Initial Environmental Examination

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Bangladesh: Khulna Water Supply Project (Phase 2)

PART B: Appendices

Prepared by Khulna Water Supply and Sewerage Authority, Ministry of Local Government and Rural Development and Cooperatives, Government of Bangladesh for the Asian Development Bank (ADB).

Appendix 1: Rapid Environmental Assessment Checklist – Water Supply

Screening Questions	Yes	No	Remarks
Project Siting Is the project area…			
▪ Densely populated?	✓		City corporation area is densely populated.
▪ Heavy with development activities?	✓		There are developmental activities in and around the town. Sewerage project is currently under implementation.
Adjacent to or within any environmentally sensitive areas?			
• Cultural heritage site		✓	There are no notable or important cultural heritage sites or protected sites within the project area. Project area only includes local mosques, temples, and other old buildings.
• Protected Area		✓	No protected area within or near the project sites.
• Wetland		✓	No wetlands within or near the project sites.
• Mangrove		✓	No, there are no mangrove areas
• Estuarine		✓	No, there are no estuaries
• Buffer zone of protected area		✓	No, there is no buffer zone of any protected area within or near the project sites.
• Special area for protecting biodiversity		✓	No, there is special area for protecting biodiversity within or near the project sites.
• Bay		✓	No
Potential Environmental Impacts Will the Project cause…			
▪ pollution of raw water supply from upstream wastewater discharge from communities, industries, agriculture, and soil erosion runoff?		✓	Project will continue to use the existing surface water sources (Madhumati and Bhairab rivers). These are in the upstream of Khulna city. Water contains high salinity during dry months. Generally, water is fit for drinking after c treatment and disinfection. Project will augment the existing WTPs to meet the demand.
▪ impairment of historical/cultural monuments/areas and loss/damage to these sites?	✓		No notable impacts envisaged. Chance find protocol will be put in place. These will be included in the EMP.
▪ hazard of land subsidence caused by excessive ground water pumping?		✓	Due to high salinity levels in surface water during dry months, project will continue to use groundwater to meet the demand. Extraction rates are based on safe yields determined by strict criteria and scientific understanding of recharge and service population and groundwater modeling findings.
▪ social conflicts arising from displacement of communities ?		✓	No displacement anticipated.
▪ conflicts in abstraction of raw water for water supply with other beneficial water uses for surface and ground waters?		✓	Not envisaged.

Screening Questions	Yes	No	Remarks
▪ unsatisfactory raw water supply (e.g. excessive pathogens or mineral constituents)?	✓		Surface water contains high salinity levels during dry season. Project design considers this and accordingly demand will be managed by a good mix of surface water and groundwater seasonally. Water will be subjected to convention treatment and disinfection. Groundwater will be disinfected prior to supply.
▪ delivery of unsafe water to distribution system?		✓	Not envisaged. Water will be subjected to conventional treatment and/or disinfection prior to supply to distribution system. Treated water will meet drinking water standards. Regular water testing will be conducted.
▪ inadequate protection of intake works or wells, leading to pollution of water supply?		✓	There are no notable sources of pollution that can lead to source contamination.
▪ over pumping of ground water, leading to salinization and ground subsidence?		✓	The extraction will be within the safe yields of the groundwater identified based on assessment of the groundwater situation in Khulna. Monitoring is required to ensure that actual abstraction is within the limits.
▪ excessive algal growth in storage reservoir?	✓		Storage reservoirs are covered and hence there is less chance of excessive algal growth. Proper treatment, post chlorination and regular cleaning of storage reservoirs will be conducted during operation
▪ increase in production of sewage beyond capabilities of community facilities?	✓		Project will increase the water supply which will, in turn, increase the generation of wastewater that will burden the capacity of the sewerage and sanitation infrastructure of the city. At present, Khulna water supply and sewerage authority (KWASA) is implementing a sewerage project funded by ADB. This will approximately cover 40% of the project area. Per KWASA, sewerage system will be expanded to remaining areas with the future projects.
▪ inadequate disposal of sludge from water treatment plants?		✓	Sludge management included in the design. Proper sludge collection, treatment and disposal/reuse system will be developed.
▪ inadequate buffer zone around pumping and treatment plants to alleviate noise and other possible nuisances and protect facilities?		✓	These facilities are located mostly away from habitation, and moreover, all pumping stations and treatment plants are in enclosed buildings.
▪ impairments associated with transmission lines and access roads?	✓		No impairment associated with transmission lines is expected. However, some portions of the roads (including access to businesses) may be affected during transmission and distribution network construction/rehabilitation works.
▪ health hazards arising from inadequate design of facilities for receiving, storing, and handling of chlorine and other hazardous chemicals.	✓		Measures for safe handling, storage and usage of chlorine will be included to avoid any health hazards. No other hazardous chemicals are expected to be used during construction phase.

Screening Questions	Yes	No	Remarks
▪ health and safety hazards to workers from handling and management of chlorine used for disinfection, other contaminants, and biological and physical hazards during project construction and operation?	✓		Measures for safe handling, storage and usage of chlorine will be included to avoid any health hazards. No other hazardous chemicals are expected to be used during construction phase. Occupational health and safety issues are anticipated both during construction and operation. Construction works present occupational risk, and use of ad hoc, substandard methods and materials, non-use of personnel protection equipment (PPE), lack of proper supervisory control etc., will increase the risk. Environmental management plans will include appropriate measures.
▪ dislocation or involuntary resettlement of people?	✓		Involuntary resettlement will be addressed through resettlement plan prepared to comply with ADB SPS requirements.
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		✓	Not anticipated. Project will cover entire population in the project area including the poor and vulnerable. Project will have a positive impact.
▪ noise and dust from construction activities?	✓		Anticipated during construction activities. Temporary increase in noise level and dusts may be caused by excavation, equipment, disturbed soil surface, traffic on roads, and the transportation of equipment, materials, and people etc., Good construction practices will mitigate/minimize noise and dust, and will be specified in the EMPs.
▪ increased road traffic due to interference of construction activities?	✓		During excavation and pipeline laying along roads, temporary interference in traffic is expected. Transportation of construction material will also result in increase in traffic. Due to narrow and congested roads impact may be significant. Proper traffic management and construction planning will be ensured to minimize the traffic disruptions and interference.
▪ continuing soil erosion/silt runoff from construction operations?	✓		Due to excavation and run-off from stockpiled materials. The impacts are negative but short-term and site-specific within a relatively small area and reversible through mitigation measures. Good construction practices, such as the provision of silt traps around construction areas, will mitigate/minimize soil erosion and silt runoff.
▪ delivery of unsafe water due to poor O&M treatment processes (especially mud accumulations in filters) and inadequate chlorination due to lack of adequate monitoring of chlorine residuals in distribution systems?	✓		This is a potential impact during operation phase. Proper operation and maintenance systems will be put in place to ensure that that facilities are kept in working condition, including checking and maintenance of distribution network through standard operating procedures. The WTP will also be equipped with a functioning laboratory to ensure water is checked prior to delivery, including the concentration of residual chlorine. Any distributed water must comply with the drinking water quality standards.
▪ delivery of water to distribution system, which is corrosive due to inadequate attention to feeding of corrective chemicals?	✓		Proper monitoring of treated water shall be ensured. Care will be taken during O&M period to ensure that corrosive chemicals do not enter the distribution system. Regular monitoring will be conducted to ensure that treated water meets the drinking water standards.

Screening Questions	Yes	No	Remarks
▪ accidental leakage of chlorine gas?	✓		This is a potential impact during operation phase. An O&M manual will be developed to include guidelines on the handling of chlorine gas leaks. WTP design will include facilities to deal with accidental leakage of chlorine gas.
▪ excessive abstraction of water affecting downstream water users?		✓	Not envisaged. Project will continue to use existing surface and groundwater sources. Abstraction is negligible compared to availability.
▪ competing uses of water?		✓	
▪ increased sewage flow due to increased water supply	✓		Project will increase the water supply which will, in turn, increase the generation of wastewater that will burden the capacity of the sewerage and sanitation infrastructure of the city. At present, Khulna water supply and sewerage authority (KWASA) is implementing a sewerage project funded by ADB. This caters for both sullage and sewage and included sewage treatment facilities with sludge management systems. This will approximately cover 40% of the project area. Per KWASA, sewerage system will be expanded to remaining areas with the future projects.
▪ increased volume of sullage (wastewater from cooking and washing) and sludge from wastewater treatment plant	✓		
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		✓	No such impact anticipated; local communities in the vicinity of the project would be employed as much as possible. Moreover, workforce requirement will not be so large to have impact on the social infrastructure and services. No large influx of population is anticipated during operation
▪ social conflicts if workers from other regions or countries are hired?		✓	The projects will not require significant number of people who will move into Khulna. Engaging local labor will be a priority under the projects.
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during operation and construction?	✓		Use of explosives not anticipated. Standard and safe practices adopted for use of fuel or other chemicals like chlorine; transport, storage and application will follow the procedures specified in respective material safety data sheets (MSDS).
▪ community safety risks due to both accidental and natural hazards, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?	✓		This is always a foreseen risk in construction works Project design will include safety measures, and design will follow the standard codes. Implementation of construction works with proper measures, and emergency response systems will mitigate/minimize the risk to great extent. Project sites will be adequately fenced and secured. Construction area will be isolated, public excluded, and entry restricted only to authorized personnel. Contractor will develop and implement a health and safety plan. Good construction practices and health and safety procedures will thus minimize impacts to the community.

Appendix 2: Bangladesh National Environment Standards

Table 1: Bangladesh National Drinking Water Quality Standards

Sl No	Parameter	Unit	Standard
1.	1,1 Dichloroethane (1,1 $C_2H_4C_{12}$)	mg/l	0.030
2.	1,2 Dichloroethane (1,2 $C_2H_4C_{12}$)	mg/l	0.030
3.	2,4,6 Trichlorophenol	mg/l	0.200
4.	Aldrin/Dieldrin	mg/l	0.030
5.	Aluminium (Al)	mg/l	0.200
6.	Ammonia (NH_3)	mg/l	1.500
7.	Anionic Detergents	mg/l	0.200
8.	Arsenic (As)	mg/l	0.050
9.	Barium (Ba)	mg/l	0.700
10.	Benzene (c_6H_6)	µS/cm	0.010
11.	Boron (B)	mg/l	1.000
12.	Cadmium (Cd)	mg/l	0.003
13.	Calcium (Ca)	mg/l	75.000
14.	Carbon Tetra Chloride (CCl_4)	mg/l	0.005
15.	Chloride	mg/l	250.000*
16.	Chloroform ($CHCL_3$)	mg/l	0.090
17.	Color	Hazen Unit	15.000
18.	Copper (Cu)	mg/l	1.500
19.	Cyanide (CN)	mg/l	0.050
20.	Fecal Coliform	NFU/100ml	0
21.	Fluoride (F^-)	mg/l	1.000
22.	Free Residual Chlorine	mg/l	0.20
23.	Hardness as $CaCO_3$	mg/l	500.000
24.	Iron (Fe)	mg/l	0.3-1.0
25.	Lead (Pb)	mg/l	0.010
26.	Magnesium (Mg)	mg/l	30-35
27.	Manganese (Mn)	mg/l	0.400
28.	Mercury (Hg)	mg/l	0.001
29.	Nickel (Ni)	mg/l	0.050
30.	Nitrate (NO_3^-)	mg/l	45
31.	Nitrite (NO_2^-)	mg/l	1.000
32.	Odor	---	Odorless
33.	Oil and Grease	mg/l	0.010
34.	Overall Beta variance	BQU/L	1.000
35.	Pentachlorophenol	mg/l	0.009
36.	pH	---	6.5-8.5
37.	Phenols	mg/l	0.002
38.	Potassium	mg/l	12.000
39.	Radioactive Materials Emitting Alpha Radiation	BQU/L	0.100
40.	Selenium (Se)	mg/l	0.010
41.	Silver (Ag)	mg/l	0.020
42.	Sodium (Na)	mg/l	200.000
43.	Sulfate (SO_4^{-2})	mg/l	250.000
44.	Sulfide as H_sS	mg/l	0.050
45.	Suspended Solid (SS)	mg/l	10.000
46.	Temperature	°C	20-30
47.	Tetrachloroethane ($C_2H_4C_{14}$)	mg/l	0.040
48.	Tin (Sn)	mg/l	2.000

Sl No	Parameter	Unit	Standard
49.	Total Chromium (Total Cr)	mg/l	0.050
50.	Total Coliform	NFU/100ml	0
51.	Total Dissolved Solids (TDS)	mg/l	1000.000
52.	Total Kjeldal Nitrogen	mg/l	1.000
53.	Trichloroethane ($C_2H_3C_{13}$)	mg/l	0.020
54.	Turbidity	NTU	5.000
55.	Zinc (Zn)	mg/l	5.000

* 1,000 mg/l in coastal areas
Source: ECR, 2023

Table 2: Bangladesh Inland Surface Water Standards

Best Practice Based classification	pH	DO mg/l	BOD mg/l	NO_3-N mg/l	NH_4-N mg/l	PO_4-P mg/l	Total Cr mg/l	Pb mg/l	Hg mg/l	Total Coliform cfu/100mg	TDS mg/l	COD mg/l
a. Source of drinking water for supply only after disinfecting:	6.5-8.5	≥6	≤2	7.0	0.1	0.1	0.02	0.03	0.001	≤100	1000	10
b. Water usable for recreational activity	6.5-8.5	≥5	≤3	7.0	0.3	0.5	0.2	0.05	0.001	≤50	1000	10
c. Source of drinking water for supply after conventional treatment	6-9	≥5	≤3	7.0	0.3	0.5	0.02	0.03	0.001	≤5000	1000	25
d. Water usable by fisheries	6-9	≥5	≤6	7.0	0.3	0.5	0.05	0.1	0.004	≤5000	1000	50
e. Water usable by various process and cooling industries	6.5-8.5	≥1	12	-	2.7	-	0.1	0.1	0.05	-	1000	100
f. Water usable for irrigation	6.5-8.5	-	≤12	5.0	1.5	2.0	0.1	0.1	0.002	≤50000	1000	100

Note: Electrical conductivity for irrigation water 2250 -µS/cm (at a temperature of 25^0C); Sodium less than 26%; boron less than 0.2%.
Source: ECR, 2023

Table 3: Bangladesh Ambient Air Quality Standards

Parameter	Bangladesh Ambient Air Quality Standard (µg/m^3) and Averaging Time [a]	WHO Air Quality Guidelines (µg/m^3) Global Update[b] 2021
PM_{10}	50 (1-year) 150 (24-h)	15 (1-year) 45 (24-h)
$PM_{2.5}$	35 (1-year) 65 (24-h)	5 (1-year) 15 (24-h)
SO_2	80 (24-h) 250 (1-h)	40 (24-h)
NO_x	40 (1-year) 80 (24-h)	10 (1-year) 25 (24-h)
CO	5,000 (8-h) 20,000 (1-h)	4 (24-h)
Lead	0.25 (1-year) 0.50 (24-h)	
Ozone (O_3)	180 (1-h) 100 (8-h)	60 (peak season) 100 (8-h)
NH_3	100 (1-year) 400 (24-h)	

ADB = Asian Development Bank, CO = carbon oxide, h = hour, µg/m^3 = microgram per cubic meter, min = minute,
NO_x = oxides of nitrogen, $PM_{2.5}$ = particulate matter 2.5, PM_{10} = particulate matter 10, SO_2 = sulfur dioxide, WHO = World Health Organization.

[a] Air Pollution Control Rules 2022

[b] Recommended 2021 WHO Global Air Quality Guidelines. https://www.who.int/

Table 4: Bangladesh Noise Standards

Receptor/ Source	National Noise Standard Guidelines[a] (dB)		WHO Guidelines Value For Noise Levels Measured Out of Doors[b] (One Hour LA_q in dBA)	
	Day (06:00-21:00)	Night (21:00-6:00)	07:00 – 22:00	22:00 – 07:00
Industrial area	75	70	70	70
Commercial area	70	60	70	70
Mixed Area	60	50	55	45
Residential Area	55	45	55	45
Silent Zone[c]	50	40	55	45

[a] Noise Pollution Control Rules, 2006

[b] WHO. 1999. Guidelines for Community Noise**;** World Bank Group. 2007. Environmental, Health and Safety General Guidelines. Washington, D.C.

[c] Area up to a radius of 100 meters around hospitals or educational institutions or special institutions/establishments identified/to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers are prohibited.

Table 5: Effluent Discharge Standards of Bangladesh

Sl. No	Parameter	Unit	Maximum Tolerable Limit at Discharge point except pH		
			Internal Surface Water	2nd Stage process of public sewage	Coastal Areas
1.	Nitrogen (N)	mg/l	50	50	50
2.	Ammonia (NH_3)	mg/l	5	5	5
3.	Arsenic (As)	mg/l	0.2	0.2	0.2
4.	BOD_5 at 20°C	mg/l	30	250	100

Sl. No	Parameter	Unit	Maximum Tolerable Limit at Discharge point except pH		
			Internal Surface Water	2nd Stage process of public sewage	Coastal Areas
5.	Boron (B)	mg/l	2	2	4
6.	Cadmium (Cd)	mg/l	2	1	2
7.	Chlorine (Cl^-)	mg/l	600	600	---
8.	Total Chromium	mg/l	0.5	1	1
9.	COD	mg/l	200	400	250
10.	Hexavalent Cr	mg/l	0.1	2	1
11.	Copper (Cu)	mg/l	3	3	3
12.	Fluoride (F)	mg/l	2	15	15
13.	Sulphide (S)	mg/l	1	--	5
14.	Iron (Fe)	mg/l	3	3	3
15.	Total Kjeldal nitrogen	mg/l	100	--	100
16.	Lead (Pb)	mg/l	0.1	1	2
17.	Manganese (Mn)	mg/l	2	2	2
18.	Mercury (Hg)	mg/l	0.01	0.01	0.01
19.	Nickel (Ni)	mg/l	1	2	5
20.	Nitrite (N)	mg/l	10	--	20
21.	Oil & Grease	mg/l	10	20	20
22.	Phenol (C_6H_5OH)	mg/l	1	5	5
23.	Phosphorus (P)	mg/l	5	--	--
24.	Radioactive Material a) Alpha Particle b) Beta Particle	Micro Curie/L	Standard Set by Bangladesh Atomic Energy Commission	---	----
25.	pH	---	6-9	6-9	6-9
26.	Selenium (Se)	mg/l	0.05	0.05	0.05
27.	Zinc (Zn)	mg/l	5	15	15
28.	Temperature	°C	Not more than 5°C of reservoir water temperature	--	Not more than 5° C of reservoir water temperature
29.	Suspended Solids	mg/l	100	500	100
30.	Cyanide	mg/l	0.1	2.0	0.2
31.	Total Residual Chlorine	mg/l	1.0	--	1.2
32.	Bio Assay Test		90% fishes remain alive after 96 hours in the treated liquid waste	90% fishes remain alive after 96 hours in the treated liquid waste	90% fishes remain alive after 96 hours in the treated liquid waste

Source: ECR, 2023

Appendix 3: Water Supply Management Options for Dry Season considered in the Feasibility Study

1. The following three possible options (or Alternatives) have been investigated for securing required quantity and quality of drinking water in dry season when salinity is high at Mollahat Intake. Components and pros and cons of these options are presented in the subsequent tables.

Table 1: Options for Water Supply Demand Management during Dry Season

Option No.	Main Approach	Primary Source of Water	Supplementary Source of Water and measures
1	Change the Source of Water	✓ New Intake in MBR Canal at Jalirpar Bazar	✓ Groundwater abstraction by Production Wells ✓ Private abstraction of water ✓ Optimization in pumping at Intakes (Mollahat and Afil gate) by online monitoring systems ✓ Water Conservation and water loss control by SCADA system
2	Reduce Salinity by Dilution with stored freshwater in Impounding Reservoirs (IPR)	✓ Mollahat Intake ✓ Construct additional Impounding Reservoir near existing WTP sites	
3	Composite Solution- Use Multiple Sources of Surface and Ground Water	✓ Mollahat Intake ✓ Additional Intake (smaller size) in Bhairab River at Afil Gate ✓ Additional Impounding Reservoir (smaller size) at BWTP and Afil gate WTP	

Option 1

Table 2: Proposed Engineering Plan under Option 1

Component	Sub-Component	Stage 1 (2035) Plan	Stage 2 (2050) Plan
New Intake at Jalirpar	Civil Works	220 MLD (for Phase 2)	-
	E/M Works	110 MLD	110 MLD
New Raw Water Pipeline from Jalirpar to Mollahat		220 MLD (for Phase 2)	-
Existing Intake at Mollahat	Civil Works	Desilting basin	-
	E/M Works	-	110 MLD
Water Treatment Plant		-	110 MLD
CW Transmission Pipeline	New Lines along By-Pass Road	220 MLD (for Phase 2)- Additional lines	WTP to Rupsha River segment only
Distribution System	All Area	For Phase 2- Additional lines	-
Distribution Reservoir & Pump Houses	All Area	For Phase 2- extension area only	-
Production Wells (Tube well)		62 MLD - New/Rehab.	-
Private Groundwater extraction		Limit to a total of 48 MLD	Limit to an additional 10 MLD

Table 3: Pros and cons under Option 1

Pros	Cons
1. Freshwater is expected to be available (to be confirmed by further study) all throughout the year. 2. Good Accessibility by Highways: The Proposed Intake Point is just beside the Highway. Hence, road	1. Future Salinity Issue: Due to continuing Climate Change effects, the movement of the salinity zone in the future is uncertain. 2. Water Availability and Water Rights Issue: The discharge at proposed Intake point is expected to be over 50 m^3/s even in dry

Pros	Cons
accessibility is very good for the transportation of materials, machinery, and manpower. 3. Topography and river morphology aresuitable for construction of Intake andpipeline. The river is straight throughout the length with no meandering, flood or bank erosion issue. 4. No major environmental or resettlement issue exists. The Project cost would be cheaper in the long term.	season. However, the entire stretch of MBR-Kumar River is heavily used for Agricultural, Livestock and Domestic purposes. Hence, water availability for diversion to Khulna is to be confirmed. This process may take time and delay in the startup of the project. 3. Permission for laying of pipeline along the RHD Road: Thepipeline alignment falls along the Madaripur-Veel Road and Dhaka-Khulna Highway. Hence, pipe laying permission from concerned department is to beascertained. The Process may take a time and prolong the execution period. 4. Land availability and Tree Cutting Permission: Since the Roads are under widening phase, land availability is alsoto be ascertained. Some Tree cutting may be required. The process may take a long time and prolong the execution period.

Option 2

Table 4: Proposed Engineering Plan under Option 2

Component	Sub-Component	Stage 1 (2035) Plan	Stage 2 (2050) Plan
Existing Intake at Mollahat	Civil Works	Desilting basin	-
	E/M Works	-	110 MLD
Impounding Reservoir		2,434 ML	5,000 ML
Water Treatment Plant		-	110 MLD
CW Transmission Pipeline	New Lines along By-Pass Road	220 MLD (for Phase 2) - Additional lines	WTP to Rupsha River segment only
Distribution System	All Area	For Phase 2- Additionallines	-
Distribution Reservoir &Pump Houses	All Area	For Phase 2- extension areaonly	-
Production Wells (Tube well)		62 MLD - New/Rehab.	-
Private Groundwater extraction		Limit to a total of 48 MLD.	Limit to an additional 10 MLD

Table 5: Pros and cons under Option 2

Pros	Cons
1. Locally available water resource: This option uses the same water resource as being used at present. So, this option eliminates the need for search of new freshwater resources and intake elsewhere. 2. No additional Conveyance cost: Since IPR can be located besides the existing WTP site, it doesn't require additional infrastructure such as intake, pumps and conveyance pipelines. There is no accessibility problem too. **3.** The land is available and is suitable for the construction of IPR. This is the time-tested	1. Long-term sustainability Problem: This option is based on dilution principle, so the requirement for storage for water will go on increasing along with the increase in the salinity level in rivers. So, this option is not viable for long-term. 2. Elaborate Land Acquisition Process can delay the start-up of the Project: Since the land requirement is high, this would require an exhaustive land acquisition process including meetings and consultations with several landowners and stakeholders. This will take relatively a longer time. **3.** Multiple Government Clearance: Since the

Pros	Cons
method for KWASA	land requirement is large (over 25 acres), this will involve lengthy procedures for obtaining approvals and clearances.

