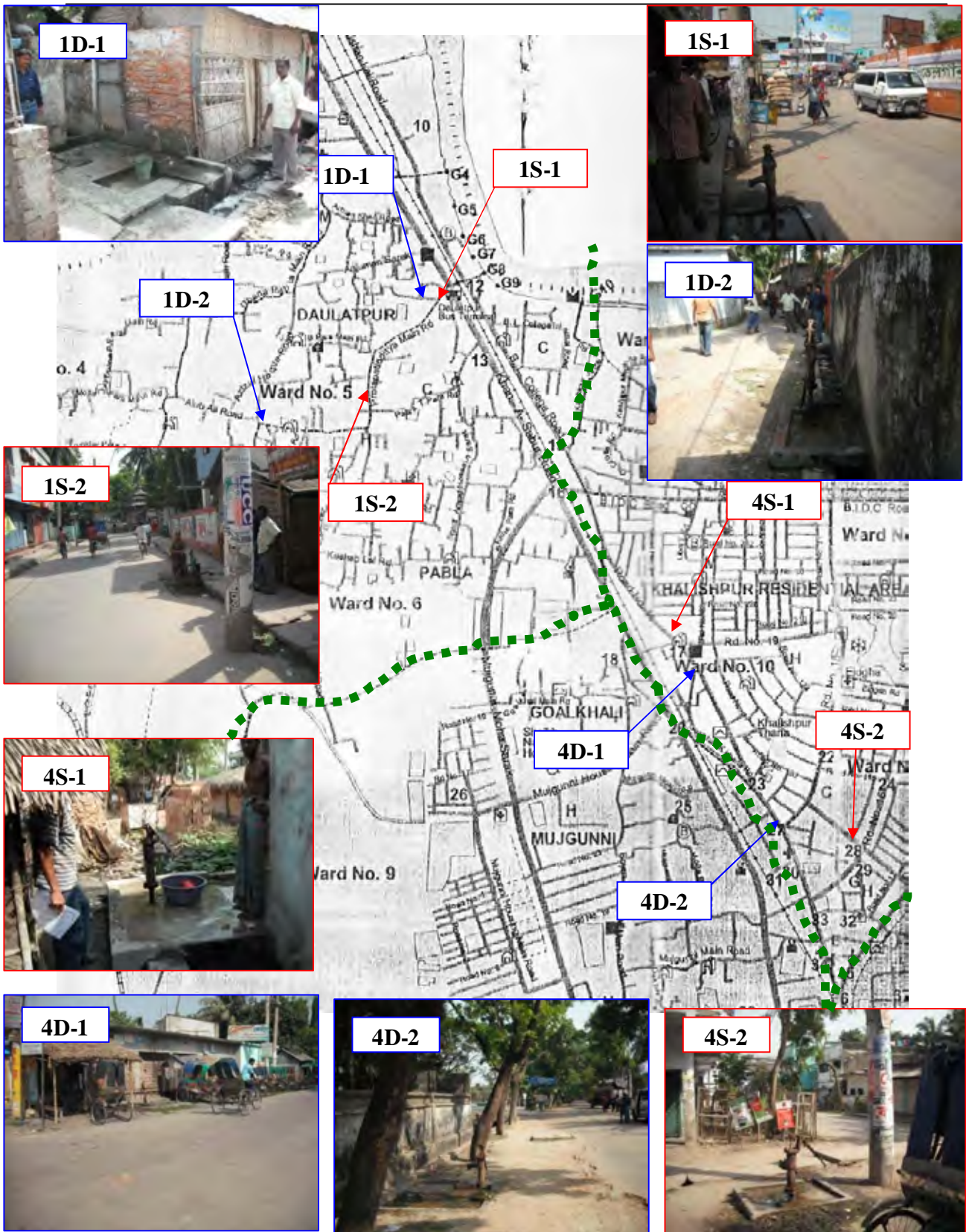


Figure -3 Locations of KWASA's Hand Pumps to be Measured (1/3)

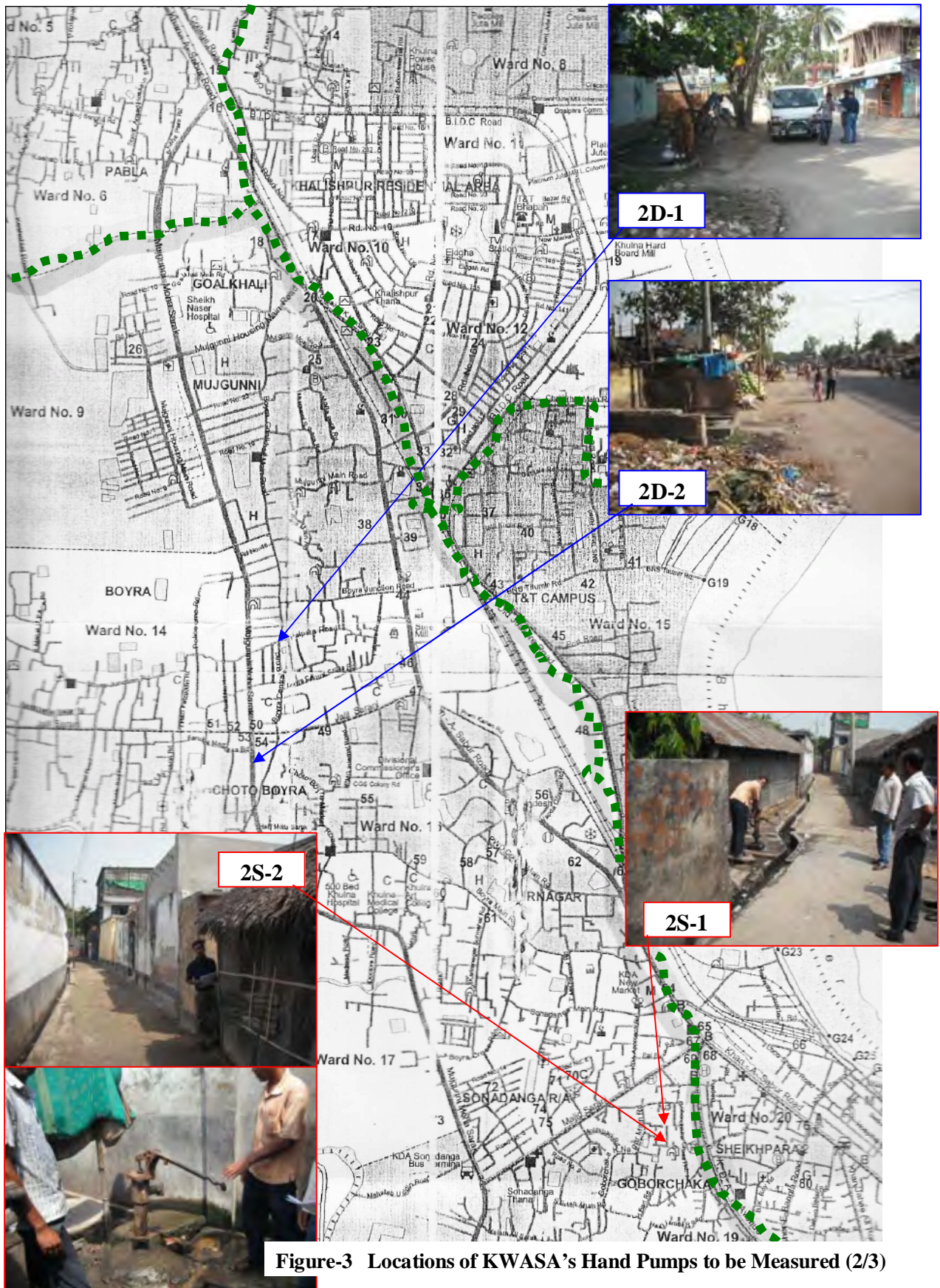
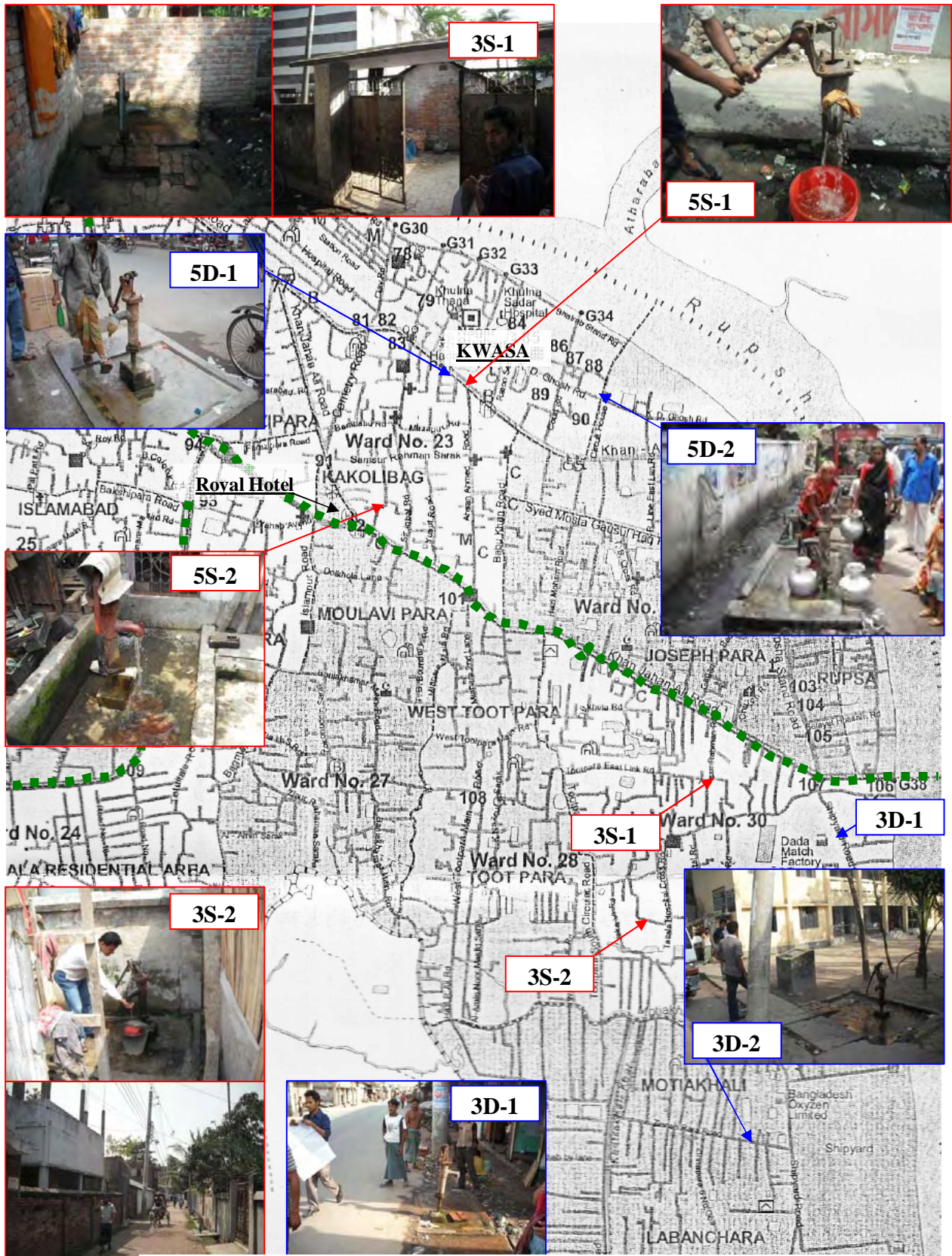


Figure-3 Locations of KWASA's Hand Pumps to be Measured (2/3)



**Figure -3** Locations of KWASA’s Hand Pumps to be Measured (3/3)  
Schedule of the Hand Pumps Investigation Works



For the comparison purpose, this study was conducted the investigation on the middle of April as shown in **Table -3**. It is nearly the end of dry season such as hardest period to get water in Khulna. (Previous survey was conducted in November when is after rainy season such as rich period to get water.)

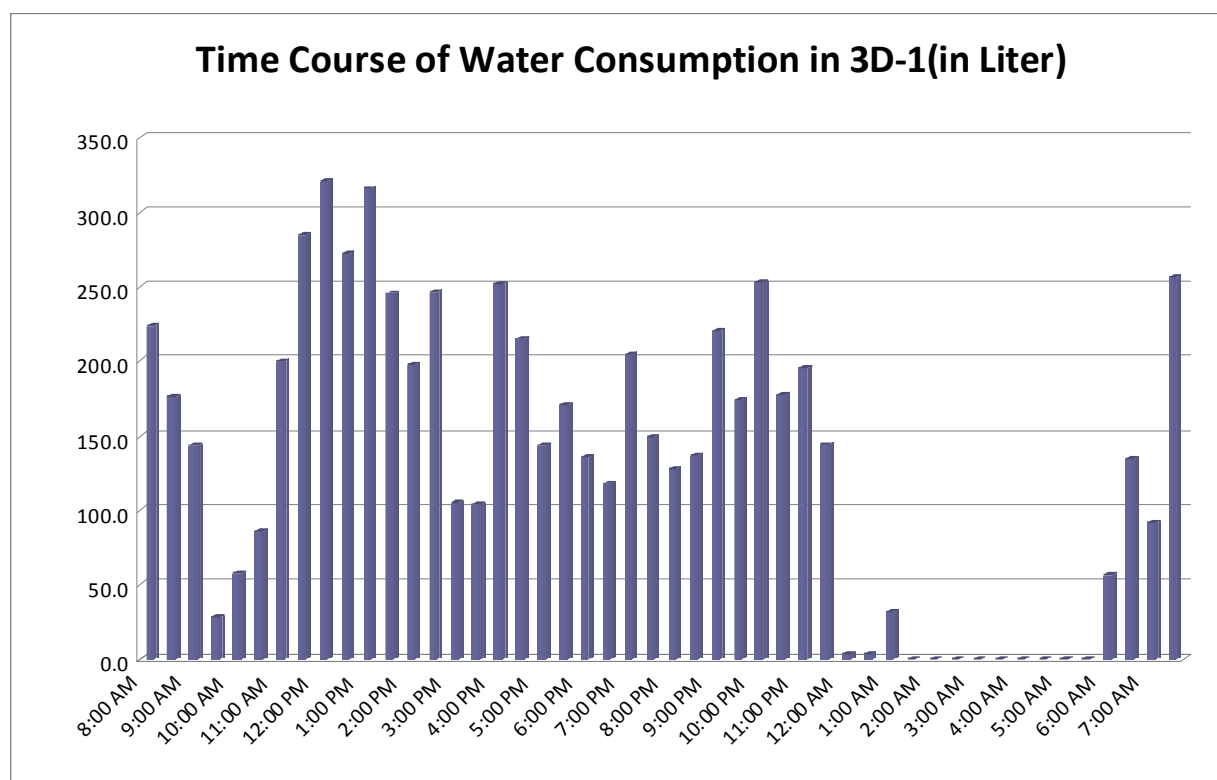
**Table -3 Schedule of Investigation Works**

Tasks	Schedule
1 5S-1, 5S-2, 5D-1 and 5D-2	Sunday, 11 <sup>th</sup> of April 2010
2 1S-1, 1S-2, 1D-1 and 1D-2	Monday, 12 <sup>th</sup> of April 2010
3 4S-1, 4S-2, 4D-1 and 4D-2	Tuesday, 13 <sup>th</sup> of April 2010
4 2S-1, 2S-2, 2D-1 and 2D-2	Thursday, 15 <sup>th</sup> of April 2010
5 3S-1, 3S-2, 3D-1 and 3D-2	Sunday, 18 <sup>th</sup> of April 2010

\* Detailed schedule described in TOR of this investigation are shown in Appendix.

#### Results of the Hand Pumps Investigation

Investigation results are shown in **Table -4**. Data sheets of this investigation are shown in Appendix. The average water consumption of KWASA's shallow hand pumps is 4.97 m<sup>3</sup>/day and deep hand pumps is 1.70 m<sup>3</sup>/day. Time of course of water consumption at 3D-1 is shown in **Figure -4** as the one of example.



**Figure -4 Time of course of water consumption at 3D-1 Hand Pump**

**Table -4 Results of Investigation on April, 2010 by JICA**

Block	Code	Flow Rate of <b>Deep</b> Hand Pumps			Code	Flow Rate of <b>Shallow</b> Hand Pumps			
		Liter/min	Liter/hour	m <sup>3</sup> /Day		Liter/min	Liter/hour	m <sup>3</sup> /Day	
1	1D-1	3.3	196	4.70	1S-1	1.9	115	2.75	
	1D-2	1.9	112	2.68	1S-2	1.8	105	2.53	
2	2D-1	3.1	187	4.49	2S-1	1.4	82	1.97	
	2D-2	4.7	281	6.75	2S-2	1.3	75	1.81	
3	3D-1	4.9	293	7.04	3S-1	1.1	63	1.50	
	3D-2	1.7	102	2.44	3S-2	1.4	83	1.98	
4	4D-1	1.7	100	2.40	4S-1	1	61	1.47	
	4D-2	0.9	55	1.31	4S-2	0.7	42	1.00	
5	5D-1	4.1	248	5.96	5S-1	0.8	50	1.21	
	5D-2	8.3	496	11.91	5S-2	0.6	33	0.79	
Average DW				4.97	Average SW				1.70

### Cross Check of the Investigation conducted in November 2009

The local consultant team computed the rate of water abstraction from hand tube wells per minute by counting the number of minutes required to fill a bucket of 50 liters. The process was repeated three times and average flow rate of each hand tube well was determined. The local consultant employed two local persons for 24 hours in shifting duties of 12 hours to record the daily use of these hand tube wells. The employee (recorder/reader) recorded the duration of use of hand tube wells.

There are four concern matters as the measuring way of last time survey, (1) flow measurement data were all 6:00 AM to 23:59 PM (might be not 24 hour measurement), (2) water consumption was calculated by measuring time of using hand pumps, (3) flow rate was fixed one value for each pump by above method and (4) only five numbers of shallow hand pumps are investigated. According to the study team trial experience, flow rate will be changed due to the person who pushes the pump (get use to or not, young or old etc.), push speed and so on.

Therefore, following hand pumps which are same as previous investigation wells were selected to cross check their investigation accuracy and used different measurement method which is direct measurement of water quantity was adopted for this investigation. Over rapped five (5) tube wells and their results are shown in **Table -5**.

**Table -5 Results Comparison between November 2009 and April 2010**

April, 2010		November, 2009	
Code	m <sup>3</sup> /Day	Sl. No.	m <sup>3</sup> /Day
2D-1	4.49	15	4.95
3D-2	2.44	30	3.07
4D-1	2.40	11	5.21
5D-1	5.96	22	7.37
5D-2	11.91	19	11.70
Average	5.44		6.46

From above results, November 2009 results are slightly higher than April 2010. Therefore, JICA Study team revised (reduce) their flow rate as following ratio;

$$5.44 / 6.46 = \mathbf{0.84}$$

Revised water flow of KWASA's hand pumps are shown in **Table -6**.

**Table -6 Water Flow of KWASA's Hand Pumps**

Deep or Shallow	Sl. No.	Address	Ward No.	Consumption (Liter/3days)	Consumption (Litre/day)	Revised 0.84
Deep well	1	Road- Maniktola Main Road	1	38,735	12,912	10,846
	2	Road- Jessore Upper Road, Fulbari Gate	2	32,602	10,867	9,128
	3	Near Madinabagh Madrasa and Mosque	3	22,716	7,572	6,360
	5	House-96, Road- Daulatpur Anjuman Road	5	37,973	12,658	10,633
	6	Road-South Karigarpara Primary School	6	103,800	34,600	29,064
	7	Road-Kashipur Madrasa Road	7	26,557	8,852	7,436
	9	BIDC Road, Crescent Jute Mill Gate	8	17,708	5,903	4,959
	11	Road No. 11, Khalishpur Noyabati More	10	14,053	4,684	3,935
	12	Platinum Jute Mill 2 No. Gate (More)	11	8,517	2,839	2,385
	14	More of Charer Hat, Near 13 No. Council office	13	11,557	3,852	3,236
	15	More of Sabur Khan, Boyra, Mojgunni R/A	14	14,846	4,949	4,157
	16	Middle of 1 No. Road	17	8,294	2,765	2,323
	17	Goborchaka Cross Road	19	8,357	2,786	2,340
	18	Near 14/1 Rupantor NGO Office	20	8,988	2,996	2,517
	19	North Side of Khulna Stadium	21	15,632	5,211	4,377
	20	Rupsa Ferry ghat Baby-taxi Stand	22	27,963	9,321	7,830
	22	Khan Sabur Road	23	22,112	7,371	6,192
	23	Middle of 1 No. Road	24	12,706	4,235	3,557
	24	Road No.66, Boshupara Lane	25	12,510	4,170	3,503
	25	West Baniakhamar Main Road	26	6,154	2,051	1,723
	26	Infront of Ideal Coaching Center	27	6,840	2,280	1,915
	27	Tootpara Korpara Road	28	8,490	2,830	2,377
	28	Gagon Babu Road	29	35,197	11,732	9,855
	29	Azijur Rahman Road, Darogapara	30	10,118	3,373	2,833
	30	Zinnapara Main Road	31	9,208	3,069	2,578
	1D-1	Right street from entrance of protapadittya road, Daulatpur bus satnd	5	Additional 24hours Survey Results		4,700
	1D-2	Aiub Ali Road, Daulatpur bus stand	5	Additional 24hours Survey Results		2,680
	2D-2	Opposite of boyra Bus stand, mujgunni moha sarak	14	Additional 24hours Survey Results		6,750
	3D-1	Shipyard road, Labanchara, Rupsha	30	Additional 24hours Survey Results		7,040
	4D-2	Near Old KWASA, Khalishpur Housing state, khalishpur	12	Additional 24hours Survey Results		1,310
<b>Deep Hand Pumps Total =</b>						<b>168,538</b>
<b>Average =</b>						<b>5.6</b>
Shallow wells	4	Road-Shaik Ayub Ali School, Daulatpur, Khulna	5	19,440	6,480	5,443
	8	Crescent Jute Mill Bazar, Near 8 No. Ward Council office	8	30,454	10,151	8,527
	10	Rented House, Near Haji Bari	10	31,082	10,361	8,703
	13	More of Pourashava and Rotary School	12	23,271	7,757	6,516
	21	End of Kakolibagh Lane	23	4,343	1,448	1,216
	1S-1	Rightside from entrance of protapadittya road, Daulatpur bus satnd	5	Additional 24hours Survey Results		2,750
	1S-2	Near Temple, protapadittya road, Daulatpur bus satnd	5	Additional 24hours Survey Results		2,530
	2S-1	Near mosque, goborchaka cross road	19	Additional 25hours Survey Results		1,970
	3S-1	Azizur rahman road, daroga para	30	Additional 24hours Survey Results		1,500
	3S-2	Right street from Taltala Hospital	30	Additional 24hours Survey Results		1,980
	5S-1	Near KWASA, Lower jessore road	21	Additional 24hours Survey Results		1,210
	5S-2	Opposite street from Castle Salam Hotel	21	Additional 24hours Survey Results		790
<b>Shallow Hand Pumps Total =</b>						<b>43,135</b>
<b>Average =</b>						<b>3.6</b>

Numbers of KWASA's hand pumps are shown in **Table -7**.

**Table -7 Number of KWASA's Hand Pumps**

Ward No.	Name of Area	Area* (km <sup>2</sup> )	No. of Hand Tube Well Pump					Remarks	
			Deep Well		Shallow Well		Total		
1	Maniktala	3.39	20		569	1	589	1	
2	Mirrerdanga	1.40	6		242	1	248	1	
3	Moheshwarpasha	3.24	7		806	1	813	1	
4	Deana	3.66	210		263		473		
5	Daulatpur	0.57	98	1	391	1	489	2	
6	Karigarpara	0.49	33		280	1	313	1	
	Pabla								
7	Khalishpur	0.41	35		443	1	478	1	
8	Khalishpur	0.36	35	1	372	1	407	2	
Sub-total (Ward 1- 8)		13.52		2		7	3,810	9	
9	Goalkhali	2.93	186		113		299		
	Mujgunni								
	Rayermahal								
10	Khalishpur Residential Area	0.96	116	1	452	1	568	2	
11		0.47	13		346	1	359	1	
12		1.01	44		275	1	319	1	
13	Charerhat	1.22	59		303	1	362	1	
14	Boyra	1.71	156	1	14		170	1	
15	T&T Campus	2.41	76		61		137		
16	Choto Boyra	2.31	185		26		211		
	Nurnagar								
17	Sonadanga R/A	1.70	255	1	14		269	1	
18	Banargati	1.74	151		4		155		
19	Goborchaka	0.52	137	1	45		182	1	
20	Sheikhpara	0.29	165	1	20		185	1	
	Farazipara								
21	Word No. 21	1.19	112	1	78		190	1	
22	Rupsa	1.17	146	1	82		228	1	
23	Kakolibag	0.83	241	1	78	1	319	2	
24	Musalman Para	0.52	190	1	28		204	1	
	Gallamari								
	Nirala Residential Area								
25	Islamabad	1.01	176	1	51		227	1	
26	Baniakhmar	0.85	125	1	35		160	1	
27	Moulavi Para	1.87	193	1	28		221	1	
28	West Toot Para	0.57	118	1	4		122	1	
	Toot Para								
29	Joseph Para	0.91	103	1	21		124	1	
30	Toot Para	1.24	160	1	89		249	1	
31	Harintana	1.17	171	1	10		181	1	
	Motiakhali								
	Labanchara								
	Mohammadia Para								
	Labanchara								
South Labanchara									
Sub-total (Ward 9 - 31)		28.60		16		5	5,441	21	
Total		42.12	3,722	18	5,543	12	9,265	30	30=Chosen well
Closed well			147		176		305		
<b>Total of active well</b>			<b>3,575</b>		<b>5,367</b>		<b>8,942</b>		

Source: KWASA hand pump list, April 2010

The number of active KWASA's deep hand pump is 3,589 and shallow hand pump is 5,344 at present April, 2010.

Based on above-mentioned two times (November 2009 and April 2010) estimations, total abstraction could be assumed as follows;

Deep hand pumps:  $3,575 \times 5.6 \text{ m}^3/\text{day} = 20,000 \text{ m}^3/\text{day}$

Shallow hand pumps:  $5,367 \times 3.6 \text{ m}^3/\text{day} = 19,300 \text{ m}^3/\text{day}$

Total abstraction from KWASA's hand pumps =  $39,300 \text{ m}^3/\text{day}$

## Supporting Report 6.4.1 (1) Design Concept of Impounding Reservoir

### 1. Approach for Retention Period of Impounding Reservoir

The retention period of impounding reservoir shall be determined by the days when the salinity of the river water exceeds the EOQ limit of Chloride, 1,000 mg/L, at the intake point.

#### 1) Boltori (Option 1) and Ulpur (Option 2)

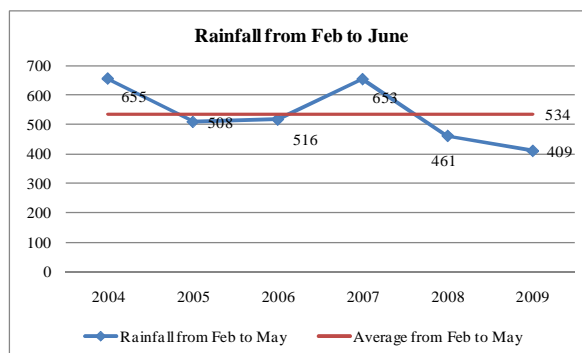
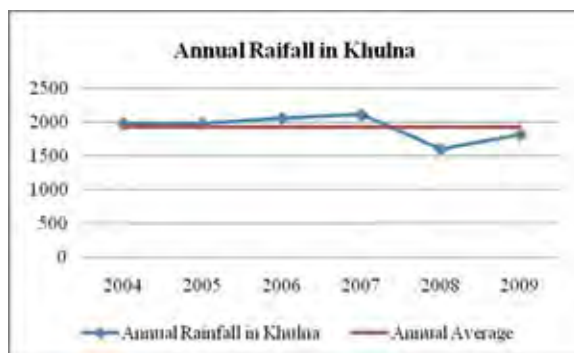
- JICA Study Team started to measure the Chloride concentration at Boltori on April 1<sup>st</sup> 2010. The result of the monitoring all the month around in April the Chloride concentration was under 1,000 mg/L, actually it was supposed to be nil.
- Ulpur locate downstream of MBR from Boltori; however, the result of Haridashpur also implies almost nil in terms of Chloride concentration.
- Based on above results for new water supply system the retention period of the impounding reservoir can be assumed as nil

#### 2) At Haridashpur (Option 3)

- KWASA Survey measured for 11 days the Chloride concentration exceeded 1,000 mg/L from April 20 to April 30 in 2009.
- DPHE Goplagandhi Division has operated a small SWTP at Goplagandhi. The water intake point of the SWTP locates near Haridashpur (MB Route). The monitoring record of Chloride at the water intake is as shown in the following table. The monitoring record makes out that the days which the Chloride concentration exceeded 1,000 mg/L in 2004 – 2007 are nil.

**Table-1 Mean (range) Monthly Salinity (Chloride)**

Year	February	March	April	May	Jun
2002	210-230	290-550	220-250	220-250	110-170
2003	220-250	280-550	230-250	230-250	110-170
2004	220-250	300-610	280-300	220-250	110-170
2005	220-280	280-610	280-290	220-250	220-250
2006	220-280	280-620	280-290	230-250	220-240
2007	250-290	330-610	250-280	230-260	190-250
2008	270-290	330-550	280-300	290-300	220-280
2009	270-290	280-550	300-550	280-290	220-230
2010		170-190	170-190		



- JICA Study Team started to measure the Chloride concentration at Haridaspur on April 1<sup>st</sup> 2010. The result of the monitoring all the month around in April the Chloride concentration was under 1,000 mg/L.
- Based on the measured records the water at Haridaspur has never exceeded 1,000 mg/L; however, the trend of the Chloride concentration slightly increasing. It is better to take into account this increasing tendency.
- Therefore for new water supply system the retention period of the impounding reservoir can be assumed as 15 days.

### 3) At Chapail Gaht (Option 4)

- JBIC measured salinity at Gopalganj (Chapail Ghat) from the middle of May to the end of June in 2007. During the measured period the maximum level was 427 on May 19. It was fairly less than 1,000 mg/L.
- KWASA measured for 39 days the Chloride concentration exceeded 1,000 mg/L from April 6 to May 14 in 2009.
- JICA Study Team started to measure the Chloride concentration at Haridaspur on April 1<sup>st</sup> 2010. The result of the monitoring all the month around in April the Chloride concentration was under 1,000 mg/L.
- As to the survey result in 2009 two reasons can be supposed to explain the 39 over-limit-days.
- At first in 2009 the precipitation in Khulna was less than the average of it from 2004 to 2009. Especially the precipitation in the dry season, from February to June, was considerably less than that of average from 2004 to 2009.

**Table-2 Monthly Rainfall Data in Khulna**

Unit: mm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	0	0	7	85	180	383	253	266	621	183	0	0	1978
2005	15	0	148	43	215	102	435	194	410	420	0	0	1982
2006	0	0	5	19	230	262	522	364	579	79	1	0	2061
2007	0	54	14	92	119	374	591	160	397	197	113	0	2111
2008	66	36	48	36	151	190	301	202	379	187	0	0	1596
2009	1	6	10	23	137	233	347	570	357	111	20	0	1815

2010	0	2	14	21	146	287	-	-	-	-	-	-	-
<b>Average (2004-2009/2010)</b>	12	14	35	45	168	262	408	293	457	196	22	0	1924

Source: Metrological Department Climate Division

- Secondly, the result of Chloride of KWASA Report was calculated by fixed number from measured Salinity level. Theoretically the calculation can be done by using the fixed number; however the measures salts are total soluble salt. This means the water with high turbidity like river water surrounding Khulna the calculated value supposed to be higher than actual Chloride concentration. But it is very difficult to calibrate the result.

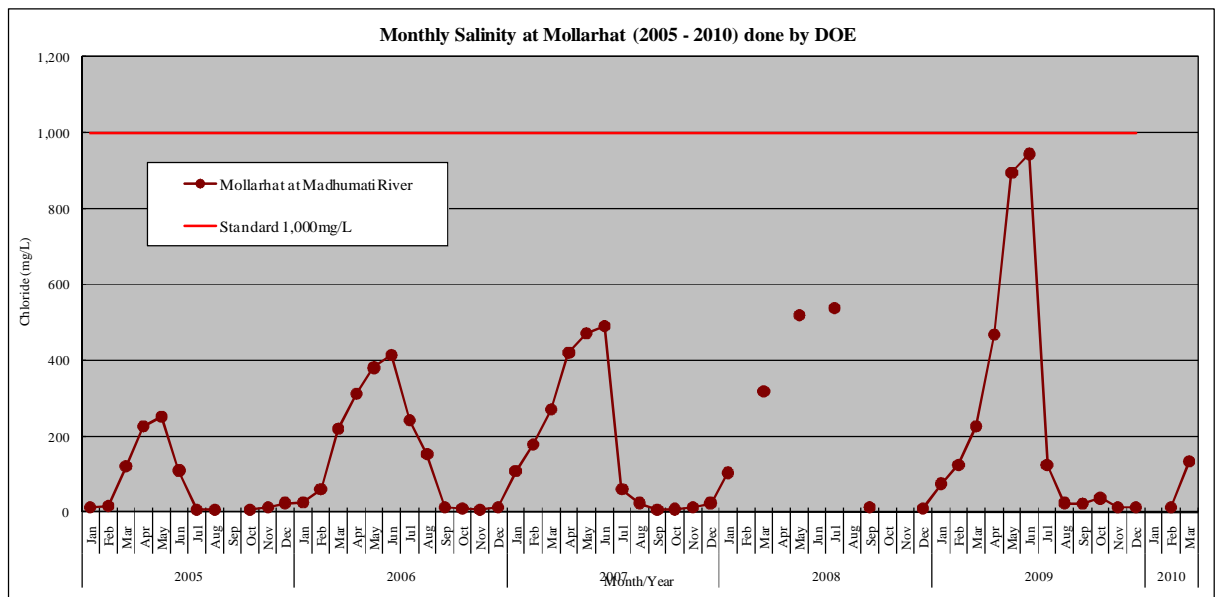
*Measuring Salinity*

The types of salts in the water are mainly common salt (sodium chloride), calcium and magnesium bicarbonates, chlorides and sulphates. Salinity is expressed as the total amount of dissolved salts in the water (total soluble salts). For ease of measurement total soluble salts are usually measured by the electrical conductivity of the water and the results are quoted as milliSiemens per metre (mS/m). Multiply the conductivity (in mS/m) by 5.5 to convert approximately to milligrams per litre (mg/L) or parts per million (ppm).

- Based on above results for new water supply system the retention period of the impounding reservoir can be assumed as 30 days.

**4) At Mollarhat (Option 5)**

- DOE has measured the Chloride concentration at Mollarhat as shown in the following figure.



**Figure -1 DOE Salinity (Chloride ) Measurement Result**

- Up to the March 2010, the measured results have never exceeded 1,000 mg/L; however, it clear that the level of salinity is becoming higher every year.



- Based on the previous DOE measured result future salinity level can be calculated as follows.

**Table-3 Focused Future Salinity Level**

	2005	2006	2007	2008	2009	2020	Remarks
Feb	16	60	179	212	125	599	$Y=49.0X+60$
Mar	121	219	271	319	225	643	$Y=38.5X+219$
Apr	226	313	420	419	467	793	$Y=43.6X+313$
May	251	381	471	519	894	1,393	$Y=46.6X+381$
June	110	413	490	529	944	1,581	$Y=48.3X+413$

- It shall be noted that DOE measures early date of every month, around 5<sup>th</sup> to 8<sup>th</sup>. And especially for June in early days the level of salinity is high; however, the salinity level decrease drastically after the rainy season start in the early days in June.
- Therefore in 2020, the day which the Chloride concentration exceeded 1,000 mg/L can be assumed as; from the beginning of May to the middle of June, 45 days.
- KWASA measured for 38 days the Chloride concentration exceeded 1,000 mg/L from April 8 to May 15 in 2009. After May 15 the data had not been taken, this means the period of high concentration could be supposed to be more.
- Focused on the date of measuring, in May 2009 DOE measured on May 8<sup>th</sup> and the result was 894 mg/L. Meanwhile the results of the same day in KWASA Report were 1,976 mg/L. at low tide time and 2,396 mg/L. at high tide time. Those are quite different.
- There is no way to adjust to fill the gap of the results of both reports; however, DOE result is more reliable than the result of KWASA Report comparatively due to the continuity of measured results prior to 2009 such as DOE monitoring data and JBIC measured result at Chapali Ghat (Gopaliganj).
- As of the end of April 2010 the measured result by JICA Study Team the Chloride concentration at Mollarhat has been quite different from other data. From April 4 to April 19 the Chloride concentration exceeded 1,000 mg/L, the period was 19 days. And after April 19 the Chloride concentration has decreased.
- Based on above results for the impounding reservoir can be planned on the condition of retaining period of impounding reservoir as 45 days.
- JICA Study Team will measure the Chloride concentration up to the end of June at Mollarhat and the result of the monitoring shall be taken into account at design stage.

#### 5) At Phultala (Option 6)

- Based on the DOE measured result the duration which the Chloride concentration exceeds 1,000 mg/L can be assumed five months, 150 days.

## 2. Approach for Construction Method for Impounding Reservoir in Samanto Sena

In the alternative comparison the impounding reservoir of each option shall be designed to meet the required retention period.

**Table-4 Option-wise Impounding Reservoir Retention Period**

Option	Water Intake	River	Retention period
Option 1	Boltori	MBR	-
Option 2	Ulpur	MBR	-
Option 3	Haridaspur	MBR	15 days
Option 4	Chapali Ghat	Madhumati	30 days
Option 5	Mollarhat	Madhumati	45 days
Option 6	Phulatala	Bhairab	150 day

### 1) Necessary Capacity of Impounding Reservoir

Option	Retention period	Retention Volume	Remarks
Option 3	15days	1,815,000 m <sup>3</sup>	110,000 m <sup>3</sup> /d and inclusive 10% evaporation
Option 4	30days	3,630,000 m <sup>3</sup>	
Option 5	45days	5,445,000 m <sup>3</sup>	
Option 6	150day	18,150,000 m <sup>3</sup>	

### 2) Location of Impounding Reservoir

Option	Location	Remark
Option 3	Samanto Sena	Paddy Field
Option 4	Samanto Sena	Paddy Field
Option 5	Samanto Sena	Paddy Field
Option 6	Dakatia Beel	Beel

### 3) Sub-Soil Condition

Sub-soil condition under Samanto Sena is as shown in the following Figure. The top layers of the Samanto Sena site have been encountered with comprising grayish silt, some clay. The underlying soil is of grayish sand little clay extending up to the 30 m depth of borings

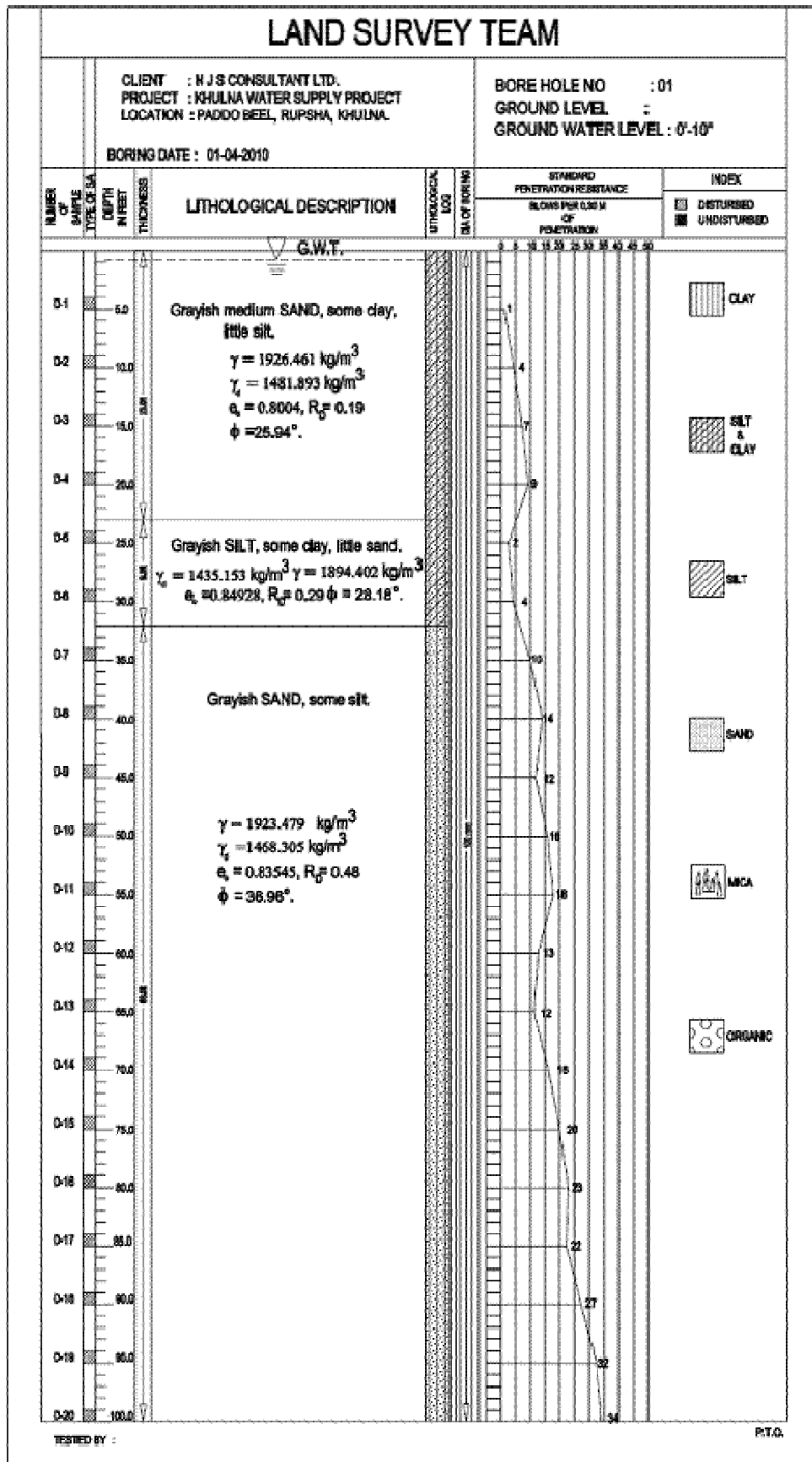
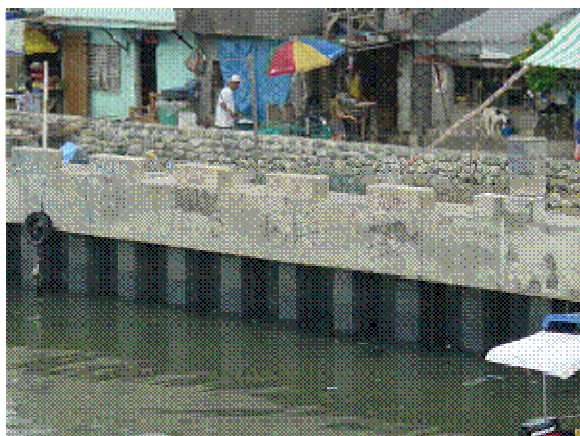


Figure -2 Sub-Soil Condition under Samanto Sena

Based on the sub-soil condition sheet pile walls can be applied to the construction of deep impounding reservoir at Samanto Sena.



Sheet pile walls consist of driven interlocked steel panels. Each pile is engaged with and driven in alongside the previous one, thereby creating an impervious wall. Sheet pile walls are commonly used in the marine environment for the construction of docksides and piers, and on inland waterways to reinforce canal and river banks.

The depth of the impounding reservoir shall be designed carefully by utilising sub-soil condition investigation; however, below 12 m from the ground level the soil condition is could be assumed stable enough to endure permanent load.

### 3. Approach for Required Land for Impounding Reservoir and Surface Water Treatment Plant in Samanto Sena

Required area for the impounding reservoir can be calculated as follows.

**Table-5 Option-wise Impounding Reservoir Area**

Option	Daily Demand	Reserve Period	Evaporation	Retention Volume	Depth	Reservoir Area
Option 3	110,000 m <sup>3</sup>	15 days	10%	1,815,000 m <sup>3</sup>	12 m	151,250 m <sup>2</sup>
Option 4	110,000 m <sup>3</sup>	30 days	10%	3,630,000 m <sup>3</sup>	12 m	302,500 m <sup>2</sup>
Option 5	110,000 m <sup>3</sup>	45 days	10%	5,445,000 m <sup>3</sup>	12 m	453,750 m <sup>2</sup>

The width of the impounding reservoir could be assumed as 500 m. And for the SWTP required area for construction of the facility to meet the water demand for 2020 could be assumed as 10 ha, that is 250 m x 400 m. On the condition of these assumptions the required land at Samanto Sena of each Option can be calculated as follows.

**Table-6 Option-wise Required Area**

Option	Reservoir		Land		Required Area for IR	SWTP		Required Area for SWTP	Total Area
	W	L	W	L		W	L		
Option 3	500m	400m	560m	460m	257,600 m <sup>2</sup>	250m	400m	100,000 m <sup>2</sup>	357,600 m <sup>2</sup>
Option 4	500m	700m	560m	760m	425,600 m <sup>2</sup>	250m	400m	100,000 m <sup>2</sup>	525,600 m <sup>2</sup>
Option 5	500m	1,000m	560m	1,060m	593,600 m <sup>2</sup>	250m	400m	100,000 m <sup>2</sup>	693,600 m <sup>2</sup>

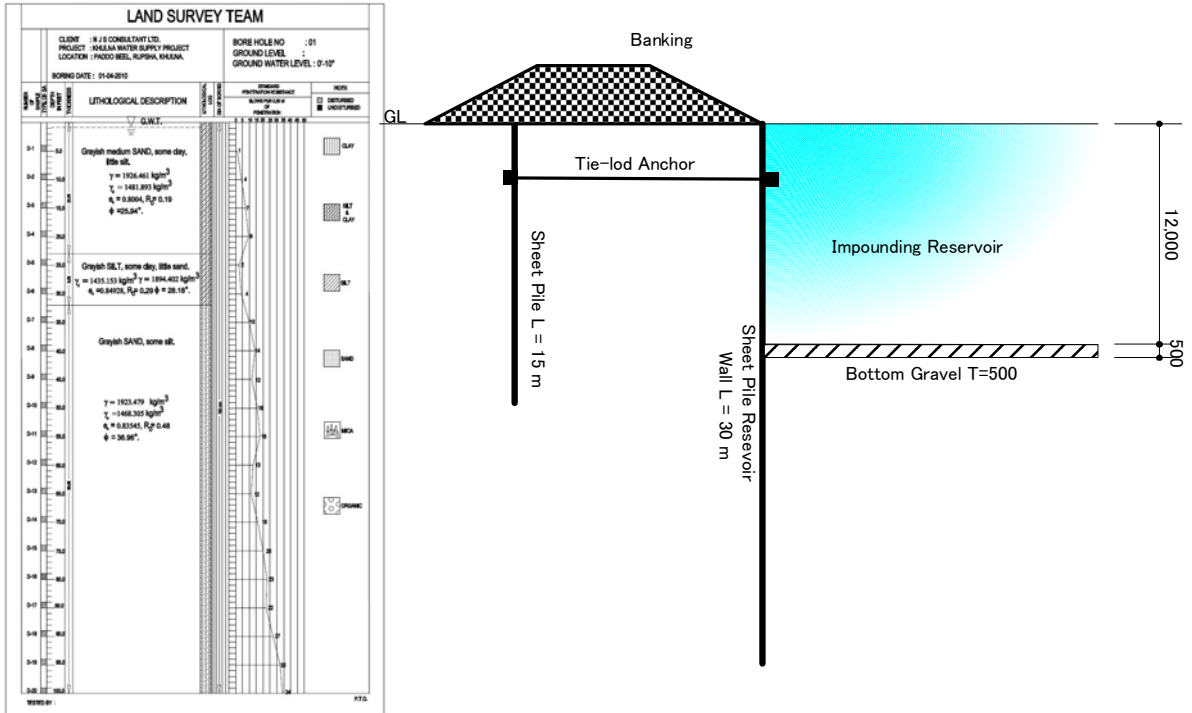
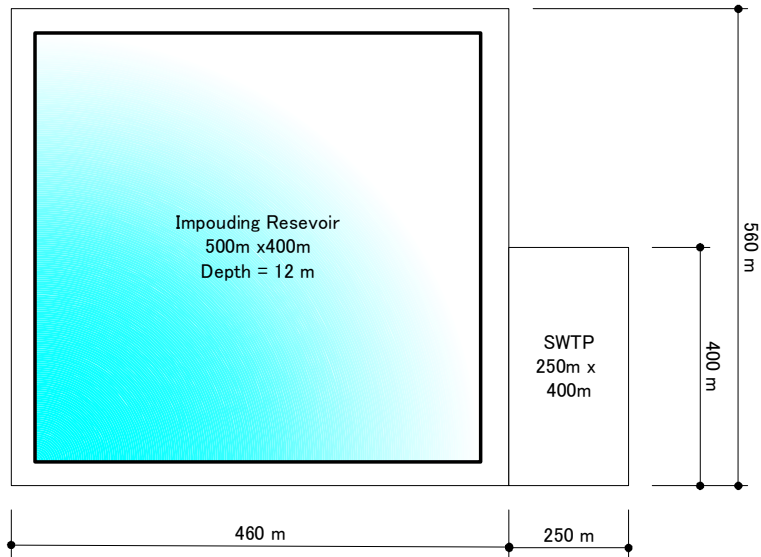
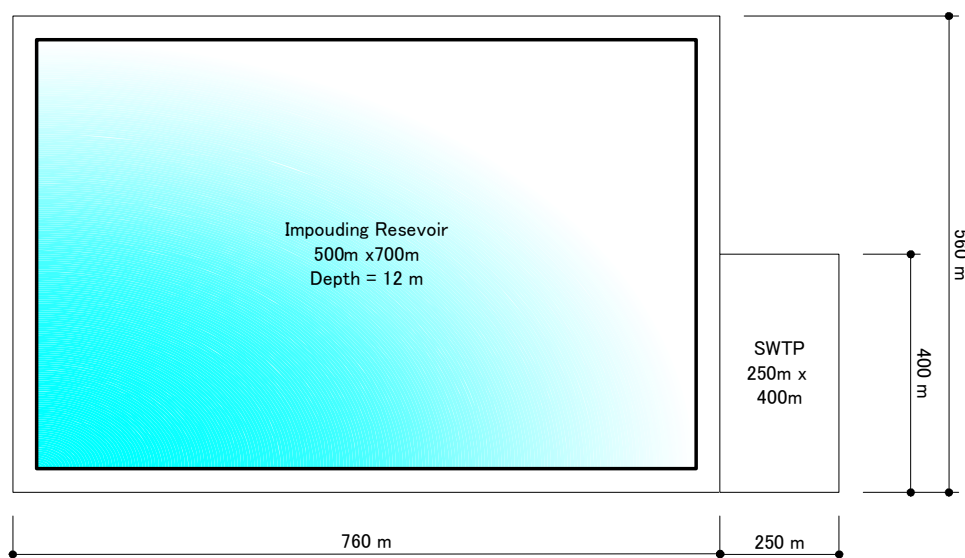


Figure - 3 Schematic Section of Sheet Pile Reservoir Wall



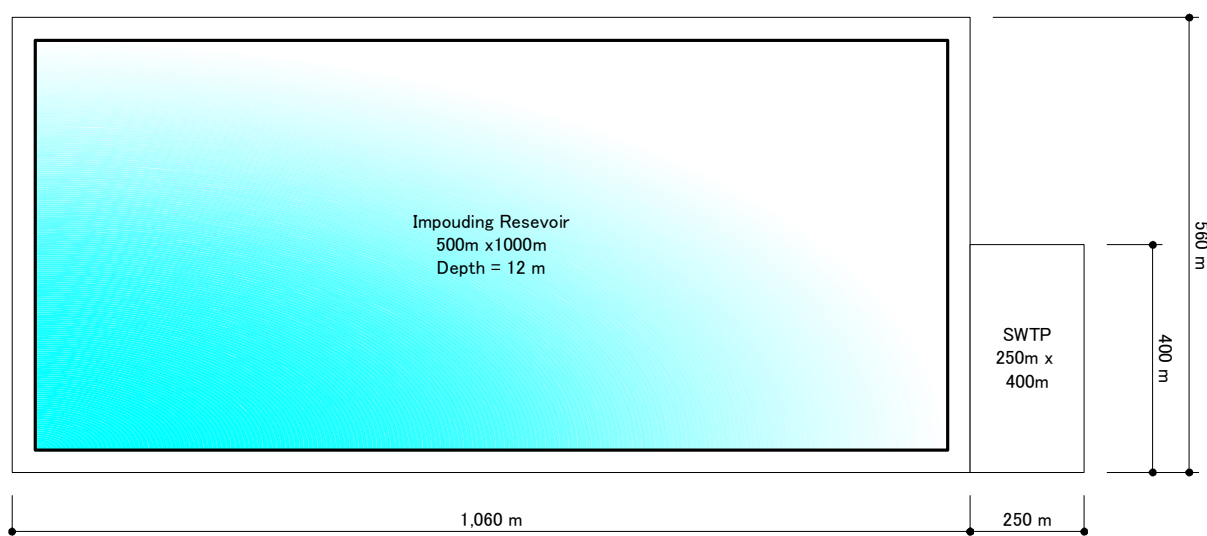
Total Required Land = 357,600 m<sup>2</sup>

Figure -4 Required Land for Option 3



Total Required Land = 525,600 m<sup>2</sup>

**Figure -5 Required Land for Option 4**



Total Required Land = 693,600 m<sup>2</sup>

**Figure -6 Required Land for Option 5**

### 3. Impact of Gorai River Restoration Project (GRRP) (Phase-II)

- As of the end April 2010 the Gorai River Restoration Project (GRRP) (Phase-II) has been in the tendering stage and the implementation of dredging will start very soon. The project period is 5 years, total length of the dredging is 30 km and in five years totally about 17million cubic meter sedimentations of the Gorai River will be dredged.

