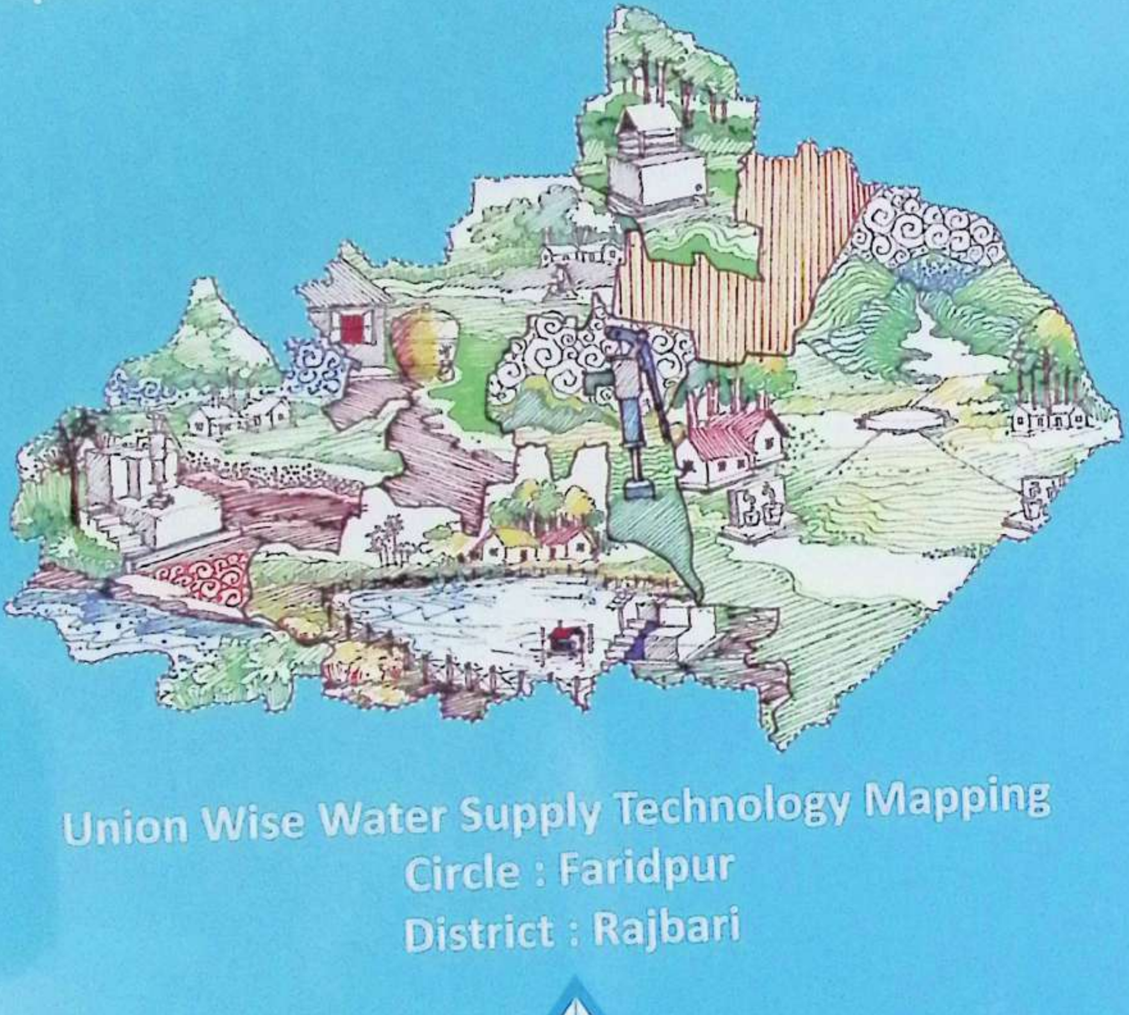
Government of the People's Republic of Bangladesh
Department of Public Health Engineering (DPHE)



Union Wise Water Supply Technology Mapping
Circle : Faridpur
District : Rajbari

June 2019

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Ground Water Circle
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FOREWORD

Rural water supply in Bangladesh is primarily depends on groundwater, using low cost tube well technology. The groundwater received importance for drinking purpose particularly due to its safety on microbial content. But the presence of arsenic in underwater mostly in shallow aquifer posed a threat on the groundwater-based drinking water supply systems.

Providing safe drinking water is quite challenging in Bangladesh. Due to high variability in availability and quality of water, it is difficult to provide unique solution throughout the country. Moreover, present aquifer condition, hydrological situation, different heavy metal contamination, saline intrusion, pollution etc. Poses serious threat to determine safe water sources for drinking. The situation is further challenging for rural water supply systems. Therefore, suitable drinking water supply technologies need to be identified on priority basis covering the lowest administrative boundary, such as union level. Selection of union boundary as unit for determining suitable water supply alternatives will help to identify, regulate and monitor the effectiveness and efficiency of the options installed, data management and also future project planning & development.

Now that, Ground Water circle of DPHE initiated necessary steps and identified procedures for collecting and preparing union based suitable water options with priority ranking. The outcomes of these initiatives will help to decide suitable water supply technologies for preparing projects proposals. This document will be useful for decision making in WASH sector and will be a valuable reference as well. It contains the basic concepts along with advantages and constraints of different drinking water supply options available. It is also includes an outline-methodology to select alternative water supplies of different union.

I would like to express gratitude to UNICEF and Village Water Supply Project (VWSP) for providing necessary support in preparing this document. My sincere thanks to Mr. A. K. M. Ibrahim, Former Additional Chief Engineer (Planning), DPHE and Mr. Md. Safiur Rahman, Superintending Engineer, Ground Water Circle, DPHE who provided utmost effort in completing this task. Special thanks are also extended to Ms. Dilruba Farzana, Executive Engineer, VWSP, DPHE and Mr. Md. Didarul Alam Tusher, Executive Engineer DPHE to complete the field work and data management . Mr. A.H.M Khalequr Rahman, Executive Engineer, R&D Divison, DPHE and Ms. Firoza Akhter, Executive Engineer, DPHE also deserve appreciation for their involvement in preparing the documentation. Credit also goes to DPHE field-level officials for their valuable contribution in the experience sharing workshop.

Considering changed scenario with elapsed time updation and revision document would be obvious taking new information and field experience into account.

(Md. Saifur Rahman)
Chief Engineer
Department of Public Health Engineering
Government of Bangladesh

Table of Content

1.0 Introduction:

Rural water supply in Bangladesh is predominantly based on ground water. But identification of arsenic in ground water particularly in shallow aquifer causes threat on ground water based water supply system. The project emphasizes on arsenic issue for providing safe water to the community. Arsenic has been identified in 271 upazilas of which 29% tub wells are found arsenic contaminated in terms of Bangladesh standard (50ppb) (BAMWSP, 2003). Spreading pattern of arsenic is sporadic, not uniform. In one upazila, some unions are severally arsenic contaminated and some are not like that. However, arsenic contamination also varies with depth of aquifer for a particular place.

The ground water of Bangladesh is extremely complex in terms of water chemistry and geology as well. On the other hand, protected but perennial surface water source is not available in many parts of the country. So, one technology my not be suitable for the larger areas because of different hydro-geological situation. In that case the water technology is required to be identified on priority basis up to specific boundary, such as union level.

In this context, initiatives were taken by Ground Water Circle of DPHE to prepare the technological map for different districts. The field visit and workshops were supported by UNICEF and documentation has been completed with the assistance from village water supply project (VWSP).

2.0 Objective of Task:

- Identification of the union wise water supply technology based on hydro-geological situation of the particular areas.
- Preparation of the GIS mapping on union wise water options.
- Preparation of union wise technology map document for future reference and use.

3.0 Methodology:

1. Union wise basic data regarding lowest water table, arsenic contamination, iron and salinity problem available in Ground Water Circle has been furnished in a table (Union wise technology 2009 as reference).

2. Based on basic information, a desk review has been made to primarily identify union-wise technology analyzing the hydro-geological situation of that particular area. In most cases particularly in the arsenic affected unions, two or more options were identified on priority basis. The forecasting of groundwater level in year 2017 is considered as maximum water level in the area.

3. The primarily identified union wise technology list was provided to the DPHE SEs, EEs and SAEs to facilitate their participation in the workshop.

4. Circle wise workshops were held with the participation of concerned Superintending Engineer, Executive Engineer, Assistant Engineer, Sub-Assistant Engineer and Mechanics. Representatives from Ground Water Circle and from different projects were present there to facilitate the workshop.

5 The workshops discussed the experience and views of the field officer focusing on technology table prepared by DPHE Ground Water Circle and along with the policy guidelines particularly "National Policy for Arsenic Mitigation 2004 and Implementation Plan for Arsenic Mitigation in Bangladesh".

6. Incorporating the findings of Workshop, the technology table has been send to concerned SEs, EEs and SAEs.

7. Based on the feed back from the field, technology table has been finalized, on basis of that GIS map for union-wise technology has been prepared.

4.0 Present challenges in drinking water supply:

The problems of water source have been discussed which are as follows:

i. Lowering of water table
ii. Arsenic contamination in ground water particularly in shallow aquifer
iii. Salinity in ground water
iv. Iron & Manganese in ground water
v. Non availability of suitable aquifer or rocky/hard layer
vi. Non-availability of protected and perennial surface water source round the year

5.0 Alternative water supply options:

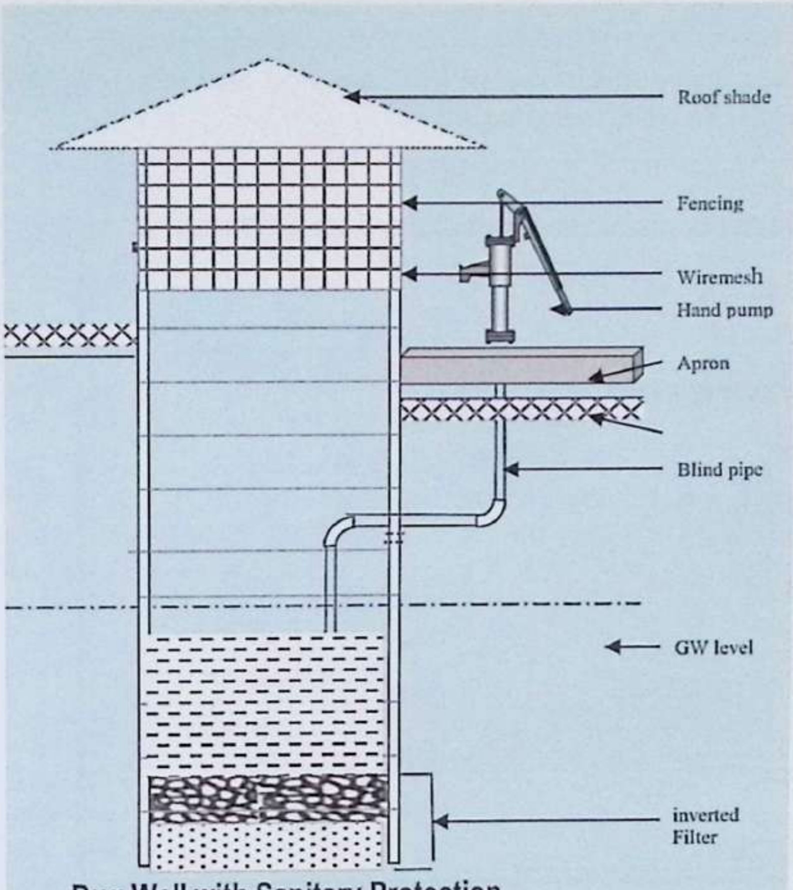
DPHE has given importance on arsenic mitigation approach as arsenic contamination emerges as a great concern for ground water based rural water supply system in Bangladesh. Here different arsenic mitigation options have been discussed following "National Policy for Arsenic Mitigation 2004 & Implementation Plan for Arsenic Mitigation in Bangladesh". The mitigations options are:

- Dug/Ring Well
- Pond Sand Filter
- Deep Tubewell
- Rain Water Harvesting as promotional option and
- Arsenic Removal Technology (ART)

5.1 Different alternative water supply options:

Regarding identification of the Arsenic Mitigation Option, the criteria including the potentialities and limitation of each option were discussed in contrast with hydro-geological situation for the particular area considering the guidelines mentioned in the "National Policy for Arsenic Mitigation 2004 & Implementation Plan for Arsenic Mitigation in Bangladesh". According to the said policy guidelines PSF and dug well will be tried first. If these technologies are found not feasible deep tubewell could be tried following the "Protocol for sinking Deep Tubewells in Arsenic contaminated areas".

It was also advised that not only the technical aspect but O&M and user friendliness should be taken under consideration for selecting the options to make it sustainable. The main feature and basic criteria for each of the option are presented as follows:



Dug Well with Sanitary Protection

5.1.1 Dug Well:

Dug well is the oldest method of groundwater withdrawal for water supplies. The water of the dug well has been found to be free from dissolved arsenic and iron even in locations where tubewells particularly in shallow aquifer are contaminated.

Pre-requisite criteria

There should be stable soil layer at the top (a clay layer is preferable)
Presence of sandy layer within 9 to 12 m

Not Feasible

Areas with the loose sandy soil
Areas with more than 15m consolidated clay.
Tidal zones of the costal belt
Areas of stony hills
Area of peaty soil should be avoided for DW as these cause an unpleasant taste and smell.

Design Requirements:

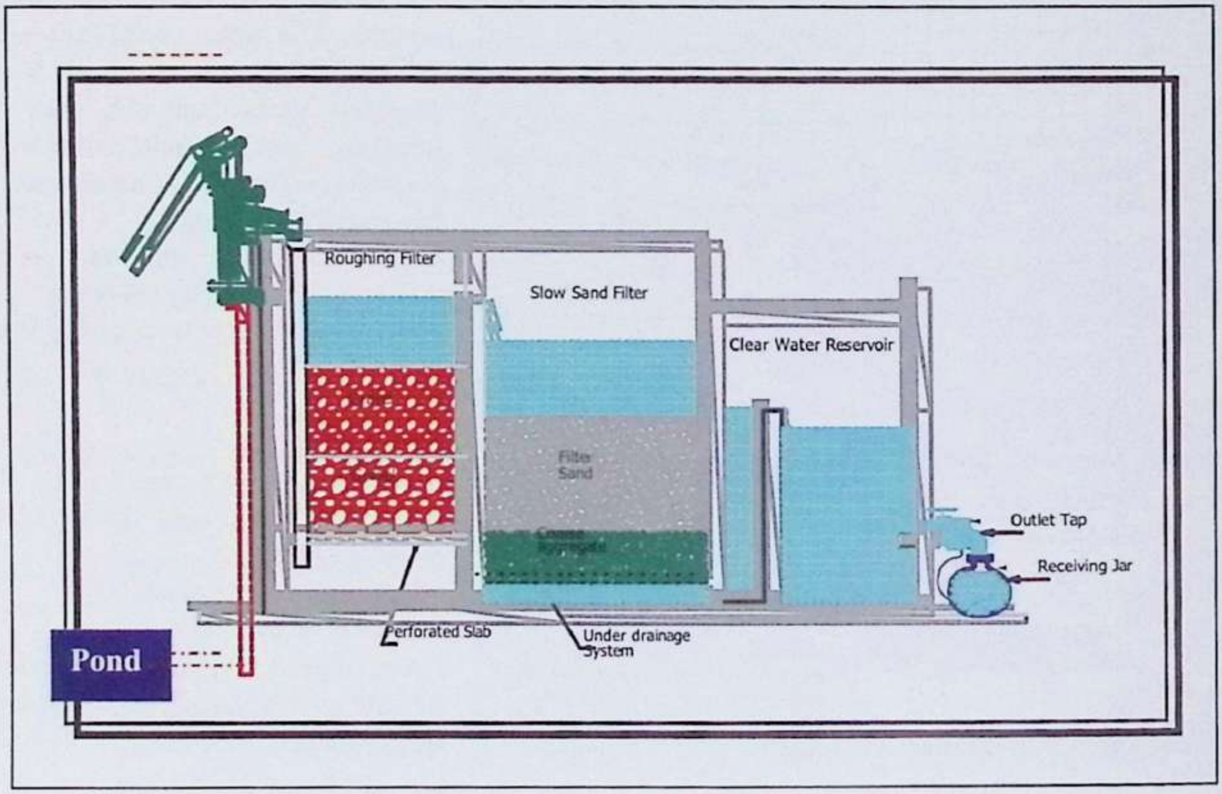
Concrete rings of 1.0 to 1.2 m in diameter used as lining.
Wells should be at least 1.0 to 1.5 m deeper than the lowest water table in the driest month.
Dug well should be constructed in the dry season to ensure availability of water round the year.