Option 3

Table 6: Proposed Engineering Plan under Option 3

Component	Sub-Component	Stage 1 (2035) Plan	Stage 2 (2050) Plan
1. Bangabandhu WTP System			
Existing Intake at Mollahat	Civil Works	Desilting basin for 135 MLD Capacity	-
	E/M Works	An additional pumping system for 25 MLD	-
Optimization in Pumping at Mollahat Intake	Smart online monitoring system	To allow abstraction of a minimum of 35 MLD raw water in the dry season.	-
Bangabandhu Water Treatment Plant (BWTP)	Retrofitting of WTP	Capacity increase from 110 MLD to 135 MLD	85 MLD
Impounding Reservoir at BWTP	New IPR	385 ML	-
CW Transmission Pipeline	New Lines along By-Pass Road	Additional lines for 220 MLD (for Phase 2) capacity	BWTP to Rupsha River segment only
Distribution System	All areas (existing + extension)	Additional lines for Phase 2 capacity	-
Distribution Reservoir & Pump Houses	All Area	For Phase 2 capacity in the Extension Area only	-
2. Afil Gate WTP System			
Afil Gate Intake	Rehabilitation of Intake and Pumping Station	15 MLD	-
Raw Water Pipeline	Intake to WTP	The pipeline works for about 1,500 m in length	-
	Intake to Mostafa Mor; Mostafa Mor to WTP	The pipeline works for about 12,000 m in length	
Afil Gate impounding reservoir	Retrofitting of existing IPR	192 ML Capacity	-
Mostafa Mor Impounding Reservoir	New Raw Water Reservoir	44 ML Capacity	
Afil Gate Water Treatment Plant (BWTP)	Retrofitting of WTP	Capacity increase from 5 MLD to 15 MLD	-
Pumping System	At Afil Gate Intake, Mostafa Mor and Afil Gate WTP	15 MLD	
3. Groundwater Supply System			
KWASA Production	New/Rehab.	118 MLD	-

Component	Sub-Component	Stage 1 (2035) Plan	Stage 2 (2050) Plan
Wells			
Managed Aquifer Recharge (MAR)	Injection Wells	Pilot Study – 2 nos.	-
Private Groundwater extraction		Limit to 45 MLD	-
4. Miscellaneous Works			
Solar Power Generation	At IPRs (two existing and one new proposed) and roof top of CWRs.	3,775 KW	
Surface and Groundwater Monitoring	Bulk Water System and Distribution System	At Ulpur, Mollahat, BWTP, Afil gate Intake and Distribution system area	

Table 7: Pros and cons under Option 3

Pros	Cons
1. Use the locally available existing water resources: This option largely uses the same water resources as available at Mollahat and Afil Gate Intakes. 2. Minimum land acquisition: It requires only 2.5 Acres of land to be acquired for 2035, which is for Distribution reservoirs. There is no land acquisition required for Intake, WTP and Impounding Reservoirs. 3. Less permissions are required from departments like RHD (for pipe laying), Forests (for tree cutting) and Resettlement as compared to the other two options. 4. The project cost is the least of all options. 5. Solar energy can be produced from over the Impounding Reservoirs. This will also reduce the evaporation loss in IPRs. 6. Good accessibility by highways: All the Proposed facilities are to be constructed in the existing facilities of KWASA. Hence, road accessibility is very good for transportation of materials, machineries, and manpower. 7. Topography and river morphology are suitable for the construction of Intake and pipeline. The river is straight throughout the length with no meandering, flood, or bank erosion issue	1. There is no Constraints as such in this scheme. Few issues to be looked into are as follows. 2. Since a little additional abstraction of water is proposed from Mollahat and Afil Gate intakes, water availability and salinity impacts are a point of concern. Institute of Water Modeling (IWM) has studied[1] this aspect, conducted hydro-geological studies and modeling as part of the feasibility study and confirmed that this is not an issue. 3. Some permissions from RHD are required for laying clear water transmission mains. This is common to all the options. However, this is not an issue as such permissions are easily granted by the concerned authorities. The consultants have also discussed with Khulna divisional office of RHD and Forest departments. 4. Some land acquisition is required for two Clear water reservoirs. This is common to all options and is unavoidable. Such cost should be borne by KWASA/GoB only. KWASA has agreed to this

Selection of alternatives

2. After evaluation of all three in detail during the feasibility study, it has been identified that option 1 and option 2 both have some technical, financial, administrative, social, and

[1] The IWM study report is available at the KWASA.

environmental issues and challenges that will take considerable time to resolve and implementation of the project. They cannot best be considered for a long-term solution.

3. Option 3 has been selected as the preferred one. This is a combined plan of Options 1 and 2, which reduces the magnitude of all issues and problems, such as water availability issues, water quality issues, land acquisition, resettlement, and permissions. Due to this, the project can be launched swiftly and realize the benefits in the short term, while the long-term plans would be made with elaborate studies in the future. However, there are a few major pros and cons of this plan that need consideration, as presented in Table 23.

4. Therefore, in this regard, option 3 endeavour is made to formulate a composite plan by drawing water resources from various sources and means for immediate mitigation of salinity. Consideration is also given to the consumptive use of water. Input from hydro-geological studies conducted by IWM, Bangladesh (June 2024) has been considered for formulation of this plan. The various sources of water and salinity mitigation measures considered in this plan include the following.

(i) Mollahat Intake (Madhumati River): Construct an Impounding Reservoir to the extent possible in the vacant land of Bangabandhu WTP complex.
(ii) Afil Gate Intake (Bhairab River): Draw water in wet season, store raw water constructing IPR at Afil Gate and Mostafa Mor and use in Dry period.
(iii) Production well: Enhance the capacity of KWASA production wells to use in the dry periods.
(iv) Private Tube wells: To enforce moderate control on the abstraction of groundwater
(v) Optimization in withdrawal of water from Mollahat Intake in the dry season by installing an online water quality monitoring system.

Table 8: Water resources potential and allocation for use under Option 3

Components	Potential	Allocation
Groundwater	Potential = 100 MLD Annual Volume = 36,500 ML	(1) From Private Tube wells: 45 MLD. Total extraction in a year = 16,425 ML. (2) Balance quantity from KWASA Production wells in a year = 20,075 ML
IPR at BWTP	Land Available at site = 45,000 m^2. Deduct 20% for berm & embankment. Net available land area for Reservoir = 37,500 m^2 (208 x 317) Assuming depth of reservoir = 12 m Potential capacity of the IPR = 450 ML	Construct an additional IPR of capacity 50% of the existing IPR. The volume of the new IPR = 385 ML Total capacity of IPR at BWTP, existing + new = 770 + 385 = 1155 ML.
IPR at Afil Gate	Existing reservoir water surface area = 120 x 160 = 19,200 m^2 Assume the depth of the reservoir to be formed = 10 m The capacity of the Reservoir = 192 ML	The present capacity is 57 ML. Increase the depth of the IPR to 10 m and make the Reservoir capacity 192 ML.
IPR at Mostafa Mor	Draw water from the Bhairab River and store it here.	Proposed Capacity of the Raw Water Reservoir = 44 ML

5. As indicated in above table, the total sustainable potential for groundwater abstraction in the Khulna area has been estimated at 100 MLD, which corresponds to an annual abstraction volume of approximately 36,500 million liters (ML). Out of this total volume, (i) private tube wells are currently abstracting approximately 45 MLD, which amounts to 16,425 ML per year, and (ii) the remaining 20,075 ML per year is allocated for abstraction through KWASA's production wells.

Appendix 4: Technical Details of Proposed Project Components

Pre-settling Tank at Mollahat Intake

1. A tentative layout plan for the pre-settling tank at Mollahat is presented in Figure 6. A pre-settling tank at Mollahat is proposed. Due to some space constraints, for 2035, it is proposed for a single circular 20-minute retention period, which will fit in with the vacant land available there, thus avoiding the need for land acquisition. The diameter of the tank shall be 25 m.

Impounding Reservoir at BWTP

2. For 2035, the impounding reservoir shall be constructed with a pond (water) area of 32,083 m^2 and a total land area of 45,000 m^2, including embankment and Berm widths. The location of IPR shall be as shown in Figure 7.

3. Accordingly, the dimensions of the pond area are proposed as 100 m x 320 m, and overall land occupies area as 130 m x 350 m. The height of the embankment shall be 1.5 m and the top width 4 m. There shall be a berm width of 3m surrounding the IPR.

4. The two IPRs shall be inter-connected by a connecting channel of about 25 m length and 10 m width. There will be a bridge to cross over the channel.

5. In order to cater for additional pumping of 25 MLD, one vertical turbine pump shall be added to the existing pump station with following specification.

   Q = 1,800 m^3/hr, H = 30 m, Rating = 250 kW

Retrofitting of Bangabandhu Water Treatment Plant

6. It is proposed to increase the capacity of WTP from 110 MLD to 135 MLD. The major design criteria and details are presented as follows.

7. ***Conversion of Sedimentation Tank is into Flocculation and Inclined Plate Settling system****:* The sedimentation tank is divided into 4 bays (chambers) and a length of 50 m. Each bay of 50 m can be split into two parts. The first part will act as a Flocculator, and the second part will act as a Plate Settler. With a 30-minute detention period, sizes are adequate. Plate Settlers are considered with a settling rate on the horizontal projected area of IPS as 1.5 $m^3/hr/m^2$. It is considered to provide uPVC IPS of 1.5 m x 1.25 m x 3 mm size fixed at 60 deg inclination from the horizon. In total, about 1,500 Plates will be required.

8. The filtration rate of the rapid sand filter can be considered as 7.5 to 10 $m^3/hr/m^2$. Based on the actual size of the existing filters, the actual loading rate comes to 5.85 $m^3/hr/m^2$. This is less than the allowable rate, hence OK. The depth of the filter tank required is 6.6m, whereas the actual depth at the site is 7.5 m; hence, OK. It is proposed to provide an air and water backwash system. The air backwash should be done for 3 minutes, followed by a water backwash of 10 minutes. Rate of Air backwash shall be 50 $m^3/hr/m^2$. Three (3) number of blowers (2W+1S) at a pressure discharge of 0.4 kg/cm^2 are considered. Regarding the drainage system, a false bottom floor fitted with polypropylene nozzles is considered. The number of nozzles per sq. m. on the filter bed shall be 45 nos., which is based on standard practice. With these criteria, the total number of nozzles required in the entire plant would be 58,140 nos.

9. Additional clear water pumps for pumping an additional 25 MLD water is required to be installed. For this, in line with the existing pumps one number of pumps can be increased as per the following specification.

Number = 1; Q = 1800 m^3/hr; H = 30 m; Rating= 250 kW

Preliminary Design of Facilities under Afil Gate WTP System for 2035

Afil Gate Intake and Pumping System

10. It is proposed to rehabilitate and upgrade the Afil Gate Intake from 5 to 15 MLD. The tentative layout of the Intake and Pump Station at Bhairab River, Gilatala, is shown in Figure 9.

11. A pumping system is proposed to be designed for 15 MLD capacity. Accordingly, Vertical Turbine Pumps of the following specifications are proposed for installation.

Number = 2 (1W+1S); Q = 1,042; m^3/hr H= 15 m; Rating= 75 kW

Raw Water Pipeline

12. Raw water pipeline from intake to IPR/WTP would be of max. 1,500 m in length. Considering the 1 m/s velocity in the pipeline, a 600 mm diameter pipe would be required. It is proposed to use DI pipes.

13. Another raw water pipeline is required for delivering raw water from Intake to the raw water reservoir at Mostafa Mor and then from Mostafa Mor to Afil Gate WTP. The total length of pipeline would be about 12 km. A 250 mm dia. HDPE pipe would be adequate for this.

Afil Gate Impounding Reservoir (IPR)

14. It is proposed to retrofit and upgrade the existing IPR (it is a pre-settling tank at present) to 192 ML capacity IPR. This can be achieved by increasing the depth to 10 m. Accordingly, the dimension of the IPR would be as follows.

Length = 160 m, Width = 120 m, Depth = 10 m.

15. The IPR shall be made of interlocking steel sheet piles with vertical sides. The length of sheet piles driven shall be 22 m out of which 12m will go below the IPR bed level. The design should be like the existing IPR at BWTP.

Mostafa Mor Impounding Reservoir (IPR)

16. It is proposed to construct a new IPR of 44 ML capacity at Mostafa Mor. This is the site where CWR-1 (for Zone 12-14) is also planned for construction. The land is to be acquired here. The Construction of this reservoir would be like the one at Afil Gate explained above. Accordingly, the dimension of the IPR would be as follows.

Length = 88 m, Width = 5 0 m, Depth = 10 m.

Retrofitting of Afil Gate Water Treatment Plant

17. It is proposed to increase the capacity of WTP from 5 MLD to 15 MLD. The design calculation is presented in the Feasibility Study report. The major design criteria and details are presented as follows.

18. Configuration and Proposed Plan: The entire WTP is about 13.5 m in width and 45 m in length by size. It is split into two parts in lengthwise directions so that each process unit can be divided into two equal half parts. The main process units in the existing system and the proposed modifications in them are explained as follows.

(i) **Intake Pumping System**: There is an intake pump station that draws water from the existing IPR (pre-settling tank) and delivers it to the inlet of the Parshall flume of WTP. This pump house can do for the proposed plan, too. There are 3 pumps in the existing system, which is OK number-wise. So, it is only proposed to replace the pumps with higher capacities so as to discharge 15 MLD water. For this, Vertical Turbine Pumps of the following specifications are proposed.

Number = 3 (1W+2S); Q = 625 m^3/hr; H = 20 m; Rating = 75 kW

(ii) **Parshall Flume**: There are 2 units, and the length of the flume unit is 3.5 m. The width of the Parshall flume (length of the weir) through which water flows is just about 15 cm. There is ample space to increase this weir length. Therefore, it is proposed to increase the length of each weir to 45 cm so as to increase the capacity of flow by three times, i.e., 15 MLD.

(iii) **Flocculation Chamber**: There are two Units, each 15 m^2 in size. Each unit has 3 bays for water flow with 2.15 m width of each, thus making the total length of water flow distance 45 m. Baffle walls are fixed throughout the length. It is now proposed to convert this flocculation bay into chambers/tanks. There can be 4 tanks (2 in each size), and it is proposed for mechanical flocculators. The size available for each tank would be 6.5 m x 6.5 m (Area 42 m^2). With a 30-minute detention time and 3m water depth, the surface area required is 27 m^2 only, which is less than 42 m^2. Hence, the provision is adequate.

(iv) **Sedimentation Basin converted to Lamella Plate Settling System**: There are 2 Units of sedimentation tank, each 17.5 m x 6.5 m in size. It is proposed to fit the Inclined Plate Settling system in them. The existing system is also fixed with some inclined plates, but the spacing between them is too high (1 m or so). The newly designed system will have plates at a spacing of just 10 cm c/c. There shall be 6 rows of inclined Plate settler, 3 rows in each compartment. The size of Inclined plates is 1.5 m x 1.25 m x 3 mm made of uPVC. The total number of plates required is 390 numbers. This is more than adequate for 15 MLD capacity.

(v) **Modification to Filtration Plant:** There are 4 Filter beds in the existing system. The size of each filter bed is 3.8 m (Length) x 3 m (Width). With this size, for 15 MLD capacity, the surface loading rate is 14.13 m^3/hr/m2. The desirable range is 7.5 to 10 $m^3/hr/m^2$. Hence, the size of the filter beds should be increased. There is space to increase the size of the piping gallery. It is proposed to increase the length to 6 m and make the filter bed size 6 m x 3 m. Each Filter bed shall be of a net size of 6 m x 6 m. With this sizing, the surface loading rate is 8.95 $m^3/hr/m^2$, which is satisfactory. The depth of the filter tank required is 5.6 m, whereas the actual depth at the site is 5.8 m, hence satisfactory.

(vi) In addition, it is proposed to provide an air and water backwash system. The air backwash should be done for 3 minutes, followed by a water backwash of 10 minutes. Rate of Air backwash shall be 50 $m^3/hr/m^2$. Three (3) number of blowers (2W+1S) at a pressure discharge of 0.4 kg/cm^2 are considered. Regarding the drainage system, a false bottom floor fitted with polypropylene nozzles is considered. The number of nozzles per sq. m. on the filter bed shall be 45 nos., which is based on standard practice. With these criteria, the total number of nozzles required in the entire plant would be 3,240 numbers.

(vii) **Clear water Pumps:** There are 3 pumps in existing system, which is OK

number-wise. So, it is only proposed to replace the pumps with higher capacities to discharge 15 MLD water. For this, in line with the intake pumps, vertical turbine pumps of following specification are proposed for installation.

Number = 3 (1W+2S); Q = 625 m^3/hr; H = 20 m; Rating = 75 kW

Other units in the existing system include the Chemical House cum Admin Building, Wash Water Tank, Electrical Building, and Clear Water Reservoir. They are found to be OK; hence no new proposal is made for them.

Planning and design of treated water transmission mains of BWTP system

Looping Arrangement by Integrating New and Existing system (Ring Main)

19. In this concept, the new proposed transmission system will be connected to the existing transmission system by a looping arrangement. This will act as a single compact and robust transmission system with a high degree of flexibility in the circulation of flow. More control valves will be required in this case. The main advantage will be in maintaining near equitable residual pressures at all CWRs. In this concept, a major part of the existing transmission system in the KCC area need not be augmented.

Table 1: Basic design details of the Transmission System

	Parameters	Details
1	Pipe length	Existing - 31 km; New (2035) - 36 km New (2050) - 15 km; Total - 82 km
2	Capital Cost for Construction	Moderate
3	Water Supply and Pressure Distribution	Better than others
4	Parallel piping in the road within the KCC area	0.26 km
5	Railway Crossing	2 Nos.
6	Difficulty in construction due to narrow road width, utilities, and traffic movement; Safety and impacts during construction; Impact on existing water supply operation	Low

Transmission Pipeline Design Details

Table 2: Pipeline Design Details for the Years 2035 & 2050

Pipe Dia mm	Existing Pipes to be utilized (km)	Proposed Pipes for 2035 (km)	Additional pipes proposed for 2050 (km)	Total Pipe Length, km	Pipe Material
350	2.263			2.263	DI
400	1.128	1.585	2.303	5.016	DI
500	1.966	2.181		4.147	DI
600	4.239	77	446	4.762	DI
700	5.521	12.549	4.769	22.839	DI
800	551	4.781		5.332	DI
900	2.926	16.637		19.563	DI
1,000	6.357			6.357	DI

1,200	6.300		6.071	12.371	DI
Total	**31.251**	**43.881**	**7.518**	**82.650**	

Pump design details

Table 3 Pump Design Details for the Years 2035 & 2050

Proposed Pump	Unit	Year 2035	The year 2050
Pumping Capacity required			
Q (MLD)	MLD	117	228
Head (m)	m	34	55
No. of working pumps proposed	Nos	3	3 (in existing PS) + 3 (in new PS)
No. of stand-by pumps	Nos	1	1 (in existing PS) + 1 (in new PS)
Existing Pumping capacity Q = 43.2 MLD (500 lps, i.e., 1800 m^3/hr) each, H = 34 m, 250 kW	MLD	130	
Addl. Proposed Pumping capacity Q = 43.2 MLD (500 lps, i.e. 1800 m^3/hr) each, H = 55 m, 4 nos., 350 kW	MLD		130 + 130

Zoning and CWR in Extension Area

Description of the extended area

Table 4: Proposed CWR Site and Estimated Water Demand in Zones of KCC Extension Area

Sl. No.	Distribution Reservoir	Zones	Area (sq. km)	Status of land (Owner)	Population for 2050	Total Water Demand for 2050, (MLD)	KWASA Supply (67%) for 2050, (MLD)
1	Proposed DR 1 (CWR-1)	Zone 11	10.9	Barren land (Private)	31,533	4.50	3.01
2	Proposed DR 2 (CWR-2)	Zone 12	7.2	Shallow land (Pvt)	35,697	5.09	3.41
3		Zone 13	8.4		27,051	3.86	2.58
4		Zone 14	6.7		59,098	8.43	5.64
5	Proposed DR 3 (CWR-3)	Zone 15	5.1	Firm land (Govt)	83,232	11.87	7.94
6	Proposed DR 4 (CWR-4)	Zone 16	5.8	Firm land (Govt)	113,822	16.24	10.86
Total			**44.1**		**350,433**	**50.00**	**33.45**

Capacity and Sizing of Zonal CWR

Table 5: Capacity, Sizing, and Land Area for Zonal Reservoir Sites

	Unit	Zone 11	Z- 12, 13, 14	Zone 15	Zone 16
		CWR-1	CWR-2	CWR-3	CWR-4
Demand	MLD	3.01	11.63	7.94	10.86
Factor for reservoir		0.5	0.5	0.5	0.5
Reservoir capacity	Cu.m.	1,506	5,815	3,972	5,432
No. of CWR	No.	1	1	1	1
Each CWR capacity	Cu.m.	1,506	5,815	3,972	5,432
Adopt, Capacity	Cu.m.	2,000	7,000	5,000	7,000
Capacity of CWR	Cu.m.	2,000	7,000	5,000	7,000

	Unit	Zone 11	Z- 12, 13, 14	Zone 15	Zone 16
Depth of Water	m	5	5	5	5
Area of water surface	Sq.m.	400	1,400	1,000	1,400
Additional for walls, piping, etc., 50%	Sq.m.	200	700	500	700
Pumping station area	Sq.m.	200	300	200	300
Generator room area	Sq.m.	100	100	100	100
OHT	Sq.m.	300	900	500	500
Roads and Other Facilities	Sq.m.	400	400	400	400
Area of land required	Sq.m.	1,600	3,800	2,700	3,400
Total Land Area for purchase	Sq.m.	2,700	7,500	KWASA Land	KWASA Land

Overhead Tanks (OHTs)

20. The purpose of OHT is to regulate pressure fluctuation and maintain a uniform pressure throughout. In line with the same principle and maintaining consistency in the water supply system of Khulna, OHT is proposed in the Extended area, too. However, to reduce the amount of land acquisition, we propose putting up a combined OHT in Zone 13 (together with CWR/PS) for Zones 12, 13, and 14. The OHT will have 3 compartments, one for each of the 3 zones. The details are as below.

Table 6: Overhead Tanks (OHTs) provided in KWASA's existing distribution system

Particulars	Unit	Zone 11	Zone 12	Zone 13	Zone 15	Zone 15	Zone 16
Height of OHT up to Top Water Level from FGL	m	23	28			23	23
OHT Configuration		Single, Circular shape	Single OHT with 3 compartments, one for each Zone. Rectangular shape			Single, Circular shape	Single, Circular shape
Capacity of OHT	m^3	300	900			500	500
Cap. of each Compartment	m^3		300	300	300		

(e) Pumping System for Distribution Zones

21. The proposed pumping system for the extended area is given below.

Table 7: Design components of the pumping system for the Extended Area, 2035

		Zone 11	Zone 12,13,14	Zone 15	Zone 16	Zone 11	Zone 12,13,14	Zone 15	Zone 16	
	Year	2035				2050				
Q	Average flow in a day	0.93	4.28	4.87	7.00	3.01	11.63	7.94	10.86	MLD
	Peak factor for Dist. System	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	hrs
Q'	Peak flow in a day	1.395	6.42	7.305	10.5	4.515	17.44	11.91	16.29	MLD
		58.1	267.5	304.4	437.5	188.1	726.6	496.2	678.7	m^3/hr
	Delivery level	25	25	25	25	25	25	25	25	m assumed
	Suction level	-2	-2	-2	-2	-2	-2	-2	-2	m assumed
	Residual head at Dis. System	3	3	3	3	3	3	3	3	m assumed

		Zone 11	Zone 12,13,14	Zone 15	Zone 16	Zone 11	Zone 12,13,14	Zone 15	Zone 16	
h1	Static head	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	m assumed
L	Length	2.000	3.000	2.000	2.000	2.000	3.000	2.000	2000	m assumed
C	Roughness coefficient	130	130	130	130	130	130	130	130	m assumed
d	Dist. diameter (average)	0.300	0.500	0.500	0.600	0.300	0.500	0.500	0.600	m assumed
h2	frictional head	0.44	0.92	0.78	0.63	3.86	5.88	1.93	1.42	m
h3	Other head losses	0.044	0.092	0.078	0.063	0.386	0.588	0.193	0.142	m
H	Total head in meters	30	31	31	31	34	36	32	32	m
v	Velocity,	0.228	0.378	0.431	0.430	0.739	1.028	0.702	0.667	m/s
h	hrs of pumping	24	24	24	24	24	24	24	24	
	No. of pumps	1	2	2	3	2	4	1	1	
	Motor rating required	7	31	35	51	24	100	60	81	kW
	Working pumps	1	3	1	1	1	3	1	2	no.
	Standby pumps	1	3	1	1	1	3	1	1	no.
	Pump Capacity	58	89	304	438	188	242	496	339	m^3/hr
	Head	30	31	31	31	34	36	32	32	m
	Motor rating	75	75	75	75	75	75	75	75	kW

Design of the distribution pipe network

Table 8: Summary of distribution pipes

No.	Output Parameter	Yr. 2035	Additional for Yr. 2050	Total in Yr. 2050	
1	**Zone-wise total length of pipes**	235.6	139.4	375.0	km
	Zone 11	34.3	27.9	62.2	Km
	Zone 12	55.0	27.9	82.9	Km
	Zone 13	28.8	27.9	56.7	Km
	Zone 14	32.2	27.9	60.1	Km
	Zone 15	40.0	13.9	53.9	Km
	Zone 16	45.3	13.9	59.2	
2	**Total length of pipe**	235.6	139.4	375.0	Km
	Distribution pipe	221.1	139.4	360.5	Km
	Dedicated Distribution Main	14.5	0.0	14.5	Km
3	**No. of DMAs**	8	0	8	Nos
	Flowmeter size/s	9	0	9	Nos
	PRVs (set at 25m)	0	5	-	Nos.
	PRVs (set at 20m)	9	4 out of 9	-	Nos.

Regeneration of Wells by Rawhiding (Surging):

22. In this process, the well is regenerated by surging action. It involves forcefully moving water into and out of the well screen. This can be done by many techniques, one of which is by compressed air. Air is introduced into the well (through the inlet) from an air compressor to push the water column down (pressurizing) to make water move through

the screen, opening into the gravel pack and surrounding the aquifer face. Moderate air pressure (preferably 1.5 to 2.5 bars) should be applied to push the water column down. It is preferable to increase the applied pressure gradually depending on the degree of clogging so that initially, any part of the well structure (joints, casing screen will not be damaged. Then, the air introduced in the housing should be released through the outlet, and the water level will be raised to a static water level (de-pressurizing). During the rise of the water column, water will move through the screen opening into the well. The pressurizing and subsequent de-pressurizing shall be applied five times in one sequence giving rest for 5-10 minutes between introducing air into the well and relief.

1. Real-time bulk water monitoring of surface and groundwater

23. In the bulk water system, a smart/dynamic real- time water monitoring system of both groundwater and surface water at the river intakes and reservoirs is proposed. This supplements the real-time smart water system for the distribution system as well as smart monitoring at the customer level (metering, grievance, asset management, etc.).

24. Real-time water monitoring should be done at the locations provided in Table 35.

Table 9: Proposed locations of real-time bulk water monitoring

	Locations where monitoring system to be implemented	**Data logging interval time**
1	Mollahat Raw Water Intake	10 min
2	Bangabandhu Water Treatment Plant	10 min
3	Ulpur or another potential site for future Intake	1 hr
4	Bhairab Raw Water Intake at Afil Gate	10 min
5	Afil Gate Water Treatment Plant	10 min
6	Groundwater Tubewells	3 hr

2. Data Processing and Presentation

25. ***Salinity Forecasts***. At Mollahat and at Bhairab River, respectively, a simulation model or, alternatively, an AI (Artificial Intelligence) App will be established to provide forecasts of salinity 1 day, 7 days, and 30 days into the future for contingency planning of bulk water sourcing.