- This dredging will make an impact on deduction of the project directly. In the DPP of the project mentions that surface water salinity at Khulna will deduce 1ppt. This means, in terms of Chloride concentration, about 550 mg/L will decrease.
- The impact of the project will vary from point of point; however, as to the water intake options which locate upstream of Khulna will get more positive impact. In other words, Option 3, Option 4 and Option 5, the period of impounding reservoir can be abbreviated.
- Base on the previous assumed level which based on DOE monitoring data, in 2020 the salinity level (Chloride concentration) at Mollarhat can be supposed as follows;

**Table-7 Predicted Salinity Level in 2020 at Mollarhat**

	2005	2006	2007	2008	2009	2020	Remarks
Feb	16	60	179	212	125	69	550 reduced in 2020
Mar	121	219	271	319	225	93	550 reduced in 2020
Apr	226	313	420	419	467	243	550 reduced in 2020
May	251	381	471	519	894	843	550 reduced in 2020
June	110	413	490	529	944	1,031	550 reduced in 2020

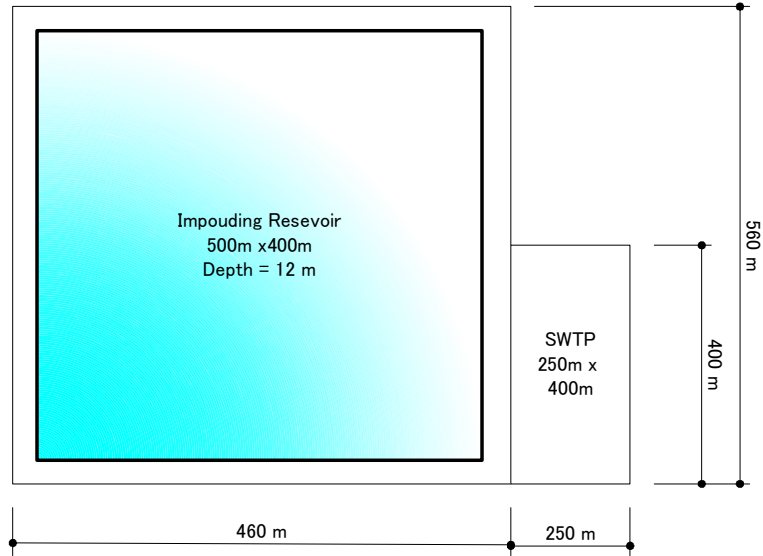
- The high values in June are due to the high concentration in the several days in the beginning of month, DOE has measures early date of every month.
- Taking into the impact of the GRRP (Phase-II) the impounding reservoir for the Option 5 can be planned on the condition of retaining period as 30 days.
- In this context for Option 3, Option 4 and Option 6, the retaining period of impounding reservoir also can be assumed as nil, 15 days and 120 days, respectively.
- Consequently design conditions of impounding reservoir in Samanto Sena for each option are summarized as follows;

**Table-8 Option-wise Reservoir Area (GRRP Considered)**

Option	Daily Demand	Reserve Period	Evaporation	Retention Volume	Depth	Reservoir Area
Option 4	110,000 m <sup>3</sup>	15 days	10%	1,815,000 m <sup>3</sup>	12 m	152,250 m <sup>2</sup>
Option 5	110,000 m <sup>3</sup>	30 days	10%	3,630,000 m <sup>3</sup>	12 m	302,500 m <sup>2</sup>

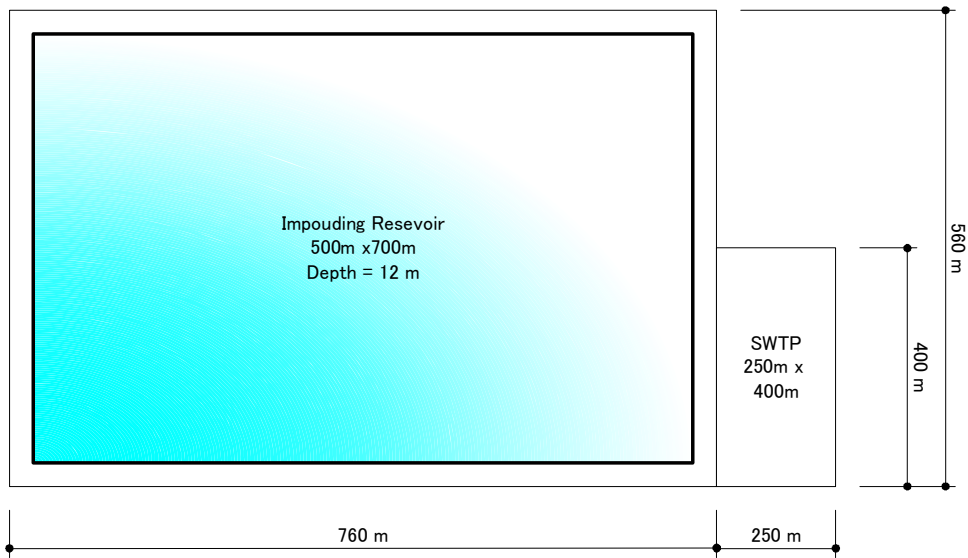
**Table-9 Option-wise Required Area (GRRP Considered)**

Option	Reservoir		Land		Required Area for IR	SWTP		Required Area for SWTP	Total Area
	W	L	W	L		W	L		
Option 4	500m	400m	560m	460m	257,600 m <sup>2</sup>	250m	400m	100,000 m <sup>2</sup>	357,600 m <sup>2</sup>
Option 5	500m	700m	560m	760m	425,600 m <sup>2</sup>	250m	400m	100,000 m <sup>2</sup>	525,600 m <sup>2</sup>



Total Required Land = 357,600 m<sup>2</sup>

**Figure -7 Required Land for Option 4 (GRRP Considered)**



Total Required Land = 525,600 m<sup>2</sup>

**Figure -8 Required Land for Option 5 (GRRP Considered)**



## Supporting Report 6.4.1 (2) Details of Social and Environmental Comparison

### 1. Social Environment Screening Results in the Preliminary Environmental Study

#### Option-1 (Boltori)

	No	Environmental Item	Description	Evaluation	Reasons
Social Environment	1	Land Acquisition/ Resettlement	Land Acquisition and Resettlement due to land occupancy(Transfer of rights of residence/ land ownership)	Yes (Pre and project period)	Transfer of rights of land ownership.
	2	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structures	In Some Degree	The project location site is paddy field.
	3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of traffic congestion and accidents	In some degree	Traffic volume will be increased by the necessary vehicle transportation of trucks and so on during construction stage
	4	Split of Communities	Community split due to interruption of area traffic	No	
	5	Cultural Property	Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	
	6	Water rights and right of common	obstruction of fishing rights and rights of common	Unknown	Need further study and survey.
	7	Public Health condition	Deterioration of public health and sanitary conditions due to generation of garbage and increase of vermin	Unknown	Need further study and survey.
	8	Waste	generation of construction waste, Debris and ash	No.	Waste management will be design at project location site.
	9	Hazards(Risk)	Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

### Option-2 (Ulpur)

	No	Environmental Item	Description	Evaluation	Reasons
Social Environment	1	Land Acquisition/Resettlement	Land acquisition and Resettlement due to land occupancy (Transfer of rights of residence/ land ownership)	Yes (Pre and project period)	Transfer of rights of land ownership.
	2	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structures	In Some Degree	The project location site is paddy field.
	3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of traffic congestion and accidents	In some degree	Traffic volume will be increased by the necessary vehicle transportation of trucks and so on during construction stage
	4	Split of Communities	Community split due to interruption of area traffic	No	
	5	Cultural Property	Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	
	6	Water rights and right of common	obstruction of fishing rights and rights of common	Unknown	Need further study and survey.
	7	Public Health condition	Deterioration of public health and sanitary conditions due to generation of garbage and increase of vermin	Unknown	Need further study and survey.
	8	Waste	generation of construction waste, Debris and ash	No.	Waste management will be design at project location site.
	9	Hazards(Risk)	Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

### Option-3 (Hariduspur)

	No	Environmental Item	Description	Evaluation	Reasons
Social Environment	1	Land acquisition/Resettlement	Land acquisition and Resettlement due to land occupancy (Transfer of rights of residence/ land ownership)	Yes (Pre and project period)	Transfer of rights of land ownership.
	2	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structures	In Some Degree	The project location site is paddy field.
	3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of traffic congestion and accidents	In some degree	Traffic volume will be increased by the necessary vehicle transportation of trucks and so on during construction stage
	4	Split of Communities	Community split due to interruption of area traffic	No	

	5	Cultural Property	Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	
	6	Water rights and right of common	obstruction of fishing rights and rights of common	Unknown	Need further study and survey.
	7	Public Health condition	Deterioration of public health and sanitary conditions due to generation of garbage and increase of vermin	Unknown	Need further study and survey.
	8	Waste	generation of construction waste, Debris and ash	No.	Waste management will be design at project location site.
	9	Hazards(Risk)	Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

#### Option-4 (Chapali Ghat)

	No	Environmental Item	Description	Evaluation	Reasons
Social Environment	1	Land Acquisition/ Resettlement	Land acquisition and Resettlement due to land occupancy (Transfer of rights of residence/ land ownership)	Yes (Pre and project period)	Transfer of rights of land ownership.
	2	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structures	In Some Degree	The project location site is paddy field.
	3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of traffic congestion and accidents	In some degree	Traffic volume will be increased by the necessary vehicle transportation of trucks and so on during construction stage
	4	Split of Communities	Community split due to interruption of area traffic	No	
	5	Cultural Property	Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	
	6	Water rights and right of common	obstruction of fishing rights and rights of common	Unknown	Need further study and survey.
	7	Public Health condition	Deterioration of public health and sanitary conditions due to generation of garbage and increase of vermin	Unknown	Need further study and survey.
	8	Waste	generation of construction waste, debris and ash	No.	Waste management will be design at project location site.
	9	Hazards(Risk)	Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

**Option-5 (Mollarhat)**

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Social Environment	1	Land acquisition /Resettlement	Land acquisition and Resettlement due to land occupancy (land ownership)	Yes (Pre and project period)	Transfer of rights of land ownership.
	2	Economic Activities	Loss of bases of economic activities, such as land and change of economic structures	In Some Degree	The project location site is paddy field.
	3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of traffic congestion and accidents	In some degree	Traffic volume will be increased by the necessary vehicle transportation of trucks and so on during construction stage
	4	Split of Communities	Community split due to interruption of area traffic	No	
	5	Cultural Property	Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	
	6	Water rights and right of common	Obstruction of fishing rights and rights of common	Unknown	Need further study and survey.
	7	Public Health condition	Deterioration of public health and sanitary conditions due to generation of garbage and increase of vermin	Unknown	Need further study and survey.
	8	Waste	Generation of construction waste, debris and ash	No.	Waste management will be design at project location site.
	9	Hazards(Risk)	Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

**Option-6 (Pultala)**

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Social Environment	1	Land Acquisition/Resettlement	Land Acquisition and Resettlement due to land occupancy(land ownership)	Yes (Pre and project period)	Transfer of rights of land ownership.
	2	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structures	In Some Degree	The project location site is paddy field.
	3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of traffic congestion and accidents	In some degree	Traffic volume will be increased by the necessary vehicle transportation of trucks and so on during construction stage
	4	Split of Communities	Community split due to interruption of area traffic	No	
	5	Cultural Property	Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	
	6	Water rights and right of common	obstruction of fishing rights and rights of common	Unknown	Need further study and survey.
	7	Public Health condition	Deterioration of public health and sanitary conditions due to	Unknown	Need further study and survey.

			generation of garbage and increase of vermin		
	8	Waste	generation of construction waste, debris and ash	No.	Waste management will be design at project location site.
	9	Hazards (Risk)	Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

#### Option-5 Impounding Reservoir (Samanto Sena)

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Social Environment	1	Land Acquisition/ Resettlement	Land Acquisition/ Resettlement due to land occupancy (land ownership)	Yes (Pre and project period)	Transfer of rights of land ownership.
	2	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structures	Unknown	Further study and survey required.
	3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of traffic congestion and accidents	In Some Degree	Traffic volume will be increased by the necessary vehicle transportation of trucks and so on during construction stage
	4	Split of Communities	Community split due to interruption of area traffic	Unknown	To be studied
	5	Cultural Property	Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	
	6	Water rights and right of common	obstruction of fishing rights and rights of common	Unknown	To be studied
	7	Public Health condition	Deterioration of public health and sanitary conditions due to generation of garbage and increase of vermin	In Some degree	During construction period it is expected sanitary and other sexually transmitted disease may be increased. Though Bangladesh is under AID risk but prevalence of this risk is low due to conservative social and religious character.
	8	Waste	generation of construction waste, debris and ash	No.	Waste management will be design at project location site.
	9	Hazards(Risk)	Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

#### Option-6 Impounding reservoir (Bill Dakatia)

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Social Environment	1	Land Acquisition/ Resettlement	Land Acquisition/ Resettlement due to land occupancy (land ownership)	Yes (Pre and project period)	Transfer of rights of land ownership.
	2	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structures	Unknown	Further study and survey required.
	3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of	In Some Degree	Traffic volume will be increased by the necessary vehicle transportation of trucks and so on during

			traffic congestion and accidents		construction stage
4	Split of Communities		Community split due to interruption of area traffic	Unknown	To be studied
5	Cultural Property		Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	
6	Water rights and right of common		obstruction of fishing rights and rights of common	Unknown	To be studied
7	Public Health condition		Deterioration of public health and sanitary conditions due to generation of garbage and increase of vermin	In Some degree	During construction period it is expected sanitary and other sexually transmitted disease may be increased. Though Bangladesh is under AID risk but prevalence of this risk is low due to conservative social and religious character.
8	Waste		generation of construction waste, debris and ash	No.	Waste management will be design at project location site.
9	Hazards(Risk)		Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

#### Option-5 Surface Water Treatment Plant (Samanto Sena)

No	Environmental Item	Description	Evaluation	Remarks
1	Land Acquisition/Resettlement	Land acquisition and Resettlement due to land occupancy(land ownership)	Yes	Transfer of rights of land ownership for pre construction and during project period.
2	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structures	Unknown	Need Further study and survey
3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of traffic congestion and accidents	In Some Degree	Impacts on Traffic and Public Facilities will be during only construction stage.
4	Split of Communities	Community split due to interruption of area traffic	Unknown	Further survey and study required.
5	Cultural Property	Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	Such structure is not found in the site.
6	Water rights and right of common	obstruction of fishing rights and rights of common	Unknown	Further survey and study required.
7	Public Health condition	Deterioration of public health and sanitary conditions due to generation of garbage and increase of vermin	In Some Degree	Impact on public health will be during only construction stage.
8	Waste	generation of construction waste,	No	Waste management will be design at project location site.

			debris and ash		
9	Hazards(Risk)		Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

#### Option-6 Surface Water Treatment Plant (Bill Dakatia)

No	Environmental Item	Description	Evaluation	Remarks
1	Land Acquisition/Resettlement	Land acquisition and Resettlement due to land occupancy(land ownership)	Yes	Transfer of rights of land ownership for pre construction and during project period.
2	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structures	Unknown	Need Further study and survey
3	Traffic and Public Facilities	Impacts on schools and present traffic conditions, such as the increase of traffic congestion and accidents	In Some Degree	Impacts on Traffic and Public Facilities will be during only construction stage.
4	Split of Communities	Community split due to interruption of area traffic	Unknown	Further survey and study required.
5	Cultural Property	Damage to or loss of value of churches, temples, shrines, archeological remains or other cultural assets	No	Such structure is not found in the site.
6	Water rights and right of common	obstruction of fishing rights and rights of common	Unknown	Further survey and study required.
7	Public Health condition	Deterioration of public health and sanitary conditions due to generation of garbage and increase of vermin	In Some Degree	Impact on public health will be during only construction stage.
8	Waste	generation of construction waste, debris and ash	No	Waste management will be design at project location site.
9	Hazards(Risk)	Increase in danger of landslide, cave-ins and accidents	In Some Degree	Impact on Hazards will be during only construction stage.

Social environment

## 2. Natural Environment / Pollution Aspect Screening Results in the Preliminary Environmental Study

### Option-1 (Boltori)

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	No	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	River Course will be same by dredging
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands is of river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project Location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some Degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time.
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipments are utilized for the construction but duration time is limited for several months.



### Option-2 (Ulpur)

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	No	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	River Course will be same by dredging
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands is of river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project Location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some Degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time.
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipments are utilized for the construction but duration time is limited for several months.

### Option-3 (Hariduspur)

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	No	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	River Course will be same by dredging
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands is of river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project Location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some Degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time..
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipments are utilized for the construction but duration time is limited for several months.

### Option-4 (Chapail Ghat)

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	No	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	River Course will be same by dredging
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands is of river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project Location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some Degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time..
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipments are utilized for the construction but duration time is limited for several months.

**Option-5 (Mollarhat)**

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	No	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	River Course will be same by dredging
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands is of river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project Location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some Degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time..
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipments are utilized for the construction but duration time is limited for several months.

**Option-6 (Pultala)**

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	No	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	River Course will be same by dredging
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands is of river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project Location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some Degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time..
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipments are utilized for the construction but duration time is limited for several months.

### Option-5 Impounding Reservoir (Samanto Sena Site)

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	Un- Known	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	No river will affect.
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands of Paddy field and farm land and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air in the rural areas.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time.
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipment are utilized for the construction but duration time is limited for several months.

**Option-6 Impounding reservoir (Bill Dakatia Site)**

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	Un- Known	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	No river will affect.
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands of Paddy field and farm land and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air in the rural areas.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time.
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipment are utilized for the construction but duration time is limited for several months.

### Option-5 Surface Water Treatment Plant (Samanto Sena Site)

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	Un- Known	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	No river will affect.
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands of Paddy field and farm land and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air in the rural areas.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time.
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipment are utilized for the construction but duration time is limited for several months.



**Option-6 Surface Water Treatment Plant (Bill Dakatia Site)**

	No	Environmental Item	Description	Evaluation	Remarks (Reasons)
Natural Environment	10	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	Un- Known	
	11	Soil Erosion	Topsoil erosion by rainfall after reclamation and vegetation removal	No	
	12	Groundwater	Depletion of Ground Water caused by the effluent of excavating work and other work, Ground water pollution by the leach ate.	No	Design of work will be done that way not to depletion of water.
	13	Hydrological (Lakes and River) Situation	Changes of river discharge rate and riverbed condition due to landfill and drainage inflow	No	No river will affect.
	14	Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	
	15	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	No	Initial studies show the project areas are developed lands of Paddy field and farm land and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	No	
	17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	No	Project location side will be reclaimed.
Pollution	18	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	In some degree	The project is not like a thermal power station. Therefore no air pollution is not expected by this option excluding at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But those impacts on the air are limited time and the pollutants easily diffuse in the air in the rural areas.
	19	Water Pollution	Pollution caused by inflow of silt, sludge sand and effluent from water treatment plant into rivers and groundwater	No	
	20	Soil Contamination	Contamination of soil by dust and chemicals, such as herbicides	No	
	21	Noise and Vibration	Noise and vibration generated by vehicles and operation of water treatment plant.	In some degree	The project is not like a thermal power station. Initially noise and vibration will be expected at the constriction stage of necessary vehicles, tracks and heavy equipment utilization as well as at the operation stage of emergency utilization of generator for electricity outage. But that impact of noise and vibration is limited time of construction and emergency time.
	22	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	No	
	23	Offensive Odor	Generation of exhaust gas and offensive odor by facility construction and operation	No	Project is water supply facility which produces no offensive odor (not like Solid Waste Deposal site construction). But during construction stage track vehicles and heavy equipment are utilized for the construction but duration time is limited for several months.

### 3. Social Environment Scoping Results in the Preliminary Environmental Study

#### Option-1 (Boltori Water Intake Site)

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Land Acquisition /Resettlement	B	Resettlement is predicted in some areas due to land acquisition, probable structure and tree loss and construction of new road and socio-economic rehabilitation of affected people is needed to at least pre project condition.
	2	Economic Activities	D	Some impact may be expected on the economic activities by the construction of road and crop field and probable fish culture in roadside and roadside structure
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased due to more traffic
	4	Split of Communities	D	More information needed
	5	Cultural Property	D	More information needed
	6	Water rights and right of common	C	Some impact may be on MBR regarding fishing, river transport and water reserve used for irrigation, due to water shortage in the dry season
	7	Public Health condition	C	Some health problem due to in migration of workers, STD and other waterborne diseases
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to construction, cave-ins, landslide, pipe settings and road accidents for increased traffic

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

#### Option-2 (Ulpur Water Intake Site)

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Land Acquisition /Resettlement	B	Resettlement is predicted in some area due to land acquisition, probable structure and tree loss and construction of new road and socio-economic rehabilitation of affected people is needed to at least pre project condition.
	2	Economic Activities	D	Some impact may be expected on the economic activities by the construction of road and crop field and probable fish culture in roadside and roadside structure
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased due to more traffic
	4	Split of Communities	D	More information is needed
	5	Cultural Property	D	More information is needed
	6	Water rights and right of common	C	Some impact may be on MBR regarding fishing, river transport and water reserve used for irrigation during draught time
	7	Public Health condition	C	Some sanitation and STD diseases may spread due to in migration of workers
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to construction related road accidents due to cave- ins and landslide.

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-3 (Haradaspur Water Intake Site)

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Land Acquisition/Resettlement	B	Resettlement is predicted in some area due to land acquisition, probable structure loss, tree loss and construction of new road.
	2	Economic Activities	D	Some impact may be expected on the economic activities by the construction of road and Crop field and probable fish culture in roadside and roadside structure
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased due to more traffic and generation of surplus soil in some points
	4	Split of Communities	D	More information is needed.
	5	Cultural Property	D	More information is needed
	6	Water rights and right of common	C	Some impact may be on MBR regarding fishing, river transport and water reserve used for irrigation during extreme draught time
	7	Public Health condition	C	Some health problem due to in migration of workers, STD and other disease other than AIDS
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to construction cave-ins, landslide and road accidents due to increased traffic

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-4 (Chapail Ghat Water Intake Site)

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Resettlement	B	Resettlement is predicted in some area due to land acquisition, probable structure loss and construction of new road.
	2	Economic Activities	D	Some impact may be expected on the economic activities by the construction of road and ferry ghat and roadside structure.
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased due to more traffic
	4	Split of Communities	D	Further information is needed
	5	Cultural Property	D	Further information is needed.
	6	Water rights and right of common	C	Not expected
	7	Public Health condition	C	Some health problem due to in migration of workers, STD other than AIDS as its prevalence is low due to strong social bondage.
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to cave-ins, landslide, pipe settings and road accidents for increased traffic.

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-5 (Mollarhat Water Intake Site)

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Land Acquisition/Resettlement	B	Resettlement is predicted in some area due to land acquisition by affecting fish culture, probable structure loss and loss of trees and construction of new road.
	2	Economic Activities	D	Some impact may be expected on the economic activities by the construction of road and crop field and probable fish culture and roadside structure
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased due to more traffic
	4	Split of Communities	D	Further information is necessary.
	5	Cultural Property	D	No impact is expected
	6	Water rights and right of common	C	No impact identified
	7	Public Health condition	C	Poor sanitation oriented and STD disease may spread due to in migration of workers
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to Cave-ins, landslide, pipe settings and road accidents due to increased traffic flow may happen.

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-6 (Phultala Water Intake Site)

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Land Acquisition/Resettlement	B	Resettlement is predicted in some area due to land acquisition, probable structure loss and construction of new road, loss of livelihood.
	2	Economic Activities	D	Some impact may be expected on the economic activities by the construction of road and crop field and probable fish culture and roadside structure
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased for more traffic movement
	4	Split of Communities	D	Further information is needed
	5	Cultural Property	D	No impact is expected
	6	Water rights and right of common	C	Large acquisition may affect fish culture in government land and beel area or large water bodies
	7	Public Health condition	C	Some health problem due to in migration of workers, STD and waterborne diseases other than HIV AIDS
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to construction related activities and vehicle movement road accidents may happen for cave-ins and landslide in the excavated area

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-5 Impounding Reservoir Site (Samanto Sena)

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Land Acquisition/Resettlement	B	Resettlement is predicted in some area due to land acquisition, probable structure loss and construction of new road, loss of livelihood.
	2	Economic Activities	C	Some impact may be expected on the economic activities by the construction of road and crop field and probable fish culture and roadside structure
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased for more traffic movement
	4	Split of Communities	C	Further information is needed
	5	Cultural Property	D	No impact is expected
	6	Water rights and right of common	C	Large acquisition may affect fish culture in government land and beel area or large water bodies
	7	Public Health condition	D	Some health problem due to in migration of workers, STD and waterborne diseases other than HIV AIDS
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to construction related activities and vehicle movement road accidents may happen for cave-ins and landslide in the excavated area

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-6 Impounding Reservoir (Bill Dakatia Site)

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Land Acquisition/Resettlement	B	Resettlement is predicted in some area due to land acquisition, probable structure loss and construction of new road, loss of livelihood.
	2	Economic Activities	C	Some impact may be expected on the economic activities by the construction of road and crop field and probable fish culture and roadside structure
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased for more traffic movement
	4	Split of Communities	C	Further information is needed
	5	Cultural Property	D	No impact is expected
	6	Water rights and right of common	C	Large acquisition may affect fish culture in government land and beel area or large water bodies
	7	Public Health condition	D	Some health problem due to in migration of workers, STD and waterborne diseases other than HIV AIDS
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to construction related activities and vehicle movement road accidents may happen for cave-ins and landslide in the excavated area

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

**Option-5 Surface Water Treatment Plant (Samanto Sena Site)**

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Land Acquisition/Resettlement	B	Resettlement is predicted in some area due to land acquisition, probable structure loss and construction of new road, loss of livelihood.
	2	Economic Activities	C	Some impact may be expected on the economic activities by the construction of road and crop field and probable fish culture and roadside structure
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased for more traffic movement
	4	Split of Communities	C	Further information is needed
	5	Cultural Property	D	No impact is expected
	6	Water rights and right of common	C	Large acquisition may affect fish culture in government land and bill area or large water bodies
	7	Public Health condition	D	Some health problem due to in migration of workers, STD and waterborne diseases other than HIV AIDS
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to construction related activities and vehicle movement road accidents may happen for cave-ins and landslide in the excavated area

Note: Evaluation Categories:

- A: Serious impact is expected.
- B: Some impact is expected.
- C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)
- D: No impact is expected.

**Option-6 Surface Water Treatment Plant (Bill Dakatia Site)**

	No	Environmental Item	Evaluation	Reasons
Social Environment	1	Land Acquisition/Resettlement	B	Resettlement is predicted in some area due to land acquisition, probable structure loss and construction of new road, loss of livelihood.
	2	Economic Activities	C	Some impact may be expected on the economic activities by the construction of road and crop field and probable fish culture and roadside structure
	3	Traffic and Public Facilities	D	Traffic jam and accident may be increased for more traffic movement
	4	Split of Communities	C	Further information is needed
	5	Cultural Property	D	No impact is expected
	6	Water rights and right of common	C	Large acquisition may affect fish culture in government land and beel area or large water bodies
	7	Public Health condition	D	Some health problem due to in migration of workers, STD and waterborne diseases other than HIV AIDS
	8	Waste	D	Spreading of soil due to earthwork and grease and generation of garbage due worker's concentration
	9	Hazards(Risk)	D	Due to construction related activities and vehicle movement road accidents may happen for cave-ins and landslide in the excavated area

Note: Evaluation Categories:

- A: Serious impact is expected.
- B: Some impact is expected.
- C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)
- D: No impact is expected.

## 4. Natural Environment / Pollution Aspect Scoping Results in the Preliminary Environmental Study

### Option-1 (Boltori)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	D	There may be no change in large scale by construction of the Intake point.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.
	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on
Pollution	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impact on soil is predicted.
	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-2 (Ulpur)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	D	There may be no change in large scale by construction of the Intake point.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.
	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on
Pollution	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impact on soil is predicted.

	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-3 (Haradaspur)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	D	There may be no change in large scale by construction of the Intake point.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.
	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on
Pollution	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impact on soil is predicted.
	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-4 (Chapail Ghat)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	D	There may be no change in large scale by construction of the Intake point.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.
	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on



Pollution	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impacts on soil are predicted.
	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-5 (Mollarhat)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	D	There may be no change in large scale by construction of the Intake point.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.
	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on
Pollution	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impacts on soil are predicted.
	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-6 (Phultala)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	D	There may be no change in large scale by construction of the Intake point.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.

	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and river banks and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on
Pollution	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impacts on soil is predicted.
	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-5 Impounding Reservoir (Samanto Sena)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	C	Need further Survey and study.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.
	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
Pollution	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on
	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impacts on soil is predicted.
	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-6 Impounding Reservoir (Bill Dakatia)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	C	Need further Survey and study.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.
	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on
Pollution	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impacts on soil is predicted.
	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)

D: No impact is expected.

### Option-5 Surface Water Treatment Plant (Samanto Sena)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	C	Need further Survey and study.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.
	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on
Pollution	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impacts on soil is predicted.
	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

- A: Serious impact is expected.
- B: Some impact is expected.
- C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)
- D: No impact is expected.

### Option-6 Surface Water Treatment Plant (Bill Dakatia)

	No	Environmental Item	Evaluation	Reasons
Natural Environment	10	Topography and Geology	C	Need further Survey and study.
	11	Soil Erosion	D	No big excavation is done for the construction. The design and its construction is considered to be prevented for surrounding soil erosion
	12	Groundwater	D	There is no specific construction which would impact on a groundwater.
	13	Hydrological Situation	D	There is no specific impact on lakes and rivers.
	14	Coastal Zone	D	There is coastal zone but will not affect in study area.
	15	Fauna and Flora	C	Initial studies show the project areas are developed lands of Paddy field and no list of endangered, rare and endemic ones. However, to make sure scrutiny on the condition shall be done.
	16	Meteorology	D	There is no impact on the Meteorological situation due to no large scale construction.
	17	Landscape	C	Consideration to landscape should be made as a future issue Including environmentally friend facility design and shape, construction of green belt and buffer zone and so on
Pollution	18	Air Pollution	D	Impact on air is predicted in some degree due to increase of traffic volume and emergency operation of generators during outage but the impacts will defuse in rural area and limited time
	19	Water Pollution	D	The area will not effect as serious water pollution, but no impact on the water by the construction
	20	Soil Contamination	D	Few impacts on soil is predicted.
	21	Noise and Vibration	D	There may be some noise problem due to increase of traffic volume and location of construction site during construction stage.
	22	Land Subsidence	D	There is no land subsidence for no groundwater pumping up
	23	Offensive Odor	D	There is no construction arisen offensive order

Note: Evaluation Categories:

- A: Serious impact is expected.
- B: Some impact is expected.
- C: Extent of impact is unknown. (Examination is needed. Impacts may become clear as study progress.)
- D: No impact is expected.

## SUPPORTING REPORT 6.4.1 (3) Water Quality Monitoring Report

### 1. Salinity Survey

#### 1.1. Method

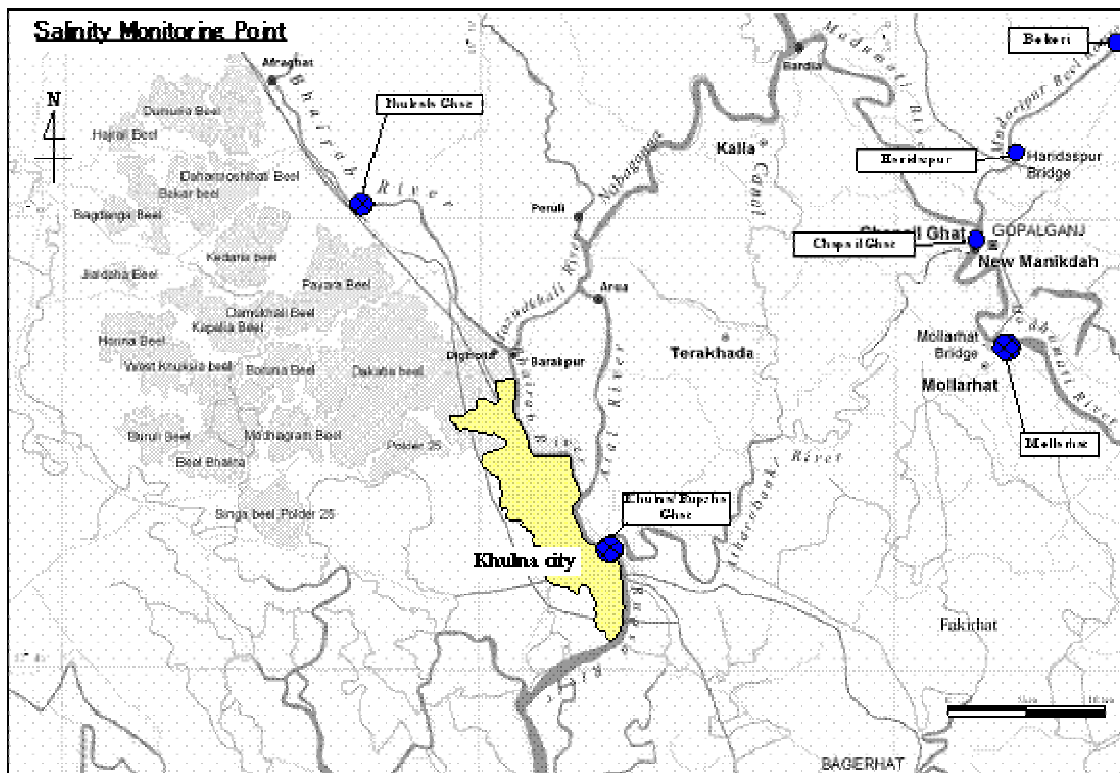
##### (1). Chloride determination method

In Phase I chloride was tested by salinity meter. Therefore in Phase II it was planned to measure chloride using salinity meter, but HANNA Chloride Test Kit was used; simplified for field test using titration method with mercuric nitrate as titlant.

##### (2). Sampling Points

Sampling points for the salinity survey are shown as **Figure -1**. The sampling points were Mollarhat, Phultala, Khulna (Rupsha), Boltori, Chapail Ghat and Hariaspul.

Samples were taken from March 1<sup>st</sup> to June 30 every day at Mollarhat, Phultala and Khulna. At Boltori, Chapail Ghat and Hariaspul April 1<sup>st</sup> to June 30, until April 15<sup>th</sup> samples were taken every day, and after 15<sup>th</sup> samples were taken every other day.



⊗ : From March 1<sup>st</sup> to June 30<sup>th</sup>. ● : From April 1<sup>st</sup> to June 30.

**Figure -1** Sampling points for the salinity survey

## 1.2. Results

**Table -1 Chloride concentration at Mollarhat, Phultala and Khulna (March)**

<b>Mollarhat Chloride (mg/l)</b>			<b>Phultala Chloride (mg/l)</b>			<b>Rupsha Chloride (mg/l)</b>		
<b>Date</b>	<b>High</b>	<b>Low</b>	<b>Date</b>	<b>High</b>	<b>Low</b>	<b>Date</b>	<b>High</b>	<b>Low</b>
3/1	360	240	3/1	2,250	1,875	3/1	3,600	3,400
3/2	360	240	3/2	3,000	2,250	3/2	4,100	3,050
3/3	360	320	3/3	3,700	2,125	3/3	4,650	3,750
3/4	320	360	3/4	3,400	2,750	3/4	4,900	3,500
3/5	340	300	3/5	3,700	3,150	3/5	4,950	3,750
3/6	360	320	3/6	2,600	2,350	3/6	4,200	4,100
3/7	340	360	3/7	3,500	2,400	3/7	4,050	3,650
3/8	380	360	3/8	3,400	2,350	3/8	3,950	3,450
3/9	360	380	3/9	2,900	2,650	3/9	3,750	3,550
3/10	400	360	3/10	2,900	2,450	3/10	3,200	3,050
3/11	380	400	3/11	3,300	1,700	3/11	4,100	3,950
3/12	360	380	3/12	3,250	2,450	3/12	4,450	4,050
3/13	400	360	3/13	3,150	2,800	3/13	4,200	4,300
3/14	380	400	3/14	3,400	2,700	3/14	4,150	4,350
3/15	350	460	3/15	3,850	3,250	3/15	4,550	4,450
3/16	360	400	3/16	4,300	3,050	3/16	4,800	4,450
3/17	420	350	3/17	4,000	3,200	3/17	4,900	4,150
3/18	460	400	3/18	4,200	3,300	3/18	4,950	4,750
3/19	460	420	3/19	4,000	3,350	3/19	5,000	4,700
3/20	500	450	3/20	3,950	3,500	3/20	5,000	4,800
3/21	480	400	3/21	4,000	3,400	3/21	4,700	5,000
3/22	480	460	3/22	4,650	4,600	3/22	6,600	5,000
3/23	500	460	3/23	4,200	3,600	3/23	8,100	7,400
3/24	490	460	3/24	4,750	3,750	3/24	7,400	5,700
3/25	440	420	3/25	3,600	3,650	3/25	7,800	6,800
3/26	450	440	3/26	4,700	4,300	3/26	7,700	7,100
3/27	480	480	3/27	3,700	3,850	3/27	5,100	4,500
3/28	420	570	3/28	4,450	4,300	3/28	5,100	5,900
3/29	440	560	3/29	4,000	3,750	3/29	8,900	6,600
3/30	420	640	3/30	5,000	4,700	3/30	8,300	6,000
3/31	480	560	3/31	4,850	4,450	3/31	9,700	9,100
Average	411	410	Average	3,763	3,161	Average	5,382	4,784
Min.	320	240	Min.	2,250	1,700	Min.	3,200	3,050
Max.	500	640	Max.	5,000	4,700	Max.	9,700	9,100

**Table -2 Chloride concentration at Mollarhat, Phultala and Khulna (April and May)**

Mollarhat Date	Chloride (mg/l)		Phultala Date	Chloride (mg/l)		Rups ha Date	Chloride (mg/l)	
	High	Low		High	Low		High	Low
4/1	520	690	4/1	4,900	3,250	4/1	9,600	9,900
4/2	580	720	4/2	5,000	4,750	4/2	8,900	8,900
4/3	630	880	4/3	8,400	7,700	4/3	6,200	5,500
4/4	890	1,000	4/4	5,500	6,500	4/4	9,500	8,700
4/5	2,750	2,500	4/5	5,700	5,000	4/5	7,800	6,100
4/6	3,500	3,000	4/6	6,400	6,100	4/6	8,200	7,100
4/7	1,600	1,380	4/7	7,000	6,500	4/7	7,800	5,900
4/8	1,340	1,200	4/8	7,100	6,400	4/8	7,600	4,300
4/9	1,420	1,260	4/9	8,000	6,300	4/9	7,300	6,500
4/10	1,200	1,000	4/10	10,000	6,600	4/10	8,100	6,500
4/11	940	960	4/11	10,000	9,400	4/11	7,500	6,200
4/12	1,070	990	4/12	9,000	10,000	4/12	8,400	8,900
4/13	1,120	920	4/13	7,700	8,300	4/13	7,800	5,900
4/14	840	1,020	4/14	10,000	8,000	4/14	6,600	5,700
4/15	990	1,000	4/15	9,800	9,500	4/15	6,700	5,500
4/16	1,230	1,120	4/16	10,000	8,600	4/16	7,500	6,100
4/17	1,340	1,260	4/17	9,400	7,300	4/17	7,200	6,500
4/18	1,400	1,180	4/18	10,000	10,000	4/18	6,800	5,900
4/19	1,260	1,320	4/19	9,300	10,000	4/19	6,400	5,600
4/20	1,000	880	4/20	10,000	9,000	4/20	7,200	6,700
4/21	940	760	4/21	10,000	10,000	4/21	8,900	6,500
4/22	920	780	4/22	9,200	8,000	4/22	8,200	5,700
4/23	840	820	4/23	9,500	8,300	4/23	6,500	5,200
4/24	760	780	4/24	9,800	6,700	4/24	6,900	6,100
4/25	360	410	4/25	9,500	7,700	4/25	6,800	5,600
4/26	560	480	4/26	8,700	7,000	4/26	7,200	6,100
4/27	520	420	4/27	10,000	10,000	4/27	6,900	5,800
4/28	490	570	4/28	10,000	10,000	4/28	7,100	5,700
4/29	420	360	4/29	10,000	9,700	4/29	7,500	5,900
4/30	510	440	4/30	9,900	9,800	4/30	7,600	5,600
Average	1,065	1,003	Average	8,660	7,880	Average	7,557	6,353
Min.	360	360	Min.	4,900	3,250	Min.	6,200	4,300
Max.	3,500	3,000	Max.	10,000	10,000	Max.	9,600	9,900

Mollarhat Date	Chloride (mg/l)		Phultala Date	Chloride (mg/l)		Rups ha Date	Chloride (mg/l)	
	High	Low		High	Low		High	Low
5/1	390	410	5/1	9,000	7,600	5/1	7,500	5,800
5/2	430	280	5/2	10,000	8,000	5/2	7,800	5,400
5/3	100	120	5/3	10,000	10,000	5/3	7,300	5,900
5/4	110	60	5/4	9,000	10,000	5/4	7,800	5,600
5/5	80	80	5/5	9,100	7,600	5/5	8,200	5,600
5/6	100	70	5/6	10,000	7,600	5/6	7,400	5,300
5/7	120	60	5/7	7,000	5,500	5/7	7,800	5,400
5/8	150	170	5/8	9,300	9,500	5/8	8,100	6,400

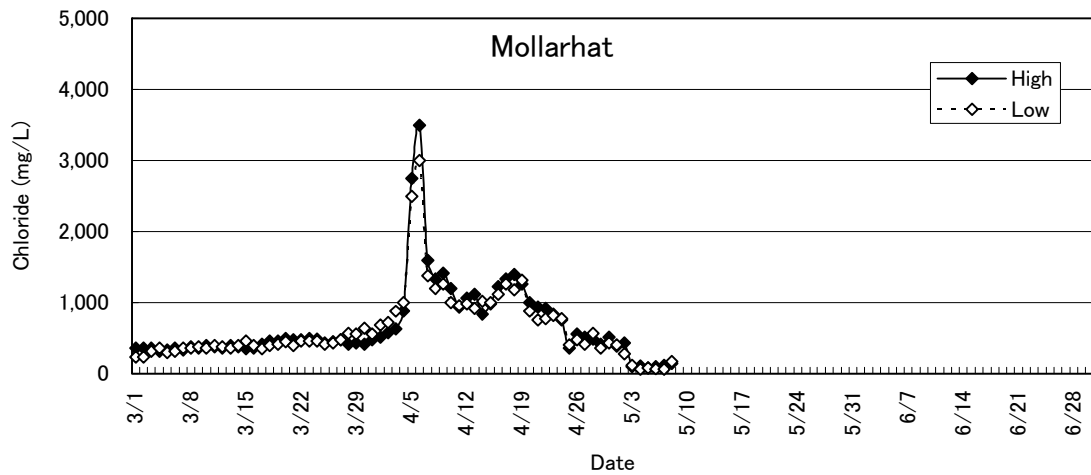


Figure -2 Chloride fluctuation at Mollarhat

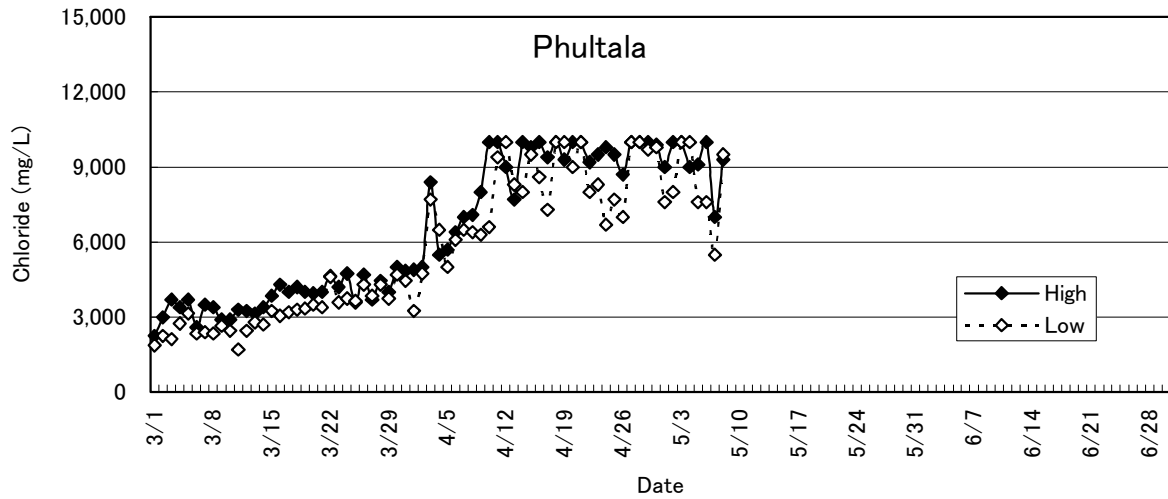


Figure -3 Chloride fluctuation at Phultala

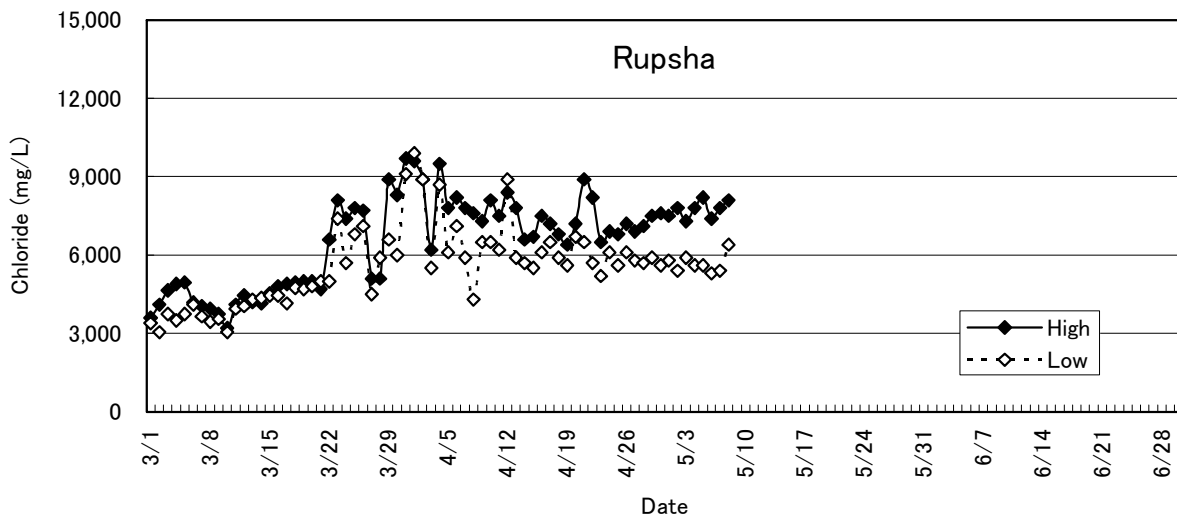


Figure -4 Chloride fluctuation at Khulna



**Table -3 Chloride fluctuation at Boltori, Haridaspur and Chapali Ghat (April and May)**

<b>Boltori Chloride (mg/l)</b>			<b>Haridas pur Chloride (mg/l)</b>			<b>Chapali Ghat Chloride (mg/l)</b>		
Date	High	Low	Date	High	Low	Date	High	Low
4/1	40	40	4/1	390	280	4/1	870	790
4/2	40	40	4/2	380	240	4/2	850	810
4/3	40	40	4/3	320	220	4/3	860	780
4/4	40	40	4/4	250	100	4/4	890	860
4/5	40	40	4/5	150	80	4/5	880	830
4/6	40	40	4/6	90	70	4/6	750	720
4/7	40	40	4/7	90	50	4/7	760	720
4/8	40	40	4/8	90	50	4/8	740	690
4/9	40	40	4/9	100	50	4/9	590	570
4/10	40	40	4/10	90	50	4/10	640	590
4/11	40	40	4/11	90	40	4/11	630	580
4/12	40	40	4/12	90	40	4/12	640	580
4/13	40	40	4/13	60	30	4/13	650	590
4/14	40	40	4/14	70	40	4/14	670	570
4/15	40	40	4/15	50	30	4/15	690	630
4/16			4/16			4/16		
4/17	40	40	4/17	50	30	4/17	790	720
4/18			4/18			4/18		
4/19	40	40	4/19	50	40	4/19	830	750
4/20			4/20			4/20		
4/21	40	40	4/21	50	40	4/21	560	510
4/22			4/22			4/22		
4/23	40	40	4/23	40	30	4/23	460	420
4/24			4/24			4/24		
4/25	40	40	4/25	40	30	4/25	340	310
4/26			4/26			4/26		
4/27	40	40	4/27	40	30	4/27	410	350
4/28			4/28			4/28		
4/29	40	40	4/29	40	30	4/29	320	300
4/30			4/30			4/30		
Average	40	40	Average	119	73	Average	674	621
Min.	40	40	Min.	40	30	Min.	320	300
Max.	40	40	Max.	390	280	Max.	890	860

<b>Boltori Chloride (mg/l)</b>			<b>Haridas pur Chloride (mg/l)</b>			<b>Chapali Ghat Chloride (mg/l)</b>		
Date	High	Low	Date	High	Low	Date	High	Low
5/1	40	30	5/1	30	20	5/1	310	280
5/2			5/2			5/2		
5/3	40	40	5/3	30	20	5/3	180	150
5/4			5/4			5/4		
5/5	40	40	5/5	30	20	5/5	150	120
5/6			5/6			5/6		
5/7	40	40	5/7	30	20	5/7	180	130

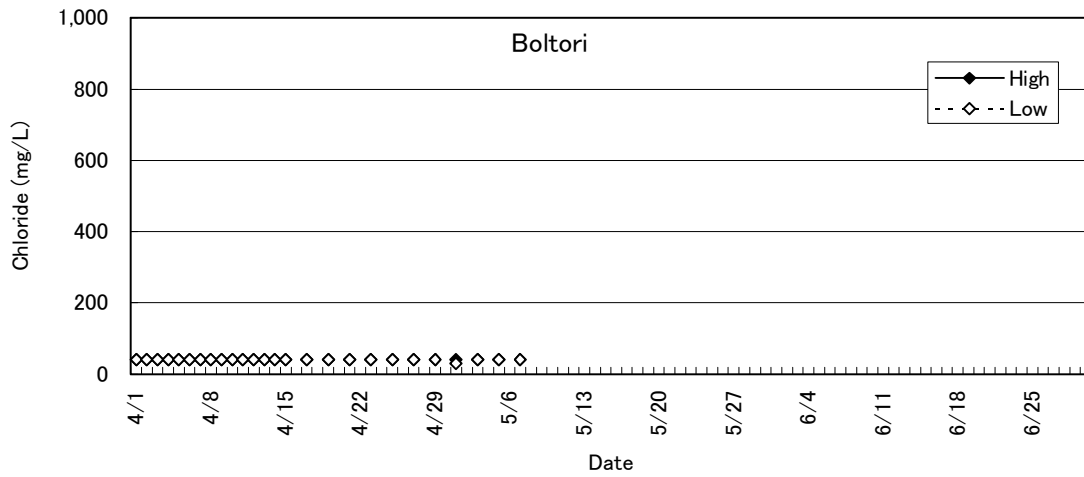


Figure -5 Chloride fluctuation at Boltori

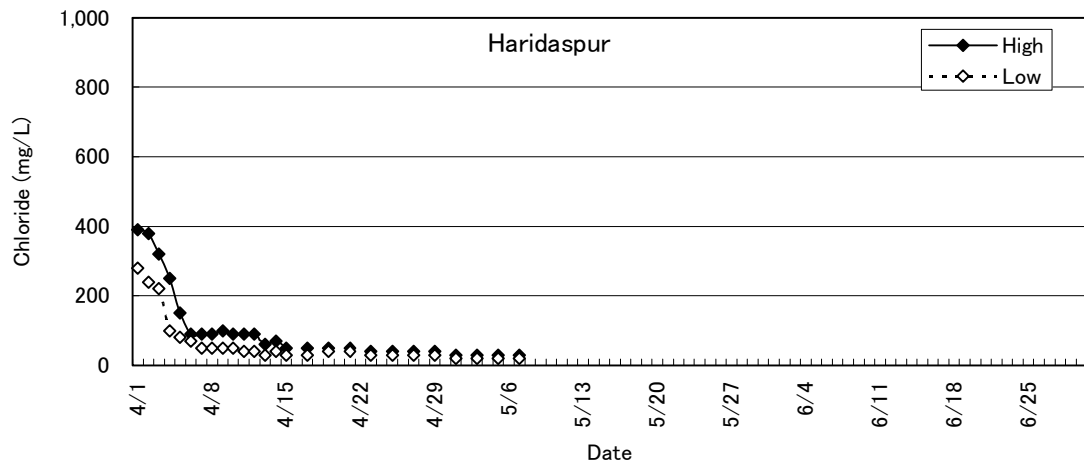


Figure -6 Chloride fluctuation at Haridaspur

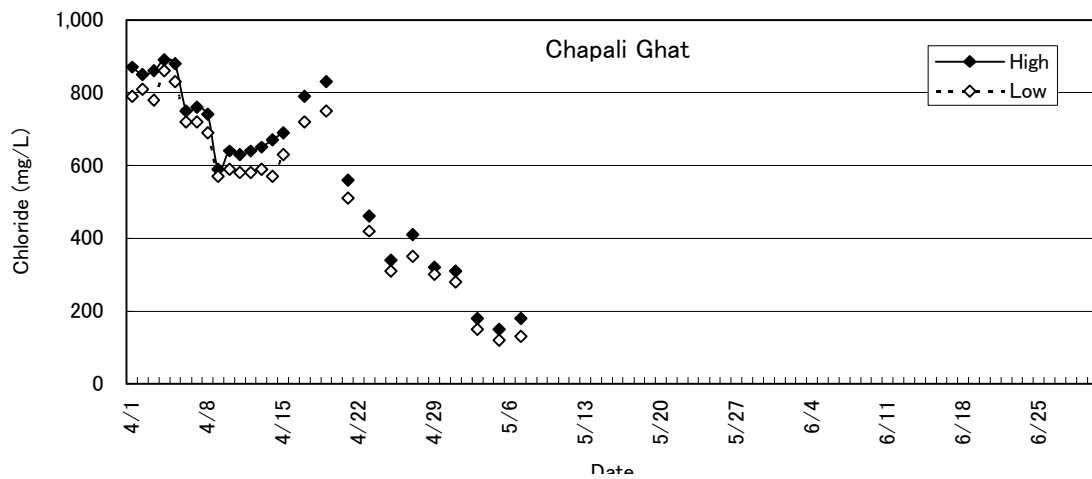


Figure -7 Chloride fluctuation at Chapali Ghat

### **Cross Check Result**

Using the sample which was taken by DOE in April, the cross check had been conducted between JICA Team and DOE. Results are the followings;

<i>Team Name</i>	<i>Chloride mg/L</i>	<i>Methods</i>
<i>JICA</i>	<i>720</i>	<i>Titration (Mercuric Nitrate)</i>
<i>DOE</i>	<i>710</i>	<i>Titration (Silver Nitrate)</i>
<i>DOE salinity meter</i>	<i>775 (1.4 ppt)</i>	<i>Salinity meter</i>

- Both titration methods, JICA and DOE are using correspond well; JICA 720 mg/L and DOE 710 mg/L
- Salinity meter tended to be little higher than the titration methods.

## Supporting Report 6.4.1 (4) Provision of Future Water Intake at Mollarhat

### 1. River Water Flow at Low Water Level for Past 30 Years

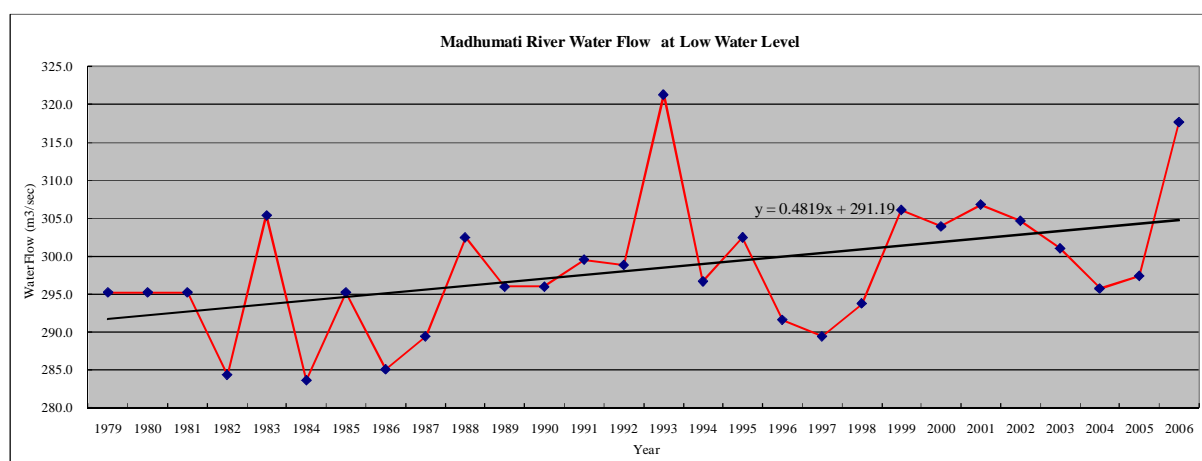
BWDB has monitored water level of Madhumati River at Mollarhat continuously. Following table shows the result of calculated river water flow based on the yearly low water at Mollarhat measured by BWD for past 30 years, from 1979 to 2008.

**Table-1 Water Flow at Low Water Level for past 30 Years**

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Low Water Level (m)	0.00	0.00	0.00	-0.15	0.14	-0.16	0.00	-0.14	-0.08	0.10
River Section Area (m <sup>2</sup> )	789	789	789	760	816	758	789	762	774	809
River Water Flow (m <sup>3</sup> /sec)	295.2	295.2	295.2	284.3	305.4	283.5	295.2	285.0	289.3	302.5
Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Low Water Level (m)	0.01	0.01	0.06	0.05	0.36	0.02	0.10	-0.05	-0.08	-0.02
River Section Area (m <sup>2</sup> )	791	791	801	799	859	793	809	780	774	785
River Water Flow (m <sup>3</sup> /sec)	295.9	295.9	299.5	298.8	321.4	296.6	302.5	291.5	289.3	293.7
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Low Water Level (m)	0.15	0.12	0.16	0.13	0.08	0.01	0.03	0.31	1.29	1.23
River Section Area (m <sup>2</sup> )	818	813	820	815	805	791	795	850	1,040	1,029
River Water Flow (m <sup>3</sup> /sec)	306.1	303.9	306.8	304.6	301.0	295.7	297.4	317.7	389.1	384.7

### 2. Provision of Future Water Flow of Madhumati River at Mollarhat

The result of the Approximate Formula approach is as shown in the following figure.



The planned water intake volumes in 2025 and 2030 are;

$$2025: 110,000 \text{ m}^3/\text{day} = 1.273 \text{ m}^3/\text{sec}$$

$$2030: 220,000 \text{ m}^3/\text{day} = 2.546 \text{ m}^3/\text{sec}$$

The assume minimum yearly water flows in 2025 and 2030 are;

$$2025: 0.4819 \times 46 + 291.191 = 313.36 \text{ m}^3/\text{sec}$$

$$2030: 0.4819 \times 51 + 291.191 = 315.77 \text{ m}^3/\text{sec}$$

### **3. Justification of Future Water Flow of Madhumati River at Mollarhat**

Flow rate for 2025 and 2030 are;

$$2020: 1.273 \text{ m}^3/\text{sec} / 313.36 \text{ m}^3/\text{sec} = 0.41 \%$$

$$2030: 2.546 \text{ m}^3/\text{sec} / 315.77 \text{ m}^3/\text{sec} = 0.81 \%$$

The Madhumati River will possess sufficient water flow enable to demarcate its water to water supply system for Khulna city in future.

## Supporting Report 6.4.1 (5) Result of Land Owners' Sample Survey at Samanto Sena

Mouza Name: Tilok, Pathar Ghata

Sl. No	Land Owners name	Land Owners Address	Dag No	Occupation	Project Affect Economic Activity	Opinion for the Project
1	Nur Ali Master	Pathar Ghata	149/150	Teacher	NO	Positive
2	Barik Halder	Samanto Sena	146	Farmer	NO	Positive
3	Nimai	Pathar Ghata	147/148	Farmer	NO	Positive
4	Hazi Sawkat	Tilok	151	Farmer	NO	Positive
5	Haridash Halder	Pathar Ghata	155/152	Farmer	NO	Positive
6	Binay Member (Syed Abul)	Pathar Ghata	156/159/156/158/165	Farmer	NO	Positive
7	Shahidul Tarafdar	Tilok	3103/3100/3199	Services (Retired)	NO	Positive
8	Jalil-Golder	Tilok	3717,3718,3785	Service man (commissioner officer dryer)	NO	Positive
9	Keramot ali, Liakot Morol	Tilok	3717,3718,3785		NO	Positive
10	Manir Choudhury	Tilok	3705	Farmer	NO	Positive
11	Kalam/ Soto Khoka (Gong)	Tilok	3709	Service Man	NO	Positive
12	Hasan Master	Tilok	3708/3707	Retire Service Man	NO	Positive
13	Fagar Vuia	Tilok	3704/3701	Farmer	NO	Positive
14	Ganesh Shaha	Tilok	3791	Farmer	NO	Positive
15	Akram	Tilok	3792	Farmer	NO	Positive
16	Asad	Tilok	3717,3718,3785	-	NO	Positive
17	Asad Tarafder	Tilok	3793	Farmer	NO	Positive
18	Manir Chaudhury/Dadu Choudhury	Tilok	3074/3049/3110	Farmer	NO	Positive
19	Mohammad Ali	Tilok	3046/3048/3110	Farmer	NO	Positive
20	Keramot Shake	Tilok	3749	Service Retire Man	NO	Positive
21	Momin Tarafdar (Khudee)	Tilok	3491/3114/3045	Farmer	NO	Positive
22	Shadon Kumer Metro	Tilok	3113	Farmer	NO	Positive
23	Akram Hossain Shake	Tilok	3112	Farmer	NO	Positive
24	Mohasin	Tilok	3702	Business	NO	Positive
25	Hamid Bangal	Tilok	3051/3050/3053	Business	NO	Positive
26	Khabir	Tilok	3101/3102	Farmer	NO	Positive
27	Boddo Nath Kunudu	Tilok	535/536	Farmer	NO	Positive
28	Sharder	Tilok	523,525	Farmer	NO	Positive
29	Entag – SA. Shuke Khundu	Tilok	525	Farmer	NO	Positive

<b>Sl. No</b>	<b>Land Owners name</b>	<b>Land Owners Address</b>	<b>Dag No</b>	<b>Occupation</b>	<b>Project Affect Economic Activity</b>	<b>Opinion for the Project</b>
30	Julfikar/ Akber Haider	Tilok	530/529	Farmer	NO	Positive
31	Shadhon Kundu	Tilok	532/532	Service	NO	Positive
32	Mazid Morol	Tilok	565/593/534	Farmer	NO	Positive
33	Dev Pal Kundu	Tilok	564	Service	NO	Positive
34	Farid Shamabi Shamite	Khulna City	520	Service	NO	Positive
35	Mohan Kumar Kundu	Tilok	515,526	Advocate	NO	Positive
36	Jaideb Kundu	Tilok	517/521	Farmer	NO	Positive
37	Jalal	Tilok North Para	3717,3718,3785	Farmer	NO	Positive
38	Sattar Shake	Tilok	522	Farmer	NO	Positive
39	Rahim Gong	Elahipur	484	Service	NO	Positive
40	Jakir Morol	Tilok	516	Farmer	NO	Positive
41	Shubod Kumar Pal	Tilok	514/519	Service	NO	Positive

## Supporting Report 7.2 (1) Capacity Calculation and Mechanical Equipment List

### A. Capacity Calculation for Civil Work

#### I. Capacity Calculation of Intake Facility

##### 1. Design Water Flow

###### 1.1 Production Capacity

Daily maximum

Year	m <sup>3</sup> /day	m <sup>3</sup> /hr	m <sup>3</sup> /min	m <sup>3</sup> /sec
2025	110,000	4,600	76.4	1.273

###### 1.2 Plant Capacity

Production Capacity + (Storage Water Amount of Impounding Reservoir)

$$= 110,000 + \{(110,000 \times 6 \text{ days}^{*1}) / 90 \text{ days}^{*2}\}$$

\*1) Estimated Salinity Impact Days: 6 days,

\*2) Raw Water is sent to IP/R by pump in 90 days for one year.