Test well is to be drilled prior to construction of ring well to make sure about the soil condition and water quality.
The well lining should be extended at least 0.5m above the ground to form a 'head wall' around the outer rim of the well.
A concrete apron, about 2 m in width, should be constructed on the ground surface extending all around the outer rim of the well.
The intake of water from a dug well can alternatively be made using float.

Very Shrouded Shallow Tubewell (VSST) can be considered as option in the DW area at the same depth. The availability of water in saturated zone should be ensured in this case. The main feature of this technology is the shrouded with coarse sand around the filter area. This is a low cost technology. This technology is also used in the saline problem areas.

5.1.2 Pond Sand Filter:

Pond sand filter is a surface water treatment option which is primarily a slow sand filter unit. If the turbidity of water is high then, there is necessity to use horizontal roughing filter.



Raw water from pond is pumped up from a pond; the turbidity gets down through the roughing filter and then discharged into the filtration unit. The water is filtered and then collected in a clear water reservoir by an under drainage system. PSF is a good option for arsenic mitigation as well as for salinity prone areas

Pre- requisite criteria

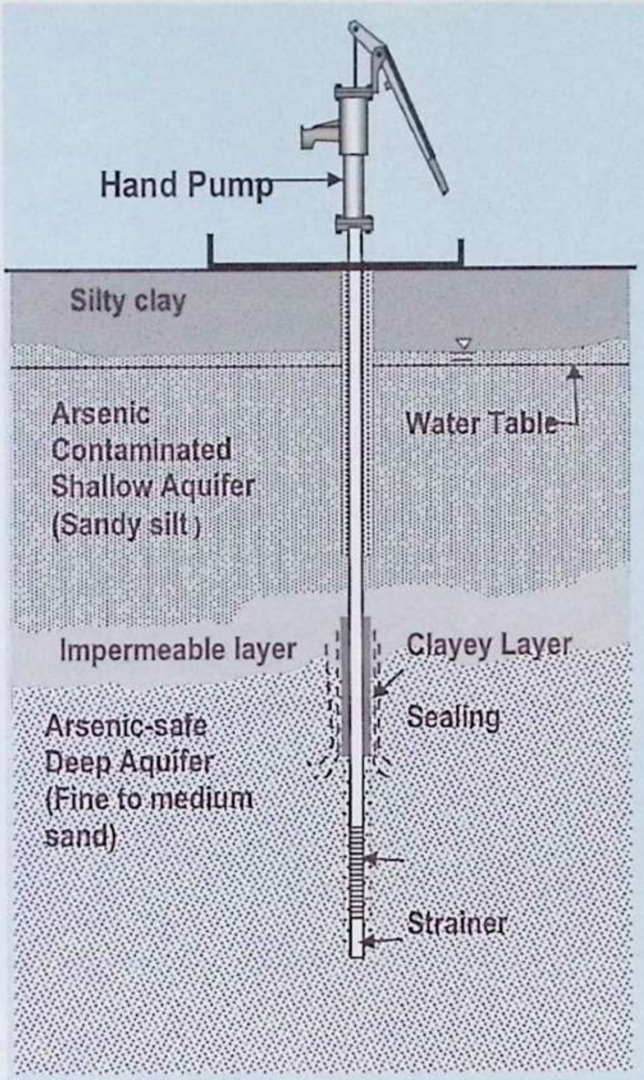
Viable alternative water supply option where perennial rivers, canals, fresh water lakes and ponds of acceptable water quality are available.

Regular maintenance is crucial for the effectiveness of PSF

Such maintenances need high level of community mobilization and proper attention to ensure safe water particularly from bacteriological contamination.

Design Criteria

- The horizontal roughing filter is divided into 3 parts: inlet tank, gravel zone and outlet tank. The gravel zone consists of 3 chambers loaded by different size of gravel (5-15 mm).
- The Sand Filter bed should be composed of 0.22 mm – 0.35 mm fine sand with a thickness of 60 to 120 cm. There is also a layer of coarse aggregate below the fine sand to support the sand against washing out through under drainage system. The uniformity coefficient should be from 2 to 3. The size of the gravel zone is 5-15 mm
- The filtration rate through SF is 0.2 – 0.3 m/hr and through roughing filters 1.5-2.0 m/hr.



Manually Operated Deep tubewell

5.1.3 Improved Deep Tubewell

The deep aquifers in Bangladesh have been found to be relatively free from arsenic contamination. The aquifers in Bangladesh are stratified and in some places the aquifers are separated by relatively impermeable strata. Deep tubewells installed in those protected deeper aquifers are producing arsenic safe water. Sealing in the impervious layer is done to prevent the leaching of arsenic through path way created during drilling of the well.

Pre-requisite criteria

It can be installed where shallow aquifer is separated from deeper aquifer by substantially thick impervious layer.

It can be installed in the coastal areas of Bangladesh having safe aquifer.

<u>Design Requirements:</u>

- The entire tube well should be installed straight and vertically deep bore hole is required therefore.
- The annular space of bore holes of the deep tube wells are required to be sealed at the level of impermeable strata.

- The entire tube well should be installed straight and vertical.

5.1.4. Rain Water Harvesting:

Rainwater harvesting is a technology to collect rainwater for its use in drinking purposes. About 203 cm rainfall occurs annually in Bangladesh. The rain water is safe if it maintained hygienically. The main limitation of this option is non-availability of rain water round the year. But it can be widely used as supplementary source. As per "National Policy for Arsenic Mitigation 2004 & Implementation Plan for Arsenic Mitigation in Bangladesh" the government's role is mainly to conduct promotional activities for RWH.

Pre- requisite criteria

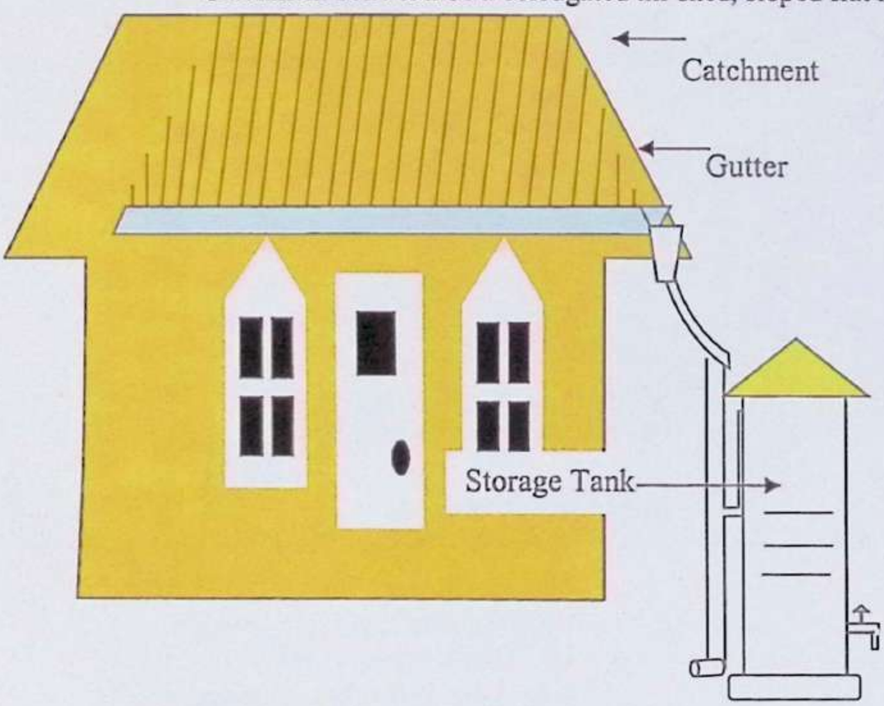
Feasible where average rainfall is 1600 mm per annum.

There should have required catchment area for rain water harvesting

Design Criteria

- Rain water has 3 basic units. 1. The catchment area (like corrugated roof top) and 2. Supporting collection system (gutter and pipe collection pipe) and 3. Storage tank.

- Catchment zone can be a corrugated tin-shed, sloped flat roof top, polythene sheet etc.



- The tank can be a made of GI, ferro-cement, burned clay (motka), plastic etc.

- The collection pipe should have an exit way beyond the connection with storage tank to let the first flush flow away.

- The down pipe should have net to bar mosquitoes, flies from entering into the storage tank.

- There should be an end plug to stop flush discharge to enter water into the storage tank after flushing.

- The location should be so selected that it allows accessibility of people.

5.1.5 Arsenic Removal Technology (ART):

ARTs are the chemical options which remove arsenic mainly using media. Four options are provisionally certified by BCSIR of which three are house hold and one is community based. These can be selected as a last effort particularly where deep tubewell and Dug well is not feasible. Filter media have to be changed after the media being clogged. The quality of raw water is specified for each technology.
The main features of the ARTs are given below:

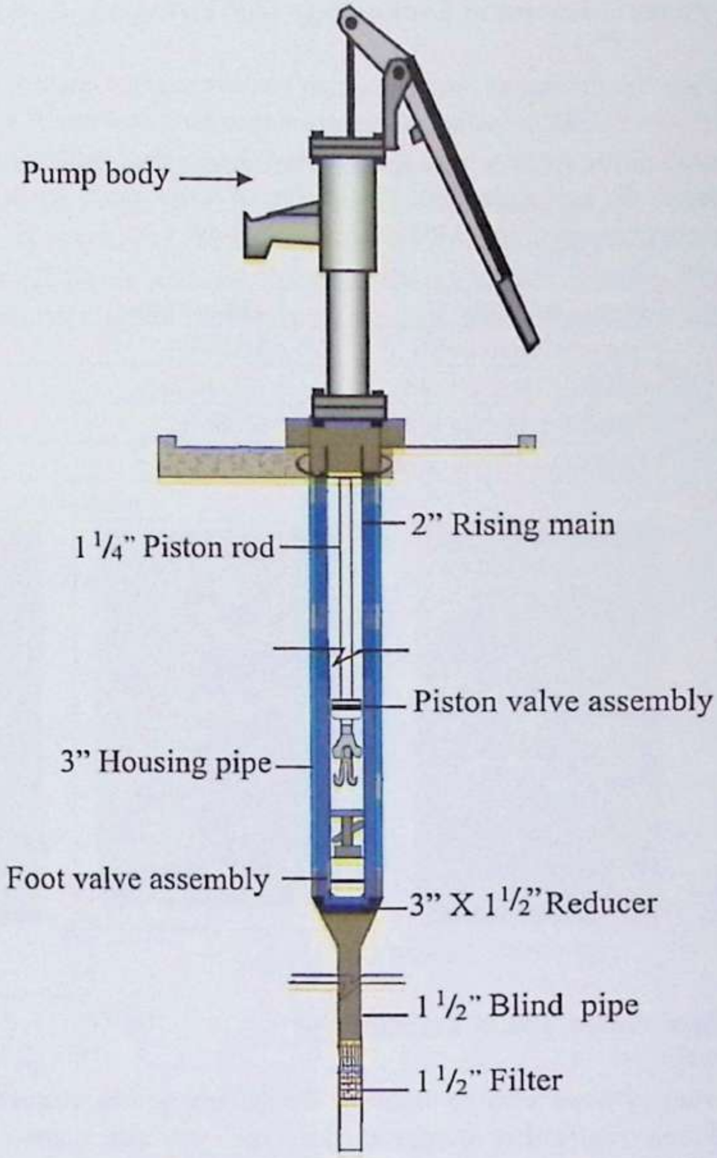
Name of ARts	Filter rate	Total Treatment
Sono (House hold)	16 lit/hr	8100 liter
Alkan (House hold)	120 lit/hr	8100 liter
Read-F (House hold)	60 lit/hr	40,000 liter
SIDKO (Community)	240 liter/hr	1,21,500 liter




6.0 Low Water Table Technology:

Lowering of water table is big issue for the tubewell based rural water supply. In view of low cost, easy to O&M and availability in the market, suction mode number 6 pump is widely used as the tubewell technology. But its limitation is that it can not abstract water beyond the 26 ft depth of water table. In that case force mode pump has to be used. Earlier direct action pump was used. In some cases where the depth of water table is marginal, in that case Tara tube well may be given preference. Now Tara #6 head pump (lever action) is being used which can abstract water upto 80-90 ft depth of water table in both extractable and non-extractable mode. The component of direct action Tara and lever action Tara with # 6 hand pump are shown as below:

Direct Action Tara
(Non-Extractable Mode)

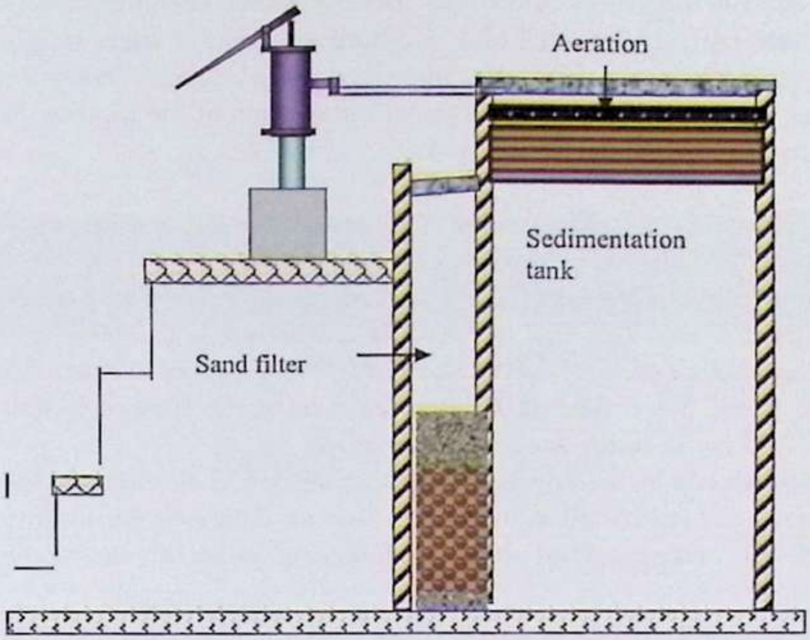


Liver Action Tara with # 6 hand pump
(Extractable Mode)

In selecting the areas of low water table in the upazilas, the study on forecasting groundwater level declination in Bangladesh conducted from early 1990 has been used and the delineated low water table map for 2017 is considered as the reference of maximum depth to water level. The pump technology is then selected for the union.

7.0 Iron Removal Technology:

Iron content exceeding 5mg/l will require treatment using Iron Removal Unit (IRU). It is to be mentioned that concentration of Iron varies with different aquifer. Iron in ground water may be present in different forms and its removal can be effected by simple methods such as aeration with or without sedimentation followed by filtration. iron from the water, thus making it acceptable for the users. Dissolved iron in water is converted in to insoluble ferric form in contact with air. This form will be removed by settling in the sedimentation tank and remaining by the filtration through sand filter. The sedimentation tank is required to reduce the load on sand filter in order to minimize the frequency of filter clogging.



8.0 Salinity issues:

Salinity problem is now not limited in the coastal belt rather salinity intrusion is now expanded in the various part of the country. Deep tubewell and PSF are the best feasible option in this area. It is to be mentioned that RWH is a suitable option as average rainfall is high in the coastal belt. The VSST is also an option in the coastal belt.

9.0 Union wise water supply technologies:

A set of technologies has been recommended for each union on priority basis based on the available hydro-geological information, the views of field personnel & policy guidelines. However, these technologies have to be implemented systematically ensuring the participation of communities. According to the policy guidelines the water options will be selected following the community action plan ensuring the active participation of community. So proper knowledge about the option shall have to be provided to the community so that the option can meet the basic criteria of the water supply such as safe, adequate and reliable round the year. It is to be mentioned that if a technology is new for the particular area, utmost care should be taken for its implementation and replication. The experience regarding implementation of the technologies in the field will be helpful for upgrading the technological mapping and for proper application of the technologies.