26. ***Reservoir Forecasts***. At the impounding reservoirs of Bangabandhu WTP and Afil Gate WTP, respectively, a simulation model or AI App will be established to provide forecasts of remaining storage volume 1 day, 7 days, and 30 days into the future for contingency planning of bulk water sourcing.

27. ***Groundwater Forecasts***. At all KWASA production wells, a simulation model or AI App will be established to provide forecasts of the groundwater table and, thereby, future potential abstraction rates 7 days, 30 days, and 180 days into the future for contingency planning of groundwater sourcing.

28. SCADA will be applied to capture data. As described above, individual monitoring modules must be “loosely” coupled only, meaning that if one set of monitoring fails, it will not influence the others.

Appendix 5: Biodiversity Assessment – Dolphin Survey Report

(i) Table of Contents

A. Introduction

The Ganges River dolphin is an endemic aquatic mammal found only in the Indian subcontinent including the vast waters of Bangladesh. The Gangetic River dolphin (*Platanista gangetica*), an endangered freshwater cetacean, inhabits the Bhairab-Rupsha River system in Khulna, Bangladesh. As a flagship species for riverine ecosystem health, its presence underscores the ecological significance of the area. Khulna city is surrounded by rivers, namely Bhairab, Atai, Rupsha, Madhumati and Mayur. Among these Bhairab-Rupsha River system has a high abundance of dolphin populations. There is an existing water intake in Bhairab river at Afil gate to abstract water, which will be continued with increased abstraction in the proposed KWSP Phase. The Bhairab-Madhumati confluence, which is a known dolphin area is about 3 km downstream of the intake location. Though no works are proposed in river, this study is conducted to assess the baseline condition. The main stem of Madhumati River that flows north-south at about 25-30 km east of Khulna is the principle source of water for Khulna. There are no dolphins in this river.

B. Basic Information about Gangetic River Dolphins

The Ganges river dolphin is an endemic aquatic mammal found only in the Indian subcontinent including the vast waters of Bangladesh. It is a tertiary organism in the food chain and is an important indicator species of a river ecosystem. On the taxonomic hierarchy, they belong to a group of marine mammal which comprises whales, dolphins and porpoises. This group of animals are collectively termed as the cetaceans.

The Ganges river dolphin is named Shushuk (শুশুক) in Bengali by the wider local communities across Bangladesh. However, it is also named differently in different regions in the country, such as Shishu (শিশু) and Thus (ঠুস) in the Sundarbans, Houmach (হওমাছ) in Bhairab, Shishuk (শিশুক) in Sirajgonj, Shishu (শিশু) in Sylhet, Shushu (শুশু) in Rajshahi, Hochchum (হোচ্চুম) in Chattogram, etc. Although the Ganges river dolphin is wrongly believed to be a fish among many communities as well, it is however widely recognized inedible. There are lots of stories and myths associated with this 'strange' animal among communities where many people believe this animal as a friend of fishermen in many ways including, forcing fishes to congregate in a particular location, indicating the presence of large fishes where it lives, etc.

C. Population Distribution

Global Population: The Ganges River dolphin is endemic to the Indian Subcontinent. In the region, the distribution of this species is in Bangladesh, India, Nepal, and possibly Bhutan, below an elevation of about 250 m (Rice, 1998). Currently the species survives in the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems, while a few individuals may survive in the Karnali, and the Sapta Kosi Rivers in Nepal (Sinha et al., 2010)

The global population estimates are about 5200 individuals with a range of 4700 to 5920 of all ages throughout its distribution range[2]. The Ganges river dolphin was officially declared as the National Aquatic Animal of India in 2010 to highlight the importance of this species in the river ecology and to ensure long term survival in the rivers of India (Sinha et al., 2010).[3] The image 1 depicts the global population of Gangetic River dolphins. A recent study report published by Wildlife Institute of India titles "Population Status of River Dolphins in India (2024)" estimates the population of Ganges River dolphin as 6,324 individuals with a range of 5,977-6,688.[4]

[2] https:www.iucnredlist.org

[3] Atlas on ganges river dolphin and irrawaddy dolphin of bangladesh, 2022

[4] Population Status of River Dolphin in India. Qamar Qureshi, Vishnupriya Kolipakam, Abdul Wakid, Soumitra Dasgupta, Satya Prakash Yadav, Virendra R. Tiwari & Bivash Ranjan. Population Status of River Dolphins in India. 2021-23 (2024). Ministry of Environment, Forest and Climate Change, New Delhi and Wildlife Institute of India, Dehradun. https://wii.gov.in/staus_river_dophin

Population and distribution in Bangladesh: Bangladesh is popularly known as land of rivers, where the entire delta is formed by the deposits of the three major river systems of the Ganges, Brahmaputra-Jamuna, and Meghna Rivers. There are around 700 rivers in Bangladesh stretching over 24,140 km, with thousands of smaller channels, floodplain depressions and extensive seasonally flooded lands that collectively form the floodplain ecosystems (Akonda, 1989). These rivers generally flowing from north to south have significantly influenced the overall physiography of the country.[5] The Ganges River dolphins are found in all of major river systems of Bangladesh, these rivers are:

a) The Jamuna-Brahmaputra river system extends from northern Bangladesh to its confluence with the Padma.
b) The Padma-Ganges comprises two sections: the Ganges, stretching from the Indian border to the Jamuna confluence, and the Padma, flowing from there to its junction with the Meghna at Chandpur.
c) The Surma-Meghna system, which courses from the northeastern border with India to Chandpur, where it joins the Padma.
d) Padma-Meghna system: When the Padma and Meghna join together to the way of Bay of Bengal.
e) The Karnaphuli-Sangu River system, independent of the major networks, flows through Chattagram and the surrounding hills, descending swiftly to the sea, with key rivers including the Feni, Karnaphuli, Sangu, Halda, and Matamuhari, along with the Kaptai reservoir and dam.

Gangetic dolphins can be found at Padma, Jamuna, Meghna, Halda-Karnafuli and the Sundarbans. In particular, the identified critical winter habitats include Paikerchhara at Dud Kumar river, Gorgachh of Chilmari at Brahmaputra in Kurigram; Silonda-Nagderma in Boral, Nagarbari-Mohonganj in Jamuna; Nazirgonj, Rajshahi T-band, Godagari and Bakorali in Padma river; Bhairab bridge in Meghna river; Halda and Karnafuli rivers; Rupsha-Bhairab-Atai in Khulna and the Sundarbans.[6]

[5] Bangladesh dolphin action plan 2020-2030
[6] Conservation Action Plan for Ganges River Dolphin and Irrawaddy Dolphin of Bangladesh, 2021-2030

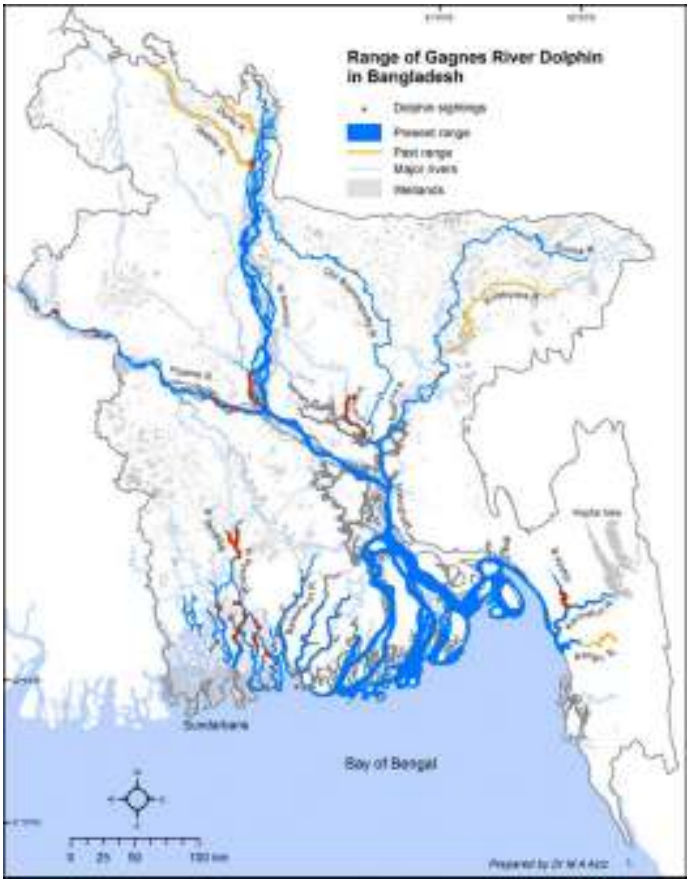

Figure 1: Population distribution of dolphins in Bangladesh. Source:[7]

Figure 2: this number should be considered the official counting of Bangladesh.

[7] Atlas of the Ganges River Dolphin and Irrawaddy Dolphin of Bangladesh Final report April 2019

Movement pattern and reproductive seasonality of dolphins and other species. These freshwater dolphins exhibit distinct movement patterns tied to seasonal hydrological changes. During the dry season (November–April), falling water levels concentrate prey fish in deeper channels, prompting dolphins to migrate to these refuges. Conversely, the monsoon (June–October) floods the river system, allowing dolphins to disperse into newly inundated habitats rich in food. Their reproductive seasonality aligns with these cycles; mating often occurs pre-monsoon, ensuring calves are born during peak flood periods when food is abundant and protective shallow waters offer refuge from predators. Like other mammals, dolphins are warm-blooded and give birth to live young. However, unlike other mammals, dolphins have lost hair, as an adaptation to their aquatic environment (Grill, 2000). An adult Ganges river dolphin can grow from 2.3 to 2.6 m in total length, although there is one record of a specimen measuring 4 m. Generally, the females are larger than the males (Prater, 1971). They live in small groups, often a mother and calf can be seen together. They give birth once every two to three years to only one calf, which is chocolate brown. Adult turns into grey-brown.[8] Regarding reproductive seasonality, specific data for the Bhairab-Atai-Rupsha confluence is limited. However, general studies on Ganges River Dolphins indicate that calving can occur throughout the year, with peaks observed between October and March. Newborn calves have been sighted during these months, suggesting a higher birth rate in this period.[9]

D. Dolphin conservation efforts in Bangladesh

Although the species is found almost all major rivers of Bangladesh, north-eastern regions of the Bangladesh Sundarbans including some upstream rivers have been a stronghold of this species. This creates a hope of future of this species in the region. The Ganges River dolphin is a flagship species for river conservation and its conservation can benefit a wider range of aquatic and threatened species including the softshell turtle (*Aspideretes gangeticus*), gharial (*Gavialis gangeticus*) and smooth-coated otter (*Lutra perspicillata*) (Sinha et al., 2010). At the end, protection and maintenance of this species will ensure better health of the river ecosystem that will ultimately benefit millions of local communities who survive on aquatic resources. The conservation importance of these species is therefore paramount and all people's greater efforts are needed on the ground to save this charismatic aquatic mammal of Bangladesh before it is upgraded on to the IUCN Red List of threatened species. [10]

Dolphin Action Plan 2023- 2030. Upon realizing that the Ganges River Dolphin and Irrawaddy Dolphin are vital indicators of river health in Bangladesh and are currently facing threats such as habitat degradation, pollution, and incidental killings, the Bangladesh Forest Department, under the Ministry of Environment, Forest, and Climate Change, published the **'Conservation Action Plan for Ganges River Dolphin and Irrawaddy Dolphin of Bangladesh 2021-2030'** in 2021. Initiated by Bangladesh Forest Department, with support from the Global Environment Facility and UNDP, launched the **EPASIIAE** project to develop this conservation action plan. The plan prioritizes 26 strategic actions over the next decade (2021–2030), including urgent research and mitigation of key threats like declining freshwater flow, unregulated fishing, and excessive vessel traffic. As flagship species, their protection benefits broader aquatic biodiversity and sustains millions of livelihoods dependent on river ecosystems. As per the Action plan, following are the main threats:

(i) **Incidental killing of dolphins.** Incidental killing in fishing nets, particularly gillnets, deployed in the dolphin habitats is the most pressing threat to the long-term survival of the cetacean species across the dolphin habitats of Bangladesh. In particular, the

[8] Conservation Action Plan for Ganges River Dolphin and Irrawaddy Dolphin of Bangladesh, 2021-2030
[9] Interview with D Mnoir H Khan and D tapan K Dey
[10] Conservation Action Plan for Ganges River Dolphin and Irrawaddy Dolphin of Bangladesh, 2021-2030

gillnet used to catch the Hilsa Shad in large rivers, estuaries and coastal areas of the Sundarbans and adjacent areas was known to kill dolphins by entanglement. [11]

(ii) **Intentional killing of dolphins and traditional use of dolphin parts.** Local people kill dolphins intentionally for use in fishing and healing pains. From the interviews done with local people and fishermen by the research team, it is understood that dolphins were killed intentionally by catching with fishing net in several instances for traditional medicinal use. Dolphins are killed by tribal people in the upper Brahmaputra for their meat and by fishermen in the middle reaches of the Ganges for their oil, which is used as a fish attractant. Although there was no report of intentional. killing or poaching for meat and fat of dolphins in the Sundarbans, but it is rarely reported in other parts of the country (Khan and Aziz, 2018).[12]

(iii) **Dam construction and extraction of upstream waters.** Modifications of river ecosystems as well as extraction of upstream water by constructing dams, barrage, embankments, etc. have been the most pressing threats to dolphins throughout the range in the Indian Subcontinent.

(iv) **Poison fishingin at Sundarbans.** It is suspected that poison fishing in the Sundarbans that has increased in the recent years which is highly detrimental to the aquatic organisms in general and fisheries in particular. There are numerous reports appeared on the daily newspapers on the scale of poison fishing in the Sundarbans, but no studies have yet been conducted on this critical issue to assess the impact on other aquatic organisms as well as the whole aquatic ecosystem.

(v) **Pollution.** Pollution is a critical threat that was known to degrade river ecosystems across the country. Dolphins in river ecosystems are particularly vulnerable to these pollutions because most of the pollutants ultimately find their ways directly or indirectly to rivers as well as wetlands.

(vi) **Fishing and harvesting aquatic resources.** Fishing and harvesting aquatic resources have been an important subsistence activity across the rivers and coast of Bangladesh. Millions of local communities earn their living through harvesting fish and aquatic resources for generations.

(vii) **Siltation and sedimentation.** More than 125 polders have been constructed in the south-west region along the upper catchment area of the Sundarbans rivers. These polders were constructed mainly to control the saline intrusion into the agricultural fields; unfortunately the impact of intervention has been felt in the rivers of the Sundarbans

(viii) **Dredging and removal of riverbed sands.** Degradation of dolphin habitats might be caused by widespread dredging across the country's major rivers. Dredging has been a long practiced phenomenon and commonplace throughout the course of Ganges-Brahmaputra basins including the removal of stones (Shrestha, 1989), sand (Mohanet al., 1998), and woody debris (Smith, 1993). These activities undermine the ecological integrity of the river health, especially small tributaries where suitable dolphin habitat is limited.

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[11] Islam, M. S., Rahman, M. R., & Shahabuddin, A. K. M. (2018). *Biodiversity and Fisheries of the Bhairab River, Khulna*. Journal of Environmental Science and Natural Resources.

Smith, B. D., Braulik, G. T., & Sinha, R. K. (2021). *Conservation Status of the Gangetic River Dolphin in South Asian River Systems*. Aquatic Conservation: Marine and Freshwater Ecosystems.

[12] Conservation Action Plan for Ganges River Dolphin and Irrawaddy Dolphin of Bangladesh, 2021-2030

(ix) **Transportation and service corridors.** This category of threat includes shipping lanes, dredging, wakes from cargo ships, etc. which have negative effect on dolphin population as well as their habitat. It has been reported that collusion between dolphins and water-based engine boats and dredging boats may be fatal to dolphins.

(x) **Climate change and severe weather.** This includes long-term climatic changes that may be linked to global warming and other severe climatic or weather events outside the natural range of variation that could wipe out a vulnerable species or habitat. It will ultimately lead to habitat shifting and alteration or major changes in habitat composition thereby location of the species.

E. Presence of endangered dolphins in KWSP 2 project influence area

The Khulna Water Supply Project (KWSP) Phase 2 aims to enhance water supply services in Khulna by expanding it's coverage area through piped water connection, implementing climate-resilient solutions to address dry-season salinity intrusion, and upgrading smart water management systems, including district metering areas, to reduce non-revenue water and improve billing. One of the components of the project is sourcing freshwater from the Bhairab River at the Afil Gate intake site during the July to February period during a year. Currently this intake abstracts about 5 MLD water and it will be upgraded to 15 MLD water. This water will be conveyed to impounding reservoir and WTP at Afil Gate for storage and treatment. Though during the drier months this facility will not abstract any water from river but will use ground water through the production wells thus ensuring a consistent and safe water supply throughout the year. This strategic approach addresses the challenges posed by seasonal salinity variations, thereby securing a reliable water source for Khulna's residents.

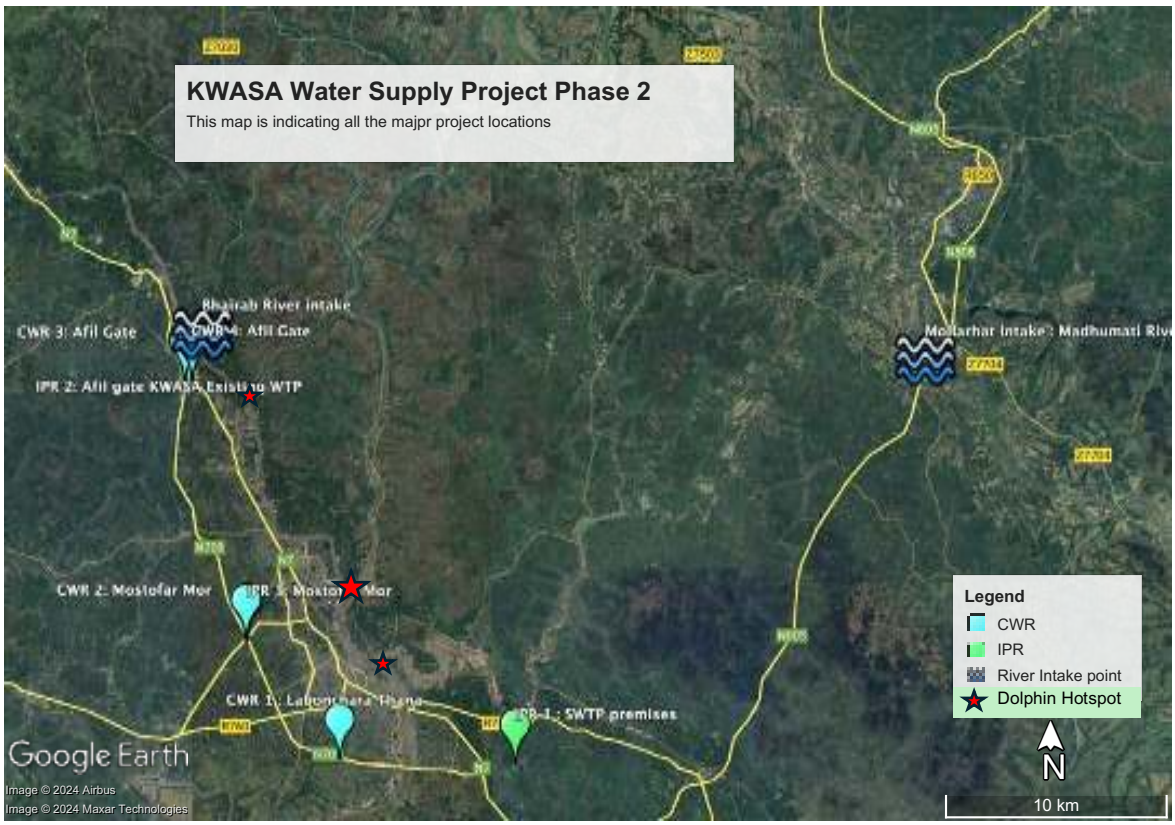


Figure 3: All project location of KWASA water supply phase 2 with dolphin locations

1. Dolphin population in project area based on secondary information.

Brairab, Atai and Rupsha rivers in Khulna, part of the larger Sundarbans deltaic region, provides an important refuge for the Gangetic River dolphin. These dolphins are often found in the deeper sections of the river, where they navigate the turbid waters using echolocation to hunt for fish and crustaceans. Just below the Khulna city there lies the largest mangrove forest of the world; Sundarbans, about 50-60 km from the city. The Sundarbans river systems have been a stronghold for dolphins in the southwest region of Bangladesh (Smith et al., 2010, 2006). In particular, this freshwater-loving dolphin was spatially distributed to the northeastern part of the Sundarbans, with some sightings on the estuarine region of the Baleshwar, Bishkhali and Payra Rivers. This pattern of distribution suggests that this dolphin prefers more freshwater habitats than saline areas of the Sundarbans and adjoining coasts. Notably, the major groups of the population were found along the upstream channels of the Passur, Sela and Sibsa Rivers (Khan and Aziz, 2018). [13]

As per the available information and reports, a high abundance of dolphin has been reported on the upstream of the eastern Sundarbans from the Rupsha bridge up to the Atai-Bhairab confluence. An important area was delineated in and around the confluence of Atai-Bhairab-Rupsha rivers. Bangladesh Forest Department's (BFD) opportunistic observations also suggest that Bhairab-Atharobeki confluence is also an important dolphin habitat in the region. However, increasing anthropogenic pressures, such as industrial pollution, agricultural runoff, and unregulated fishing practices, pose significant risks to their survival.[14]

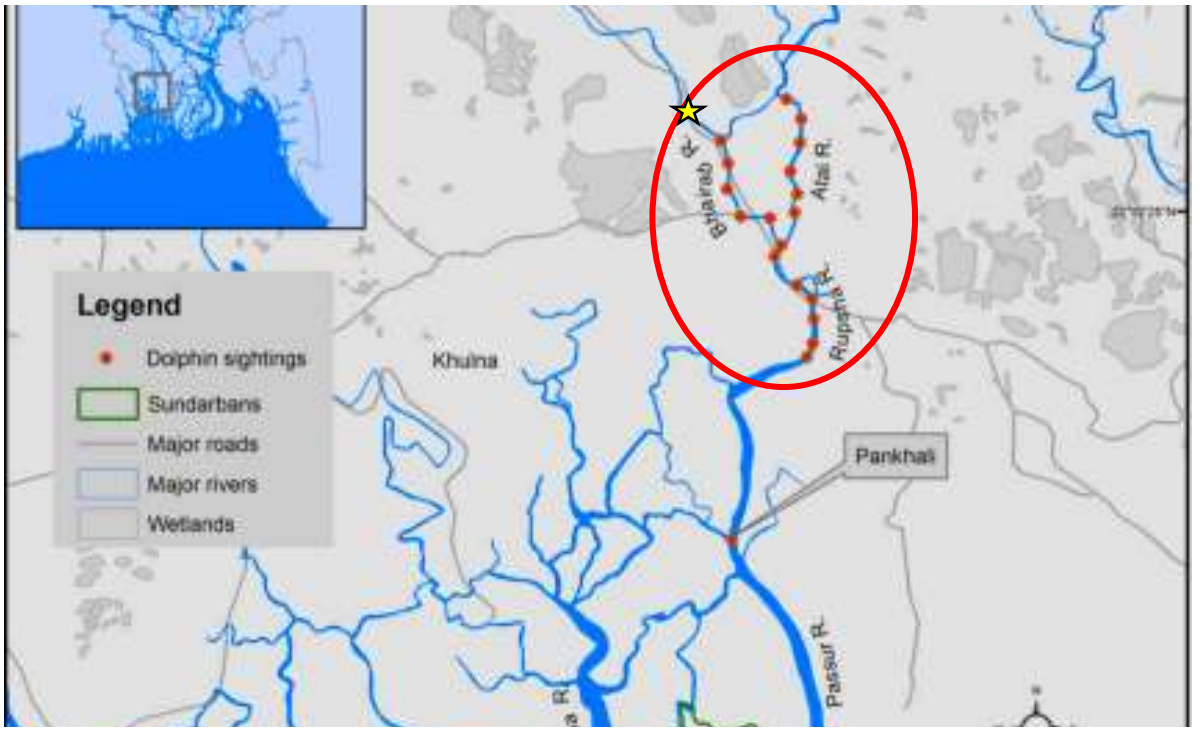


Figure 4: Dolphins at Bhairab river system of Khulna region (Red circled) depicted at Dolphin Action plan report. Interestingly KWASA intake point is above the Bhairab-madhumati confluence, yellow star marked area of this map. Source[15]

A Dolphin survey was conducted in Khulna by the IUCN Bangladesh in 2017 titled 'Biodiversity

[13] Atlas of the Ganges River Dolphin and Irrawaddy Dolphin, 2019.
[14] Atlas of the Ganges River Dolphin and Irrawaddy Dolphin, 2019.
[15] Atlas on ganges river dolphin and irrawaddy dolphin of bangladesh, 2022.pdf

Assessment for Rupsha 800MW Combined-Cycle Power Plant' by North-West Power Generation Company Limited (NWPGCL) which was funded by Asian Development Bank (ADB). This survey covered 30 km length of river stretches in Bhairab, Atai and Rupsha Rivers and their confluence in different seasons (pre-monsoon, monsoon and post-monsoon). [16] The first four surveys (pre-monsoon, first and second monsoon and first post-monsoon) were conducted by calculating encounter rate, and the last three surveys (second pre-monsoon, first and second winter) were conducted using Mark-recapture method. IUCN first survey yield about 34 to 47 numbers of dolphins and identifed six locations in and around Khulna as important doplhin locations: (i) confluence of Bhairab – Atai – Rupsha, (ii) Atai River, (iii) near Rupsha bridge, (iv) Bhairab-Madhumati confluence, (v) Gekhana Ghat confluence, (vi) near Daulatapur. These locations are shown in Figure 5. A total of 284 sightings were made with an overall encounter rate of 1.18/ km. Using the mark- recapture method, the study estimated 34 dolphins from the areas during four seasonal surveys All the six locations are in the downsteam of existing Khulna water intake on Bhairab river at Afil gate. This location is about 3 km upstream of Bhairab-Madhumati confluence. Discussions with IUCN Bangladesh expert involved in the survey indicated that the follow-on seasonal monitoring surveys (pre-monsoon, monsoon, post monsoon and winter) for the power plant project between May 2021 and August 2024 resulted in lower number of Dolphins (12- 25 numbers.