Year	m <sup>3</sup> /day	m <sup>3</sup> /hr	m <sup>3</sup> /min	m <sup>3</sup> /sec
2025	118,000	4,900	81.9	1.366

##### 2. Raw Water Intake Facilities

###### 2.1 Intake Channel

	Madhumati River LWL at Mollarhat	-0.2 m (PWD)	
Unit Number :	2 channels		*) DWDBの1929年～2008年の観測結果よ 1984年が最低水位
Flow Per Channel :	1.366 / 2 =	0.683 m <sup>3</sup> /sec	
Intake Velocity :	0.6 m/sec to 1.0m/s		
Water Depth :	1.0 m ----- minimum water depth		
Width :	0.683 / ((0.6 to 1.0) x 1.0) =	1.2m to 07m	therefore <span style="border: 1px solid black; padding: 2px;">1.20 m</span>
Check : Average Velocity :	1.366 / (1.0 × 1.2) =	0.6 m/sec	...OK

###### 2.2 Primary Screen

Type :	Manual operation type Bar-screen		
Screen Opening :	Arrangement	100 mm	
Unit Number :	2 units		
Flow Per Unit :	1.366 / 2 =	0.683 m <sup>3</sup> /sec	
Screen face Velocity :	0.45 m/sec to 0.9 m/sec		
Dimension :	Depth	1.0 m/unit	Minimum water depth
	Width	1.20 m	
Check : Average Velocity :	0.683 / (1.0 × 1.2) =	0.6 m/sec	...OK
Specification :	<span style="border: 1px solid black; padding: 2px;">Width 1,200mm x Screen Opening 100mm x 2units</span>		

###### 2.3 Grit Chamber

Unit Number :	2 basin		
Flow Per Unit :	81.9 / 2 =	40.95 m <sup>3</sup> /min	
Surface Loading :	500 mm/min		
Required Area :	41.0 / 500 =	81.9 m <sup>2</sup>	
Basin Width :	4.0 m		
Basin Length :	81.9 / 4	20.48 m	therefore <span style="border: 1px solid black; padding: 2px;">21.0 m</span>
Basin Length/Width :	21 / 4 =	5.25	< 3 to 8 times : OK
Depth :	3.0 m		
Check : Average Velocity :	1.366 / (4 × 3 × 2 basins) =	0.057 m/sec	
		= 5.7 cm/sec	< 2 to 7 cm/sec : OK
Specification :	<span style="border: 1px solid black; padding: 2px;">Width 4.0m × Length 21.0m × Depth 3.0m × 2 basins</span>		



## 2.4 Raw Water Lift Pump

Type : Vertical type double volute pump

Calculation for Raw Water Lift Pump is shown in Mechanical Equipment Capacity Calculation

## 2.5 Raw Water Transmission Pipe

Unit Number :	for 2025	1 pipe, 2pipes for the Future Expansion	
Flow Per Pipe :	for 2025	81.9 m <sup>3</sup> /min	
Transmission velocity vp	More than	1.0 m/sec	
Pipe Diameter :	for 2025	$146 \times (81.9 / v p)^{1/2} =$	1,321 mm
	:	therefore	1,350 mm

<b>Check of Pump Head</b>	AH + PH + ΔHo =	35.6 m	→	36.0 m
<i>Actual Head Loss</i> :	AH =	9.3 m		
<i>Pump around Loss</i> :	PH =	2.0 m		
<i>Pipe Pressure Loss</i> :	$10.666 \times C^{-1.85} \times D^{-4.87} \times qs^{1.85} \times L =$	24.3 m		
	C :	110	D (m) :	1.35 m
	qs (m <sup>3</sup> /sec) :	1.366	L (m) :	33,000 m
	for 2025			

## II. Capacity Calculation of SWTP

### 1. Design Criteria

#### 1.1 Basic Items

- Plant name SAMANTO SENA SWTP
- Location Samanto Sena
- Intake Source Madhumati River
- Treatment Method (Water Treatment)

Intake Facility + Mixing Tank + Sedimentation + Rapid Sand Filter  
+ Clear Water Reservoir + Chlorination + Distribution Reservoir

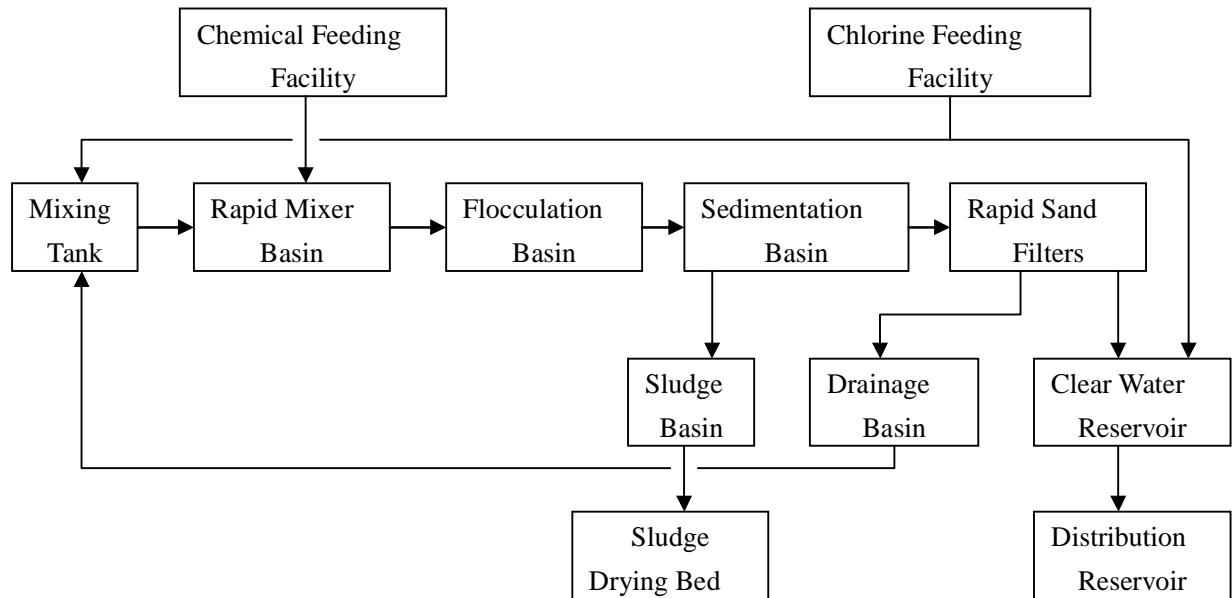
- Water Supply Rate in 2025 : 110,000 m<sup>3</sup>/day

#### 1.2 Design Rate of Water Conduct

Design Rate for Water Treatment

ITEM	m <sup>3</sup> /day	m <sup>3</sup> /hr	m <sup>3</sup> /min	m <sup>3</sup> /sec
2025	110,000	4,583.3	76.39	1.273
2030	220,000	9,166.7	152.78	2.547

### 1.3 Flow Chart



### 1.4 Design Condition

#### 1.4.1 Mixing Tank

- 1) Retention Time  $T = 3.0 \text{ min}$
- 2) Unit Number  $1 \text{ unit}$
- 3) Dimension  $4.3 \text{ mW} \times 18.9 \text{ mL} \times 3.0 \text{ mD}$   
 $V = 243 \text{ m}^3$

#### 1.4.2 Rapid Mixer Basin

- 1) Retention Time  $T = 3.0 \text{ min}$
- 2) Unit Number  $2 \text{ units}$
- 3) Dimension  $5.5 \text{ mW} \times 5.5 \text{ mL} \times 4.0 \text{ mD}$   
 $V = 242 \text{ m}^3$

#### 1.4.3 Flocculation Basin

- 1) Retention Time  $T = 30 \text{ min}$
- 2) Unit Number  $4 \text{ units}$
- 3) Dimension  $15.0 \text{ mW} \times 12.6 \text{ mL} \times 4.0 \text{ mD}$   
 $V = 3,024 \text{ m}^3$

#### 1.4.4 Sedimentation Basin

- 1) Retention Time  $T = 4 \text{ hour}$
- 2) Unit Number  $4 \text{ units}$
- 3) Dimension  $14.7 \text{ mW} \times 70.0 \text{ mL} \times 4.5 \text{ mD}$   
 $V = 18,522 \text{ m}^3$

#### 1.4.5 Rapid Sand Filter

- 1) Washing System  $\text{Self Washing Type}$

2) Filtration Velocity	120 m/day	
3) Back Wash	0.6 m <sup>3</sup> /min/m <sup>2</sup>	
4) Surface Wash	0.15 m <sup>3</sup> /min m <sup>2</sup>	
5) Unit Number	12 units	
6) Dimension	9.2 mW × 9.2 mL	
7) Unit Filtration Area	A= 84.64 m <sup>2</sup>	

※one unit is not working / during one unit is washing

#### 1.4.6 Clear Water Reservoir

1) Retention Time	T= 1 hour	
2) Unit Number	2 units	
3) Dimension	20.0 mW × 30.0 mL × 4.0 mD	
	V= 4,800 m <sup>3</sup>	

#### 1.4.7 Filter Drain Basin

1) Backwash Water	86.84m <sup>2</sup> × 0.6m <sup>3</sup> /m <sup>2</sup> × 6min =	305 m <sup>3</sup>
2) Surface Water	86.84m <sup>2</sup> × 0.15m <sup>3</sup> /m <sup>2</sup> × 6min =	76 m <sup>3</sup>
3) Disposal Water	86.84m <sup>2</sup> × 120m/day/1,440 × 10min =	72 m <sup>3</sup>
		453 m <sup>3</sup>
4) Unit Number	2 units	
5) Dimension	8.5 mW × 18.0 mL × 3.0 mD	
	V= 459 m <sup>3</sup> × 2 units	

#### 1.4.8 Sludge Drying Bed

1) Turbidity	48 NTU	
2) Chemical Feeding	18 mg/L	
3) Water Content	50 %	
4) Solid Loading	30 kg/m <sup>2</sup>	
5) Drying Days	40 days	
6) Sludge Amount	7,167 kg/day	
7) Unit Drying Area	9,556 m <sup>2</sup>	
8) Unit Number	8 units	
9) Dimension	25.0 mW × 50.0 mL × 1.0 mD	
	A = 10,000 m <sup>2</sup>	

### III. Capacity Calculation of Impounding Reservoir

#### 1. Design Criteria

##### 1.1 Basic Items

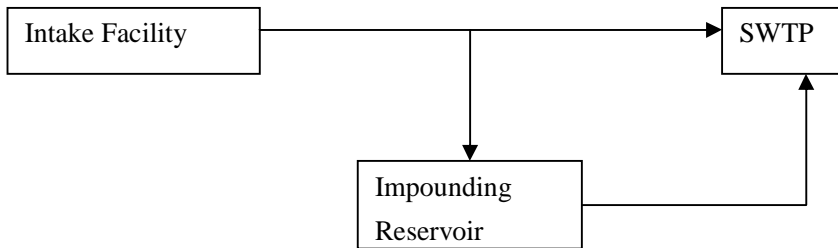
- Plant name               SAMANTO SENA IMPOUNDING RESERVOIR
- Location                 Samanto Sena
- Intake Source          Madhumati River
- Water Supply Rate in 2025 : 110,000 m<sup>3</sup>/day

##### 1.2 Design Rate of Water Conduct

Design Rate for Water Treatment

ITEM	m <sup>3</sup> /day	m <sup>3</sup> /hr	m <sup>3</sup> /min	m <sup>3</sup> /sec
2025	110,000	4,583.3	76.39	1.273
2030	220,000	9,166.7	152.78	2.547

##### 1.3 Flow Chart



##### 1.4 Design Condition

- 1) Retention Time                                T= 6 days
- 2) Unit Number                                    1 units
- 3) Dimension                                    190.0 mW × 340.0 mL × 12.0 mD  
  V= 775,200 m<sup>3</sup>
- 4) Facility Area                                    A= 10 ha

## B. Capacity Calculation for Mechanical Equipment

### I. Calculation for Intake Pump

Case 1-1 is recommended due to Mechanical & Electrical review.

1	Case Study		Case1-1	Case1-2	Case1-3
2	Pump Type		Double suction	Double suction	Double suction
3	<b>q : Capacity (m3/min)</b>		<b>20.5</b>	<b>27.4</b>	<b>41.0</b>
4	<b>N : Operation number</b>		<b>4</b>	<b>3</b>	<b>2</b>
	<b>Pump Number</b>		4D + 1S	3D + 1S	2D + 1S
	Total Head $H=ha+hf1+hf2+hf3+hf4$				
5	ha : Actual head (m) =DWL-SWL		9.3	9.3	9.3
6	DWL (m)		8.60	8.60	8.60
7	SWL (m)		-0.70	-0.70	-0.70
8	hf1 : Straight pipe loss (m) = $(10.666 \times Q^{1.85}) \times L \times Cc$ $(C^{1.85} \times D^{4.87})$		25.807	25.924	25.807
9	Q : Flow (m3/sec) =q x N/60		1.367	1.370	1.367
10	C : Coefficient LWL: 100 HWL: 140		<b>110</b>	<b>110</b>	<b>110</b>
11	D : Pipe Dia. (m)		1.35	1.35	1.35
12	L : Pipe length (m)		35000	35000	35000
13	Cc : Correction coefficient Water: 1.0 Sludge: WT99.2% :		1.0	1.0	1.0
14	hf2		0.000	0.000	0.000
15	hf3 : Pump around loss (m) Horizontal type : 2.0m Submersible type : 0.7m		2	2	2
16	hf4 : Other head				
17	H' =ha+hf1+hf2+hf3+hf4 (m)		37.11	37.22	38.00
18	<b>H : Total head (m)</b>		<b>38.0</b>	<b>38.0</b>	<b>38.0</b>
	Velocity		0.96	0.96	0.96
<b>Motor Power</b>					
19	BKW =0.163*SG*q*H/Pe (kW)		158.721	212.145	317.443
20	SG : Specific gravity		1.0	1.0	1.0
21	Pe : Pump efficiency		0.8	0.8	0.8
22	kW =BKW x C		182.529	243.966	365.059
23	C : Coefficient (1.15)		1.15	1.15	1.15
24	<b>Motor Power (kW)</b>		<b>190</b>	<b>250</b>	<b>370</b>

## II. Calculation for Raw Water Pump

Case 1-1 is recommended due to Mechanical & Electrical review.

1	Case study		Case1-1	Case1-2	Case1-3	Case1-4
2	Pump Type		Submercible Non-clog	Submercible Non-clog	Submercible Non-clog	Submercible Non-clog
3	q : Capacity (m3/min)		19.1	25.5	38.2	76.4
4	N : Operation number		4	3	2	1
	Pump Number		4D + 2S	3D + 2S	2D + 2S	1D + 2S
	Total Head H=ha+hf1+hf2+hf3+hf4					
5	ha : Actual head (m) =DWL-SWL		17.6	17.6	17.6	17.6
6	DWL (m)		8.60	8.60	8.60	8.60
7	SWL (m)		-9.00	-9.00	-9.00	-9.00
8	hf1 : Straight pipe loss (m) = $(10.666 \times Q^{1.85}) \times L \times Cc$ $(C^{1.85} \times D^{4.87})$		0.175	0.176	0.175	0.175
9	Q : Flow (m3/sec) =q x N/60		1.273	1.275	1.273	1.273
10	C : Coefficient LWL: 100 HWL: 140		110	110	110	110
11	D : Pipe Dia. (m)		1.1	1.1	1.1	1.1
12	L : Pipe length (m)		100	100	100	100
13	Cc : Correction coefficient Water: 1.0 Sludge: WT99.2% :		1.0	1.0	1.0	1.0
14	hf2		0.000	0.000	0.000	0.000
15	hf3 : Pump around loss (m) Horizontal type : 2.0m Submersible type : 0.7m		0.7	0.7	0.7	0.7
16	hf4 : Other head		0	0	0	0
17	H' =ha+hf1+hf2+hf3+hf4 (m)		18.48	18.48	18.48	18.48
18	H : Total head (m)		18.0	18.0	18.0	18.0
	Velocity		1.34	1.34	1.34	1.34
<b>Motor Power</b>						
19	BKW =0.163*SG*q*H/Pe (kW)		93.399	124.695	186.798	373.596
20	SG : Specific gravity		1.0	1.0	1.0	1.0
21	Pe : Pump efficiency		0.6	0.6	0.6	0.6
22	kW =BKW x C		107.409	143.399	214.818	429.635
23	C : Coefficient (1.15)		1.15	1.15	1.15	1.15
24	Motor Power (kW)		110	150	220	430

### III. Calculation for Clear Water Pump

Case 1-1 is recommended due to Mechanical & Electrical review.

1	Case study		Case1-1	Case1-2	Case1-3
2	Pump Type		Double suction	Double suction	Double suction
3	q : Capacity (m3/min)		17.4	23.2	34.8
4	N : Operation number		4	3	2
	Pump Number		4D + 2S	3D + 2S	2D + 2S
	Total Head H=ha+hf1+hf2+hf3+hf4				
5	ha : Actual head (m) =DWL-SWL		3.4	3.4	3.4
6	DWL (m)		3.00	3.00	3.00
7	SWL (m)		-0.40	-0.40	-0.40
8	hf1 : Straight pipe loss (m) = (10.666 x Q <sup>1.85</sup> ) x L x Cc (C <sup>1.85</sup> xD <sup>4.87</sup> )		42.00	42.00	42.00
9	Q : Flow (m3/sec) =q x N/60		1.160	1.160	1.160
10	C : Coefficient LWL: 100 HWL: 140		110	110	110
11	D : Pipe Dia. (m)		1.1	1.1	1.1
12	L : Pipe length (m)		more than 10000	more than 10000	more than 10000
13	Cc : Correction coefficient Water: 1.0 Sludge: WT99.2% :		1.0	1.0	1.0
14	hf2		0.000	0.000	0.000
15	hf3 : Pump around loss (m) Horizontal type : 2.0m Submersible type : 0.7m		2	2	2
16	hf4 : Other head		1.6	1.6	1.6
17	H' =ha+hf1+hf2+hf3+hf4 (m)		49.00	49.00	49.00
18	H : Total head (m)		50.0	50.0	50.0
	Velocity				
<b>Motor Power</b>					
19	BKW =0.163*SG*q*H/Pe (kW)		177.263	236.350	354.525
20	SG : Specific gravity		1.0	1.0	1.0
21	Pe : Pump efficiency		0.8	0.8	0.8
22	kW =BKW x C		203.852	271.803	407.704
23	C : Coefficient (1.15)		1.15	1.15	1.15
24	Motor Power (kW)		210	280	410

#### IV. Calculation for Distribution Pump

Case 1-1 is recommended due to Mechanical & Electrical review.

1	Reservoir zone		Zone 1	Zone 1	Zone 2	Zone 2	Zone 3	Zone 3	Zone 3	Zone 4	Zone 5	Zone 5	Zone 5
	Overhead Tank Name		Rab Sarani	Deana West Para	Mujgunni	Ward No.16 Office	Sonadanga Moha Sarak	Andir Pukur	South Side of Ward No.31 Office	Beside of No.7 Ward Office	Khalishpur Charehat River Ghat	Ferry Ghat Power House More	DPHE Rupsha
2	Pump Type		End suction	End suction	End suction	End suction	End suction	End suction	End suction	End suction	End suction	End suction	End suction
3	q : Capacity (m3/min)		3.2	5	3.1	3.3	4.5	3.7	2.3	5.1	4.6	2.6	2.8
4	N : Operation number		2	1	2	2	2	2	4	1	2	2	3
	Pump Number		2D +1S	1D +1S	2D +1S	2D +1S	2D +1S	2D +1S	4D +1S	1D +1S	2D +1S	2D +1S	3D +1S
	Total Head H=ha+hf1+hf2+hf3+hf4												
5	ha :Actual head (m) =DWL-SWL		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
6	DWL (m)		28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0
7	SWL (m)		-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00
8	hf1 : Straight pipe loss (m) = $(10.666 \times Q^{1.85}) \times L \times Cc$ ( $C^{1.85} \times D^{4.87}$ )		22.642	1.538	20.016	1.058	0.886	18.511	39.503	0.657	0.923	37.431	32.560
9	Q : Flow (m3/sec) =q x N/60		0.107	0.083	0.103	0.110	0.150	0.123	0.153	0.085	0.153	0.087	0.140
10	C : Coefficient LWL: 100 HWL: 140		110	110	110	110	110	110	110	110	110	110	110
11	D : Pipe Dia. (m)		0.35	0.25	0.35	0.3	0.35	0.35	0.4	0.3	0.35	0.3	0.4
12	L : Pipe length (m)		4800	100	4500	100	100	3000	8200	100	100	5500	8000
13	Cc : Correction coefficient Water: 1.0 Sludge: WT99.2% :		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
14	hf2		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	hf3 : Pump around loss (m) Horizontal type : 2.0m Submersible type : 0.7m		2	2	2	2	2	2	2	2	2	2	2
16	hf4 :Other head		0	0	0	0	0	0	0	0	0	0	0
17	H' =ha+hf1+hf2+hf3+hf4 (m)		54.64	33.54	52.02	33.06	32.89	50.51	71.50	32.66	32.92	69.43	64.56
18	H : Total head (m)		56.0	35.0	53.0	34.0	34.0	52.0	72.0	33.0	34.0	70.0	65.0
	Velocity		1.11	1.70	1.07	1.56	1.56	1.28	1.22	1.20	1.59	1.23	1.11
	<b>Motor Power</b>												
19	BKW =0.163*SG*q*H/Pe (kW)		38.946	38.033	35.708	24.385	33.252	41.815	35.990	36.577	33.991	39.555	39.555
20	SG :Specific gravity		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	Pe :Pump efficiency		0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
22	kW =BKW x C		44.788	43.738	41.064	28.043	38.240	48.087	41.389	42.064	39.090	45.488	45.488
23	C :Coefficient (1.15)		1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
24	Motor Power (kW)		55	45	45	30	45	55	45	45	45	55	55



## C. Capacity Calculation for Electrical Equipment

### Transformer , Capacitor and Generator Calculation Sheet

Water Intake

Load Name	Q.ty	stand-by	Output	Drive	Total	Tranformer	Capacitor	Generator
Automatic Inflow Screen	2		3.7	R	7.4		To 95% from 85%	
Sand Pump	2		5.5	NR	11			
Intake Pump	6	1	190	SRS	950			
Discharge Valve	6	2	0.4	R	1.6			
Seal Pump	4	2	2.2	NR	4.4			
Drain Pump	2	1	5.5	NR	5.5			
Overhead Crane	1		5	F	5			
Ventilation	4		0.2	F	0.8			
Lighiting	1		10	F	10			
<b>Total &amp; Calculate Result</b>					<b>988.3</b>	<b>1,204</b>	<b>26</b>	<b>1,321</b>
<b>Determined Facilities</b>						<b>750*2</b>	<b>7.5*2*2</b>	<b>1,000*2</b>

Impounding Reservoir

Load Name	Q.ty	stand-by	Output	Drive	Total	Tranformer	Capacitor	Generator
Raw Water Pump	6	2	110	SRS	440		To 95% from 85%	
Discharge Valve	6	2	0.2	R	0.8			
Drain Pump	2	1	5.5	NR	5.5			
Overhead Crane	1		5	F	5			
Ventilation	3		0.2	NR	0.6			
Lighiting	1		7	F	7			
<b>Total &amp; Calculate Result</b>					<b>458.9</b>	<b>559</b>	<b>21</b>	<b>668</b>
<b>Determined Facilities</b>						<b>500*2</b>	<b>7.5*2*2</b>	<b>700*1</b>

Surface Water Treatment Plant

Load Name	Q.ty	stand-by	Output	Drive	Total	Tranformer	Capacitor	Generator
Papid Mixer	2		11	NR	22		To 95% from 85%	
Sludge Collector	8		0.75	NR	6			
De-sludge Valve	32		0.4	R	12.8			
Sedimentation Drain Pump	4	2	2.2	NR	4.4			
Sludge Discharge Pump	3	1	5.5	NR	11			
Inlet Water Sampling Pump	2	1	2.2	NR	2.2			
Front of Filter Water Sampling Pump	2	1	2.2	NR	2.2			
Inflow Valve	12		0.4	R	4.8			
Filtrated&Backwash Valve	12		1.5	R	18			
Surface wash Valve	12		0.2	R	2.4			
Wash Waste Gate	12		0.75	R	9			
Rapid Filter Drain Pump	4	2	2.2	NR	4.4			
Wash Waste Pump	3	1	45	NR	90			
Filtrated Water Sampling Pump	2	1	2.2	NR	2.2			
Clear Water Pump	6	2	210	SRS	840			
Discharge Valve -1	6	2	0.2	R	0.8			
Surface wash Pump	3	2	90	SRS	90			
Clear Water PST Drain Pump	4	2	2.2	NR	4.4			
Overhead Crane	1		5	F	5			
Alum Mixer	2		3.7	NR	7.4			
Alum Dosing Pump	4	2	0.75	NR	1.5			
Lime Mixer	2		3.7	NR	7.4			
Lime Dosing Pump	4	2	0.75	NR	1.5			
Chemical Crane	1		1.85	F	1.85			
Chemical Building Drain Pump	2	1	2.2	NR	2.2			
Chlorine Crane	1		1.85	F	1.85			
Chlorine Booster Pump	3	1	7.5	NR	15			
Exhaust Fan	7		0.25	NR	1.75			
Ventilation	18		1.5	NR	27			
Lighiting	1		30	F	30			
Outdoor Lighting	25		0.3	F	7.5			
<b>Total &amp; Calculate Result</b>					<b>1,229.1</b>	<b>1,497</b>	<b>68</b>	<b>1,429</b>
<b>Determined Facilities</b>						<b>1,200*2</b>	<b>20*2*2</b>	<b>1,000*2</b>

No.1 Distribution Reservoir & Pump Station (Deana West Para)

Load Name	Q.ty	stand-by	Output	Drive	Total	Tranformer	Capacitor	Generator
Distribution Pump for Deana West Para	2	1	45	RSD	45		To 95% from 85%	
Distribution Pump for Rab Sarani	3	1	55	RSD	110			
Discharge Valve for Rab Sarani	3	1	0.2	R	0.4			
Chlorination Booster Pump	2	1	2.2	NR	2.2			
Exhaust Fan	2		0.25	NR	0.5			
Ventilation	2		0.2	NR	0.4			
Lighting	1		3	F	3			
<b>Total &amp; Calculate Result</b>					161.5	197	7.89	187
<b>Determined Facilities</b>						300*1	5*2	200*1

No.2 Distribution Reservoir & Pump Station (Ward No.16 Office)

Load Name	Q.ty	stand-by	Output	Drive	Total	Tranformer	Capacitor	Generator
Distribution Pump for Ward No.16 Office	3	1	30	RSD	60		To 95% from 85%	
Distribution Pump for Mujgunni	3	1	45	RSD	90			
Discharge Valve for Mujgunni	3	1	0.2	R	0.4			
Chlorination Booster Pump	2	1	2.2	NR	2.2			
Exhaust Fan	2		0.25	NR	0.5			
Ventilation	2		0.2	NR	0.4			
Lighting	1		3	F	3			
					0			
<b>Total &amp; Calculate Result</b>					156.5	191	7.89	176
<b>Determined Facilities</b>						300*1	5*2	200*1

No.3 Distribution Reservoir & Pump Station (Sonadanga Moha Sarak)

Load Name	Q.ty	stand-by	Output	Drive	Total	Tranformer	Capacitor	Generator
Distribution Pump for Sonadanga Moha Sarak	3	1	45	RSD	90		To 95% from 85%	
Distribution Pump for Andir Pukur	3	1	55	RSD	110			
Discharge Valve for Andir Pukur	3	1	0.2	R	0.4			
Distribution Pump for South Side of Ward No.31 Office	5	1	45	RSD	180			
Discharge Valve for South Side of Ward No.31 Office	5	1	0.2	R	0.8			
Chlorination Booster Pump	2	1	2.2	NR	2.2			
Exhaust Fan	2		0.25	NR	0.5			
Ventilation	2		0.2	NR	0.4			
Lighting	1		3	F	3			
					0			
<b>Total &amp; Calculate Result</b>					387.3	472	12.13	397
<b>Determined Facilities</b>						500*1	5*3	400*1

No.4 Distribution Reservoir & Pump Station (Beside of No.7 Ward Office)

Load Name	Q.ty	stand-by	Output	Drive	Total	Tranformer	Capacitor	Generator
Distribution Pump for Beside of No.7 Ward Office	2	1	45	RSD	45		To 95% from 85%	
Chlorination Booster Pump	2	1	2.2	NR	2.2			
Exhaust Fan	2		0.25	NR	0.5			
Ventilation	2		0.2	NR	0.4			
Lighting	1		3	F	3			
					0			
<b>Total &amp; Calculate Result</b>					51.1	62	3.78	81
<b>Determined Facilities</b>						100*1	2*2	100*1

No.5 Distribution Reservoir & Pump Station (Khalishpur Charerhat River Ghat)

Load Name	Q.ty	stand-by	Output	Drive	Total	Tranformer	Capacitor	Generator
Distribution Pump for Khalishpur Charerhat River Ghat	3	1	45	RSD	90		To 95% from 85%	
Distribution Pump for Ferry Ghat Power House	3	1	55	RSD	110			
Discharge Valve for Ferry Ghat Power House	3	1	0.2	R	0.4			
Distribution Pump for DPHE Rupsha	4	1	55	RSD	165			
Discharge Valve for South Side of Ward No.31 Office	4	1	0.2	R	0.6			
Chlorination Booster Pump	2	1	2.2	NR	2.2			
Exhaust Fan	2		0.25	NR	0.5			
Ventilation	2		0.4	NR	0.8			
Lighting	1		3	F	3			
					0			
<b>Total &amp; Calculate Result</b>					372.5	454	12.18	377
<b>Determined Facilities</b>						500*1	5*3	400*1

## D. Mechanical Equipment List

### 1. Water Intake Facility

Facility Name	Item	Specification	Q'ty	Motor Power
		Machine Type Capacity/Dimension	Duty (Standby)	kW
<b>01 Intake Facility</b> 118,000m <sup>3</sup> /d				
1-1	Inlet Stop Log	FRP Log (6 pieces /lot) W-1.2m x H-2.5m	2 (0)	---
1-2	Inlet Gate	Manual Sluice Gate W-1.0m x H-2.5m	2 (0)	---
1-3	Inflow Screen	Manual Bar Screen W-1.2m x H-3.5m x S.O-100mm	2 (0)	---
1-4	Automatic Inflow Screen	Fine Screen (include trough) W-4.0m x H-10.7m x S.O-10mm	2 (0)	3.7
1-5	Outlet Gate	Manual Sluice Gate W-1.0m x H-1.0m	2 (0)	---
1-6	Isolation Gate	Manual Sluice Gate W-1.0m x H-1.0m	1 (0)	---
1-7	Sand Pump	Submersible Sand (Portable type) 0.2m <sup>3</sup> /min x 15m x 5.5kW	2 (0)	5.5
1-8	Intake Hoist	Manual Chain Block 2.0t	3 (0)	---
1-9	Intake Pump	Vertical Double Volute D-400 x 20.5m <sup>3</sup> /min x 38m 190kW	4 (1)	190
1-10	Seal Pump	Tube Well D-40(3) x 0.1m <sup>3</sup> /min x 40m x 2.2kW	4 (1)	2.2
1-11	Drain Pump	Submersible Sump D-80 x 0.2m <sup>3</sup> /min x 20m x 5.5kW	1 (1)	5.5
1-12	Suction Valve	Manual Sluice D-450	4 (1)	---
1-13	Check Valve	Swing D-450	4 (1)	---
1-14	Discharge Valve	Manual Butterfly D-450	4 (1)	---
1-15	Discharge Valve	Motorized Butterfly D-450 x 0.2kW	4 (1)	0.2
1-16	Flow Control Valve	Manual Butterfly D-1100	1 (0)	---
1-17	Isolation Valve	Manual Butterfly D-1100	2 (1)	---
1-18	Overhead Crane	Electrically Crane 3.0t	1 (0)	5
1-19	Elevated Water Tank	PVC Tank 1.0m <sup>3</sup>	1 (0)	---

## 2. Impounding Reservoir

Facility Name	Item	Specification	Q'ty	Motor Power
		Machine Type Capacity/Dimension	Duty (Standby)	kW
<b>02</b>	<b>Impounding Reservoir</b> 110,000m <sup>3</sup> /d			
2-1	Raw Water Pump	Submersible non-clog pump D-400 x 19.1/min x 18m 110kW	4 (2)	110
2-2	Drain Pump	Submersible Sump D-80 x 0.2m <sup>3</sup> /min x 20m x 5.5kW	1 (1)	5.5
2-3	Check Valve	Swing D-450	4 (2)	---
2-4	Discharge Valve	Manual Butterfly D-450	4 (2)	---
2-5	Discharge Valve	Motorized Butterfly D-450 x 0.2kW	4 (2)	0.2
2-6	Flow Control Valve	Manual Butterfly D-1000	1 (0)	---
2-7	Isolation Valve	Manual Butterfly D-1000	2 (1)	---
2-8	Overhead Crane	Electrically Crane 3.0t	1 (0)	5

### 3. SWTP

Facility Name	Item	Specification	Q'ty	Motor Power
		Machine Type Capacity/Dimension	Duty (Standby)	kW
<b>03 Receiving Well/ Mixing Chamber/ Floccurator/ Clarifier</b> 110,000m <sup>3</sup> /d		Rectangular Parallel-flow Type x 8 Tanks		
3-1	Inlet Stop Log	Manual Weir	2 (0)	---
3-2	Rapid Mixer	Turbine Mixer D-1.0m x 8blades x 50min <sup>-1</sup> x 11kW	2 (0)	11
3-3	Inlet Gate	Manual Sluice W-0.6m x H-0.6m	8 (0)	---
3-4	Sludge Collector	W-7.45m x L-70m x 0.75kW	8 (0)	0.75
3-5	De-sludge Valve	Motorized Eccentric D-200 x 0.4kW	32 (0)	0.4
3-6	Drain Pump	Submersible Sump D-80 x 0.2m <sup>3</sup> /min x 20m x 2.2kW	2 (2)	2.2
3-7	Sampling Pump	Self-priming Centrifugal Sump 0.06m <sup>3</sup> /min x 12m x 0.2kW	1 (1)	0.2
<b>04 Filter</b> 110,000m <sup>3</sup> /d		Self Backwash System W-9.2m x L-9.2m x 12tanks		
4-1	Inflow Valve	Motorized Butterfly D-600 x 0.4kW	12 (0)	0.4
4-2	Filtrated&Backwash Valve	Motorized Butterfly D-1000 x 1.5kW	12 (0)	1.5
4-3	Surface wash Valve	Motorized Butterfly D-300 x 0.2kW	12 (0)	0.2
4-4	Wash Waste Gate	Motorized Rectangular Butterfly W-0.9m x H-0.9m x 0.75kW	12 (0)	0.75
4-5	Drain Pump	Submersible Sump D-80 x 0.2m <sup>3</sup> /min x 20m x 2.2kW	2 (2)	2.2
4-6	Sampling Pump	Self-priming Centrifugal Sump 0.06m <sup>3</sup> /min x 12m x 0.2kW	2 (2)	0.2
4-7	Surface wash Pipe Unit	SUS 304 D-300~25	12 (0)	---
4-8	Sand	Total 9.2mW x 9.2mL x 12 units sand 610m <sup>3</sup> , gravel 510m <sup>3</sup>	1 (0)	---

<b>05 Filter Drain Tank</b>				
5-1	Inlet Gate	Manual Sluice W-0.6m x H-0.9m	2 (0)	---
5-2	Wash Waste Pump	Horizontal End Suction Volute D-300 x 11m <sup>3</sup> /min x 16m x 45kW	2 (1)	45
5-3	Suction Valve -1	Manual Sluice D-350	2 (1)	---
5-4	Check Valve -1	Swing D-350	2 (1)	---
5-5	Discharge Valve -1	Manual Butterfly D-350	2 (1)	---
5-6	Maintenance Hoist	Manual Chain Block 2ton	1 (0)	---
<b>06 Sludge Discharge Tank</b>				
6-1	Inlet Gate	Manual Sluice W-0.6m x H-0.9m	2 (0)	---
6-2	Sludge Discharge Pump	Horizontal End Suction Pump D-125 x 2m <sup>3</sup> /min x 10m x 5.5kW	2 (1)	5.5
6-3	Suction Valve -1	Manual Sluice D-150	2 (1)	---
6-4	Check Valve -1	Swing D-150	2 (1)	---
6-5	Discharge Valve -1	Manual Sluice D-150	2 (1)	---
6-6	Maintenance Hoist	Manual Chain Block 2ton	1 (0)	---
<b>07 Clear Well/ Transmission Pump Station</b> 100,000m <sup>3</sup> /d				
7-1	Clear Water Pump	Horizontal Double Volute D-350 x 17.4m <sup>3</sup> /min x 50m 210kW	4 (2)	210
7-2	Suction Valve -1	Manual Sluice D-400	4 (2)	---
7-3	Check Valve -1	Swing with Dash-pot D-400	4 (2)	---
7-4	Discharge Valve -1	Manual Butterfly D-400	4 (2)	---
7-5	Discharge Valve -1	Motorized Butterfly D-400 x 0.2kW	4 (2)	0.2
7-6	Surface wash Pump	Horizontal End Suction Volute D-300 x 14m <sup>3</sup> /min x 28m x 90kW	1 (2)	90
7-7	Suction Valve -1	Manual Sluice D-350	1 (2)	---
7-8	Check Valve -1	Swing D-350	1 (2)	---
7-9	Discharge Valve -1	Manual Butterfly D-350	1 (2)	---

7-10	Isolation Valve	Manual Butterfly D-300	1 (0)	---
7-11	Isolation Valve	Manual Sluice D-350	2 (0)	---
7-12	Drain Pump	Submersible Sump D-80 x 0.2m <sup>3</sup> /min x 20m x 2.2kW	2 (2)	2.2
7-13	Overhead Crane	Electrically Crane 3.0t	1 (0)	5
7-14	Inlet Valve	Manual Butterfly D-1000	2 (0)	---
7-15	Suction Header Valve	Manual Butterfly D-1000	2 (0)	---
7-16	Isolation Valve	Manual Butterfly D-1000	2 (1)	---
<b>08 Chemical Building</b>				
8-1	Alum Mixer (Agitator)	Double Impeller Turban Mixer Peripheral Dia.1000 x 3.7kW	2 (0)	3.7
8-2	Alum Pump	Daiaphram 0.75kW	2 (2)	0.75
8-3	Lime Mixer (Agitator)	Double Impeller Turban Mixer Peripheral Dia.1000 x 3.7kW	2 (0)	3.7
8-4	Lime Pump	Daiaphram 0.75kW	1 (2)	0.75
8-5	Chemical Crane	Electrically Chain Block 3.0t	1 (0)	1.85
8-6	Drain Pump	Submersible Sump D-80 x 0.2m <sup>3</sup> /min x 20m x 2.2kW	1 (1)	2.2
<b>09 Chlorine Building</b>				
9-1	Chlorine Cylinder	Cylindrical Convexed Container 1000kg	14 (0)	---
9-2	Weight Scale	Load Cell 0 to 2.0ton	2 (0)	---
9-3	Chlorinator	Self-Stand Vacuum 40kg/hr	2 (1)	---
9-4	Chlorine Booster Pump	End Suction Volute D-50 x 0.3m <sup>3</sup> /min x 50m x 7.5kW	2 (1)	7.5
9-5	Chlorine Crane	Electrically Chain Block 3.0t	1 (0)	1.85
9-6	Exhaust Fan	Unit Fan 50m <sup>3</sup> /min x 0.25kW	7 (0)	0.25
9-7	Chlorine Leak Detector	Cl <sub>2</sub> Gas Leak Detekuter Sencer 5sets / detector	1 (0)	---
<b>10 Sludge Drying Bed</b>				
10-1	Inlet Valve	Manual sluice D-200	8 (0)	---
10-2	Stop Log		16 (0)	---

#### 4. Distribution Reservoir

Facility Name	Item	Specification	Q'ty	Motor Power
		Machine Type Capacity/Dimension	Duty (Standby)	kW
<b>11 Distribution Reservoir</b>				
<b>Zone 1 Distribution Reservoir</b>				
11-1-1	Distribution Pump for Rab Sarani	Horizontal End suction Volute D-150 x 3.2m <sup>3</sup> /min x 56m 55kW	2 (1)	55
11-1-2	Suction & Discharge Valve	Manual Butterfly D-150	4 (2)	---
11-1-3	Check Valve	Swing D-150	2 (1)	---
11-1-4	Discharge Valve	Motorized Butterfly D-150x 0.2kW	2 (1)	0.2
11-1-5	Isolate Valve	Manual Sluice D-150	2 (1)	---
11-1-6	Distribution Pump for Deana West Para	Horizontal End suction Volute D-200x 5.0m <sup>3</sup> /min x 35m 45kW	1 (1)	45
11-1-7	Suction & Discharge Valve	Manual Butterfly D-200	2 (2)	---
11-1-8	Check Valve	Swing D-200	1 (1)	---
11-1-9	Isolate Valve	Manual Sluice D-200	2 (1)	---
11-1-10	Inlet Valve	Manual Butterfly D-500	2 (0)	---
11-1-11	Suction Header Valve	Manual Butterfly D-500	2 (0)	---
11-1-12	Overhead Crane	Manual Crane 1.0t	1 (0)	---
11-1-13	Chlorine Cylinder	Cylindrical Convexed Container 1000kg	4 (0)	---
11-1-14	Weight Scale	Load Cell 0 to 2.0ton	2 (0)	---
11-1-15	Chlorinator	Self-Stand Vacuum 10kg/hr	1 (1)	---



11-1-16	Chlorine Booster Pump	End Suction Volute D-50 x 0.1m <sup>3</sup> /min x 50m x 2.2kW	1 (1)	2.2
11-1-17	Chlorine Crane	Manual Chain Block 3.0t	1 (0)	---
11-1-18	Exhaust Fan	Unit Fan 10m <sup>3</sup> /min x 0.25kW	2 (0)	0.25
11-1-19	Chlorine Leak Detector	Cl <sub>2</sub> Gas Leak Detekuter	1 (0)	---
<b>Zone 2 Distribution Reservoir</b>				
11-2-1	Distribution Pump for Mujgunni	Horizontal End suction Volute D-150x 3.1m <sup>3</sup> /min x 53m 45kW	2 (1)	45
11-2-2	Suction & Discharge Valve	Manual Butterfly D-150	4 (2)	---
11-2-3	Check Valve	Swing D-150	2 (1)	---
11-2-4	Discharge Valve	Motorized Butterfly D-150x 0.2kW	2 (1)	0.2
11-2-5	Isolate Valve	Manual Sluice D-150	2 (1)	---
11-2-6	Distribution Pump for Ward No.16 Office	Horizontal End suction Volute D-150x 3.3m <sup>3</sup> /min x 34m 30kW	2 (1)	30
11-2-7	Suction & Discharge Valve	Manual Butterfly D-150	4 (2)	---
11-2-8	Check Valve	Swing D-150	2 (1)	---
11-2-9	Isolate Valve	Manual Sluice D-150	2 (1)	---
11-2-10	Inlet Valve	Manual Butterfly D-600	2 (0)	---
11-2-11	Suction Header Valve	Manual Butterfly D-600	2 (0)	---
11-2-12	Overhead Crane	Manual Crane 1.0t	1 (0)	---
11-2-13	Chlorine Cylinder	Cylindrical Convexed Container 1000kg	4 (0)	---
11-2-14	Weight Scale	Load Cell 0 to 2.0ton	2 (0)	---
11-2-15	Chlorinator	Self-Stand Vacuum 10kg/hr	1 (1)	---

11-2-16	Chlorine Booster Pump	End Suction Volute D-50 x 0.1m <sup>3</sup> /min x 50m x 2.2kW	1 (1)	2.2
11-2-17	Chlorine Crane	Manual Chain Block 3.0t	1 (0)	---
11-2-18	Exhaust Fan	Unit Fan 10m <sup>3</sup> /min x 0.25kW	2 (0)	0.25
11-2-19	Chlorine Leak Detector	Cl <sub>2</sub> Gas Leak Detekuter	1 (0)	---
<b>Zone 3 Distribution Reservoir</b>				
11-3-1	Distribution Pump for Sonadanga Moha Sarak	Horizontal End suction Volute D-150x 4.5m <sup>3</sup> /min x 34m 45kW	2 (1)	45
11-3-2	Suction & Discharge Valve	Manual Butterfly D-150	4 (2)	---
11-3-3	Check Valve	Swing D-150	2 (1)	---
11-3-4	Isolate Valve	Manual Sluice D-150	2 (1)	---
11-3-5	Distribution Pump for Andir Pukur	Horizontal End suction Volute D-150x3.7m <sup>3</sup> /min x 52m 55kW	2 (1)	55
11-3-6	Suction & Discharge Valve	Manual Butterfly D-150	4 (2)	---
11-3-7	Check Valve	Swing D-150	2 (1)	---
11-3-8	Discharge Valve	Motorized Butterfly D-150x 0.2kW	2 (1)	0.2
11-3-9	Isolate Valve	Manual Sluice D-150	2 (1)	---
11-3-10	Distribution Pump for South Side of Ward No.31 Office	Horizontal End suction Volute D-150x 2.3m <sup>3</sup> /min x 72m 45kW	4 (1)	45
11-3-11	Suction & Discharge Valve	Manual Butterfly D-150	8 (2)	---
11-3-12	Check Valve	Swing D-150	4 (1)	---
11-3-13	Discharge Valve	Motorized Butterfly D-150x 0.2kW	4 (1)	0.2
11-3-14	Isolate Valve	Manual Sluice D-150	2 (1)	---

11-3-15	Inlet Valve	Manual Butterfly D-600	2 (0)	---
11-3-16	Suction Header Valve	Manual Butterfly D-600	2 (0)	---
11-3-17	Overhead Crane	Manual Crane 1.0t	1 (0)	---
11-3-18	Chlorine Cylinder	Cylindrical Convexed Container 1000kg	4 (0)	---
11-3-19	Weight Scale	Load Cell 0 to 2.0ton	2 (0)	---
11-3-20	Chlorinator	Self-Stand Vacuum 10kg/hr	1 (1)	---
11-3-21	Chlorine Booster Pump	End Suction Volute D-50 x 0.1m <sup>3</sup> /min x 50m x 2.2kW	1 (1)	2.2
11-3-22	Chlorine Crane	Manual Chain Block 3.0t	1 (0)	---
11-3-23	Exhaust Fan	Unit Fan 10m <sup>3</sup> /min x 0.25kW	2 (0)	0.25
11-3-24	Chlorine Leak Detector	Cl <sub>2</sub> Gas Leak Detekuter	1 (0)	---
<b>Zone 4 Distribution Reservoir</b>				
11-4-1	Distribution Pump for Beside of No.7 Ward Office	Horizontal End suction Volute D-200x 5.1m <sup>3</sup> /min x 33m 45kW	1 (1)	45
11-4-2	Suction & Discharge Valve	Manual Butterfly D-200	2 (2)	---
11-4-3	Check Valve	Swing D-200	1 (1)	---
11-4-4	Isolate Valve	Manual Sluice D-200	2 (1)	---
11-4-5	Inlet Valve	Manual Butterfly D-500	2 (0)	---
11-4-6	Suction Header Valve	Manual Butterfly D-500	2 (0)	---
11-4-7	Overhead Crane	Manual Crane 1.0t	1 (0)	---
11-4-8	Chlorine Cylinder	Cylindrical Convexed Container 1000kg	4 (0)	---
11-4-9	Weight Scale	Load Cell 0 to 2.0ton	2 (0)	---

11-4-10	Chlorinator	Self-Stand Vacuum 10kg/hr	1 (1)	---
11-4-11	Chlorine Booster Pump	End Suction Volute D-50 x 0.1m <sup>3</sup> /min x 50m x 2.2kW	1 (1)	2.2
11-4-12	Chlorine Crane	Manual Chain Block 3.0t	1 (0)	---
11-4-13	Exhaust Fan	Unit Fan 10m <sup>3</sup> /min x 0.25kW	2 (0)	0.25
11-4-14	Chlorine Leak Detector	Cl <sub>2</sub> Gas Leak Detekuter	1 (0)	---
<b>Zone 5 Distribution Reservoir</b>				
11-5-1	Distribution Pump forKhalishpur Charehat River Ghat	Horizontal End suction Volute D-150x 4.6m <sup>3</sup> /min x 34m 45kW	2 (1)	45
11-5-2	Suction & Discharge Valve	Manual Butterfly D-150	4 (2)	---
11-5-3	Check Valve	Swing D-150	2 (1)	---
11-5-4	Isolate Valve	Manual Sluice D-150	2 (1)	---
11-5-5	Distribution Pump for Ferry Ghat Power House More	Horizontal End suction Volute D-150x 2.6m <sup>3</sup> /min x 70m 55kW	2 (1)	55
11-5-6	Suction & Discharge Valve	Manual Butterfly D-150	4 (2)	---
11-5-7	Check Valve	Swing D-150	2 (1)	---
11-5-8	Discharge Valve	Motorized Butterfly D-150x 0.2kW	2 (1)	0.2
11-5-9	Isolate Valve	Manual Sluice D-150	2 (1)	---
11-5-10	Distribution Pump for DPHE Rupsha	Horizontal End suction Volute D-150x 2.8m <sup>3</sup> /min x 65m 55kW	3 (1)	55
11-5-11	Suction & Discharge Valve	Manual Butterfly D-150	6 (2)	---
11-5-12	Check Valve	Swing D-150	3 (1)	---
11-5-13	Discharge Valve	Motorized Butterfly D-150x 0.2kW	3 (1)	0.2

11-5-14	Isolate Valve	Manual Sluice D-150	2 (1)	---
11-5-15	Inlet Valve	Manual Butterfly D-500	2 (0)	---
11-5-16	Suction Header Valve	Manual Butterfly D-500	2 (0)	---
11-5-17	Overhead Crane	Manual Crane 1.0t	1 (0)	---
11-5-18	Chlorine Cylinder	Cylindrical Convexed Container 1000kg	4 (0)	---
11-5-19	Weight Scale	Load Cell 0 to 2.0ton	2 (0)	---
11-5-20	Chlorinator	Self-Stand Vacuum 10kg/hr	1 (1)	---
11-5-21	Chlorine Booster Pump	End Suction Volute D-50 x 0.1m <sup>3</sup> /min x 50m x 2.2kW	1 (1)	2.2
11-5-22	Chlorine Crane	Manual Chain Block 3.0t	1 (0)	---
11-5-23	Exhaust Fan	Unit Fan 10m <sup>3</sup> /min x 0.25kW	2 (0)	0.25
11-5-24	Chlorine Leak Detector	Cl <sub>2</sub> Gas Leak Detekuter	1 (0)	---
<b>12 Overhead Tank</b>				
12-1	Isolate Valve	Manual Butterfly D-400	4 (2)	---
12-2	Isolate Valve	Manual Butterfly D-350	10 (5)	---
12-3	Isolate Valve	Manual Butterfly D-300	6 (3)	---
12-4	Isolate Valve	Manual Butterfly D-250	2 (1)	---
12-5	Drain Valve	Manual Sluice D-150	11 (0)	---

## Supporting Report 7.2 (2) Outline of Major Facility and Equipment

### 1) Water Intake

The outline of major facilities and equipment at the water intake station for the 2025 is as shown in **Table 7.2.1**.

**Table 7.2.1 Outline of Major Facilities and Equipment in Water Intake**

Name	Dimension/ Specification	No. of Units	Remarks
Intake Mouse	6.5 to 3.9mW × 6.4mL × 1.0mD	1	Stop Log, Inflow Screen
Intake Box Culvert	1.2mW × 6.0mL × 1.0mD	2	v = 0.683m/sec
Grit Chamber	4.0mW × 21.0mL × 3.0mD	2	v = 5.7cm/sec
Pump Well	23.0mW × 6.5mL × 5.5mD	1	
Pump Room	23.0mW × 12.0mL × 5.0mH	1	
Intake Pump	φ 400mm × 20.5m <sup>3</sup> /min × 38m, 190kW	4 duty 1 stand-by	
Power Receiving Equipment	750 kVA	2	
Office	7.0mW × 10.0mL	1	
Electrical Room/ Generator Room	12.0mW × 24.0mL	1	
	Generator: 1000kVA	1	
Compact Filter	6.0mW × 6.0mL	1	
Guard House	3.0mW × 3.0mL	1	

W: width, L: length, H: height, D: depth, v: velocity

### 2) Outline of Raw Water Transmission Pipe

The outline of raw water transmission pipe for the 2025 is listed below.

Number of Pipeline:	1 line
Diameter:	φ 1,350 mm
Length:	33.0 km
Pipe Material:	DIP (Ductile Cast Iron Pipe)
Flow:	Pumping from Water Intake
Maximum Velocity:	1.0 m/sec
Pipe Route:	Gopalganji-Khulna Road and Bahirdia-Baghmara Road

### 3) Outline of Impounding Reservoir

The outline of major facilities and equipment at the impounding reservoir for the 2025 is shown in **Table 7.2.2**.

**Table 7.2.2 Outline of Impounding Reservoir Major Facility and Equipment**

Facility	Dimension/Spec	No. of Unit	Remark
Impounding Reservoir	340mW×190mL×12.0mD V=775,200m <sup>3</sup>	1	
Raw Water Pump	φ 400mm × 19.1m <sup>3</sup> /min × 18m, 110kW	4 duty 2 stand-by	
Power Receiving Equipment	500 kVA	2	
Generator	700kVA	1	

#### 4) Outline of SWTP

The outline of major facilities and equipment at the SWTP for the 2025 is as shown in **Table 7.2.3**.

**Table 7.2.3 Outline of SWTP Major Facility and Equipment**

Facility	Dimension/Spec	No. of Unit	Remark
Receiving Well	4,3mW×18,9mL×4.5mD	1	
Hydraulic Rapid Mixer	5.5mW×5.5mL×4.0mD	2	Retention time: 30min
Hydraulic Flocculation Basin	Vertical Flow type 15.0mW×12.6mL×4.0mD	4	Retention time: 30min
Sedimentation Basin	Horizontal Flow 14.7mW×70.0mL×4.5mD	4	With mechanical Sludge Scrapper
Rapid Sand Filters	9.2mW×9.2mL Self-backwashing type	12	Filtering rate: 120m/day
Clear Water Reservoir	20.0mW×30.0mL×4.0mD	2	Retention time: 1hour
Sludge Drying Bed	25mW×50mL	8	
Clear Water Pump	φ 350mm × 17.4m <sup>3</sup> /min × 50m, 210kW	4 duty 2 stand-by	
Main Building	912m <sup>2</sup>		
Chemical	476m <sup>2</sup>		
Chlorine	280m <sup>2</sup>		
Power Receiving Equipment	1,200 kVA	2	
Generator	1,000kVA	2	

#### 5) Clear Water Transmission Facility

##### a) Clear Water Transmission Pipe

The outline of clear water transmission pipe for the 2025 is listed below.

- Transmission Flow: 110,000 m<sup>3</sup>/day
- Pipe Material: DIP (Ductile Cast Iron Pipe)
- Pipe Length: 24.6 km
- River Crossing: Pipe Jacking Method, Length 390m, Shaft 2 points

##### b) Distribution Reservoir

The outline of major facilities and equipment at the distribution reservoir for the 2025 is shown in **Table 7.2.4**.

**Table 7.2.4 Outline of Distribution Reservoir Major Facility and Equipment**

Facility	Dimension/Spec	No. of Unit	Remark
<b>&lt;No.1&gt;</b>			
Distribution Reservoir	25.8mW×33.0mL×5.0mD, V=8,000m <sup>3</sup>	2	Retention time: 12hour
Clear Water Pump	φ 150mm × 3.2m <sup>3</sup> /min × 56m, 55kW	2 duty 1 stand-by	For Rab Sarani
Clear Water Pump	φ 200mm × 5.0m <sup>3</sup> /min × 35m, 45kW	1 duty 1 stand-by	For Deana West Para
Power Receiving Equipment	300 kVA	1	
Generator	200 kVA	1	
<b>&lt;No.2&gt;</b>			
Distribution Reservoir	25.8mW×36.4mL×5.0mD, V=9,000m <sup>3</sup>	2	Retention time: 12hour
Clear Water Pump	φ 150mm × 3.1m <sup>3</sup> /min × 53m, 45kW	2 duty 1 stand-by	For Mujgunni
Clear Water Pump	φ 150mm × 3.3m <sup>3</sup> /min × 34m, 30kW	2 duty 1 stand-by	For Ward No.16 Office
Power Receiving Equipment	300 kVA	1	
Generator	200 kVA	1	
<b>&lt;No.3&gt;</b>			
Distribution Reservoir	25.8mW×72.8mL×5.0mD, V=18,000m <sup>3</sup>	2	Retention time: 12hour
Clear Water Pump	φ 150mm × 4.5m <sup>3</sup> /min × 34m, 45kW	2 duty 1 stand-by	For Sonadanga Moha Sarak
Clear Water Pump	φ 150mm × 3.7m <sup>3</sup> /min × 52m, 55kW	2 duty 1 stand-by	For Andir Pukur
Clear Water Pump	φ 150mm × 2.3m <sup>3</sup> /min × 72m, 45kW	4 duty 1 stand-by	For South Side of Ward No.31 Office
Power Receiving Equipment	500 kVA	1	
Generator	400 kVA	1	
<b>&lt;No.4&gt;</b>			
Distribution Reservoir	25.8mW×20.0mL×5.0mD, V=5,000m <sup>3</sup>	2	Retention time: 12hour
Clear Water Pump	φ 200mm × 5.1m <sup>3</sup> /min × 33m, 45kW	1 duty 1 stand-by	For Beside of No.7 Ward Office
Power Receiving Equipment	100 kVA	1	
Generator	100 kVA	1	
<b>&lt;No.5&gt;</b>			
Distribution Reservoir	25.8mW×60.5mL×5.0mD, V=15,000m <sup>3</sup>	2	Retention time: 12hour
Clear Water Pump	φ 150mm × 4.6m <sup>3</sup> /min × 34m, 45kW	2 duty 1 stand-by	For Khalishpur Charehat River Ghat
Clear Water Pump	φ 150mm × 2.6m <sup>3</sup> /min × 70m, 55kW	2 duty 1 stand-by	For Ferry Ghat Power House More
Clear Water Pump	φ 150mm × 2.8m <sup>3</sup> /min × 65m, 55kW	3 duty 1 stand-by	For DPHE Rupsha
Power Receiving Equipment	500 kVA	1	
Generator	400 kVA	1	

c) Overhead Tank

The outline of major facilities and equipment at the overhead tank for the 2025 is shown in **Table 7.2.5**.



**Table 7.2.5 Outline of Overhead Tank Major Facility and Equipment**

Facility	Dimension/Spec	No. of Unit	Remark
<No.1>			
Overhead Tank 1-1	$\phi$ 10m $\times$ 4.0mD,V=300m <sup>3</sup>	1	Rab Sarani
Overhead Tank 1-2	$\phi$ 10m $\times$ 4.0mD,V=300m <sup>3</sup>	1	Deana West Para
<No.2>			
Overhead Tank 2-1	$\phi$ 10m $\times$ 4.0mD,V=300m <sup>3</sup>	1	Mujgunni
Overhead Tank 2-2	$\phi$ 10m $\times$ 4.0mD,V=300m <sup>3</sup>	1	Ward No.16 Office
Overhead Tank 2-3	$\phi$ 12.8m $\times$ 4.0mD,V=500m <sup>3</sup>	1	Sonadanga Moha Sarak
<No.3>			
Overhead Tank 3-1	$\phi$ 12.8m $\times$ 4.0mD,V=500m <sup>3</sup>	1	Andir Pukur
Overhead Tank 3-2	$\phi$ 12.8m $\times$ 4.0mD,V=500m <sup>3</sup>	1	South Side of Ward No.31 Office
<No.4>			
Overhead Tank 4-1	$\phi$ 12.8m $\times$ 4.0mD,V=500m <sup>3</sup>	1	Beside of No.7 Ward Office
Overhead Tank 4-2	$\phi$ 12.8m $\times$ 4.0mD,V=500m <sup>3</sup>	1	Khalishpur Charehat River Ghat
<No.5>			
Overhead Tank 5-1	$\phi$ 10m $\times$ 4.0mD,V=300m <sup>3</sup>	1	Ferry Ghat Power House More
Overhead Tank 5-2	$\phi$ 12.8m $\times$ 4.0mD,V=500m <sup>3</sup>	1	For DPHE Rupsha

## 6) Water Distribution System

The outline of water distribution system for the 2025 is listed below.

**Table 7.2.6 Outline of Water Distribution System**

Facility	Diameter (mm)	Pipe Length	Remark
Distribution Pipe	$\phi$ 400	20 km	
Distribution Pipe	$\phi$ 350	30 km	
Distribution Pipe	$\phi$ 300	10 km	
Distribution Pipe	$\phi$ 250	60 km	
Distribution Pipe	$\phi$ 200	70 km	
Distribution Pipe	$\phi$ 150	100 km	
Distribution Pipe	$\phi$ 100	110 km	
Distribution Pipe	$\phi$ 75	200 km	
Service Connection Pipe	$\phi$ 20	100 km	
Total		<b>700 km</b>	

## Supporting Report 8.1.3 157 Non-Permanent Revenue Post Establishment for KWASA

PEOPLE'S REPUBLIC OF BANGLADESH  
Ministry of Local Government, Rural Development and Cooperatives  
**Local Government Division**  
PAS-2 Department

Ref #: LGD/PAS-2/K-1/2007(Part-1)/832

From:

Syeda Sahana Bari

Additional Secretary (PAS-2)

To:

Managing Director

KWASA

**Subject: 157 Non-Permanent Revenue Post Establishment for KWASA**

Vide Ref:

- (1) Ministry of Establishment Reference-SAM/SOB/Team/3(1)/LG-5/91-176, date: 30.10.2000.
- (2) Ministry of Finance Ref- AM/FD/Moni/Khulna/Rev/wasa/2000/401, date: 13.08.2003.
- (3) Ministry of Finance Ref- AM (Basto-2)Be:Sch:Ni(LGD)-71/2003/6, date: 16.01.2005.
- (4) Ministry of Establishment Reference-SAM/SOB-Sec-5/LG-5/91-221, date: 21.10.2008
- (5) Ministry of Finance Ref- AM/FD/Moni/KWASA(Post creation)/2008/225,date: 05.11.2008.
- (6) Ministry of Finance Ref- AM (Basto-2)Be:Sch:Ni(LGD)-71/2003/223, date: 13.11.2008.