10.0 Use of union wise water supply technology mapping document:

It has been proved from different studied that hand pump system of water options particularly Shallow and Deep hand pump tube wells are very much popular among the community. But the arsenic contamination in groundwater compelled the implementer of water supply to switch over to different alternative water supply options in the arsenic affected areas. The technology in a union has been recommended considering the Arsenic Policy 2004 and its implementation plan along with other particular information of the locality. In implementing water supply options the following steps should be followed:

a) In all cases arsenic and other required water quality parameters need to be tested before the system is bought to operation.
b) In the villages/unions where there is presence of arsenic but the average contamination level is less than 5%, the existing technology is recommended STW. In that case, before going for installation of STW, testing of arsenic of 5 to 10 tube wells within 500 meters of the site need to be tested. If any tubewell shows arsenic >0.05 mg/L, follow the alternative option.
c) Dug well and PSF should be investigated as the feasible option of alternative of STW. If sufficient documentation is available about its failure in the locality then Deep tubewell with modified design (following protocol) should be adopted.
d) In case of non-successful of non chemical based option (STW, DW, PSF and DTW) chemical based option for Arsenic Removal Unit should be used as the technology.
e) In all cases in problem areas promotional activities on RWH should be done.

List of Upazillas

Circle : Faridpur

District: Rajbari

Serial No	Name of District	Name of Upazila	No. of Union	Page No.
1	Rajbari	Baliakandi	7	A-1
2		Goalanda	4	A-6
3		Kalukhali	7	A-11
4		Pangsha	10	A-16
5		Rajbari Sadar	14	A-21
	Total	5	42	

District: **Rajbari**

Upazila:

Baliakandi
Goalanda
Kalukhali
Pangsha
Rajbari Sadar

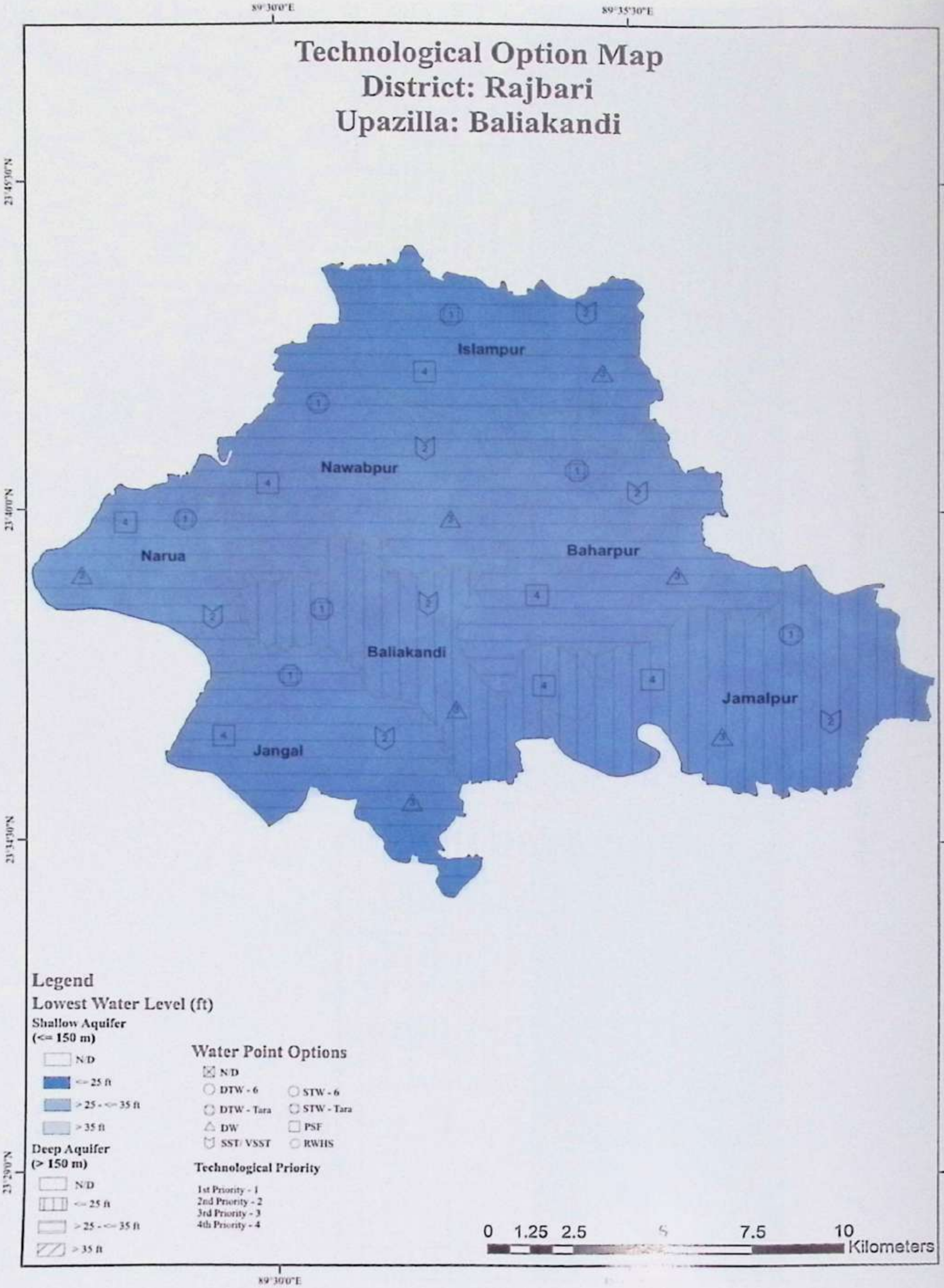
Table for mapping union wise Water Supply Technology

Baliakandi, Rajbari

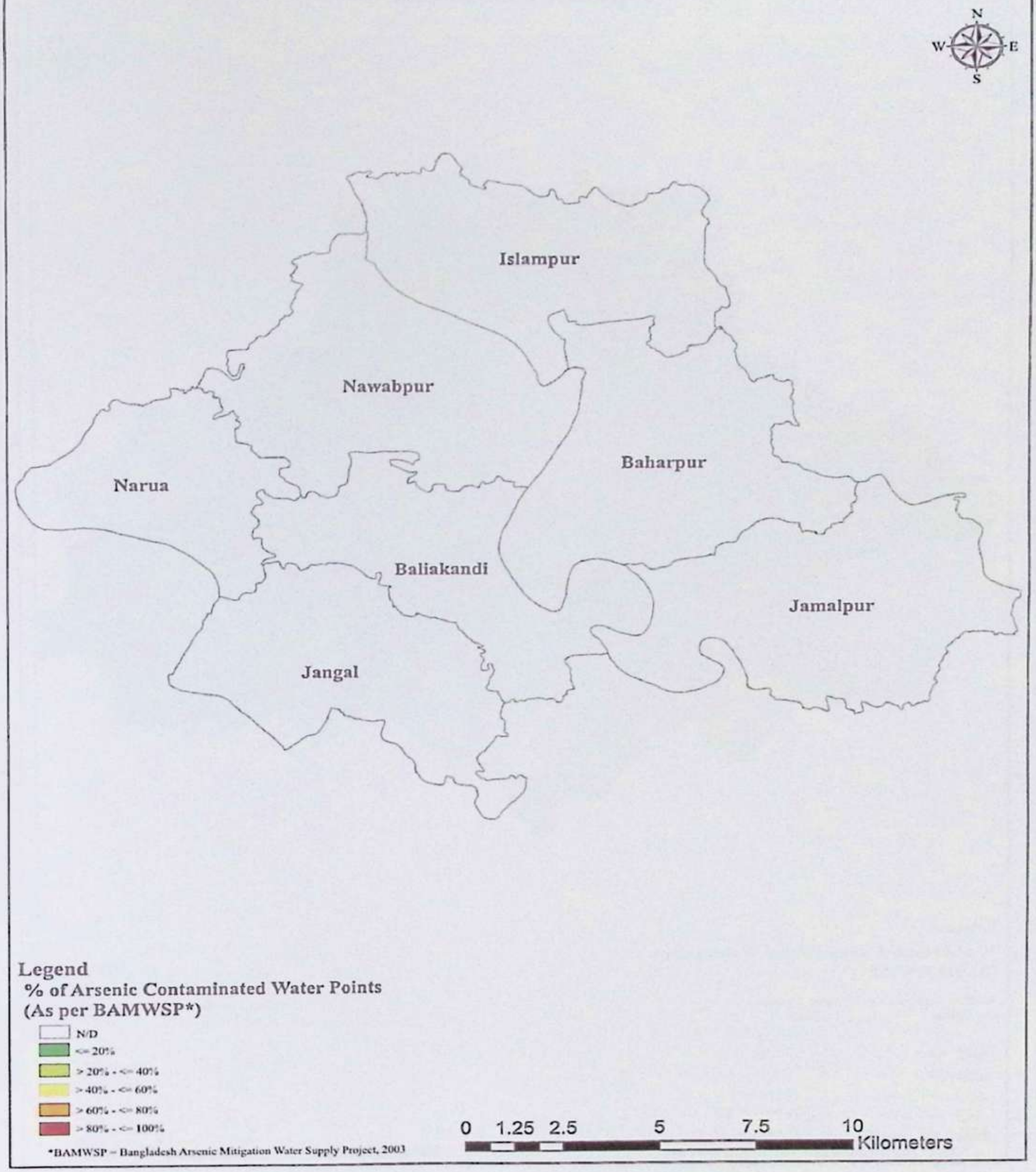
SL	District	Upazila	Union	Lowest Water Table of the Union in the year 2017, ft		As contamination Status (% of Contaminated TW as per NAMIC, BAMWSP 2003)	As Contamination Status (> 50ppb) (% of affected DPHE Water Points Installed during 2006-12)		Fe Problem (> 5ppm) (% of DPHE TW)		Cl Problem (>1000ppm) (% of DPHE TW)		Average Depth of Water point, ft			Recommended Priority Options* STW -6 : Shallow Tubewell, with No. 6 Pump STW-Tara: Shallow Tubewell, with Tara Pump DTW -6 : Deep Tubewell, with No. 6 Pump DTW-Tara: Deep Tubewell, with Tara Pump DW : Dugwell (Ringwell) DW-Tara: Dug (Ring) well with Tara Pump PSF : Pond Sand Filter RWHS: Rain Water Harvesting System ART : Arsenic Removal Technology IG : Infiltration Galary GFS : Gravity Flow System SST/VSST: Shallow Shrouded Tubewell/ Very Shallow Shrouded Tubewell				Remark
1	2	3	4	5		6	7		8		9		10			11				
				STW	DTW	STW	STW	DTW	STW	DTW	STW	DTW	STW	DTW	DW	1	2	3	4	
1	Rajbari	Baliakandi	Baharpur	24	26	N/D	27.27	17.24	50	0	0	0	160	480	35	DTW - Tara	SST/ VSST	DW	PSF	
2			Baliakandi	24	25	N/D	50	15	60	0	0	0	170	455	35	DTW - Tara	SST/ VSST	DW	PSF	
3			Islampur	24	26	N/D	0	25	40	0	0	0	170	400	30	DTW - Tara	SST/ VSST	DW	PSF	
4			Jamalpur	22	24	N/D	0	20	40	0	0	0	180	480	40	STW - Tara	SST/ VSST	DW	PSF	
5			Jangal	24	27	N/D	0	23.08	20	0	0	0	160	465	30	DTW - Tara	SST/ VSST	DW	PSF	
6			Narua	18	27	N/D	0	0	20	0	0	0	160	415	30	STW - Tara	SST/ VSST	DW	PSF	
7			Nawabpur	24	28	N/D	33.33	7.41	45	0	0	0	150	435	30	STW - Tara	SST/ VSST	DW	PSF	

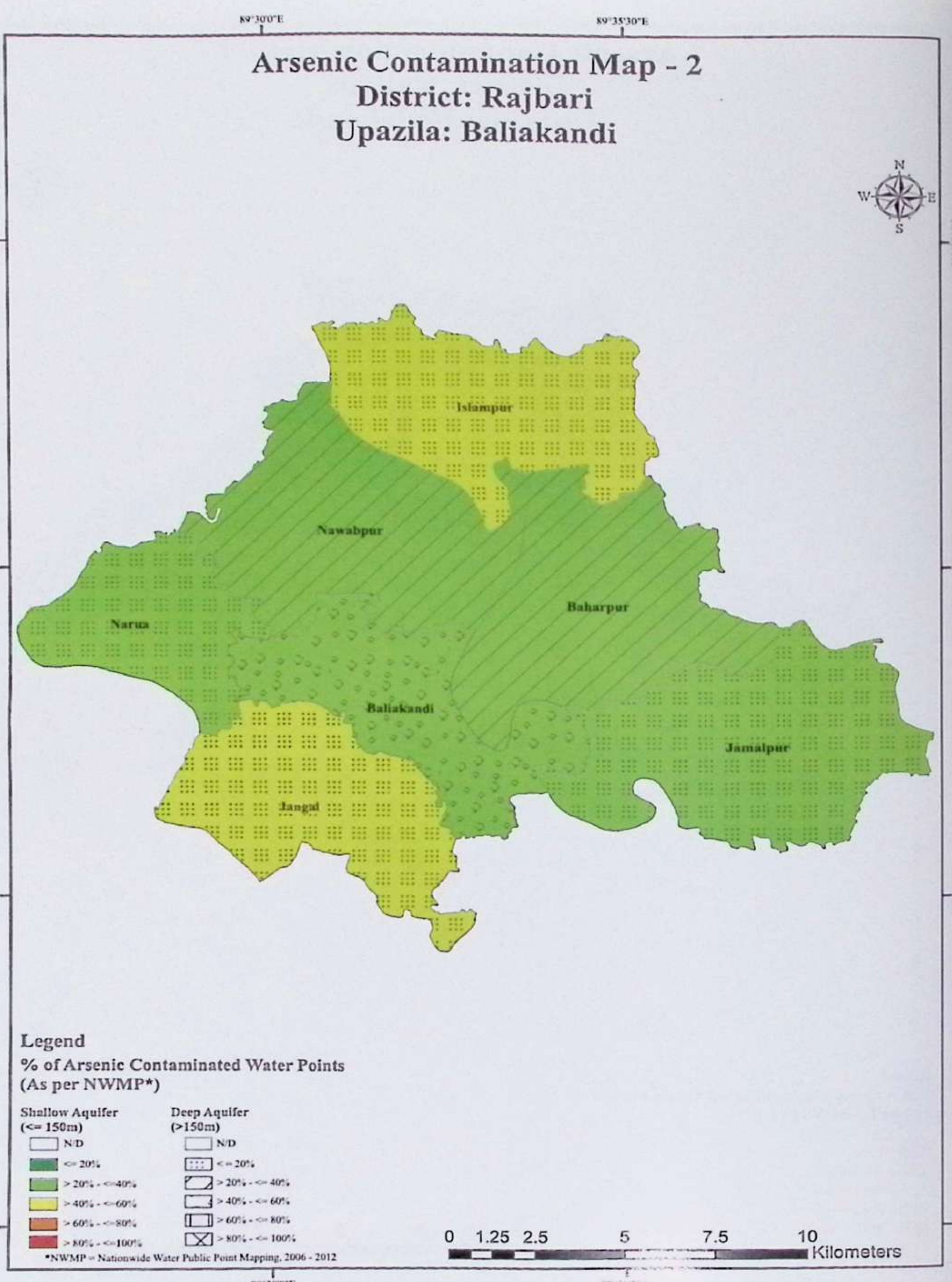
Note: Iron and Chloride contamination derived based on people's perception, 2014

N/D = No Data


Technological Option Map
District: Rajbari
Upazilla: Baliakandi
89°30'0"E
89°35'30"E
23°45'30"N
23°40'0"N
23°34'30"N
23°29'0"N
Islampur
Nawabpur
Narua
Baharpur
Baliakandi
Jamalpur
Jangal
Legend
Lowest Water Level (ft)
Shallow Aquifer
(<= 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Deep Aquifer
(> 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Water Point Options
N/D
DTW - 6
STW - 6
DTW - Tara
STW - Tara
DW
PSF
SST/ VSST
RWHS
Technological Priority
1st Priority - 1
2nd Priority - 2
3rd Priority - 3
4th Priority - 4
0
1.25
2.5
7.5
10
Kilometers