Figure 5: The Dolphin sightings in 2017 locations are shown in a map

2. Field survey on dolphins for KWSP Phase 2, January 2025

A team of national environmental consultant and local experts with previous experience in conducting dolphin surveys were mobilized to conduct the dolphin survey. The study aims to determine whether the stretch of the Bhairab River—extending from the Afil Gate KWASA intake point to the adjoining rivers at the confluence up to Rupsha Bridge—constitutes a critical habitat for the survival of the Gangetic River Dolphins. Survey was conducted with the following objectives: (i) assess the population and distribution of dolphins in the Bhairab – Atai-Rupsha River, (ii) build a baseline database for future monitoring, and (iii) screen project area for potential critical habitat according to International Finance Corporation (IFC) performance

[16] EIA(Draft) Annexes: BAN: Rupsha 800 MW Combined Cycle Power Plant Project

standards, and (iv) assess potential impacts of abstraction of increase water from Bhairab river (from 5 MLD to 15 MLD) on the species.

Survey Methodology and Survey Area. To conduct the primary field survey, team headed by national environmental consultant has reviewed available reports and dolphins action plan. Since the 2017 Dolphin for 800 MW CCPP survey has been conducted on the same river and very close proximity, the report was considered as a guide. Team also conducted focus group discussions. These consultations took place at Madhumati intake and Bhairab intake. Local farmers, boatmen and fishermen were interviewed with dynamic questionnaire. Total five consultations took place in those two intake points. Besides the information regarding the presence of dolphins, frequency of sightings, their migration patterns, breeding and habitat information etc.., the participants were asked questions such as on crop yield, fish yield, salinity problem, seasonal variation of salinity of crop, agricultural water demand, household water demand, water sharing practices. Team also interviewed several large water vessel drivers in several Ghats with questions related with Dolphins.

To conduct dolphin survey, several transects were set along the route (starting 2km upstream of Bhairab River which were ended at 2 km downstream of Rupsha River) and each transect is 1 to 2 km long. Afil gate intake in Bhairab is situated at the 3 km upstream of Madhumati-Bhairab river confluence, which is the upper most dolphin area in Khulna, and other five locations are in the downstream. A total 24 locations were set for transect surveys from starting point to end points in the first two days of survey.

During the survey four observers on boat actively searched for dolphins along transects at all times and record sighting data. One observer was stationed on the port and one on starboard side of the vessel. All the time two observers search with handheld binoculars and naked eye from the beam to about 10˚ past the bow. The third observer stands in the centre and scans with the naked eye in about a 20˚ cone in front of the bow. Survey team kept their record of sightings and changed their seating positing at a rotating order. The height from the water level to the observer was approximately 2 meters. The speed was set to 5 to 8 km/hour. This survey made transect survey covered river courses and confluence zones, include stretches where there no dolphins' sightings were reported previously. So, no dolphins sightings are still a valuable data.

At each transect point, GPS coordinates are recorded, and the survey team idled the boat at the station for a minimum of 5 minutes to a maximum of 30 minutes, depending on dolphin sightings, with the engine turned off. When dolphins are spotted, the sighting number is recorded, and the group size is estimated. All collected data is documented under the sighting tab during the recording process.. The total number of dolphins is estimated based on expert evaluations, and group sizes are determined accordingly. Since the Ganges River dolphin can hold its breath for a maximum of two minutes, any dolphins present in the area must surface within this time frame.

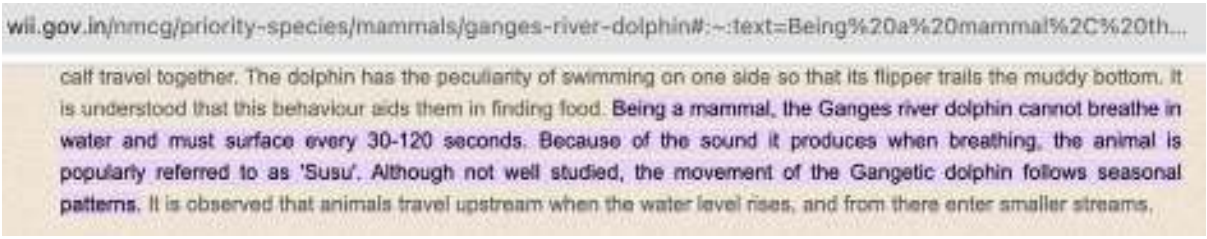


Figure 6: reference of dolphin's surface recurrence

The primary hotspot identified during the survey was the confluence of the Bhairab, Atai, and Rupsha Rivers. This area has highest number of sightings and dolphin abundance. Over the three-day survey period, this location was surveyed three times. At Atai River (upstream from

the confluence station), only the confluence point was surveyed, as the upstream section held little significance to the project's objectives. The timeframe for conducting the KWASA Water Supply Project Phase 2 dolphin survey at the Bhairab River was limited and a rapid survey was conducted. The primary objective was to identify key dolphin area within the Bhairab River and establish this survey as a baseline assessment. The survey was conducted over three consecutive days. On the first day, the survey commenced at 1 PM due to extreme foggy weather but proved to be highly productive, lasting until 6 PM. The Assistant Engineer of KWASA also participated in the survey. The survey route began 2 km upstream of the Bhairab KWASA intake point and extended through the 800MW CCPP area, eventually reaching the Rupsha-Atai-Bhairab confluence. On the second day, the survey started at 9:30 AM and continued until 5:30 PM. It covered a route beginning 2 km downstream of the Rupsha Bridge, following the stretch up to the Bhairab-Atai-Rupsha confluence. The third day's survey started from the Rupsha Bridge and continued to the Afil Gate KWASA intake point. Unlike the previous days, this survey was conducted with the engine running at a controlled speed of approximately 5 km/h.

During the survey, fishermen and boat operators were interviewed to gather additional insights. After completing the fieldwork, the team held a detailed meeting with the Divisional Forest Officer (DFO) of Sundarbans West to discuss the findings.

a. Survey Team

- **Team Leader:** Asif Imran. National consultant; environmental specialist engaged to support preparation KWSP Phase 2. The consultant has previously conducted Dolphin survey using hydrophone under Padma multipurpose bridge project in the year 2015 to 2016.
- **Marine Biologist:** D Tapan k Dey. Retired Deputy Chief Conservation of Forest (DCCF) of Bangladesh Forest Department (BFD). Author of several books about wildlife and biodiversity, marine wildlife and avian species. Formulate rules and done training about conducting Dolphin survey. All dolphins survey done by IUCN were conducted under his supervision or guidance. Before any dolphin survey happens in Bangladesh, he provided the survey teams with necessary training and procedure on behalf of Bangladesh Forest Department.
- **Field Researchers:** Rajib Rashedul Kabir. Experienced in conducted dolphin survey every year in Sundarbans and Padma River and distributaries.
- **Volunteers:** Md. Ashraf Hossain, Civil engineer for Eco Concern. The Boatman hired for this 3 days survey also act as a survey volunteer. The boatman was very enthusiastic about the survey work and the second day another fellow boatman joined the team who has previous experience of doing dolphin survey. They were both interviewed for getting information of the Bhairab river and biodiversity.
- **Data Analysis:** D Tapan and Asif Imran

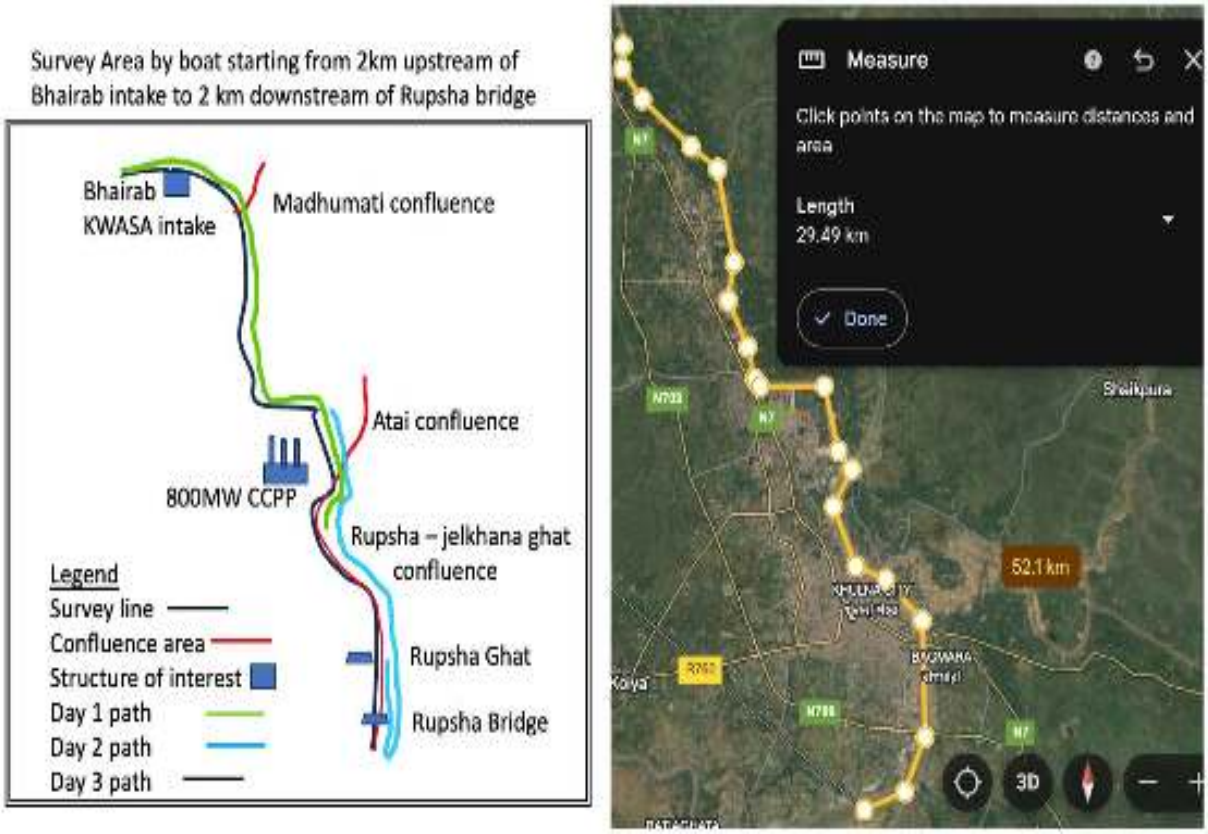


Figure 7: Three days survey route and survey route in Map

Table 1: Three-day Dolphin survey Schedule

Day	Time	Coverage area	Remarks
1 (23-Jan)	1 PM to 6 PM	Afil gate to Rupsha-Atai Confluence crossed 800MW CCPP site. Started 2 km upstream of Bhairab intake and surveyed several points.	Before starting the survey had a meeting with XEn Mr. Kamal and Ast. Eng. Mr. A. Razzak at KWASA building.
2 (24-Jan)	9:30 AM to 5:30 PM	Rupsha Ghat to Rupsha Bridge then upto Rupsha Confluence	Visited floating research centre of BFD
3 (25-Jan)	9:30 AM to 3 PM	From Rupsha Ghat to Rupsha Bridge then Upto Afil Gate Intake point.	Meeting with DFO Sundarban West after the survey, also communicate with DFO Surdarban East by phone

Table 2: Recording of the field survey KWSP-2

Location ID	No of sightings	Dolphin Population	Distance from boat	Survey duration (min)	Vehicular (boat) movement	Other wildlife	GPS coordinates
1 (-2km)	No			5	Moderate		22°57'11" N 89°28'59" E
2 Afil gate intake	No			5	Moderate		22°56'30" N 89°29'41" E
3	No			5	Moderate		22°56'20" N 89°29'52" E
4 Mirpara	No			5			22°56'07" N 89°30'11" E
5.Bharab-Madhumati confluence	1, 2, 3,4	1	5-30m	30	Heavy	Otter nest	22°55'38" N 89°30'52" E 5-8 all within 50m radius
6	5	1,1,1	10- 20m	10	Moderate		
7	6,7,8			10			
8	9	1	30m	10			
9 Ba rakpur	No			5	Moderate		22°55'18" N 89°30'57" E
10	No			5	Moderate		22°54'48" N 89°31'05" E
11	No			5	Moderate		22°54'15" N 89°31'08" E
12 CSD	No			5	Moderate		22°53'36" N 89°31'07" E
13 Ispahani	No			5	Moderate		22°52'37" N 89°31'30" E
14 Senhati	No			5	Moderate		22°52'13" N 89°32'37" E
15 Wonder land	No			5	Heavy	Comorant	22°52'13" N 89°32'39" E
16 CCPP	10,11,12,13, 14	1,1,1	5 – 40m	30	Heavy	Otter, egret	22°51'08" N 89°33'22" E
17 confluence Rupsha	15, 16	1	10m	20	Heavy	Northern pintail	
Day 2							
18 (+1km)	No			10	Continuous		22°46'10" N 89°34'59" E
19 Brz Rupsha	No			20	Continuous		22°46'43" N 89°35'03" E
20 ship yard	No			20	Continuous		22°47'20" N 89°35'03" E
21	No			5	Continuous		22°48'07" N 89°34'59" E
22 confluence jelkhana	17	1	30m	10	Continuous		22°48'57" N 89°34'28" E
23 Jl confluence	18	1	25m	10	Continuous	Stingray ??	22°49'06" N 89°34'18" E

Location ID	No of sightings	Dolphin Population	Distance from boat	Survey duration (min)	Vehicular (boat) movement	Other wildlife	GPS coordinates
24 Biwta Ghat	No			5	Continuous		22°49'32" N 89°33'34" E
25 Navy Ghat	No			5	Moderate		22°50'16" N 89°33'16" E
26 6no ghat	No			5	Moderate		22°50'16" N 89°33'16" E
27 confluence Rupsha	19,20,21	1	30-40m	10	Heavy		22°50'54" N 89°33'37" E 200m radius
28	22, 23, 24, 25, 26, 27, 28	1,1,1	20-50m	30	Heavy	otter	
29	29,30,31,32,33, 34, 35	1,1,1	20-40m	30	Heavy	Monitor lizard	
30	36,37,38,39	1,1	10-40m	20	Heavy		
31	40,41,42,43	1,1,1	10-40m	30	Heavy		
32	44,45	1	5m	10	Moderate		22°50'56" N 89°33'41" E 200m Radius
33 conf Rupsha	46,47,48,49	1,1	10-40m	20	Moderate		
	50,51,52,53	1,1,1,1	20-40m	20	Moderate		
34	54, 55	2	20/10m	20	Moderate		
	56,57,58,59	1,1, 2	10-40m		Moderate	Otter	
35	60,61,	2	10/30m	15	Moderate		
36	62, 63, 64	2, 1	10-40m	15	moderate		
3rd day							
Jelkhana confluence	65	1	10m	Running boat at 5 km/h	Continuous		
Rupsha	66, 67	1,1	20m		Heavy		
Rupsha	68,	1	30m		Heavy		
CCPP	69,70, 71	1,1,1	10-20m	20	Moderate		
Madhu	72	1	10m		Moderate		

*** Vehicular movement indication:** Moderate = 10 to 20 water vehicles pass during this point; Heavy = over 20 to 30 water vehicles passed during this point; Continuous= over 30 vehicle pass during this point (Bangladesh Dolphin action plan 2020 to 2030)

(ii) **Dolphin's Number Estimation.** Chapman Estimator (Improved Formula) - The total population size in project area is estimated using this formula.

$$N = \frac{(M+1)(C+1)}{(R+1)-1}$$

Where:
N = Estimated total dolphin population
M = is the number of groups detected by the primary observer team
C = Total number detected by the secondary observer team
R = is the total number of group detected by both teams

After the survey, the estimated dolphin population over the two-day period was determined by the team expert to be N = 10. The primary observers conducted the initial assessments, while the secondary observers, along with the boat driver, provided additional verification. The total detections recorded by both the primary and secondary teams were identical. Although the overall number of detections was lower, it remained consistent with the expected formula, M + C > R.[17]

So,

$$N = \frac{(10+1)(12+1)}{(12+1)-1}$$

$$N = \frac{(13)(13)}{= (11)-1}$$

$$N = 15.36-1$$

$$N \approx 14.36$$

After putting the field observation into Chapman's modified Lincoln-Petersen Estimator reveals that during this survey done in January 2025 there's about 14 to 15 dolphins were present in that area. This is very much close to 2024's IUCN survey which said to be yielded 17-18 number. It may be noted that the presently study does not include Atai River channel.

Consultation with experts, IUCN Bangladesh and BFD to finalize survey findings. To complete the dolphin survey report and maintaining the required standard, several meeting sessions has been conducted at different stages of the survey. Prior to the survey an introductory online meeting were conducted with survey members, international specialist and ADB's environmental specialist. Survey plan, team member's competencies and methodologies were discussed. After completion of the survey, the team had a meeting with Divisional Forest Officer (DFO) Sundarbans west. Survey methodology and biodiversity findings and estimated dolphin population were discussed with the DFO.

While preparing the report, national consultant also discussed with the IUCN Bangladesh on the **survey methodology adapted and the findings. The IUCN specialist pooled insights from the surveys** conducted by IUCN for the power plant project in Khulna, and provided valuable comparative data on dolphin population trends, changes, movement pattern, lifecycle etc., These meetings gave the team a better understanding of various dolphin species, population estimation methodologies, including Chapman and Lincoln-Petersen Estimators, to ensure alignment with global best practices in this report.

[17] Page 82, EIA annex Rupsha 800 MW CCPPP

1		
	Dolphin at Bhairab-Atai-Rupsha confluence	A dead dolphin found on the way to Rupsha confluence
2		
	Dolphin at Bhairab - Atai - Rupsha confluence	Dolphin at Madhumati – Bhairab confluence
3		
	Dolphin spotted between jelkhana ghat confluence and Rupsha bridge	At Bhairab - Atai - Rupsha confluence

4		
	At Bhairab-Atai-Rupsha confluence	In the course from Rupsha bridge to Rupsha ghat
5		
	Asian smooth coated Otters spotted at the northern side river bank of power plant in the vicinity of Rupsha confluence	Smooth coated Otters Captured along the survey routes near jelkhana confluence
6		
	Winter birds (Northern Pintails) spotted along the survey routes	A large flock of egrets detected along the route

7		
	Local fishermen were interviewed about dolphins, fish catching and other wildlives	Local boatman were interviewed from Rupsha ghat to Rupsha river area
8		
	Survey team accompanied by A Razzak of KWASA at Madhumati-Bhairab confluence	Rupsha bridge were surveyed 2 days but no dolphins were sighted at the vicinity
9		
	Floating wildlife research center of Sundarban FD, they have historical images of wildlife of Rupsha-Bhairab river's fauna and flora	Meeting with Mr. Hasanur Rahmnan, DFO Sundarban west after the survey, the findings and methodology were shared with him

10		
	Meeting at IUCN Bangladesh Dhaka office. IUCN provide the survey team their recent publication "Dolphins of Bangladesh".	

F. Aquatic and other fauna in Project Area

In addition to dolphins, the Bhairab, Atai, and Rupsha rivers support diverse fish and shellfish populations. A survey identified 27 species in these rivers, with the Bhairab River hosting the highest diversity at 18 species. Notably, species such as the Paradise Threadfin (*Polynemus paradiseus*) and Pama Croaker (*Otolithoides pama*) were recorded. The presence of these species indicates a rich biodiversity that supports the ecological balance of the river system. The confluence zone, where nutrient-rich waters merge, acts as a biodiversity hotspot. Fish species like hilsa (*Tenualosa ilisha*) undertake seasonal spawning migrations, moving upstream to breed during monsoon-driven high flows. This period also triggers synchronized spawning in many carp species, attracting predators like otters and birds. Smooth-coated otters (*Lutrogale perspicillata*), often observed here, breed post-monsoon, leveraging the abundance of fish to nourish pups.[18]

Avian diversity peaks in winter, when migratory waterfowl, including garganeys and northern pintails, arrive from temperate regions. Resident birds like kingfishers and egrets exploit year-round fish stocks, nesting during the dry season when riverbanks are exposed. The confluence's ecological significance lies in its role as a transitional hub, where seasonal fluxes in water and nutrients sustain interconnected life cycles, underscoring the need for conservation in this vital riparian corridor.

Overall, the Bhairab-Atai-Rupsha river confluence serves as a crucial habitat for the Ganges River Dolphin and other avian and aquatic species, with seasonal movements and reproductive patterns closely tied to the region's hydrological dynamics.

Currently KWASA has two raw water intake facility situated respectively at Mollarhat taking water from Madhumati river and at Afil gate which taking water from Bhairab River. These two intake points are situated at two extreme points among all project locations of Khulna water supply phase 2. Mollahat intake on Madhumati is located at about 25-30 km east (arial distance) while Afil gate intake on Bhairav is on the extreme north of the town, about 3 km upstream of Bhairab-Madhumati confluence. Project will continue to use these existing intakes, and capacity will be augmented from existing 5 MLD to 15 MLD at Afil gate and from 110 MLD to 135MLD at Mollahat. However, since the existing intake arrangements in river are adequate to meet this demand, not works are

[18] EIA(Draft) Annexes: BAN: Rupsha 800 MW Combined Cycle Power Plant Project

proposed. Under the project, capacity of intake pumping stations, located adjacent to riverbanks will be augmented by installing new pumps. WTPs will also be retrofitted to augment their capacities.

Afil Gate intake site: Small fish, water insects, snails, dragonflies, and frogs were seen during the field survey. Spotted snakehead and Kechi fish were identified. Boatmen and local shop owners indicated occasional spotting of dolphins, and that sightings happen mostly at confluence areas especially in the middle of the river following the ships. Also, they added over the year the sightings are becoming less frequent and there is also decline in fish populations.

Mollarhaat Madhumati river intake site: Heavy riverbank vegetation is seen, which plays a good part in stabilizing the soil, though continuous passing of water hyacinths indicates eutrophication. Public consultations confirmed declining fish populations and variations of fish species. During the field visit, egrets and kingfishers were seen waiting to catch fish from the river. From the boundary of the intake point, snails, frogs, and small fish were seen; during the time, no human fishing activity took place, though public consultation confirmed that fishing activity from this zone of the river is a common practice. The intake facility has many trees characterized by timber, medicinal, and fruits. Those trees are the nesting places of lots of birds. The survey shows Magpie, Shalik, Tuntuni, and sparrows species at the intake premises pecking at fruit trees. Mongoose house cats were also seen at this facility. The river is carried huge amount of water hyacinth. The movement of water vehicles is also high.