On reference and order of mentioned letters and memo, we are releasing the approval of establishment 157 non-permanent revenue posts for KWASA under **Local Government Division** as noted below:

Sl.	Designation and # of Posts	Fixed salary scale by Implementation sector of Finance Division	Condition and Qualifications
1.	Managing Director 1 (One) Post	<ul style="list-style-type: none"> <li>• According to contract condition if contractual.</li> <li>• Officers will continue pay-scale if in deputation</li> </ul>	The post may be filled by contract or deputation according to the appointment rules of KWASA.
2.	Deputy Managing Director 2 (Two) Posts	<ul style="list-style-type: none"> <li>• According to contract condition if contractual.</li> <li>• Officers will continue pay-scale if by deputation.</li> </ul>	The post may be filled by contract or deputation according to the appointment rules of KWASA.
3.	Chief Engineer 1 (One) Post	Tk. 10700-13100 (Scale – 4)	<ul style="list-style-type: none"> <li>• In case of promotion, B.Sc. Engineering or equivalent AMIE (Part A &amp; B), especially Sanitary Engineering with 7 years experience as Superintendent Engineer with continuation of 18 years service experience.</li> <li>• Same or same post experience in case of deputation.</li> </ul>
4.	Secretary 1 (One) Post	Tk. 7200-10840 (Scale – 6)	<ul style="list-style-type: none"> <li>• In case of promotion, required 15 years working experience as a 1<sup>st</sup> class officer as well as 7 years as Additional Secretary.</li> <li>• Same or same post experience in case of deputation.</li> </ul>

Sl.	Designation and # of Posts	Fixed salary scale by Implementation sector of Finance Division	Condition and Qualifications
5.	Commercial Manager 1 (One) Post	Tk. 7200-10840 (Scale – 6)	<u>For direct appointment:</u> <ul style="list-style-type: none"> <li>• Minimum 2<sup>nd</sup> class Honors with Masters Degree in Accounting / Economics / Business Management from any reputable university or Chartered Accountant.</li> <li>• 15 years experience as executive level in well-known commercial / industries / organization / semi-government organization / government organization and 10 years experience for chartered accountant.</li> </ul> <u>For promotion:</u> 18 years 1 <sup>st</sup> class service with 7 years as chief accounts officer / chief revenue officer.
6.	Superintendent Engineer 1 (One) Post	Tk. 9500-12100 (Scale – 5)	In case of promotion, minimum 7 years working experience as Executive Engineer.
7.	Executive Engineer 2 (Two) Posts	Tk. 7200-10840 (Scale – 6)	In case of promotion, minimum 5 years working experience as Sub-Divisional / Assistant Engineer.
8.	Assistant Engineer 4 (Four) Posts	Tk. 4300-7740 (Scale – 9)	<ul style="list-style-type: none"> <li>• In case of direct recruitment, B.Sc in Civil/Mechanical/ Electrical or AMIE (part A &amp; B) or equivalent degree from any reputed university / institute.</li> <li>• In case of promotion, Diploma from any reputable institute with minimum 7 years working experience as Sub-Assistant Engineer/Estimator.</li> </ul>
9.	Medical Officer 1 (One) Post	Tk. 4300-7740 (Scale – 9)	<u>For direct recruitment</u> , MBBS with 2 years practical experience
10.	Accounts Officer 1 (One) Post	Tk. 3400-6625 (Scale – 10)	<u>For direct recruitment:</u> Minimum 2 <sup>nd</sup> class Masters Degree in Commerce discipline / Accounting from any reputable university. <u>For promotion:</u> 10 years service experience with 5 years as Accountant / Auditor.
11.	Budget Officer 1 (One) Post	Tk. 3400-6625 (Scale – 10)	<u>For direct recruitment:</u> Minimum 2 <sup>nd</sup> class in Masters Degree in Commerce discipline. <u>For promotion:</u> 5 years working experience as Accountant. Fixed by the Ministry of Finance vide reference - MF/FD (Impl.-2)(3) CA-6/89/ (Part-2), dated 24/06/1995.
12.	Assistant Head 1 (One) Post	Tk. 3400-6625 (Scale – 10)	<u>For direct recruitment:</u> Fixed by the Ministry of Finance vide reference- MF/FD (Impl.-2) (3) CA-6/89/(Part-2), dated 24/06/1995. <u>For promotion:</u> 4 years working experience as Planning Officer.

Sl.	Designation and # of Posts	Fixed salary scale by Implementation sector of Finance Division	Condition and Qualifications
13.	Revenue Officer 3 (Three) Posts	Tk. 3400-6625 (Scale – 10)	<u>For direct recruitment:</u> 2 <sup>nd</sup> class Masters Degree. Fixed by the Ministry of Finance vide reference- MF/FD (Impl.-2) (3) CA-6/89/(Part-2), dated 24/06/1995. <u>For promotion:</u> 10 years service experience with 5 years as Revenue Inspector.
14.	Sub-Assistant Engineer 8 (Eight) Posts	Tk. 3400-6625 (Scale – 10)	3 years long Diploma in engineering from any reputed polytechnic institute.
15.	Steno-typist 3 (Three) Posts	Tk. 2250-4735 (Scale – 13)	Graduate with short hand and typing speed 100 & 30 in English and 80 & 25 words in Bangla.
16.	Administrative Officer 1 (One) Post	Tk. 2250-4735 (Scale – 13)	<u>For direct recruitment:</u> 2 <sup>nd</sup> class Masters Degree with Honors course. <u>For promotion:</u> 10 years service experience with 5 years as Office Super.
17.	Revenue Supervisor 2 (Two) Post	Tk. 2250-4735 (Scale – 13)	<u>For direct recruitment:</u> 50% of posts reserved. Minimum 2 <sup>nd</sup> class Graduate Degree with 5 years working experience as Surveyor/ TAX fixations works. Experience will be reduced for the Master's degree holder candidates. <u>For promotion:</u> 7 years service experience as LDA or 5 years as Revenue Investigator.
18.	Foreman 2 (Two) Posts	Tk. 2250-4735 (Scale – 13)	<u>For direct recruitment:</u> a) SSC with tread course in electrical from any reputable technical institute. b) ABC license holder form the Government Electrical Licensing Board. <u>For promotion:</u> 5 years service experience as Assistant Foreman or Electrician with 8 years experience of maintaining motor, starter, electrical sub-station and instruments.
19.	Store Keeper 2 (Two) Posts	Tk. 1875-3605 (Scale – 16)	Minimum 2 <sup>nd</sup> class in HSC or equivalent degree.
20.	Computer Operator -1 (One) Post	Tk. 2250-4735 (Scale – 13) Tk. 2250-5505 (Scale – 11) (Scale-11 will be given on basis of successfully passing of internal training.)	According to the computer personnel recruitment rules-1985, it is fixed by the Ministry of Finance via reference- MF/FD (Imp-1) (F) -9/85/32, dated 20/04/1985.
21.	Revenue Investigator 4 (Four) Posts	Tk. 1875-3605 (Scale – 16)	Minimum 2 <sup>nd</sup> class in HSC or equivalent degree.
22.	Treasurer 1 (One) Post	Tk. 1875-3605 (Scale – 16)	Minimum 2 <sup>nd</sup> class in HSC in commerce background or higher degree.
23.	Head Clark 2 (Two) Posts	Tk. 2100-4315 (Scale – 14)	<u>For direct recruitment,</u> Graduate degree. <u>For promotion:</u> 5 years service experience as LDA cum Typist / Revenue Investigator.

Sl.	Designation and # of Posts	Fixed salary scale by Implementation sector of Finance Division	Condition and Qualifications
24.	Draftsman 1 (One) Post	Tk. 1875-3605 (Scale – 16)	HSC with diploma/draftsman course completed from any reputable institute.
25.	Accountant 1 (One) Post	Tk. 2250-4735 (Scale – 13)	<u>For direct recruitment</u> , Graduate degree in commerce faculty. <u>For promotion</u> : 5 years service experience as UDA.
26.	Lower Division Assistant (LDA) 6 (Six) Posts	Tk. 1875-3605 (Scale – 16)	<u>For direct recruitment</u> , HSC degree with typing speed 30 in English and 25 words in Bangla. <u>For promotion</u> : HSC pass and 2 years service experience as 4 <sup>th</sup> grad with typing speed 30 in English and 25 words in Bangla.
27.	Assistant Accountant 2 (Two) Posts	Tk. 2100-4315 (Scale – 14)	Minimum 2 <sup>nd</sup> class graduate in commerce/business background. Experienced candidates will be privileged.
28.	Store Keeper 1 (One) Post	Tk. 1875-3605 (Scale – 16)	HSC pass.
29.	Compounder 1 (One) Post	Tk. 2100-4315 (Scale – 14)	Minimum 2 <sup>nd</sup> class HSC in science background with compoundership or certificate course from a government / reputable institute as well as 5 years experience in related service.
30.	Tracer 2 (Two) Post	-	-
31.	Surveyor 2 (Two) Post	Tk. 1750-3300 (Scale – 17)	SSC with certificate course in surveying from any other reputable institute.
32.	Electrician 4 (Four) Posts	Tk. 1875-3605 (Scale – 16)	<u>Direct recruitment</u> , HSC pass with valid BC license from Electrical Licensing Board.
33.	Head tube-well Mechanic 2 (Two) Posts	Tk. 1875-3605 (Scale – 16)	Mechanical / Electrical certificate course from government or any other reputable institute as well as 5 years experience in related service.
34.	Pump Operator 30 (Thirty) Post	Tk. 1875-3605 (Scale – 16)	<u>In case of direct recruitment</u> : HSC pass with 5 years experience in pump / electric motor / internal combustion / engine sector. <u>For promotion</u> : 5 years experience as master-roll pump operator.
35.	Lift Operator -3 (Three) Posts	Tk. 1625-2905 (Scale – 18)	<u>In case of direct recruitment</u> : HSC pass with 2 years experience in water treatment plant filter operation sector. <u>For promotion</u> : 5 years experience as Assistant Filter Operator.
36.	Plumbing Mechanic 4 (Four) Posts	Tk. 1625-2905 (Scale – 18)	<u>In case of direct recruitment</u> : Class VIII pass with 5 years experience as Assistant Plumbing Mechanic/ Assistant Pipeline Mechanic. <u>For promotion</u> : 5 years experience as Assistant Plumbing Mechanic.

Sl.	Designation and # of Posts	Fixed salary scale by Implementation sector of Finance Division	Condition and Qualifications
37.	Assistant Pump Operator 30 (Thirty) Posts	Tk. 1625-2905 (Scale – 18)	<u>In case of direct recruitment:</u> HSC pass with practical experience in internal combustion engine sector. <u>For promotion:</u> SSC with minimum 3 years experience as 4 <sup>th</sup> class service.
38.	Cash Sarker 1 (One) Post	Tk. 1625-2905 (Scale – 18)	2 years working experience with SSC pass.
39.	Nurse 1 (One) Post	-	Direct recruitment.
40.	MLSS 15 (Fifteen) Posts	Tk. 1500-2400 (Scale – 20)	Class VIII pass.
41.	Guard 2 (Two) Posts	Tk. 1500-2400 (Scale – 20)	Class VIII pass with good health.
42.	Sweeper/Gardener- 4 (Four) Posts	Tk. 1500-2400 (Scale – 20)	Class VIII pass with good knowledge in gardening.

#### Terms and Reference:

1. Government has no financial responsibilities for these posts and the organization will fulfill salaries from own fund.
2. Must maintain the Ordinance of the Cabinet Ministry vide reference No. MPB/K:B:S:/KPG-11/2001-111, dated 03.05.2003.
3. Must maintain all decorum of governmental ordinances for reserving all posts.
4. KWASA must take approval each year from the Finance Department to renew these 157 nonpermanent posts.
5. The 114 Khulna City Corporation staffs are working in different posts in water section will must absorbed against 157 created posts for KWASA.
6. Nurse / Sweeper / Gardener / Guard will be calculated as contingency staff.
7. The salary scale fixed by the Implementation and Rules Section of the Finance Department, as well as the qualifications will be kept as mentioned in the recruitment procedure and according to that the recruitment rules to be submitted.
8. Must maintain the terms of vide reference 1-6 letters.

Signed  
(Syeda Sahana Bari)  
Additional Secretary (PAS-2)  
Phone # 7160370.

## Supporting Report 8.2.6 (1) Selected Indicators of Bangladesh Water Utilities with KWASA

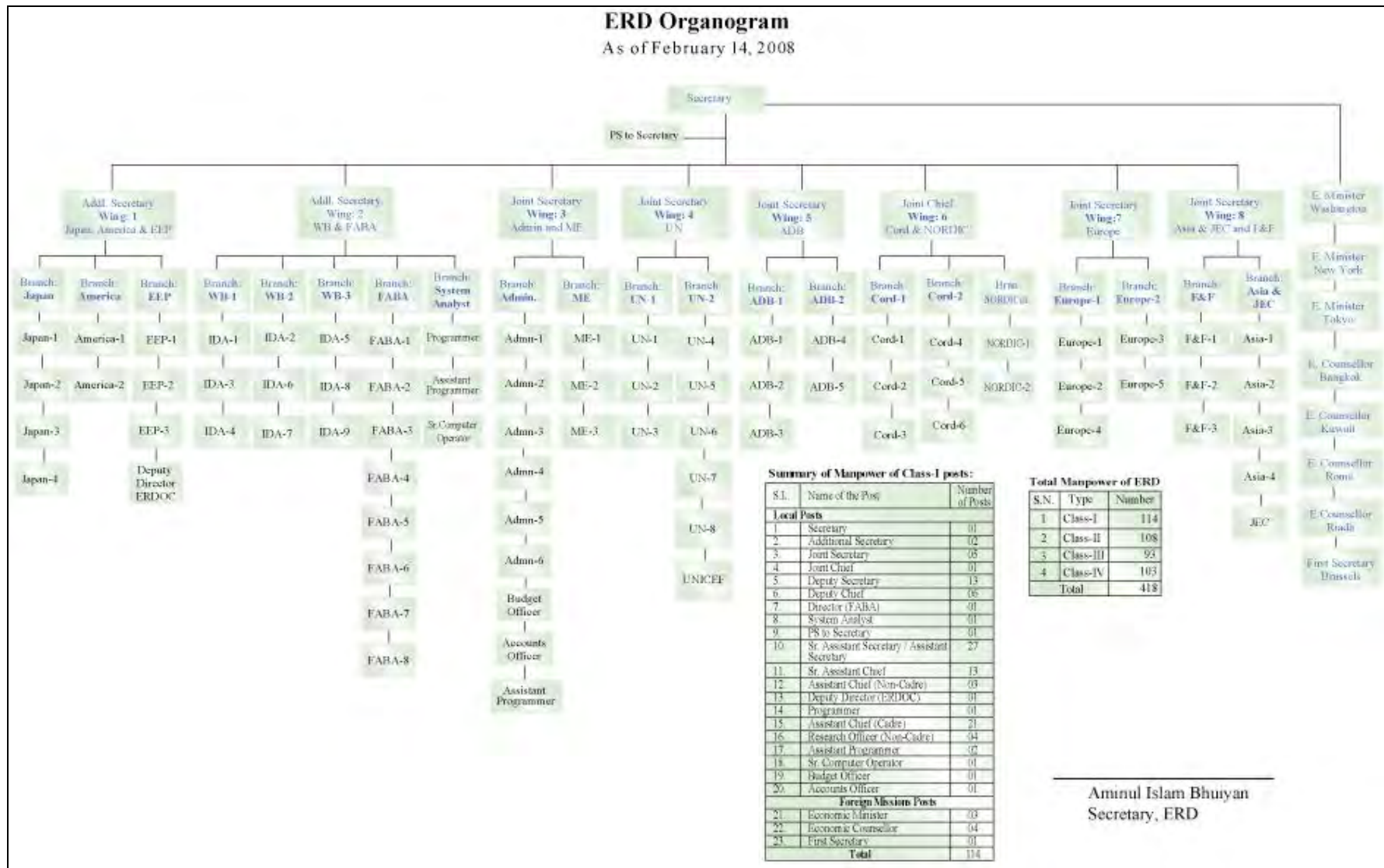
	SELECTED INDICATORS OF WATER UTILITY PERFORMANCE AND EFFICIENCY	BANGLADESH WATER UTILITIES			
		Dhaka WASA	Rajshahi	Jessore	Khulna WASA
<b>1.</b>	<b>GENERAL DATA</b>				
	Population	12,000,000	773,430	147,000	946,129
	Nu. of Total Service Connections	243,000	22,650	8,950	15,252
	Active Connections Only				12,673
	No. of Staff	2,888	196	73	259
<b>2.</b>	<b>MANAGEMENT INDICATORS</b>				
a)	Operating Ratio Ave: 0.89	0.78	0.71	1.00	1.53
b)	Accounts Receivable Ave: 13.0 months	13.1	6.0	8.6	No data
c)	Revenue Collection Efficiency Ave: 98.55%	108	60	100	No data
d)	Staff per 1,000 Connections Ave: 9.3	11.9	8.7	8.2	16.98
	SPI for active connections				20.43
<b>3.</b>	<b>PRODUCTION AND CONSUMPTION</b>				
a)	Average Daily Production m <sup>3</sup> /day	1,585,014	86,082	10,685	35,039
b)	Connections Metered Ave: 17.6%	70	0	0	18
c)	Non-Revenue Water Ave: 24.8%	48.6	33.3	30.5	37
<b>4.</b>	<b>CUSTOMER SERVICE INDICATORS</b>				
a)	Water Service Coverage Ave: 55.4 %	83	85	68	48
b)	Water Availability 11.7 hours/day	23	12	9	No data
<b>5.</b>	<b>TARIFF AND COSTS</b>				
a)	Average Tariff Ave: Tk. 4.38/m <sup>3</sup>	6.43	2.11	5.00	Flat rate
b)	Residential Connection Fee Ave: Tk. 1,526	2,111	2,000	500	1,000



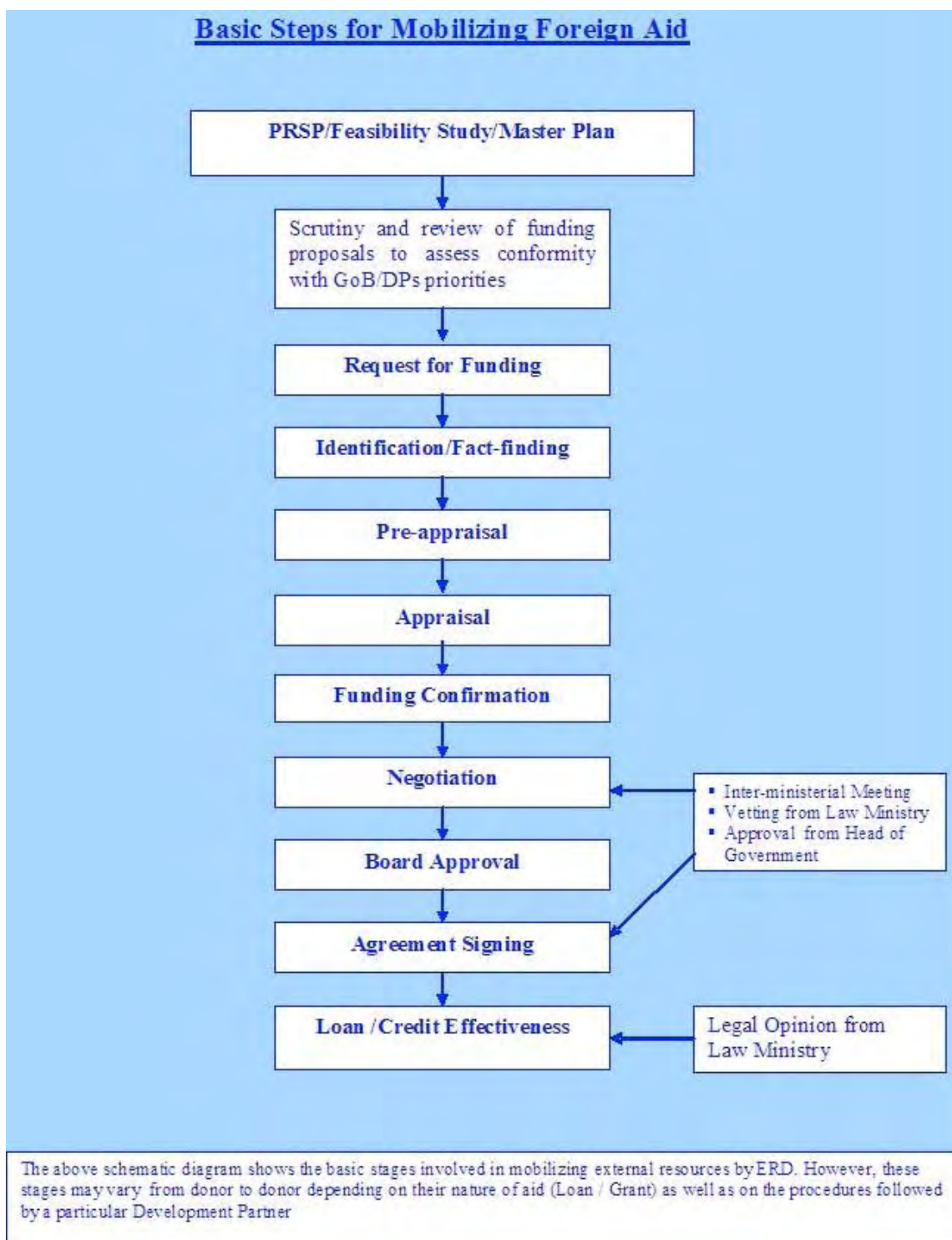
## Supporting Report 8.2.6 (2) Selected Indicators of SE Asian Water Utilities with KWASA

	SELECTED INDICATORS OF WATER UTILITY PERFORMANCE AND EFFICIENCY	BANGLADESH WATER UTILITIES			
		Dhaka WASA	Rajshahi	Jessore	Khulna WASA
<b>1.</b>	<b>GENERAL DATA</b>				
	Population	12,000,000	773,430	147,000	946,129
	No. of Total Service Connections	243,000	22,650	8,950	15,252
	Active Connections Only				12,673
	No. of Staff	2,888	196	73	259
<b>2.</b>	<b>MANAGEMENT INDICATORS</b>				
a)	Operating Ratio Ave: 0.89	0.78	0.71	1.00	1.53
b)	Accounts Receivable Ave: 13.0 months	13.1	6.0	8.6	No data
c)	Revenue Collection Efficiency Ave: 98.55%	108	60	100	No data
d)	Staff per 1,000 Connections Ave: 9.3	11.9	8.7	8.2	16.98
	SPI for active connections				20.43
<b>3.</b>	<b>PRODUCTION AND CONSUMPTION</b>				
a)	Average Daily Production m <sup>3</sup> /day	1,585,014	86,082	10,685	35,039
b)	Connections Metered Ave: 17.6%	70	0	0	18
c)	Non-Revenue Water Ave: 24.8%	48.6	33.3	30.5	37
<b>4.</b>	<b>CUSTOMER SERVICE INDICATORS</b>				
a)	Water Service Coverage Ave: 55.4 %	83	85	68	48
b)	Water Availability 11.7 hours/day	23	12	9	No data
<b>5.</b>	<b>TARIFF AND COSTS</b>				
a)	Average Tariff Ave: Tk. 4.38/m <sup>3</sup>	6.43	2.11	5.00	Flat rate
b)	Residential Connection Fee Ave: Tk. 1,526	2,111	2,000	500	1,000

**SUPPORTING REPORT 8.3.2 (1) ERD Organogram**

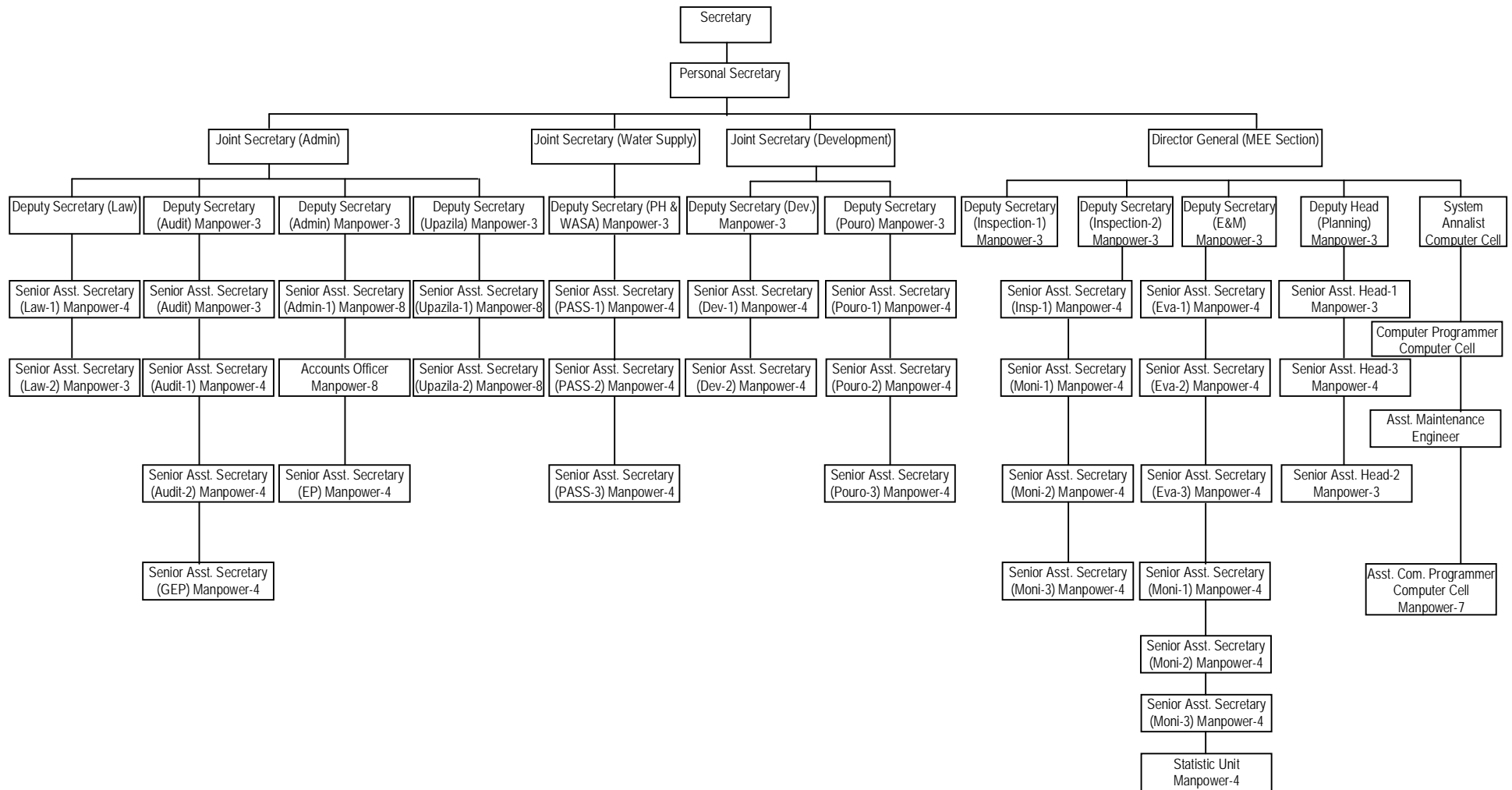


## Supporting Report 8.3.2 (2) Steps in Mobilizing Foreign Aid



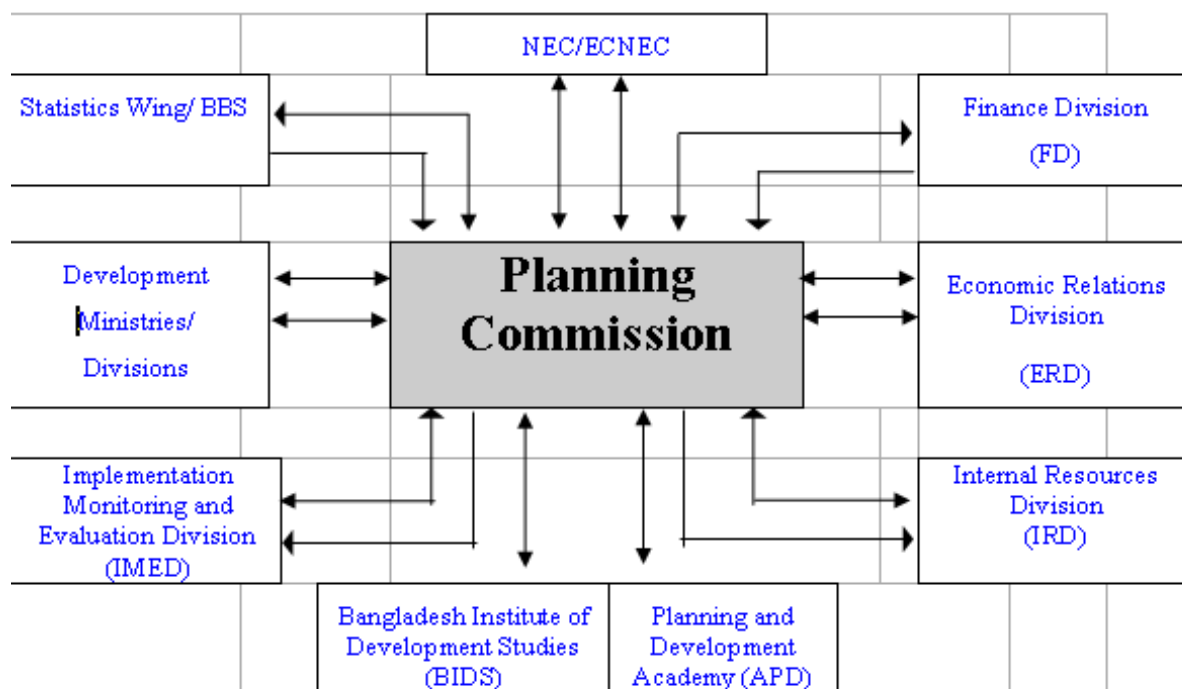
**SUPPORTING REPORT 8.3.2 (3) LGD Organogram**

**Local Government, Rural Development and Cooperatives, Local Government Division Organogram**

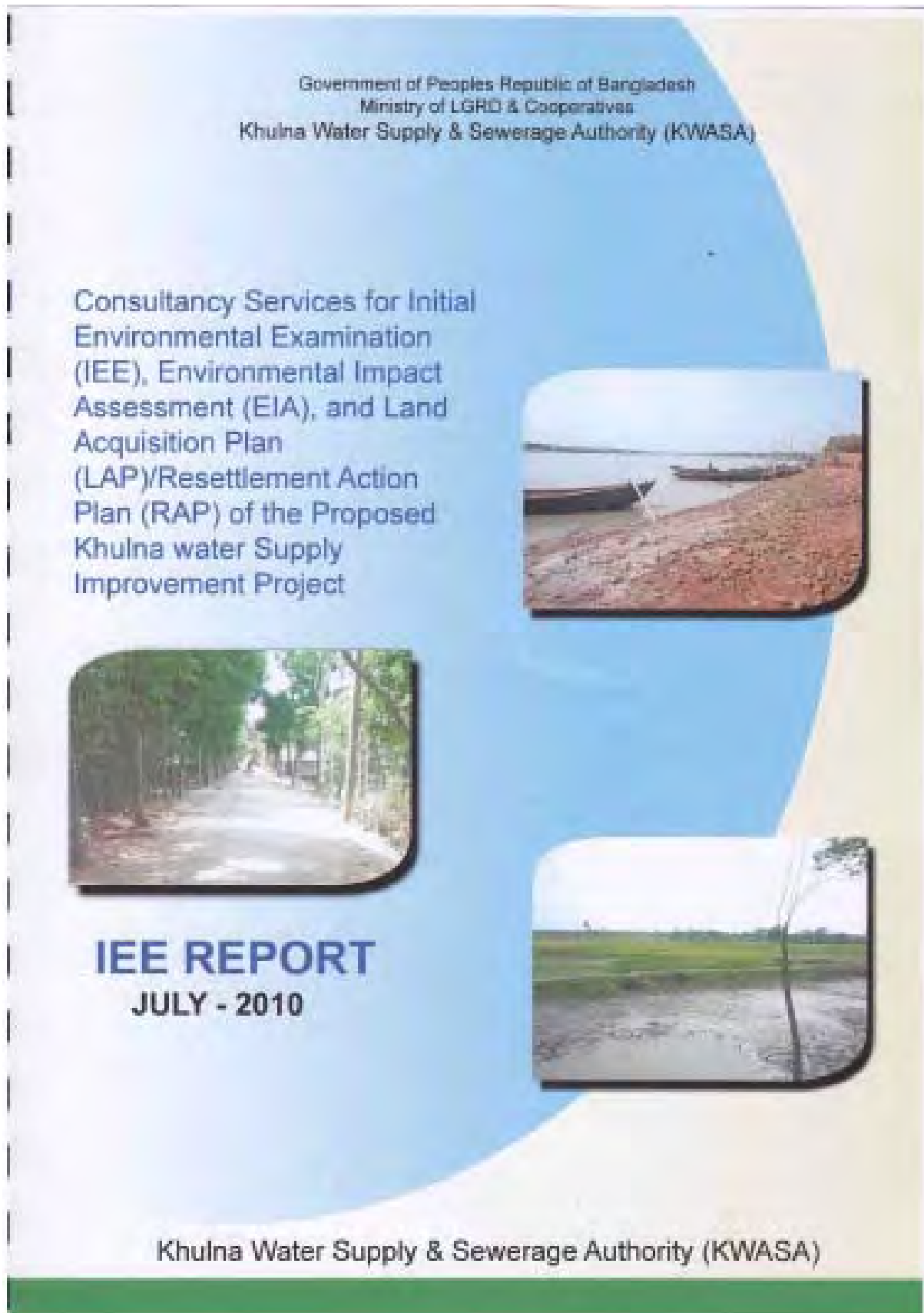


**SUPPORTING REPORT 8.3.2 (4) Linkages of Planning Commission with Other Government Agencies**

**Institutional Linkages of Planning Commission  
With other Ministries/Divisions/Organizations**



## Supporting Report 10.1 IEE REPORT



IEE Report on Khulna Water Supply  
Improvement Project, KWASA, Khulna (Final)

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Abbreviations

ADB	Asian Development Bank
ARIPO	Acquisition & Requisition Property Ordinance
BOD	Biological Oxygen Demand
BDT	Bangladeshi Taka
BWDB	Bangladesh Water Development Board
CCL	Cash Compensation under the Law
CDIA	City Development Initiative for Asia
COD	Chemical Oxygen Demand
DF/R	Draft Final Report
DMD	Deputy Managing Director
DOE	Department of Environment
DPHE	Department of Public Health Engineering, MLGRD&C
DWASA	Dhaka Water and Sewerage Authority
EA	Environmental Assessment
ECC	Environmental Clearance Certificate
ECCo	Environmental Clearance Committee
EIA	Environmental Impact Analysis
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EQS	Environmental Quality Standard
ERD	Economic Relations Division, Ministry of Finance
FCD/I	Flood Control Drainage and Irrigation
FGD	Focus Group Discussion
FIRR	Financial Internal Rate of Return
F/R	Final Report
F/S	Feasibility Study
GI	Galvanized Iron
GDP	Gross Domestic Product
GOB	Government of Bangladesh
GOJ	Government of Japan
GRC	Grievance Redress Committee
HR	Human Resource
HRD	Human Resource Development
IC/R	Inception Report
IEE	Initial Environmental Examination
IIP	Interim Improvement Project
IT/R	Interim Report
IUCN	International Union for Conservation of Nature & Natural Resources
JBIC	Japan Bank of International Cooperation
JICA	Japan International Cooperation Agency
JTU	Jackson Turbidity Unit
JVIT	Joint Inventory Verification Team
KCC	Khulna City Corporation
KDA	Khulna Development Authority
KWASA	Khulna Water Supply and Sewerage Authority
LAP	Land acquisition Plan
LGD	Local Government Division, MLGRD&C
MARV	Maximum Allowable Replacement Value
MBBR	Moving Bed Bio-Reactor
MBR	Madanipur Beel Route
MD	Managing Director
MDG	Millennium Development Goal
MLGRD&C	Ministry of Local Government, Rural Development and Co-operatives
MoEF	Ministry of Environment and Forest
NCS	National Conservation Strategy
NEMP	National Environmental Management Plan
NOC	No Objection Certificate
NRW	Non-Revenue Water
NWMP	National Water Management Plan
NWP	National Water Policy
NWRC	National Water Resources Council
O&M	Operation and Maintenance
PAP	Project Affected People

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PCU	Project Coordination Unit
PMO	Project Management Officer
PMU	Project Management Unit
PPTA	Project Preparatory Technical Assistance
PTW	Production Tube Well
P/R	Progress Report
RAP	Resettlement Action Plan
RO	Reverse Osmosis
RU	Resettlement Unit
SAPROF	Special Assistance for Project Formation
SCC	Site Clearance Certificate
S/C	Steering Committee
STA	Social Impact Assessment
SPS	Safeguard Policy Statement
SPT	Standard Penetration Test
SRDI	Soil Resources Development Institute
S/W	Scope of Work
SWTP	Surface Water Treatment Plant
TA	Technical Assistance
TOR	Terms of Reference
UFW	Unaccounted for Water
USD	United States Dollar
WASA	Water and Sewerage Authority
WARPO	Water Resource Planning Organization
WTP	Water Treatment Plant

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## Chapter-01

### Introduction

#### 1.0 INTRODUCTION

##### 1.1 Background

Khulna, the third largest city in Bangladesh, is located in the southwest of the country and has a population of 1.5 million. The present water supply to Khulna is mainly from groundwater sources drawn from production tube wells and both deep and shallow hand tube wells. To cope with current insufficient supply and increasing demand, the Khulna Water Supply and Sewerage Authority (KWASA) plans to construct a new treatment plant for surface water with assistance from the Japan International Cooperation Agency (JICA). Consequently in December 2008 the GOB requested the assistance of the Government of Japan (GOJ) with regard to the improvement of water supply for Khulna and GOJ agreed to undertake the study. Based on the agreement, the JICA has dispatched a JICA study team consisting of various experts to KWASA for conducting a feasibility study for the Water Supply Improvement Project in Khulna.

In this relation, the environmental legislation in Bangladesh, particularly, the Environmental Conservation Act, 1997 (recently amended-Amendment 2000) states that any development project shall require environmental clearance from the Department of Environment (DOE), Ministry of Environment and Forest (MoEF), Government of the People's Republic of Bangladesh. The proposed Project falls under the "Red Category" as per the Environmental Conservation Rules of 1997, which requires submitting an Initial Environmental Examination (IEE) report prior to an Environmental Impact Assessment (EIA) report based on previously approved to obtain both Site Clearance Certificate (SCC) and then Environmental Clearance Certificate (ECC) from the DOE.

On the other hand, JICA may provide a financial assistance for this project in Khulna as a loan scheme of the Japanese ODA (Official Development Assistance). For the implementation of the ODA loan projects, the proposed project shall meet and follow the JICA's guidelines on Environmental and Social Consideration for the loan projects for obtaining necessary clearance from JICA. Thus, in order to implement the construction of proposed water supply project, the Environmental study i.e. IEE, EIA and Land Acquisition Plan (LAP)/Resettlement Action Plan (RAP) shall be conducted accordingly.

This Terms of Reference (TOR) is for conducting the Environmental study such as an IEE, an EIA and a LAP/ RAP for the proposed Khulna Water Supply Improvement Project consisting of a Water Intake Facility, Water Transmission & distribution pipes, an Impounding reservoir and a Water Treatment Plant and other necessary facilities like distribution reservoirs and overhead water tanks, and to obtain necessary clearance from DOE as applicable for construction of the proposed facilities.

As per commitment of protection of the local environment as well as the health and safety of their employees, contractors and the community in and neighborhood of the project area, accordingly engaged the Bangladesh Engineering and Technological Services Ltd (BETS), a reputed Engineering Consultancy firm to conduct this IEE of the proposed project to identify and evaluate all the interactions from the implementation of the project which may have potential impacts upon the adjacent environment.

The IEE will, therefore, examine the technical aspects of the project activities, which are likely to interact with the surrounding environment. This IEE study will cover possible activities and impacts with the environment and community. The IEE report will also provide a suggestive EMP along with certain mitigation measures plan with a view to reduce effect of the adverse impacts. A Terms of Reference (TOR) for more detailed study in EIA is also provided herewith.

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## 1.2 Objectives

This report describes the findings of Initial Environmental Examination (IEE) of the proposed Khulna Water Supply Improvement Project. The main objective of this report is to identify the major environmental impacts due to the implementation of proposed project along with the suggestion of effective measures to mitigate the adverse impacts and to recommend whether a **Comprehensive Environmental Impact Assessment (CEIA) is required** or not. In this context, it should be noted that the term 'Environment' and its derivatives have been used in a wide sense, which covers not only physical and chemical aspect, but also the human dimension.

The overall objectives of this study is to conduct IEE (which shall include comparison analyses of each project option which has been proposed by the JICA study team), for the above mentioned Khulna Water Supply Improvement Project in order to assess the biophysical and socio-environmental impacts if any, with recommendation of appropriate mitigation plan in the project areas and to prepare reports on IEE for the Project; in accordance with the Environment conservation ACT 1995, the Environmental Conservation Rules 1997, the DOE's EIA guideline for industries, the EIA Guidelines for Water Resources Sector of Water Resources Planning Organization (WARPO), and JICA (former JBIC) Guidelines for Confirmation of Environmental and Social Considerations April 2002, JICA, for submission to DOE and obtain both Site clearance and Environmental clearance from DOE as well as refer to the Asian Development Bank (ADB) safeguard policy Statement 2009, for a future possible project by ADB.

## 1.3 Project Components

The followings are the main components of the project:

- Water Intake
- Raw Water Transmission Pipe
- River Crossing
- Impounding Reservoir
- Surface Water Treatment Plant (SWTP)
- Clear Water Transmission Pipe
- Distribution Reservoir
- Overhead Tank
- Distribution Pipe Network
- Service Pipe Connection
- Others

For impounding reservoir, Water treatment Plant, Distribution Reservoir and overhead tank there may require land acquisition permanently.


## 1.4 Scope of Work

The IEE will provide baseline environmental condition (physical, biological and social environment) of the project area. It will identify potential impacts of the proposed project activity in the project area on environment, following DOE Guidelines.

The IEE will also be used as a basis to prepare Terms of Reference (ToR) for Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) to render or offset adverse impacts. The EMP shall also include Environmental Monitoring Plan and institutional arrangement for future monitoring.

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The Terms of Reference (ToR) for Environmental Impact Assessment (EIA) is enclosed herewith at Annexure-A.

### 1.5 Limitations

An IEE is generally carried out as an integral part of feasibility study prior to site selection of a project. In case of the present project, the IEE is being prepared as a separate document from feasibility study. Also the detailed design of the project has not been prepared yet. The report of feasibility study is carrying out by KWASA, this report has made under the results of the feasibility study.

### 1.6 Methodology

The IEE is based on information from the following:

- The project brief and scope of works
- Additional information supplied by the project proponent
- Site visits.

Field visits were undertaken to the project location with a view to reconnaissance survey of the surrounding areas. On the basis of collected relevant data, identification of possible impacts has been done using Checklists method. This was followed by evaluation of likely impacts along with the impacts origin and extensiveness. The possible mitigation/enhancing measures for negative and beneficial impacts have been suggested to develop an Environmental Management Plan (EMP). The collected data/information are also used to evaluate and formulate the TOR of environmental impact study (EIA) to be undertaken.

### 1.7 The EIA Team

The EIA team comprising various environmental and social expert to conduct EIA for the Project. The team comprising the following experts:

- 1 Water Supply Specialist
- 2 Environmental Specialist
- 3 Geologist/ Hydrologist
- 4 Socio-economist
- 5 Ecologist
- 6 Resettlement specialist
- 7 Surveyor and survey team
- 8 A group of Data Collectors cum Field Personnel (Enumerator)

### 1.8 Structure of the Report

The report has been structured in compliance with the requirement of TOR

Chapter -1 Introduction: The introduction chapter presents a brief overview of the assignment along with background, objectives, project components, scope of work methodology etc.

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- Chapter – 2 Policy legal and Administrative Framework: Chapter Two outlines the policy and legislation on the environmental issues.
- Chapter – 3 Analysis of Suitability for Alternative Options
- Chapter – 4 Description of the Project: Chapter Three describes proposed interventions including alternative options of the project background, project category, need for the project, location, size and magnitude of operation.
- Chapter – 5 Environmental Baseline and Existing Facilities: Chapter four presents the description of the environmental baseline (Socioeconomic, physical and biological) of the project. This chapter also includes existing facilities of water supply system.
- Chapter – 6 Environmental Impacts and Mitigation: This chapter deals with the environmental impacts of the proposed project and possible mitigation measures. Opinions of the local people have to been elaborated in this chapter.
- Chapter – 7 Institutional requirement and environmental monitoring program: The chapter mainly deals with the monitoring program of the project.
- Chapter – 8 Conclusion and Recommendation: This chapter gives the finding, conclusion and recommendation of the project.

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## Chapter-02

# Policy and Legal Administrative Framework

### 2.1 INTRODUCTION

The proposed water supply project to be implanted by KWASA requires strict compliance with laws, rules and regulations pertinent to environment. The Department of Environment (DoE) of Government of Bangladesh is responsible for ensuring application of environmental laws and issuance of necessary of necessary clearances in industrial and development activities.

In any country, development projects are governed directly or indirectly by some type of legal and/or institutional requirements. Assessment of policy, strategy and regulatory issues are extremely important for any project proponent or developer before they physically execute a Program or Plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. The following sections review the relevant National Legislative, Regulatory and Policy Requirements along with some international ones.

KWASA will conduct its operations in compliance with local, national legislations and international Agreements. The proposed project will be conducted in accordance with Bangladesh Legislation or International Agreements to which Bangladesh is a party.

### 2.2 REGULATORY FRAMEWORK

#### 2.2.1 Environmental Agencies

There are a number of agencies relevant to the environmental considerations / concerns in Bangladesh. Following sub-sections present a precise description of such organizations.

- **Ministry of Forest and Environment (MoFE)**

The Ministry of Environment and Forest (MoEF) is the key government institution in Bangladesh for matters relating to national environmental policy and regulatory issues. Realizing the ever-increasing importance of environmental issues, the MoEF was created in 1989 and is presently a permanent member of the Executive Committee of the National Economic Council. This group is the major decision-making body for economic policy and is also responsible for approving public investment projects. The MoEF oversees the activities of the following agencies:

- Department of Environment (DoE);
- Department of Forest (DoF);
- Forest Industries Development Corporation;
- Bangladesh Forest Research Institute and Institute of Forestry;
- Forestry Division of the Bangladesh Agricultural Research Council and
- National Herbarium.

Of the above agencies precise description of the first two departments including other pertinent ones are presented below as considered relevant.

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• Department of Environment (DoE)

The Department of Environment (DoE), established in 1989 under the jurisdiction of the MoEF, is the executing agency for planning and implementing environmental issues including, but not limited to, the following activities:

- Reviewing environmental impact assessments and issuing environmental clearance where appropriate;
- Implementing environmental monitoring programs and enforcement measures;
- Developing and maintaining environmental data bases, and
- Coordinating international events with the MoEF (e.g., representing Bangladesh in international seminars, workshops, etc).

The DoE is headed by a Director General (DG) who is supported by a team of Directors, Deputy Directors, Assistant Directors, Engineers, and other technical staff (e.g., chemists and laboratory technicians). The DoE has regional offices, monitoring stations and several laboratories. Figure-2.1 shows the Organizational Set-up of DoE.

• Department of Forest (DoF)

The Department of Forest (DoF), under the Ministry of Environment and Forest, is responsible for protection and management of the Reserve Forests in the country. The department manpower extends down to Union levels in areas where reserve forest exists. Officers of the DoF are responsible for protection of wildlife in these forest areas.



Figure-2.1 : The Organizational Set-up of DoE.

• Ministry of Land - Land Reform and Land Acquisition Directorate

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The Ministry of Land (MoL) manages revenue generation for Government-owned land (called khas), excluding agency-owned lands controlled by the Bangladesh Water Development Board (BWDB), Roads & Highways, etc. The MoL controls open water bodies (rivers, beels, haors) above a specified size, except for those that were transferred to the Ministry of Fisheries and Livestock under the new fisheries management policy. The MoL must approve the process where the government acquires private land on behalf of a private development program.

- **Ministry of Water Resources and Flood Control - Bangladesh Water Development Board (BWDB)**

The Ministry of Water Resources and Flood Control is responsible for the water management program of the country. This includes preparation and implementation of water master plans, flood control measures, surface and ground water hydrology data-collection, modeling, monitoring and planning irrigation projects. The executing agency is the Bangladesh Water Development Board (BWDB).

- **Ministry of Fisheries and Livestock - Directorate of Fisheries**

The Directorate of Fisheries, under the Ministry of Fisheries and Livestock, is responsible for managing the fish seed farms in each district. It is also responsible for managing 152 open water bodies under the new fisheries management policy which includes open rivers, depressed basins (haors), oxbow lakes (baors) and other large inland permanent water bodies (beels).

## **2.2.2 ENVIRONMENTAL POLICY.**

### **2.2.2.1 Introduction**

Bangladesh National Environmental Policy has become a priority consideration for any development intervention.

### **2.2.2.2 National Environmental Policy**

Bangladesh National Environmental Policy of 1992 sets out the basic framework for environmental action together with a set of broad sector guidelines. The Environment Policy provides the broader framework of sustainable development in the country. It also states that all major undertakings, which will have a bearing on the environment, (including setting up of an industrial establishment) must undertake an IEE / EIA before they initiate the project.

The Environment Policy delineates the Department of Environment (DOE), as the approving agency for all such IEE / EIAs to be undertaken in the country.

Policies of fifteen sectors are described in the Policy. Under the Energy and Fuel sector, the use of fuel that has the least environmental impact is encouraged. Conservation of fossil fuel and the need for conducting EIAs before implementation of projects for fuel and mineral resources is stressed in the policy.

Under the Environmental Action Plan Section of the Policy, under sub-section 'Fuel and Energy', it suggests that:

- In the rural areas the use of gas, coal, kerosene and petrol as fuel will be expanded, so that fuel wood, agricultural residues, and cow dung is conserved. This will help use of agricultural residues, and cow dung etc. as manure; and

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- Appropriate measures will be taken to ensure that extraction, distribution and use of natural resources such as oil, gas, coal etc. do not adversely affect air, water, land, the hydrological balance and the ecosystem.

"Forest, Wildlife and Biodiversity" section requires:

- Conserve Wildlife and Biodiversity, strengthen related research and help dissemination and exchange of knowledge in these areas; and
- Conserve and develop wetlands and protection of migratory birds.

### 2.2.2.3 National Water Policy

The government has adopted following of policies to putting matters right in the sector,

- National Water Policy (1999),
- National Water Management Plan (2004),
- National Policy for Arsenic Mitigation (2004)

#### National Water Policy (1999)

NWP was adopted in 1999 and it explicitly states 6 main objectives

- To address the use and development of groundwater and surface water in an efficient and equitable way
- To ensure the availability of water to all parts of the society
- To accelerate the development of public and private water systems through legal and financial measures and incentives, including appropriate water rights and water pricing rules
- To formulate institutional changes, encouraging decentralization and enhancing the role of women in water management
- To provide a legal and regulatory framework this encourages decentralization, consideration of environmental impacts, and private sector investment

#### National Water Management Plan (2004)

NWMP was approved by the National Water Resources Council (NWRC) in 2004 and aims at implementing the NWMP within 25 years. It is expected to be reviewed and updated every five years. In 2005, the government included the improvement of water supply and sanitation as part of its agenda for reducing poverty.

#### National Policy for Arsenic Mitigation (2004)

Complementing the NWP, the government adopted a National Policy for Arsenic Mitigation in 2004. The policy emphasizes public awareness, alternative safe water supply, proper diagnosis and management of patients, and capacity building. In terms of alternative supplies it gives "preference to surface water over groundwater".

The Department of Public Health and Engineering (DPHE) under the Ministry of Local Government, Rural Development and Co-operatives (MLGRD&C) are in charge of assisting municipalities and communities in building water supply infrastructure, exclusive Dhaka, Chittagong and Khulna. For the above three metropolitan areas Water and Sewerage Authority (WASA) is responsible to provide water supply and sewerage facilities to the subscribers.

### 2.2.2.4 National Environmental Management Action Plan

The National Environmental Management Action Plan (NEMAP) is a wide ranging and multi-faceted plan, which builds on and extends the statement set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements for a period between 1995 to 2005 and sets out

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the framework within which the recommendations of the National Conservation Strategy are to be implemented.

NEMAP has the broad objectives of:

- o Identification of key environmental issues affecting Bangladesh;
- o Identification of actions necessary to halt or reduce the rate of environmental degradation;
- o Improvement of the natural and built environment;
- o Conservation of habitats and biodiversity;
- o Promotion of sustainable development; and
- o Improvement in the quality of life of the people.

### 2.2.2.5 National Conservation Strategy

National Conservation Strategy was drafted in late 1991 and submitted to the Government in early 1992. This was approved in principle; however the final approval of the document is yet to be made by the cabinet.

### 2.2.3 Compliance with International Requirement

Bangladesh has agreed to, approved or signed a number of major international treaties, conventions and protocols related to environment protection and conservation of natural resources.

- **Rio Declaration 1992**

United Nations Conference on Environment and Development (UNCED) adopted the global action program for sustainable development called 'Rio Declaration' and 'Agenda 21'. Principle 4 of the Rio Declaration, 1992, to which Bangladesh is a signatory along with a total of 178 countries, states, "In order to achieve sustainable development, environmental protection should constitute an integral part of the development process and cannot be considered in isolation from it".

- **Convention on Biological Diversity, Rio de Janeiro, (1992)**

The convention on Biological Diversity, Rio de Janeiro, 1992 was adopted on 05 June, 1992 and entered into force on 29 December 1993. Bangladesh ratified the Convention on 20 March, 1994. This is the overarching framework for bio-diversity and the signatories are required to develop a National Bio-diversity Strategy and Action Plan that incorporates the articles of the convention into national law and statutes.

Obligation has been placed on State parties to provide for environmental impact assessments of projects that are likely to have significant adverse effect on biological diversity.

- **Convention on Wetland of International Importance Especially as Waterfowl Habitats, Ramsar (1972)**

The Ramsar Convention was adopted on 02 February 1971 and entered into force on 21 December 1975. Bangladesh has ratified the Convention on 20 April 2002. This provides a framework for national action and international cooperation for the convention and wise use of wetlands and their resources. There are 172 parties with 1085 wetland sites designated as 'Wetlands of International Importance'.

This is an intergovernmental treaty, which provides the framework for international cooperation for the conservation of wetland habitats. Obligation for Contracting Parties include the designation of

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wetlands to the "List of Wetland of International Importance", the provision of wetland considerations within their national land use planning, and the creation of Natural Reserves.

Bangladesh has two Ramsar Sites- (i) Parts of Sundarban Reserved Forest (Southwest of Bangladesh) and (ii) Tangar Haor (Northeast of Bangladesh).

• **Others (Convention and Agreements)**

The following conventions and agreements may include provisions relevant to different aspects of project operations for environmental management, nature protection, and biodiversity conservation:

- Convention relating to the Preservation of Fauna and Flora in their Natural State 1993;
- International Convention for the Protection of Birds, Paris, 1950;
- International Plant Protection Convention, Rome, 1951;
- Convention concerning the Protection of the World Cultural and Natural Heritage, Paris, 1972 has been ratified by 175 states. This defines and conserves the world's heritage by drawing up a list of natural and cultural sites whose outstanding values should be preserved for all humanity. Of the 730 total sites, there are currently 144 natural, 23 mixed and 563 cultural sites that have been inscribed on the World Heritage List (distributed in 125 State parties);
- Convention on International Trade in Endangered Species of Wild Fauna and Flora, Washington, 1973 (known as CITES): this provides framework for addressing over harvesting and exploitation patterns which threaten plant and animal species. Under CITES governments agree to prohibit or regulate trade in species which are threatened by unsustainable use patterns; and
- Convention on the Conservation of Migratory Species of Wild Animals, Bonn, 1979 (Amended 1988): This provides a framework for agreements between countries important to the migration of species that are threatened.

**2.2.4 Land Acquisition Rules and Regulations**

(1) Statute Framework on Land Acquisition and Resettlement

Table 2.1 shows relevant ordinance and acts on land acquisition and resettlement in Bangladesh.

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Table 2.1 Relevant ordinance and Act on land acquisition and resettlement

Title	Year	Outline
Acquisition and Requisition of Immovable Property Ordinance	1982	The Ordinance (Ordinance 11 of 1982) has replaced the Land Acquisition Act of 1894 and the East Bengal (Emergency) Requisition of Property Act of 1948. The Ordinance governs acquisition and requisition by the government of immovable property for any public purpose or in the public interest. It may be noted that contrary to the previous Acts (i.e. Act XIII of 1948), this Ordinance deals only with immovable property. Detailed procedures have been prescribed to ensure that a Deputy commissioner proceeds systematically and on sound principles in such cases, leaving room for owners to raise objections which must be disposed of after due hearing. In addition, the Ordinance has well-defined procedures regarding payment of compensation for an acquired piece of land. If, for example, the land is used for rice growing, then an amount equivalent to approximately 1.5 times the market value of a given variety of rice (e.g., paddy) that is currently being (or could be) produced annually is fixed as a yearly lease value. In case of outright purchase (carried out on a 99-year lease), the compensation value of acquired land varies widely according to the locality, soil fertility, and access to transportation and related infrastructure facilities.
The Acquisition of Immovable Property Rules 1982	1982	The Acquisition of Immovable Property Rules of 1982, are made for the exercise of the powers conferred upon by Section 46 of the Acquisition and Requisition of Immovable Property Ordinance 1982.
Land Reform Ordinance	1984	Under the Ordinance 1984, families owning lands up to 60 Bighas (about 6.7 ha) at a given time were to be barred from acquiring further land by purchase, inheritance, or otherwise. A family or person inheriting lands in excess of 60 Bighas would have to surrender the 'surplus' land, for which due compensation was to be paid.
The Movable Property Requisition (Compensation) Rules, 1990	1990	The Rules makes provision for constituting a Compensation Assessment Committee in each district for determining compensation for any requisitioned vehicle, vessel or bus, truck, minibus etc. In case of requisition of a vehicle or vessel, the order of requisition should clearly state the period of requisition, purpose of requisition, and the amount of compensation to be awarded.
Acquisition and Requisition Act, 1994 (under determining compensation)	1994	In December 1994 the government passed a rule in order to amend the provisions of the Acquisition of Property on Emergency Basis Act 1989 for determining compensation under the Acquisition and Requisition Act. According to this Rule, in case of an arbitration suit lodged against the compensation determined by the Deputy Commissioner an increase of only an additional 10 % of the compensation can be awarded by the Arbitrators. Similarly, the Arbitration Appellate Tribunal should limit its award to within this additional 10 %.

Source: Acquisition and Requisition of Immovable Property Ordinance 1982,  
Land Reform Ordinance, 1984  
Banglapedia "National Encyclopedia of Bangladesh", February 2006, Asiatic Society of Bangladesh

### 2.2.5 Rules and policies in Related Fields

In addition to the policies, rules and regulations related environment and water the following rules and regulations, listed in Table-2.2 are to be checked for compliance for the maintaining sustainable environment.

Table-2.2 Environmental Laws, Regulations and Standards of Bangladesh

Year	Title	Objectives
1950	East Bengal protection and conservation of fish act.	Conservation and development of fisheries resources.
1958	The protection and conservation of fish rules	Prevention of harming fisheries resources and fisheries habitat in coastal and inland waters.
1958	Antiquities act	Protection and preservation of Archeological and historical articles
1960, 1966	Port rules, shipping operation.	Control of discharges in ports; waterway rules
1965	Factories act	Industrial workers' health and working conditions.
1971	Pesticide ordinance	Pesticide use, production, selection and importation.
1976	Antiquates (Amendment) Ordinance	Protection and prohibition export of archeological artifacts.

Chapter-2

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District Managing Director (KWASA)

MD. ABDULLAH, PEH  
Managing Director  
Khulna WASA.

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1977	Municipal ordinance	Municipal activities in health, sanitation, water supply, drainage, etc in the city.
1979	Factory rules	Disposal of wastes and effluents.
1980	Agricultural pesticide (amendment) act	Revised agricultural pesticides ordinance.
1982	Acquisition and requisition of immovable properties ordinance	The acquisition of immovable property rules, 1982 (No. S. R. O. 172-U82) The Government made these rules in exercise of the powers conferred upon by section 46 of the acquisition and requisition of the immovable property ordinance, 1982 (Ordinance No. 11 of 1982).
1983	Agricultural pesticides (Amendment) ordinance.	Revised agricultural ordinance.
1985	The pesticide rule	Pesticides selling, use and safety measures.
1990	Bangladesh standard specification for drinking water.	Formulation and revision of national standards.
1996	The penal code	This contains several articles related with environmental protection and pollution management.
1996	Building construction (Amendment) act and building construction rules	The Rules are more comprehensive to take care of the present day circumstances and issues of building.

## 2.3 ENVIRONMENTAL ACTS AND RULES

### 2.3.1 Introduction

A considerable amount of legislation has been established in Bangladesh: to protect environmental health; to control environmental pollution, and to conserves natural resources.

### 2.3.2 The Environmental Conservation Act, 1995

The Bangladesh Environment Conservation Act of 1995 (ECA '95) is currently the main legislation relating to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. It has repealed the Environment Pollution Control Ordinance of 1977.

The main objectives of ECA '95 are:

- o Conservation and improvement of the environment; and
- o Control and mitigation of pollution of the environment.

The main strategies of the Act can be summarized as:

- o Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried out/ initiated in the ecologically critical areas;
- o Regulations in respect of vehicles emitting smoke harmful for the environment;
- o Environmental clearance;
- o Regulation of the industries and other development activities' discharge permits;
- o Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- o Promulgation of a standard limit for discharging and emitting waste; and
- o Formulation and declaration of environmental guidelines.



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Before any new project can go ahead, as stipulated under the rules, the project promoter must obtain Environmental Clearance from the Director General. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of 5 years imprisonment or a maximum fine of Tk.100, 000 or both. The Department of Environment (DoE) executes the Act under the leadership of the Director General (DG).