Arsenic Contamination Map - 1
District: Rajbari
Upazilla: Baliakandi




89°30'0"E
89°35'30"E
Arsenic Contamination Map - 2
District: Rajbari
Upazila: Baliakandi
N
W
E
S
23°45'30"N
23°40'0"N
23°34'30"N
23°29'0"N
Islampur
Nawabpur
Narua
Baharpur
Baliakandi
Jamalpur
Jangal
Legend
% of Arsenic Contaminated Water Points
(As per NWMP*)
Shallow Aquifer
(<= 150m)
N/D
<= 20%
> 20% - <=40%
> 40% - <=60%
> 60% - <=80%
> 80% - <=100%
Deep Aquifer
(>150m)
N/D
< = 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
*NWMP = Nationwide Water Public Point Mapping, 2006 - 2012
0 1.25 2.5 5 7.5 10
Kilometers
89°30'0"E


Chloride Concentration Map
District: Rajbari
Upazila: Baliakandi
89°30'0"E
89°35'30"E
23°45'30"N
23°40'0"N
23°34'30"N
23°29'0"N
N
S
E
W
Islampur
Nawabpur
Narua
Baharpur
Baliakandi
Jamalpur
Jangal
Legend
% of Chloride Contamination
Shallow Aquifer (<= 150m)
Deep Aquifer (> 150m)
N/D
<= 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
N/D
<= 20 %
> 20 % - <= 40%
> 40 % - <= 60%
> 60 % - <= 80%
> 80 % - <= 100%
0 1.25 2.5 5 7.5 10
Kilometers

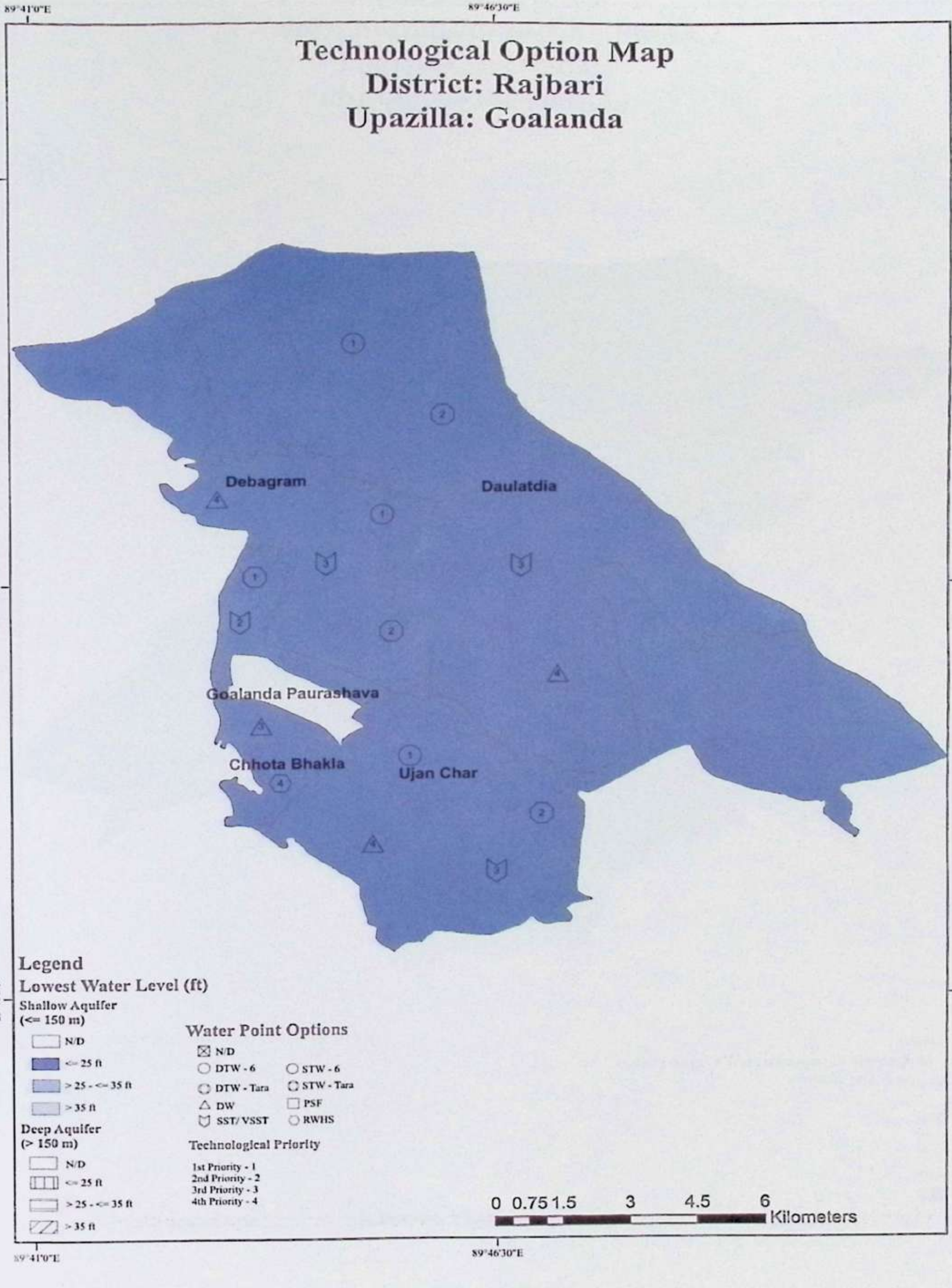
Table for mapping union wise Water Supply Technology

Goalanda, Rajbari

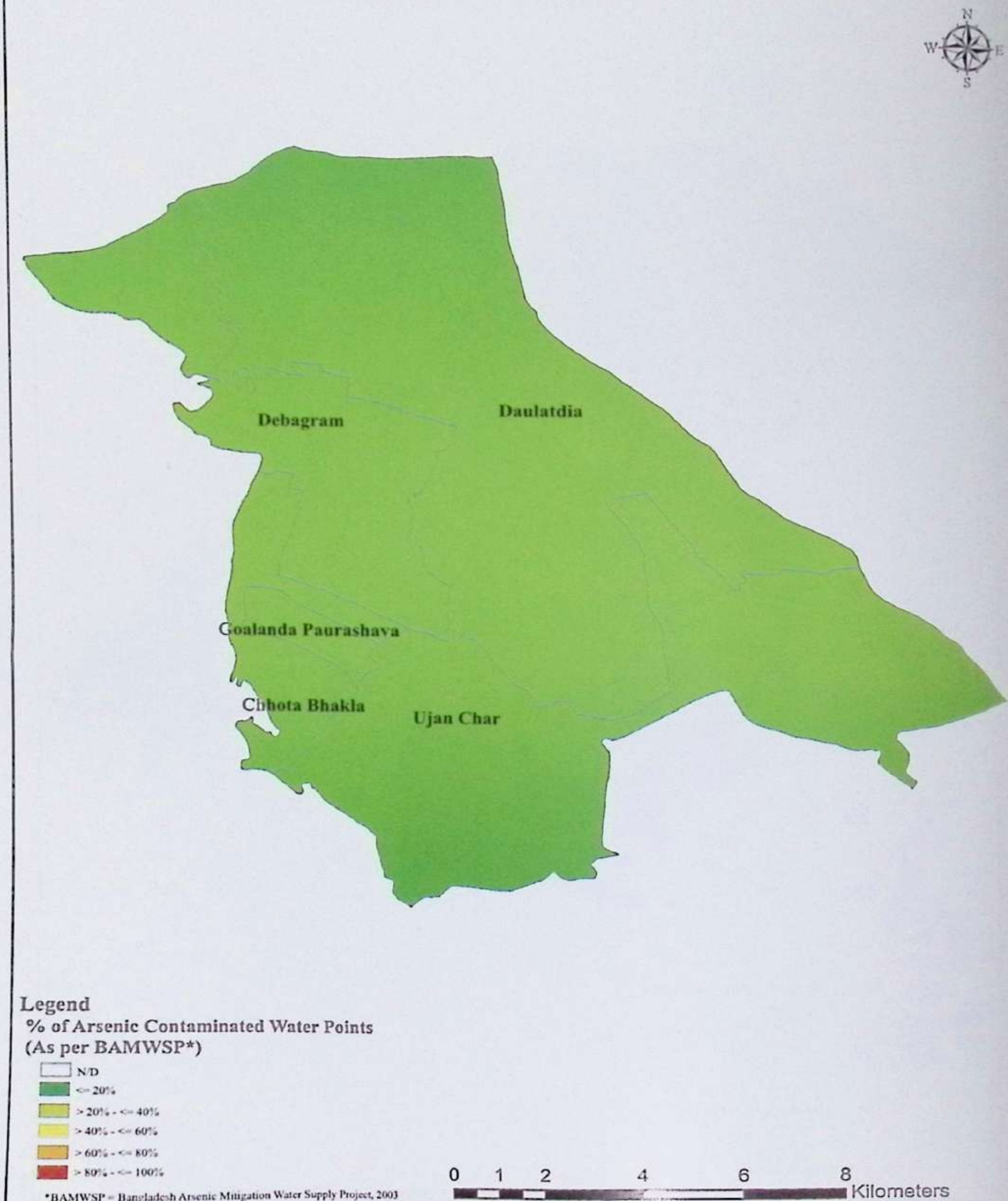
SL	District	Upazila	Union	Lowest Water Table of the Union in the year 2017, ft		As contamination Status (% of Contaminated TW as per NAMIC, BAMWSP 2003)	As Contamination Status (> 50ppb) (% of affected DPHE Water Points Installed during 2006-12)		Fe Problem (> 5ppm) (% of DPHE TW)		Cl Problem (>1000ppm) (% of DPHE TW)		Average Depth of Water point, ft			Recommended Priority Options* STW -6 : Shallow Tubewell, with No. 6 Pump; STW-Tara: Shallow Tubewell, with Tara Pump; DTW -6 : Deep Tubewell, with No. 6 Pump; DTW-Tara: Deep Tubewell, with Tara Pump; DW: Dugwell (Ringwell); DW-Tara: Dug (Ring) well with Tara Pump; PSF : Pond Sand Filter; RWHS: Rain Water Harvesting System; ART : Arsenic Removal Technology; IG : Infiltration Galary; GFS : Gravity Flow System; SST/VSST: Shallow Shrouded Tubewell/ Very Shallow Shrouded Tubewell				Remark
1	2	3	4	5		6	7		8		9		10			11				
				STW	DTW	STW	STW	DTW	STW	DTW	STW	DTW	STW	DTW	DW	1	2	3	4	
1	Rajbari	Goalanda	Chhota Bhakla	19	N/D	15	0	15.79	20	N/D	0	N/D	100	N/D	50	DTW - 6	SST/ VSST	DW	RWHS	
2			Daulatdia	21	N/D	5	0	0	0	N/D	0	N/D	90	N/D	50	STW - 6	DTW - 6	SST/ VSST	DW	
3			Debagram	21	N/D	8	0	0	10	N/D	0	N/D	80	N/D	50	STW - 6	DTW - 6	SST/ VSST	DW	
4			Ujan Char	18	N/D	1	0	0	10	N/D	0	N/D	90	N/D	50	STW - 6	DTW - 6	SST/ VSST	DW	

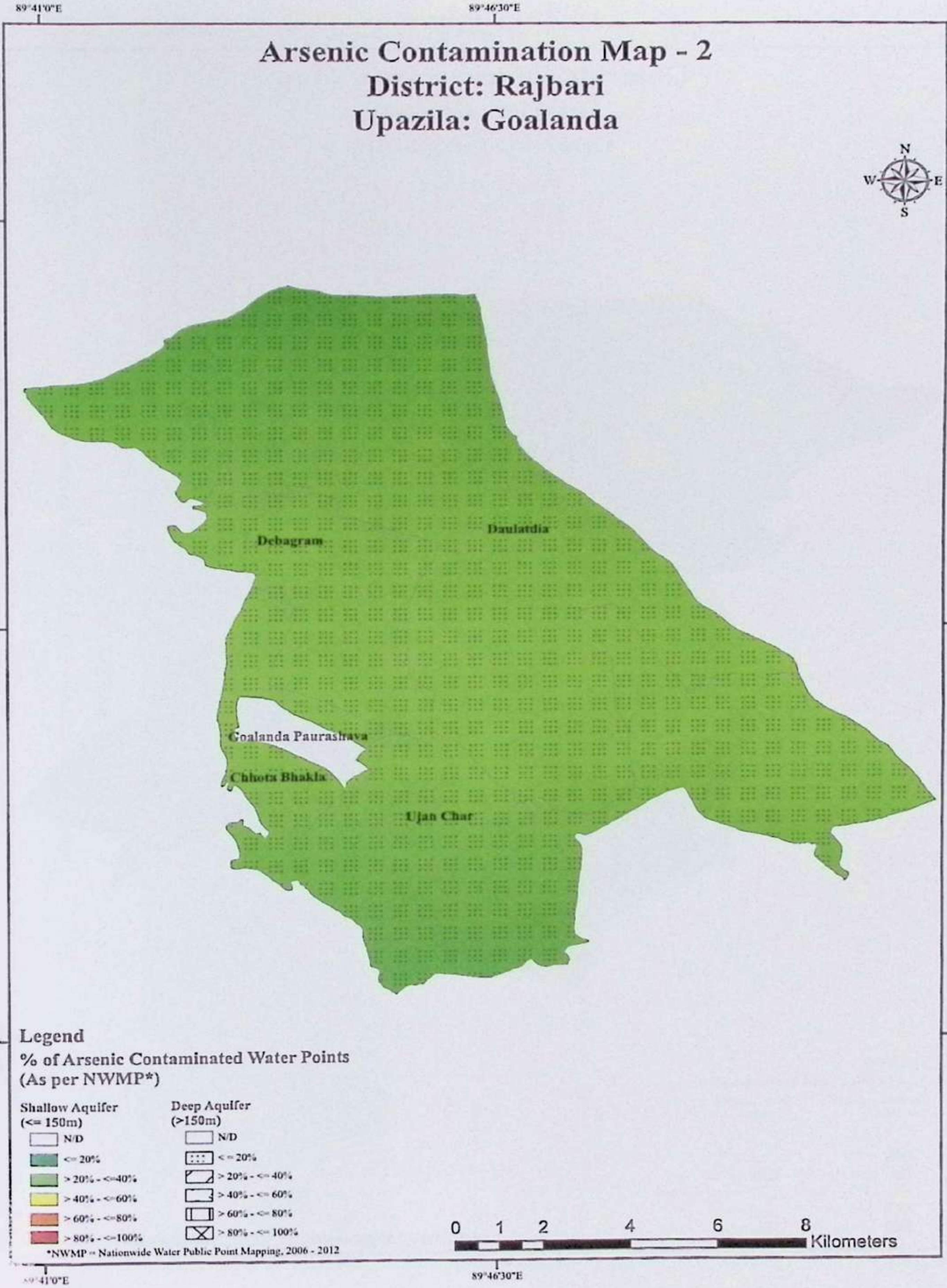
Note: Iron and Chloride contamination derived based on people's perception, 2014

N/D = No Data


Technological Option Map
District: Rajbari
Upazilla: Goalanda
89°41'0"E
89°46'30"E
23°51'0"N
23°45'30"N
23°40'0"N
Debagram
Daulatdia
Goalanda Paurashava
Chhota Bhakla
Ujan Char
Legend
Lowest Water Level (ft)
Shallow Aquifer
(<= 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Deep Aquifer
(> 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Water Point Options
N/D
DTW - 6
STW - 6
DTW - Tara
STW - Tara
DW
PSF
SST/ VSST
RWHS
Technological Priority
1st Priority - 1
2nd Priority - 2
3rd Priority - 3
4th Priority - 4
0 0.75 1.5 3 4.5 6
Kilometers

Arsenic Contamination Map - 1
District: Rajbari
Upazilla: Goalanda





89°41'0"E
89°46'30"E
Arsenic Contamination Map - 2
District: Rajbari
Upazila: Goalanda
N
W
E
S
23°51'0"N
23°45'30"N
23°40'0"N
Debagram
Daulatdia
Goalanda Paurashava
Chhota Bhakla
Ujan Char
Legend
% of Arsenic Contaminated Water Points
(As per NWMP*)
Shallow Aquifer
(<= 150m)
N/D
<= 20%
> 20% - <=40%
> 40% - <=60%
> 60% - <=80%
> 80% - <=100%
Deep Aquifer
(>150m)
N/D
< = 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
*NWMP = Nationwide Water Public Point Mapping, 2006 - 2012
0 1 2 4 6 8
Kilometers