List of fauna species in project area, compiled based on both field visits and secondary sources is in Table 3:

Table 3: Fauna species in Project Area

SL No.	Local Name	Scientific Name	Source of info	IUCN Red List mark
Terrestrial Fauna (Reptiles)				
1.	Anjila	*Mabuya carinata*	Secondary source	Least concern
2.	Dhura Shap	*Fowlea PMSCator*	Secondary source	Least concern
3.	Matia Shap	*Atretium schistosum*	Secondary source	Least concern
4.	Tiktiki (P)	*Hemidactylus brookii*	Field visit (many locations)	Least concern
5.	Daraish Shap	*Ptyas mucosus*	Secondary source	Least concern
6.	Gui Shap	*Varanus sparnus*	Field visit (Bhairab River)	Data deficient
Terrestrial Fauna (Mammals)				
1.	Badur/ Bat	*Pteropus giganteus*	Secondary source	Near threatened
2.	Idur / Rodent	*Mus musculus*	Secondary source	Least concern
3.	Shial / jackals	*Vulpes bengalensis*	Secondary source	Least concern
4.	Chika	*Suncus murinus*	Secondary source	Least concern
5.	Beji (P)/ Mongoose	*Herpestes fuscus*	Field visit (Mollahat)	Least concern
6.	Vodor/ smooth coated otter	*Lutra perspicillata*	Field visit (Bhairab rive	Vulnerable
Avians (Birds)				
1.	Choroi (P)	*Passer domesticus*	Field visit (many locations)	Least concern
2	Doyel (P)	*Copsychus saularis*	Field visit (many locations)	Least concern
3.	Kak (P)	*Carvus splendens*	Field visit (many locations)	Least concern
4.	Ghugho	*Streptapelia Orientalis*	Secondary source	Least concern

SL No.	Local Name	Scientific Name	Source of info	IUCN Red List mark
5.	Shalik (P)	*Stuma contra*	Field visit (many locations)	Least concern
6.	Tuntuni (P)	*Orthotomus sutorius*	Field visit (Mostafa mor)	Least concern
7.	Machranga (P)/ kingfisher	*Helcyon smyrrensis*	Field visit (Mostafa mor)	Least concern
8.	Haludpakhi	*Oriolus xanthornus*	Secondary source	Least concern
9.	Katthokra	*Picus canus*	Secondary source	Least concern
10.	Pecha	*Tyto alba*	Secondary source	Least concern
11.	Bok (Heron) (P)	*Ardeidae*	Field visit (Mostafa mor & Mollahat)	Least concern
12.	Drongo / Finge (P)	*Dicrurus macrocercus*	Field visit (Mostafa mor, Mollahat & Labonchara)	Least concern
13.	Brahminy kite (P)	Haliastur indus	Secondary source	Least concern
15.	Cormorant	Phalacrocorax fuscicollis	Field visit (Bhairab river & Rupsha River)	Least concern
Insects				
1.	Dragon fly nymph	Odonata	Field visit (WTP, Mollahat & Bhairab river)	Least concern
2	Damsel fly nymph	Odonata	Secondary source	Least concern
3.	Water strider (P)	Hemiptera	Field visit (Mostafa mor & Bhairab river)	Least concern
4.	Midge	Diptera	Field visit (fairly common)	Least concern
5.	Flies (P)	Diptera	Field visit (fairly common)	Least concern
6.	Ant (P)	Hymenoptera	Field visit (fairly common)	Least concern
7.	Caddisfly	Trichoptera	Secondary source	Least concern
8.	Mantis (P)	Mantodea	Field visit (Labonchara)	Least concern
9.	Earth Worm (P)	Lumbricina	Field visit (WTP & Afil gate)	Least concern
10.	Snails (P)	Cyclophorus auranticus	Field visit (WTP & Afil gate, Mollahat, Mostafa mor & Bhairab river)	Least concern
11.	Frogs (P)	*Polypedates leucomystax*	Field visit (WTP, Afil gate, Mollahat, Mostafa mor & Bhairab river)	Least concern
Fish				
1.	Pabda (P)	*Ompoc pabda*	Fish market at Mostafa mor, coming from Bhairab river	Least concern
2	Golsha (P)	*Mystus cavasius*	Fish market at Mostafa mor, coming from Bhairab river	Least concern
3.	Bele	*Glossogobius giuris*	Secondary source	Least concern
4.	Tengra (P)	*Mystus vittatus*	Fish market at Mostafa mor, coming from Bhairab river	Least concern
5.	Puti	*Puntius conchonius*	Secondary source	Least concern
6.	Fali	*Notopterus notopterus*	Secondary source	Least concern
7.	Kachki	*Corica suborna*	Secondary source	Least concern
8.	Mola	*Amblypharyngodon mola*	Secondary source	Least concern

SL No.	Local Name	Scientific Name	Source of info	IUCN Red List mark
9.	Kakila	*Xenentodon cancila*	Secondary source	Least concern
10.	Chapila	*Gudusia chapra*	Secondary source	Least concern
11.	Kholisha	*Colisa fasciatus*	Secondary source	Least concern
12.	Chingri	*Macrobrachium eqidense*	Secondary source	Least concern
13.	Shol	*Channa striates*	Secondary source	Least concern
14.	Taki	*Channa punctatus*	Secondary source	Least concern
15.	Shing	*Heteropneustes fossilis*	Secondary source	Least concern
16.	Koi	*Anabas testudineus*	Secondary source	Least concern
17.	Gozar	*Channa marulius*	Secondary source	Least concern
18.	Chela	*Chela cachius*	Secondary source	Least concern
19.	Rui	*Labeo rohita*	Secondary source	Least concern
20.	Katla	*Catla catla*	Secondary source	Least concern
21.	Kalibaush	*Labeo calbasu*	Secondary source	Least concern
22.	Boal (P)	*Wallago attu*	Fish market at Mostafa mor	Least concern
23.	Ayre (P)	*Sperata aor*	Fish market at Mostafa mor,	Least concern
24.	Bain	*Mastacembelus armatus*	Secondary source	Least concern
25.	Chital	*Chitala chitala*	Secondary source	Least concern
26.	Fasha	*Setipinna phasa*	Secondary source	Least concern
27.	Bata	*Liza Persia*	Secondary source	Least concern
28.	Dari	*Scistura scaturigina*	Secondary source	Least concern

Reference: IUCN red list assessment categories

Not evaluated	Data deficient	Least concern	Near threatened	Vulnerable	Endangered	Critically endangered	Extinct in the wild	Extinct

G. Critical habitat Screening

IBAT Screening. IBAT (Integrated Biodiversity Assessment Tool) is a web-based platform designed to support biodiversity assessment and decision-making for conservation projects and such organizations. IBAT provides access to critical biodiversity data, including information on protected areas, key biodiversity areas (KBAs), and species from the IUCN Red List of Threatened Species. The tool enables users to conduct spatial analyses to identify biodiversity risks and opportunities in specific regions, supporting efforts to minimize environmental impacts and promote sustainable development. IBAT screening was conducted for the following two locations of KWASA water supply project phase 2: (i) Mollahat intake, Madhumati River (Location: 22.9 N, 89.8 E) and (ii) Afil gate intake, Bhairab River (Location: 22.9 N, 89.5 E). As per IBAT screening, there are no protected areas or key biodiversity areas (KBAs) within or close to project area. Two protected areas (Char Muguria eco park and Pankhali wildlife sanctuary and dolphin reserve) are the nearest sensitive areas, located in 50 km buffer. Sundarbans protected area, an ecologically sensitive and biodiversity rich area, is located at about 50 km areal distance from the project area.

Before screening secondary data generated through IBAT for Khulna using criteria in the IFC's Guidance Note 6 (updated June 27, 2019) for critical habitat determination, it is necessary to verify the availability of those species in the Area of Analysis. IBAT data was generated within a 50km radius of the project location, and therefore, species inhabiting other sensitive or protected areas were also included in the list. These species sometimes cannot be found in the area of analysis, so it is necessary to verify their existence. These verifications were carried out using available literature and expert knowledge. Though the IBAT screening report identifies **20+ species** in the **critically endangered (CR)** and **endangered (EN)** categories within **50 km,** except endangered dolphin, there are no recent records or reports or evidence that suggest their presence in the Khulna area in the recent past.

Presence and population of Gangetic River Dolphins in project area. In Bhairab and Ruphsa Rivers in Khulna project area, continuous surveys are being done by IUCN Bangladesh of monitoring for Combined Cycle Power Plant (CCPP) project. The baseline survey conducted by IUCN in 2017 as part of EIA for the CCPP project in Khulna, with water intake on Bhairab, recorded a dolphin population of 34 individuals in the study area. However, discussions with IUCN Bangladesh expert involved in the survey indicated that the follow-on seasonal monitoring surveys (pre-monsoon, monsoon, post monsoon and winter) for the power plant project between May 2021 and August 2024 resulted in lower number of Dolphins (12- 25 numbers. The dolphin survey conducted for this Khulna Water Supply Project Phase 2 also recorded a dolphin population range between 14 and 15 individuals in the study area. It makes about only 1% of national population and less than 0.5% of global population in the project area.

Consultation with experts indicate that although overall numbers in Bangladesh are increasing, the reduction in numbers in this area is can be attributed to a number of factors. These include oil spills from boats, tankers and industrial waste discharges, increasing number of fishers, the use of illegal fishing nets with excessively small mesh sizes, the application of toxic substances to catch fish, riverbed depletion, and escalating noise pollution caused by extensive waterway transportation. It is also pointed out during consultations that the Pankhali Dolphin Sanctuary, officially designated as a gazetted dolphin sanctuary by the Government of Bangladesh in 2020, is located approximately 20 km downstream of the Bhairab-Rupsha River in Dacope Upazila, Khulna. It falls within the Pashur-Rupsha confluence. This sanctuary provides a significantly safer habitat for dolphins, as all water vessel traffic and fishing activities are strictly prohibited, ensuring better conservation measures. As a result, dolphins from the Bhairab-Rupsha region may be migrating toward the sanctuary in search of more favorable survival conditions. This migration could be a primary factor contributing to the declining dolphin numbers observed in recent surveys. Recent studies show that the dolphin global population is increasing as well as national population is also increasing. The recent study by Wildlife Institute of India (WII) estimated the population of Ganges River dolphin as 6,324 individuals with a range of 5,977-6,688.[19], a significant increase.

As per International Finance Corporation (IFC) performance standard 6 (PS6) to establish critical habitat, species threatened with global extinction and listed as CR and EN on the IUCN Red List of Threatened Species shall be considered as part of Criterion 1. It stipulates the following thresholds for an area to qualify as a critical habitat: (a) areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥

[19] Population Status of River Dolphin in India. Qamar Qureshi, Vishnupriya Kolipakam, Abdul Wakid, Soumitra Dasgupta, Satya Prakash Yadav, Virendra R. Tiwari & Bivash Ranjan. Population Status of River Dolphins in India. 2021-23 (2024). Ministry of Environment, Forest and Climate Change, New Delhi and Wildlife Institute of India, Dehradun. https://wii.gov.in/staus_river_dophin

5 reproductive units of a CR or EN species). Therefore, based on this criteria, the project area is not qualified as a critical habitat for dolphins as it holds less than 0.5% of global population.

G. Protected Areas

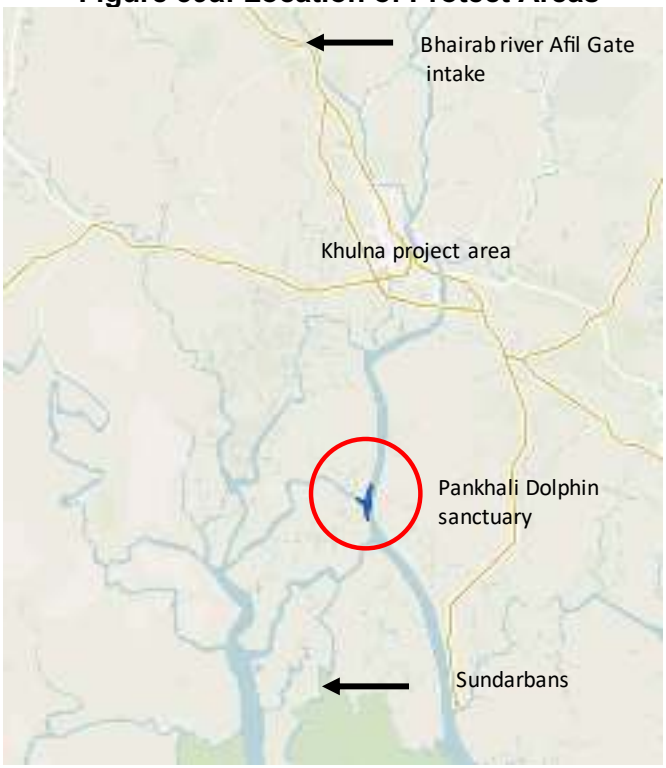
There are no protected areas in or near the project area. The nearest ones as per IBAT screening are Pankhali Dolphin sanctuary and Charmuguria Eco Park, which are located within 50 km from the project area.

Pankhali Dolphin sanctuary. This dolphin hotspot and sanctuary is located upstream of Sundarbans Mangrove Forest, at the confluence of Passur and Jhapjhapia Rivers in Khulna District where the density of Ganges River dolphin is very high. It is consisting of an area of 1.41 sq km, which was considered for inclusion in the protected area network. Notably, the Passur River is used as a major shipping route, connecting Mongla Port and smaller river ports upstream. But the hotspot occupies a small area on the west side of the river. Passur river is the downstream part of Rupsha river, and is about 40-45 km (water course length) downstream of Afil Gate intake on River Bhairab and about 20 km from the project area boundary. [20]

Charmuguria Eco Park. The Eco-Park is located in Nayachar area of Kumarakhali in Madaripur district. The area of the eco-park is 4.20 hectares and was. established in 2015. Charmuguria is mainly known for monkeys. Till 2015, Two to two-and-a-half thousand monkeys lived in Charmuguria. This is located at about 50 km from Khulna.

[20] Dolphins Of Bangladesh

Figure 39a: Location of Protect Areas



IBAT

Integrated Biodiversity Assessment Tool

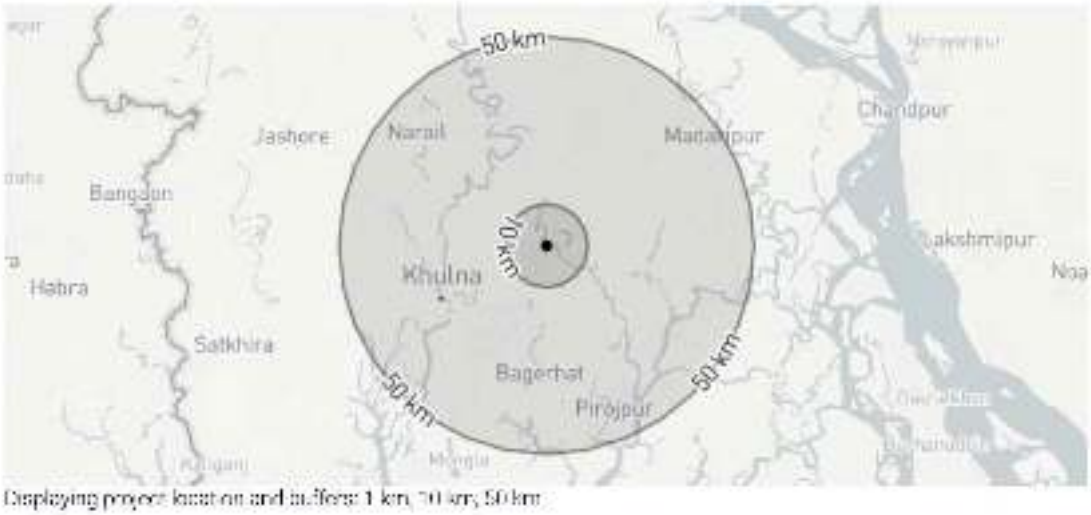
World Bank Group Biodiversity Risk Screen

MADHUMATI INTAKE KHULNA

- **Country:** Bangladesh
- **Location:** [22.9, 89.5]
- **IUCN Red List Biomes:** Marine, Freshwater, Terrestrial
- **Created by:** Achyutha Rao Alla

Overlaps with:

Protected Areas	1 km: 0	10 km: 0	50 km: 2	2
World Heritage (WH)	1 km: 0	10 km: 0	50 km: 0	0
Key Biodiversity Areas	1 km: 0	10 km: 0	50 km: 0	0
Alliance for Zero Extinction (AZE)	1 km: 0	10 km: 0	50 km: 0	0
IUCN Red List				48
Critical Habitat				Unclassified



Displaying project location and buffers: 1 km, 10 km, 50 km

WORLD BANK GROUP

Image 9: IBAT screening, Madhumati River, Mollahat intake point.

IBAT

Integrated Biodiversity Assessment Tool
World Bank Group Biodiversity Risk Screen

BHAIRAV RIVER INTAKE, KHULNA

- **Country:** Bangladesh
- **Location:** [22.9 89.5]
- **IUCN Red List Biomes:** Marine, Freshwater, Terrestrial
- **Created by:** Achyutha Rao Alet

Overlaps with:

Protected Areas	1 km: 0	10 km: 0	50 km: 1	1
World Heritage (WH)	1 km: 0	10 km: 0	50 km: 0	0
Key Biodiversity Areas	1 km: 0	10 km: 0	50 km: 0	0
Alliance for Zero Extinction (AZE)	1 km: 0	10 km: 0	50 km: 0	0
IUCN Red List				20
Critical Habitat				Likely

Displaying project location and buffers: 1 km, 10 km, 50 km

WORLD BANK GROUP

Image 10: IBAT screening, Bhairab river, Afil gate intake point.

Table 4: List of Critically endangered and endangered species of the Two locations'

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Batagur baska	Northern River Terrapin	Reptilia	CR	Decreasing	Terrestrial, Marine, Freshwater
Pelochelys cantorii	Asian Giant Softshell Turtle	Reptilia	CR	Decreasing	Terrestrial, Marine, Freshwater
Orcaella brevirostris	Irrawaddy Dolphin	Mammalia	EN	Decreasing	Marine, Freshwater
Urogymnus polylepis	Giant Freshwater Whipray	Chondrichthyes	EN	Decreasing	Marine, Freshwater
Batagur kachuga	Red-crowned Roofed Turtle	Reptilia	CR	Decreasing	Terrestrial, Freshwater
Batagur dhongoka	Three-striped Roofed Turtle	Reptilia	CR	Decreasing	Terrestrial, Freshwater
Geoclemys hamiltonii	Spotted Pond Turtle	Reptilia	EN	Decreasing	Terrestrial, Freshwater
Hardella thurjii	Crowned River Turtle	Reptilia	EN	Decreasing	Terrestrial, Freshwater
Morenia petersi	Indian Eyed Turtle	Reptilia	EN	Decreasing	Terrestrial, Freshwater
Nilssonia gangetica	Indian Softshell Turtle	Reptilia	EN	Decreasing	Terrestrial, Freshwater
Nilssonia hurum	Indian Peacock Softshell Turtle	Reptilia	EN	Decreasing	Terrestrial, Freshwater
Platanista gangetica	Ganges River Dolphin	Mammalia	EN	Decreasing	Freshwater
Rynchops albicollis	Indian Skimmer	Aves	EN	Decreasing	Terrestrial, Freshwater
Haliaeetus leucoryphus	Pallas's Fish-eagle	Aves	EN	Decreasing	Terrestrial, Freshwater
Gyps bengalensis	White-rumped Vulture	Aves	CR	Decreasing	Terrestrial
Sarcogyps calvus	Red-headed Vulture	Aves	CR	Decreasing	Terrestrial
Panthera tigris	Tiger	Mammalia	EN	Decreasing	Terrestrial
Varanus flavescens	Yellow Monitor	Reptilia	EN	Decreasing	Terrestrial
Aquila nipalensis	Steppe Eagle	Aves	EN	Decreasing	Terrestrial
Eretmochelys imbricata	Hawksbill Turtle	Reptilia	CR	Decreasing	Terrestrial, Marine
Carcharhinus longimanus	Oceanic Whitetip Shark	Chondrichthyes	CR	Decreasing	Marine
Sphyrna lewini	Scalloped Hammerhead	Chondrichthyes	CR	Decreasing	Marine
Sphyrna mokarran	Great Hammerhead	Chondrichthyes	CR	Decreasing	Marine
Calidris pygmaea	Spoon-billed Sandpiper	Aves	CR	Decreasing	Terrestrial, Marine, Freshwater
Balaenoptera musculus	Blue Whale	Mammalia	EN	Increasing	Marine
Rhincodon typus	Whale Shark	Chondrichthyes	EN	Decreasing	Marine
Isurus oxyrinchus	Shortfin Mako shark	Chondrichthyes	EN	Decreasing	Marine
Urogymnus asperrimus	Porcupine Ray	Chondrichthyes	EN	Decreasing	Marine
Eusphyra blochii	Winghead Shark	Chondrichthyes	EN	Decreasing	Marine
Mobula eregoodoo	Longhorned Pygmy	Chondrichthyes	EN	Decreasing	Marine

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
	Devil Ray				
Mobula tarapacana	Sickle n Devil Ray	Chondrichthyes	EN	Decreasing	Marine
Mobula thurstoni	Bent n Devil Ray	Chondrichthyes	EN	Decreasing	Marine
Isurus paucus	Long n Mako	Chondrichthyes	EN	Decreasing	Marine
Acropora rudis		Anthozoa	EN	Decreasing	Marine
Millepora tenera		Hydrozoa	EN	Decreasing	Marine
Acropora glauca		Anthozoa	EN	Decreasing	Marine
Millepora platyphylla		Hydrozoa	EN	Decreasing	Marine
Alopias pelagicus	Pelagic Thresher	Chondrichthyes	EN	Decreasing	Marine
Pateobatis jenkinsii	Jenkins' Whipray	Chondrichthyes	EN	Decreasing	Marine
Heritiera fomes		Magnoliopsida	EN	Decreasing	Terrestrial, Marine, Freshwater
Holothuria scabra		Holothuroidea	EN	Decreasing	Marine
Holothuria lessoni		Holothuroidea	EN	Decreasing	Marine
Thelenota ananas	Pineapple Sea Cucumber	Holothuroidea	EN	Decreasing	Marine
Mobula birostris	Oceanic Manta Ray	Chondrichthyes	EN	Decreasing	Marine
Tringa guttifer	Spotted Greenshank	Aves	EN	Decreasing	Terrestrial, Marine, Freshwater
Mobula mobular	Spinetail Devil Ray	Chondrichthyes	EN	Decreasing	Marine
Acropora abrotanoides		Anthozoa	EN	Decreasing	Marine

H. Anticipated impacts and mitigation measures

Among all the factors mentioned in the Bangladesh Dolphin action plan only the extraction of water from upstream may apply to KWASA water supply project phase 2. But if the water extraction is limited in the dry season, then the adverse effect can be minimized to a great extent. Furthermore, KWASA is abstracting Bhairab's water during March to June dry season due to high salinity issues that action even puts the downstream dolphin issue much lower magnitude. Bhairab is a carries heavy flows compared to the requirement, and is a tidal river, every day there's a high tide and low tide so 15MLD water abstraction has very minuscule effect on the down stream's dolphin habitats. As per the estimate provided in the feasibility study, project abstraction will constitute only about 0.21% of lean season flow, and since abstraction is only limited non-lean season, the percentage abstraction will even be very small. A rapid dolphin survey in KWSP 2 project area is conducted to understand their presence and population.

Table 6: Anticipated impacts and mitigation measures

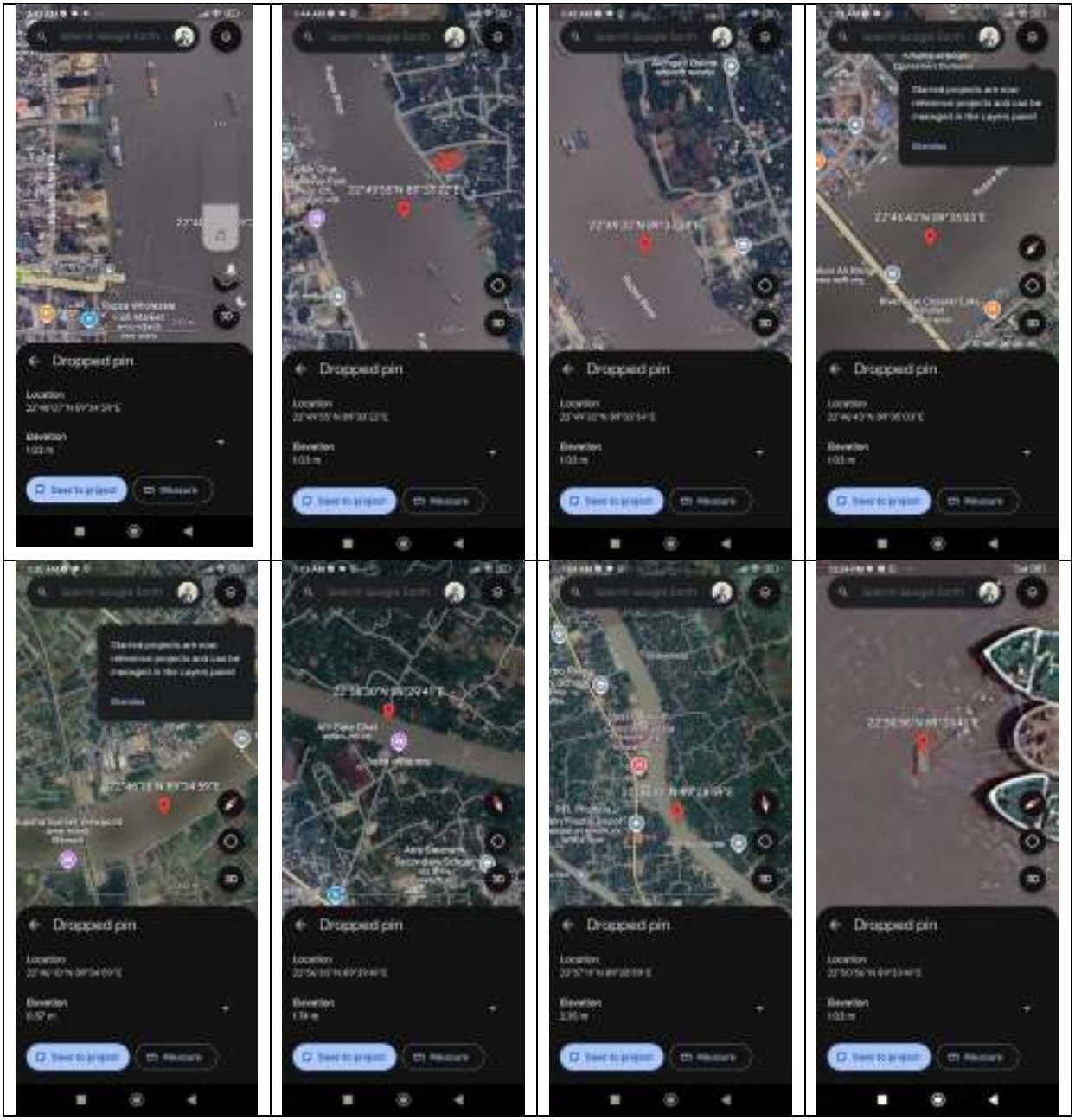
No.	Potential impact	Impact stage	Mitigation Measure	Implementation and monitoring
1.	Increase in water abstraction from Bhairab River may lead to reduced river flow, increased salinity, reduced fish availability etc, which	Project operation	No additional mitigation measures required. Ensure that water abstraction does not exceed the allotted amount. Restrict water extraction	KWASA