### **2.3.3 Bangladesh Environment Conservation Act (Amendment 2000)**

This Act focuses on: (1) ascertaining responsibility for compensation in cases of damage to ecosystems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences.

### **2.3.4 Bangladesh Environment Conservation Act (Amendment 2002)**

This Act elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale, production of environmentally harmful items like polythene bags, (3) assistance from law enforcement agencies for environmental actions, (4) break up of punitive measures and (5) authority to try environmental cases.

### **2.3.5 East Bengal Protection and Conservation of Fish Act (1950)**

The East-Bengal Protection and Fish Conservation Act of 1950, as amended by the Protection and Conservation of Fish (Amendment) Ordinance of 1982 and the Protection and Conservation of Fish (Amendment) Act of 1995, provide provisions for the protection and conservation of fish in inland waters of Bangladesh. This is relatively unspecific and simply provides a means by which the Government may introduce rules to protect those inland waters not in private ownership.

This is framework legislation with rule making powers. Among others, some of these rules may:

- Prohibit the destruction of, or any attempt to destroy, fish by the poisoning of water or the depletion of fisheries by pollution, by trade effluent or otherwise.

### **2.3.6 The Protection and Conservation of Fish Rules (1985)**

These are a set of rules in line with the overall objectives of the Fish Act. The Rule requires that "no person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters". The Rule further states - "No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters".

### **2.3.7 Environment Conservation Rules (1997)**

These are the first set of rules, promulgated under the Environment Conservation Act of 1995 (so far there have been three amendments to this set of rules - February and August 2002 and April 2003). The Environment Conservation Rules of 1997 has provided categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects.

Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for IEE / EIAs according to categories of industrial and other development interventions.

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The Rules are not explicit for various oil and gas exploration interventions. Rather, this is covered under the broader heading of "exploration, extraction and distribution of mineral resources" under the Red Category Projects.

The proposed project, according to the DoE, falls under the Red category of the Environmental Conservation Rules, 1997. Exploration of some of the mineral resources, including hydrocarbons, should not be treated as a Red Category activity, as the environmental issues involved due to such exploration are often moderate and the physical activities of exploration in the field are very temporary and in general do not cause a significant impact.

## 2.4 ENVIRONMENTAL STANDARDS

### 2.4.1 Introduction

The appropriate national environmental standards are applied under the Environmental Conservation Rules 1997.

### 2.4.2 National Environment Quality Standards

At present there are environmental standards in operation in Bangladesh also promulgated under the Environment Conservation Rules of 1997. There are standards prescribed for varying water sources, ambient air, noise, odor, industrial effluent and emission discharges, vehicular emissions, etc.

The Bangladesh standards intend to impose restrictions on the volume and concentrations of wastewater / solid waste / gaseous emissions, etc. discharged into the environment. In addition, a number of surrogate pollution parameters like biochemical oxygen demand, or chemical oxygen demand; total suspended solids, etc. are specified in terms of concentration and/or total allowable quality discharged in case of waste water / solid waste. Additionally, specific parameters depending on the manufacturing process are specified such as phenol, cyanide, copper, zinc, chromium, etc. Air emission quality standards refer mostly to concentration of mass emission of various types of particulate, sulfur dioxide, oxides of nitrogen and in some cases volatile organic compounds and other substances.

The Bangladesh standards in general are less stringent compared to developed countries. This is to promote and encourage industrialization in the country. The Bangladesh standards are not for any specific period of time and there is no provision for partial compliance either.

The proposed project is not separately considered as an item under any category in the ECR '97. Though it is a low environmental potential activity, the DoE decided to consider this as a part of 'water, power and gas distribution line laying/relaying/extension' (Item 64, Red Category List of ECR '97) and therefore the present project is considered to fall under the Red Category of the Rules. Therefore the relevant environmental clearance procedure, as has been mentioned before, is applicable here and it is required that the project is to comply with those procedures. It should be mentioned that exploration activities for hydrocarbon and some other mineral resources are not new in Bangladesh and such activities were conducted before by various organizations.

The standards, commonly known as Environmental Quality Standards (EQS), are legally binding. There is a separate schedule on industry specific standards, other than the general industrial emission and effluent standards. This schedule covers a wide range of industries - fertilizer, tannery, integrated textile, food, cement, etc. However, there are no specific standards for proposed project or as a whole for hydrocarbon exploration activities. In the present case, it is considered that the standards for ambient air, noise, odor, sewage, industrial and project effluent, industrial and project emission as prescribed in the EQS will apply (This is DoE's general requirement practice, as they would ask such relevant EQS compliance.). The

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present project under consideration is to comply with these standards during its development and take due care of these in the planning and design stages also.

For reference, the Bangladesh standards for ambient air, noise, odor, sewage, industrial effluent and industrial emission are furnished hereinafter as six separate Tables, **Table-2.3** to **Table-2.10** These are all in an authentic translation from original Bengali citing the specific source.

**Table - 2.3 Standard for inland surface water**

Best Practice based classification	pH	BOD mg/L	DO mg/L	Total Coliform number/100
a. Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
b. Water usable for recreational activity	6.5-8.5	3 or less	5 or more	200 or less
c. Source of drinking water for supply after conventional treatment	6.5-8.5	6 or less	6 or more	5000 or less
d. Water usable by fisheries	6.5-8.5	6 or less	5 or more	--
e. Water usable by various process and cooling industries	6.5-8.5	10 or less	5 or more	5000 or less
f. Water usable for irrigation	6.5-8.5	10 or less	5 or more	1000 or less

Notes: 1. In water used for pisciculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.  
2. Electrical conductivity for irrigation water - 2250  $\mu$  mhos/cm (at a temperature of 25° C); Sodium less than 20%, boron less than 0.2%

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Table - 2.4 Standard for drinking water

Parameter	Unit	Standards	Parameter	Unit	Standards
1. Aluminum	mg/L	0.2	26. Hardness (as CaCO <sub>3</sub> )	mg/L	200 - 500
2. Ammonia (NH <sub>3</sub> )	mg/L	0.5	27. Iron	mg/L	0.3 - 1.0
3. Arsenic	mg/L	0.05	28. Kjeldahl Nitrogen (total)	mg/L	1
4. Barium	mg/L	0.01	29. Lead	mg/L	0.05
5. Benzene	mg/L	0.01	30. Magnesium	mg/L	30 - 35
6. BOD <sub>5</sub> 20°C	mg/L	0.2	31. Manganese	mg/L	0.1
7. Boron	mg/L	1.0	32. Mercury	mg/L	0.001
8. Cadmium	mg/L	0.005	31. Manganese	mg/L	0.1
9. Calcium	mg/L	75	32. Mercury	mg/L	0.001
10. Chloride	mg/L	150 - 600*	33. Nickel	mg/L	0.1
11. Chlorinated alkanes			34. Nitrate	mg/L	10
carbon tetrachloride	mg/L	0.01	35. Nitrite	mg/L	<1
1,1 dichloroethylene	mg/L	0.001	36. Odor	mg/L	Odorless
1,2 dichloroethylene	mg/L	0.03	37. Oil and grease	mg/L	0.01
tetrachloroethylene		0.03	38. pH	--	6.5 - 8.5
trichloroethylene		0.09	39. Phenolic compounds	mg/L	0.002
12. Chlorinated phenols			40. Phosphate	mg/L	6
pentachlorophenol	mg/L	0.03	41. Phosphorus	mg/L	0
2,4,6 trichlorophenol	mg/L	0.03	42. Potassium	mg/L	12
13. Chlorine (residual)	mg/L	0.2	43. Radioactive materials (gross alpha activity)	Bq/L	0.01
14. Chloroform	mg/L	0.09	44. Radioactive materials (gross beta activity)	Bq/L	0.1
15. Chromium (hexavalent)	mg/L	0.05	45. Selenium	mg/L	0.01
16. Chromium (total)	mg/L	0.05	46. Silver	mg/L	0.02
17. COD	mg/L	4	47. Sodium	mg/L	200
18. Coliform (fecal)	n/100ml	0	48. Suspended particulate matters	mg/L	10
19. Coliform (total)	n/100 ml	0	49. Sulfide	mg/L	0
20. Color	Hazen unit	15	50. Sulfate	mg/L	400
21. Copper	mg/L	1	51. Total dissolved solids	mg/L	1000
22. Cyanide	Mg/L	0.1	52. Temperature	°C	20-30
23. Detergents	mg/L	0.2	53. Tin	mg/L	2
24. DO	mg/L	6	54. Turbidity	JTU	10
25. Fluoride	mg/L	1	55. Zinc	mg/L	5

\*In coastal area 1000. Reference: Bangladesh Gazette, Addendum, August 28, 1997

Table-2.5: Bangladesh Standards for Ambient Air Quality  
(All values in micrograms per cubic meters)

Sl. No.	Area	Suspended Particulate Matters (SPM)	Sulfur Dioxide (SO <sub>2</sub> )	Carbon Monoxide (CO)	Oxides of Nitrogen (NO <sub>x</sub> )
Ka	Industrial and mixed	500	120	5000	100
Kha	Commercial and mixed	400	100	5000	100
Ga	Residential and rural	200	80	2000	80
Gha	Sensitive	100	30	1000	30

Source : Schedule-2, Rule 12, Environment Conservation Rules of 1997 (Page 3423, Bangladesh Gazette, 28 August 1997) (Own author's translation from original Bengali)

- Note :
1. Sensitive area includes national monuments, health resorts, hospitals, archaeological sites, educational institutions and other government designated areas (if any).
  2. Any industrial unit located not in a designated industrial area will not discharge such pollutants, which may contribute to exceed the ambient air quality above in the surrounding areas of category 'Ga' and 'Gha'.
  3. Suspended particulate matters mean airborne particles of diameter of 10 microns or less.

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Table-2.6: Bangladesh Standards for Noise

Sl. No.	Area Category	Standards Values (all values in dBA)	
		Day	Night
Ka	Silent zone	45	30
Kha	Residential area	50	40
Ga	Mixed area (basically residential and together used for commercial and industrial purposes)	60	50
Gha	Commercial area	70	60
Umma	Industrial area	75	70

Source : Schedule 4, Rule-12, Environment Conservation Rules, 1997. (Page 3127, Bangladesh Gazette, 28 August 1997). Own authentic translation from original Bengali

- Note :
1. Daytime is reckoned as the time between 6 a.m. to 9 p.m.
  2. Night time is reckoned as the time between 9 p.m. to 6 a.m.
  3. Silent zones are areas up to a radius of 100 meter around hospitals, educational institutions or special establishments declared or to be declared as such by the Government. Use of vehicular horn, other signals and loudspeakers is prohibited in silent zones.

Table-2.7: Bangladesh Standards for Odor

Parameters	Unit	Values
Acetaldehyde	PPM	0.5-5
Ammonia	PPM	1-5
Hydrogen Sulfide	PPM	0.02-0.2
Methyl Disulfide	PPM	0.009-0.1
Methyl Mercaptan	PPM	0.02-0.2
Methyl Sulfide	PPM	0.01-0.2
Styrene	PPM	0.4-2.0
Trimethylamine	PPM	0.005-0.07

Source : Schedule-5, Rule-12, Environment Conservation Rules, 1997. (Page 3130, Bangladesh Gazette, 28 August 1997) Own authentic translation from original Bengali

- Note :
1. Regulatory standards at emission/discharge outlets (apply to those outlets which are higher than 3 meters):  
 $Q = 0.108 \times H e^2 \text{ cm}$   
 Where Q – gas emission rate (Nm<sup>3</sup>/hour)  
 He – effective height of the outlet (m)  
 Cm – above mentioned standard (ppm)
  2. Where there is a range given for a parameter, the lower value will be used for warning and the higher value for initiation of legal procedure or punitive measures.

Table-2.8: Bangladesh Standards for Sewage Discharge

Parameters	Unit	Values
BOD	mg/l	40
Nitrate	mg/l	250
Phosphate	mg/l	35
Suspended Solids (SS)	mg/l	100
Temperature	°C	30
Coliforms	number/100ml	1000

Source : Schedule-9, Rule-13, Environment Conservation Rules, 1997. (Page-3131 of the Bangladesh Gazette of 28 August 1997) (Own authentic translation from original Bengali)

- Note :
1. These standards are applicable for discharge into surface and inland water bodies.
  2. Chlorination is to be done before final discharge.

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Table-2.9: Bangladesh Standards for Industrial and Project Effluent

Sl. No.	Parameters	Unit	Discharge To		
			Inland Surface Water	Public Sewer to Secondary Treatment Plant	Irrigable Land
1	Ammonical nitrogen (as elementary N)	mg/l	50	75	75
2	Ammonia (as free ammonia)	mg/l	5	5	15
3	Arsenic (as As)	mg/l	0.2	0.05	0.2
4	BOD <sub>5</sub> at 20°C	mg/l	50	250	100
5	Boron	mg/l	?	?	?
6	Cadmium (as Cd)	mg/l	0.05	0.5	0.5
7	Chloride	mg/l	600	600	600
8	Chromium (as total Cr)	mg/l	0.5	1.0	1.0
9	COD	mg/l	200	400	400
10	Chromium (as hexivalent Cr)	mg/l	0.1	1.0	1.0
11	Copper (as Cu)	mg/l	0.5	3.0	3.0
12	Dissolved oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8
13	Electro-conductivity (EC)	µs/cm/cm	1200	1200	1200
14	Total dissolved solids	mg/l	2100	2100	2100
15	Fluoride (as F)	mg/l	2	15	10
16	Sulfide (as S)	mg/l	1	2	2
17	Iron (as Fe)	mg/l	2	2	2
18	Total kjeldahl nitrogen (as N)	mg/l	100	100	100
19	Lead (as Pb)	mg/l	0.1	1	0.1
20	Manganese (as Mn)	mg/l	5	5	5
21	Mercury (as Hg)	mg/l	0.01	0.01	0.01
22	Nickel (as Ni)	mg/l	1.0	2.0	1.0
23	Nitrate (as elementary N)	mg/l	10.0	Not yet set	10
24	Oil and grease	mg/l	10	20	10
25	Phenolic compounds (as C <sub>6</sub> H <sub>5</sub> OH)	mg/l	1.0	5	1
26	Dissolved phosphorus (as P)	mg/l	8	8	15
27	Radioactive substance	(to be specified by Bangladesh Atomic Energy Commission)			
28	PH		6-9	6-9	6-9
29	Selenium (as Se)	mg/l	0.05	0.05	0.05
30	Zinc (as Zn)	Mg/l	5	10	10
31	Total dissolved solids	Mg/l	2100	2100	2100
32	Temperature	°C (summer)	40	40	40
		°C (winter)	45	45	45
33	Suspended solids	Mg/l	150	500	200
34	Cyanide	Mg/l	0.1	2.0	0.2

Source : Schedule (B, Rule-13, Environment Conservation Rules, 1997 (Pages 3112 - 3134 of the Bangladesh Gazette of 28 August 1997) (for uniformity translation from original Bangali).

Note :

These standards will be applicable for all industries other than those which are specified under industrial sector-specific standards.

These standards will have to be complied from the moment of trial production in case of industries and from the moment of the very beginning in case of projects.

These standards will have to be met at any point of time and any sampling. In case of need for ambient environment condition, these standards may be made stringent.

Inland surface water will include drains, ponds, tanks, water bodies, ditches, canals, rivers, streams and estuaries.

Public sewer means leading to full fledged joint treatment facility comprising primary and secondary treatment.

Land for irrigation means organized irrigation of selected crops on adjacent land determined on the basis of quantity and characteristics of waste water.

If any discharge is made into public sewer or on land which does not meet the respective definitions in notes 3 and 4 above, then the inland surface water standards will apply.

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Table-2.10: Bangladesh Standards for Industrial and Project Emissions

Sn. No.	Parameters	Values (in mg/Nm <sup>3</sup> )
1	Particulates	
	(ka) Power station of capacity of 200 MW or more (kha) Power station of capacity of less than 200 MW	150 350
2	Chlorine	150
3	Hydrochloric acid vapor and mist	350
4	Total fluoride (as F)	25
5	Sulfuric acid mist	50
6	Lead particulates	50
7	Mercury particulates	10
8	Sulfur dioxide	kg/ton acid
	(ka) Sulfuric acid production (DCDA* process)	4
	(kha) Sulfuric acid production (SCSA* process)	100
	(* DCDA : Double conversion, double absorption, SCSA : Single conversion single absorption)	
	Lowest height of stack for sulfur dioxide dispersion :	
	(ka) Coal based power plant	
500 MW or more	27.5 m	
200 MW – 500 MW	220m	
Less than 200 MW	14(Q) <sup>0.3</sup>	
(kha) Boiler		
Steam per hour – up to 15 tons	11m	
Steam per hour – more than 15 tons	14(Q) <sup>0.3</sup>	
(Q = SO <sub>2</sub> emission in kg/hour)		
9	Oxides of nitrogen	3 kg/ton acid
	(ka) Nitric acid production	50 ppm
	(kha) Gas based power stations	50 ppm
	500 MW or more	40 ppm
	200 – 500 MW	30 ppm
	Less than 200 MW	200 ppm
(Ga) Metallurgical oven		
10	Kiln soot and dust	Mg/Nm <sup>3</sup>
	(ka) Blast furnace	500
	(kha) Brick kiln	1000
	(Ga) Coke oven	500
	(Gha) Lime kiln	250

Source : Schedule-11, Rule-13, Environment Conservation Rules, 1997 (Page 3135, 3136, Bangladesh Gazette, 28 August 1997) (Chin authentic translation from original Bengali)

## 2.5 ENVIRONMENTAL CLEARANCE REQUIREMENTS

### 2.5.1 National Environmental Clearance

For most proponents, planning an industrial project or projects of various natures (including 'exploration, extraction and distribution of mineral resources'), in Bangladesh is currently mandatory to obtain an "environmental clearance" from the Department of Environment.

The first step for the project proponent is to complete an application form, which may be obtained from the appropriate DoE Divisional Office. The application form with a cover letter is then addressed to Director / Deputy Director of the respective Divisional Office of the Department of Environment as prescribed in the Environmental Conservation Rules of 1997. The application should include, a feasibility study report of the project, IEE/ EIA, NOC's of local authorities, a mitigation plan for minimizing the impact of environmental pollution and a Treasury Chalan of requisite fees (this will depend on the amount of investment by the project proponent). The DoE authority reserves the right to request additional information and supporting documents for the proposed project.

As per the Environment Conservation Rules of 1997, the DoE divisional authority issues environmental site clearance within 60 working days or the refusal letter with appropriate reasons for such a refusal. The clearance issued is valid for a one-year period, which requires being renewed 30 days prior to the expiry date. For projects requiring both site clearance and environmental clearance (like in the present case), a

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two-tier system is applied (actually this is a three tier system) as after one obtains the site clearance, they need to apply again at an appropriate time along with the EIA. Once the EIA is approved (this approval is actually the second tier), then the proponent applies for the Environmental Clearance.

The Environmental Conservation Rules of 1997 ensures the right of the aggrieved to appeal against the Notice Order or Decision to the appellate authority. The appeal should be made to the appellate authority with the clear justification and the attested copy of the specific Notice Order / Decision of the respective DoE office against which the appeal is to be made. Moreover, the prescribed fee is to be paid through treasury Chalan and the relevant papers for the appeal are required to be placed.

The focus of the environment conservation rules in terms of environmental clearance and EIA lies with the classification of industries and certain projects into four groups; Green, Orange-A, Orange-B and Red based on their pollution or environment damage potential.

Green List Industries / projects are considered relatively pollution-free and therefore do not require an environmental clearance from the DoE and consequently no environmental study.

Orange List Industries / projects fall into two categories, Category-A and Category- B. Category- A industries are required to submit general information, a feasibility report, a process flow diagram and schematic diagrams of waste treatment facilities along with their application for obtaining DoE environmental clearance. Category-B industries / projects are required to submit an Initial Environmental Examination (IEE) report, along with their application and the information and papers specified for Category- A industries / projects.

Red List Industries / projects, according to the Rules, are those which may cause 'significant adverse' environmental impacts and are therefore required to submit an EIA Report. However they require obtaining an initial site clearance on the basis of an IEE Report, and subsequently submitting an EIA Report for obtaining environmental clearance along with other necessary papers, like the feasibility study report and no objections from local authorities.

Figure-2.2 furnished hereinafter show respectively the present environmental site/technical clearance procedure for projects in Bangladesh and steps involved in obtaining the environment clearance.

Figure-2.2.1 furnished hereinafter shows Flow Chart for Site Clearance procedure.



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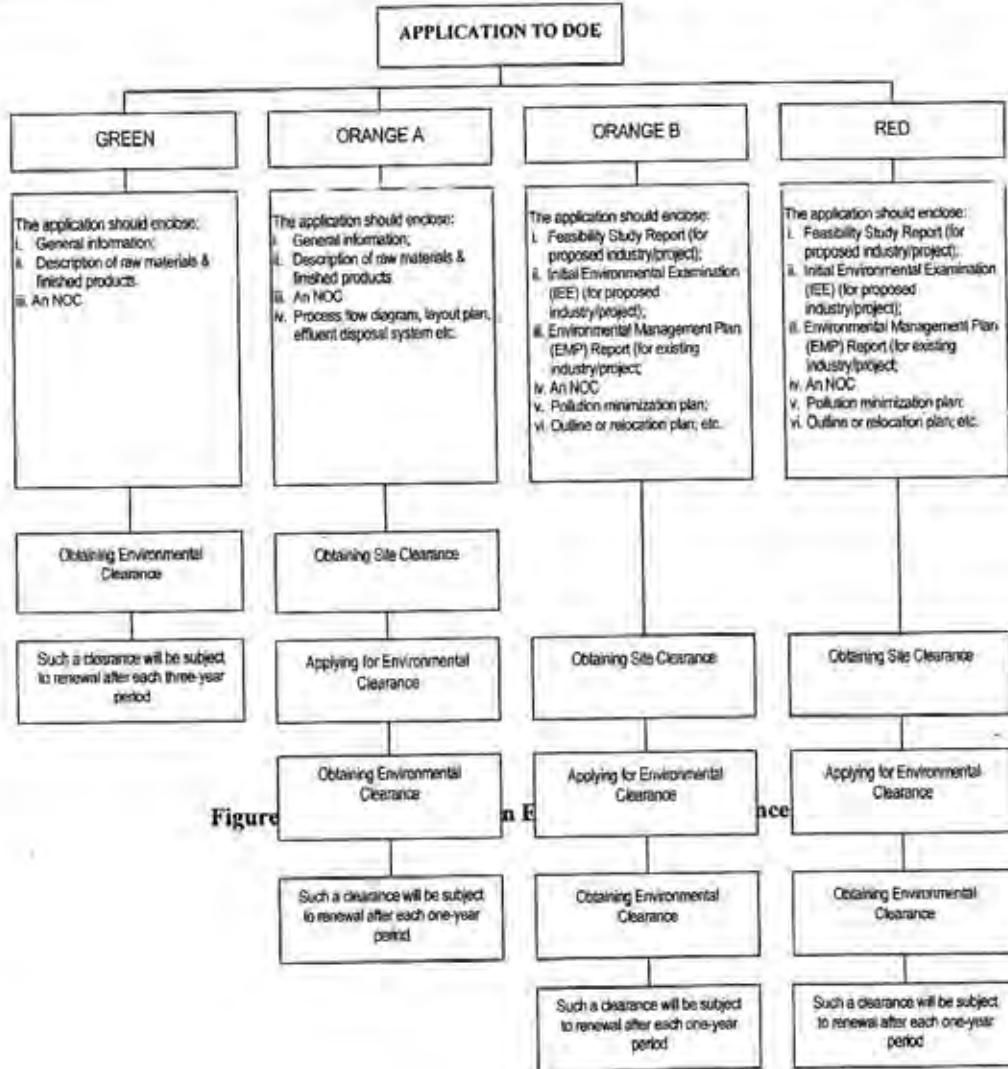


Figure 10.1: Flowchart on Environmental Clearance

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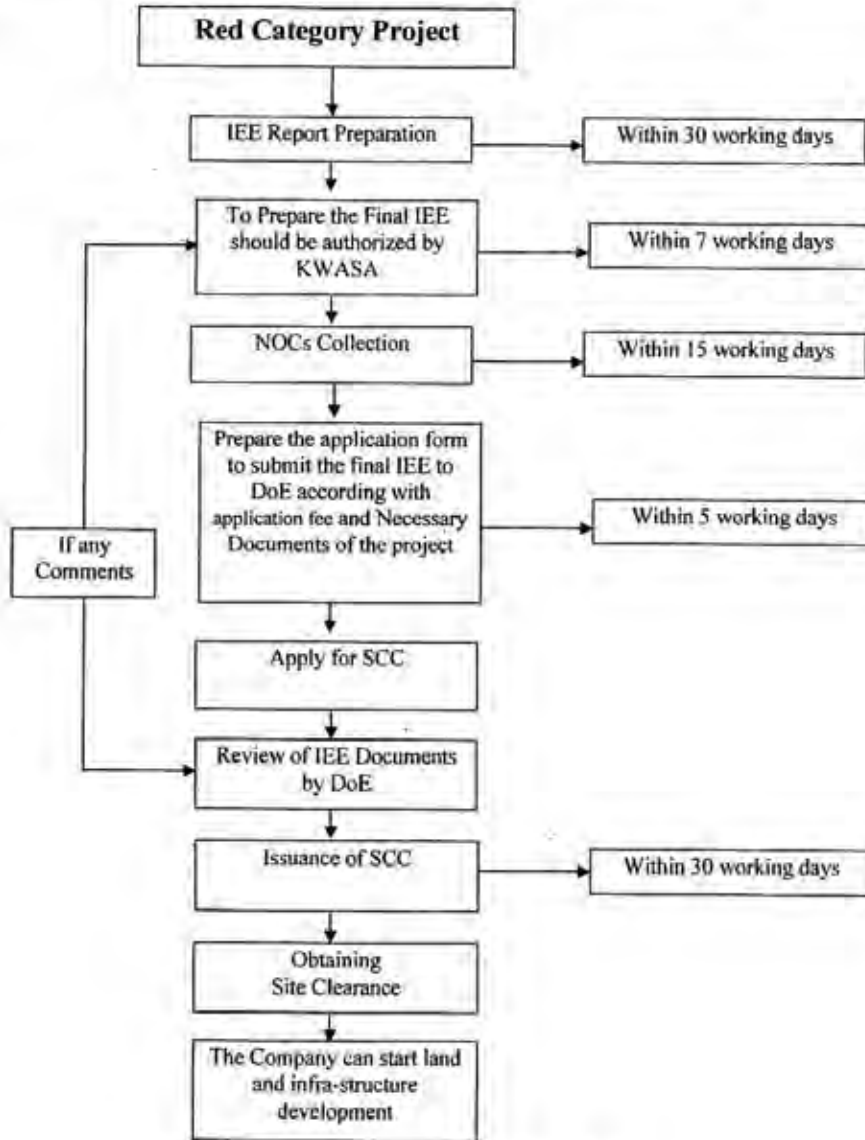


Figure 2.2.1 Flow Chart of Site Clearance Procedure

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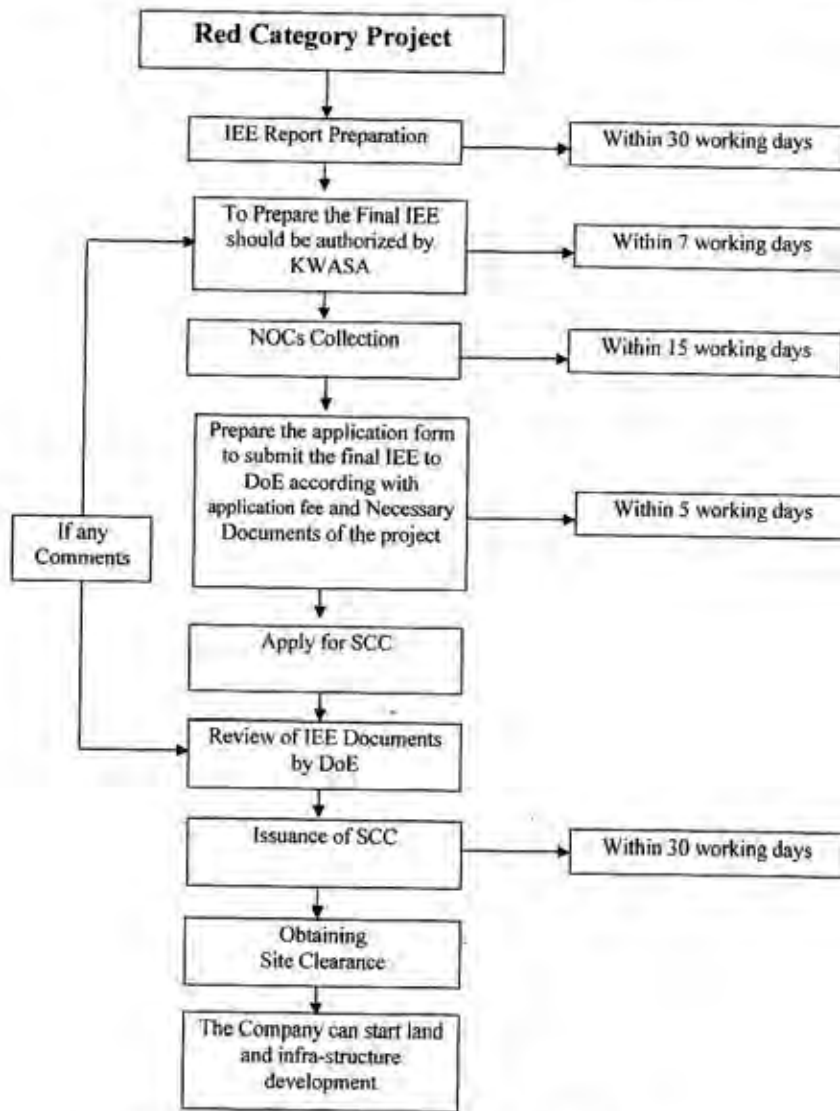


Figure 2.2.1 Flow Chart of Site Clearance Procedure

## Chapter-03

### **Analysis of Suitability for Alternative Options**

#### 3.2 Option Selection Factors

To minimize the adverse impact on the environment, identification of a suitable option for intake of water is very important. Options suitability depends on the quality of water (specially salinity) in the river. The length of pipe line, quantum of impoundment of water as well as river crossing depends on location of intake points. Factors those were taken into account include:

- Length of the pipe line from intake point to impounding reservoir and to the distribution reservoir and overhead tank;
- Minimal Highway Crossing;
- Avoid Rivers crossing as much as possible;
- Minimal obstruction to habitation;
- Avoid large trees and tree plantations as much as possible;
- Avoid water bodies and / swampy areas as much as possible;
- Avoid homestead, schools, grave yard, mosque, church/ temple, cremation yards etc.;
- Avoid environmental sensitive areas, historic and archaeological sites as much as possible;
- Avoid more land acquisition for the project;
- Better quality of water; and
- Minimum cost of the Project.

#### 3.2 Selection of Water Intake Point Location

Location of Boultoali, Ulpur, Haridapur and Chapil Ghat are about 47km, 39km, 36km and 30km north east of Khulna city respectively in the district of Gopalganj along the river Modhumati. Mollarhat is located 28km northeast of Khuna city in the district Bagherhat on river bank Modhumati.

Depending on daily salinity record surveyed by KWASA, impoundment of water require about 15 days for Bouliali, Ulpur and Haridapur points. That for Chapial Ghat require about 30days and Mollarhat points requires 45days impoundment of water. The location of different water intake points is shown in the map (Map-3.1).

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3.3 Comparative Analysis

3.3.1 Major Environmental Features along different options

Preliminary surveys have been conducted in the entire study area and have provided five alternative options. Comparative analysis of route features is shown in Table-3.1.

Table 3.1: Comparative analysis of salient features of alternative Water Intake Points

Options	Different Features in the options								
	Pipe length	Water Quality	Highway Crossing	River Crossing	Obstruction of habitation	Tree Cutting	Khal/Pond Crossing	Cost	Obstruction to natural drainage system
Option-1	E	E	E	E	E	E	E	E	E
Option-2	D	E	D	E	D	D	D	D	D
Option-3	C	E	C	E	C	C	C	B	C
Option-4	B	D	B	E	B	B	B	A	B
Option-5	A	C	A	D	A	A	A	C	A

Note: Environmental Deterioration

E=5: Most Deterioration, D=4: More Deterioration, C=3: Medium Deterioration, B=2: Little Deterioration, A=1: Less Deterioration

3.4 Findings

In view of the foregoing discussion and the salient features as shown in Table 3.1, it appears Option-5 is the best option among the five alternatives.

During comparison it is apparent that Option-5 is with minimum pipe raw water intake pipe length, less highway crossing, less obstruction of habitation, less tree cutting and less obstruction to natural drainage system; also disturbance to the environment (Air, water, soil, etc.) and stand most favorable in consideration of other technical and social points of view. It is, therefore, concluded that Option-5 is considered the most suitable for constructing the surface water treatment plant for KWASA for Long Term Basis (e.g., upto the year 2030)

## Chapter-04

### Description of the Project

#### 4.0 Background and Outline of the Project

##### 4.1 Background

To mitigate water demand of Khulna City upto the year 2030, Khulna Water Supply Improvement Project in the People's Republic of Bangladesh has been carried out in accordance with the Scope of Work for Feasibility Study for Khulna Water Supply Improvement Project in The People's Republic of Bangladesh agreed upon between Ministry of Finance, Ministry of Local Government, Rural Development and Co-operatives, Khulna Water Supply and Sewerage Authority (KWASA) and Japan International Cooperation Agency (JICA), Dhaka on 31 March 2009; and Minutes of the Meeting on 2<sup>nd</sup> Preparatory Study on the Feasibility Study for Khulna Water Supply Improvement Project in The People's Republic of Bangladesh agreed upon between Ministry of Finance, MLGRD&C, KWASA and JICA, Dhaka, signed on 12 August 2009.

##### 4.2 Object of the Project

The objectives of the study are; (1) to review and analyze National and Local Policies of water supply and existing conditions in the study area, (2) to formulate of a Long Term Water Supply Development Program for the study area, and (3) to identify priority project(s) and conduct a Feasibility Study (F/S) on the identified priority projects.

##### 4.3 Study Area

The Study area covers the whole area of Khulna City Corporation (KCC) and a part of Phultala Thana. The location of Khulna City is shown in the Figure 4.1. For selecting water intake point, the study area extended upto Gopalganj and Bagherhat district.

##### 4.4 Design Years

"Long Term Development Plan of the Water Supply System in Khulna" projected the water demand in the study area by 2030. As for the design year for the Feasibility Study shall be set the year 2020 in consideration of the construction period of the new water supply system including the time needed for detailed design and project implementation.

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Figure 4.1 Location Map of Study Area

4.5 Scenario of Long Term Development Plan

The most important factor to propose a long term development plan for the water supply system in Khulna is to make a clear scenario to establish its integrated sound water supply system in future. KAWASA is a new established organization and its both capacities in terms of financial and in terms of technical have not established yet. This means to promote sound and more

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balance development based on financial and technological consideration to enable KWASA to effectively mobilize cost-savings and productive investment on its facilities construction to satisfy future water demand in Khulna.

Especially for the early stage of the development it is recommended that to utilize existing water supply system as far as possible to evade over investment. As to the water resource development, specifically up to 2025, the target year of the feasibility study to use the present abstraction flow and current utilize existing groundwater resource and to develop new surface water resource only to satisfy the exceed water demand as expected. Taking into consideration of this point all alternative comparisons and discussions in the section are based on what will be required up to 2025. And technologies are discussed conventionally and universally basis and evaded to introduce costly state-of-art methods.

#### 4.6 Proposed Water Supply System

Raw water collected from the Madhumati River at Mollarhat and sent to Surface Water Treatment Plant (SWTP) by raw water transmission pipe of the diameter 1350mm and the length 35km. Salinity influence period at this intake point during dry season is about 45 days (salinity concentration greater than 600mg/L). Impounding reservoir is necessary to store non saline raw water during wet season when the salinity concentration is less than 600mg/L in the river. Location of proposed water supply facilities in Khulna city is shown in Figure 4.2 and Figure 4.3.

Treated water sent to five distribution reservoirs in Khulna city by transmission pipe of diameter 600mm to 1000mm. The length of clear water transmission pie is about 15km in total. Store clear water in distribution reservoir in order to proper distribution of water in response to water demand for five service area in Khulna city. Eleven (11) overhead tanks are use for sufficient water pressure required for the consumers (houses, schools, office, factories and public facilities etc.). The overhead tanks are filled with clear water pumping from distribution reservoir. Distribution pipe will be constructed to supply water to the consumer end. The list of proposed water supply facilities is shown in Table below.

Table-4.1 List of Proposed Water Supply Facilities for Year 2025

	Facility Name	Capacity	Quantity	Remarks
1	Water Intake	110,000m <sup>3</sup> /day	1 nos	
2	Raw Water Transmission Pipe	-	φ1350mm, L=35km	
3	Impounding Reservoir	775,200m <sup>3</sup>	1 no	
4	SWTP	110,000m <sup>3</sup> /day	1 no	
5	Clear Water Transmission Pipe	-	φ600mm-1000mm, L=15km	
6	Distribution Reservoir	50,000m <sup>3</sup> - 18,000m <sup>3</sup>	5 nos	
7	Overhead Tank	300m <sup>3</sup> - 500m <sup>3</sup>	11 nos	
8	Distribution Pipe Network	-	φ50mm-600mm, L=1000km	



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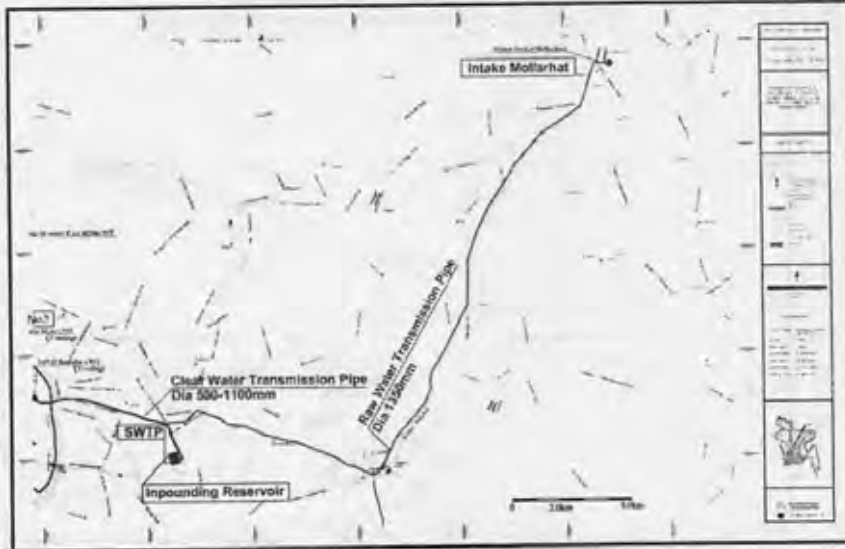


Figure 4.2 Proposed Water Supply System in Khulna City

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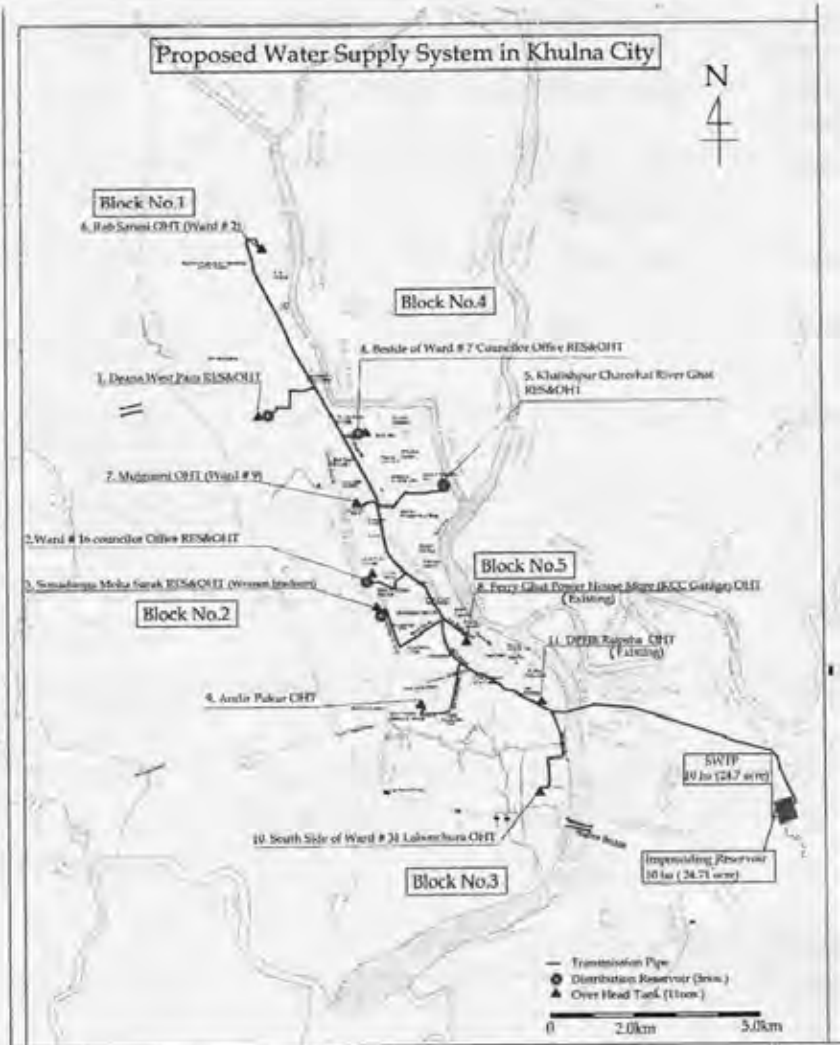


Figure 4.3 Proposed Water Supply System in Khulna City

#### 4.7 Site for Proposed Water Supply Facilities

The list of sites for proposed water supply facilities is shown in below. Land acquisition is necessary as the list below.

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Table 4.2 Site for Proposed Water Supply Facilities for Year 2025

Name	Capacity	Dimension (m)	Area	Proposed Location
Water Intake	110,000m <sup>3</sup> /d	75 x 125 + Acces Road 120m	1.0ha (2.5acre)	Mollarhat (Madhumati River)
Impounding Reservoir	775,200m <sup>3</sup>	250 x 400	10ha (25acre) +6ha(15acre) for Buffer Zone	Samanto Sena
Surface water treatment plant (SWTP)	110,000m <sup>3</sup> /d	250 x 400	10ha (25acre)	Samanto Sena
Deana West Para Reservoir with 300m <sup>3</sup> OHT	8,000m <sup>3</sup>	100 x 70	0.7ha (1.7acre)	Paddy Land
No.16 Ward office Reservoir with 300m <sup>3</sup> OHT	9,000m <sup>3</sup>	100 x 70	0.7ha (1.7acre)	KCC Land
Sonadanga Moha Sarak Reservoir with 500m <sup>3</sup> OHT	18,000m <sup>3</sup>	100 x 90	0.9ha (2.2acre)	Personal Land
Beside of No.7 Ward office Reservoir with 500m <sup>3</sup> OHT	5,000m <sup>3</sup>	100 x 70	0.7ha (1.7acre)	Personal Land
Khalishpur Charerhat River Ghat Reservoir with 500m <sup>3</sup> OHT	15,000m <sup>3</sup>	100 x 90	0.9ha (2.2acre)	Government Land
Rab Sarani OHT	300m <sup>3</sup>	45x30	0.14ha (0.33acre)	Personal Land
Mujguni OHT	300m <sup>3</sup>	45x30	0.14ha (0.33acre)	KCC Land
Ferry Ghat Power House	300m <sup>3</sup>	45x30	0.14ha (0.33acre)	KCC Land
Andir Pukur OHT	500m <sup>3</sup>	50x35	0.18ha (0.43acre)	Personal Land
South Side of Ward No. 31 Office OHT	500m <sup>3</sup>	50x35	0.18ha (0.43acre)	Paddy Land
DPHE Rupsa OHT	500m <sup>3</sup>	50x35	0.18ha (0.43acre)	DPHE

#### 4.8 Massive Construction Works

Impounding reservoir construction and River crossing works are the massive construction work.

##### 4.8.1 Impounding Reservoir

Due to huge excavation of earth for construction of impounding reservoir the construction work is considered as massive construction work. Considering rainy season yearly construction period is estimated about eight (8) months, because earth work won't be conducted during rainy season in Bangladesh. But the construction work will be able to complete within three (3) years construction period.

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4.8.2 River Crossing

River crossing is necessary for Option-5 at one river shown below.

	River Name	Width	Crossing Pipe
1	Rupsha River	600m	Clear Water Transmission Pipe, Dia 1000mm

Photo of river crossing points is shown in Photo 3.1



Photo 3.1 River Crossing Point  
(Rupsha River)

As river crossing method, (1) attached pipe on the existing bridge and (2) installation of pipe under the river by tunneling method e.g., shield method or pipe jacking method. Pipe can not be attached existing bridge since existing bridge wasn't designed pipe load as structure calculation. Considering construction cost, easiness of construction work and environmental aspect, pipe jacking method is supposed to be the most suitable method for river crossing even though this is costlier and complicated.

4.9 Environmental Impact

The common impacts are disruption of earth surface, change in landscape, etc caused due to project locations. During construction period the environmental impacts encountered noise, air pollution, water pollution, spreading of disease, accidents etc. Noise and vibration, abstraction of surface water, sedimentation, water treatment sludge, accidents etc are the common impact during operation period.

4.10 Land Acquisition

Land Acquisitions for SWTP, impounding reservoir and water intake facility are required as summarized Table 4.3

Table 4.3 Present Condition for Land Acquisition for Options

Components	Present Condition for Land Acquisition	
	Present condition	On going
SWTP	Paddy Field + Shrimp	Acquisition Procedural will be complexes and necessary for a long time

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I. Reservoir	Paddy Field + Shrimp	Acquisition Procedural will be complexes and necessary for a long time
Water Intake	Public /Private Lands	Acquisition Procedural will be complexes and necessary a certain amount of time
Water T. Pipe	Existing Roads	Basically not necessary for Land Acquisition excluding some special areas if any

Note  
 SWTP: Surface Water Treatment Plant  
 I. Reservoir: Impounding Reservoir  
 Water Intake: Water Intake Facility  
 Water T. Pipe: Raw water Transition Pipe & Clear-water Transmission Pipe


**4.11 Construction and Operation Cost**


Rough estimate construction cost in thousand USD is calculated as follows. This cost includes all facilities for water supply system and all kinds of work such as pipe work, civil work, architecture work, mechanical work and electrical work. The construction cost is shown in the following Table (Table-4.4)

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Table 4.4 construction cost and operation cost in thousand USD (option 1-5)

Option	Construction Cost											Total Construction Cost	Operation cost per year
	Water Intake	Raw Water Transmission Pipe	River crossing	Impounding Reservoir	SWTP	Clear Water Transmission Pipe	Distribution Reservoir	Overhead Tank	Distribution Pipe Network	Service Pipe Connection	Others		
1. Boulfali	5,800	124,000	5,600	16,980	45,000	14,480	20,380	5,500	20,000	15,000	5,000	271,940	2,570
2. Ulpur	5,800	108,000	5,600	16,980	45,000	14,480	20,380	5,500	20,000	15,000	5,000	255,940	2,520
3. Haridaspur	5,800	98,000	5,600	16,980	45,000	14,480	20,380	5,500	20,000	15,000	4,000	244,940	2,490
4. Chapaulghat	5,800	86,000	5,600	28,660	45,000	14,480	20,380	5,500	20,000	15,000	4,000	244,620	2,440
5. Mollahat	5,800	98,000	5,600	28,660	45,000	14,480	20,380	5,500	20,000	15,000	4,000	256,620	2,590

  
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#### 4.12 Implementation Schedule

The expected overall schedule is shown in Figure 4.4. In preparation of the overall schedule, following schedule is considered for pre-construction and construction stage.

Pledge of JICA Loan	February 2011
Exchange of Note between GOB and GOJ	March 2011
Signing of Loan Agreement	March 2011
Selection of consultant for Designing and PMC	9 months
Detailed Engineering Design, Preparation of specifications	12 months
Contractor Prequalification (P/Q), evaluation and JICA concurrence	3 months
Tender documents for individual project components, JICA concurrence on tender documents	3 months
Project Tender period	2 months
Evaluation of contractor proposals	2 months
JICA concurrence on tender evaluation (Contractor proposals)	1 month
Contract negotiation	1.5 months
JICA concurrence on contract award	0.5 month
L/C Issuance for project	1 month
Total period of Construction Work	36 months
Completion of the Project and Plant trials	December 2016

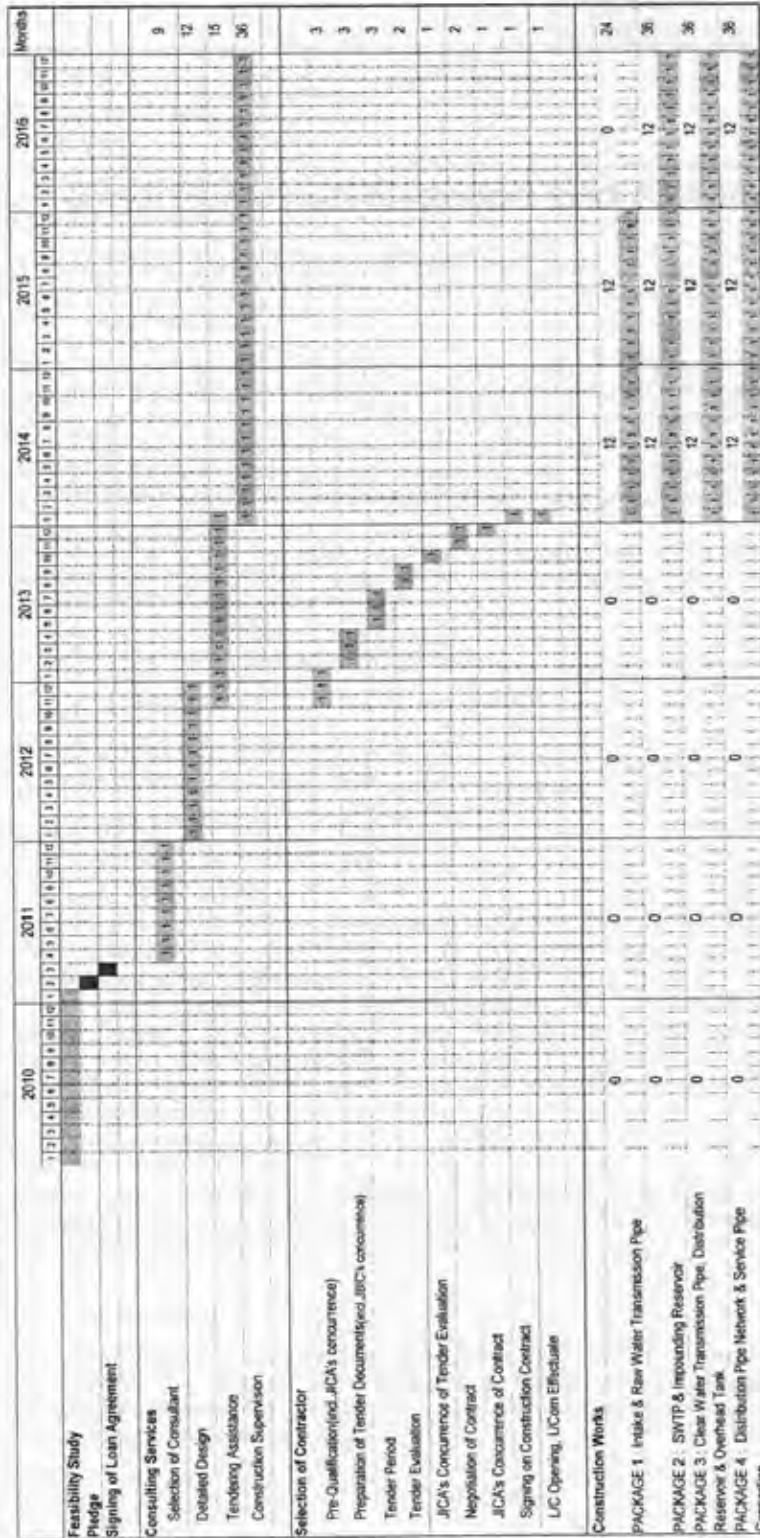
The construction periods of major sub-projects are assumed and summarized as follows considering the size of the project and work volume and workability.

Water Intake Facility	24 months	Package 1
Raw Water Transmission Pipe	12 months	
SWTP	36 months	Package 2
Impounding Reservoir	12 months	Package 3
Clear Water Transmission Pipe	36 months	
Distribution Reservoir	24 months	
Overhead Tank	24 months	Package 4
Distribution Pipe and Service Pipe	36 months	

  
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5.0 Figure: 4.4 Implementation Schedule

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## Chapter-05

### **Environmental Baseline and Existing Facilities**

#### **5.2.4 PHYSICAL BASELINE ENVIRONMENT**

##### **5.1.1 Introduction**

The existing condition of different components of environment in the absence of any development activity or project is described as the baseline environment. Environmental baseline is established by examining the existing environment of the project site against which potential impacts from development activities of the project both during implementation and operation phases can be compared. The secondary objective of establishing the baseline for important environmental parameters such as air, water, soil, is to ensure that any difficulties arising from existing sources are not erroneously attributed to the present project.

The following sections describe the existing physical components of the project area. These include topography, land use, geology and soil, climate, natural hazards, water resources, ecological resources, ambient air quality and ambient noise level.

##### **5.1.2 Site location, Topography and Land Use**

###### **5.1.2.1 Site Location**

Khulna, the third largest city in Bangladesh, is located in the southwest of the country and has a population of 1.5 million (estimated in 2008). The location map of the area shown in the Figure-5.1

###### **5.1.2.2 Topography**

- **Nationwide Area**

Bangladesh is a tropical country, situated mainly on the deltas of large rivers flowing from the Himalayas. The Brahmaputra River, known locally as the Jamuna, unites with part of the Ganges to form the Padma, which, after its juncture with a third large river, the Meghna, flows into the Bay of Bengal. Offshoots of the Ganges-Padma, including the Burishwar, Garai, Kobadak, and Madhumati, also flow south to the Bay of Bengal. No part of the delta area is more than 150 m above sea level, and most of it is but a meter or two above sea level. Its soil consists mostly of fertile alluvium, which is intensively farmed; mineral deposits are negligible. During the rainy season floodwater covers most of the land surface, damaging crops and injuring the economy.

- **Khulna Division**

Khulna Division is situated in the southeast of Bangladesh and lies in the delta of the River Ganges. The topography is flat, slopes gently towards the Bay of Bengal and is criss-crossed by a network of rivers and canals which are affected by tides and intrusion of seawater.

- **Khulna City**

The city of Khulna is in the northern part of the district, and is mainly an expansion of trade centers close to the Rupsha and Bhairab rivers. The city lies along the River Bhairab over a length of about 15km, covering area of approximately 45 km<sup>2</sup>. Low lying swamps and marshes located in northwest of the city are other major topographic features.

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Figure – 5.1 Location of Khulna City

5.1.2.3 Land Use

In the late 1990s, around 80% of the KCC area was built up as shown in the Table 5.1. Almost two thirds of the built up area was in residential use. By 2009, a significant proportion of this land is likely to have become urban but basic land uses have not changed drastically. The main exception is Khulna University which is located between the Moyur river and the bypass on the Satkhira Road.

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Table 5.1 Land Use, KCC Area, 1999

Land Use	Sq kms	%
Residential	23.5	65%
Mixed uses	6.6	18%
Industry (incl. railway and shipyards)	3.6	10%
Commerce/ government/ education	1.0	3%
Others	1.5	4%
Built up area	36.2	79%
Agricultural land	9.8	21%
Total	46.0	100%

### 5.1.3 Geology and Soils

The Structure and surface geology of Bangladesh are related to its tectonic evolution, which started during late Cretaceous period when the northward moving Indian plate collided with Eurasian plate. The collision caused the northern extremity of Bengal to separate into gulf of Assam and Burma. The tectonic map of Bangladesh shows that most of the west Bengal of India and whole Bangladesh are occupied by Bengal Basin, where the Precambrian basement lies more than 3 km below mean sea level. The Basin is bordered on the western side by the peninsular shield of India and on the eastern side by the Tripura-Naga Orogenic Belt. On the northeast, the basin is bordered by the Shillong Massif.

The surface geology of Bangladesh is essentially the geology of the sediment of only the Cenozoic era. The geological succession of Bangladesh shows that the sub-surface stratigraphy includes: the Precambrian, the Permian Gondwana sediments, the upper Jurassic Volcanic rocks, and a thin mantle of Cretaceous sedimentary rocks originating mainly from deposition of the denuded volcanic. Overlaying these deposits are the Tertiary limestones, sandstones and shales. Thus surficial geology of the country consist of Holocene deposits (80%), Tertiary sedimentary rocks (12%) and uplifted Pleistone clay residual (8%). The Holocene deposits, consisting of unconsolidated sand, silt and clay of varying amounts, are the products of piedmont alluvial, fluvial, deltaic or coastal activities (Karim, 1999). Physiographic unit map of Bangladesh is shown in the Figure-5.2.

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Figure – 5.2 Physiographic Unit Map of Bangladesh

The Khulna City area consists of late Holocene to Recent Alluvium of the Ganges deltaic plain in north and tidal plain in south. The area is composed of sand, silt and clay in various proportions with small amount of coarse sand, which is classified into seven litho-stratigraphic units from base to top. Complexes of channels of fluvial/tidal origin, natural levees, bars, swamps and plains like floodplain, deltaic plains, estuarine plains or coastal plain constitute the Khulna City area. Channels (tidal as well as fluvial), natural levee, flood plain, flood basin, ox-bow lake, abandoned channels, bars, swamps/ flood basins and estuarine plain have been recognized as geomorphologic units within the Khulna City area.

5.1.3.1 Chemical properties of Soil at Rupsa Bridge Site

Soils of Rupsha Bridge site are poorly or very poorly drained, grey clays with variable range of seasonal salinity. Except for homesteads, man-made platforms and ridge tops this landscape is seasonally or tidally flooded. Even on the highland part rainwater is collected by field bunds during the Kharif-II season for paddy cultivation. Physico-chemical data of soil analyses are given in Table-5.2. The soils are fined loamy on ridges and clayey in basins.

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Table: 5-2. Physico-chemical Properties of the Topsoil

Soil Series	pH	Salinity (mmhos)	Organic Matter (%)	Exchangeable cations Meq/100cm <sup>3</sup> soil			P	S	B	Mn	Zn
				Ca	Mg	K					
Iswardi	7.3		2.5	11.3	5.7	0.22	9	128	2.2	9	1
Gopalpur	6.9	5.6	0.95	12.9	5.1	0.12	30	165	1.8	22	2
Barisal	7.2		2.5	17.3	2.8	0.11	2	106	1.0	15	1
Bajra	7.3	5.5	1.6	14.2	4.0	0.12	3	250	2.5	29	2

Note: Ca = calcium, Mg = magnesium, K = potassium, P = phosphorus, S = sulphur, B = boron, Mn = manganese, Zn = zinc

Source: EIA, JICA, Rupsha Bridge

The soil and water salinity of Rupsha Bridge Point a rhythmic seasonal variations. Both soil and water salinity increases from December and reaches the peak in May and falls sharply in June with the beginning of the monsoon because of rain water flushing. This happens due to local rainfall and run-off that is received from the catchments areas from within and out side Bangladesh boundary. Soil salinity during November-May period varies from slight to moderate range as per USDA (Anon 1972) classification. These ranges are as follows:

Salinity	Conductivity (µs/cm)
None saline	0.0-2.0
Slightly saline	2.0-4.0
Moderately saline	4.0-8.0
Strongly saline	>8.0

Soil salinity decreases steadily with the passage of time inside the poldered area due to rainwater flushing. The gradual loss of soluble salts from the profile, this may create an undesirable low bearing capacity of the soil profile unless properly managed with addition of organic matter and gypsum during the tillage operations.

#### 5.1.4 Climate

Bangladesh is located at the central part within the Asiatic monsoon region where the climate is tropical. Being relatively small size of the country and generally low-lying area causes moderate variation in terms of temperature, precipitation, relative humidity and wind speeds.

The mean annual rainfall in the area is 1946mm (year 2004-2008), with peak rainfalls occurring in July and August. The mean monthly maximum temperature for Khulna varies from 26.3 °C in January to 34.6 °C in April. A maximum daily of 40.6 °C and minimum 7.2°C have been recorded. The mean daily maximum temperatures rise during March and April as a prelude to the on coming monsoon.

##### 5.1.4.1 Monsoon Climate

The region has a tropical monsoon climate. There are two marked seasons: the rainy seasons from May to October, during which more than 85% of the total annual rainfall occurs and the dry season from November to April. The beginning of the rainy season vary from year to year; heavy rains may commence anywhere between mid April and early June and may end anywhere between the end of September and mid November.