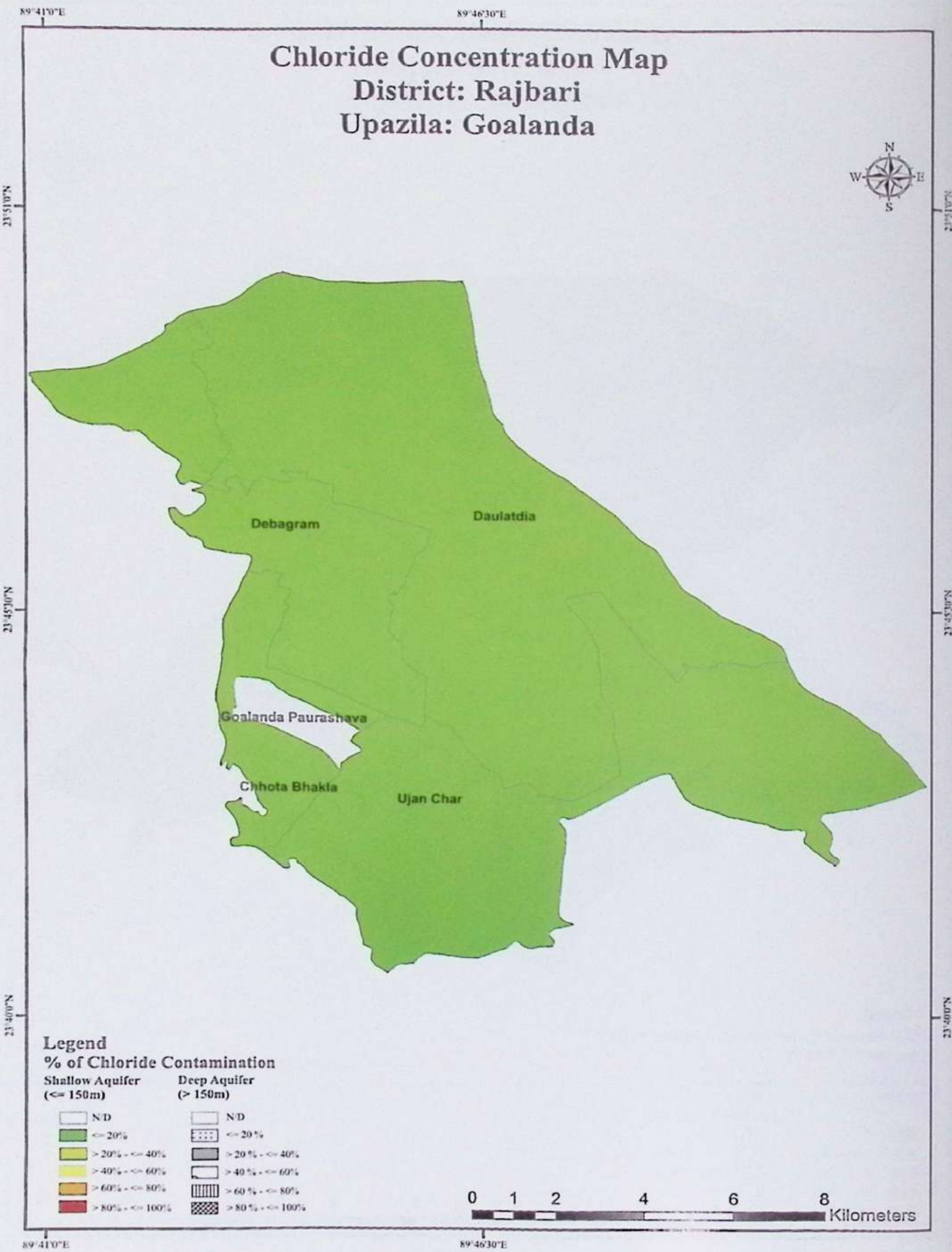
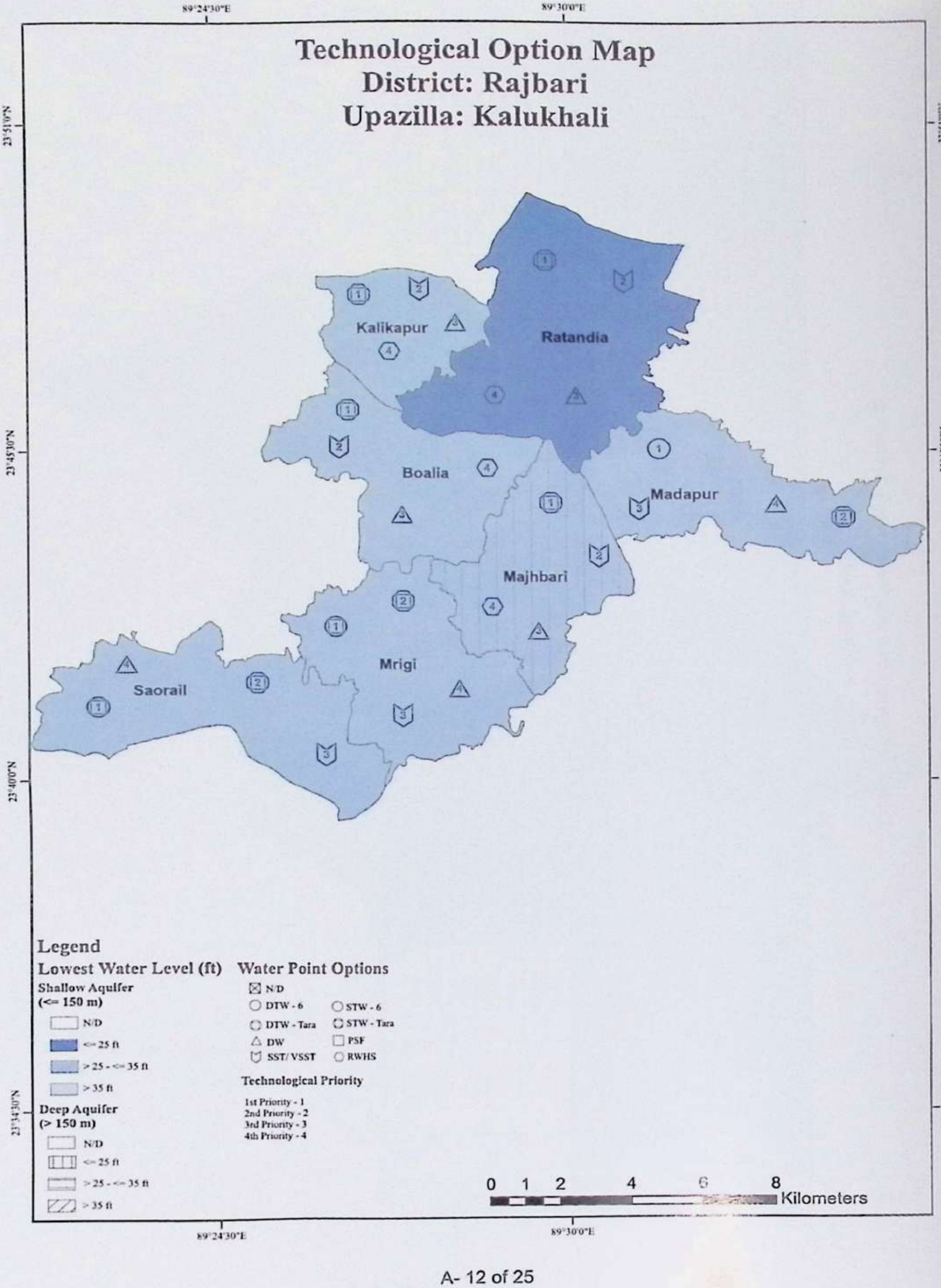

89°41'0"E
89°46'30"E
Chloride Concentration Map
District: Rajbari
Upazila: Goalanda
N
W
E
S
23°51'0"N
23°45'30"N
23°40'0"N
Debagram
Daulatdia
Goalanda Paurashava
Chhota Bhakla
Ujan Char
Legend
% of Chloride Contamination
Shallow Aquifer
(<= 150m)
Deep Aquifer
(> 150m)
N/D
<= 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
N/D
<= 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
0 1 2 4 6 8
Kilometers

Table for mapping union wise Water Supply Technology

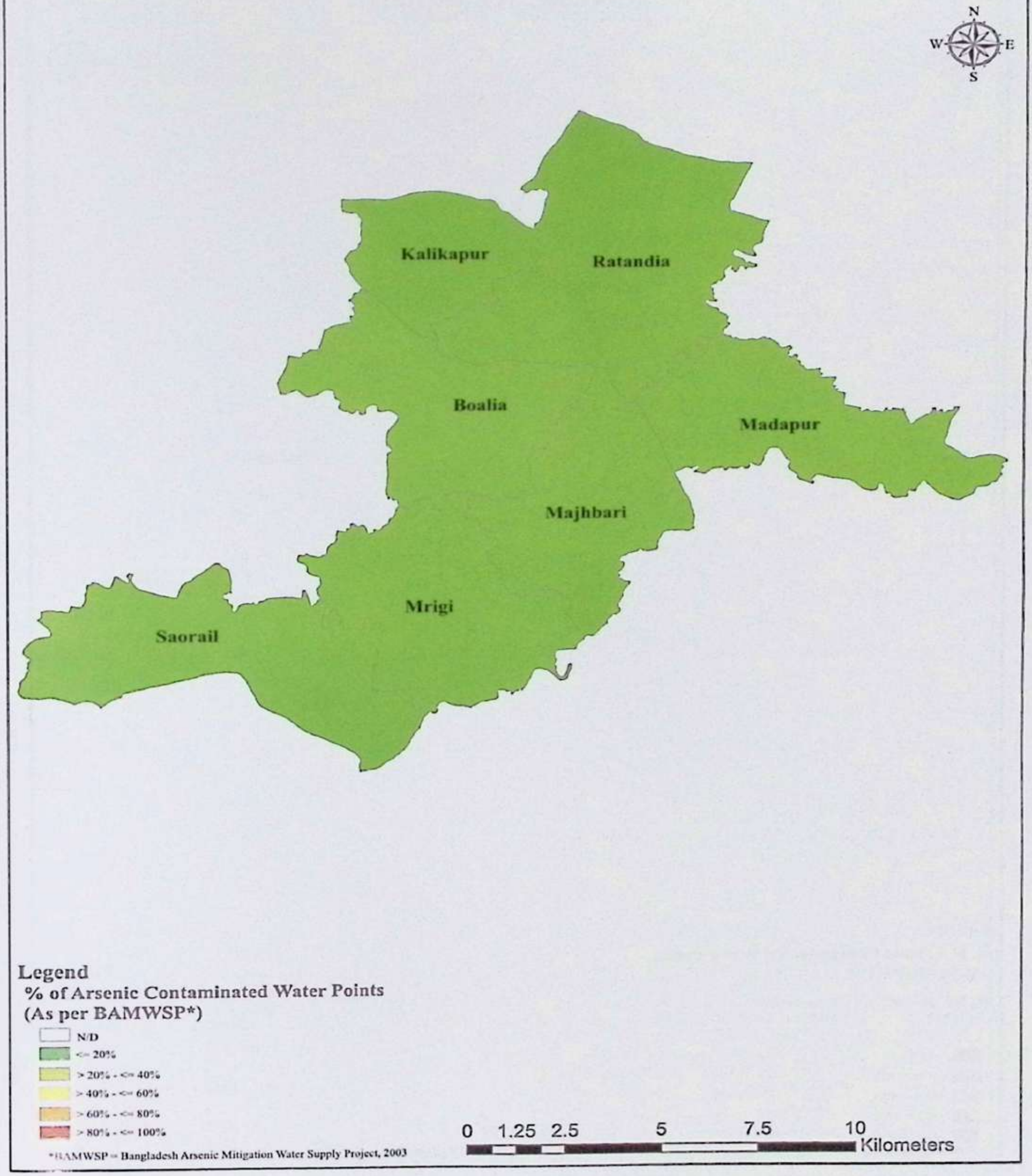
Kalukhali, Rajbari

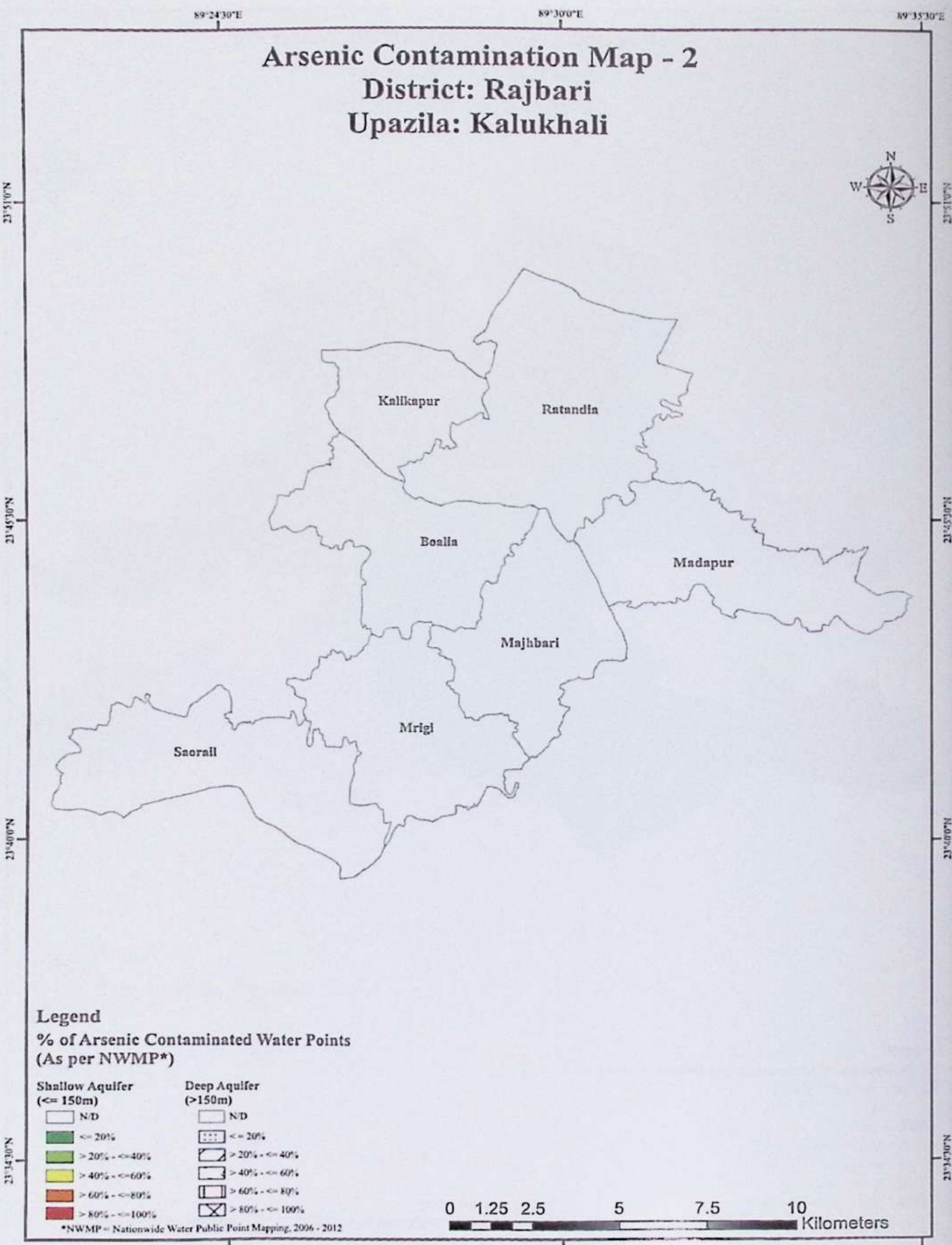
SL.	District	Upazila	Union	Lowest Water Table of the Union in the year 2017, ft		As contamination Status (% of Contaminated TW as per NAMIC, BAMWSP 2003)	As Contamination Status (> 50ppb) (% of affected DPHE Water Points installed during 2006-12)		Fe Problem (> 5ppm) (% of DPHE TW)		Cl Problem (>1000ppm) (% of DPHE TW)		Average Depth of Water point, ft			Recommended Priority Options* STW -6 : Shallow Tubewell, with No. 6 Pump STW-Tara: Shallow Tubewell, with Tara Pump DTW -6 : Deep Tubewell, with No. 6 Pump DTW-Tara: Deep Tubewell, with Tara Pump DW: Dugwell (Ringwell) DW-Tara: Dug (Ring) well with Tara Pump PSF : Pond Sand Filter RWHS: Rain Water Harvesting System ART : Arsenic Removal Technology IG : Infiltration Galary GFS : Gravity Flow System SST/VSST: Shallow Shrouded Tubewell/ Very Shallow Shrouded Tubewell				Remark
1	2	3	4	5		6	7		8		9		10			11				
				STW	DTW	STW	STW	DTW	STW	DTW	STW	DTW	STW	DTW	DW	1	2	3	4	
1	Rajbari	Kalukhali	Boalia	26	N/D	7	N/D	N/D	0	0	0	0	140	430	45	DTW - Tara	SST/VSST	DW	RWHS	
2			Kalikapur	26	N/D	14	N/D	N/D	15	0	0	0	135	400	45	DTW - Tara	SST/VSST	DW	RWHS	
3			Madapur	28	N/D	8	N/D	N/D	40	0	0	0	105	430	40	STW - 6	DTW - Tara	SST/VSST	DW	
4			Majhbari	27	25	18	N/D	N/D	50	0	0	0	135	420	50	DTW - Tara	SST/VSST	DW	RWHS	
5			Mrigi	27	N/D	8	N/D	N/D	40	0	0	0	137	420	45	STW - Tara	DTW - Tara	SST/VSST	DW	
6			Ratandia	23	N/D	17	N/D	N/D	50	0	0	0	105	390	45	DTW - Tara	SST/VSST	DW	RWHS	
7			Saorail	28	N/D	4	N/D	N/D	20	0	0	0	136	390	45	STW - Tara	DTW - Tara	SST/VSST	DW	