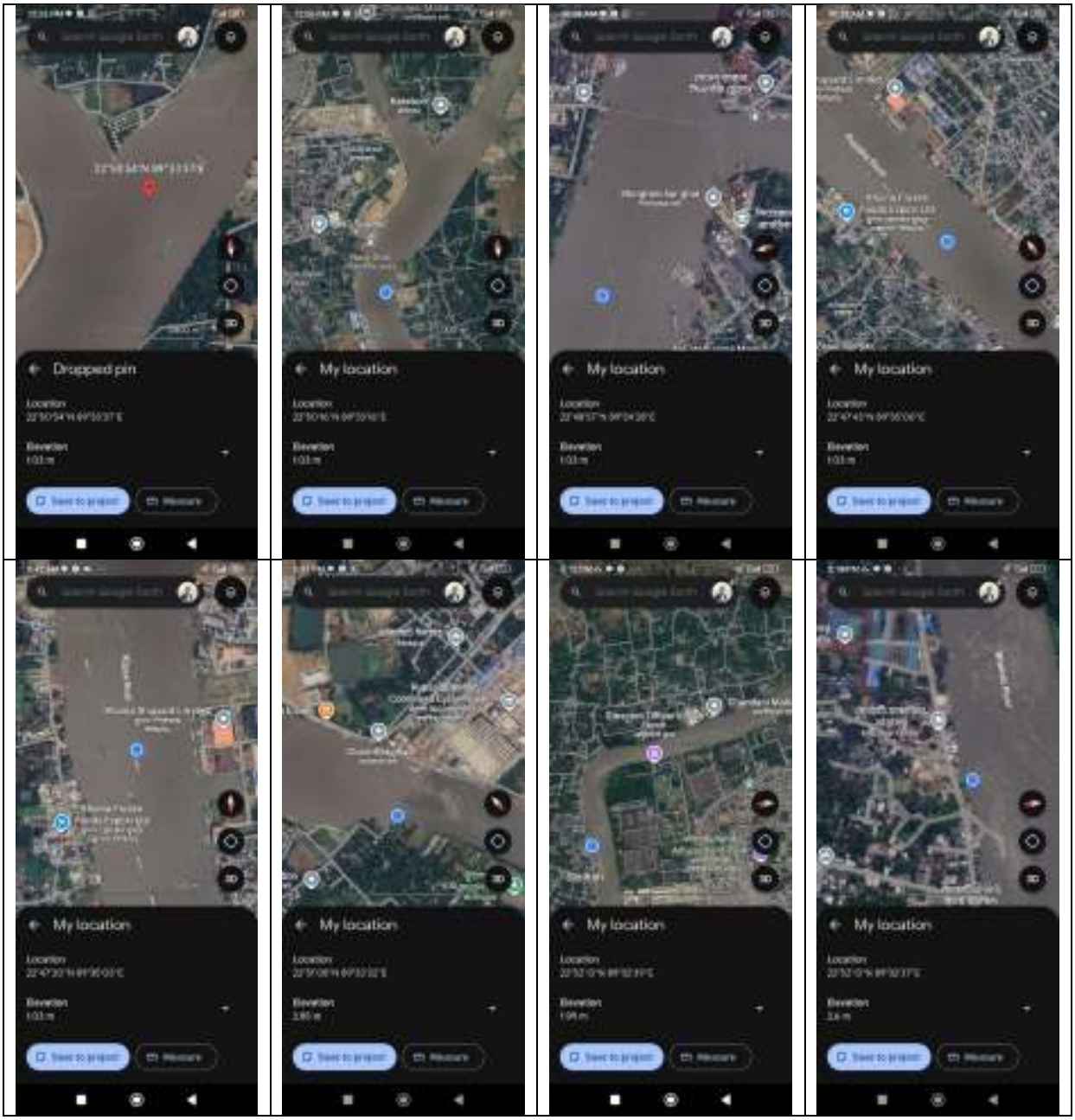
No.	Potential impact	Impact stage	Mitigation Measure	Implementation and monitoring
	may adversely affect the dolphins. The potential impact, however, considered as insignificant as the proposed water abstraction from the existing 5 MLD to 15 MLD, in comparison with river flow is minor. Bhairab River carries very high flows including in dry season, the volume of water to be extracted for the project (the abstraction is estimated as just 0.21% of lean season flow. This fraction will even be smaller compared to high volume it carries during the non-lean season. Due to higher salinity levels, project will not abstract water during lean season (Mar – June)		in dry season for mentioned 4 months.	
2.	Possibility of poaching of dolphins and other wildlife by project related personnel during the construction phase of the project	construction	Create awareness among the project personnel, local community, fishermen, boatmen etc., Ensure proper supervision and monitoring	Contractor, PISC, and KWASA
3.	Construction noise near confluences may impact wildlife. This impact is considered not significant as no works are proposed within the river and works close to the river are very minimal. At Bhairav intake, civil works include rehabilitation/retrofitting of intake sump and pump house and installation of additional pumps. Survey finds that Bhairab intake location is a public Ghat, continuous human presence and the river is heavily used by large water vehicles. Pumps operation will also generate noise. Since these will be located in enclosed rooms, no significant noise is anticipated near the river.	Construction and operation	If high noise generating tasks or machinery is necessary, use noise attenuating measures. Do not conduct noisy works before and after sunset. Conduct periodic noise monitoring during the construction phase. Use low noise generating pumps and motors.	Contractor, PISC, and KWASA
6.	Effluent discharge into river and other pollution	Construction and operation	During construction, no wastewater shall be discharged into the river. During operation phase, the increased water supply will increase sewage generation. The ongoing sewerage project covers	KWASA during the operation, PMU during the construction

No.	Potential impact	Impact stage	Mitigation Measure	Implementation and monitoring
			about 40% of project area. KWASA shall ensure expansion of sewerage system to the remaining area with the future projects. KWASA shall ensure that in uncovered areas, septage from on-site sanitation facilities are treated and disposed through sewage / septage treatment plants.	

APPENDIX

1. All dolphins transect survey locations

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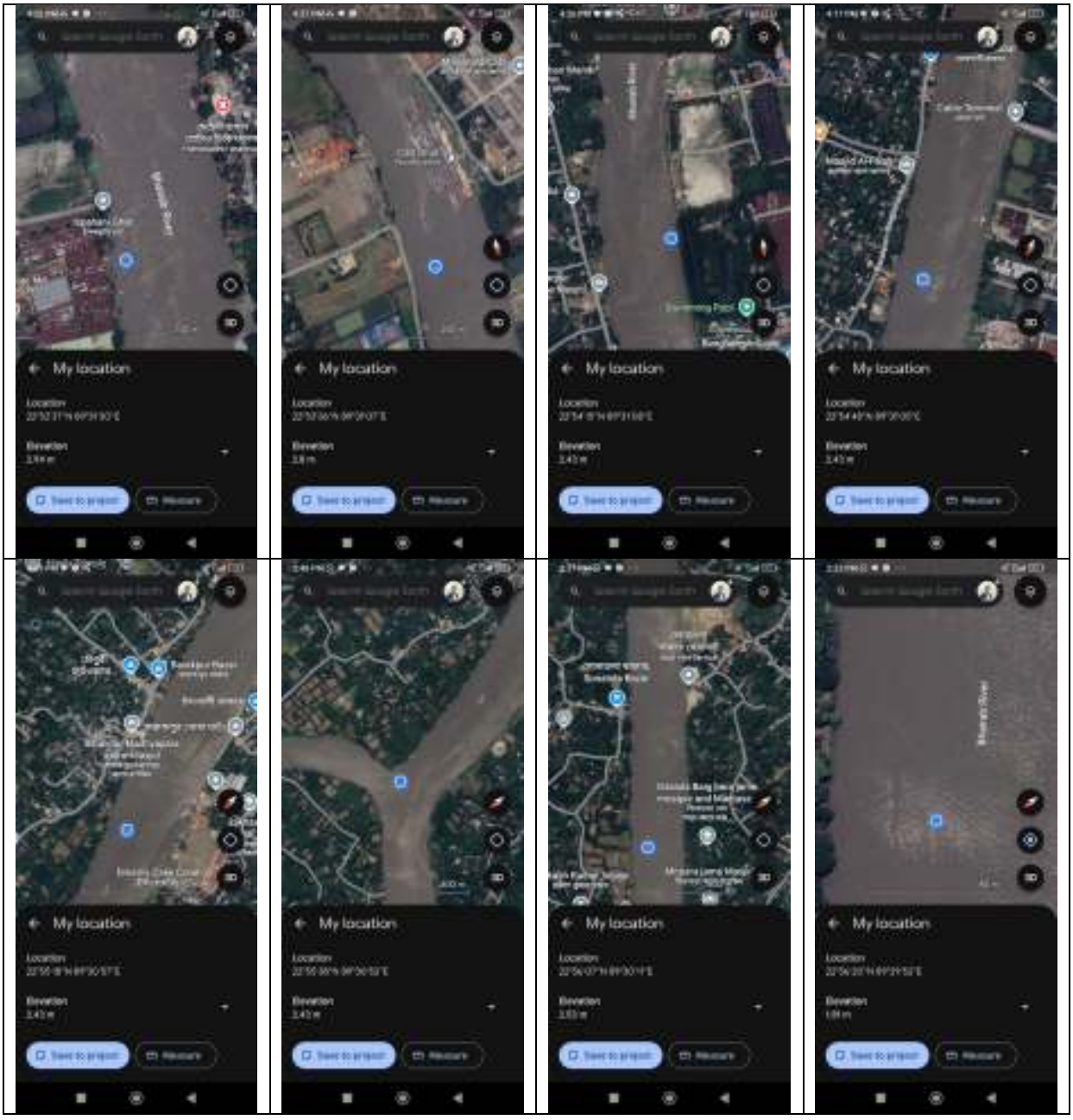
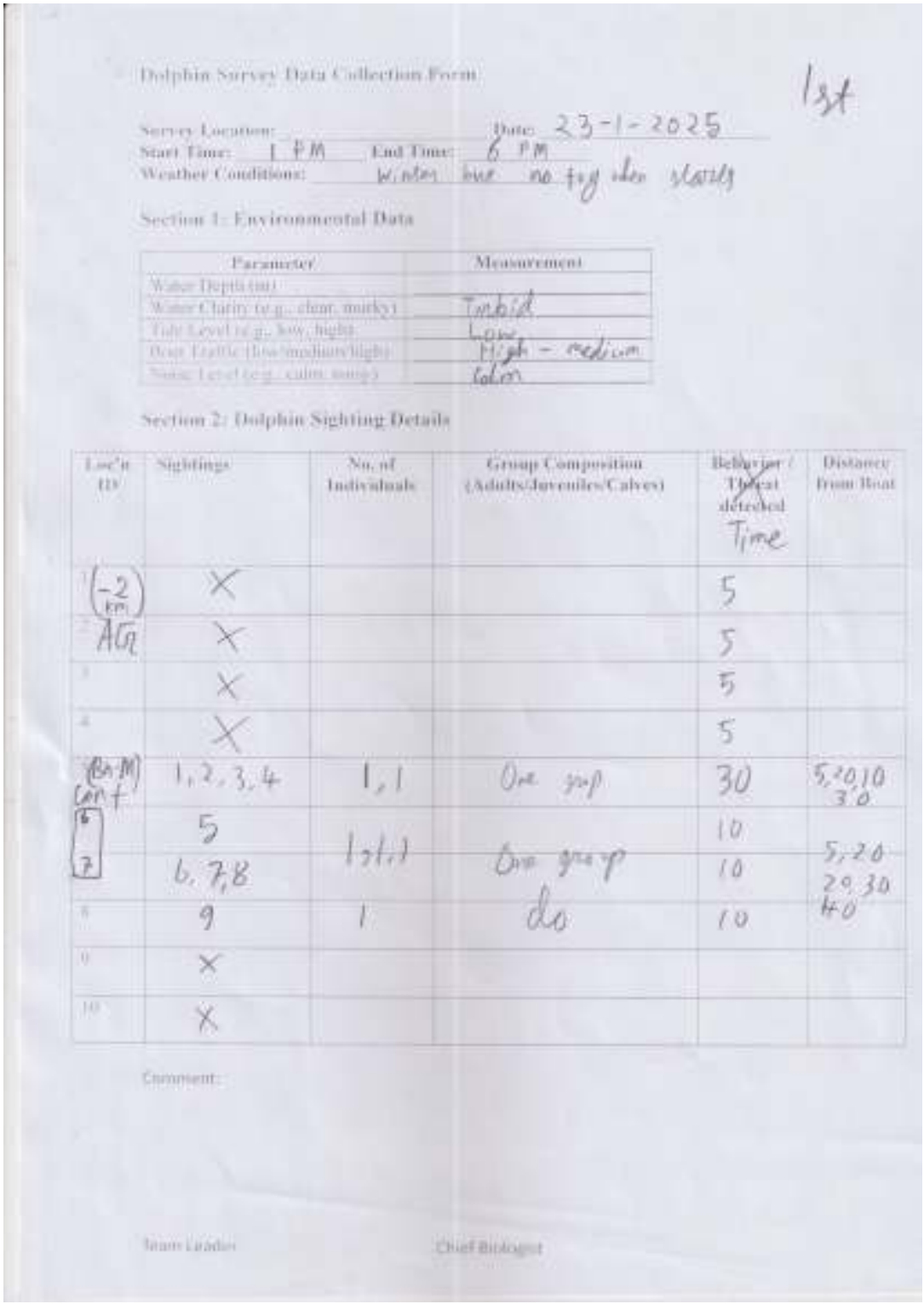

My location
Location
Elevation
Save to project
Measure

2. all Survey forms



Dolphin Survey Data Collection Form

1st

Survey Location: Date: 23-1-2025

Start Time: 1 PM End Time: 6 PM

Weather Conditions: Winter sun no fog also clearly

Section 1: Environmental Data

Parameter	Measurement
Water Depth (m)	
Water Clarity (e.g., clear, murky)	Turbid
Tide Level (e.g., low, high)	Low
Boat Traffic (low/medium/high)	High - medium
Noise Level (e.g., calm, noisy)	Calm

Section 2: Dolphin Sighting Details

Loc'n ID	Sightings	No. of Individuals	Group Composition (Adults/Juveniles/Calves)	Behavior / Threat detected Time	Distance from Boat
(-2 km) AG	X			5	
	X			5	
	X			5	
	X			5	
(BoM) cont	1, 2, 3, 4	1, 1	One grp	30	5, 20, 10 30
6	5	1, 1, 1	One grp	10	5, 20 20, 30 40
7	6, 7, 8			10	
	9	1	do	10	
	X				
	X				

Comment:

Team Leader Chief Biologist

Dolphin Survey Data Collection Form

1 cont.

Survey Location: _____ Date: _____
Start Time: _____ End Time: _____
Weather Conditions: _____

Section 1: Environmental Data

Parameter	Measurement
Water Depth (m)	
Water Clarity (e.g., clear, murky)	
Tide Level (e.g., low, high)	
Boat Traffic (low/medium/high)	
Noise Level (e.g., calm, noisy)	

Section 2: Dolphin Sighting Details

Loc'n ID	Sightings	No. of Individuals	Group Composition (Adults/Juveniles/Calves)	Behaviour / Threat detected / Time	Distance from Boat
11	X				
Esp	X				
1'	X				
1+	X				
1' Park	X				
1' PP	10, 11, 12, 13, 14	1, 1, 1	One group	1km 30m	5, 10, 20 mtrs
1' Rmp Cen	15, 16	1	Second group	20. PM	20, 30
1"					
1"	End of Dog				
2'					

Comment

Team Leader

Chief Biologist

2nd

Dolphin Survey Data Collection Form

Survey Location: Start from Rapsha Ghat Date: 24-1-2025

Start Time: 9:30 End Time: 5:30

Weather Conditions: Foggy

Section 1: Environmental Data

Parameter	Measurement
Water Depth (m)	
Water Clarity (e.g., clear, murky)	Turbid
Tide Level (e.g., low, high)	High-Low-High
Boat Traffic (low/medium/high)	
Noise Level (e.g., calm, noisy)	

Section 2: Dolphin Sighting Details

Loc'n ID	Sightings	No. of Individuals	Group Composition (Adults/Juveniles/Calves)	Behaving / Threat detected Time	Distance from Boat
18	X				
19 Bridge	X				
20 Mayor	X				
21	X				
22J cont	1	1	Some	30m	30m
23	1	1		25m	20m
24	X				
25 No.9	X				
26	X				
27 cont	19, 20, 21	1	Some	10	30m 40m

Comment:

Team Leader

Chief Biologist

Dolphin Survey Data Collection Form

2 cont

Survey Location: _____ Date: _____
Start Time: _____ End Time: _____
Weather Conditions: _____

Section 1: Environmental Data

Parameter	Measurement
Water Depth (m)	
Water Clarity (e.g., clear, murky)	
Tide Level (e.g., low, high)	
Boat Traffic (low/medium/high)	
Noise Level (e.g., calm, noisy)	

Section 2: Dolphin Sighting Details

Loc'n ID	Sightings	No. of Individuals	Group Composition (Adults/Juveniles/Calves)	Behaviour / ~~Type of Activity~~ Time	Distance from Boat
28	22, 23, 24, 25, 26, 27, 28	1, 1, 1	1st group	30m	10-30m
29	29, 30, 31, 32, 33, 34, 35	1, 1, 1		30m	
30	36, 37, 38, 39	1, 1		20	
*31	40, 41, 42, 43	1, 1, 1		30-	
*32	42, 45			10 m	
*33 PP	46, 47, 48, 49, 50, 51, 52, 53	1, 1, 1, 1	2nd group	20m	
34	54, 55, 56, 57, 58, 59	2, 1, 2		20m	
*35	60, 61	2, 2	[Possible 3rd group]	10m	
*36	62, 63, 64	2, 1, 1		15m	
10				1	

Comment:

Team Leader

Chief Biologist

3rd

Dolphin Survey Data Collection Form

Survey Location: Ruphsha Ghat → Afil Gate   Date: 25-1-2025
Start Time: 9:30   End Time: 3 PM
Weather Conditions:

Section 1: Environmental Data

Parameter	Measurement
Water Depth (m)	
Water Clarity (e.g., clear, murky)	Turbid
Tide Level (e.g., low, high)	
Boat Traffic (low/medium/high)	High
Noise Level (e.g., calm, noisy)	calm

Section 2: Dolphin Sighting Details   Continuous movement, only stopped at PP side

Loc'n ID	Sightings	No. of Individuals	Group Composition (Adults/Juveniles/Calves)	~~Behavior / Threat detected~~ Time	Distance from Boat
1 Jelly ...	65	1		~~[illegible]~~	10m
2 Rupsh	66, 67	1, 1		~	20m
3 PP Upper	68	1		[20m]	30m
4 CEPP	69, 70, 71	1, 1, 1			5-30m
5 Madhu	72	1			10m
6					
7					
8					
9					
10					

Comment:

Team Leader   Chief Biologist

Appendix 6: List of Physical cultural resources in and around khulna

(i) Temples and Religious Sites (R)

- Durga Shankar Mission Kali Mandir: A historic Hindu temple known for its cultural and religious significance. Located inside the city
- Sri Raj Lakshmi Temple/ Jora Shivbari temple: An old temple in the city that reflects traditional Hindu architecture and rituals. Located inside the city.
- Dhormoshova temple: A famous temple often visited by devotees during religious festivities. Located inside the city
- ISKON temple
- Shitalbari Mandir

(ii) Khulna Baptist Church: It is a 200 years old church placed in Koylaghata zone Historical Sites and Recreational-Cultural sites (H)/(C)

- Dakkhindighi Rabindra complex: it is the in-law's house of the great poet of Bengal, Rabindranath Tagore. Located at Jugnipasha, about 6 km west of Afil gate.
- Rupsha Ghat: A historic port area that played a vital role in trade and communication during the British colonial era. Located on the city border, the riverbank of the Rupsha River.
- Hadis Park: A historic park in the city that serves as a recreational and cultural gathering place. Located inside the city
- Khulna Railway Station: Built during the British period, it retains its colonial architectural charm. Located inside the city
- Khulna Circuit House: Built in the British period, it retains its colonial architectural charm. Located inside the city.
- Khulna DC Office: A British era Government building, office of the Deputy commissioner of Khulna.
- Banabilash Zoo: The only zoo in Khulna, located inside the cantonment area
- Khulna Shilpakala Academy: A center for cultural performances, art exhibitions, and traditional music, promoting and preserving the cultural heritage of Khulna. Located inside the city area
- Golokdham: A historical landmark, residential place built in British era.
- Umesh Chandra Public Library: A historical library that established in the year 1897. Situated just beside Shishu hospital of Khulna.
- Divisional public library
- Sheikh Abu Naser international stadium
- Wonderland Amusement park.
- Ullash Amusement Park
- Central postal park
- Solar park
- KPS Shishu park

(iii) Museums (M)

- Khulna Divisional Museum: A repository of archaeological artifacts, cultural relics, and historical items significant to the Khulna region. Located inside the city

- 1971: Genocide and torture museum: it's dedicated to Bangladesh's liberation war. Located inside the city

(iv) Educational Institutions (E)

- Khulna City College: One of the oldest educational institutions, which also holds cultural significance due to its role in education and public events over the decades. Located inside the city area.

(v) Mosques (R)

- Sixty Dome Mosque (Shat Gombuj Masjid): Although technically in Bagerhat, this UNESCO World Heritage Site is often associated with Khulna due to its proximity and cultural relevance to the region.
- Darul Ulum mosques and madrasa.
- Zinnah mosque: stablished in 1929 AD, is a nicely decorated mosque located in heart of Khulna city.
- Dargah Mosque of Khan Jahan Ali: Located in the nearby region of Bagerhat, a prominent mosque with rich Islamic architectural features.

Appendix 7: Environmental baseline of proposed project sites

Labonchara Clear Water Reservoir Site (CWR 1). The area is in a semi-urban and rural environment, and the site is located between a road and Mayur River (Coordinates: 22°46'50"N, 89°33'14"E). Overgrowth of plants and submerged aquatic vegetation was observed. The site has timber trees like Arjun, Acacia, Bibul, Shishu, and other native species along the boundary. This is originally an agricultural field, currently it is vacant, and parts of the land are covered with shrubs and grasses. Shalik, kaak were seen also some bird nests on the trees, small fish, and amphibians were observed. Road drain is Te filled with water hyacinths, where access roads will be built. There is a police station just within 50 m of the project site.

Figure 41: Site for CWR at Lebonchara

Mostafa Mor proposed a site for CWR 2, IPR 3. The site is located in a semi-urban area (coordinates: 22°49'43"N, 89°30'48"E), along a main road. This was originally a low-lying area and currently filled up and site is levelled by the owner of the land. There are large trees along the boundary, which may not be disturbed for construction of CWR. There are several shops and fish markets just beside the proposed location.

Figure 42: Site for IPR at the Mostafa Mor

Gilatola, Afil Gate existing WTP and IPR 2 and proposed CWR 3. Site is located within the existing water treatment plant (WTP) site (Coordinates: 22°55'59"N, 89°29'11"E). A mix of planted and natural vegetation surrounds the well-maintained and landscaped area, with reservoirs. There is a government institute at about 400 m south of the facility, which is called Bangladesh Krira Shikkha Protishtan (BKSP). This is the National Sports Institute of Bangladesh.

Figure 43: WTP and Pumping Station at Afil Gate

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Existing WTP</td><td>Existing IPR</td></tr>
<tr><td>  </td><td> 
</td></tr>
<tr><td>Proposed CWR site</td><td></td></tr>
</table>

Afil Gate old Pumping Station, CWR 4 Site. Located in a semi-urban area with visible vegetation and abandoned infrastructure. (Coordinates: 22°55'58"N, 89°29'23"E). Existing structures will be dismalnted and CWR will be constructed at the same site. This site is located near junction point of Khulna bypass and Khulna to Jassore Highway. A rail crossing is very close to the location. A plant nursey run by the Forest Department is close to the site.

Figure 44: Old Pumping station and proposed CWR 4 at Afil Gate

Bhairab River Intake Point and pump house. Existing intake pump house is located on the banks on Bhairav River Coordinates: 22°56'23"N, 89°29'42"E. There is an underground intake pipe laid from the river to sump and pumping station at the site. This intake pipe has a screen. This is adequate to meet the demand, there it will remain as it is, and no works are proposed in the river. There is a small jetty near the intake, where only small boats can anchor. There is a mosque at about 30 m from the site. of this facility. There is a small jetty near the intake which is called Afil gate Ghat, where only small boats can anchor. From N7 highway a narrow access semi-pucca road (brick soiling) leads to this ghat. There is visible littering due to people's use of this ghat those are; plastic packages, polythene bags, food wastes, water and soft drinks bottles, coughs and spits etc. Heavy river traffic contributes to oil spills and solid waste discharge in the river.

Consultation with local people and boatmen indicate o spotting of dolphins, especially in the middle of the river, but the sightings have become less frequent. The Bhairab-Atai confluence is situated about 5km downstream from this location. There are some trees inside the KWASA facility like palm, acasia, coconut etc. This is the one farthest site in this KWSP project. There are dense human settlements consist of small shops, restaurants, tea stall, grocery shops at the nearby surroundings. There is a mosque at about 30 m from the site. of this facility. An old jute mill complex is just adjacent to the KWASA facility. Within 500m radius there's 2 jute mills, one mandirs, 2 schools and several mosques are situated. The closest historical place from this location is Dakshin Dighi Rabindra Complex which is about 7 km north west.

Figure 46: Bhairab River Intake Point

Bangabandhu Water Treatment Plant (SWTP) Retrofitting and proposed IPR 1. Works will be conducted in the existing WTP facility (Coordinates: 22°46'44"N, 89°37'51"). New IPR will be constructed on a vacant land within the WTP facility site and adjacent to the existing IPR. The facility is surrounded by farmland and rural settlements. Inside the facility, there are open grassy fields with some scattered trees. This is a remote area inside a rural zone. Site comprises open grassy fields with some scattered trees.

There are great numbers of frog, gecko, lizards found, and the long grassy terrain supports insects like moths, butterfly, earthworms, snails, mantis, dragonfly etc. sometimes frogs, and small fishes found in the WTP's sedimentation chambers. This location is about 5.5km away from Khan Jahan Ali bridge and about 2km from nearest highway N7. A primary school and a mandir situated near the entrance point.