In more detail, mid November to February is the coolest and driest period; March to May is the hottest period with periodic heavy thunderstorms; June to mid September is the most rainy and humid period; and mid September to early November is a transitional period with decreasing rainfall, often with association of thunder but with relatively high temperature and humidity.

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Squally winds of up to 50 mph or occasionally more, usually from the northwest, often accompanying thunderstorms (Nor'-wresters) in the pre-monsoon period may damage property and crops. Cyclonic storms occurring in the Bay of Bengal in April-May and October-November rarely penetrate as far as Narayanganj district, but these may cause serious damage to property, crops, livestock as well as human casualties when they do so. Monsoon rains are generally not stormy, but downpours of 2-3 inches (50-75mm) per day are not uncommon and rain falls of more than 10 inches (250 mm) in a day are occasionally experienced. The evaporation regime over the area is fairly high and consistent with the maximum extending over March through May when the temperature is at the highest but dropping slightly during the monsoon and gradually decreasing during the dry season.

The relevant climatic data of the Khulna areas e.g., precipitation, temperature, relative humidity, wind speeds and sunshine are described below.

**5.1.4.2 Precipitation**

Annual rainfall in Khulna is shown in Table 5.3. The average annual rainfall during 2004 to 2008 is 1,946 mm.

**Table 5.3 Rainfall in Khulna**

Unit: mm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	0	0	7	85	180	383	253	266	621	183	0	0
2005	15	0	148	43	215	102	435	194	410	420	0	0
2006	0	0	5	19	230	262	522	364	579	79	1	0
2007	0	54	14	92	119	374	591	160	397	197	113	0
2008	66	36	48	36	151	190	301	202	379	187	0	0
Average (2004-2008)	16	18	44	55	179	262	420	237	477	213	23	0

Source: Metrological Department Climate Division

**5.1.4.3 Evaporation**

Annual evaporation in Khulna is shown in Table 5.4. The average annual evaporation during 2003 to 2007 is 953 mm.

**Table 5.4 Evaporation in Khulna**

Unit: mm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	60	85	143	156	169	110	110	116	93	69	78	73
2004	69	110	166	151	179	108	109	91	94	105	91	72
2005	56	71	117	129	134	112	82	71	78	75	77	64
2006	78	83	118	142	121	95	81	96	89	101	87	88
2007	83	72	106	135	139	111	80	106	96	102	77	67
Average (2003-2007)	57	67	101	111	115	85	70	73	71	77	66	58

Source: Metrological Department Climate Division

**5.1.4.4 Temperature, Relative Humidity, Wind and Sunshine**

Temperature, relative humidity, wind, sunshine duration in Khulna, and sunshine duration in Jessore are as shown in Table 5.5.

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Table 5.5 Temperature, Relative Humidity, and Wind in Khulna/Sunshine Duration  
in Jessore

Temperature °C of Khulna												
Item	J	F	M	A	M	J	J	A	S	O	N	D
Highest	32.2	36.1	39.4	40.6	41.7	39.4	37.2	36.1	37.2	36.1	34.4	31.7
Av. Max	26.3	29.2	33.4	34.6	34.3	32.6	31.2	31.3	31.7	31.3	29.1	26.7
Av. Min	13.6	16.1	21.0	24.2	25.6	26.1	26.2	26.2	26.0	24.3	19.7	14.7
Lowest	7.2	7.2	10.0	17.8	18.3	21.7	21.7	22.2	22.8	17.8	11.7	7.2
Relative Humidity in % of Khulna												
9 A.M.	73	71	73	76	78	83	86	85	83	78	62	72
6 P.M.	62	55	55	65	74	82	84	84	83	78	69	67
Average wind velocity of Khulna												
Km/hr	3.0	3.9	5.8	7.8	8.9	7.4	7.8	6.9	5.6	3.9	3.2	3.0
mi/hr	1.9	2.4	3.6	4.8	5.6	4.6	4.8	4.3	3.5	2.4	2.0	1.9
Sunshine Duration of Jessore												
Hours of bright sunshine	9.1	9.5	8.7	8.9	9.7	4.8	5.1	5.7	5.9	8.2	9.3	9.4
Day (Length) (hours)	10.9	11.4	12.0	12.7	13.3	13.6	13.4	13.0	12.3	11.7	11.1	10.7
Sunshine as % of Day Length	83	83	72	70	73	35	38	44	48	70	84	88

### 5.1.5 Natural Hazards

#### 5.1.5.1 Introduction

Bangladesh can be regarded as susceptible to natural calamities. This is due to its unique combination of physiographic, morphological and other natural features which have lead to the direct loss of life and physical property on a massive scale. The natural calamities are floods, cyclones and storm surges, and earthquakes. Each of these natural hazards is discussed below.

#### 5.1.5.2 Storm Surges

Coastal flooding associated with storm surges is one of the world's foremost natural hazards in terms of loss of life and property damage. Storm surges associated with tropical cyclones formed over the Bay of Bengal affect greatly the coastal areas of Bangladesh. These surges are due to the effect of storm tide and astronomical tide, and the shallow bathymetric configuration and funneling shape of the Bay of Bengal. Historical records (Table-4.6) show that the Noakhali-Chittagong coast and Barisal-Noakhali coast are much more vulnerable for storm surges having maximum storm surge height of 13.64 m. The Khulna-Sundarban coastal region experiences storm surges with height ranging from 0.61 to 4.55 m.

Table – 5.6 Ranges of Storm Surge Height along different areas of Bangladesh  
(Source: SMRC, 1997)

Coast	Range of Storm height (m)
Khulna Sundarban	0.61-4.55
Barisal Pataukhali-Noakhali	0.6-13.03
Noakhali-Chittagong	0.90-13.64
Chittagong-Cox's Bazar	0.90-5.15

#### 5.1.5.3 Flooding

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Flood is a common phenomenon in Bangladesh. Every year certain area of Bangladesh is subjected to flooding. The major cause of flood is monsoon rainfall runoff from upstream catchments. More than 90 percent of runoff is from outside Bangladesh.

It has been observed that land development works need to be conducted to a certain height for avoiding flood. The equipments of intake pump, treatment plant pump and machineries, distribution reservoir pumping station must keep 1m above the highest flood level.

#### 5.1.5.4 Cyclones

Bangladesh is also cyclone prone. The country experiences, at times, catastrophic cyclones that cause immense loss of life and property. However, cyclones usually decay rapidly after coming into contact with land and such losses are largely confined to coastal regions. Since the project area is within the coastal belt, the likely impact of cyclones will be relatively high and it will be necessary to implement specific contingencies for such an event.

#### 5.1.5.5 Earthquakes

Bangladesh and northeast Indian states have long been one of the seismically active regions of the world, and they have experienced numerous large earthquakes during the past 200 years at an average rate of one in every 30 years.

The catastrophic earthquakes of 1762 and 1782 are believed to have been partially responsible for the diversion of the Old Brahmaputra River from the west of Mymensingh to the present Jamuna Channel and the diversion of the Ganges River from its main Arial Khan distributary to the present Padma channel. Since 1860 over 20 shallow and intermediate major earthquake epicentres have been recorded in Bangladesh and surrounding area.

Bangladesh has been classified as falling into three seismic zones with zone -III (0.25) the most severe and zone-I ( $Z = 0.075$ ) the least, where  $Z$  is called zone coefficient. The project area falls into Zone-II. As a result, the land buildings and land based structures for this project should be designed to withstand maximum lateral load of 10% of gravity load.

#### 5.1.6 Water Resources

The management of water resources has become a critical need in Bangladesh because of growing demand for water and increasing conflict over its alternative uses. In Bangladesh water had been considered as a free gift of nature and access to water is recognised as a basic right. But procedural and fiscal measures are enforced to regulate its mobilisation and use. The Government of Bangladesh has formulated a National Water Policy, which is in operation since 1999. According to the Government policy, the ownership of water DOES not vest in an individual but in the State. The Government reserves the right to allocate water to ensure equitable distribution, efficient development and use, and to address poverty. The Government can redirect its use during periods of droughts, floods, cyclones, and other natural and man-made disasters, such as contamination of groundwater aquifers that threaten public health and the ecological integrity. Allocation rules will be the formal mechanism for deciding who gets water, for what purpose(s), how much, at what time, for how long, and under what circumstances water use may be curtailed. Rules for water allocation will be developed for in-stream needs (ecological, water quality, salinity control, fisheries and navigation) during low flow periods; for off-stream withdrawal (irrigation, municipal and industrial, power), and for groundwater recharge and abstraction. Allocation for non-consumptive use (e.g. navigation) would imply ensuring minimum levels in water bodies used for that purpose.

##### 5.1.6.1 River Water Abstraction

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Bangladesh has about 24,000 km. of rivers, streams and canals that together cover about 7% of the country's surface. Most part of the country is linked by a complex network of waterways which reaches its extensive size in the monsoon period. Out of 24,000 km. of rivers, streams and canals only about 5,968 km. is navigable by mechanized vessels during monsoon period which shrinks to about 3,865km during dry period.

The area is mainly drained by a number of north-south flowing rivers. From east to west, important rivers are the Gorai-Madhumati-Baleswar, the Bhairab-Pusur, the Bhadra- Gengrail, the Hari-Teka-Mukteswari, Sibsa, the Kabadak- Betna system and the Jamuna-Ichamati-Kalindi rivers. Most of the rivers are tidal in nature. East-west rivers interconnect the north-south rivers. Flows of these east-west rivers are very important for the complete circulation of tide all over the tidal flat. In rainy season, water becomes fresh to slightly salty and in the dry season, it becomes salty. Most of the river waters carry appreciable amounts of suspended sediments.

In the Khulna area, the coastal rivers or estuaries are saline because of low freshwater discharges, especially in the dry season. The river flow regimes are driven by high, variable sediment loads. The rivers of this region show a continuous process of silting gradually from the NW towards the SE direction.

#### 5.1.6.2 Surface Water Resources for Drinking Water Supply

The investigations to find potable or near-potable surface water around Khulna City started in February 2003. In March 2003, following the negative results, the prosecution area was expanded, up to 35 km (when the rivers were navigable) around the City. It has been found that as follows;

- The only perennial Surface water resource Bhairab River is during 5 months very highly mineralized north ward from Khulna and up to a distance of 35 km. During the seven remaining months the water is highly turbid but very lowly mineralized.
- Decreasing river discharge results in lower river water levels whereas the tidal cycles of the sea fluctuate around same average values. Depending on discharge of Bhairab River, controlled by inflow far North from Ganges the position of the salt-fresh water interface in the river does change and reduced river discharge increases the length of the season during which the river water at Khulna remains salty.

#### 5.1.6.3 Approach for River Water Source Development

##### 5.1.6.3.1 River Water Quality

- Water Quality Monitoring Station

DOE, JBIC, KWASA and JICA Study Team conducted water quality analysis at the following points shown in Figure 5.3.



Figure 5.3 Location of Water Quality Analysis and Salinity Investigation

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- Current River Water Quality Situation
- JICA Study Team Water Quality Analysis

JICA Study Team conducted water quality analysis on October 2009. The results of water quality analysis are as shown in following Table (Table-5.7).


Table 5.7 Result of Water Quality Analysis done by JICA Study on October 2009


Parameters	Locations	Standard	Locations									
			Mofarhat	Chapailghat	Haridaspur	Khulna	Arna	Perul	Bandia	Airaghat	Ujpur	
Sampling Date/time	Unit		10/10.2009	10/10.2009	10/10.2009	10/11.2009	10/12.2009	10/12.2009	10/11.2009	10/10.2009	10/11.2009	
pH	-	6.5-8.5	7.6	7.5	7.3	7.8	7.9	7.9	8.1	7.6	8.01	
Turbidity	NTU	10	72	87	101	270	207	85	152	55	240	
TDS	mg/L	1,000	151	164	134	157	122	142	131	223	145	
SS	mg/L	10	36	39	41	105	85	43	77	82	89	
COD(Cr)	mg/L	4	5	7	14	<5	<5	<5	<5	31	8	
BOD <sub>5</sub>	mg/L	0.2	0.6	1.2	1.2	0.2	<0.2	<0.2	<0.2	2.6	2	
Mercury (Hg)	mg/L	0.001	0.0028	0.002	<0.0005 <sup>(*)</sup>	0.002	0.002	0.0015	0.0033	0.0038	0.002	
Lead (Pb)	mg/L	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Arsenic (As)	mg/L	0.05	0.006	0.007	0.007	0.004	0.002	0.003	0.003	0.007	0.015	
Hexavalent Chromium (Cr <sup>6+</sup> )	mg/L	0.05	(0.003)	(0.007)	(0.008)	(0.01)	(0.01)	(0.003)	(0.008)	(0.007)	(0.008)	
Calcium (Ca <sup>2+</sup> )	mg/L	75	32	33	35	35	32	32	33	37	35	
Copper (Cu)	mg/L	1	0.04	0.05	0.06	0.14	0.05	0.04	0.04	0.05	0.04	
Zinc (Zn)	mg/L	5	0.08	0.06	0.14	0.17	0.05	0.05	0.05	0.07	0.06	
Cadmium (Cd)	mg/L	0.005	0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	0.001	
Chloride (Cl)	mg/L	600	10	12	10	19	9	11	7	30	9	
Sulfate (SO <sub>4</sub> <sup>2-</sup> )	mg/L	400	<7	<7	9.4	11	15	14	14	<7	12	
Phosphate (PO <sub>4</sub> <sup>3-</sup> )	mg/L	6	0.15	0.15	0.19	0.43	0.26	0.18	0.30	0.29	0.22	
Nitrate (NO <sub>3</sub> <sup>-</sup> )	mg/L	10	1.8	1.8	1.8	2.2	1.8	2.2	2.2	1.3	2.3	
Nitrite (NO <sub>2</sub> <sup>-</sup> )	mg/L	<1	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.10	<0.03	
Ammonia (NH <sub>4</sub> <sup>+</sup> )	mg/L	0.5	0.17	0.36	0.38	0.05	0.27	0.56	0.03	0.18	0.30	
Iron (Fe)	mg/L	0.3-1.0	0.77	0.67	1.1	3.2	1.8	0.75	2.6	0.86	2.5	
Manganese (Mn)	mg/L	0.1	0.05	0.05	0.07	0.16	0.11	0.03	0.06	0.05	0.15	
Dissolved Oxygen (DO)	mg/L	6	5.8	6.3	6.0	7.4	6.6	7.0	7.2	5.3	6.7	

Note: Mercury at Haridaspur shows the data analysed at Laboratory in Tokyo. The other data is analysed by BUET. Chromium data shows ( ) as Total Cr.

- DOE Water Quality Analysis

Tables 5.8 and 5.9 shown below the results of water quality analysis conducted by DOE:

  
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Table 5.8 Water Quality Analysis done by DOE on 2005 - 2008

Date	Temp. (°C)	PH	EC	Chloride (mg/L)	P. Alka	T. Alka	Turbidity (NTU)	TS (mg/L)	TDS (mg/L)	SS (mg/L)	DO (mg/L)	BOD (mg/L)	COD (mg/L)
10/1/05	22.5	7.51	300	12.3	0	36	32.8	175	150	25	5.4	0.6	25
23/2/05	24.5	7.41	320	15.9	0	32	32.3	180	155	25	5.5	0.7	20
15/3/05	29.5	7.41	740	120.78	0	36	45.8	390	360	30	5.3	0.8	25
21/4/05	30.5	7.61	1030	225.9	0	36	52.8	570	520	50	5.2	0.8	40
20/5/05	32.5	7.61	1370	251	0	34	56.6	700	650	50	5.2	0.9	45
21/6/05	33.5	7.71	530	109.8	0	34	52.8	300	260	40	5.3	0.8	32
15/7/05	30.5	7.41	280	6.9	0	30	22.8	150	135	15	5.1	0.8	25
11/8/05	31.5	7.56	275	7.1	0	36	32.8	137	112	25	5.2	0.8	25
25/10/05	30.9	7.65	265	6.8	0	36	62.8	176	135	41	5.2	0.8	42
11/11/05	25.5	7.81	280	12.9	0	36	32.8	160	140	20	5.3	0.7	20
15/12/05	22.5	7.49	320	23.78	0	36	42.8	180	160	20	5.4	0.8	30
26/1/06	22.5	7.41	360	25.43	0	36	42.8	200	180	20	5.6	0.6	35
24/2/06	27.5	7.51	570	59.9	0	36	52.8	310	285	25	5.4	0.6	30
21/3/06	30.1	7.71	1070	218.9	0	36	57.8	600	533	65	5.3	0.6	25
25/4/06	30.5	7.81	1490	312.5	0	36	52.8	780	740	40	5.3	0.9	35
22/5/06	31.9	7.67	1590	380.9	0	32	57.8	830	790	40	5.3	0.8	35
26/6/06	32.5	7.71	1720	412.9	0	36	62.8	900	845	55	5.2	0.9	55
29/7/06	35.5	7.73	880	240.9	0	46	62.8	500	440	60	5.3	0.8	58
23/8/06	32.5	7.71	680	152	0	36	62.8	400	340	60	5.3	0.8	26
19/9/06	30.5	7.68	360	12.34	0	36	42.8	210	180	30	5.2	0.9	25
20/10/06	29.5	7.71	300	8.9	0	36	52.8	175	145	30	5.3	0.6	25
20/11/06	24.5	7.65	290	5.67	0	36	42.8	170	140	30	5.5	0.8	25
24/12/06	24.5	7.56	320	13.5	0	36	32.8	190	165	25	5.5	0.7	21
25/1/07	28.5	7.61	570	108.9	0	36	22.8	290	270	130	5.4	0.7	25
15/2/07	29.5	7.61	740	178.9	0	36	22.8	400	370	30	5.3	0.8	25
29/3/07	31.5	7.61	1380	270.9	0	36	42.8	720	690	30	5.1	0.8	45
25/4/07	33.5	7.71	1750	420	0	36	52.8	920	850	70	5.2	0.9	55
29/5/07	33.5	7.64	2140	470.8	0	34	42.3	1120	1070	50	5.3	0.9	55
28/6/07	34.8	7.68	2350	489.9	0	36	41.8	1220	1175	35	5.3	0.9	55
30/7/07	32.5	7.73	480	60.3	0	36	38.7	280	240	40	5.3	0.9	35
26/8/07	32.5	7.51	370	23.5	0	36	58.9	240	190	50	5.4	0.8	25
26/9/07	30.5	7.67	320	5.68	0	36	45.8	210	160	50	5.8	0.7	25
21/10/07	30.5	7.49	310	7.89	0	36	43.7	200	150	50	5.4	0.8	28
30/11/07	28.5	7.71	340	12.7	0	36	45.8	190	160	30	5.3	0.7	22
30/12/07	25.5	7.68	540	23.6	0	36	52.8	320	270	50	5.3	0.7	24
22/1/08	23.5	7.65	600	103.8	0	56	32.8	340	300	40	5.2	0.9	25
27/3/08	29.5	7.64	1380	318.9	0	36	32.8	740	690	50	5.6	0.9	35
29/5/08	31.9	7.63	2170	518.5	0	36	42.8	1140	1085	55	5.3	0.8	55
28/7/08	32.5	7.67	2450	538.9	0	36	43.8	1270	1220	50	5.4	0.8	55
05/9/08	32.5	7.68	480	13.68	0	36	43.8	280	240	40	5.4	0.9	28
05/12/08	29.5	7.61	360	8.98	0	36	32.8	210	180	30	5.3	0.7	28
Ave.	29.7	7.63	831	152	0	36	44.7	451	412	41	5.3	0.8	34
Max.	35.3	7.81	2450	539	0	56	62.8	1270	1220	130	5.8	0.9	58
Min.	22.5	7.41	265	5.7	0	30	22.8	137	112	15	5.1	0.6	20

Sampling Point: Modhumati River, Mollarhat, Bagertat

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Khulna WASA

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Table S.9 Water Quality Data: Bhairab River at Phultala for 2005 - 2009 done by DOE

Water Quality Item	pH	Chloride mg/L	Alkalinity mg/L	Hardness mg/L	Turbidity NTU	EC µS/cm	DO mg/L	BOD mg/L	TDS mg/L	SS mg/L	COD mg/L
Unit	-	mg/L	mg/L	mg/L	NTU	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L
Standard	6.5-8.5	600	-	200-500	10	-	6	0.2	1000	10	4
2005	Jan	7.64	192	34	235	112.8	780	5.2	0.6	390	98
	Feb	7.68	274	34	310	123.6	1,050	5.1	0.8	525	112
	Mar	7.54	659	38	420	145.3	2,410	5	0.7	1,205	122
	Apr	7.56	2,087	36	720	156.1	8,100	4.7	1	4,050	167
	May	7.18	4,571	32	1050	178.8	17,200	4.6	1	8,502	220
	Jun	7.67	824	30	270	210	3,220	5	0.9	1,610	188
	Jul	7.71	329	36	318	125.8	1,210	5.2	0.8	605	136
	Aug	7.73	36	34	145	78.6	280	5.8	0.4	140	105
	Sep	7.69	56	30	178	102.8	310	5.6	0.6	155	100
	Oct	7.74	103	28	211	112.6	360	5.4	0.7	180	102
	Nov	7.68	109	30	215	118.4	370	5.4	0.5	185	110
	Dec	7.72	175	30	245	121.1	610	5.5	0.8	305	120
2006	Jan	7.66	192	32	235	118.6	780	5.3	0.8	390	110
	Feb	7.61	329	34	278	122.8	910	5.2	0.8	455	126
	Mar	7.63	879	32	389	145.8	3,220	5.1	0.9	1,610	148
	Apr	7.54	2,967	36	987	156.8	10,800	4.7	1.3	5,400	155
	May	7.51	4,775	38	1398	179.6	15,800	4.5	0.9	7,900	182
	Jun	7.62	989	40	421	221	3,890	5	0.8	1,945	232
	Jul	7.71	331	32	271	146.8	1,250	5.2	0.7	625	125
	Aug	7.69	43	36	143	78.8	280	5.6	0.4	140	90
	Sep	7.74	87	34	132	104.6	420	5.7	0.4	210	100
	Oct	7.71	115	28	178	112.4	430	5.2	0.5	215	108
	Nov	7.69	168	30	198	120.8	580	5.3	0.6	290	124
	Dec	7.68	175	32	218	118.9	720	5.4	0.8	360	120
2007	Jan	7.81	188	34	234	88.4	740	6.6	0.8	370	88
	Feb	7.77	327	34	278	117.2	928	5.6	0.9	464	126
	Mar	7.87	705	32	328	118.4	2,820	5.6	1.1	1,410	128
	Apr	7.79	3,549	38	1178.9	126.5	12,800	5.4	1.1	6,400	176
	May	7.57	7,775	34	2612	167.8	29,400	4.7	1.1	14,700	180
	Jun	7.67	2,010	34	710	180	8,200	4.9	1	4,100	220
	Jul	7.77	336	36	322	76.8	1,250	5.1	0.8	625	98
	Aug	7.78	48	32	146	78.7	280	5.4	0.6	140	95
	Sep	7.79	76	30	176	76.9	310	5.5	0.6	155	79
	Oct	7.57	89	36	198	58.8	480	5.1	0.8	240	67
	Nov	7.74	189	30	278	53.4	750	5.2	0.7	375	62
	Dec	7.68	210	34	278	58.2	770	5.4	0.8	385	70
2008	Jan	7.75	197	34	233	50.6	784	6.1	0.6	392	68
	Feb	7.77	331	32	279	52.5	1,280	6.1	0.8	640	71
	Mar	7.68	2,307	34	742	68.8	8,600	5.5	1	4,300	79
	Apr	7.76	5,109	36	1730	142	20,100	4.8	1.2	10,050	186
	May	7.73	7,362	36	2439	150.8	24,400	4.8	1.2	12,200	200
	Jun	7.68	7,417	38	2480	168	24,800	4.5	1.3	12,400	210
	Jul	7.78	881	34	451	78.8	3,320	54.9	0.8	1,660	96
	Aug	7.74	55	32	124	78.9	270	5.5	0.6	135	94
	Sep	7.69	54	30	143	78.9	310	5.4	0.8	155	71
	Oct	7.66	58	34	179	58.8	370	5.8	0.4	185	68
	Nov	7.68	108	34	181	58.9	380	5.8	0.5	190	70
	Dec	7.72	133	32	210	58.6	480	5.6	0.8	240	72
2009	Jan	7.61	192	32	236	78.8	628	5.6	0.6	314	105
	Feb	7.73	338	34	298	76.4	1,240	5.4	0.8	620	138
	Mar	7.68	2,812	36	942	169.8	8,200	4.8	1.1	4,100	178
	Apr	7.67	5,769	34	1930	176.6	14,800	4.7	0.9	7,400	187
	May	7.52	8,681	34	2851	180	28,800	4.6	1	14,400	201
	Jun	7.54	8,677	36	2871	180	17,200	4.7	0.9	8,600	211
	Jul	7.72	1,758	32	623	78.8	6,820	4.8	0.8	3,410	109
	Aug	7.74	384	32	322	79.9	1,280	5.1	0.6	640	98
	Sep	7.73	158	30	258	76.9	620	5.6	0.8	310	89
	Oct	7.7	36	34	156	78	310	5.5	0.6	155	90
	Nov										
	Dec										

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5.1.6.4 Salinity Influence

• DOE Salinity Investigation

The results of saline water intrusion survey conducted by DOE are as shown in followings.

Table 5.10 Chloride Monitoring Data from 2005 to 2009 done by DOE

River Site	Noapara Ghat	Bhambur River Phulata Ghata	Chourhat Ghata	Repsa River Kapsia Ghata	Madhumon River Molharat	
2005	Jan	133	192	211	275	12
	Feb	165	275	275	329	16
	Mar	332	659	67	2,527	121
	Apr	1,338	2,088	2,122	2,692	326
	May	4,166	3,571	4,286	4,780	251
	Jun	828	834	2,473	2,383	110
	Jul	220	330	326	272	7
	Aug	378	36	44	24	7
	Sep	46	36	37	23	
	Oct	76	103	82	92	7
	Nov	132	110	99	135	13
	Dec	151	175	154	269	24
2006	Jan	173	102	215	273	25
	Feb	220	330	326	386	69
	Mar	334	829	382	2,088	219
	Apr	1,784	2,467	4,112	4,778	313
	May	4,305	4,375	4,831	5,385	381
	Jun	989	989	3,184	3,298	413
	Jul	57	331	721	174	241
	Aug	37	43	46	59	132
	Sep	136	47	39	38	12
	Oct	133	115	75	99	9
	Nov	152	168	709	136	6
	Dec	135	175	187	269	14
2007	Jan	165	188	198	329	160
	Feb	228	327	439	834	170
	Mar	421	661	693	2,122	271
	Apr	3,225	3,549	4,412	5,943	420
	May	7,326	7,776	8,148	8,352	471
	Jun	2,352	2,011	5,934	6,644	490
	Jul	136	337	439	218	60
	Aug	37	49	45	46	24
	Sep	120	76	69	57	6
	Oct	136	125	129	134	8
	Nov	142	207	188	157	13
	Dec	165	210	196	269	24
2008	Jan	156	198	275	279	164
	Feb	312	331	484	1,040	
	Mar	442	23,76	3,313	2,311	119
	Apr	3,227	5,110	5,330	6,759	
	May	7,227	7,163	7,915	7,912	519
	Jun	4,440	7,418	8,132	8,463	
	Jul	131	882	2,087	2,638	130
	Aug	41	55	55	73	
	Sep	66	54	39	57	14
	Oct	110	108	145	55	
	Nov	120	108	156	220	
	Dec	154	133	165	248	9
2009	Jan	156	192	217	248	75
	Feb	312	439	878	1,310	125
	Mar	442	7,812	2,856	3,846	225
	Apr	3,737	5,769	6,266	6,714	467
	May	7,227	8,681	7,915	10,759	894
	Jun	4,440	8,677	9,613	11,274	944
	Jul	131	1,758	3,627	5,340	125
	Aug	41	385	1,265	1,817	24
	Sep	66	159	139	175	23
	Oct	55	36	38	39	37
	Nov	46	58	54	59	13
	Dec	40	58	54	59	13
2010	Jan					
	Feb	718	956	1,040	1,268	13
	Mar	2,013	2,258	5,880	2,945	133

: Over 1000 mg/L.

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5.1.6.5 Approach of Groundwater Source Development

• LGED's Approach (MSP Study)

Groundwater is abundant in Bangladesh and the aquifers are highly productive. The sediments are predominantly non-indurate and easy to drill by hand, at least to shallow levels. Water tables vary across the country but are typically shallow at around 1–10 m below the ground surface. These factors have made groundwater an attractive and easily accessible resource and have led to a rapid proliferation in the use of groundwater over the last few decades. Today, 97% of the population relies on groundwater for potable supplies and groundwater is also an important source for irrigation and industry.


Groundwater levels across Bangladesh become depressed during the dry season, but the aquifers replenish fully during the monsoon. Exceptions occur beneath the major cities, especially Dhaka, where large-scale abstraction has led to long-term drawdown of the water table.


LGED conducted a study "Groundwater Resources & Hydro-Geological Investigations in and around Khulna City/ Municipal Services Project (MSP) /Final Report in May 2005". In this study the potential resources of the project area that may contribute to the water supply of Khulna City by drilling and monitoring of more than 75 exploratory tube wells (up to 354 m. depth) within an area of more than 600 km<sup>2</sup>, around Khulna city as shown in the **Figure 5.4** And two years study of the perennial and non-perennial surface water up to 35 km North of Khulna, highlighted the presence of only two resources that might be used for water supply of Khulna City.

Based on the monitoring result the study found followings for the water resources potential for water supply of Khulna

• Groundwater Resources for Drinking Water Supply

Up to the investigated depth of 350 m. the only substantial available fresh water resource is a small portion of the Deep aquifer, located S of the City centre. The others two aquifers, Shallow and Upper, are both not fit for drinking water supply due to high mineral (salt) content or the presence of toxic elements. The Arsenic concentration is normal and below the admissible ranges; however, Iron and Manganese concentrations are above the admissible limits.

  
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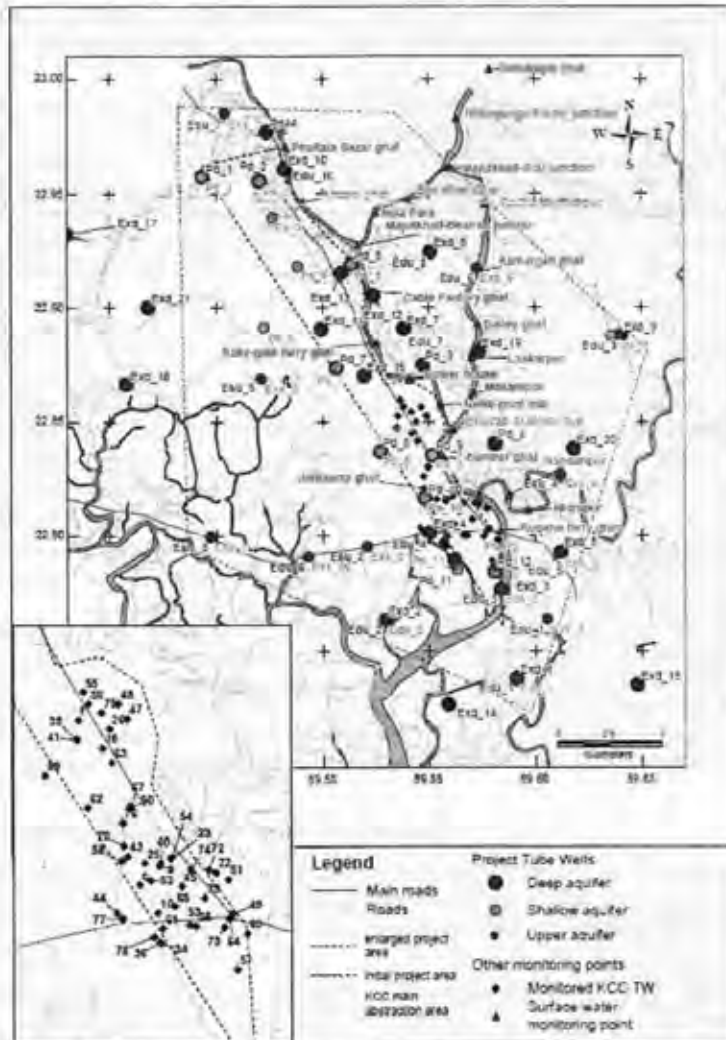


Figure 5.4 Monitoring Network in "Groundwater Resources & Hydro-Geological Investigations in and around Khulna City"

• ADB's Approach

In the ADB's PPTA program, Preparing Khulna Water Supply Project, a groundwater assessment study had been conducted. In this study the potential of groundwater with a simulation model and propose a strategy to manage the groundwater in a sustainable manner was assessed.

The summary of the report are as follows:

- In most cases the aquifers beneath Khulna are productive, however the distribution of salinity in the aquifers and water quality impacts due to pumping are the main constraints on increasing extractions.
- Future studies will need to consider modeling the shallow aquifer and the deep aquifer.

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- The average abstractions from KWASA's tube wells over the past 25 years averages 30,000 m<sup>3</sup>/d and is about 25,000 m<sup>3</sup>/d during recent years due to declining well yields from older production bores.
- In the past only 22 percent of industrial wells were exploiting the deep aquifer, whereas at present about 90 percent of new wells are in the deep aquifer. Industrial usage is 15,000 m<sup>3</sup>/d and is projected to rise to 30,000 m<sup>3</sup>/d by 2030. It is difficult to accurately assess the number of private wells as no regulation or system of licensing deep wells is in place for Khulna. It is recommended that KWASA institute a monitoring program for the industrial and private wells that are tapping the deep aquifer along with licensing and regulating usage to minimize impacts on municipal supply wells.
- The deep aquifer at Khulna does not show any signs of deterioration in water quality, despite a significant increase in pumping by industry and private wells which suggests that additional groundwater supplies may be available from the Khulna area for new municipal supply well. Initial estimates suggest a total of 50,000 m<sup>3</sup>/d can be extracted from the KCC and Phultala municipal supply wells. It should be noted that the above estimate is a conservative estimate and does not include DPHE, industrial and private wells which are already abstracting groundwater from the shallow and deep aquifers. Further modeling is recommended to determine the production potential of the deep aquifer so that accurate estimates can be provided for supplementary water to augment the planned surface water supplies.

And prior to this assessment in August 2009, using existing MSP study's groundwater monitoring network, a facility survey had been conducted. The results are as follows:

- The average static water level (SWL) the project area was -1.42 m from meter above sea level (MASL) in 2005 and in 2009 it became -2.06 m MASL. Thus the net average declination of SWL for the whole project area becomes 0.64 m in last five years. The maximum declination of SWL at the City Centre is 1.00 m. This declination of SWL has been taken place in the central and southern part of the City where maximum KWASA's tube wells are located.
- It is difficult to find all answers about the declination of SWL by a single monitoring session.

• **Policy of Groundwater Source Development**

Groundwater is an important source of clean drinking water in Khulna City, but sustainable management has not yet been established for this resource in the aspects of quantity and quality. On the other hand, KCC and KWASA's have supplied water to their service area barely sustainably with continuous repair and renovation of their tube wells.

In this study current total groundwater abstraction is assumed as 123,000 m<sup>3</sup>/d. Meanwhile, ADB's approach is 97,300m<sup>3</sup>/d. And in the ADB's study a consumer survey inclusive willingness-to-pay survey had been conducted. In this consumers survey it is very difficult to find any significant complains regarding inconvenience of water quantity.

The results of MSP study and ADB's approaches are slightly deferent but both of them did not find any significant problems regarding continuous abstraction with current level.

Based on above-motioned reasons, in this study the policy of groundwater source development is specified as follows:

- To keep the level of current situation and do not propose extenuative development without any clarification of potential of groundwater development to be given in future.

**5.1.7 Air Quality**

**5.1.7.1 Introduction**

Air quality in the Khulna City and its adjacent areas is deteriorating from natural and manmade reasons. Air pollution is one of the major environmental pollutions commonly reported in every industrial towns and cities. Air quality standards prescribe pollutant levels that cannot be legally exceeded during a specific



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time period in a geographical area. The emissions of air pollutants therefore need to be controlled so that the ground level concentrations (GLCs) for these pollutants do not exceed the ambient air quality.

**5.1.7.2 Local Air Quality**

The local area may be classified as a mixed industrial area defined and found from survey. Air pollution survey conducted in mid-monsoon and after monsoon period on two sites of the Rupsa bridge are given in the following tables Table 5.11 and Table 5.12.

**Table-5.11: Air Quality Determination of the Rupsa Bridge Site (mid-monsoon data)**

Date	Location	Ambient Air Pollution Concentration in micro gram/cubic meter		
		SPM	NO <sub>x</sub>	SO <sub>x</sub>
21.8.99 (Holiday)	Krishna Nagar (Khulna-Satkhira Road)	306 (400)	56.02 (100)	29.42 (100)
25.8.99 (Working Day)	Krishna Nagar (Khulna-Satkhira Road)	318 (400)	59.86 (100)	32.18 (100)
21.8.00 (Holiday)	Char Rupsa (near Jahanabad Sea Food Factory)	491 (500)	47.99 (100)	43.30 (100)
25.8.99 (Working Day)	Char Rupsa (near Jahanabad Sea Food Factory)	364 (500)	60.22 (100)	43.04 (100)

Source: EIA Rupsa Bridge

Note:- SPM - Suspended Particular Matter; SO<sub>2</sub> - Sulphur di Oxide; NO<sub>x</sub> - Oxides of Nitrogen. Figures in ( ) indicate limit values of Standard.

**Table-5.12: Air Quality Determination of the Rupsa Bridge Site (after-monsoon data)**

Date	Location	Ambient Air Pollution Concentration in micro gram/cubic meter		
		SPM	NO <sub>x</sub>	SO <sub>x</sub>
20.10.99 (Holiday)	Krishna Nagar (Khulna-Satkhira Road)	216 (400)	10.88 (100)	23.6 (100)
19.10.99 (Working Day)	Krishna Nagar (Khulna-Satkhira Road)	265.7(400)	12.49 (100)	26.5 (100)
21.8.00 (Holiday)	Char Rupsa (near Jahanabad Sea Food Factory)	319.1(500)	15.76 (100)	29.46(100)
25.8.99 (Working Day)	Char Rupsa (near Jahanabad Sea Food Factory)	799.5 (500)	15.37 (100)	34.49 (100)

Source: EIA Rupsa Bridge

Note:- SPM - Suspended Particular Matter, SO<sub>2</sub> - Sulphur di Oxide; NO<sub>x</sub> - Oxides of Nitrogen. Figures in ( ) indicate limit values of Standard.

**5.1.8 Noise Pollution**

Noise pollution survey was conducted in both mid monsoon and after monsoon on different sites are furnished in the tables (Table-5.13 and Table-5.14)

**Table-5.13: Noise level Rupsa Bridge Site (mid-monsoon data)**

Date	Location	Min. Average	Max. Average
21.8.99 (Holiday)	Krishna Nagar (Khulna-Satkhira Road)	49.16	89.00
25.8.99 (Working Day)	Krishna Nagar (Khulna-Satkhira Road)	49.75	98.30
21.8.00 (Holiday)	Kudir Battala (Rupsa-Mongla Road)	60.58	95.75
25.8.99 (Working Day)	Kudir Battala (Rupsa-Mongla Road)	68.00	97.25
21.8.00 (Holiday)	Rupsa Ferray Ghat	70.40	97.50
25.8.99 (Working Day)	Rupsa Ferray Ghat	71.83	96.08

Source: EIA Rupsa Bridge

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Table- 5.14: Noise level Rupsa Bridge Site (after-monsoon data)

Date	Location	Min. Average	Max. Average
19.10.99 (Working Day)	Laban Chara	35.0	52.6
20.10.99 (Holiday)	Laban Chara	34.33	54.00
19.10.99 (Working Day)	Harin Tana	36.9	52.8
20.10.99 (Holiday)	Harin Tana	33.41	56.25
19.10.99 (Working Day)	Jabusa (near Unique Ice Factory)	33.6	53.83
20.10.99 (Holiday)	Jabusa (near Unique Ice Factory)	30.86	49.83
19.10.99 (Working Day)	Jabusa (near Elipur Vagon Para)	30.75	83.66
20.10.99 (Holiday)	Jabusa (near Elipur Vagon Para)	33.33	81.33

Source: EIA Rupsa Bridge

#### 5.2.4 ECOLOGICAL BASELINE

##### 5.2.1 Background

This section of the report deals with flora and fauna of the project area. The consultant made ecological assessment of existing flora and fauna within the study area. The study area is rich in plant and faunal diversity. The ecological setting of the project is mostly wetland, homestead and roadside vegetation, etc. This report is prepared on the basis of field trip, available published and unpublished information.

##### 5.2.2 Ecological and Conservation Designations

###### 5.2.2.1 Overview

The Bangladesh Wildlife (Preservation) Order, 1973, promulgated under Presidential Order No.23 has been enacted and amended in two phases as the Bangladesh Wildlife (Preservation) Amendment) Act. This provides for the establishment of national parks, wildlife sanctuaries, game reserves, and private game reserves. Each of these designations is briefly described below:

###### 5.2.2.2 National Parks

A National Park is defined in Bangladesh as "a comparatively large area of outstanding scenic or natural beauty, in which the protection of wildlife and preservation of the scenery, flora and fauna in their natural state is the primary objective, and to which the public may be allowed access for recreation, education and research". Activities prohibited in the country's National Parks include hunting, trapping, felling, destroying or burning plants or trees, cultivation, mining or pollution of waterways.

Construction of access roads, rest houses, hotels and public amenities within the park should be planned so as not to impair the primary objective of the establishment of a National Park.

###### 5.2.2.3 Wildlife Sanctuaries

In Bangladesh, Wildlife Sanctuaries represent an area closed to hunting and maintained as an undisturbed breeding ground. Such sites are primarily for the protection of wildlife including all natural resources such

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as vegetation, soil and water. Under Article 23, Wildlife Sanctuaries are assigned a greater degree of protection than National Parks in Bangladesh although the restrictions on activities are broadly similar.

#### 5.2.2.4 Game Reserves

These represent an area in which wildlife is protected to enable populations of important species to increase. Here the capture of wild animal is prohibited although hunting and shooting may be allowed on a permit basis.

#### 5.2.2.5 Private Game Reserves

A private game reserve is an area of land set aside by the owner to broadly fulfill the same purpose as any other game reserve. Such areas are established following application by the owner who shall exercise all the powers of an officer under this Act. The proposed project site is not situated in such reserves.

#### 5.2.2.6 Reserve Forest

The Forest Act, 1927, enables the government to declare any forest or waste land to be reserved for protected forest. Most activities are generally prohibited in reserve forests although certain actions such as the removal of forest produce may be permitted under license in protected forest. Prohibited activities include enlargement of clearings, cultivation and quarrying etc. The proposed project site is not situated in or near any reserve forest.

#### 5.2.2.7 Other Designations

Bangladesh is also party to the Convention concerning the Protection of World Cultural and Natural Heritage (World Heritage Convention) which it accepted on 3 August 1983.

The Sunderbans mangrove forests, Naluar Haor represent the areas in Bangladesh to represent World Heritage Sites/ Ramsar Sites.

#### 5.2.2.8 Ecological and Conservation Designations in the Project Area

Figure 5.5, shows the location of the project area in relation to the country's forests and protected areas. The map illustrates that no protected habitats or reserve forests occur within 20 km of the site. It is, therefore, concluded that these areas are outside of the project's sphere of impact.

### 5.2.3 Terrestrial and Aquatic Ecology

#### 5.2.3.1 Terrestrial Flora

There is no natural forest in the project site as industrial and commercial establishments dominate the area. Before development of the site, it was a low-lying area with mixed crop and vegetation. Rice, other grains and seasonal vegetables are the main crops in this area. There was no forestland in this area other than monoculture tree plantation before site development. The composition of plant community was low growing and herbaceous vegetation as well as other flora.

#### Homestead Vegetation

Homestead vegetation has a positive effect on improvement in soil moisture through shading and mulching process. Trees growing at homesteads also ensure easy access to the fuel wood, fodder and other products. Thus, it reduces the pressure on forestlands.

A large number of multipurpose trees (fruit, timber, fodder, medicine) is grown in the project area. The most common among them are Am (*Mangifera indica*), Kanthal- (*Artocarpus heterophyllus*), Lebu- (*Citrus sp.*), Kola (*Musa sp.*) Korai- (*Albizia procera*), Jam- (*Syzygium cumini*), Kul- (*Zizyphus sp.*) etc.

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**Roadside vegetation**

Most of the 10-15 families of the plant species are present in the study area. These are: Gramineae, Leguminosae, Moraceae, Myrtaceae, Cyperaceae, Euphorbiaceae, Rutaceae, Solanaceae, Labiate, Rubiaceae, Malvaceae, Compositae, etc. The most common roadside plantation trees are Sisso-(*Dalbergia sissoo*), Mahogany-(*Sweitonina mahagoni*), Katanote-(*Amaranthus spinosus*), Apang-(*Achyranthus aspera*), Chokanta-(*Chrysopogon aciculatus*), Jagadumur-(*Ficus glomoretta*), Swetadrun-(*Leacus lavendulifolia*), Tulsi-(*Ocimum sanctum*), Tibegun-(*Solanum indicum*), Benna-(*Veteveria zizanioides*), Bantani-(*Begonia benghalensis*) etc.



Figure 5.5 The location of the project area in relation to the country's forests and protected areas

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### 5.2.3.2 Terrestrial Fauna

A number of avian species were observed in the area such as crow, eagle, shalik, sparrow etc. Besides this avian species, the habitats are likely to have variety of reptile, mammals and invertebrates. No record of wild animals and endangered species are found in the project area.

#### Study Area in General

No comprehensive surveys have been carried out in the study area to date, and in particular the range of bird species present is much greater than these indicated; including many common birds typical of the open countryside such as the roller *Coracias benghalensis*, and the bee eaters *Meliops superciliosus*, and *Meliops orientalis*. No information was available on the invertebrate species found in the area.

#### Proposed Project Site

No wild mammal species were observed during the visit to site and site survey. Mammals typical of cultivated rural habitats of this type are likely to include the Indian fox *Iepus migrocollis*, and rodent species such as brown and black rat, Indian gerbil and sand-colored rat. Other species, in particular the more endangered species are almost certainly absent due to the lack of suitable natural habitat.

Bird species were observed at the site included the parish kite *Milvus migrans*, the house crow *Corvus splendens* and the Brahmani kite. All of these species are typical inhabitants of urban fringe and are considered common on both a local and regional level. A few waders were seen feeding in areas of standing water adjacent to the site. These included little egret and black wing stilt, both of which are extremely common in the deltaic regions of Bangladesh.

A few reptiles were observed, including common skink *Mabuia carinata*, smooth water snake *Enhydryis*, and wall gecko *Gekko gekko*. All of these are common within the study area. Anecdotal evidence suggests that cobra occur in the study area but not at site. As the site is inundated for much of the area, it is a particularly suitable habitat for amphibians, however none were observed during the site visit.

As already mentioned, the site is typical of much of the study area, and its lack of natural habitats makes it highly unlikely that of the endangered fauna of the area is present.

### 5.2.3.3 Aquatic Flora

Wetland flora plays a vital role for biodiversity conservation. The wetland habitat characterized by anaerobic conditions, which inhibits normal plant growth. The project area supports two types of wetland e.g., (a) Permanent wetland and (b) Seasonal wetland. The permanent wetland includes rivers and perennial water bodies. The permanent wetland provides refuge and shelter for the most of the aquatic flora. The seasonal wetland serves as the cultivated land.

Kalmilata (*Ipomoea reprens*), Shapla (*Nymphaea lotus*), Helencha (*Altemathera philoxeroides*) and Kuchuripana (*Eihicormia crassipes*) are the main aquatic flora in the project area.

### 5.2.3.4 Aquatic Fauna

The main aquatic fauna in this area are different types of fishes. A few ponds that remain almost dry in the summer season in this area are used for natural cultivation of seasonal fresh water fishing. The fresh water fishes are carp (Rui, Katal, Mrigel, Ghania, Kalibaus etc.). The stretch of the adjoining rivers of Khulna city provides a habitat for a wide variety of fishes and shellfish species, which include carp, catfish (Boal, Pangas, Shilong, Bacha etc.) and live fish (Koi, Singh, Magur etc.). Tortoise, Frogs, Water Snakes etc. are other aquatic found in the project area. Table 4.15 presents available fish species in the in the adjoining rivers of Khulna city.

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A large number of aquatic fauna was observed in the project area. Many are totally dependent on wetlands (beels, river, ponds) and species are partially dependent on wetlands. There are little available aquatic habitats for faunal species. Wetlands are intensively exploited and the habitat is highly disturbed. Despite this, some species have adapted to the altered environment, and others have even flourished.

Among the amphibians the skipper frog (*Rana cyanophlyctis*) is common-being found in most of the wetland habitats and has been the most successful in adapting to the altered environment. The common roof turtle (*Kachuga tecta*) and the flat-shelled spotted turtle (*Lissemys punctata*) are the most common of the reptiles. These freshwater turtle species face problems of migration during summer when water levels are inadequate.

The common aquatic snakes include the checkered keelbaek (*Xenochrophis piscator*) and the smooth water snake (*Enhydris enhydris*). The common lizards found within the project area comprise the common skink (*Mabuya carinata*) and the garden lizard (*Calotes versicolor*).

Among other species that once were common but now are only occasionally seen are the monitor lizards (*Varanus bengalensis* and *V. flavescens*). These species prefer a habitat with or near water.

Aquatic and water-dependent birds have been severely affected by habitat alteration. Wetland degradation has left virtually no sheltered place for waterfowl to roost or nest. Herons, egrets, bitterns and ducks have been intensely affected by habitat alteration.

Wetland dependent birds like kingfishers and other birds of prey have little scope for adoption. Sonic species (mostly piscivores) have moved to areas more favorable to their needs.

The freshwater dolphin (*Platanista gangetica*) is generally absent from the project area, though a few are seen in the Meghna during the monsoon season.

Table – 5.15 : Fish Species in the Bairab, Rupsa and Madhumati Rivers.

Local Name	Scientific Name
Rui	Labeo rohita
Katal	Catla catla
Bata	Labeo bata
Raib	Cirrhinus reba
Jat puti	Puntius sophore
Tit puti	Puntius ticto
Mola	Amblypneogodon mola
Kakila	Xenentodon caudata
Boal	Wallago attu
Pabda	Ompok pabda
Tengra	Mystus tengra
Ayre	Mystus nor
Bala	Glossogobius aureus
Kajuli	Aila coila
Kachki	Corica soborna
Narte chanda	Chanda nama
Lal chanda	Chanda rigida
Foli	Notopterus notoptermisnotopterus chital
Chital	Macrognathus aculeatus
Tara Baim	Mastacembelus pancrus
Oochi baim	Mastacembelus armatus
Shal baim	Chanda punctatus
Taki	Charina striatus
Shoi	Chirocentrus gamma
Olawa	Lepidocephalus gunta

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5.2.4 Existing Water Supply System and Facilities

5.2.5 Water Source

The summary of current water source of Khulna water supply system is as follows.

Water Source		Extraction per day
Ground water	KWASA's tubewells	30,100 m <sup>3</sup> /d
	KWASA's hand pumps	39,300 m <sup>3</sup> /d
	Private pumps	49,700 m <sup>3</sup> /d
	Sub-Total	119,100 m <sup>3</sup> /d
Surface water		0 m <sup>3</sup> /d
<b>Total</b>		<b>119,100 m<sup>3</sup>/d</b>

5.2.6 Water Quality

The JICA Study Team conducted a sample survey on water quality of following water supply systems in Khulna city.

5.2.7 Definition of Salinity Standard surrounding in Khulna City Area

As to the Chloride concentration for drinking water the Environment Conservation Rules, 1997 Standards for Water prescribe two standards, 600 mg/l and 1,000 mg/l for coastal zone. Ministry of Water Resources of GOB defines the coastal management zone in its report as follows:

The coastal zone covers 19 districts facing or having proximity to the Bay of Bengal and the exclusive economic zone. The districts are Bagerhat, Barguna, Barisal, Bhola, Chandpur, Chittagong, Cox's Bazar, Feni, Gopalganj, Jessore, Jhalkati, Khulna, Lakshmipur, Narail, Noakhali, Patuakhali, Pirojpur, Satkhira and Shariatpur. Together these districts account for 32 percent of the area and 28 percent of the population of Bangladesh as shown in the Figure 5.6.



Figure 5.6 Map of Coastal Zone of Bangladesh

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And the Ministry of Environment and Forest of GOB also refers to the same definition as the coastal zone in its report. The above-mentioned paper goes on to state that there is no unambiguous definition of what. In this report costal area definition argument is not a major matter for concerned. Therefore in this report the approaches and discussions concerning to the water salinity problem the standard of the drinking water for Chloride concentration is to be specified as 1000 mg/l.

**2.2.8 Served Population**

Based on the ADB's Technical Assistance Consultant's Report current water served population in Khulna can be calculated as follows.

Calculation of Served Population	Numbers
Registered Connections	15,251
Inactive Connections	2,579
Active Connections	12,672
Consumers per each	13.5
Served Population	171,100
Total Connections	503
Inactive Connections	403
Active Connections	100
Consumers per each	100
Served Population	10,000
Number of Deep Hand Pumps	3,748
Number of Shallow Hand Pumps	5,338
Consumers per each	30
Served Population	278,600
Number of Private Wells	13,733
Consumers per each	30
Served Population	412,000
<b>Total</b>	<b>871,700</b>

Total population of the Khulna City is assumed to be 957,000 (this figure is mentioned later in Clause 4.3.2).

The difference between two figures; i.e.  $957,000 - 871,700 = 85,300$ , cannot be categorized; however, it can be assumed that those un-categorized persons supposed to get water from KWASA's piped water, deliberately or un-intentionally.

**5.2.9 Water Use**

Water consumption in Khulna City is impossible to count from the billing result because current billing system has not been based on metering system. Based on the consumer survey result which had been conducted in ADB's Technical Assistance Program and the Study Team current household, current water use situation can be assumed as follows:

**5.2.9.1 Non-Domestic Water Use**

There is no reliable date to examine the amount of non-domestic water use due to a lack of reliable measurement data for water use. In February 2009, ADB Technical Assistant Consultant has started to conduct sample survey which focuses on non-domestic consumers in Khulna.



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In the 1997 Feasibility Report, non-domestic demand has been taken as 20% of the domestic demand. This is considered a reasonable figure for a location where industrial demands generally provided independently and where some institutional demands are also provided by private supplies.

**5.2.9.2 Unaccounted for Water**

Definition of UFW (Water Balance) is summarized in Table 5.16.

**Table 5.16 Definition of Unaccounted for Water (Water Balance)**

Water Source Production	System Input Volume	Authorized Consumption	Billed Authorized Consumption	1) Billed Metered Consumption	Revenue Water	
			Un-billed Authorized Consumption	2) Billed Un-metered Consumption		
		Water Losses	Apparent Losses	3) Un-billed Metered Consumption		Non- -Revenue Water
			Real Losses	4) Un-billed Un-metered Consumption		
			5) Un-authorized Consumption			
			6) Metering Accuracy			
			7) Leakage from Service Connection			
			8) Leakage from Pipeline			
			9) Leakage & Overflow from Utilities			
	Loss during Water Treatment & Evaporation					

Note: Colored columns will be confirmed as current situation of water supply.

In the Bangladesh Water Utilities Data Book 2006-7, mentioned the average UFW is 22.5 % in Bangladesh. This figure has been calculated based of 11 cities in Bangladesh; (1) Dhaka, (2) Chittagong, (3) Rajshahu, (4) Bagerhat, (5) Chandpur, (6) Chapai Nawadbanj, (7) Chuadanga, (8) Gazipur, (9) Jessore, (10) Manikganj, and (11) Narsingdi.

Khulna water supply system there is no reliable data to examine the amount of UFW due to a lack of reliable measurement data for water use. In the ADB's consultant report it is estimated the water loss to be 37% of production from the pumps to the piped water.. Taking into consideration above-mentioned figure and definition of UFW it is assumed the UFW of Khulna water supply system as 40% for the pumps to pipe water system.

**5.2.10 Summary of Water Use**

Current water use situation in Khulna city is summarized as follows,

Water Source	Water Use
KWASA's tubewells	No. of consumers: 171,100+10,000=181,100 UFW= 40% : 30,000x0.40=12,000 m <sup>3</sup> /d Non-domestic=20%: 18,000x0.20=3,600 m <sup>3</sup> /d Domestic=14,400 m <sup>3</sup> /d Lpcd=80 litre/day/person
KWASA's hand pumps	No. of consumers: 278,600 Abstraction for domestic=18,300 m <sup>3</sup> /d Non-domestic= 24,700 m <sup>3</sup> /d Lpcd=65 litre/day/person
Private pumps	No. of consumers: 412,000 Water loss= 10% : 50,000x0.10=5,000 m <sup>3</sup> /d Non-domestic=20%: 45,000x0.20=9,000 m <sup>3</sup> /d Domestic=36,000 m <sup>3</sup> /d Lpcd=87 litre/day/person

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## Chapter-06

# Environmental Impacts and Mitigation

### 6.1 Identification of Environmental Impacts

Environmental Impact assessment is a multi-step process by which a wide range of issues are taken into consideration to determine whether and under which environmental constraints a project should be undertaken. Most of the development project causes adverse impacts on environment and appropriate measures are required to reduce the intensity of adverse impacts to an acceptable level. Industrial projects also have positive impacts on the society and economy. Both the positive and negative potential impacts of the projects are identical in nature on the basis of existing environmental conditions in context to the local situations.

An environmental baseline survey was conducted in the project areas to identify the environmental parameters likely to be affected by the project intervention. All the major environmental parameters covering ecological, physico-chemical and human interest related aspects were considered in identifying the affected areas at different stages of the project cycle. A checklist of the screened environmental parameters is prepared as shown in a Table-5.1 hereinafter. Anticipated environmental impacts due to Project location, construction and operation of the proposed water supply improvement project have been identified and shown in the Table. This Table of comprehensive lists of environmental parameters, their consequences and impacts are very useful in designing various activities of the proposed Project in an environmental friendly manner. The magnitudes of environmental impacts are classified as none, minor, moderate and major in the checklists. In order to distinguish the short and long-term impacts, both the construction and operational phases are considered separately in the checklist. Socioeconomic environment is considered to be affected positively as the project activities will create job opportunity for the local people and the area will be more developed and commercial activities will be increased in the locality. All these impacts will contribute to improve the quality of life of the local community. Mitigating measures of the adversely affected parameters are discussed in the subsequent sections.

### 6.2 Evaluation and Mitigation of Impacts

Environmental impacts are identified and predicted in Section 6.1 for both positive and negative impacts in terms of ecological, physico-chemical and socioeconomic parameters. Evaluation of impacts and possible mitigation measures are described in this section mentioning the sources and characteristics of impacts. Status of residual impacts is also discussed.

#### 6.2.1 Adverse Impacts and Mitigation Measures

##### 6.2.1.1 Impact due to Project Location

Land filling (for intake, water treatment plant etc.) and excavation (for impounding reservoir, pipelines etc) will be required for the site, which may be done by mechanically or manually. If the existing environmental situation is considered as baseline condition, there would be no significant adverse impacts due to project location. Disruption of earth surface, changed landscape and inadequacy in buffer zone are identified as the adverse impacts due to location of the project.

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• *Disruption of Earth Surface*

**Source of Impact**

As mentioned earlier that the land will be filled up to develop the site to provide protection against flood. And excavate for impounding reservoir permanently and for pipeline temporarily. This kind of filling and excavation from its original level certainly disrupt the natural surface of earth which will obstruct the natural drainage system of the area and as a result water logging will occur in certain area. Water logging would be serious problem if filling soil is collected from near by land because this will make more difference in reduced levels between filling and cutting site. Water logging results numerous problems like it damages roads, agricultural activities etc.

**Mitigation Measure**

Minimize cutting of top soil as possible. Cutting of nearby land should be avoided. Cross drainage works should be constructed to bypass the surface run-off and other discharges. For ascertaining cutting volume of soil and filling thereof a **Comprehensive Environmental Impact Assessment (CEIA) is required.**

**Residual Impact**

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

• *Change in Landscape*

**Source of Impact**

A visual intrusion to the local people may be created by the project if the plant buildings are designed without considering the local landscape. Although the landscape is a subjective matter that cannot be quantified precisely, due consideration should be given in designing the project infrastructure to avoid visual intrusion. The water supply improvement project will change the local landscape of the area to some extent by converting a developed vacant land into a built-up area. This will modify the natural and visual balance for the local people.