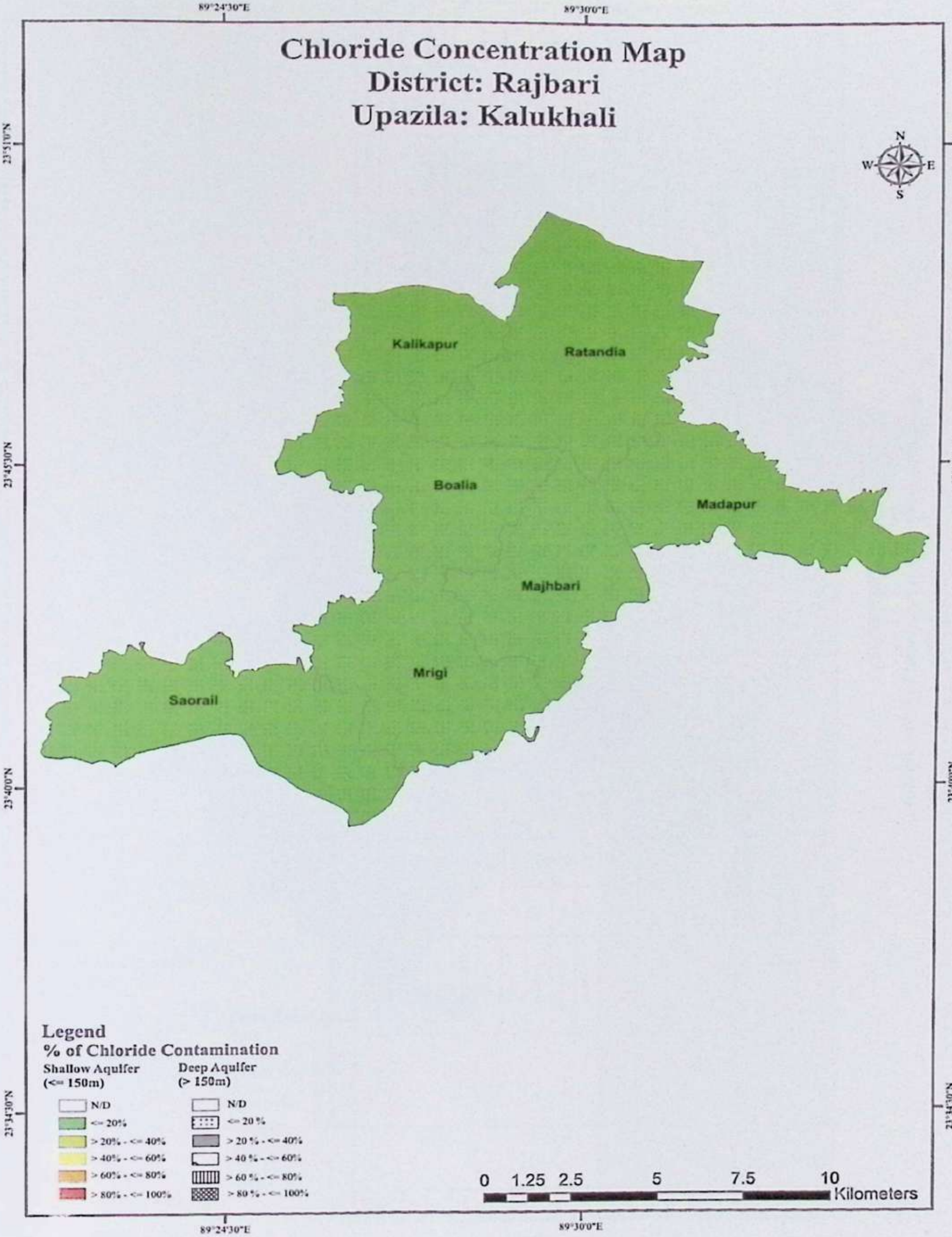
Note: Iron and Chloride contamination derived based on people's perception, 2014
N/D = No Data


89°24'30"E
89°30'0"E
23°51'0"N
23°45'30"N
23°40'0"N
23°34'30"N
Technological Option Map
District: Rajbari
Upazilla: Kalukhali
Kalikapur
Ratandia
Boalia
Madapur
Majhbari
Mrigi
Saorail
Legend
Lowest Water Level (ft)
Shallow Aquifer
(<= 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Deep Aquifer
(> 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Water Point Options
N/D
DTW - 6
STW - 6
DTW - Tara
STW - Tara
DW
PSF
SST/ VSST
RWHS
Technological Priority
1st Priority - 1
2nd Priority - 2
3rd Priority - 3
4th Priority - 4
0 1 2 4 6 8
Kilometers

Arsenic Contamination Map - 1
District: Rajbari
Upazilla: Kalukhali




Arsenic Contamination Map - 2
District: Rajbari
Upazila: Kalukhali
N
W
E
S
Kalikapur
Ratandia
Boalia
Madapur
Majhbari
Mrigi
Saorail
Legend
% of Arsenic Contaminated Water Points
(As per NWMP*)
Shallow Aquifer
(<= 150m)
N/D
<= 20%
> 20% - <=40%
> 40% - <=60%
> 60% - <=80%
> 80% - <=100%
Deep Aquifer
(>150m)
N/D
< = 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
*NWMP = Nationwide Water Public Point Mapping, 2006 - 2012
0 1.25 2.5 5 7.5 10
Kilometers
89°24'30"E
89°30'0"E
89°35'30"E
23°51'0"N
23°45'30"N
23°40'0"N
23°34'30"N



89°24'30"E
89°30'0"E
Chloride Concentration Map
District: Rajbari
Upazila: Kalukhali
23°51'0"N
23°45'30"N
23°40'0"N
23°34'30"N
N
W
E
S
Kalikapur
Ratandia
Boalia
Madapur
Majhbari
Mrigi
Saorail
Legend
% of Chloride Contamination
Shallow Aquifer
(<= 150m)
N/D
<= 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
Deep Aquifer
(> 150m)
N/D
<= 20 %
> 20 % - <= 40%
> 40 % - <= 60%
> 60 % - <= 80%
> 80 % - <= 100%
0 1.25 2.5 5 7.5 10
Kilometers

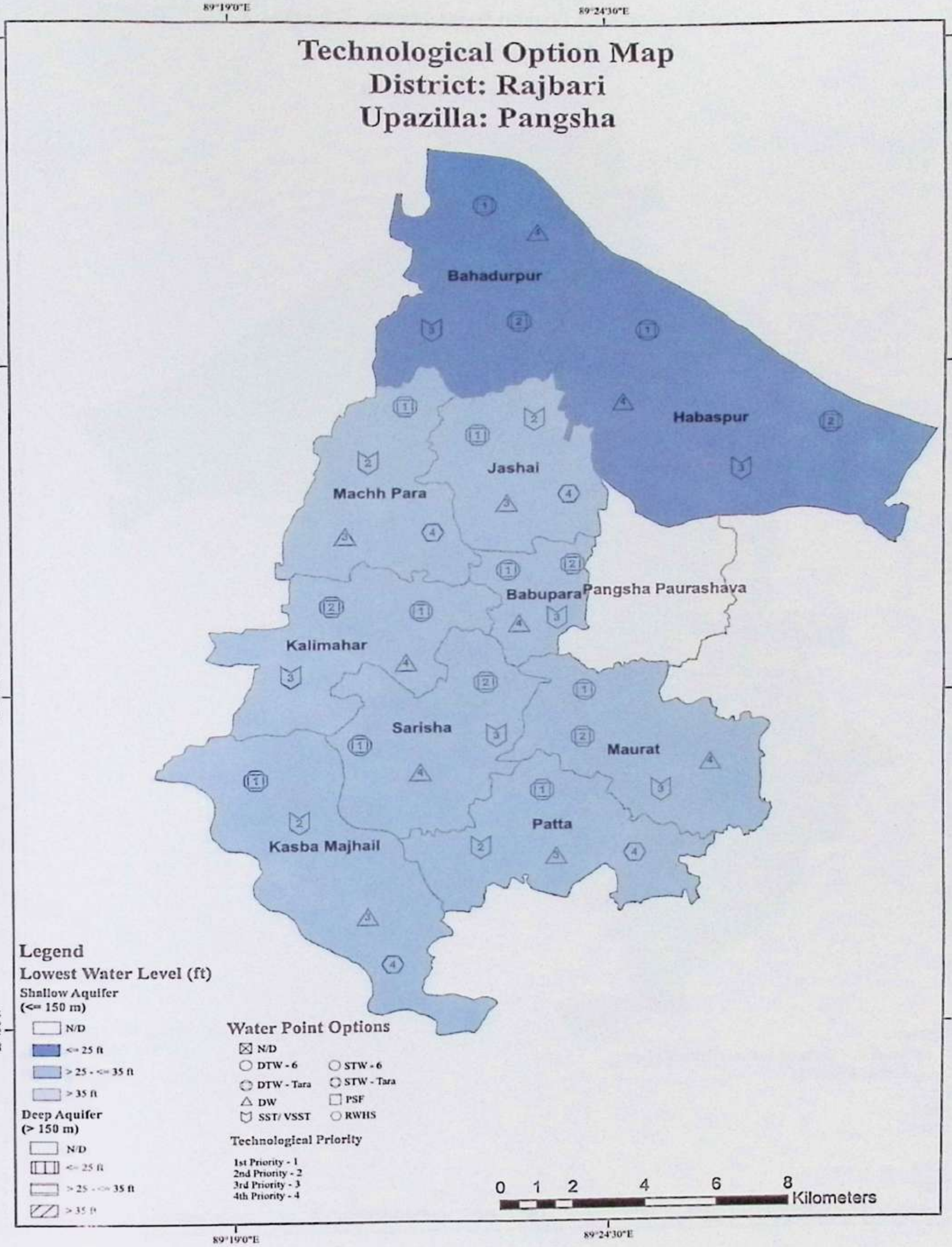
Table for mapping union wise Water Supply Technology