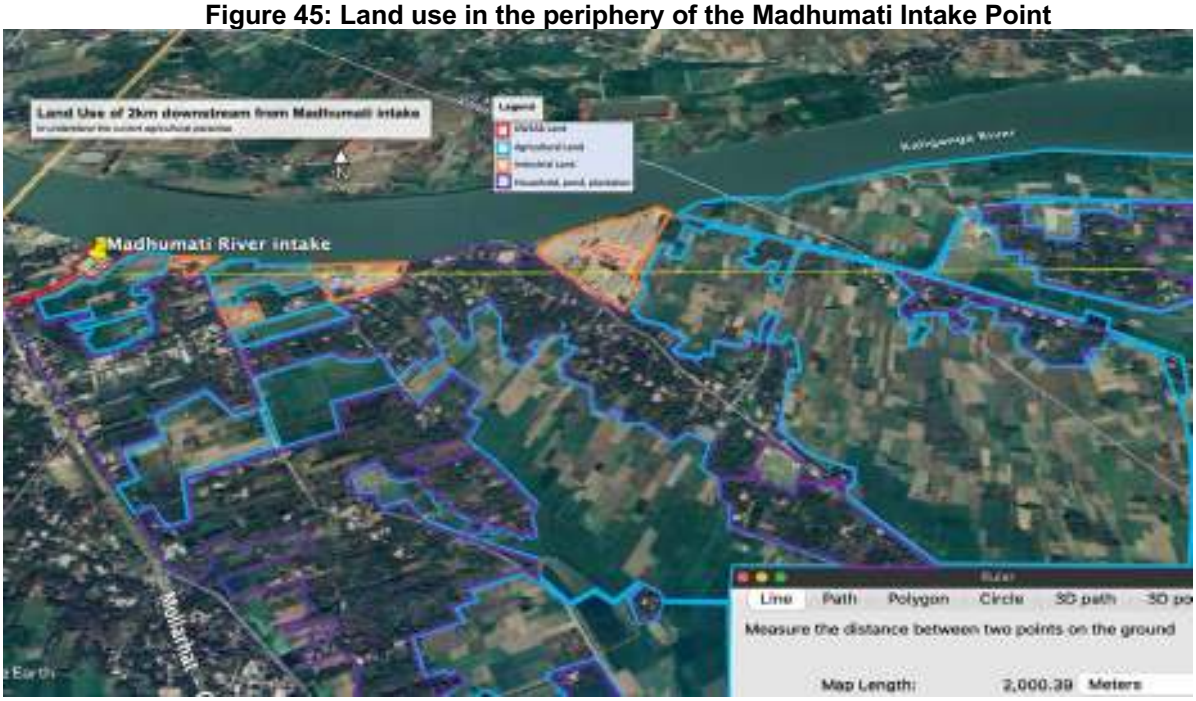
Figure 47: BWTP and IPR

Existing IPR, clear water reservoir. Possible site for New IPR 1 (See blue rectangle)

Mollahat Intake. This location is just placed at the bank of Madhumati River in a semi urban bazar zone called Mollahat, site is surrounded mostly by agricultural fields. To access this KWASA facility is only less than 200 m from the Madhumati Bridge on highway N805. Just opposite of this facility there is a 100 MW based power plant. A brick factory is about 1km east and a rice mill at about 0.5 km Intake campus facility is well decorated with lots of fruit and medicinal trees such as guava, mango, jackfruit, moringa, star fruit, neem etc. also there is deciduous flower trees; Krishnachura, Radhachura, Bougainvillia etc. The Madhumati riverbank is covered with large grass and shrubs and water is covered hyacinth which is also an indicator of presence of low salinity. The riverbank walking finds several types of frogs, crickets, water striders, water insects etc. The interview from local people about Madhumati's fauna shows there are several types of fish are present: Taki, Baim, Rui, Bacha, Ayeer etc. Turtle and otters are also occasionally observed in the river. There's one community clinic, one madrasa (Islamic school), one primary school and two mandirs situated within 1km radius of the intake point facility. There's no historical place in the vicinity.

Figure 48: Mollahat Intake

Figure 45: Land use in the periphery of the Madhumati Intake Point



Clear Water Transmission Mains (38 km; from BWTP and from Afil Gate WTP to CWRs). No tree cutting is envisaged as pipe will be laid along the existing roads within the right of way. KWASA confirms that about 60-80% of the pipe laying will be trenchless method. There are two locations where the transmission mains cross the railway lines. Transmission pipeline sections goes along the highway N709 and N7, and other roads and connected to all four CWRs. Clear water main crosses Moyur river; trenchless method is adapted to lay the pipeline below the riverbed. Common trees along the roads include Shishu, Krishnachura, Babla, Banyan, Mahogony, pakur etc.,. KWASA is determined to not cut any trees but if any such condition arise in this subproject then permission should be required from RHD. Beside the N709 most of the land are agricultural fields, there are some major junctions and crossroads like Zero point, Mostofar mor, Sonadanda bypass, Khulna city bypass, Bastuhara bypass, Satkhira road, Kuet road etc. those are the connection roads of N709 and N7. Pipeline connects with existing pipeline at Notun rastar Mor of N7.

Figure 48: Clear water transmission main alignment (N709 & N7 roads)

Distribution Pipeline Existing and Extension Area. The total length of the KWASA's current distribution network is approximately 663 km. The existing city area is divided into 10 water zones thus it serves all 31 wards. The proposed distribution system pipeline in the existing area (KCC area) would be 243 km in length and 235 km in the extension area, thus totaling 478 km in length. The pipelines would be DI and HDPE pipes. The HDPE pipes would be laid by two methods, namely Horizontal Directional Drilling (HDD) and open trench/cut method in nearly 50/50 ratio. The extended area is predominantly low-density and has a semi-urban setting. Roads are under development in the vacant areas. No notable tree cutting is envisaged A main road, Khula Bye-pass Road, runs along the north-south direction of the extended area.. This road is the lifeline for this extended area.

Figure 48: Distribution Pipeline Alignments

Production wells, Rehabilitation of existing 28 and 47 new production wells are proposed covering entire project area. Locations are broadly recommended by the IWM study, and exact locations will be identified by the KWASA and contractor based on the feasibility of drilling and site accessibility. Land acquisition is not required for driving these production wells since there are hundreds of old and defunct Productions Well sites available from KCC era of construction. Land required for the production is minimal.

Figure 48: Existing Production Tube well

Vertical Expansion of KWASA head quarter building by one floor. KWASA started operating in this current building in 2008, on Roosevelt ghat road within the city. This is about 500m away from the N7 which runs through the Khulna city. Building is within the city area and about 150-200 m from Rupsha River and 6 number Ghat. An additional floor will be constructed under the project.

Figure 48: KWASA Headquarter Building

Figure 49: Map of all work sites and connectivity

Note: The yellow line shows the road connection inside Khulna city. All the major locations are marked here

Appendix 8: Planning and preparatory guidelines and techniques for pipe laying to avoid/mitigate impacts

Parameter	Planning Guidelines and Techniques to avoid/mitigate impacts
Trench width excavation	During the preparation of the trenches, sufficient allowance shall be made on each side of the pipe. Thus, the minimum trench excavation width shall be pipe diameter and width allowed at both sides of the pipeline, as specified in Trench Details. These specifications will allow the contractors to determine the portion of the road available to car and pedestrian traffic during construction.
Road crossings	Manual boring is adopted for road crossings in narrow streets to minimize traffic. For busy intersections in Khulna town and other urban areas, horizontal directional drilling (HDD) is adopted, if possible [if there is road-side space is sufficient for the rigs and approach shafts (if any)] after making sure that no other utilities are in the way of drilling equipment. About 172 km of the pipe network will be constructed using HDD.
Hauling of excavated materials	All excavated materials shall be hauled away from the excavation site and deposited in an area designated by the KWASA. This will result in cleanliness in the area and avoid accidents. The stockpile shall be processed where it is deposited so that it can be brought back to the trenches as selected filling material. Hauling vehicles must always be present at the excavation site.
Closure of areas and roads	Careful planning and scheduling of the activities shall be ensured. Work in particular areas shall be limited to a duration which should be decided in consultation with the neighborhood and stakeholders. This will mean that excavation, pipe-laying, and installation of service connections, installation of valves and hydrants, interconnection with existing pipelines, hydro-testing, backfilling, and pavement restoration shall be completed within a specified duration (on a given day). The contractor must maintain all the materials necessary in his inventory so that these can be easily hauled to the construction site when needed. The full-scale road closure will be allowed only after ensuring undisrupted traffic flow by diverting traffic to alternative routes. A proper traffic management plan shall be prepared, and approval to be obtained from Police and roads authorities before the commencement of work.
Barricades and warning signs	Easily transportable barricades and warning signs, such as those made of high reflector plastic materials, shall be used. Aluminized rolled warning signs can also be used to warn the public regarding the ongoing works and deep excavation.
Reuse of excavated materials	Use quarry dust, sand, or processed excavated material as trench backfill materials. Quarry dust is widely available and cheaper than sand and can be used as backfill material for trenches. The contractor can also process the excavated materials at the disposal site and use these as selected backfill materials. If readily available, local sand can be mixed with the backfill material to ensure pipe integrity. The backfill material must not contain pointed broken stones since these might affect the plastic pipe and cause breakage.
Equipment	Use appropriately sized mechanical excavators. In areas where there are other utilities buried under the ground as verified from the results of the survey and KWASA GIS mapping, the contractor shall use mechanical excavators to attain faster trenching progress. The excavator shall be immediately followed by skilled workers who will trim and clean the trenches to proper size and depth as required in the plan. They shall see to it that the trenches are ready for pipe installation as soon as they move away from

Parameter	Planning Guidelines and Techniques to avoid/mitigate impacts
	them.
Access	The contractor shall make available in his stock steel plates and wooden planks, which will be deployed on top of trench excavation to provide temporary access to houses, building carports and entrances, street crossings, canals and drains, and other areas where these will be necessary.
Workers	It is always advantageous for the contractor to employ workers with adequate experience, training, and know-how in the line of work that they are doing. These people are usually reliable and can be counted upon to exercise good judgment in the field. These workers shall be led by an experienced supervisor or engineer who will provide the leadership in daily activities.
Community and public awareness	Careful planning and extensive coordination with various government agencies must be established. A massive information campaign must precede any construction activity to make the public aware of the extent of the problem that might be present during the period of construction.
Surveys	The following surveys must be completed prior to the start of construction: (i) **Existing service connection survey** – This is a house-to-house survey of all existing houses in the project area by the officers/engineers of the KWASA and the contractor. The objectives are to obtain the present water supply service level, collect details of the present customers, identify new service provision requirements, and communicate the benefits of the project to the customers. (Note: a sample survey has already been done by the Feasibility Study team covering 200 households) (ii) **Road surveys** – This is to be carried out collectively by the staff/engineers of the KWASA and the contractor. The objectives are to collect information on the traffic condition of the roads during daytime and nighttime, road width, surface condition, existing structures along the roads, road users and their usage pattern, parking areas, and open spaces. (iii) **Land surveys** – This is to be carried out by the contractor by consulting a surveyor licensed by the Survey of Bangladesh. The objective is to conduct a control level survey, control traverse survey, and conduct a trace survey of the longitudinal section along the pipeline, and detailed road surveying and plotting. (iv) **Initial status photography and video and crack survey** – This is to be carried out by the contractor with the participation of staff/engineers of the KWASA. The objectives are to record all existing conditions of structures on both sides of the roads, all buildings, boundary walls, fences, temporary structures, and visible details of utilities on the road surface. Any damage that may happen to structures during the construction phase can be accurately identified and compensated using this information. (v) **Existing survey of utilities (tracing and/or excavation of trial pits)** – This is to be carried out by the contractor. Tracing of existing utilities can be conducted using a magnetic-type pipe and cable locator. Excavation of trial pits can be used to obtain existing line details at connection points and existing underground utility details. The results of the trial pits shall be used to decide on the pipeline trace along the road. A trial pit shall have an area of approximately 1–2 m^2 and a depth of up to 2 m. As much as possible, excavate trial pits during nighttime to avoid disrupting traffic flow. The trial pits must be backfilled, and road conditions must be reinstated on the same night before 5.00 a.m.

Source: Modified from Feasibility Study for the Khulna Water Supply Project (Phase 2), Final Report (Vol. I: Main Report, July 2024): TA-6559 REG: Implementing the Cities Development Initiative for Asia.

Appendix 9: Groundwater Monitoring System Recommended by IWM Report

5.2.3 Groundwater Monitoring System

Groundwater flow and recharge depends mostly on formation lithology and aquifer parameters. Semi-consolidated to unconsolidated sediments constitute the aquifers of the study area. The water bearing formations so far identified and explored in the study area are sedimentary aquifers. These aquifers are always very sensitive to abstraction and flow situation, which reflects in the groundwater table, thus its periodic monitoring is essential. Moreover, as the demand for clean water increases, more and more effort will be needed to monitor and understand the nature of groundwater system. Development of groundwater needs sustainable balance between the natural recharge abstracted and the quantity remained in the aquifer to protect aquatic environment. Different factors usually govern the sustainability of groundwater resources. As such periodic evaluation of the groundwater situation through continuous monitoring of resource is essential. In case of city water supply from groundwater appropriate monitoring of production wells on its different functions is also required to avoid increased production cost, decrease well efficiency and premature well failure. Moreover, when groundwater model use for addressing questions about the future responses of the groundwater system, then field monitoring of groundwater system should continue for periodic evaluation of model output and to incorporate new information. Monitoring is also a tool for groundwater project management support system. A need-based quantitative and qualitative automated groundwater monitoring system will be designed in consultation with the project authority to perform the purpose.

The proposed monitoring system will be designed to provide much of the data needed to evaluate the response of the aquifer to the producing wells, groundwater withdrawal and surface water bodies.

The following parameters will be considered for regular and periodic monitoring of groundwater resources under the proposed monitoring system:

- Groundwater table of the project area
- Hydro-chemical properties of the aquifer yield
- Specific capacity and efficiency utilization of project wells
- Well operation and maintenance performance

Project would be benefited on the following aspects from the outcome of the proposed groundwater monitoring system:

- Present and future groundwater scenario on management of study area aquifer system
- Optimum utilization of groundwater resource and project facilities
- Timely maintenance and repairs of project wells
- Evaluation of progress towards fulfilling project objectives
- Assessment of production cost benefit and realistic appraisal of water well rehabilitation
- Development of valuable reference for research and study on groundwater technology

Groundwater Table Monitoring

The study area of the project for groundwater assessment can be divided into two area, one is Khulna city area and other is outside of city area. As such, both the area will be covered under the new monitoring system. KWASA already installed 4 monitoring wells under Phase 2 project. For studying groundwater table and seasonal fluctuation of deeper aquifer additional groundwater monitoring wells would be installed in 10 selected locations of the study area as shown in Figure 2. Out of which 4 locations will be in outside of city area and remaining 6 will be in the Khulna City area. One monitoring well is being installed at a single location of the study area. The locations of the monitoring wells are shown in Figure 5-2. The monitoring wells would be in the deeper aquifer with an average depth of 300m.

Figure 5-2 The Tentative Locations of the Monitoring Wells

50mm diameter UPVC pipe will be used as casing pipe except upper 3 m, which will be 50mm GMS pipe. Out of this 3 m GMS pipe, 0.60 m will remain above the ground surface as standpipe. 6m 10 slot UPVC screen are installed in the aquifer. At the bottom of the screen, 4.5 m UPVC casing will be fixed as bail sump. Top of the monitoring wells have the provision of closing with threaded cap. Standpipes are fixed with 0.6m x 0.6m x 0.6m cement concrete platform.

An automated groundwater level sensor with telemetry system will be added to get the information through website. A fixed nest casing covering the well will be installed for the protection of the well. The conceptual figure for in situ sensor based real-time groundwater monitoring (Modified Approach from Schmidt et al., 2018) is shown in Figure 5-3.

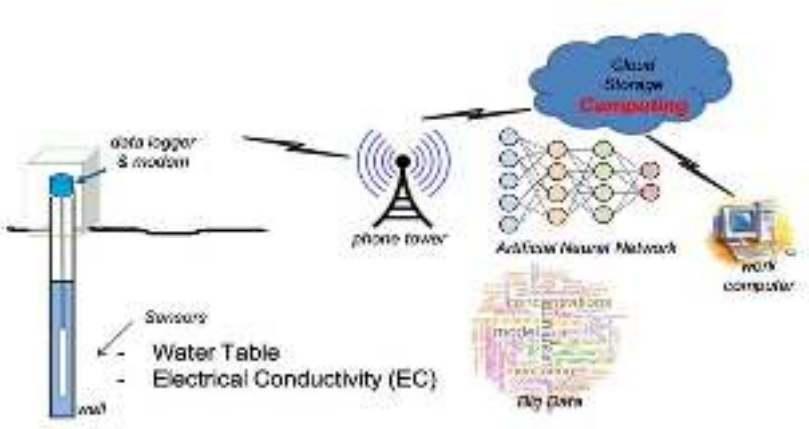


Figure 5-3 The conceptual figure for in situ sensor based real-time groundwater monitoring (Modified Approach from Schmidt et al., 2018)

5.2.4 Groundwater Quality Monitoring

Quality of groundwater depends on the natural physical and chemical state of the water. Alteration of water quality may result as natural process and consequence of human activity. To monitor the groundwater quality as well as its impact on the environment requires periodic determination of certain physical and chemical parameters. Such periodic assessment is to be carried out during March and September for measuring dry and wet season quality condition. The selected groundwater piezometer will be used as groundwater quality monitoring stations. Sample locations will be finalized based on the results of water quality analysis and the reconnaissance EC survey results and considering the natural variability, point pollution sources, aquifer depths and different abstraction technology. The location plan would emphasis the spatial and vertical variability of water quality. It is planned to collect groundwater samples from (10+4) 14 locations for monitoring purpose. Auto logger will also measure the EC of groundwater with level data in 14 monitoring wells. The following parameters will be measured under periodic quality monitoring programme.

The parameters are Temperature, pH, Eh, EC, DO and TDS would be determined at the site using portable field instrument. The major constituents (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, CO_3^{2-}, HCO_3^{-}, and SO_4^{2-}), minor constituents (Fe, B, I, F, PO_4^{2-}, NH_3, NH_4^{+} NO_3^{-}, $NO_2^{-}$and CO_2) and some trace elements (As, Pb, Zn, Cd and Mn) will be determined in the laboratory including total and Fecal Coliforms.

Results will be compared with national and international standards for drinking water quality. Comparison will be with historical data, if available from other sources, to determine temporal trends, further investigations, monitoring needs, source protection measures etc.

5.2.5 Groundwater Abstractions and well efficiency

Groundwater table of any area is mainly dependent on abstraction and recharge. In the study area, the abstractions are an important water balance component, which dominates the changes in potential head. An accurate account of abstraction rate and well efficiency is a pre-requisite to obtain optimum output. Detail information on abstraction production well efficiency is to be collected through regular monitoring programme. The basic data will include static water level, pumping water level, energy consumption, and maintenance record and abstraction rate. This production well monitoring is proposed to be carried out in every quarter of the year.

Appendix 10: Details of Stakeholder Consultations

Appendix 4a: FOCUS GROUP DISCUSSION (FGD) / COMMUNITY CONSULTATION REPORT

Sl. NO	Place, date and no of participants	Participants	Issues discussed
1	Golla Mari Bazar 5th June, 2024	Small traders, women, farmer, KWASA officials	• Discussions were carried out on project's facilities and features. • Main goal of the project is to provide safe and reliable drinking water to every household in salinity, arsenic and fluoride affected rural areas. • All residential, commercial, educational, religious, health institutions will get potable water from this project. • The project will provide 24 x 7 drinking water to every household in project area. • Special emphasis has been given to women's well-being. The project will aim to reduce the time burden and challenges associated fetching water, contributing to improved convenience for women. • Necessity of water conservation, maintenance of personal hygiene and health related issues relating to use of safe drinking water were discussed. • People may face some access disruption during construction work. Suitable measures will be taken to avoid or minimize any disruption. People's cooperation will be needed for successful implementation of the project. • All project affected persons will receive compensation as per project entitlements. • There is a grievance registration and redressal system. People can raise any relevant project related grievances or suggestions and the same will be addressed within stipulated time frame
2	Arongtana Bazar, 5th June, 2024	Small traders, farmers, Service holders and KWASA officials	• Discussions were carried out on project's facilities and features. • Main goal of the project is to provide safe and reliable drinking water to every household in salinity, arsenic and fluoride affected rural areas. • All residential, commercial, educational, religious, health institutions will get potable water from this project. • The project will provide 24x7 drinking water to every household in project area. • Special emphasis has been given to women's wellbeing. The project will aim to reduce the time burden and challenges associated fetching water, contributing to improved convenience for women. • Necessity of water conservation, maintenance of personal hygiene and health related issues relating to use of safe drinking water were discussed. • People may face some access disruption during construction work. Suitable measures will be taken to avoid or minimize any disruption. People's cooperation

Sl. NO	Place, date and no of participants	Participants	Issues discussed
			will be needed for successful implementation of the project. • All project affected persons will receive compensation as per project entitlements. • There is a grievance registration and redressal system. People can raise any relevant project related grievances or suggestions and the same will be addressed within stipulated time frame
3	Harin Tana Bazar, 6th June, 2024	Multi Professionals people KWASA officials	• Discussions were mainly carried out on project facilities and features. • Main goal of the project is to provide safe and reliable drinking water to every household in salinity, arsenic and fluoride affected rural areas. • All residential, commercial, educational, religious, health institutions will get potable water from this project. • The project will aim to reduce the time burden and challenges associated fetching water, contributing to improved convenience for women. • People may face some access disruption during construction work. Suitable measures will be taken to avoid or minimize any disruption. People's cooperation will be needed for the successful implementation of the project. • There will be a grievance registration and redressal system. People can raise any relevant project related grievances or suggestions and the same will be addressed within stipulated time frame. • All compensation will pay to the affected persons before any displacement takes place
4	Harin Tana Mor, 13th June,2023	Small traders, farmers, students, Women	• The objectives: timeline, and scope of work for the project were explained to the participants. • Advantages of treated surface water over ground water were discussed. • 24X7 treated water service through individual piped connections will be provided to individual households within the reach of project scope • Water Meter will be installed in each and every household. Each household will benefit from receiving 70 litres of water treated per capita daily per day for domestic purposes only. • No adverse impact on community assets or individuals is assessed • All project related grievances will be addressed through the Grievance Redress Mechanism of the project. • While addressing a query, the participants were informed about the meter reading process. They were also reassured not to be afraid or concerned due to it, as water meters will be used to determine the domestic water consumption. For operation and maintenance of the assets, a unified and affordable user charge may be

Sl. NO	Place, date and no of participants	Participants	Issues discussed
			introduced by the Government in the future which has not been finalized yet. • Doorstep, the regular supply of clear and treated water will reduce the burden of water collection from distant for all households • The waterborne diseases will be greatly minimized. After completion of the project, the Gram Panchayat will be responsible for the operation and maintenance of the assets created through the project.
5	Mustofa Mor Bazar, 20th June, 2024	Farmers, businessman, labourers	• The objectives: timeline, and scope of work for the project were explained to the participants. • Advantages of treated surface water over ground water were discussed. • 24X7 treated water service through individual piped connections will be provided to individual households within the reach of project scope • Water Meter will be installed in each and every household. Each household will benefit from receiving 70 litres of water treated per capita daily per day for domestic purposes only. • No adverse impact on community assets or individuals is assessed • All project related grievances will be addressed through the Grievance Redress Mechanism of the project. • While addressing a query, the participants were informed about the meter reading process. They were also reassured not to be afraid or concerned due to it, as water meters will be used to determine the domestic water consumption. For operation and maintenance of the assets, a unified and affordable user charge may be introduced to by the government in the future, which has not been finalized yet. • Doorstep, the regular supply of clear and treated water will reduce the burden of water collection from distant for all households • The risk of waterborne diseases will be greatly minimized After completion of the project, the Gram Panchayat will be responsible for the operation and maintenance aspect of the assets created through the project.
6	Tea stall of Sohorab Mia, Bellal Nagar	Farmers, businessman, labourers	• The objectives: timeline, and scope of work for the project were explained to the participants. • Advantages of treated surface water over ground water were discussed. • 24X7 treated water service through individual piped connections will be provided to individual households within the reach of project scope • Water Meter will be installed in each and every household. Each household will benefit from receiving 70 litres of water treated per capita daily per day for domestic purposes only.

Sl. NO	Place, date and no of participants	Participants	Issues discussed
			• No adverse impact on community assets or individuals is assessed • All project related grievances will be addressed through the Grievance Redress Mechanism of the project. • While addressing a query, the participants were informed about the meter reading process. They were also reassured not to be afraid or concerned due to it, as water meters will be used to determine the domestic water consumption. For operation and maintenance of the assets, a unified and affordable user charge may be introduced to by the government in the future, which has not been finalized yet. • Doorstep, the regular supply of clear and treated water will reduce the burden of water collection from distant for all households The risk of waterborne diseases will be greatly minimized. After completion of the project, Gram Panchayat will be responsible for the operation and maintenance aspect of the assets created through the project.
7	Ghuturia UP Chairman's Office, 2nd July, 2024	Local govt. representatives	• The objectives: timeline, and scope of work for the project were explained to the participants. • Advantages of treated surface water over ground water were discussed. • 24X7 treated water service through individual piped connections will be provided to individual households within the reach of project scope • Water Meter will be installed in each and every household. Each household will benefit from receiving 70 litres of water treated per capita daily per day for domestic purposes only. • No adverse impact on community assets or individuals is assessed • All project related grievances will be addressed through the Grievance Redress Mechanism of the project. • While addressing a query, the participants were informed about the meter reading process. They were also reassured not to be afraid or concerned due to it, as water meters will be used to determine the domestic water consumption for operation and maintenance of the assets, a unified and affordable user charge may be introduced to by the government in the future, which has not been finalized yet. • Doorstep, the regular supply of clear and treated water will reduce the burden of water collection from distant for all households • The risk of waterborne diseases will be greatly minimized After completion of the project, Gram Panchayat will be responsible for the operation and maintenance of the assets created through the project.