**Mitigation Measure**

Any built up part of the Plant should be designed considering key criteria of landscape like coherence, readability, hierarchy and stability. It is understood that the plants of water supply system will have a modern architectural view, which does not provide any significant visual intrusion. Detail design of the project not yet done. For ascertaining landscape after completion of detailed design a **Comprehensive Environmental Impact Assessment (CEIA) is required**

One simple way by which the altered green area can be turned into its original visual quality is the plantation of trees around the project area.

**Residual Impact**

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

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- **Inadequate buffer zones**

**Source of Impacts**

Buffer zones are the spaces that provide natural environmental protection from damage by external events. In context to the local area, there will be no such buffer zones if industrial plants are built close to each other. Buffer zone can provide wind-breakers, erosion control, sediment traps, sound insulation and visual screening. Lack of plantation and vegetated spaces will create inadequacy of buffer zone required for environmental protection.

**Mitigation Measures**

KWASA would try to keep some open space within the plant premises that can be developed as a buffer zone. Tree plantation of various species in all possible open spaces within the plant premises would render the view as a green belt. Oxygen is released by trees and plants and carbon-dioxide is consumed in the process of photosynthesis. This phenomenon contributes in cleaning the air. Some trees also absorb the toxic gases and particulate. Trees and plants that would be planted surrounding the project area would also create a good noise barrier. In addition, tree and plants provide wood, fruits, fuel as well as ecological balance of the area.

**Residual Impacts**

Residual impact would almost be negligible provided the mitigation measures are undertaken properly.

### 6.2.1.2 Adverse Impacts during Construction

Several activities will be performed during construction period of the proposed power Project. The occurrence of environmental hazards is very common in all types of construction works. These hazards may include air pollution, noise pollution, spreading of diseases and accident.

- **Air Pollution**

**Source of Impacts**

The soil in the project area is mainly dusty. Dusty soil can pollute the air during heavy wind. It was anticipated that the air would be polluted with dust particles for the movement of light and heavy transport vehicles during the period of Project construction. This air pollution may create breathing problems to the workers as well as to the surrounding people living and engaged in other commercial activities in the area.

**Mitigation Measures**

To reduce air pollution in any site, attempt is normally made to complete the construction of infrastructures within the wet season. Due to high rainfall in this period, air and soil remain wet and dust particles cannot spread over easily. If construction work is continued during dry period, dust control arrangement is needed. Water carriers will be required to regularly operate in order to keep the soil wet as the mitigation measures to reduce air pollution at the site during construction in dry season.

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**Residual Impacts**

Residual impacts will become very low as water is sprayed regularly in dusty places of the project site.

• **Noise Pollution**

**Source of Impacts**

Noise is generated from various construction activities such as piling of foundation, crushing of stones and bricks and installation of machines and equipment. In addition, working conversation of the labor force also enhances the noise pollution. The noise pollution creates disturbance to the workers of the adjacent establishments and surrounding people involved in commercial activities as well as nearby homestead people.

**Mitigation Measures**

Generation of noise pollution is an integral component of any construction work that cannot be avoided completely. However, it is possible to take certain measures to reduce the level of noise to an acceptable level. Appropriate precautions and skilled operation of machines and equipment would contribute to reduce noise pollution. Precaution like selection of proper working period considering the comfortable time of the people working and living around is being followed for construction work. The construction work normally starts at about 8.00 am and continues until 6.00 pm at the Project site. Working beyond this period may create sound hazards to the local people and hence the above work period shall be enforced.

**Residual Impacts**

Residual impact is within the acceptable limit the above mitigation measures are being undertaken.

• **Spreading Diseases**

**Source of Impacts**

It is not unlikely that diseases may be spread among the construction workers as most of them are illiterate and their level of knowledge on health and hygiene is very low. They are not aware of water pollution, healthy accommodation and food poisoning. Moreover, due to high concentration of labor force for construction, unhygienic condition may be created in the vicinity and thereby leading to transmission of various diseases. Thus, the worker may suffer from various diseases such as diarrhea, dysentery and skin infections. These diseases can spread from one worker to another and to the people living around the area.

**Mitigation Measures**

In construction phase, all of the impacts are reversible including spreading of diseases among the workers and the people working and living nearby. Moreover, the impacts are of short duration. In order to reduce or avoid the spreading of diseases, it is suggested that arrangement for good quality of drinking water, hygienic sanitation and accommodation facilities for the staff and the workers shall be made. Frequent medical check-up would also be helpful in controlling the spreading of diseases. Emergency medical services and adequate first aid facilities should always be available at the site during construction period.

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**Residual Impacts**

Residual impacts of spreading diseases can be avoided or reduced to a minimum level provided the suggested mitigation measures are undertaken and properly implemented.

• **Accidents**

**Sources of Impacts**

Adequate precautionary measures will be undertaken at the project site to avoid any accident. However, accident is unexpected and it may occur any time during construction work and cause loss of lives and properties.

**Mitigation Measures**

A high level of precautions shall be undertaken that would reduce the occurrence of accidents remarkably. Adequate first aid facilities and emergency contacts to the adjacent health complexes and other emergency services will help to save the lives from accidents.

**6.2.1.3 Adverse Impacts during Operation Stage**

The occurrence of environmental hazards in operation period causes due to air pollution, noise pollution and vibration, lubricating oil, plant wastewater, solid waste etc.

• **Impact on Air quality**

**Source of Impact**

The water supply improvement project use many engine generating sets at different places e.g., pump house, water treatment plant. The generating sets are operate for the short term when electricity cutoff from the national grid or load shedding period. Vehicles and other mechanical equipment used for the operation also cause air pollution.

Ambient air quality may be affected due to emission of flue gases from the engines. Incomplete burning of fuel from the operation of engine may also affect the air quality. The situation becomes aggravated when fuel contains high percentage of impurities like sulfur, hydrocarbon, nitrogen etc.

The high temperature of flue gas also produces impacts on the air quality in terms of thermal pollution. The combustion of fossil fuels for generation inevitably results in emission of gaseous pollutants to the atmosphere. The major pollutants of potential concern are sulfur dioxide (SO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), carbon monoxide (CO).

**Mitigation Measures**

Optimum efficiency of engine generating set would be used hence there will be less CO<sub>2</sub> emission per unit of energy (kWh) generated.

Sulfur free fuel will be used for minimizing SO<sub>2</sub> emission. Introducing catalytic converter in the engine generating sets reduces air pollutant (NO<sub>x</sub>, CO, etc) emission.

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**Residual Impacts**

Residual impacts of air pollution can be reduced to a minimum level provided the suggested mitigation measures are undertaken and properly implemented.

• **Noise and vibration impacts**

**Source of Impact**

The water supply improvement project use many engine generating sets at different places e.g., pump house, water treatment plant. The generating sets are operate for the short term when electricity cutoff from the national grid or load shedding period. Vehicle and other electro-mechanical equipment used for the operation also cause noise pollution.

Significant level of noise would be generated from the engine room of generating set. "Noise" is an unwanted sound of an unacceptable intensity at a wrong time and wrong place. Noise pollution is considered as one of the major dimensions that leads to the environmental degradation. This creates psychological and physical effects on human health. It is difficult to assess and quantify the environmental degradation or discomfort caused by noise; however, it includes auditory fatigue and reduces hearing capacity of the people working in the plant and living in the adjacent area. Noise level depends on two major parameters- sound pressure and sound intensity. These are measured in different units giving varying degree of magnitude. The common scientific unit is the "decibel" (dB).

**Mitigation Measures**

Emergency generating set will be enclosed in a civil building with RCC columns, brick cladding and roof (metallic or RCC). The control room will be a separate room with double glass fixed windows. Normally, no operating personnel will be present in the engine room. Whenever occasional visits are required, operators will be provided ear plugs. Noise level in control room will be much less.

Exhaust gas from the engine will be lead into atmosphere through a silencer which will bring the noise level to 35 dB(A).

The noise level in the boundary limit of the plant is expected to be minimum level which is within the limit of Bangladesh Standard (EQS). All these measures will keep the noise level within the prescribed permissible levels of noise for the country as shown in Table 6.2 below:

**Table-6.2: Standard Values for Noise (DOE, 1997)**

Area category	dBA (Day time)	dBA (Night time)
Calm Area	45	35
Residential Area	50	40
Mixed Area	60	50
Commercial	70	60
Industrial Area	75	70

Note:

1. Day time is from 0600 hrs in the morning to 1900 hrs. in the evening
2. Night time is from 2100 hrs in the night to 0600 hrs in the morning.
3. Calm area is the 100 meter radius within hospital or school or any government designated special areas.

It should be ensured that all generating equipment is noise suppressed. Tall trees are to be planted at the property line for noise attenuation particularly during operation stage. Plant foundation shall be designed to minimize vibration effect.

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**Residual Impacts**

Residual impacts of noise pollution and vibration can be reduced to a minimum level provided the suggested mitigation measures are undertaken and properly implemented.

- **Lubricating oil**

**Source of Impacts**

Vehicles and equipment used for operation and maintenance purposes, spilling of lube oil from the workshops can create environmental impact. Lube oil creates pollutions of surface soil and adjoining surface water.

**Mitigation Measures**

The dirty oil from the engine will be collected in drums and proposed to be supplied to the prospective re-users in an environmental friendly manner. This oil is generally used in the brick kilns and has other secondary users. The project proponent mentioned that they would sell this waste oil to secondary users. As such there will be no waste oil discharge that can degrade the quality of soil, groundwater or surface water.

**Residual Impacts**

There will be no residual impacts as oil waste will not be discharged outside.

- **Plant Waste Water**


**Source of Impacts**

Water will be mainly used as raw materials of the project. The expected wastewater quantity from the treatment plant will be about 10% intake water and is basically rejected from the treatment unit. The water contains high dissolved solid but non-toxic in nature and with normal temperature.

**Mitigation Measures**

The rejected water from treatment plant will be diluted prior to discharge in to the canal, river and other inland water bodies. Maintain water quality standard set by DOE showing the following **Table-6.3**. Thus there will no environmental hazards due to discharging water in the river.

  
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Table - 6.3 Standards for Inland Surface Water

Best Practice based classification	pH	BOD mg/L	DO mg/L	Total Coliform number/100
a. Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
b. Water usable for recreational activity	6.5-8.5	3 or less	5 or more	200 or less
c. Source of drinking water for supply after conventional treatment	6.5-8.5	6 or less	6 or more	5000 or less
d. Water usable by fisheries	6.5-8.5	6 or less	5 or more	---
e. Water usable by various process and cooling industries	6.5-8.5	10 or less	5 or more	5000 or less
f. Water usable for irrigation	6.5-8.5	10 or less	5 or more	1000 or less

Notes: 1. In water used for pisciculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.  
2. Electrical conductivity for irrigation water - 2250  $\mu$  rhoms/cm (at a temperature of 25° C). Sodaam less than 26%, boron less than 0.2%.

**Residual Impacts**

The residual impacts will be very insignificant if the appropriate measures suggested above are implemented properly.

• **Solid Waste**

**Source of Impacts**

The people working at the plant will produce some solid wastes such as paper, packaging materials and food wastes etc. All such solid waste would be non-toxic and does not require any special disposal requirements. These materials could be transported to a designed site for final disposal in an environmentally sound manner.

**Mitigation Measures**

Valuable items of solid wastes would be separated at the point of generation and remaining portion would be disposed at a convenient point and transported safely to the designated disposal site. There are low lying areas surrounding the project site and the general solid wastes could be safely disposed of by transporting the wastes to the nearby designated site.

**Residual Impact**

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

**6.2.2 Occupational Health**

**Source of Impact**

The workers who work in water treatment plant inside will face occupational health hazards due to different operational processes. Safe and good occupational health status of the employees and workers is important for only the persons working in the plant, but also for the better plant operation and maintenance.

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### Mitigation Measures

Protective clothing, earplug, hamlets, shoes and accessories should be provided to the workers, who would be subjected to adverse situation. Adverse impact on worker's safety would be minimized by implementing an occupational health program. Regular medical check up would be done to ensure the soundness of health of employees and workers. Pollution control measures would duly adopted if necessary.

### Residual Impact

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

### 6.2.3 Other Mitigation Measures

#### 6.2.3.1 Disaster Management Plan

The project authority will take necessary disaster management plan to protect the properties from water logging / flood etc. In this regard all construction works have been undertaken at a higher level taking the highest flood level into consideration.

#### 6.2.3.2 Other Safety Provision

In addition to the above measures, the Project will have full provision for fire fighting and first aid medical services. The project has provision in its recurring annual expenditure for maintaining facilities for safety measures during operational phase.

A summary of the adverse impacts and their mitigating measures is presented in the Table-6.4 furnished hereinafter.

### 6.3 Positive Impacts and Enhancement

**6.3.1 During Construction Phase:** The project will create job opportunities during its construction phase for a good number of skilled and semi-skilled local labors. In addition to this, the area will be more commercially developed. The land value will also be increased. Local people will be encouraged to get themselves involved in employment and other commercial activities.

**6.3.2 During Operation Phase:** The most significant positive impacts of the proposed water supply Project is that it will improve the reliability and stability of the water supply system in order to meet the water shortage in the area. It would be possible to supply the water during peak demand. The project will play special role in implementing the economic development in the region. The other important positive impact of the proposed Project would be the employment of personnel for the operation of the Project. The project will involve local human resources. Good quality of water supply reduces communicable diseases like cholera, jaundice etc.

Apart from these positive impacts mentioned above, other beneficial impacts include benefit to the local transport business, local economy because of employment, community development etc.

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6.4 Summary of Adverse Impacts and their Mitigation Measures

The summary of adverse impacts and their mitigation measures are summarized in the Table-6.4.

Table-6.4: Summary of the Adverse Impacts and their Mitigating Measures

Project Phase	Potential Impacts	Mitigating Measures
Project Location	Landscape Quality Visual intrusion	<ul style="list-style-type: none"> <li>Local landscape will be taken into consideration in designing the built-up part of the Project.</li> <li>A modern architectural will be considered.</li> </ul>
	Inadequate Buffer Zone; Reduction in natural environmental protection	<ul style="list-style-type: none"> <li>Provision of some open space has been made within the Project premises that will be developed as buffer zone.</li> <li>Planting of trees of various species in all possible open spaces within the Project premises would develop a green belt.</li> </ul>
	Disruption of Earth Surface; Reduction in natural environmental protection	<ul style="list-style-type: none"> <li>Minimize cutting of top soil as possible.</li> <li>Cutting of nearby land should be avoided.</li> <li>Cross drainage works should be constructed to by pass the surface run-off and other discharges.</li> </ul>
Construction Phase	Air Quality: Dust is generated from construction activities and transport vehicle	<ul style="list-style-type: none"> <li>Attempt will be made to complete civil construction works during wet season.</li> <li>Water carrier will be used to keep the soil wet so that dust generation will minimum when the civil construction works continues during dry season.</li> </ul>
	Noise Hazards: Noise is generated during construction phase.	<ul style="list-style-type: none"> <li>Working Hours will be selected carefully.</li> <li>Skill operation of construction equipment will be provided</li> </ul>
	Health Hazards: Diseases may be spread among the workers	<ul style="list-style-type: none"> <li>Provision of good quality drinking water and sanitation facilities will be made during construction period.</li> <li>Healthy accommodations will be arranged.</li> <li>Frequent medical check-up for staff and workers will be available</li> </ul>
	Health and Safety: Accident may occur and cause loss of lives and property.	<ul style="list-style-type: none"> <li>A high level of precautions will be undertaken.</li> <li>Adequate first aid facilities will be provided</li> </ul>
Operation Phase	Air Pollution: Ambient air quality may be affected due to emission	<ul style="list-style-type: none"> <li>Appropriate mitigating measures will be incorporated in the design and specification of the Project to reduce the level of air emission</li> </ul>
	Noise Pollution: Significant level of noise would be generated from the Project engine.	<ul style="list-style-type: none"> <li>Appropriate devices would be provided at different points of noise generation of the Project</li> </ul>
	Lube Oil: Dirty oil would be generated from engines.	<ul style="list-style-type: none"> <li>Dirty oil will be collected in drums and sold to the re-users</li> </ul>
	Waste water: Waste water would be generated from the treatment plant (treatment plant sludge). Sewage: Project staff will generate sewage and domestic wastewater.	<ul style="list-style-type: none"> <li>Treatment plant sludge will be diluted prior to dispose in the river and nearby canal to meet the EQS.</li> <li>Septic tanks with soak-pit will be used to manage sewage and domestic wastewater</li> </ul>
	Solid Waste: Small quantity of solid waste will be generated from Project personnel.	<ul style="list-style-type: none"> <li>Recycling system will be introduced to reduce the volume of solid wastes</li> <li>Remaining portion of solid waste will be disposed into the designated landfill site.</li> </ul>

## Chapter-07

# Institutional Requirement and Environmental Monitoring Program

### 7.1 INTRODUCTION

Water Supply Treatment Plant projects, in general, have potentials for adverse environmental impacts during both the construction and operation phases. These projects also have some positive impacts particularly, in terms of socio-economic benefits. Environmental Management Plan (EMP) is related to the implementation of the measures prescribed in the EIA to reduce the adverse impacts at the acceptable levels as well as to enhance the beneficial impacts. The objective of EIA cannot be achieved unless the mitigation and benefit enhancement measures, identified in the EIA are observed properly. For the proposed Khulna Water Supply Improvement project, all the measures will be said to be successful if they comply with the Environmental Quality Standards (EQS) as specified in the Bangladesh Environmental Conservation Rules (BECR), 1997. Thus the general objective of EMP for this project are (i) implementation of the mitigation measures to reduce or eliminate negative impacts and (ii) implementation of enhancement activities in order to maximize positive impacts and (iii) identifying monitoring requirements and monitoring indicators.

The site environmental management plan will be used to ensure that the proposed Khulna Water Supply Improvement Project is operated with the minimum impact. The environmental management plan prepared for the project will include an examination of the following:

- Work plans and schedules
- Resources necessary for implementation
- Emergency procedures
- Training requirements.

These aspects are discussed in the subsequent paragraphs hereinafter.

### 7.2 WORK PLANS AND SCHEDULES

#### 7.2.1 Air quality management

During construction phase, dusts will be generated from the construction activities and movement of transport vehicles. Attempt will be made to complete the construction works during wet periods and daytime only. Water will be sprayed on exposed surfaces regularly during dry season in order to keep the soil wet so that dust generation is reduced.

#### 7.2.2 Water Quality Management

Raw water will be abstracted during the entire period of project life. Water will be withdrawn from the River and supply to the consumers.

The volume of waste-water discharge from the treatment plant will comprise effluent from the sedimentation tank, backwash of filter bed and other occasional releases and it will be passed to a treatment facility for treatment to maintain standard effluent quality.

#### 7.2.3 Solid Waste Management

There will be plant waste management system in place to handle sludge, wastewater, and solid

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waste. Solid wastes, oily rags and used fuel and lube oil filters, will be collected in leak proof and fire proof containers that will be taken off the site for disposal. The waste will be collected in a designated place and handled in a sanitary manner either in land development purpose or incinerated if appropriate.

**7.2.4 Lubricating and Chemicals Management**

The dirty oil from the system will be collected in drums and sold to other-users.

**7.2.5 Health and Safety Management**

Construction and operational activities will be carried out in accordance with relevant health and safety procedures. The procedures of World Bank Health and Safety Guidelines will be followed in this regard. These are briefly described below:

- **Workplace Air Quality**

The workplace air quality of World Bank is furnished below:

**World Bank Threshold Limit Values (TLVs)**

Pollutant	Concentration (mg/m <sup>3</sup> )
Carbon Monoxide	29
Nitrogen Oxides	6
Particulate (Inert and Nuisance Dust)	10
Sulphur Dioxide	5

Protective respiratory equipment will be used in areas where employees are exposed to welding fumes, solvents and other material present that exceed accepted standards or the World Bank threshold limits.

- **Workplace Noise**

To limit noise level within allowable limit, sound-insulated equipment and control rooms will be employed in normal work areas. Plant equipment will be well maintained to minimize noise levels. Hearing protection must be worn in areas where personnel are exposed to noise levels above 85 dBA.

- **Electrocution**

In order to reduce the risk of electrocution a formal "permit-to-work system" will be operated. Strict procedures will be followed for de-energizing and checking electrical equipment before maintenance work. Strict safety procedures must be implemented in the case of energized equipment including constant supervision. Full training will be provided on the revival techniques for electrocution.

- **Work in Confined Spaces**

Confined spaces such as tanks, sumps sewers and excavations will be tested for the presence of toxic, flammable and explosive gases or vapors and for the lack of oxygen before entry. Employees will use air-supplied respirators in areas, which may be contaminated or deficient in oxygen during any period of time in a confined area. Additionally, adequate ventilation will be provided before entry and during occupancy of these spaces.

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• **General Health**

In order to maintain sound health and safety for the plant personnel on a routine basis, the following general procedures will be undertaken.

- Ensure use of personal protective equipment at the plant site. Personnel will use special footwear, masks and clothing for work in areas with high dust levels or contaminated with hazardous materials. Safety equipment will be supplied where applicable, particularly in areas where exposure to high temperature or chemicals is likely.
- Shield guards and guard railings will be installed at all belts, pulleys, gears and other moving parts.
- Elevated platforms and walkways, stairways and ramps will be equipped with handrails and non-slip surfaces.
- All electrical equipment will be grounded, well insulated and will conform to all applicable codes.
- Emergency eyewash and showers will be installed in areas containing corrosive material.
- Provision of first aid kit with required items shall be kept and maintained at the plant site.

• **Record keeping and Reporting**

Records will be maintained of significant environmental matters, including monitoring data, accidents and occupational illnesses, spills, fires and other emergencies. The information should be reviewed and evaluated to improve the effectiveness of the environmental, health and safety program.

• **Training**

To ensure employees' health and safety, training is essential. Both theoretical and practical training will be imparted to the employees on the hazards, precautions and procedures for the safe storage, handling and use of all potentially harmful materials. Training procedures will incorporate information from the Material Safety Data Sheets (MSDSs) for potentially harmful materials. Training will include:

- use of personal protective equipment
- prevention of accident
- safe chemical handling practices
- location and proper use of emergency equipment
- procedures for raising the alarm and notifying emergency response teams
- proper response actions for each foreseeable emergency situation.

• **Maintenance**

Maintenance of the plant will be undertaken to ensure that releases to the environment are kept to a minimum. Equipment specific maintenance will be carried out in accordance with the manufacturer's guide lines.

## 7.3 COMPENSATORY MEASURES AND EMERGENCIES

### 7.3.1 Resources, Implementation and Training

• **Resources**

In order to ensure proper operation, maintenance and environmental safety, the water supply system operational workforce will include a designated Environmental Engineer who will be a senior manager with executive responsibility for environmental matters.

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• **Implementation**

The Environmental Engineer will be responsible for ensuring that the environmental management plan is effective. He will be responsible for initiating any necessary improvements, via direct reporting to the Plant Manager.

• **Training**

The Environment Engineer will be responsible for conducting following environmental training:

- Environmental protection procedure;
- Promotion of environmental awareness;
- Specific training for staff working in sensitive areas;
- Updating staff on changes to environmental standards;
- Reporting to staff on plant environmental performance.

**7.3.2 Compensatory Measures**

If any specific problem areas are identified in relation to the plant's environmental performance, mitigatory measures will be adopted if deemed to be appropriate, included in the improvement plans for the plant. This deviation in the environmental performance of the plant may arise through the deterioration of performance of components of the plant or changes in legislation.

**7.3.3 Emergencies**

To ameliorate any environmental risk, there shall be an "Emergency Action Plan" in place so that in case of an emergency, all plant personnel are aware of their responsibilities. Fire protection equipment and facilities will be available at suitable locations within the plant and these will include:

- Fixed fire protection systems
- Fire hydrants
- Alarm enunciators
- Portable fire fighting equipment
- Automatic fire vents
- Fire compartments
- Fire exit signs.

In the event of an emergency, the Environmental Engineer will be available to provide specialist advice as to the environmental aspects of the situation and potential for pollution incidences. Advice will also be provided on the use of fire equipment on site.

In order to provide 24 hour coverage, either a member of staff will be appointed for those times not covered by the full-time Engineer, or provision will be made for the Engineer to be accessible 24 hours a day.

**7.4 ENVIRONMENTAL MONITORING PROGRAMME**

**7.4.1 Introduction**

Environmental monitoring is the repetitive and systematic collection of data of specific environmental parameters/resources over a time to achieve some objectives. The term monitoring is defined in the context of environmental impact assessment as an "activity undertaken to provide specific information on the characteristics and time. Environmental monitoring is a very useful tool for the management of

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environment and natural resources. Environmental monitoring may be broadly classified into *baseline monitoring, impacts or effects monitoring, mitigation monitoring and compliance monitoring*.

A crucial part of the environmental management plan is the monitoring scheme, which is carried out in operation of the plant. This section considers the environmental monitoring plan for the proposed water supply system, together with the institutional requirements for its successful execution. The monitoring programme will be designed to ensure that up-to-date records of the environmental parameters are maintained during both the construction and operational phases to allow timely intervention in the advent of unacceptable environmental impacts.

#### **7.4.2 Institutional Capability & Requirements**

In order to ensure that the project achieves desired goals with minimal environmental risks, a proper institutional setup shall be established by the project proponent so that a close coordination is maintained between KWASA and DoE, representing the national government agency with overall responsibility for environmental monitoring.

DoE will specify environmental guidelines regarding monitoring and examine levels of compliance either on a regular or ad-hoc basis. Therefore, the project Sponsor must maintain the appropriate staff, skills, tools and equipment in order to undertake a surveillance programme capable of satisfying national monitoring requirements.

It will be the responsibility of the Environmental Engineer to implement the Site Environmental Monitoring and Environmental Management Plan and to encourage general environmental awareness at site. The Environmental Engineer will be suitably trained and will be responsible for the following tasks:

- ensuring that all environmental protection procedures are followed
- co-ordination of environmental monitoring
- liaison with member of the public, local organizations and governmental and non governmental organizations
- ensuring all data on environmental aspects of plant operation is continuously updated and available in the form suitable for immediate inspection by authorized personnel
- the monitoring of hazardous substances on site to ensure that the possibility of accidental release is minimized
- promoting on site environmental awareness
- liaison with other industry.

The EMP may also require the employment of a laboratory technician to analyze air and water samples and report results to the Environmental Engineer. The technician will be provided with on site facilities for carrying out all of the required chemical analyses. KWASA will ensure that such facilities are available for proper monitoring exercise.

### **7.5 ENVIRONMENTAL MONITORING PLAN**

#### **7.5.1 Parameters to be Monitored**

The plan will consist of on-site monitoring for the following parameters:

- Air quality
- Water quality and liquid discharge
- Noise levels
- Chemical Wastes



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- Socio-economics
- Public complaints.

The monitoring plan will aim at ensuring that the proposed plant continually meets with all relevant standards. The program employed to carry out this monitor will employ standard internationally recognized procedures. In addition to quantitative analysis, a number of qualitative monitoring steps will also be included. Post construction monitoring of the impacts on the local community and economy will also be included within the monitoring programme to ensure that all the mitigation measures have been successfully undertaken. Detailed monitoring plan including estimates will be taken up during design phase of the project. Monitoring will ensure compliance with any current and future standards.

### 7.5.2 Target Media and Monitoring Schedule

- **Ambient Air Quality**

In order to assess ambient air quality after commissioning of the plant, air quality monitoring will be carried out with the help of suitable institution or monitoring agency to measure NO<sub>x</sub>, SO<sub>x</sub> and SPM at sites in the surrounding area. This will typically include at least three monitoring points within the study area, including one at the expected point of maximum impact. Also, an additional monitoring plant will be located within the existing plant boundary. This information will provide the DOE with a better understanding of the ambient NO<sub>x</sub>, SO<sub>x</sub> and SPM.

- **Water Quality**

Water will be continuously taken from the Rivers for the water supply to the consumers. Abstracted water quality will be monitored regularly on the parameters DO, Chloride, SS, BOD, Dissolved Solids, Turbidity etc.

- **Noise**

A noise survey within operational areas at the site boundary and sensitive receptors will be undertaken during the operation phase of the project. Additional monitoring may be required at various times in response to public complaints, in order to verify that ambient noise level limits are reasonably consistent with historical measurements and permissible limit.

- **Socio-economic**

To assess project impact on social and economic status of the stakeholders, periodic social survey will be conducted. This will include keeping and up-dating information on demographic and employment statistics within the area and will involve a number of different pointers, such the cost of electricity tariffs, food and fuel, in addition to the cost of board and lodgings, rented accommodation, etc.

The socio-economic survey will include a programme of public consultation exercises and should be conducted on a regular basis. Public consultation will also serve to identify any possible complaints which the local populace may have regarding the construction and operation of the water supply system and will provide an opportunity to inform the residents concerning the project progress. Public consultation also represents an opportunity for advising local people of any foreseen disturbances that might otherwise cause concern.

In course of time, if the adverse impacts of the water supply system be perceived to be insignificant and public complaints attributed to the water supply system be few, the required monitoring will be conducted on a less frequency basis.

Chapter-7

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• **Public Complaints Procedure**

Any complaints that will be lodged by the public be noted on a complaint register to include the name and address of the complainant including the time and date that the complaint is registered, and the details of the complaint. The Environmental Engineer or other nominated representative will then contact each complainant either by means of a personal visit or telephone, in order to discuss the details of the complaint and to establish how the complaint can be rectified in the interests of all concerned. Table – 6.1 presents a monitoring program in a summarized form.

**7.5.3 Reporting Procedures**

There shall be a proper reporting system at every water supply system site. KWASA will need to delegate the responsibility for environmental issues to a senior member of its existing staff. Implementation of the Environmental Monitoring Plan will be the responsibility of the appointed Environmental Engineer who will be responsible for arranging and reporting the results of all emissions, ambient air quality, noise and water quality monitoring. The Environmental Engineer will also be responsible for obtaining, reporting and maintaining all environmental data records and for correct implementation of the public complaints and emergency procedures. The project proponent shall also comply with the requirement of the regulatory body, namely, DOE in maintaining reporting procedure.

The laboratory technician will be responsible for conducting all in-house analysis and for reporting all in-house analytical results direct to the Environmental Engineer, who will in turn be responsible for compilation of all monitored results and for informing the authorities of any possible non-conformities.

As mentioned above, there may be occasions where outside bodies are required for specialist monitoring or training. The Environmental Engineer will be responsible for coordinating any monitoring conducted by outside bodies. In either case, all monitoring results obtained by outside monitoring bodies will be reported direct to the Environmental Engineer. It is the responsibility of the Environmental Engineer to check calibration procedures and to verify the authenticity of the results.

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**Table 7.1: Monitoring Program Khulna Water Supply Improvement Project**

Sl. No.	Monitoring Item	Process and Methodology	Frequency	Responsibility
1	Construction dust	Sheeting of lorries carrying friable materials, Damping exposed earthen surface and control of vehicle movement	Monthly	Contractor
2	Construction noise	Major work to be undertaken during normal working hours Nearby residents to be warned of any unusual noisy operation	Monthly	Contractor
3	Water Quality	Analysis by sampling (Daily for oil & grease, DO, Chloride, SS, TDS, BOD, pH and temperature)	Daily/Weekly	KWASA
4	Noise Level	Plant to meet design values Ear muffs to be provided Warning signs where appropriate Noise monitoring	Quarterly and upon receipt of complaint	KWASA
5	Chemicals	Chemical used for treatment of water e.g., alum, hypochloride etc.	Monthly	KWASA
9	Socio-Economic	By periodic social survey	Annual	KWASA
10	Public Complaints	Complaint will be noted by maintaining register	As soon as complaint is received	KWASA
11	Terrestrial ecology	Air quality to be monitored for NOx and SPM	Quarterly	KWASA
12	Aquatic ecology	Effluent discharge to be monitored for pH, BOD, oil & grease and temperature	Quarterly	KWASA

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## Chapter-08

### Findings and Recommendations

#### 8.1 GENERAL

Khulna, the third largest city in Bangladesh, is located in the southwest of the country and has a population of 1.5 million (estimated in 2008). The present water supply to Khulna is mainly from groundwater sources drawn from both deep and shallow tube wells. To cope with current insufficient supply and increasing demand, the Khulna Water Supply and Sewerage Authority (KWASA) plans to construct a new treatment plant for surface water with assistance from the Japan International Cooperation Agency (JICA)

After considering various options, KWASA now intends to establish new surface water treatment plant. The configurations of the new plants are as follows:

#### Planned Capacity

#### Average Day Demand

The average day demand for the new surface water plant in 2030 will be 282,927 m<sup>3</sup>/day and in 2025 will be 234,357 m<sup>3</sup>/day respectively

#### Design Capacity

Taking into consideration of peak factor as 1.15, the design capacity of the new plant for 2025 will be 160,000 m<sup>3</sup>/day and the one for 2030 will be 220,000 m<sup>3</sup>/day to meet the maximum day demands respectively.

As water supply projects are identified as having the potential for environmental impact, the Bangladesh Department of the Environment (DOE) has categorized them as being the "Red Category" of industrial processes. As such, an Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) are required. The IEE study team members observed that major environmental impact of the project would be water pollution, air pollution and noise pollution in post construction/operation phase due to solid waste, and liquid waste emission. These problems would be overcome by taking proper mitigation measures as stated in EMP. However, the residual impacts of the project should be identified in detail EIA study.

As the use of external finance is expected for implementing the proposed project, a comprehensive EIA is also required to satisfy the appropriate funding review criteria.


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
## 8.2 RECOMMENDATIONS

It is observed from the overall examination of the project interventions and possible impact that water treatment project will not have major irreversible negative impact on the environment. But this water treatment plant supply reliable amount of water to the consumer of the Khulna City.

Further socio-economic benefits derived from the project implementation are expected to be high. It may be stated that there is a need for acquisition of land for project implementation and that no resettlement will be required.

Finally, on proper examination it is observed that the project has been proposed to be implemented safely and in environment friendly manner. So it is recommended that the project may be cleared to proceed with works.

  
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**Annexure-A**

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Terms of Reference (TOR) for  
Environmental Impact Assessment (EIA) of  
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1.0 Introduction

Khulna Water Supply and Sewerage Authority (KWASA) is responsible for collecting, treating, and transmitting to consumer of water in Khulna City the third largest city of Bangladesh. To meet growing water demand and to mitigate its demand KWASA undertake a long term plans upto 2030.

Till to date DOE does not have any environmental guidelines for water sector, therefore, KWASA as a government organisation always maintains international standard for such activities. KWASA is very much concern about the environmental issues and the top management of the organisation is strict to carry out the project activities smoothly so that any project activity should not create any environmental hazard. Generally the Environmental and Social Impact Assessment is aimed at examining all the interactions of proposed activities both in operation and post operation stages, which may result in impacts upon the natural environment and as well as social environment. Following Department of Environment (DOE) guideline and those of JBIC and ADB, the EIA will identify all aspects of environmental impacts both positive and negative impacts, short term and long term impacts, direct and indirect impacts, reversible and irreversible impacts. The EIA shall consider the physical disturbance to existing environment as well as potential impacts on various Stakeholders due to the proposed activities. Based on the analysis of impacts the EIA shall identify the potential mitigation measures to reduce and offset the negative impacts. The EIA will also suggest Environmental Management Plan (EMP) including the social management plan incorporating suggested mitigation measures.

2.0 EIA Report Structure

The EIA report will be prepared following the DOE, JBIC and ADB guidelines in general. Proposed table of contents (attached) illustrates the major sections of the report and outline of the contents under each section.



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Indicative Outline/Table of Contents

S. EXECUTIVE SUMMARY

(Short and focused description of the project, environmental, social and biological setting, significant findings, major social, biological and environmental impacts of the proposed activities, recommended actions to mitigate/minimise potential negative environmental, biological and social impacts and suggest enhancement measures for positive impacts and monitor environmental and social performance)

1. INTRODUCTION

- 1.1 Background
- 1.2 Objective
- 1.3 Project Overview
- 1.4 Scope of the present study
- 1.5 Methodology
- 1.6 Limitation
- 1.7 Report Structure
- 1.8 Acknowledgement

2. LEGISLATIVE, REGULATORY AND POLICY CONSIDERATIONS

(Will cover the potential legal, administrative, planning and policy framework within which the EIA will be prepared. This will describe the pertinent regulation and standards governing environmental quality and safety, protection of sensitive areas, protection of endangered species, siting, land use control etc., social status, social demands at national and local levels).

- 2.1 Introduction
- 2.2 Environmental Agencies
- 2.3 Environment Policy 1992
- 2.4 Energy and power policies
- 2.5 National Conservation Strategy
- 2.6 National Environmental Management Plan
- 2.7 Fifth Five Year Plan
- 2.8 Forest Policy 1994
- 2.9 Industrial policy
- 2.10 National Environmental Quality Standard
- 2.11 Environmental Conservation Act 1995
- 2.12 Environment Conservation Rules 1997
- 2.13 Petroleum act
- 2.14 World Bank Standard
- 2.15 Compliance with DOE EIA guidelines
- 2.16 Obtaining Environmental Clearance
- 2.17 JBIC Environmental and social guidelines

3. THE PROJECT

(This chapter will present a concise description of the project/proposed interventions and will cover relevant activities).

Annexure-A

MD. ABDULLAH PENA 86  
Managing Director  
Khulna WASA

*IEE Report on Khulna Water Supply  
Improvement Project, KWASA, Khulna (Final)*

- 3.1 Present Status
- 3.2 Location
- 3.3 Project Activities
  - Preparatory works
  - Description of major activities
  - Post operation activities
- 3.4 Materials and equipment requirement
- 3.5 Wastes' generation and discharge facilities
- 3.6 Storage and transportation
- 3.7 Staffing Requirement
- 3.8 Project Schedule

#### 4. BASELINE/EXISTING CONDITION

(This chapter will assemble and provide an evaluation and assessment of baseline data on the environmental social characteristics of the study area, sourced from a combination of (i) previous studies reported in the literature, and (ii) new data obtained by the EIA team). Topics to be covered include:

- Physical environment
- Biological environment
- Socio-economic & cultural environment

##### *Study area*

- 4.1 Environment
  - 4.1.1 Climate and air quality
  - 4.1.2 Topography, Geology and Soils
  - 4.1.3 Surface water Ground water quality
  - 4.1.4 Ambient noise level
- 4.2 Ecological Environment
  - 4.2.1 Ecosystems, flora and fauna
- 4.3 Socioeconomics

(This will deal with baseline socio-economic conditions. Socio-economic issues of concern will include population, education, religion, livelihood practices, human habitation and social/community activities; employment; cultural and religious activities; indigenous people/tribes.)

#### 5. IDENTIFICATION AND EVALUATION OF POTENTIAL IMPACTS

(Will identify and assess positive and negative environmental impacts likely to result from the proposed project). Impact assessments shall include:

- Impacts on water, air, soil quality
- Noise impacts
- Impacts on flora (crops, vegetation) and fauna; effects on wildlife and on biodiversity
- Impacts on ecosystems and habitats; effects on biodiversity
- Impacts on socio-economics

- 5.1 General
- 5.2 Environmental Impacts During Pre-Construction Phase
- 5.3 Environmental Impact During Construction Phase
  - 5.3.1 Air Impacts
  - 5.3.2 Noise Impacts
  - 5.3.3 Land and Soil Impacts

*Annexure-A*

Engr. S.M. Jahid Hossain MD. ABDULLAH, P.Eng.  
Joint Managing Director (Engg) Managing Director  
Khulna WASA Khulna WASA  
2023/08/01

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Improvement Project, KWASA, Khulna (Final)*

- 5.3.4 Water Impacts
- 5.3.5 Disposal of Solid waste
- 5.3.6 Biological Impacts
- 5.3.7 Socio-economic Impacts
- 6.4 Environmental Effects Relating To Operations Stage
  - 6.4.1 Atmospheric emission
  - 6.4.2 Water abstraction and Discharge
  - 6.4.3 Noise Impact
  - 6.4.4 Socio-economic impact

## 6. MANAGEMENT PLAN/PROCEDURES

(For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures. Impacts, which are not capable of mitigation, will be identified as residual impacts).

The EIA report will include an outline of the Environmental Management Plan (EMP) to be developed for the project. The plan will include:

- An environmental, biological and social policy for the intervention to include continuous improvement
- Proposals for staff training and technology transfer;
- Proposals for an environment and social monitoring plan.

### General Considerations

- 6.1 Environmental management
  - 6.1.1 Water quality management
  - 6.1.2 Air quality management
  - 6.1.3 Noise, odour and vibration management
  - 6.1.4 Solid waste management
- 6.2 Monitoring
- 6.3 Personnel and training

## 7. CONSULTATION WITH STAKEHOLDERS/PUBLIC CONSULTATION

(This will ensure that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project. Contacts will be made and meetings/interviews/discussions set up with appropriate organizations, government departments, NGOs, local authorities and community leaders and other stakeholders).

- 7.1 Approach
- 7.2 People's general perceptions
- 7.3 Major findings

## 8. CONCLUSION AND RECOMMENDATION

TABLES  
FIGURES  
ANNEXES

Annexure-A

*A*  
Engr. S.M. Jaguul Haider  
Project Managing Director (Engr.)  
KWASA

*AN*  
MD. ABDULLAH PERREG  
Managing Director  
Khulna WASA

*IEE Report on Khulna Water Supply  
Improvement Project, KWASA, Khulna (Final)*

**Annexure-B**

WORK SCHEDULE									
Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) and Land Acquisition Plan (LAP) and Resettlement Action Plan (RAP) for the Khulna Water Supply Improvement Project									
Task No	Description of Activities	Months							
		Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
0.0	<b>Khulna Water Supply Improvement Project</b>								
1.0	<b>Selection of Consultant (JICA Study Team)</b>								
1.1	Preparation of the TOR, cost estimate and the budget								
1.2	Preparation of the short list of consultants								
1.3	Preparation and issuance of the Request for Proposal (RFP)								
1.4	Receipt of Proposals from Consultants								
1.5	Evaluation of Proposals								
1.6	Negotiations and award of the contract to the selected firm								
2.0	<b>Inception Report</b>								
2.1	Inception Report								
3.0	<b>Prior-Option Comparison Report</b>								
3.1	Comparison Report for Options								
4.0	<b>Initial Environmental Examination (IEE) Study</b>								
4.1	Mobilization								
4.2	Meetings with client								
4.3	Collection of project data, maps and reports								
4.4	Project scoping and Bounding								
4.5	Preparation and finalization of questionnaire								
4.6	Briefing, orientation of surveyors, data collectors and field testing of questionnaire								
4.7	Field visit and alternative analysis								
4.8	Hazard and risk assessment								
4.9	Preparation of all required maps								
4.10	Assistance to Client in public disclosure								
4.11	Consultation with stakeholders/project affected persons								
4.12	Description of ROW & Existing Baseline (Bio-physical and Social) Conditions								
4.13	Review of relevant rules, regulations, Policies, Codes and Practices								
4.14	Determination of Potential Impacts and Suggest Mitigation Measures								
4.15	Development of Environmental Management Plan								
4.16	Preparation of IEE Report								
4.17	NOC from local authority and obtain site clearance from DOE								
5.0	<b>Land Acquisition Plan (LAP)/Resettlement Action Plan (RAP)</b>								
5.1	Collection of data and review of regulations, Policies, Codes and Practices								
5.2	Field survey to identify the affected areas, groups, persons, including collection of land index, land ownership, land price, crops, trees, shops, houses etc.								
5.3	Consultation with affected groups and other stakeholders								
5.4	Preparation of basis for compensation of PAPs								
5.5	Institutional arrangement, monitoring and evaluation of LAP/RAP								
5.6	Preparation of the resettlement plan and budget for LAP/RAP								
5.7	Preparation of LAP/RAP Report								
6.0	<b>Environmental Impact Assessment (EIA) Study</b>								
6.1	Field survey and primary data collection through questionnaire and Data analyses								
6.2	Collection of representative samples and analyses								
6.3	Description of base line condition								
6.4	Identification of potential impacts and mitigation measures								
6.5	Prepare environmental and social management plan								
6.6	Preparation of EIA study report								
6.7	Obtain Environmental Clearance from DOE								
7.0	<b>Completion and Submission of Reports</b>								
7.1	Inception Report								
7.2	Prior-Option Comparison Report								
7.3	Draft IEE Study Report (5 Copies)								
7.4	Draft EIA Study Report (5 Copies)								
7.5	Draft Resettlement Plan (RAP) Report (5 Copies)								
7.6	Final (IEE, EIA and LAP/RAP) Report (10 Copies)								

S.M. Jaglal Haider MD. ABULLAH, P.Eng  
Project Manager

**Supporting Report 10.2 EIA REPORT**

Government of Peoples Republic of Bangladesh  
Ministry of LGRD & Cooperatives  
Khulna Water Supply & Sewerage Authority (KWASA)

Consultancy Services for Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA), and Land Acquisition Plan (LAP)/Resettlement Action Plan (RAP) of the Proposed Khulna water Supply Improvement Project



**EIA REPORT**  
November- 2010



**Khulna Water Supply & Sewerage Authority (KWASA)**

০৮/১০/১৯৯৯  
০৮/১০/১৯৯৯  
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**চালানি ফরম**

১. আবেদন নং ৯ (এস. আর ৩৭ ট্রাঙ্ক)

২. আবেদন নং ১০ (এস. আর ৩৭ ট্রাঙ্ক)  
৩. আবেদন নং ১১ (এস. আর ৩৭ ট্রাঙ্ক)  
৪. আবেদন নং ১২ (এস. আর ৩৭ ট্রাঙ্ক)  
৫. আবেদন নং ১৩ (এস. আর ৩৭ ট্রাঙ্ক)  
৬. আবেদন নং ১৪ (এস. আর ৩৭ ট্রাঙ্ক)  
৭. আবেদন নং ১৫ (এস. আর ৩৭ ট্রাঙ্ক)  
৮. আবেদন নং ১৬ (এস. আর ৩৭ ট্রাঙ্ক)  
৯. আবেদন নং ১৭ (এস. আর ৩৭ ট্রাঙ্ক)  
১০. আবেদন নং ১৮ (এস. আর ৩৭ ট্রাঙ্ক)

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গণপ্রজাতন্ত্রী বাংলাদেশ সরকার  
জেলা প্রশাসকের কার্যালয়, খুলনা  
এল,এ (সিঃ) শাখা।

স্মারক নম্বর- জেপ্রখু/এল,এ (সিঃ) - ৪২৭ (৮)/২

তারিখ : ০১/২/২০১০ খ্রিঃ

বিষয় : খুলনা ওয়াসা কর্তৃক পানি সরবরাহ ও উন্নয়ন প্রকল্পে ৭০.৩৪ একর জমি অধিগ্রহণের  
বিষয়ে মতামত প্রদান।

সূত্র : স্থানীয় সরকার বিভাগ এর স্মারক নং স্থাসবি/পাস-২/খুঃওয়াসা/এল-১/২০১০/৫৬০,  
তারিখ ১৬/৮/২০১০

উপর্যুক্ত বিষয় ও সূত্রের স্মারকের প্রেক্ষিতে জানানো যাচ্ছে যে, খুলনা ওয়াসা কর্তৃক পানি সরবরাহ ও উন্নয়ন প্রকল্পে ৮৮.২৪ একর জমি অধিগ্রহণের ভূমি ব্যবহারের প্রত্যয়ন পত্র সংক্রান্ত পত্র অত্র কার্যালয়ে পাওয়া গেছে। খুলনা ওয়াসা কর্তৃক পানি সরবরাহ ও উন্নয়ন প্রকল্পের জন্য নিম্ন তফশীল বর্ণিত ৭০.৩৪ একর জমি অধিগ্রহণের জন্য অনাপত্তি প্রদান করা হলো।

তফশীল

জেলা	উপজেলা	মৌজার নাম	জেএলনং	সিট নং	এস,এ দাগ নং	প্রস্তাবিত জমি
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সর্বমোট ৭৯.৩৭ একর জমির মধ্যে অধিহন প্রস্তাবিত জমি : ৬৪.২৫ একর। (কম/বেশি)।

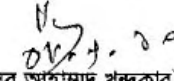
জেলা	উপজেলা/থানা	মোজার নাম	জেএলনং	সিট নং	এস,এ দাগ নং	মোট জমি	প্রস্তাবিত জমি
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সচিব  
স্থানীয় সরকার পল্লী উন্নয়ন ও সমবায় মন্ত্রণালয়  
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তারিখঃ- ০৬ সেপ্টেম্বর, ২০১০ খ্রিঃ।

বিষয় : জাহিকার আর্থিক সহায়তায় খুলনা ওয়াসার প্রস্তাবিত প্রকল্প "Khulna Water Supply Improvement Project" এর জন্য পরিবেশ অধিদপ্তর হতে Site Clearance/Environmental Clearance Certificate প্রদানের উদ্দেশ্যে প্রকল্পের জন্য নির্ধারিত জমি অধিগ্রহণের বিষয়ে যত্নমত প্রদান।

সূত্র : স্থানীয় সরকার ও পল্লী উন্নয়ন ও সমবায় মন্ত্রণালয় এর বিপত ১৬-৮-২০১০ খ্রিঃ তারিখের হুসবি/পাস-২/পুঃওয়াস/এর.-১/২০১০/৫৫৯ নং স্মারক।

উপর্যুক্ত বিষয় ও সূত্রোক্ত স্মারকের প্রেক্ষিতে জানানো যাচ্ছে যে, খুলনা ওয়াসা কর্তৃক পানি সরবরাহ ও উন্নয়ন প্রকল্পে বাগেরহাট জেলার মোলাহাট উপজেলার গাড়কা মৌজার ০২.৫২৬ একর জমি অধিগ্রহণ সংক্রান্ত পত্র পাওয়া গেছে। খুলনা ওয়াসা কর্তৃক পানি সরবরাহ ও উন্নয়ন প্রকল্পের জন্য মোলাহাট উপজেলায় উন্নয়নপূর্ণ ইউনিয়নের গাড়কা নিবাসীগণের বিতর্কিত পানি গ্রাণ্ডির থাকাকালীনকৈ বিবেচনায় যেনে নিম্ন তফসীল বর্ণিত ০২.৫২৬ একর জমি অধিগ্রহণের জন্য অনাপত্তি প্রদান করা হল।

তফসীল

জেলা	উপজেলা	মৌজা	জিএল নং	সিট নং	এল এ	আয়তন (একর)
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(দুই দশমিক পাঁচ দুই হয় একর)

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০১। ব্যবস্থাপনা পরিচালক, বান এ স্কুর রোড, খুলনা ওয়াসা, খুলনা।

জেলা প্রশাসক  
বাগেরহাট।

**ABBREVIATION**

## ABBREVIATION

JICA	:	Japan International Cooperation Agency
ADB	:	Asian Development Bank
AQM	:	Air Quality Management
BBS	:	Bangladesh Bureau of Statistics
BMD	:	Bangladesh Meteorological Department
BWDB	:	Bangladesh Water Development Board
DC	:	District Commissioner
DOE	:	Department of Environment
DOF	:	Department of Fisheries
DTW	:	Deep Tube Well
ECA	:	Ecologically Critical Area
ECR	:	Environment Conservation Rules 1997
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
GIS	:	Geographic Information System
GOB	:	Government of Bangladesh
GPS	:	Global Positioning System
KWASA	:	Khulna Water Supply and Sewerage Authority
IEE	:	Initial Environmental Examination
IUCN	:	International Union for Conservation of Nature and Natural Resources or the World Conservation Union
KII	:	Key Important Informant
LGED	:	Local Government Engineering Department
NGO	:	Non-governmental Organization
NWMP	:	National Water Management Plan
PAP	:	Project Affected Person
SRDI	:	Soil Resource Development Institute
TOR	:	Terms of Reference
SCC	:	Site Clearance Certificate
ECC	:	Environmental Clearance certificate
KCC	:	Khulna City Corporation
LGED	:	Local Government Engineering Department
RHD	:	Roads & Highway Department

  
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**ENVIRONMENTAL IMPACT ASSESSMENT FOR KHULNA  
WATER SUPPLY IMPROVEMENT PROJECT**

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
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
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
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
  
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
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
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**CHAPTER-01**

**INTRODUCTION**

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## CHAPTER 1 INTRODUCTION

### 1.1 Background

Khulna, the third largest city in Bangladesh, is located in the southwest of the country and has a population of 1.5 million at the moment. The present water supply to Khulna is mainly from groundwater sources drawn from production tube wells and both deep and shallow hand tube wells. To cope with current insufficient supply and increasing demand, the Khulna Water Supply and Sewerage Authority (KWASA) plans to construct a new treatment plant for surface water with assistance from the Japan International Cooperation Agency (JICA). Consequently in December 2008 the GOB requested the assistance of the Government of Japan (GOJ) with regard to the improvement of water supply for Khulna and GOJ agreed to undertake the study. Based on the agreement, the JICA has dispatched a JICA study team consisting of various experts to KWASA for conducting a feasibility study for the Water Supply Improvement Project in Khulna.

In this relation, the environmental legislation in Bangladesh, particularly, the Environmental Conservation Act, 1997 (recently amended-Amendment 2000) states that any development project shall require environmental clearance from the Department of Environment (DOE), Ministry of Environment and Forest (MoEF), Government of the People's Republic of Bangladesh. The proposed Project falls under the "Red Category" as per the Environmental Conservation Rules of 1997, which requires submitting an Initial Environmental Examination (IEE) report prior to an Environmental Impact Assessment (EIA) report based on previously approved to obtain both Site Clearance Certificate (SCC) and then Environmental Clearance Certificate (ECC) from the DOE.

On the other hand, JICA may provide a financial assistance for this project in Khulna as a loan scheme of the Japanese ODA (Official Development Assistance). For the implementation of the ODA loan projects, the proposed project shall meet and follow the JICA's guidelines on Environmental and Social Consideration for the loan projects for obtaining necessary clearance from JICA. Thus, in order to implement the construction of proposed water supply project, the Environmental study i.e. IEE, EIA and Land Acquisition Plan (LAP)/Resettlement Action Plan (RAP) shall be conducted accordingly.

As per commitment of protection of the local environment as well as the health and safety of their employees, contractors and the community in and neighborhood of the project area, accordingly Khulna Water Supply and Sewerage Authority (KWASA) engaged the Bangladesh Engineering and Technological Services Ltd (BETS), a reputed Engineering Consultancy firm (herein after referred to as "the Consultant") to conduct IEE and EIA of the proposed project to identify and evaluate all the interactions from the implementation of the project which may have potential impacts upon the adjacent environment as well as to get SCC and ECC from DOE accordingly.

### 1.2 Objective

The overall objectives of this assignment is to conduct EIA study for the Khulna Water Supply Improvement Project proposed by the JICA Study Team in order to assess the biophysical and socio-environmental impacts if any, with recommendation of appropriate mitigation plan in the project areas and to prepare reports on EIA for the Project in

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accordance with the Scoping result in the IEE, Terms and Conditions written in SCC and the followings. (See Chapter 2).

- Environment Conservation ACT 1995
- Environmental Conservation Rules 1997
- DOE's EIA guideline for industries
- EIA Guidelines for Water Resources Sector of Water Resources Planning Organization (WARPO)
- JICA (former JBIC) Guidelines for Confirmation of Environmental and Social Considerations April 2002, JICA
- Asian Development Bank (ADB) safeguard policy Statement 2009

According ECR 2007, water supply projects fall under the "Red" category which requires getting SCC and ECC for the implementation of the water supply projects (See Chapter 2).

### 1.2.1 SCC

#### (1) IEE preparation

Prior to the preparation of EIA and application for ECC to be submitted to DOE, according to the Environmental Conservation Act 2007, an IEE report shall be prepared for applying ECC.

In this regard, the Final Draft IEE report for the project was prepared by the Consultant in the end of June 2010 which was approved by KWASA on August 2010.

#### (2) SCC Issuance

After the IEE report preparation, KWASA prepared the SCC application form including necessary other document which was put forwarded to the DOE Khulna office dated on 8<sup>th</sup> September 2010. All SCC application documents reviewed by the DOE Khulna were transferred to DOE Head Office (HO) in Dhaka dated on 16<sup>th</sup> Sept. 2010.

On 22<sup>nd</sup> Sept. 2010, an Environmental Clearance Committee was convened at DOE HQ Office for evaluating the SCC application of KWASA.


Eventually, the SCC for the project was issued by DOE HO dated on 18<sup>th</sup> October 2010 with the terms and conditions (See Appendix 1.1) in preparing for an EIA report for the project which is necessary for the issuance of ECC.

### 1.2.2 ECC

Based on the Scoping result in the IEE report and the terms and conditions which are subject to the SCC issuance for the project, preparation of an EIA is a must for applying ECC for the project as follows.

- In preparing the EIA Report, detailed description of the aspects referred to in the TOR identified in the IEE shall be incorporated.
- At the time of submitting the EIA Report, the following documents/particulars shall be submitted.

  
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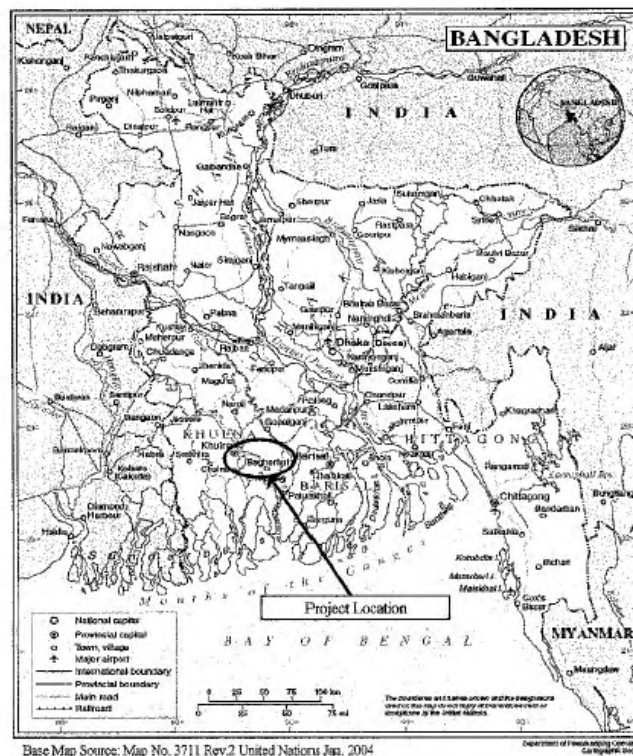
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- Application in Prescribed Form seeking environmental clearance
- Copy of Project Feasibility Report
- No Objection Certificates (NOC) which were issued by relevant District Commissioner offices and KCC in the time of SCC application
- Copy of Chalan (Environmental Clearance Fee), which was remitted to DOE in the time of SCC application
- Others such as like drawings, Maps and so on.

**1.3 Project Overview**

**1.3.1 Location**

Project site is mainly located in and around Khulna city. Figure 1.1 shows a location map of the city of Khulna where is in the northern part of the district, and is mainly an expansion of trade centers close to the Rupsha and Bhairab rivers. The city lies along the River Bhairab over a length of about 15km, covering area of approximately 45 km<sup>2</sup>. Low lying swamps and marshes located in northwest of the city are other major topographic features. (For more details See Chapter 4)



**Figure 1.1 Project Location Map**

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### 1.3.2 Project Components

The followings are the main components of the project: (for more details See Chapter 4)

- Water Intake Facility
- Raw Water Transmission Pipes
- Impounding Reservoir
- Surface Water Treatment Plant
- Clear Water Transmission Pipe
- Distribution Reservoirs
- Overhead Tanks
- Distribution Pipe Networks
- Service Pipe Connection
- Others

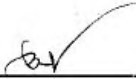
### 1.4 Project Overview

The EIA study was conducted in accordance with the following scope, scoping result in IEE as well as considering all terms and conditions written in the SCC.

#### 1.4.1 Review of Institutional and Statute Framework on Environment and Social Aspects

- (1) Describe the relevant laws, ordinances acts, rules, public notices, regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection endangered species, sizing, and use control, land acquisition, compensation, etc. at the local, regional, national, and International levels as follows:
  - Organizations for environmental management (National and local levels)
  - Environmental legislation and policies (National and local levels)
  - International treaties and agreements ratified and/or signed by the Government
  - IEE/EIA Systems, flow charts and necessary time (days) to be required
  - Environmental licensing system of SCC/ECC (National and local levels)
  - Environmental Monitoring system to be required in the EIA
  - Environmental regulations and standards (National and local levels)
  - Relevant guidelines (to be applied for the JICA water supply project of KWASA)
  - Land Acquisition/Resettlement plan to be required in the EIA system
  - Past practices of environmental impact assessment for projects in the related area
  - Legislation and Policies on Resettlement, land acquisition and compensation for development projects (National and local levels)
  - Law and regulations, local ordinances on Resettlement, land acquisition and compensation for development projects (National and local levels)
  - Organizational systems to be required for Resettlement, land acquisition and compensation (National and local levels)
  - Public consultation, Public Explanatory meeting and public hearing systems on resettlement, land acquisition and compensation systems
  - Monitoring systems after the implementation of resettlement and land acquisition
  - Past practices of Resettlement, land acquisition and compensation for similar projects in the related area

  
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- (2) Review GOB'S current policies, operational procedure and practices to address and mitigate social issues as well as EIA guideline for industries of DOE) the EIA Guidelines for Water Resources Sector of WARPO, and JICA (former JBIC) Guidelines for *Confirmation of Environmental and Social Considerations April 2002 as well as the ADB safeguard policy Statement 2009.*
- (3) Assess the compatibility of the core principles of the Governments' policies with the JICA's policies, identify any gaps and suggest measures for policy enhancements where necessary.