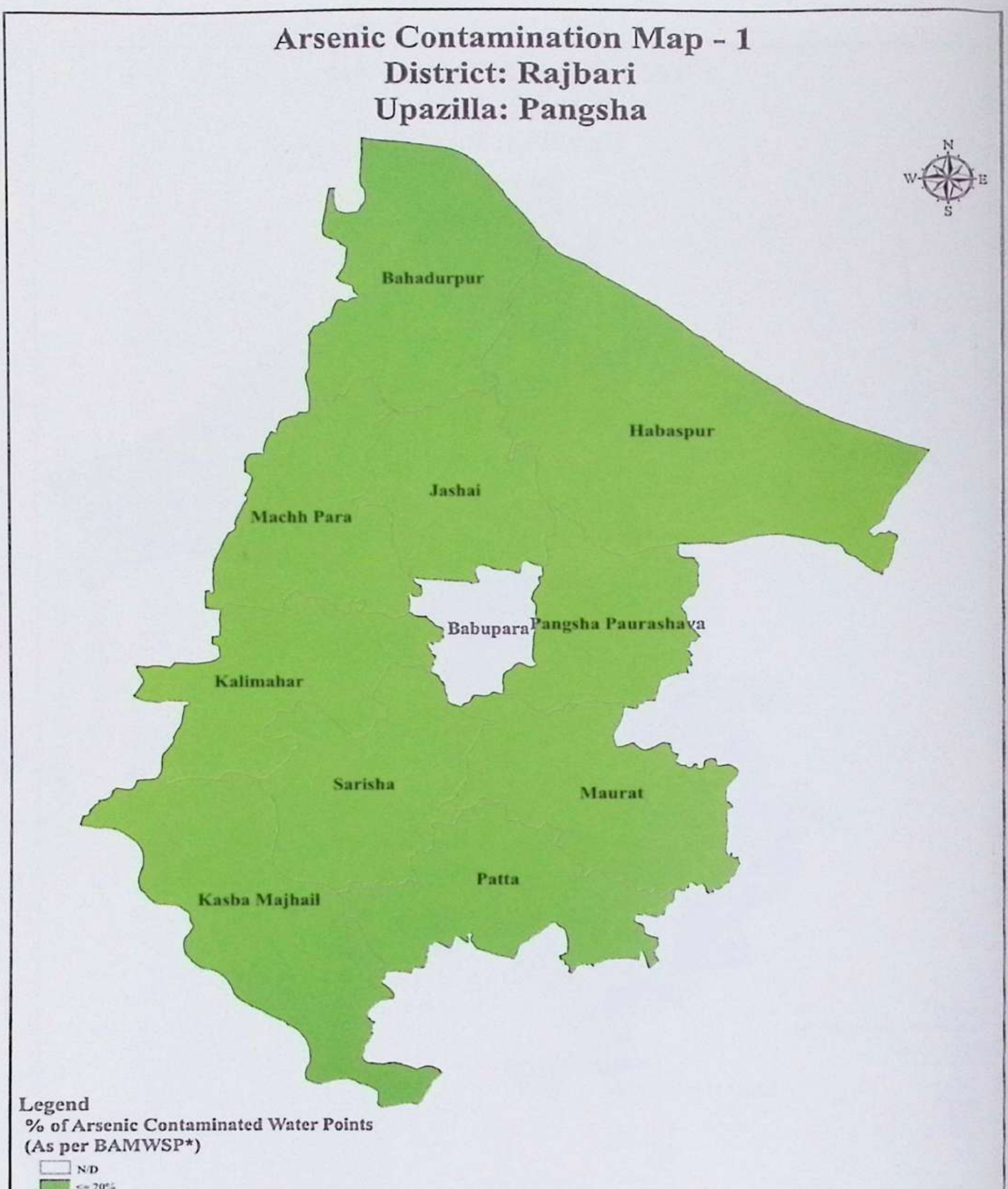
Pangsha, Rajbari

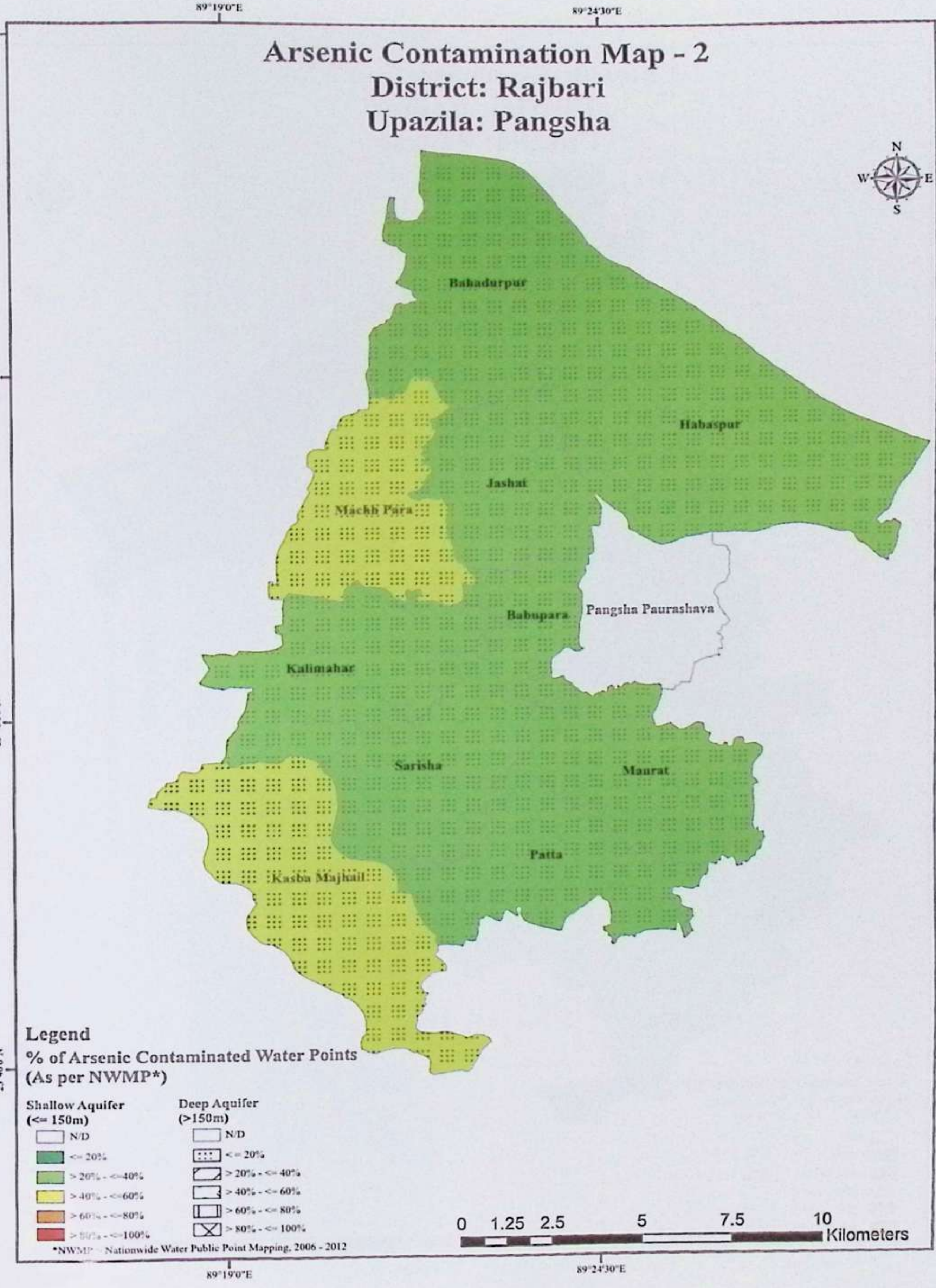
SL	District	Upazila	Union	Lowest Water Table of the Union in the year 2017, ft		As contamination Status (% of Contaminated TW as per NAMIC, BAMWSP 2003)	As Contamination Status (> 50ppb) (% of affected DPHE Water Points installed during 2006-12)		Fe Problem (> 5ppm) (% of DPHE TW)		Cl Problem (>1000ppm) (% of DPHE TW)		Average Depth of Water point, ft			Recommended Priority Options*				Remark
1	2	3	4	5		6	7		8		9		10			11				
				STW	DTW	STW	STW	DTW	STW	DTW	STW	DTW	STW	DTW	DW	1	2	3	4	
1	Rajbari	Pangsha	Babupara	28	N/D	N/D	0	0	30	10	0	0	200	500	50	STW - Tara	DTW - Tara	SST/ VSST	DW	
2			Bahadurpur	24	N/D	9	0	0	40	10	0	0	200	500	50	STW - Tara	DTW - Tara	SST/ VSST	DW	
3			Habaspur	23	N/D	5	0	0	30	0	0	0	200	500	50	STW - Tara	DTW - Tara	SST/ VSST	DW	
4			Jashai	26	N/D	20	0	18.18	50	10	0	0	200	500	50	DTW - Tara	SST/ VSST	DW	RWHS	
5			Kalimahar	28	N/D	4	0	5.26	25	0	0	0	200	500	50	STW - Tara	DTW - Tara	SST/ VSST	DW	
6			Kasba Majhail	30	N/D	1	0	21.05	20	0	0	0	200	500	50	DTW - Tara	SST/ VSST	DW	RWHS	
7			Machh Para	29	N/D	2	0	23.08	40	0	0	0	200	500	50	DTW - Tara	SST/ VSST	DW	RWHS	
8			Maurat	29	N/D	1	0	5.88	35	0	0	0	200	500	50	STW - Tara	DTW - Tara	SST/ VSST	DW	
9			Patta	30	N/D	11	0	7.14	40	0	0	0	200	500	50	DTW - Tara	SST/ VSST	DW	RWHS	
10			Sarisha	30	N/D	2	0	16.67	25	0	0	0	200	500	50	STW - Tara	DTW - Tara	SST/ VSST	DW	

*Recommended Priority Options:
STW -6 : Shallow Tubewell, with No. 6 Pump
STW-Tara: Shallow Tubewell, with Tara Pump
DTW -6 : Deep Tubewell, with No. 6 Pump
DTW-Tara: Deep Tubewell, with Tara Pump
DW: Dugwell (Ringwell)
DW-Tara: Dug (Ring) well with Tara Pump
PSF : Pond Sand Filter
RWHS: Rain Water Harvesting System
ART : Arsenic Removal Technology
IG : Infiltration Gallery
GFS : Gravity Flow System
SST/VSST: Shallow Shrouded Tubewell/ Very Shallow Shrouded Tubewell

Note: Iron and Chloride contamination derived based on people's perception, 2014
N/D = No Data


Technological Option Map
District: Rajbari
Upazilla: Pangsha
Bahadurpur
Habaspur
Jashai
Machh Para
Babupara
Pangsha Paurashava
Kalimahar
Sarisha
Maurat
Patta
Kasba Majhail
89°19'0"E
89°24'30"E
23°51'0"N
23°45'30"N
23°40'0"N
Legend
Lowest Water Level (ft)
Shallow Aquifer
(<= 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Deep Aquifer
(> 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Water Point Options
N/D
DTW - 6
STW - 6
DTW - Tara
STW - Tara
DW
PSF
SST/ VSST
RWHS
Technological Priority
1st Priority - 1
2nd Priority - 2
3rd Priority - 3
4th Priority - 4
0 1 2 4 6 8
Kilometers


Arsenic Contamination Map - 1
District: Rajbari
Upazilla: Pangsha
N
W
E
S
Bahadurpur
Habaspur
Jashai
Machh Para
Babupara
Pangsha Paurashava
Kalimahar
Sarisha
Maurat
Patta
Kasba Majhail
Legend
% of Arsenic Contaminated Water Points
(As per BAMWSP*)
N/D
<= 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
*BAMWSP = Bangladesh Arsenic Mitigation Water Supply Project, 2003
0 1.25 2.5 5 7.5 10
Kilometers


89°19'0"E
89°24'30"E
23°56'30"N
23°51'0"N
23°45'30"N
23°40'0"N
Arsenic Contamination Map - 2
District: Rajbari
Upazila: Pangsha
N
W
E
S
Bahadurpur
Habaspur
Jashai
Machh Para
Babupara
Pangsha Paurashava
Kalimahar
Sarisha
Maurat
Patta
Kasba Majhail
Legend
% of Arsenic Contaminated Water Points
(As per NWMP*)
Shallow Aquifer
(<= 150m)
N/D
<= 20%
> 20% - <=40%
> 40% - <=60%
> 60% - <=80%
> 80% - <=100%
Deep Aquifer
(>150m)
N/D
<= 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
*NWMP = Nationwide Water Public Point Mapping, 2006 - 2012
0 1.25 2.5 5 7.5 10 Kilometers

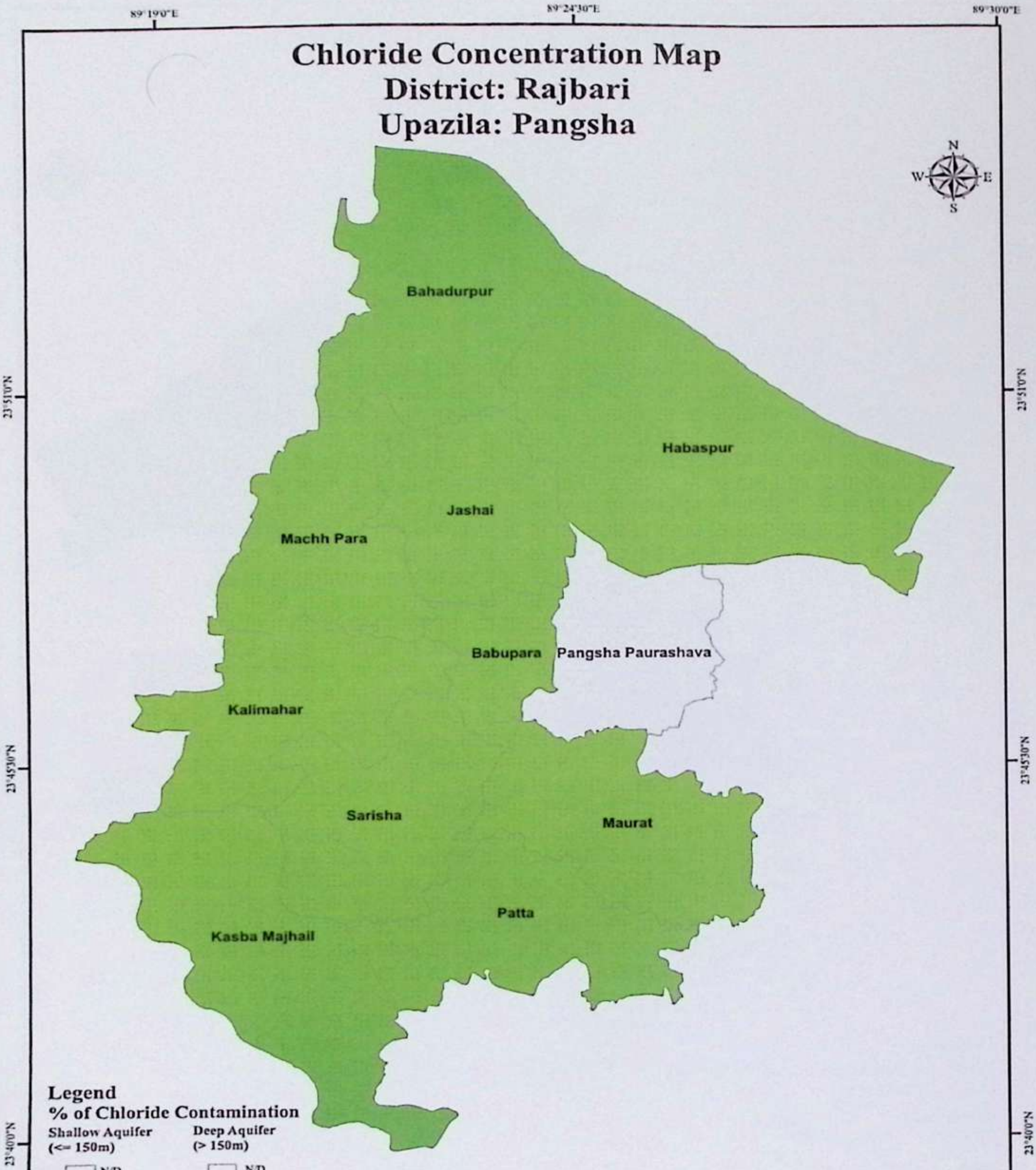
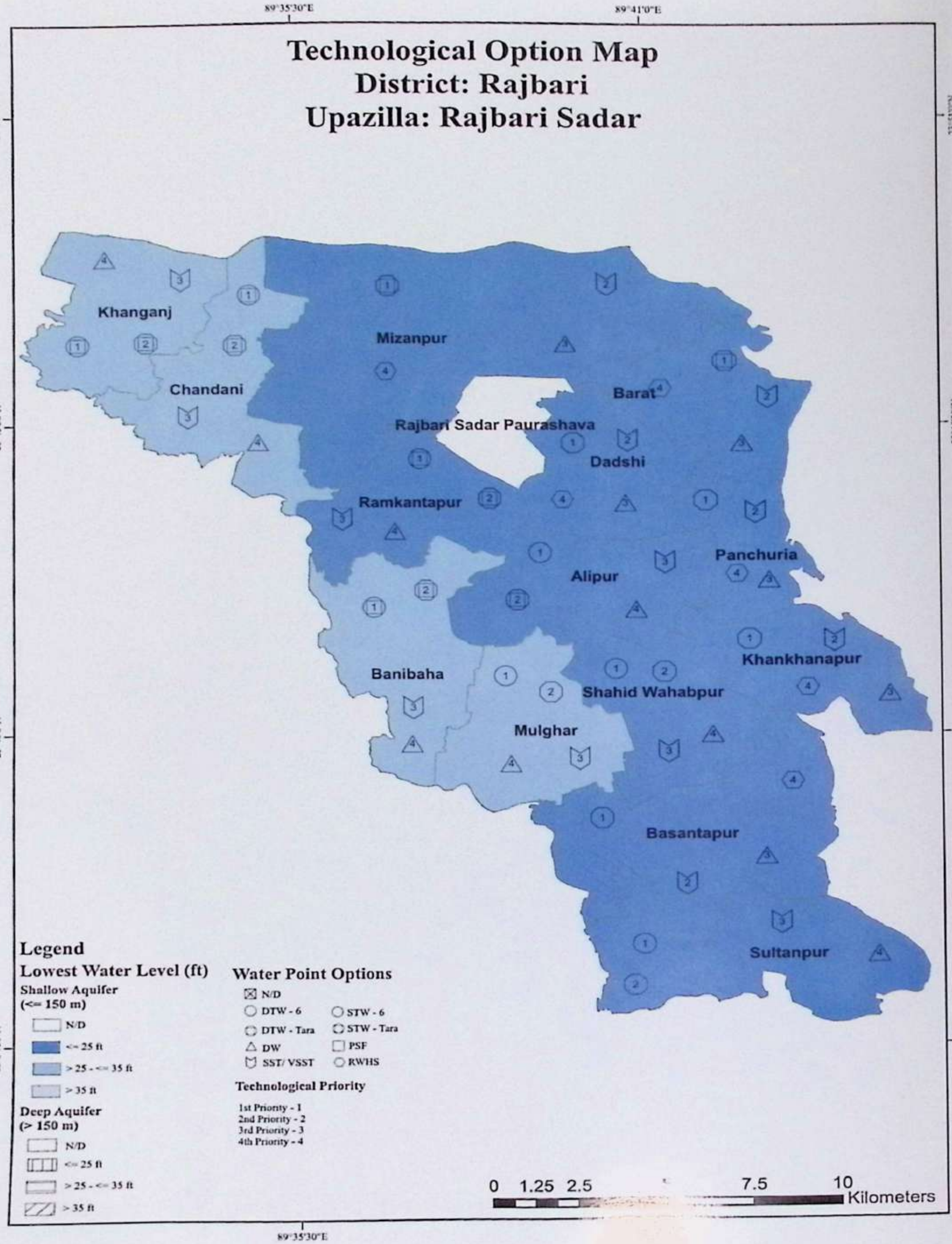