Photographs of FGD/ Community Consultation

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>FGD with local people at Asrang Ghat</td><td>Ghat</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Interview with the local traders</td><td>Interview with the local traders</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">FGD with local people at Gollamari Bazar</td></tr>
</table>

Attendance Sheet

Strengthening Capacity for Livable and Resilient Cities Project
KWASA, Khulna

Focus Group Discussion/Community Consultation

Attendance Sheet

Venue: Harin Tana More Date: 5.06.2024

Sl. No.	Name of Participants	Male/ Female	Occupation Designation	Address/ Organization	Mobile No.	Signature
01	Md. Turkan	Male	Student	Rira Bazar	01305327441	
02	Md. Mamun Sheik	Male	Service	Harin tana	01627716952	
03	Md. Ripon Sheik	Male	Student	Harin tana	01646643885	RIPON
04	Md. Baclur Khan	Male	Tea Stall	Harin tana	01919[illegible]885	
05	Md. Mahabub Khondoker	Male	Tea Stall	Harin tana	01758552664	
06	Md. Rabiul Islam	Male	Contractor	Ali More	01773467700	
07	Most. Sokina Begum	Female	Tea Stall	Harin tana		
08	Md. Faridul Islam	Male	Student	Harin tana	01308512245	Anik
09	Md. Sahorab Islam	Male	Tea stall	Harin tana	01911076125	Showrov
10	Md Bilal Hossain	Male	Day labor	Harin tana	01728904703	
11	Md. Sajjad Hossain	Male	Service	Harin tana	01781891122	
12	Md. Khairul Islam	Male	Business	Harin tana	01716954742	
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Strengthening Capacity for Livable and Resilient Cities Project
KWASA, Khulna

Focus Group Discussion/Community Consultation

Attendance Sheet

Venue: Gollamari Mor / Bazar Date: 5.06.2024

Sl. No.	Name of Participants	Male/ Female	Occupation/ Designation	Address/ Organization	Mobile No.	Signature
01	Biplob Mondal	Male	Business	Gollamari Mor	01790011777	Biplob
02	Lovely Shakha	Female	House wife	Gollamari	01714479641	Lovely
03	Abu Yusuf	Male	Business	Gollamari Mor	01911615955	
04	Md. Jakar	Male	Business	Gollamari	01915079227	
05	Md. Zakir Hossain	Male	Tea Stall	Gollamari	01581405471	
06	Md. Asad Mia	Male	Tea Stall	Gollamari	01400295795	
07	Md. Mehedi Hasan	Male	Laundry Business	Golla Mari	01919288517	
08	Md. Habibur Rahman	Male	Tea Stall	Gollamari	01917671569	
09	Md. Magun Mia	Male	Restaurant Business	Gollamari	01749780830	
10	Md. Nurul Nabi	Male	Labour	Gollamari	01307457396	
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Strengthening Capacity for Livable and Resilient Cities Project
KWASA, Khulna

Focus Group Discussion/Community Consultation

Attendance Sheet

Venue: Arong ghata Bazar ..... Date: 05.06.2026

Sl. No.	Name of Participants	Male/ Female	Occupation Designation	Address/ Organization	Mobile No.	Signature
01	Md. Sorifful Sheik	Male	Business	Arong ghata	01917795075	
02	M A Rab Chowdhury	Male	Service	Arong ghata Dakkin Para	01969862528	
03	Mannan Sheik	Male	Business	Arong ghata	01952773103	
04	Md. Habibur Rahman	Male	Service	Pabla, Doulat Pur	01670352228	
05	Kontom Mondol	Male	Technician	Arong ghata Kayah Para	01921712146	
06	Md. Moniruk Sheik		Business	Arongghata	01917795075	
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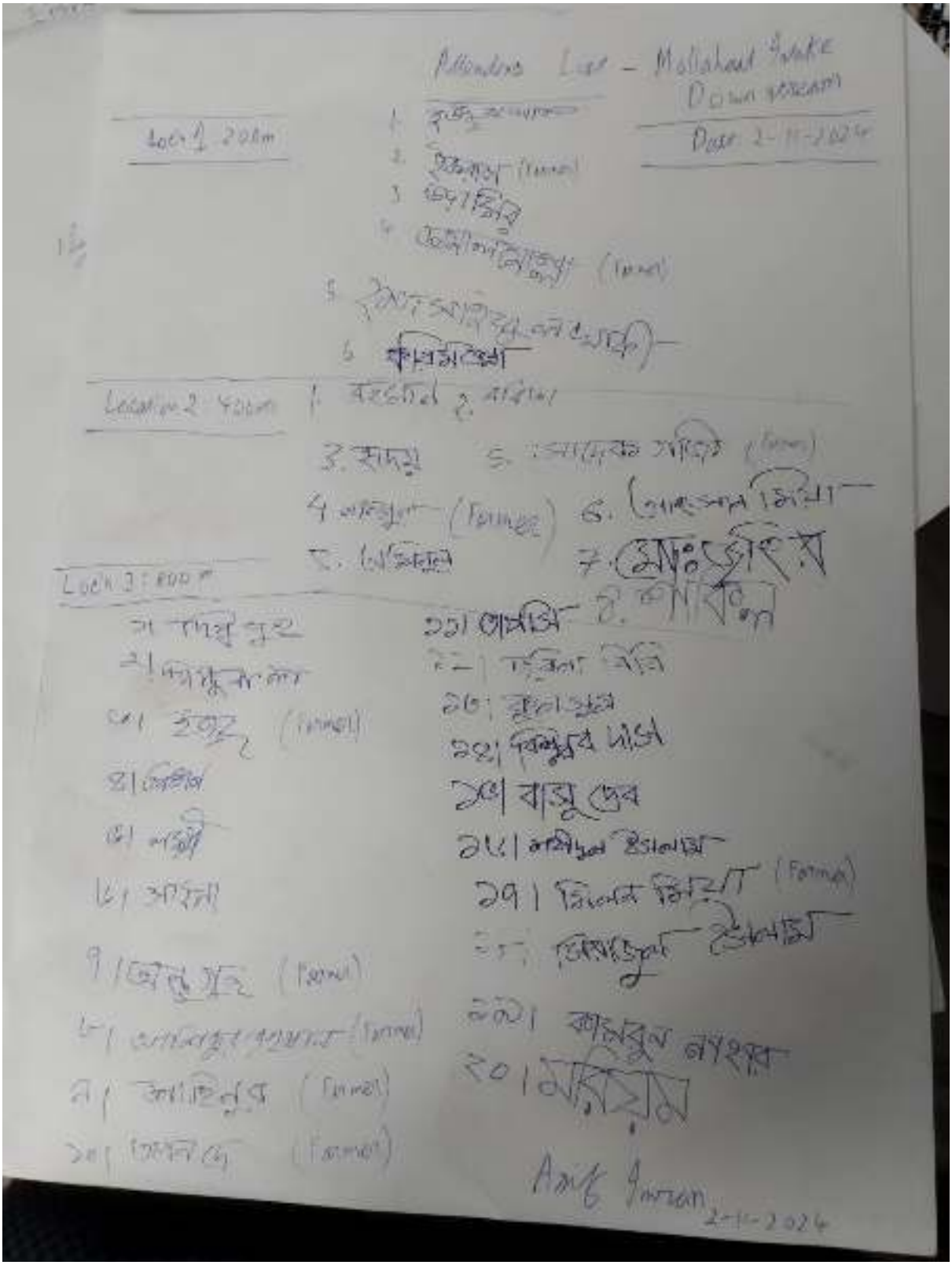
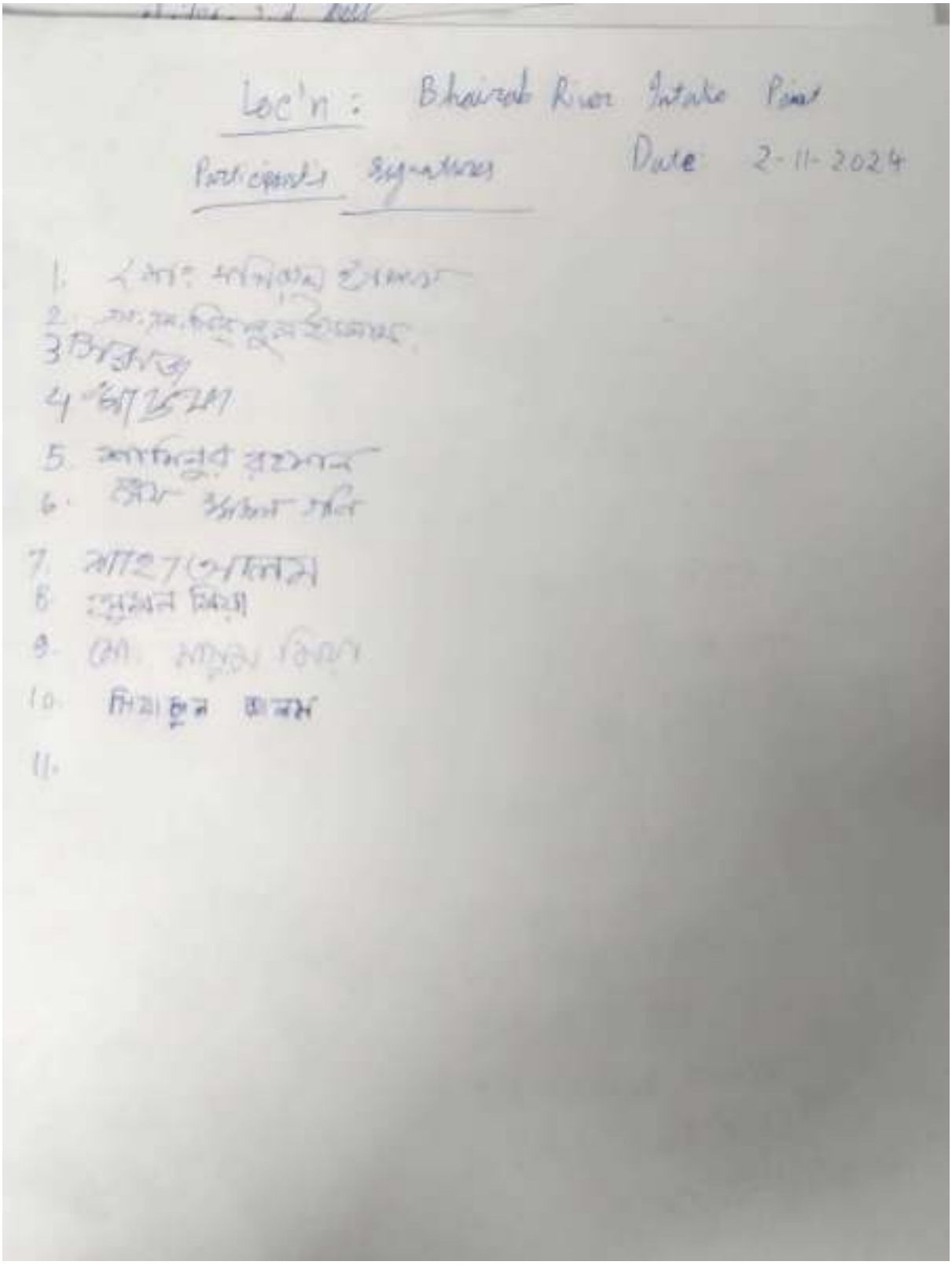
Focused Group Discussions conducted at Mollahat and Afil Gate

Images: FDG held at 3 points of the downstream of Mollhat intake and Bhairab intake





Loc'n : Bhairab River Intake Point

Participants' Signatures

Date 2-11-2024

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Details of Town Level Discussions conducted

Sl. NO	Place, date and no of participants	Participants	Issues discussed
1	Inception Workshop, KWASA conference hall, 22th August, 2023. About 21 participants.	key government and non-government organizations, including KDA, DoE, DPHE, RHD, KCC, LGED, and INGOs such as PADECO and TECI.	• The primary agenda of the workshop was to introduce the project objectives, scope, and expected outcomes to the stakeholders. • Discussions focused on the technical, environmental, and social aspects of the water supply initiative, ensuring alignment with regulatory frameworks and urban planning policies. • The consultation process emphasized the importance of inter-agency coordination, infrastructure readiness, and compliance with environmental standards. • The outcomes included an initial stakeholder commitment, identification of potential challenges, and a roadmap for effective project execution. • This meeting was very successful and all the agencies representative welcome this project since it is vital to ensure safe drinking water supply for the people of Khulna.
2	Gender Action Plan Workshop GAP, KWASA conference hall, 15th January, 2023. About 23 participants.	Participants included officers from KDA, DWA, KHD, KCC, KWASA and from NGO's BRAC, SNV, JJS, and Nobolok etc.	• The second town-level discussion, **Gender Action Plan Workshop**, was organized to integrate gender-inclusive policies into the KWASA Water Supply Project Phase 2. • Participants included Govt officers and from NGO's, ensuring a diverse representation of expertise in gender and social development. • The agenda covered strategies for ensuring equitable access to water supply services, empowering women in decision-making, and addressing gender-specific water management needs. • The consultation process included discussions on gender-sensitive infrastructure design, women's participation in community awareness programs, and employment opportunities within the project. • The key outcome of this workshop was the formulation of a comprehensive Gender Action Plan, with actionable recommendations to promote inclusivity and mitigate gender disparities in water access and service delivery.
3	Interim Workshop held at KWASA conference hall. At 5th February, 2024.	Attended by officers from KWASA, KDA, KCC, DPHE, RHD, LGED, BWDB, and DoE	• The **Interim Workshop** was the third town-level discussion aimed at reviewing the progress of the KWASA Water Supply Project Phase 2. • the workshop served as a mid-term evaluation platform. • The agenda included progress assessment, policy compliance, and addressing emerging challenges in project implementation. • Key discussions focused on infrastructure development, environmental impact mitigation, and resource allocation efficiency.

Images of inception workshop held at KWASA conference hall at 22-8-2023.

Image: Interim workshop held at KWASA conference hall at 5-2-2024.

Image: Gender action plan workshop held at KWASA conference hall at 15-1-2024.

Workshop inception

TA No. 6559:

Implementing the Cities Development Initiative for Asia - Preparation of the Feasibility Study for the Khulna Water Supply Project" (Phase 2)

Inception Workshop Attendance Sheet

Venue: KWASA Conference Hall

Date: 2nd August, 2023, Time: 11 AM-1.30 PM

Sl	Name	Designation	Organization	Contact No.	Email	Signature
1.	Md. Abdullah P. Eng.	MD	KWASA	01720030066		
2.	Khan Salim Ahmed	SE, KWASA	KWASA	01715602241	[illegible]@yahoo.com	
3.	[illegible]	Secretary	KWASA	01712014303	[illegible]@gmail.com	
4.	Galib Mahmud Pasha	Executive Magistrate	KWASA	01987041406	mahmud_pasha05@gmail.com	
5.	Md. [illegible]	EE/DPHE/Khulna	DPHE	01797-985595	[illegible]	
6.	Md. [illegible]	EE, RHD, Khulna	RHD	01730-782756	[illegible].gov.bd	
7.	[illegible]	Assistant Director	DoE	01747-453981	[illegible]11@gmail.com	
8.	Abu Sayed	Assistant Town Planner	KDA	01554908585	abu.sayed@kda.gov.bd	
9.	Masud Karim	ExEn	KCC	01911049177	kccmasud@gmail.com	
10.	Shaikh Mehedi Hasan	AE	LGED	01711-366195	[illegible]@gmail.com	
11.	Md. Abdur Rahman	AE	KWASA	01715-63997-6	eng.[illegible]@gmail.com	
12.	Jasmin Akhter	[illegible]	KWASA	01748497475	[illegible]@gmail.com	

Sl	Name	Designation	Organization	Contact No.	Email	Signature
	M. Khademul Salam	Commercial Manager	KWASA	01711134064	[illegible]@gmail.com	
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	Md [illegible] Hossain	XEN, KWASA	KWASA	01749562200	[illegible]@gmail.com	
	SK. MASUDU ISLAM	Asst. Chief	KWASA	01710126702	[illegible]@gmail.com	
	Md. Shohel Billah	Asst. Programmer	Khulna WASA	01729954842	it.kwasa@gmail.com	
	Md. Rezaul Islam	Executive Engr.	Khulna WASA	01713237217	[illegible]@gmail.com	
	Phatta Thapa	Civil Eng., TEC	TEC International	01407392226	thapa-p@tecii.jp	
	Fatemeh Masoudeh	Climate Change	PADECO	01973303407	fatemeh.masoudeh@padeco.jp	
	Atsuo Ohno	Economist	TEC international	01768780960	ohno-a@tecii.jp	

Workshop
hnP

TA No. 6559:
"Implementing the Cities Development Initiative for Asia - Preparation of the Feasibility Study for the Khulna Water Supply Project" (Phase 2)

Gender Action Plan (GAP) Workshop Attendance Sheet

Venue: KWASA Conference Hall

Date: 15th January,2024 Time:10 AM-1.30 PM

Sl No.	Name	Designation	Organization	Contact No. & Email	Signature
1	Md. Abdullah P. Eng.	MD	KWASA		[signature]
2	Kazi Md Sabirul Alam	Chief Engineer	KDA	01711825305	[signature] 15.1.24
3.	[illegible]	Deputy Director	DWA	01711-44 90 11	[signature]
4.	Md-Mizanur Rahman Patwary	SAE	KHD	01736782758	[signature]
5	Shipra Biswas	BRAC District Co-ordinator	BRAC	01313407165	[signature]
6	Rozina Sultana Fatema	Business officer	SNV	[illegible]	[signature]
7	SK SHAKER AHMED	Sanitation Engineering coordinator	SNV	01789 441910	[signature]
8	Sourav Saha	P.O	Nobolok	01711579718	[signature]
9	Kazol Bagem	CBO Leader Rupsha Veribad		01971173508	Kazol
10	Shantona [illegible] Santa	Slum Development officer	J.J.S	01610-560660	[signature]

TA No. 6559:
"Implementing the Cities Development Initiative for Asia - Preparation of the Feasibility Study for the Khulna Water Supply Project" (Phase 2)

Gender Action Plan (GAP) Workshop Attendance Sheet

Venue: KWASA Conference Hall

Date: 15th January,2024 Time:10 AM-1.30 PM

Sl No.	Name	Designation	Organization	Contact No. & Email	Signature
1	Md. Abdullah P. Eng.				
11.	Md. Shohel Billah	Asstt. Programmer	KWASA	01742454842 [illegible]kwasa@gmail.com	[signature]
12.	RAFIQUL ALAM	Asstt. Engineer	KWASA	rafiqul9828@gmail.com	[signature]
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16	Md. Abdur Razzak	AE	KWASA	01715 439976 [illegible]	[signature]
17.	Rozbina Khanam	Architect.	K.C.C.	01911-742234 [illegible]	[signature]
18.	Rezaul Islam	Executive Engineer	KWASA	01713277917 [illegible]@gmail.com	[signature]
19.	Md Kamal Hossain	XEN	KWASA	kamal[illegible]@gmail.com	[signature]
20.	Galib mahmud pasha	Executive Magistrate	KWASA	mahmud.pasha05@gmail.com	[signature]

TA No. 6559:

"Implementing the Cities Development Initiative for Asia - Preparation of the Feasibility Study for the Khulna Water Supply Project" (Phase 2)

Venue: KWASA Conference Hall

Gender Action Plan (GAP) Workshop Attendance Sheet

Date: 15th January,2024 Time:10 AM-1.30 PM

Sl No.	Name	Designation	Organization	Contact No. & Email	Signature
1	Md. Abdullah P. Eng.				
21	Mst Shahanaz Parvin	Secretary	KWASA	01717014393	[illegible]
22	Ashek Ahmed	MP	VERC	01706179671	[illegible]
23	[illegible]	Superintending Engineer	KWASA	[illegible]	[illegible]

TA No. 6559:

"Implementing the Cities Development Initiative for Asia - Preparation of the Feasibility Study for the Khulna Water Supply Project" (Phase 2)

Interim Workshop Attendance Sheet

Venue: KWASA Conference Hall

Date: 5th February,2024 Time:10 AM-1.30 PM

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4.	Rakib Mahmud Pasha	Executive Magistrate	KWASA	[illegible]	[illegible] 05/02/24
5.	Rezbina Khanam	Architect	K.C.C.	[illegible]	[illegible]
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TA No. 6559:
"Implementing the Cities Development Initiative for Asia - Preparation of the Feasibility Study for the Khulna Water Supply Project"
(Phase 2)

Interim Workshop Attendance Sheet

Venue: KWASA Conference Hall **Date:** 5th February 2024 **Time:** 10 AM-1.30 PM

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14	Md. Rezaul Islam	Exen, KWASA	KWASA	01713-033917	
15.	M. Khabirul Islam	CM - KWASA	KWASA	01711-134064	
16	Sk. MASUDUL ISLAM	Assistant Chief	KWASA	01710126708	
17.	Md. Shahal Billah	Asstt. Programmer	KWASA	01792454862	
18.	Kazi Md. Sabirul Ali	Chief Engineer	KDA	01711825305	

Details of Public Consultation held at KWASA on 11, December 2024

Participants	• **Feedback and comments**
Officer's from KWASA, NGO wave foundation, journalist from National daily, general participants from different wards specially housewives, political person, Khulna city corporation, businessman etc.	• This is the largest meeting ever arranged by KWASA and organized by an NGO called wave foundation under another project of KWASA. • The main agenda was enhancing accountability and risk address amongst the stakeholders at KWASA projects and gave introduction to WASA's future water supply phase 2 project and currently under construction sewerage projects. • Organizers raised issues such as water conservation, responsible usage, GRM and reporting service was highly prioritized. • Community members, especially women, shared concerns about difficulties they face such as water tariffs, irregular water supply, low water pressure, etc • Finally KWASA officials and NGO representatives addressed the concerns, shared future plans mainly about the importance of implementing KWSP phase 2, and showing their committment to improving service efficiency and accountability.

Image: Public hearing held at KWASA training room of current projects at KWASA, targeted to enhance accountability and address risks at KWASA training room at 11th December 2024.

Image: public hearing held at KWASA about water and sanitation which covers details discussion about KWSP phase 2

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Support for Enhancing Accountability in Water and Sanitation Sector to Address Risks of WASH (SEARS) Project

Public Hearing

Date: 11 December 2024

Venue: WASA Training Room, Khulna

Registration Sheet

Sl.	Name of the participant	Organization/ Address	Mobile Number	E-Mail	Signature
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4.	MD. [illegible]	KHULNA	[illegible]	—	
5.	[illegible]	[illegible]	[illegible]	—	
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7.					
8.					
9.					
10.	Dipamoy Roy	The Daily Star			
11.					
12.					
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72					
73					
74					
75					
76					

[illegible]
Program Officer
WAVE Foundation, Khulna

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Appendix 11: Sample Environmental Site Inspection Report

Package: _____ Date: _____
Location: _____
Chainage (for linear works): _____

Monitoring/Inspection Questions		Findings			Comments/Clarifications
1.	Supervision and Management On-SIte	Yes	No	NA	
	a. Is an EHS supervisor available?				
	b. Is a copy of the SEMP available?				
	c. Are daily toolbox talks conducted on site?				
2.	The Facilities	Yes	No	NA	
	a. Are there a medical and first aid kits on site?				
	b. Are emergency contact details available on-site?				
	c. Are there PPEs available? What are they?				
	d. Are the PPEs in good condition?				
	e. Are there firefighting equipment on site?				
	f. Are there separate sanitary facilities for male and female workers?				
	g. Is drinking water supply available for workers?				
	h. Is there a rest area for workers?				
	i. Are storage areas for chemicals available and with protection? in safe locations?				
3.	Occupational Health and Safety	Yes	No	NA	
	a. Are the PPEs being used by workers?				
	b. Are excavation trenches provided with shores or protection from landslide?				
	c. Is breaktime for workers provided?				
	d. How many for each type of collection vehicle is in current use?				
4.	Community Safety	Yes	No	NA	
	a) Are excavation areas provided with barricades around them?				
	b) Are safety signages posted around the sites?				
	c) Are temporary and safe walkways for pedestrians available near work sites?				

Monitoring/Inspection Questions		Findings			Comments/Clarifications
	d) Is there a record of treated wastewater quality testing/measurement?				
5.	Solid Waste Management	Yes	No	NA	
	a. Are excavated materials placed sufficiently away from water courses?				
	b. Is solid waste segregation and management in place?				
	c. Is there a regular collection of solid wastes from work sites?				
6.	Wastewater Management	Yes	No	NA	
	a) Are there separate sanitary facilities for various types of use (septic tanks, urination, washing, etc.)?				
	b) Is any wastewater discharged to storm drains?				
	c) Is any wastewater being treated prior to discharge?				
	d) Are measures in place to avoid siltation of nearby drainage or receiving bodies of water?				
	e) Are silt traps or sedimentation ponds installed for surface runoff regularly cleaned and freed of silts or sediments?				
7.	Dust Control	Yes	No	NA	
	a. Is the construction site watered to minimize generation of dust?				
	b. Are roads within and around the construction sites sprayed with water on regular intervals?				
	c. Is there a speed control for vehicles at construction sites?				
	d. Are stockpiles of sand, cement and other construction materials covered to avoid being airborne?				
	e. Are construction vehicles carrying soils and other spoils covered?				
	f. Are generators provided with air pollution control devices?				
	g. Are all vehicles regularly maintained to minimize emission of black smoke? Do they have valid permits?				
8.	Noise Control	Yes	No	NA	

Monitoring/Inspection Questions		Findings			Comments/Clarifications
	a) Is the work only taking place between 7 am and 7 pm, week days?				
	b) Do generators operate with doors closed or provided with sound barrier around them?				
	c) Is idle equipment turned off or throttled down?				
	d) Are there noise mitigation measures adopted at construction sites?				
	e) Are neighboring residents notified in advance of any noisy activities expected at construction sites?				
9.	Traffic Management	Yes	No	NA	
	a) Are traffic signages available around the construction sites and nearby roads?				
	b) Are re-routing signages sufficient to guide motorists?				
	c) Are the excavation sites along roads provided with barricades with reflectors?				
	d) Are the excavation sites provided with sufficient lighting at night?				
10.	Recording System	Yes	No	NA	
	a) Do the contractors have recording system for SEMP implementation?				
	b) Are the daily monitoring sheets accomplished by the contractor EHS supervisor (or equivalent) properly compiled?				
	c) Are laboratory results of environmental sampling conducted since the commencement of construction activities properly compiled?				
	d) Are these records readily available at the site and to the inspection team?				

This is sample; shall be updated by PMSC with project specific items as per the package EMP

Other Issues: _____

_____

_____

_____

Prepared by: _____

Name, Designation and Signature