**1.4.2 Describe the proposed assignment with clear explanation of activities**

Providing information on the following:

- (1) Provide satellite image of proposed alignment;
- (2) Present plans and status of the project;
- (3) Layout of existing other utility services network (i.e.: gas pipeline network; DESA, KWASA, T&T etc. which ones are applicable);
- (4) Provide Project area maps at appropriate scales to illustrate general setting of project-related development sites and ROW(right-of-way)'s as well as surrounding areas likely to be environmentally and socially affected;
- (5) These maps shall include topographic contours, as available, as well as locations of major surface waters, roads, railways, town centers, parks and reserves, and political boundaries, etc;
- (6) Also provide as available, maps to illustrate existing land use, including industrial, residential, commercial and institutional development, agriculture, etc;
- (7) General layout of facilities at project related sites;
- (8) Pre-construction activities;
- (9) Provide information on the various operational control and safety system that are part or project design.

**1.4.3 Alternative Analysis**


The environmental assessment should also include an analysis or alternatives that would examine different alternatives with the objective of minimizing environmental, health, safety and social impacts of the project. The analysis would focus on the following:

- Alternative alignments to avoid/minimize damage to environmental sensitive areas.
- Alternative sites for associated facilities (to improve public safety as well as to reduce public interference on such facilities- Social Impacts
- Provide opinion on alternative construction technologies.

**1.4.4 Hazard anti Risk Assessment**

The environmental assessment should also include assessment of various hazards and risks associated with the operation of the Water Supply Project and its associated facilities. The consultant shall identify the potential failures (e.g. leaks in transmission pipelines, cross contamination with sewage and the growth of insect vectors from the impounding reservoir, etc.) in different facilities that could lead to emergencies such as disrupted water supply and acute public health hazard.

  
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Relevant quantitative models shall be used to evaluate the risks and impacts of such failures under different likely scenarios. Based on the assessment of risks and as per the international *best practices, the consultant shall recommend the various preventive measures. The consultant shall also prepare an emergency response and a preparedness plan in order to handle the various emergencies that are identified in the hazard assessment study.*

#### 1.4.5 Public Disclosure

The consultant have been to provide support and assistance to the KWASA in meeting the disclosure requirements, which at the minimum shall meet the Government of Bangladesh, DOE's EIA guidelines, WARPO EIA guidelines, the JICA's Guidelines and the ADB safeguard policy Statement 2009 and others if any on public disclosure. The consultants will prepare a plan for the disclosure, specifying the timing and locations, translate the key documents, such as the Environmental Assessment summary in local language. The consultants shall prepare a non-technical environmental Assessment summary Report for public disclosure.

#### 1.4.6 Description of the Environment and Social Base-line conditions

To collect, evaluate and present baseline up-to-date data on the environmental and social characteristics (air, water and soil quality data, etc.) of the areas to be impacted by the project. For ambient conditions, collect historical data, and collect field observations to validate. Include information on any changes anticipated before the project commences. Describe specific natural resources around the project area.

#### 1.4.7 Physical Environments

- (1) Geology
  - Conditions of geology
  - Stratigraphy and structure
  - Seismic history if any of the areas
  - History and present condition of Landslide
- (2) Topography
  - Conditions of Topography
  - Drainage patterns around each construction area
  - View-shed around facilities
- (3) Soils
  - Soil condition
  - History and present condition of Soil erosion
- (4) Climate and meteorology (data of last 10 years)
  - Temperature
  - Humidity
  - Rainfall
  - Wind velocity and directions
  - Prevail wind
- (5) Hydrology and ground water
  - Ground water table condition of the study area
  - Distribution of main river systems and Coastal zone
  - Conditions of hydrology such as flow pattern,

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- Capacity volume
  - Existing drainage system for surface water
  - River and channel use which may be used for drainage
  - River system and river use ground water level and flow
- (6) Significant sources of pollution in the area and prospects for their mitigation.
- (7) Natural Landscape

**1.4.8 Biological Environment**

- (1) Flora (types and diversity)
- (2) Fauna (resident and migratory)
- (3) Rare or endangered species and protected species within or in areas adjacent in project-related development sites and/or ROW's;
- (4) Sensitive habitats; including wetlands, parks or reserves, significant wild lands, forests like mangroves within or in areas downstream/downgrading of project-related development areas and/or ROWs
- (5) Marine (river) biology and marine (river) resources
- (6) Mapping of ecosystem and habitat of fauna and flora; and
- (7) Species of commercial importance in areas affected by the project

**1.4.9 Pollution**

- (1) Ambient air quality
  - Conditions of air quality (CO, NO<sub>2</sub>, SO<sub>2</sub>, SPM) and climate and traffic volume
- (2) Ambient water quality
  - Conditions of water quality on the Rivers/Channels (water temperature, Cl<sup>-</sup>, pH, DO, BOD, COD, SS)
- (3) Surface water hydrology;
- (4) Receiving water quality (other major pollution sources in the area if any);
- (5) Ambient noise
  - Noise level ( Leq(A), L<sub>50</sub>) and traffic volume (note contribution from major sources; if any)
- (6) Vibration
  - Vibration level (L<sub>10</sub>) and traffic volume
- (7) Solid Waste
  - Present condition of solid waste collection and its pollution
- (8) Ground Subsidence
  - Present condition of Ground Subsidence and its history
- (9) Offensive Odors
  - Present condition of Offensive Odors

**1.4.10 Social Environment (Include both present and projected, where appropriate)**

- (1) Demography and Population
  - Full time and seasonal
  - Population density
  - Households and family structures
- (2) Community structures
  - Distribution of community
  - Distribution of illegal settlement and slum squatter

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- Minority races and communities
- (3) Vulnerable groups
  - Very poor
  - *Those without formal title*
  - Household headed by woman
  - Isolated groups
  - The disabled)
- (4) Land use (i.e. year-round and seasonal)
  - Distribution of land use
  - Land ownership system and its condition
  - Regional development plan
  - Planned development activities
- (5) Economic Activities
  - Economic activities
  - Income of residents (If possible, estimate average income for each source for representative family types)
  - Distribution of income, goods and services
  - Primary and main industry
  - Distribution of major industrial and commercial facilities
  - Condition of recruitment
  - Employment and labour market
- (6) Water Rights and Rights of Common
  - Fishing rights
  - Water rights
  - Rights of common
  - Community associations
  - Regional regulation and restriction
- (7) Customs, aspirations, and attitudes
- (8) Transportation
  - Major transportation network
  - Traffic volumes by types of vehicle in each direction
- (9) Infrastructure and Public Facilities
  - Distribution of major infrastructure and public facilities ex. school, hospital, public market, solid waste disposal site, urban drainage facility, sewage treatment facility, high-voltage electric cable, water pipeline, gas pipe, telephone cable,
- (10) Archaeological and Cultural properties
  - World heritage
  - Locations of archaeological, historical attributes and cultural assets including mosques, monuments
  - History and outline of each property
  - Traditional culture, art and attraction
- (11) Historical and Cultural Landscape
- (12) Recreation
- (13) Public health
- (14) Education
- (15) Risks
  - Traffic accidents
  - land subsidence
  - flood & inundation and so on

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**1.4.11 Determination of the Potential Impacts of the Proposed Project**

Identify all significant impacts, which the project would incur:

- (1) These would include, among others: changes in the following: emissions and ambient air quality, effluents and ambient water quality, ambient noise, land-use
- (2) Impacts due to land acquisition and construction water intake facility, water transmission pipelines, Impounding reservoir and Surface Water Treatment Plant and others (if any).
- (3) Impacts of the project - and their activities on the community's access to social infrastructure. ecologically sensitive areas such as forests, wet lands, national parks, wild life etc.; cultural properties, public water, health center, schools, Irrigation, extension services, markets, roads, sources of credit, government scheme - for development, etc.
- (4) Assess the impacts from changes brought about by the project on baseline environmental and social conditions;
- (5) Assess the impact on health and safety of public and workers,
- (6) Distinguish between positive and negative impacts, direct and indirect impacts including impacts from possible accidents, and immediate and long-term impacts. Identify impacts, which are unavoidable or Irreversible.
- (7) Describe impacts quantitatively, in terms of - environmental and social costs and benefit, assigning economic values when feasible.

**1.4.12 Impacts during Construction**

(1) Environment Impacts

- Loss of vegetation
- Erosion during installation of pipelines, leading to instability in soils and landslides, resulting in runoff and sedimentation in rivers and streams during construction,
- Disruption of traffic;
- Sanitation facilities;
- Housing facilities for workers;
- Noise and vibration
- Accidental (Fire /explosion or other emergencies);
- Blockage of waterways, channels;
- Soil and Water contamination;
- Workers and public safety during construction;
- Others (if any)

(2) Social Impacts

- Displacement people,
- Workers and public safety issues including prevention of HIV and AIDS
- Adverse impacts upon income or Living standards including split of communities, due to land acquisition or other activities associated with construction.
- Others (If any)

**1.4.13 Impacts during operations (including maintenance and repair)**

(1) Environmental Impacts due to

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- Alternation of drainage patterns;
- Impacts of condensate or other effluents;
- *Invasion of exotic plants due to creation of ROW's;*
- Loss of land use and impacts on agriculture and forests;
- Barriers created for human and migratory wildlife;
- Indirect impacts caused by ROW's allowing access to otherwise inaccessible areas;
- Waste/sludge disposal from associated facilities/activities such as SWTP, Impounding reservoir transmission pipes, distribution reservoir and overhead tank maintenance.

(2) Social impacts caused by operation of the project. Among others, these should include

- Impacts on the local market in change in demand for local services;
- Impacts due the creation of barriers including split of communities for human and migratory life and others
- Access to social infrastructure;
- Impacts on employment;
- Impacts on archaeological sites, historical buildings/ heritage;
- Impacts caused by inducing secondary development, such as squatters, within the transmission pipelines ROW.
- Water leakage and cross contamination with sewage
- Threat to public safety.

#### 1.4.14 Development of an Environmental and Social Management Plan

Develop an Environmental and Social Management Plan with feasible and cost-effective measures to prevent or reduce significant negative impacts during construction / installation/ intervention/ post construction/operation stages to acceptable levels.

#### 1.4.15 Environmental Management Plan (EMP)

The management plans contain detailed implementation and monitoring plan along with indicators, construction managements including time restriction, disaster management and emergency response plan, risk management, clear allocation of responsibility among project sponsor, government agencies, and community based organizations for the implementation and monitoring.

It was prepared in consultation with affected people, public authorities and other stakeholders. Provide the list of the bound environmental management activities, who will be responsible for that, what would be the cost, who will pay, and where will the money come from etc.

Identification was made for institutional/organizational needs to implement the recommendations of the project in EIA. As well steps to strengthen or expand were proposed, if required. This extends to new agency functions, inter-sectoral arrangements, management procedures and training, stalling, operation and maintenance, training and budgeting,

#### 1.4.16 Monitoring Plan

Types of monitoring needed for potential environmental impacts during construction' and operation have been specified in the EIA. In addition, detailed mitigation measures to address

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the environmental consequences associated with the project have been discussed in the EIA. The mitigation measures for construction/ installation intervention/ post construction operation phases (including maintenance and repair) of the project have been discussed in the EIA. Among other things, this focused on:

- Treatment and discharge of sludge;
- Control of waste materials including surplus soil
- Control of Insect Vectors from impounding reservoir
- Storage and handing of material and equipment
- Public Health
- Improving public safety
- Traffic management and road safety
- Measures to manage all construction related impacts.

#### 1.4.17 Social Management Plan

A Social Management Plan has been proposed to address the adverse impacts on project affected persons.

#### 1.4.18 Consultation with Affected Groups

The EIA process involved consultation and participation with the affected groups. Prepare a consultation strategy to ensure that all affected people and stakeholders are fully informed about the project, and the views of these people on the consequences of the project are taken into account consideration.

#### 1.5 Methodology

A team of multidisciplinary specialists were employed to prepare the EIA Report. Both secondary and primary data were used in the preparation of the EIA Report.

The EIA study has been conducted and prepared based on the information provided by KWASA. All possible secondary information and data have been collected from all relevant sources and from the field through observation, primary data collection, public consultation, survey and certain degree of field validation.

During this process, the following steps have been followed:

- A map of the area surrounding the proposed Project has been prepared. These areas are the bases for collecting relevant information and data needed for the EIA Study. Numerous Field Enumerators have been engaged for carrying out extensive survey in the designated area and for collecting relevant data as per designed Questionnaire Formats. While the field survey was gaining momentum, several Focus Group Discussions (FGD) were held comprising the members of the public, representing different professions, NGOs and CBOs. In these FGD meetings, the participants were listed and their opinion/comments were recorded in well designed Formats. Finally, all these data have been entered into a computer to form a data base and analyzed.
- Review the already conducted EIA for completed projects and identify areas to focus during the EIA;
- Collection of information relating to the study from KWASA;

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- Detailed understanding of the scope of the assignment, activities involved and for the intervention areas and their surrounding environment;
- Engage resource persons / field staff keeping in mind the limited time available for the assignment, arrange mobilization and necessary orientation;
- Collect all possible data on the environmental, social and natural resource components and parameters of necessity;
- Collection and review of pertinent reports and other references. *This particularly included DOE EIA Guidelines for industries, Environmental policies, strategies and acts.*
- Meet concerned agencies and gather information from various government and other agencies of concern (*Local Union Councils, Upazilla Councils, KWASA, DOE, BWDB, etc*);
- Develop and utilize different information gathering tools, as necessary or deemed appropriate;
- Undertake field visits and field surveys including public hearing process;
- Conduct a representative survey using prepared questionnaire covering a wide cross-section of people in the study area;
- Collect samples, as necessary (air, water, noise) from predetermined points and areas within the study area and analyze relevant parameters;
- Identification of environmental, biological and social impacts and evaluation of their significance and consequences;
- Consult the people / stakeholders in the intervention areas through a public consultation process;
- Presentation of an outline of a management plan for future to handle the environmental, and social management issues;
- Prepare the draft EIA report;
- Receive feedback on the draft and obtain quality check; and
- Prepare the Final EIA Report incorporating the observations from KWASA and DOE and submit the same to KWASA.

In the process of preparing the EIA, EIA Guidelines of DOE for industries have been specially consulted and considered.

#### 1.6 Limitations

Major limitation of the present study is the time constraints. EIA report generally requires primary data on seasonal basis. This could not be materialized due to limitation of time. Further, the work was interrupted due to delaying site selection. However, all possible attempts have been made to collect maximum information within the stipulated time frame.

#### 1.7 Structure of the Report

Chapter -1	Introduction: The introduction chapter presents a brief overview of the assignment along with background, objectives, project components, scope of work methodology etc.
Chapter -2	Policy legal and Administrative Framework: Chapter Two outlines the

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- Chapter – 3 policy and legislation on the environmental issues.  
Project Description: Chapter Three describes the project components and location, size and other aspects of the components
- Chapter – 4 Environmental Baseline and Existing Facilities: Chapter four presents the description of the environmental baseline (Socioeconomic, physical and biological) of the project. This chapter also includes existing facilities of water supply system.
- Chapter – 5 Public Consultation: This section includes:  
(i) describes the process undertaken during project design and preparation for engaging stakeholders, including information disclosure and consultation with affected people and other stakeholders;  
(ii) summarizes comments and concerns received from affected people and other stakeholders and how these comments have been addressed in project design and mitigation measures; and  
(iii) describes the planned information disclosure measures (including the type of information to be disseminated and the method of dissemination) and the process for carrying out consultation with affected people and facilitating their participation during project implementation.
- Chapter – 6 Identification, Prediction and Mitigation of Potential Impacts: This chapter deals with the identification of potential impacts of the proposed project and possible mitigation measures.
- Chapter – 7 Environmental Monitoring Plan: The chapter mainly deals with the monitoring program of the project.
- Chapter – 8 Conclusion and Recommendation: This chapter gives the finding, conclusion and recommendation of the project.

### 1.8 The EIA Team

The EIA team comprising various environmental and social expert to conduct EIA for the Project. The team comprising the following experts:

- 1 Water Supply Specialist
- 2 Environmental Specialist
- 3 Geologist/ Hydrologist
- 4 Socio-economist
- 5 Ecologist
- 6 Resettlement specialist
- 7 Surveyor and survey team
- 8 A group of Data Collectors cum Field Personnel (Enumerator)

### 1.9 Acknowledgment

The EIA Team has prepared this EIA Report on behalf of KWASA.

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The Project proponent had been extremely positive in providing necessary information and documents and also in providing necessary guidance during undertaking of the study and preparation of the report. The Consultant gratefully acknowledges the help, advice and information provided by the Khulna Water Supply and Sewerage Authority (KWASA) as well as the support and interest shown by local people, government and non-government organizations.

  
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**CHAPTER-02**

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**POLICY AND LEGAL CONSIDERATIONS**

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## **CHAPTER 2 LEGAL REGULATORY AND POLICY FRAMEWORK**

### **2.1 Introduction**

The proposed water supply project to be implanted by KWASA requires strict compliance with laws, rules and regulations pertinent to environment. The Department of Environment (DoE) of Government of Bangladesh is responsible for ensuring application of environmental laws and issuance of necessary clearances in industrial and development activities.

KWASA shall conduct its operations in compliance with local, national legislations and international Agreements. The proposed project shall be conducted in accordance with Bangladesh Legislation or International Agreements to which Bangladesh is a party.

### **2.2 Environmental Agencies**

There are a number of agencies relevant to the environmental considerations / concerns in Bangladesh. Following sub-sections present a precise description of such organizations.

#### **2.3.1 Ministry of Forest and Environment (MoFE)**

The Ministry of Environment and Forest (MoEF) is the key government institution in Bangladesh for matters relating to national environmental policy and regulatory issues. Realizing the ever-increasing importance of environmental issues, the MoEF was created in 1989 and is presently a permanent member of the Executive Committee of the National Economic Council. This group is the major decision-making body for economic policy and is also responsible for approving public investment projects. The MoEF oversees the activities of the following agencies:

- Department of Environment (DoE);
- Department of Forest (DoF);
- Forest Industries Development Corporation;
- Bangladesh Forest Research Institute and Institute of Forestry;
- Forestry Division of the Bangladesh Agricultural Research Council and
- National Herbarium.

Of the above agencies precise description of the first two departments including other pertinent ones are presented below as considered relevant.

#### **2.3.2 Department of Environment (DoE)**

The Department of Environment (DoE), established in 1989 under the jurisdiction of the MoEF, is the executing agency for planning and implementing environmental issues including, but not limited to, the following activities:

- Reviewing environmental impact assessments and issuing environmental clearance where appropriate;
- Implementing environmental monitoring programs and enforcement measures;
- Developing and maintaining environmental data bases, and
- Coordinating international events with the MoEF (e.g., representing Bangladesh in international seminars, workshops, etc).

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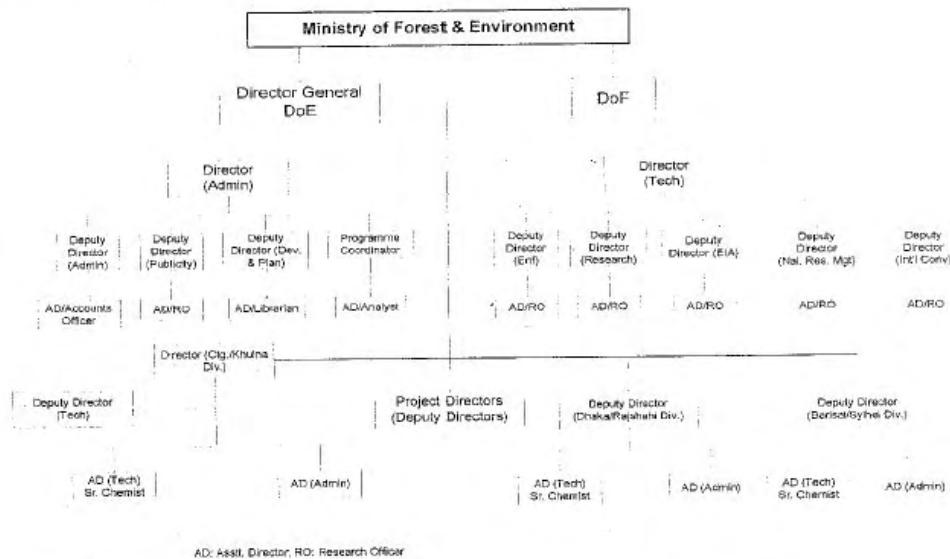
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The DoE is headed by a Director General (DG) who is supported by a team of Directors, Deputy Directors, Assistant Directors, Engineers, and other technical staff (e.g., chemists and laboratory technicians). The DoE has regional offices, monitoring stations and several laboratories. Figure-2.1 shows the Organizational Set-up of DoE.

**2.3.3 Department of Forest (DoF)**

The Department of Forest (DoF), under the Ministry of Environment and Forest, is responsible for protection and management of the Reserve Forests in the country. The department manpower extends down to Union levels in areas where reserve forest exists. Officers of the DoF are responsible for protection of wildlife in these forest areas.



Source: MOEF

**Figure 2.1 : The Organizational Set-up of DoE.**

**2.3.4 Ministry of Land - Land Reform and Land Acquisition Directorate**

The Ministry of Land (MoL) manages revenue generation for Government-owned land (called khas), excluding agency-owned lands controlled by the Bangladesh Water Development Board (BWDB), Roads & Highways, etc. The MoL controls open water bodies (rivers, beels, haors) above a specified size, except for those that were transferred to the Ministry of Fisheries and Livestock under the new fisheries management policy. The MoL must approve the process where the government acquires private land on behalf of a private development program.

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**2.3.5 Ministry of Water Resources and Flood Control - Bangladesh Water Development Board (BWDB)**

The Ministry of Water Resources and Flood Control is responsible for the water management program of the country. This includes preparation and implementation of water master plans, flood control measures, surface and ground water hydrology data-collection, modeling, monitoring and planning irrigation projects. The executing agency is the Bangladesh Water Development Board (BWDB).

**2.3.6 Ministry of Fisheries and Livestock - Directorate of Fisheries**

The Directorate of Fisheries, under the Ministry of Fisheries and Livestock, is responsible for managing the fish seed farms in each district. It is also responsible for managing 152 open water bodies under the new fisheries management policy which includes open rivers, depressed basins (haors), oxbow lakes (baors) and other large inland permanent water bodies (beels).

**2.3 Environmental Policies**

**2.3.1 National Environmental Policy**

Bangladesh National Environmental Policy of 1992 sets out the basic framework for environmental action together with a set of broad sector guidelines. The Environment Policy provides the broader framework of sustainable development in the country. It also states that all major undertakings, which will have a bearing on the environment, (including setting up of an industrial establishment) must undertake an IEE / EIA before they initiate the project.

The Environment Policy delineates the Department of Environment (DOE), as the approving agency for all such IEE / EIAs to be undertaken in the country.

Policies of fifteen sectors are described in the Policy. Under the Energy and Fuel sector, the use of fuel that has the least environmental impact is encouraged. Conservation of fossil fuel and the need for conducting EIAs before implementation of projects for fuel and mineral resources is stressed in the policy.

Under the Environmental Action Plan Section of the Policy, under sub-section 'Fuel and Energy', it suggests that:

- In the rural areas the use of gas, coal, kerosene and petrol as fuel will be expanded, so that fuel wood, agricultural residues, and cow dung is conserved. This will help use of agricultural residues, and cow dung etc. as manure; and
- Appropriate measures will be taken to ensure that extraction, distribution and use of natural resources such as oil, gas, coal etc. do not adversely affect air, water, land, the hydrological balance and the ecosystem.

"Forest, Wildlife and Biodiversity" section requires:

- Conserve Wildlife and Biodiversity, strengthen related research and help dissemination and exchange of knowledge in these areas; and
- Conserve and develop wetlands and protection of migratory birds.

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### 2.3.2 National Water Policy (1999)

National Water Policy (NWP) was adopted in 1999 and it explicitly states 6 main objectives

- To address the use and development of groundwater and surface water in an efficient and equitable way
- To ensure the availability of water to all parts of the society
- To accelerate the development of public and private water systems through legal and financial measures and incentives, including appropriate water rights and water pricing rules
- To formulate institutional changes, encouraging decentralization and enhancing the role of women in water management
- To provide a legal and regulatory framework this encourages decentralization, consideration of environmental impacts, and private sector investment

### 2.3.3 National Policy for Arsenic Mitigation (2004)

Complementing the NWP, the government adopted a National Policy for Arsenic Mitigation in 2004. The policy emphasizes public awareness, alternative safe water supply, proper diagnosis and management of patients, and capacity building. In terms of alternative supplies it gives "preference to surface water over groundwater".

The Department of Public Health and Engineering (DPHE) under the Ministry of Local Government, Rural Development and Co-operatives (MLGRD&C) are in charge of assisting municipalities and communities in building water supply infrastructure, exclusive Dhaka, Chittagong and Khulna. For the above three metropolitan areas Water and Sewerage Authority (WASA) is responsible to provide water supply and sewerage facilities to the subscribers.

### 2.4 National Conservation Strategy

National Conservation Strategy was drafted in late 1991 and submitted to the Government in early 1992. This was approved in principle; however the final approval of the document is yet to be made by the cabinet.

### 2.5 National Environmental Management Action Plan

The National Environmental Management Action Plan (NEMAP) is a wide ranging and multi-faceted plan, which builds on and extends the statement set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements for a period during 1995 to 2005 and sets out the framework within which the recommendations of the National Conservation Strategy are to be implemented.

NEMAP has the broad objectives of:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;

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- Promotion of sustainable development; and
- Improvement in the quality of life of the people.

## **2.6 National Water Management Plan (2004)**

NWMP was approved by the National Water Resources Council (NWRC) in 2004 and aims at implementing the NWMP within 25 years. It is expected to be reviewed and updated every five years. In 2005, the government included the improvement of water supply and sanitation as part of its agenda for reducing poverty.

## **2.7 Environmental Acts and Rules**

### **2.7.1 The Environmental Conservation Act, 1995**

The Bangladesh Environment Conservation Act of 1995 (ECA '95) is currently the main legislation relating to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. It has repealed the Environment Pollution Control Ordinance of 1977.

The main objectives of ECA '95 are:


- Conservation and improvement of the environment; and
- Control and mitigation of pollution of the environment.

The main strategies of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried out/ initiated in the ecologically critical areas;
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of the industries and other development activities' discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines.

Before any new project can go ahead, as stipulated under the rules, the project promoter must obtain Environmental Clearance from the Director General. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of 5 years imprisonment or a maximum fine of Tk.100,000 or both. The Department of Environment (DoE) executes the Act under the leadership of the Director General (DG).

  
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**2.7.2 Bangladesh Environment Conservation Act (Amendment 2000)**

This Act focuses on: (1) ascertaining responsibility for compensation in cases of damage to ecosystems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences.

**2.7.3 Bangladesh Environment Conservation Act (Amendment 2002)**

This Act elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale, production of environmentally harmful items like polythene bags, (3) assistance from law enforcement agencies for environmental actions, (4) break up of punitive measures and (5) authority to try environmental cases.

**2.7.4 East Bengal Protection and Conservation of Fish Act (1950)**

The East-Bengal Protection and Fish Conservation Act of 1950, as amended by the Protection and Conservation of Fish (Amendment) Ordinance of 1982 and the Protection and Conservation of Fish (Amendment) Act of 1995, provide provisions for the protection and conservation of fish in inland waters of Bangladesh. This is relatively unspecific and simply provides a means by which the Government may introduce rules to protect those inland waters not in private ownership.

This is framework legislation with rule making powers. Among others, some of these rules may:

- Prohibit the destruction of, or any attempt to destroy, fish by the poisoning of water or the depletion of fisheries by pollution, by trade effluent or otherwise.

**2.7.5 The Protection and Conservation of Fish Rules (1985)**

These are a set of rules in line with the overall objectives of the Fish Act. The Rule requires that "no person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters". The Rule further states - "No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters".

**2.7.6 Environment Conservation Rules (1997)**

These are the first set of rules, promulgated under the Environment Conservation Act of 1995 (so far there have been three amendments to this set of rules - February and August 2002 and April 2003). The Environment Conservation Rules of 1997 has provided categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects. Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for IEE / EIAs according to categories of industrial and other development interventions.

The Rules are not explicit for various oil and gas exploration interventions. Rather, this is covered under the broader heading of "exploration, extraction and distribution of mineral resources" under

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the Red Category Projects. The proposed project, according to the DoE, falls under the Red category of the Environmental Conservation Rules, 1997. Exploration of some of the mineral resources, including hydrocarbons, should not be treated as a Red Category activity, as the environmental issues involved due to such exploration are often moderate and the physical activities of exploration in the field are very temporary and in general do not cause a significant impact.

2.7.7 Other Relevant Acts, Ordinances and Rules

Table 2.1, 2.2 and 2.3 summarizes relevant acts, ordinances and rules to be considered for compliance for the maintaining sustainable environment for development projects.

Table 2.1 Relevant Acts Ordinances and Rules in Bangladesh

Title	Year	Objectives
East Bengal protection and conservation of fish act	1950	Conservation and development of fisheries resources.
The protection and conservation of fish rules	1958	Prevention of harming fisheries resources and fisheries habitat in coastal and inland waters
Antiquities act	1958	Protection and preservation of Archeological and historical articles
Port rules, shipping operation.	1960, 1966	Control of discharges in ports; waterway rules
Factories act	1965	Industrial workers' health and working conditions.
Pesticide ordinance	1971	Pesticide use, production, selection and importation.
Antiquates (Amendment) Ordinance	1976	Protection and prohibition export of archeological artifacts.
Municipal ordinance	1977	Municipal activities in health, sanitation, water supply, drainage, etc in the city.
Factory rules	1979	Disposal of wastes and effluents.
Agricultural pesticide (amendment) act	1980	Revised agricultural pesticides ordinance.
Acquisition and requisition of immovable properties ordinance	1982	The acquisition of immovable property rules, 1982 (No. S. R. O. 172-U82) The Government made these rules in exercise of the powers conferred upon by section 46 of the acquisition and requisition of the immovable property ordinance, 1982 (Ordinance No. II of 1982).
Agricultural pesticides (Amendment) ordinance.	1983	Revised agricultural ordinance.
The pesticide rule	1985	Pesticides selling, use and safety measures.
Bangladesh standard specification for drinking water.	1990	Formulation and revision of national standards.
The penal code	1996	This contains several articles related with environmental protection and pollution management.
Building construction (Amendment) act and building construction rules	1996	The Rules are more comprehensive to take care of the present day circumstances and issues of building.
Inspection and Enforcement manual	2008	This manual has been written to provide national standard and uniformity environmental sampling for the inspections, investigations and chemist in the Department of Environment (DOE) in Bangladesh. Field Inspection, Compliance & enforcement: -Inspection and monitoring to verify compliance -Investigation of the suspected violators -Using enforcement tools to obtain compliance

Source: Bangladesh Environmental Lawyers Association, 2004

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**Table 2.2 Summarizes relevant statute including policy, strategy, action plan, act, ordinance on Environment, Social & Inspection consideration during construction stage of Bangladesh.**

Title	Year	Outline
Social Security under the Act, 1923 and an amendment in 1980	1923	<ul style="list-style-type: none"> <li>According to the relevant laws and ordinance like Social Security Act, 1923, as to standard concept "Social impact assessment includes the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment, in the project development &amp; construction work.</li> </ul>
The Employer's Liability Act	1938	<ul style="list-style-type: none"> <li>The Employer's Liability Act, 1938 declares that the doctrine of common employment and of assumed risk shall not be raised as a defense in suits for damages in respect of employment injuries. Under the Maternity Benefit Act, 1939, the Maternity Benefit Act, 1950, the Mines Maternity Benefit Act, 1941, and finally the rules framed there under, female employees are entitled to various benefits for maternity, but in practice they enjoy leave of 6 weeks before and 6 weeks after delivery.</li> <li>Statutory provisions exist for only two contingencies, i.e. employment-related injuries and childbirth. The liability in both cases is entirely that of the employer. The Workmen's Compensation taka 400 per month, including all railway and other categories of workers specified in the Act, e.g. workers engaged in factories, mines, plantations, loading or unloading, construction or repairs to mechanically propelled vehicles.</li> </ul>
Public Health (Emergency Provisions) Ordinance, 1994	1994	<p><b>Public Health &amp; Diseases Related Education like AIDS/HIV:</b></p> <ul style="list-style-type: none"> <li>Calls for special provisions in regard to public health. Whereas an emergency has arisen, it necessary to make special provision for preventing the spread of human disease, safeguarding the public health and providing them adequate medical service and other services essential to the health of respective community and workers in particular during the construction related work.</li> </ul>
The Employees State Insurance Act	1948	It has to be noted that health, injury and sickness benefit should be paid to people particularly respective workers at work place under the this Act of 1948.
Bangladesh Factory Act	1979	Calls for every workplace like small or large scale construction i.e. KWASA, where in particular women are employed should have an arrangement of childcare services. As per this factory Act and Labor Laws medical facilities, first aid and accident and emergency arrangements are to be provided by the authority to the workers at workplace like KWASA project.
Water Supply and Sewerage Authority Act, 1996	1996	The Act calls for specifically ensuring water supply and sewerage system to the public and its development extensive and preservation with considering others related to health and environmental facilities to the community.
Building Construction Act	1952	<p>This Act calls for prevention of haphazard construction of building and other objects which are likely to interfere with the planning of creation of certain areas in Bangladesh. During the large or small scale construction.</p> <p>According to the Act and building code regulation of Bangladesh the largest number of constructors traditionally stick to building construction. This could cover the following areas:</p> <ul style="list-style-type: none"> <li>Housing units and compound complexes,</li> <li>Any large or small scale construction</li> <li>Schools</li> <li>Recreation facilities</li> <li>Hospitals</li> <li>Community development centres</li> <li>Commercial complexes &amp; shopping centres</li> <li>Industrial complexes and factory sheds, and</li> <li>Multi-storey residential and office blocks</li> </ul> <ul style="list-style-type: none"> <li>Calls for any unauthorized construction hampers to people's normal life</li> </ul>

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Building Construction Rules	1996	can be removed through demolish by the enforcement authorities. Building Construction (amendment) Rules, 1996 concerns all Development Authorities and Local Governments. i.e. accident, injury etc.
Labour Relations under Labor Laws, (Some major revisions combined 25 scattered Acts and Ordinances to formulate on updated code.)	1996	<ul style="list-style-type: none"> <li>▪ Labor laws specifically concerns during development work to the project manager has to learn to live with the labor union which is generally out to squeeze &amp; more &amp; more money for less &amp; less work. It can mislead the labor, resulting in work stoppages &amp; strikes. In social point of view, in big construction and labor-strike sensitive areas, it may be a good idea to have a labor-relations man visiting the job site as often as necessary. And a periodic review of the living conditions and minimum wages of the labor must not be ignored. Peace must be maintained without giving into unreasonable demands, taking care that the prevalent market conditions are met.</li> </ul>
Khulna City Corporation Ordinance Ordinance No. LXXII of 1984	1984	<p>This ordinance may be called the Khulna City Corporation Ordinance, 1984. In this Ordinance part IV stated that the corporation shall be responsible for the sanitation of the City and for this purpose it may cause such measures to be taken as are required by or under this Ordinance. The following socio-environmental factor for the public convenience may be ensured</p> <ol style="list-style-type: none"> <li>(1) Insanitary Building:             <ol style="list-style-type: none"> <li>a) to clean or otherwise put it in a proper state;</li> <li>b) to make arrangements to the satisfaction of the Corporation for its proper sanitation for the public in related workplace including construction work in a large whole;</li> <li>c) to take such other steps in regard to such building construction or such related specified work need to considered as social issues.</li> </ol> </li> <li>(2) Latrine and Urinals:             <ol style="list-style-type: none"> <li>a) Corporation may, and if so required by the Government shall, provide and maintain, in sufficient number and in proper sanitation, public latrines and urinals for the separate use of each sex may be considered in the work place.</li> </ol> </li> <li>(3) Infectious Diseases and Promotion of Public Health:             <ol style="list-style-type: none"> <li>a) The Corporation shall adopt such measure to prevent infection disease like other disease HIV/AIDS and needed for proper education in this regard.</li> </ol> </li> </ol>

Source: Bangladesh Government Rules and Regulation book

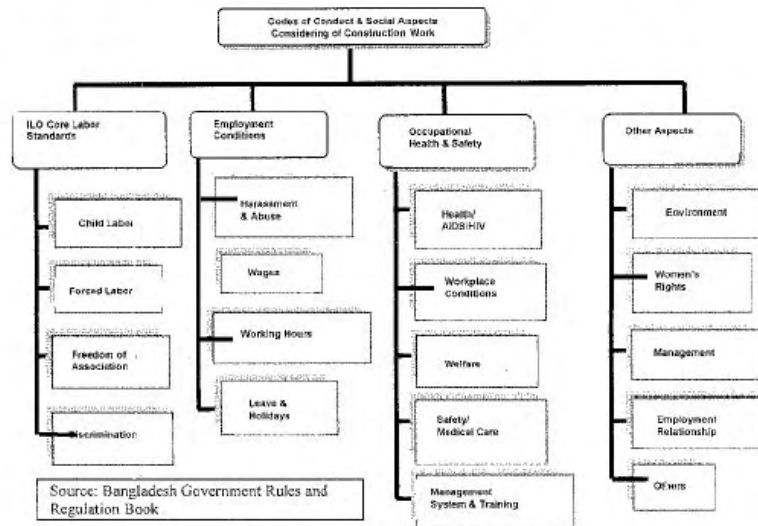


Figure: 2.1 Comparative view between the Bangladesh Labor Law 2006 and several general codes of conduct

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Table 2.3 Detailed Comparison of the Bangladesh Labor Law and General Codes of Conduct Including Socio-environmental Factors during Development & Construction

Standard	Bangladesh Labor Law 2006	Social Accountability Int. SA 8000 (SAI)	Ethical Trading Initiative (ETI)
Child Labor	<p><b>Minimum age:</b> 14 years Child attaining 12-year age may be employed if the work is not dangerous for his health &amp; development and does not hamper education.</p>	<p>Minimum age 15; or 14 if meets developing country exemption; or local minimum age if higher</p>	<p>Minimum age 15; or 14 in accordance with developing country exception under ILO Convention 138; or local minimum age if higher • Adequate transitional and economic assistance provided to any replaced child workers</p>
	<p>Restriction of appointment of adolescent in certain work Cleaning, or for other adjustment operation of the machinery while it is in motion. • Any work in under ground or under water</p>	<p>• Not expose children or young workers to situations that are hazardous, unsafe, or unhealthy</p>	<p>Children and young people under 18 not employed in hazardous conditions</p>
Working Hours	<p><b>Maximum hours:</b> 48/week - 8/day <b>Overtime:</b> 12/week - 2/day</p>	<p>• 12/week • overtime voluntary • not demanded on regular basis</p>	<p>12/week • Overtime voluntary • not demanded on regular basis</p>
Leave	<p><b>Leave and holidays:</b> Weekly: 1 day off Annual leave: 1 day for every 18 days of work performed during previous period of 12 months <b>Festival Holidays:</b> 11 Casual leave: 10 days with full payment Sick leave: 14 days with full payment</p>	<p>• 1 day off in 7</p>	<p>• 1 day off in 7</p>
Health and Safety	<p><b>Health:</b> Healthy working environment Access to clean facilities and potable water provision of dustbins and spittoons First Aid Appliances Medical Facilities <b>Workplace Conditions:</b> Space Temperature Ventilation Noise Light Safety: Safety of building Safety of machinery Gates/Stairs Emergency Exits Fire extinguisher Personal protective equipment Welfare: First aid appliances <b>Toilets and washing facilities</b> Where &gt; 100 workers - canteen Where &gt; 50 workers - Rest room Where &gt; 40 female workers employed - child crèches/daycare <b>Training:</b> • Where &gt; 10 workers are employed other than in the ground floor, there shall be a training for all the workers about the means of escape in case fire. • There shall be a parade of fire extinction and escape at least once a year in a factory where more than fifty workers are employed.</p>	<p>Access to clean facilities and potable water, and if appropriate, sanitary facilities for food storage. • Safe and hygienic working environment- knowledge of industry and specific hazards • Take adequate steps to prevent accidents and injury, by minimizing the causes of hazards • Responsibility for health and safety assigned to senior management representative. • Establish systems to detect, avoid or respond to potential threats to the health and safety. • Accommodation, where provided, meets basic needs of workers.</p> <p>• all workers shall receive regular and recorded health and safety training</p>	<p>• Safe and hygienic working environment; knowledge of industry and specific hazards • Access to clean facilities and potable water, and if appropriate, sanitary facilities for food storage • Accommodation, where provided, meet basic needs of workers. • Responsibility for health and safety assigned to senior management representative. • Workers receive regular and recorded health and safety training.</p>
Environment	<p><b>Disposal of waste and effluents:</b> Every establishment shall have the proper arrangement to remove the wastes created from the process of manufacturing.</p>	N/A	N/A
Employment Relationship	<p>• Employer shall provide employment contract and Identity card with photo to every employee • Appointment Letter and Identity Card, Service Book; register of workers</p>	<p>Not avoid obligations under law through use of labor-only Contracting or false apprenticeship schemes</p>	<p>Work should be performed on Basis of recognized employment relationship established through law and national practice. • Not avoid obligations under law through use of labor-only contracting, subcontracting or home-working arrangements or apprenticeship schemes</p>

Source: Bangladesh Government Rules and Regulation Book

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2.8 Land Acquisition Rules and Regulations

Table 2.4 shows relevant ordinance and acts on land acquisition and resettlement in Bangladesh.

Table 2.4 Relevant ordinance and Act on land acquisition and resettlement

Title	Year	Outline
Acquisition and Requisition of Immovable Property Ordinance	1982	The Ordinance (Ordinance 11 of 1982) has replaced the Land Acquisition Act of 1894 and the East Bengal (Emergency) Requisition of Property Act of 1948. The Ordinance governs acquisition and requisition by the government of immovable property for any public purpose or in the public interest. It may be noted that contrary to the previous Acts (i.e. Act XIII of 1948), this Ordinance deals only with immovable property. Detailed procedures have been prescribed to ensure that a deputy commissioner proceeds systematically and on sound principles in such cases, leaving room for owners to raise objections which must be disposed of after due hearing. In addition, the Ordinance has well-defined procedures regarding payment of compensation for an acquired piece of land. If, for example, the land is used for rice growing, then an amount equivalent to approximately 1.5 times the market value of a given variety of rice (e.g. paddy) that is currently being (or could be) produced annually is fixed as a yearly lease value. In case of outright purchase (carried out on a 99-year lease), the compensation-value of acquired land varies widely according to the locality, soil fertility, and access to transportation and related infrastructure factors.
The Acquisition of Immovable Property Rules 1982	1982	The Acquisition of Immovable Property Rules of 1982, are made for the exercise of the powers conferred upon by Section 46 of the Acquisition and Requisition of Immovable Property Ordinance 1982.
Land Reform Ordinance	1984	Under the Ordinance 1984, families owning lands up to 60 Bighas (about 6.7 ha) at a given time were to be barred from acquiring further land by purchase, inheritance, or otherwise. A family or person inheriting lands in excess of 60 Bighas would have to surrender the 'surplus' land, for which due compensation was to be paid.
The Movable Property Requisition (Compensation) Rules, 1990	1990	The Rules makes provision for constituting a Compensation Assessment Committee in each district for determining compensation for any requisitioned vehicle, vessel or bus, truck, minibus etc. In case of requisition of a vehicle or vessel, the order of requisition should clearly state the period of requisition, purpose of requisition, and the amount of compensation to be awarded.
Acquisition and Requisition Act, 1994 (under determining compensation)	1994	In December 1994 the government passed a rule in order to amend the provisions of the Acquisition of Property on Emergency Basis Act 1989 for determining compensation under the Acquisition and Requisition Act. According to this Rule, in case of an arbitration suit lodged against the compensation determined by the Deputy Commissioner an increase of only an additional 10 % of the compensation can be awarded by the Arbitrators. Similarly, the Arbitration Appellate Tribunal should limit its award to within this additional 10 %.

Source: Acquisition and Requisition of Immovable Property Ordinance 1982,  
Land Reform Ordinance, 1984  
Banglapedia "National Encyclopedia of Bangladesh", February 2006, Asiatic Society of Bangladesh  
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2.9 National Environment Quality Standards

At present there are environmental standards in operation in Bangladesh also promulgated under the Environment Conservation Rules of 1997. There are standards prescribed for varying water sources, ambient air, noise, odor, industrial effluent and emission discharges, vehicular emissions, etc. The standards, commonly known as Environmental Quality Standards (EQS), are legally binding. The Bangladesh standards for ambient air, noise, odor, sewage, industrial effluent and emission are furnished hereinafter as six separate Tables, Table 2.5 to Table 2.12. These are all in an authentic translation from original Bengali citing the specific source.

Table 2.5 National Standard for Inland Surface Water

Best Practice based classification	pH	BOD (mg/l)	DO (mg/l)	Total Coliform Number/100
a. Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
b. Water usable for recreational activity	6.5-8.5	3 or less	5 or more	200 or less
c. Source of drinking water for supply after conventional treatment	6.5-8.5	6 or less	6 or more	5000 or less
d. Water usable by fisheries	6.5-8.5	6 or less	5 or more	---
e. Water usable by various process and cooling industries	6.5-8.5	10 or less	5 or more	5000 or less
f. Water usable for irrigation	6.5-8.5	10 or less	5 or more	1000 or less

Notes: 1. In water used for pisciculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.  
2. Electrical conductivity for irrigation water – 2250 μmhos/cm (at a temperature of 25°C). Sodium less than 26%, boron less than 0.07 mg/l.  
Source: Department of Environment (DOE)

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**Table 2.6 National Standard for Drinking Water**

Parameter	Unit	Standards	Parameter	Unit	Standards
1. Aluminium	mg/L	0.2	26. Hardness (as CaCO <sub>3</sub> )	mg/L	200-500
2. Ammonia (NH <sub>3</sub> )	mg/L	0.5	27. Iron	mg/L	0.3-1.0
3. Arsenic	mg/L	0.05	28. Kjeldahl Nitrogen (total)	mg/L	1
4. Barium	mg/L	0.01	29. Lead	mg/L	0.05
5. Benzene	mg/L	0.01	30. Magnesium	mg/L	50-35
6. BOD <sub>5</sub> 20°C	mg/L	0.2	31. Manganese	mg/L	0.1
7. Boron	mg/L	1.0	32. Mercury	mg/L	0.001
8. Cadmium	mg/L	0.005	31. Manganese	mg/L	0.1
9. Calcium	mg/L	75	32. Mercury	mg/L	0.001
10. Chloride	mg/L	150-600*	33. Nickel	mg/L	0.1
11. Chlorinated alkanes			34. Nitrate	mg/L	10
carbon tetrachloride	mg/L	0.01	35. Nitrite	mg/L	<1
1,1-dichloroethylene	mg/L	0.001	36. Odor	mg/L	Odorless
1,2-dichloroethylene	mg/L	0.03	37. Oil and grease	mg/L	0.01
tetrachloroethylene	mg/L	0.03	38. pH		6.5-8.5
trichloroethylene	mg/L	0.09	39. Phenolic compounds	mg/L	0.002
12. Chlorinated phenols			40. Phosphate	mg/L	6
pentachlorophenol	mg/L	0.03	41. Phosphorus	mg/L	0
2,4,6-trichlorophenol	mg/L	0.03	42. Potassium	mg/L	12
13. Chlorine (residual)	mg/L	0.2	43. Radioactive materials (gross alpha activity)	Bq/L	0.01
14. Chloroform	mg/L	0.09	44. Radioactive materials (gross beta activity)	Bq/L	0.1
15. Chromium (hexavalent)	mg/L	0.05	45. Selenium	mg/L	0.01
16. Chromium (total)	mg/L	0.05	46. Silver	mg/L	0.02
17. COD	mg/L	4	47. Sodium	mg/L	200
18. Coliform (fecal)	n/100ml	0	48. Suspended particulate matters	mg/L	10
19. Coliform (total)	n/100 ml	0	49. Sulfide	mg/L	0
20. Color	Hazen unit	15	50. Sulfate	mg/L	400
21. Copper	mg/L	1	51. Total dissolved solids	mg/L	1000
22. Cyanide	Mg/L	0.1	52. Temperature	°C	20-30
23. Detergents	mg/L	0.2	53. Tin	mg/L	2
24. DO	mg/L	6	54. Turbidity	FTU	10
25. Fluoride	mg/L	1	55. Zinc	mg/L	3

\*In coastal area 1000. Reference: Bangladesh Gazette, Addendum, August 28, 1997  
Source: Department of Environment (DOE)

**Table 2.7: Bangladesh Standards for Ambient Air Quality** (Micrograms /cubic meters)


Sl. No.	Area	Suspended Particulate Matters (SPM)	Sulfur Dioxide (SO <sub>2</sub> )	Carbon Monoxide (CO)	Oxides of Nitrogen (NOx)
Ka	Industrial and mixed	500	120	5000	100
Kha	Commercial and mixed	400	100	5000	100
Ga	Residential and rural	200	80	2000	80
Gha	Sensitive	100	30	1000	30


Source: Schedule-2, Rule 12, Environment Conservation Rules of 1997 (Page 3123, Bangladesh Gazette, 28 August 1997) (Own authentic translation from original Bengali).  
Note : 1. Sensitive area includes national monuments, health resorts, hospitals, archaeological sites, educational institutions and other government designated areas (if any).  
2. Any industrial unit located not in a designated industrial area will not discharge such pollutants, which may contribute to exceed the ambient air quality above in the surrounding area of category 'Ga' and 'Gha'.  
3. Suspended particulate matters mean airborne particles of diameter of 10 micron or less.  
Source: Department of Environment (DOE)

**Table 2.8: Bangladesh Standards for Noise**

Sl. No.	Area Category	Standards Values (all values in dBA)	
		Day	Night
Ka	Silent zone	45	30
Kha	Residential area	50	40
Ga	Mixed area (basically residential and together used for commercial and industrial purposes)	60	50
Gha	Commercial area	70	60
Umma	Industrial area	75	70

Source : Schedule 4, Rule-12, Environment Conservation Rules, 1997. (Page 3127, Bangladesh Gazette, 28 August 1997). Own authentic translation from original Bengali.  
Note : 1. Daytime is reckoned as the time between 6 a.m. to 9 p.m.  
2. Night time is reckoned as the time between 9 p.m. to 6 a.m.  
3. Silent zones are areas up to a radius of 100 meter around hospitals, educational institutions or special establishments declared or to be declared as such by the Government. Use of vehicular horn, other signals and loudspeakers is prohibited in silent zones.  
Source: Department of Environment (DOE)

  
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Table 2.9: Bangladesh Standards for Odor

Parameters	Unit	Values
Acetaldehyde	PPM	0.5-5
Ammonia	PPM	1-5
Hydrogen Sulfide	PPM	0.02-0.2
Methyl Disulfide	PPM	0.009-0.1
Methyl Mercaptan	PPM	0.02-0.2
Methyl Sulfide	PPM	0.01-0.2
Styrene	PPM	0.4-2.0
Trimethylamine	PPM	0.005-0.07

Source: Schedule 8, Rule-12, Environment Conservation Rules, 1997. (Page 3130, Bangladesh Gazette, 28 August 1997). Own authentic translation from original Bengali

Note: 1. Regulatory standards at emission/discharge outlets (apply to those outlets which are higher than 5 meters):  
 $Q = 0.108 \times He^2 \times Cm$ , Where Q – gas emission rate (Nm<sup>3</sup>/hour), He – effective height of the outlet (m), Cm – above mentioned standard (ppm)

2. Where there is a range given for a parameter, the lower value will be used for warning and the higher value for initiation of legal procedure or punitive measures.

Source: Department of Environment (DOE)

Table 2.10: Bangladesh Standards for Sewage Discharge

Parameters	Unit	Values
BOD	mg/l	40
Nitrate	mg/l	250
Phosphate	mg/l	35
Suspended Solids (SS)	mg/l	100
Temperature	°C	30
Coliforms	number/100ml	1000

Source: Schedule-9, Rule-13, Environment Conservation Rules, 1997. (Page-3131 of Bangladesh Gazette of 28 August 1997) (Own authentic translation from original Bengali)

Note: 1. These standards are applicable for discharge into surface and inland water bodies. 2. Chlorination is to be done before final discharge.

Source: Department of Environment (DOE)

Table 2.11: Bangladesh Standards for Industrial and Project Effluent

Sl. No.	Parameters	Unit	Discharge To		
			Inland Surface Water	Public Sewer to Secondary Treatment Plant	Irrigable Land
1	Ammonical nitrogen (as elementary N)	mg/l	50	75	75
2	Ammonia (as free ammonia)	mg/l	5	5	15
3	Arsenic (as As)	mg/l	0.2	0.05	0.2
4	BOD <sub>5</sub> at 20°C	mg/l	50	250	100
5	Boron	mg/l	2	2	2
6	Cadmium (as Cd)	mg/l	0.05	0.5	0.5
7	Chloride	mg/l	600	600	600
8	Chromium (as total Cr)	mg/l	0.5	1.0	1.0
9	COD	mg/l	200	400	400
10	Chromium (as hexavalent Cr)	mg/l	0.1	1.0	1.0
11	Copper (as Cu)	mg/l	0.5	3.0	3.0
12	Dissolved oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8
13	Electro-conductivity (EC)	µsiemens/cm	1200	1200	1200
14	Total dissolved solids	mg/l	2100	2100	2100
15	Fluoride (as F)	mg/l	2	15	10
16	Sulfide (as S)	mg/l	1	2	2
17	Iron (as Fe)	mg/l	2	2	2
18	Total kjeldahl nitrogen (as N)	mg/l	100	100	100
19	Lead (as Pb)	mg/l	0.1	1	0.1
20	Manganese (as Mn)	mg/l	5	5	5
21	Mercury (as Hg)	mg/l	0.01	0.01	0.01
22	Nickel (as Ni)	mg/l	1.0	2.0	1.0
23	Nitrate (as elementary N)	mg/l	10.0	Not yet set	10
24	Oil and grease	mg/l	10	20	10
25	Phenolic compounds (as C <sub>6</sub> H <sub>5</sub> OH)	mg/l	1.0	5	1
26	Dissolved phosphates (as P)	mg/l	8	8	15
27	Radioactive substance	(to be specified by Bangladesh Atomic Energy Commission)			
28	PH		6-9	6-9	6-9
29	Selenium (as Se)	mg/l	0.05	0.05	0.05
30	Zinc (as Zn)	Mg/l	5	10	10
31	Total dissolved solids	Mg/l	2100	2100	2100
32	Temperature	°C (summer)	40	40	40
		°C (winter)	45	45	45
33	Suspended solids	Mg/l	150	500	200
34	Cyanide	Mg/l	0.1	2.0	0.2

Source: Schedule-10, Rule-15, Environment Conservation Rules, 1997 (Page 3132-3134 of Bangladesh Gazette of 28 August 1997) (Own authentic translation from original Bengali)

Note:

These standards will be applicable for all industries other than those which are specified under 'Industrial sector specific standards'.

These standards will have to be complied from the moment of trial production in case of industries and from the moment of the very beginning in case of projects.

These standards will have to be used at any point of time and any sampling. In case of need for ambient environment condition, these standards may be made stringent.

Inland surface water will include direct ponds, tanks, water bodies, streams, canals, rivers, streams and canals.

Public sewer means leading to full fledged sewer treatment facility comprising primary and secondary treatment.

Land for irrigation means organic irrigation of selected crops on adequate land determined on the basis of quantity and characteristics of waste water.

If any discharge is made into public sewer or on land which does not meet the respective definitions in rules 5 and 6 above, then the inland surface water standards will apply.

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Table 2.12: Bangladesh Standards for Industrial and Project Emissions

Sr. No.	Parameters	Values (in mg/Nm <sup>3</sup> )
1	Particulates	
	(ka) Power station of capacity of 200 MW or more (kha) Power station of capacity of less than 200 MW	150 350
2	Chlorine	150
3	Hydrochloric acid vapor and mist	350
4	Total fluoride (as F)	25
5	Sulfuric acid mist	50
6	Lead particulates	50
7	Mercury particulates	10
8	Sulfur dioxide	kg/ton acid
	(ka) Sulfuric acid production (DCDA* process)	4
	(kha) Sulfuric acid production (SCSA* process)	100
	(* DCDA : Double conversion, double absorption, SCSA : Single conversion single absorption)	
	Lowest height of stack for sulfur dioxide dispersion :	
	(ka) Coal based power plant 500 MW or more	275 m
	200 MW - 500 MW Less than 200 MW	220m 14(Q) <sup>0.3</sup>
(kha) Boiler Steam per hour - up to 15 tons Steam per hour - more than 15 tons (Q = SO <sub>2</sub> emission in kg/hour)	11m 14(Q) <sup>0.3</sup>	
9	Oxides of nitrogen	
	(ka) Nitric acid production	3 kg/ton acid
	(kha) Gas based power stations 500 MW or more	50 ppm
	200 - 500 MW	50 ppm
	Less than 200 MW	40 ppm
(Ga) Metallurgical oven	30 ppm	
10	Kiln soot and dust	Mg/Nm <sup>3</sup>
	(ka) Blast furnace	500
	(kha) Brick kiln	1000
	(Ga) Coke oven	500
	(Gha) Lime kiln	250

Source : Schedule-11, Rule-13, Environment Conservation Rules, 1997 (Page 1135, 1136, Bangladesh Gazette, 28 August 1997) (Own authentic translation from original Bangali).  
Source: Department of Environment (DOE)

## 2.10 Environmental Clearance Requirements

For most proponents, planning an industrial project or projects of various natures (including 'exploration, extraction and distribution of mineral resources'), in Bangladesh is currently mandatory to obtain an "environmental clearance" from the Department of Environment.

The first step for the project proponent is to complete an application form, which may be obtained from the appropriate DoE Divisional Office. The application form with a cover letter is then addressed to Director / Deputy Director of the respective Divisional Office of the Department of Environment as prescribed in the Environmental Conservation Rules of 1997. The application should include, a feasibility study report of the project, IEE/ EIA, NOC's of local authorities, a mitigation plan for minimizing the impact of environmental pollution and a Treasury Chalan of requisite fees (this will depend on the amount of investment by the project proponent). The DoE authority reserves the right to request additional information and supporting documents for the proposed project.

As per the Environment Conservation Rules of 1997, the DoE divisional authority issues environmental site clearance within 30 working days or the refusal letter with appropriate reasons for such a refusal. The clearance issued is valid for a one-year period, which requires being renewed 30 days prior to the expiry date. For projects requiring both Site clearance and Environmental clearance (like in the present case), a two-tier system is applied (actually this is a three tier system) as after one obtains the site clearance, they need to apply again at an appropriate time along with the EIA. Once the EIA is approved (this approval is actually the second tier), then the proponent applies for the Environmental Clearance.

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The Environmental Conservation Rules of 1997 ensures the right of the aggrieved to appeal against the *Notice Order or Decision to the appellate authority. The appeal should be made to the appellate authority* with the clear justification and the attested copy of the specific Notice Order / Decision of the respective DoE office against which the appeal is to be made. Moreover, the prescribed fee is to be paid through treasury Chalan and the relevant papers for the appeal are required to be placed.

The focus of the environment conservation rules in terms of environmental clearance and EIA lies with the classification of industries and certain projects into four groups; Green, Orange-A, Orange-B and Red based on their pollution or environment damage potential.

Green List Industries / projects are considered relatively pollution-free and therefore do not require an environmental clearance from the DoE and consequently no environmental study.

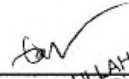
Orange List Industries / projects fall into two categories, Category-A and Category- B. Category- A industries are required to submit general information, a feasibility report, a process flow diagram and schematic diagrams of waste treatment facilities along with their application for obtaining DoE environmental clearance. Category-B industries / projects are required to submit an Initial Environmental Examination (IEE) report, along with their application and the information and papers specified for Category- A industries / projects.

Red List Industries / projects, according to the Rules, are those which may cause 'significant adverse' environmental impacts and are therefore required to submit an EIA Report. However they require obtaining an initial site clearance on the basis of an IEE Report, and subsequently submitting an EIA Report for obtaining environmental clearance along with other necessary papers, like the feasibility study report and no objections from local authorities.

Figure 2.2 furnished hereinafter show respectively the present environmental site/technical clearance procedure for projects in Bangladesh and steps involved in obtaining the environment clearance.

Figure 2.3 furnished hereinafter shows Flow Chart for Site Clearance procedure.

  
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