Chloride Concentration Map
District: Rajbari
Upazila: Pangsha
89°19'0"E
89°24'30"E
89°30'0"E
23°51'0"N
23°45'30"N
23°40'0"N
N
S
E
W
Bahadurpur
Habaspur
Jashai
Machh Para
Babupara
Pangsha Paurashava
Kalimahar
Sarisha
Maurat
Patta
Kasba Majhail
Legend
% of Chloride Contamination
Shallow Aquifer (<= 150m)
Deep Aquifer (> 150m)
N/D
<= 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
N/D
<= 20 %
> 20 % - <= 40%
> 40 % - <= 60%
> 60 % - <= 80%
> 80 % - <= 100%
0 1 2 4 6 8
Kilometers

Table for mapping union wise Water Supply Technology

Rajbari Sadar, Rajbari

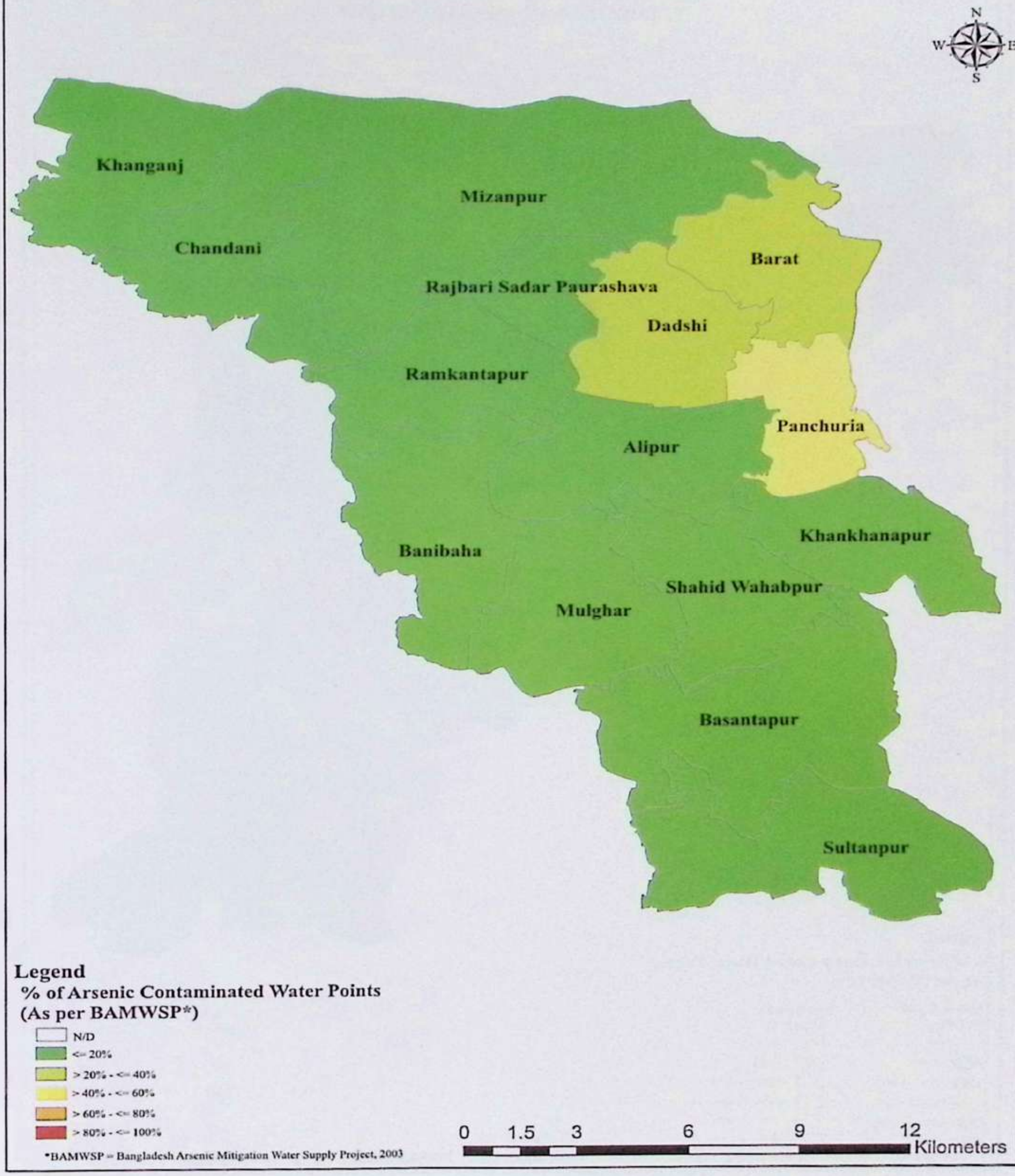
SL	District	Upazila	Union	Lowest Water Table of the Union in the year 2017, ft		As contamination Status (% of Contaminated TW as per NAMIC, BAMWSP 2003)	As Contamination Status (> 50ppb) (% of affected DPHE Water Points Installed during 2006-12)		Fe Problem (> 5ppm) (% of DPHE TW)		Cl Problem (>1000ppm) (% of DPHE TW)		Average Depth of Water point, ft			Recommended Priority Options* STW -6 : Shallow Tubewell, with No. 6 Pump STW-Tara: Shallow Tubewell, with Tara Pump DTW -6 : Deep Tubewell, with No. 6 Pump DTW-Tara: Deep Tubewell, with Tara Pump DW : Dugwell (Ringwell) DW-Tara: Dug (Ring) well with Tara Pump PSF : Pond Sand Filter RWHS: Rain Water Harvesting System ART : Arsenic Removal Technology IG : Infiltration Galary GFS : Gravity Flow System SST/VSST: Shallow Shrouded Tubewell/ Very Shallow Shrouded Tubewell				Remark
1	2	3	4	5		6	7		8		9		10			11				
				STW	DTW	STW	STW	DTW	STW	DTW	STW	DTW	STW	DTW	DW	1	2	3	4	
1	Rajbari	Rajbari Sadar	Alipur	22	N/D	5	0	0	10	10	0	0	180	700	50	STW - 6	DTW - Tara	SST/ VSST	DW	
2			Banibaha	30	N/D	1	0	0	0	0	0	0	165	750	50	STW - Tara	DTW - Tara	SST/ VSST	DW	
3			Barat	21	N/D	22	0	24.14	40	40	0	0	85	600	50	DTW - Tara	SST/ VSST	DW	RWHS	
4			Basantapur	20	N/D	14	0	7.14	0	0	0	0	115	750	50	DTW - 6	SST/ VSST	DW	RWHS	
5			Chandani	27	N/D	0	0	0	0	0	0	0	150	650	50	STW - Tara	DTW - Tara	SST/ VSST	DW	
6			Dadshi	20	N/D	35	0	10	40	40	0	0	115	600	50	DTW - 6	SST/ VSST	DW	RWHS	
7			Khanganj	28	N/D	0	0	0	0	0	0	0	150	600	50	STW - Tara	DTW - Tara	SST/ VSST	DW	
8			Khankhanapur	18	N/D	14	0	40	10	10	0	0	85	700	50	DTW - 6	SST/ VSST	DW	RWHS	
9			Mizanpur	25	N/D	12	0	16.67	0	0	0	0	155	600	50	DTW - Tara	SST/ VSST	DW	RWHS	
10			Mulghar	26	N/D	10	0	0	20	20	0	0	195	750	50	STW - 6	DTW - 6	SST/ VSST	DW	
11			Panchuria	17	N/D	49	0	18.75	40	40	0	0	85	500	50	DTW - 6	SST/ VSST	DW	RWHS	
12			Ramkantapur	20	N/D	10	0	7.69	0	0	0	0	135	700	50	STW - Tara	DTW - Tara	SST/ VSST	DW	
13			Shahid Wahabpur	19	N/D	10	0	0	0	0	0	0	115	750	50	STW - 6	DTW - 6	SST/ VSST	DW	
14			Sultanpur	19	N/D	17	0	0	0	0	0	0	115	600	50	STW - 6	DTW - 6	SST/ VSST	DW	

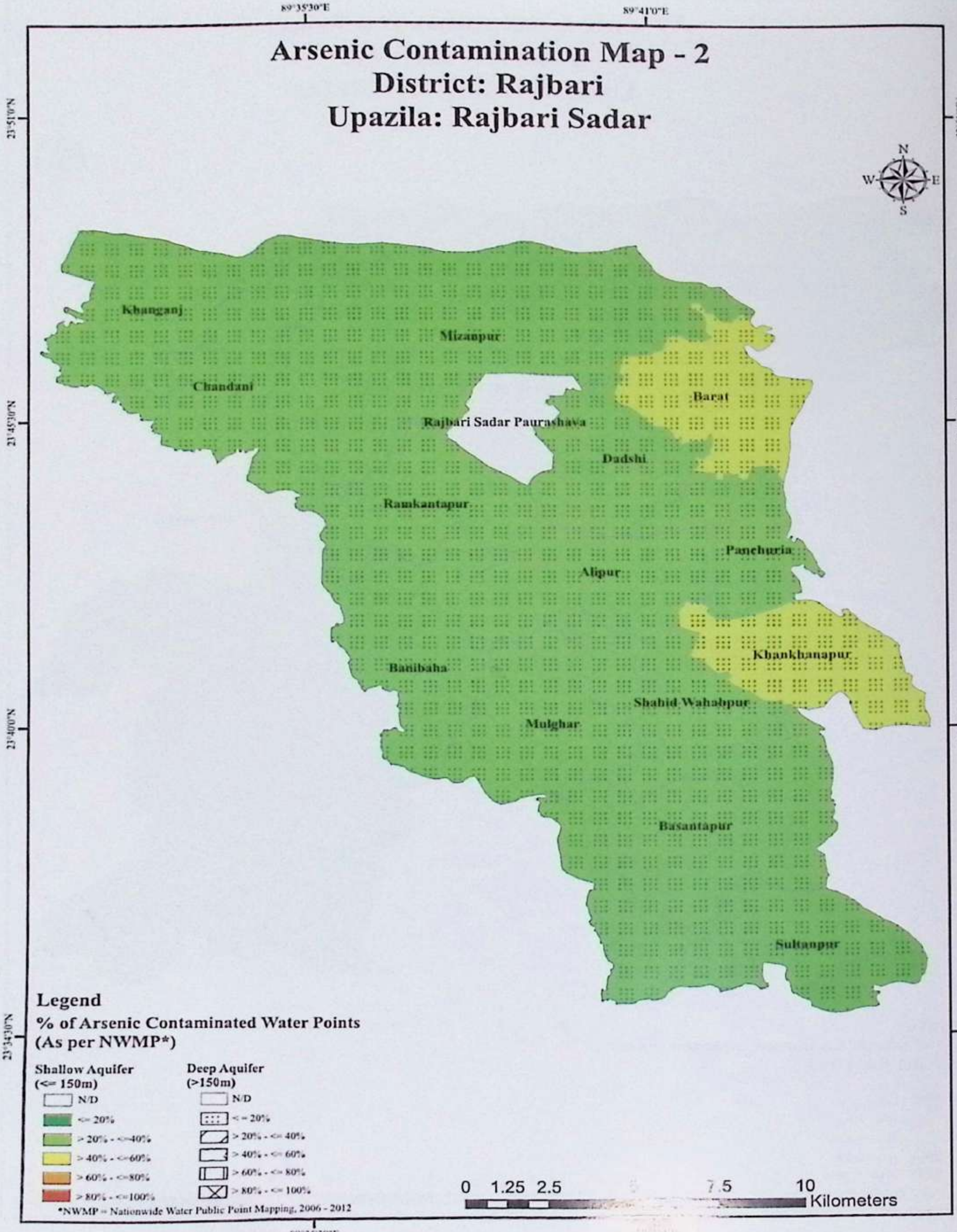
\# Note: Iron and Chloride contamination derived based on people's perception, 2014
N/D = No Data



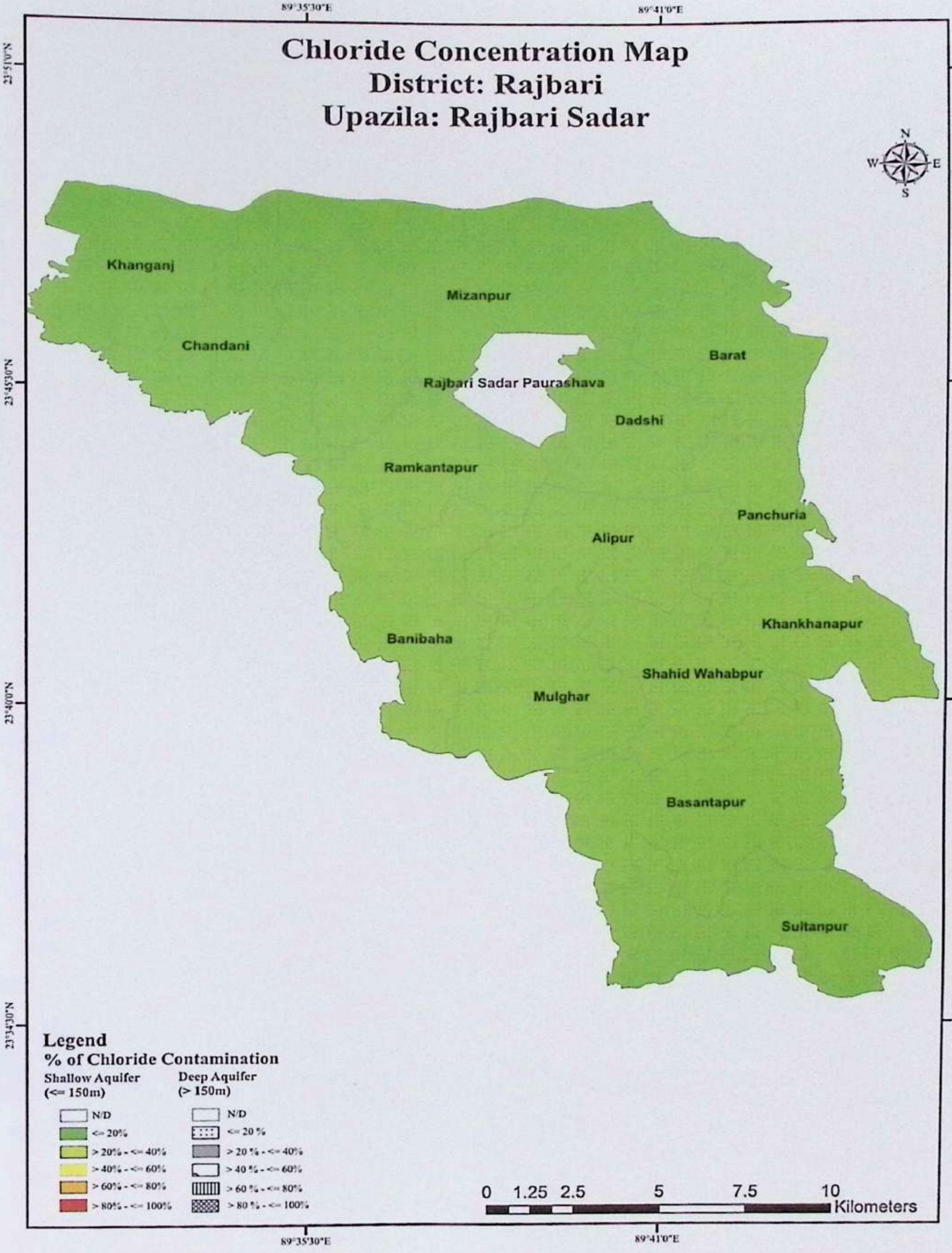
89°35'30"E
89°41'0"E
23°51'0"N
23°45'30"N
23°40'0"N
23°34'30"N
Technological Option Map
District: Rajbari
Upazilla: Rajbari Sadar
Khanganj
Chandani
Mizanpur
Barat
Rajbari Sadar Paurashava
Dadshi
Ramkantapur
Panchuria
Alipur
Khankhanapur
Banibaha
Shahid Wahabpur
Mulghar
Basantapur
Sultanpur
Legend
Lowest Water Level (ft)
Shallow Aquifer
(<= 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Deep Aquifer
(> 150 m)
N/D
<= 25 ft
> 25 - <= 35 ft
> 35 ft
Water Point Options
N/D
DTW - 6
STW - 6
DTW - Tara
STW - Tara
DW
PSF
SST/ VSST
RWHS
Technological Priority
1st Priority - 1
2nd Priority - 2
3rd Priority - 3
4th Priority - 4
0 1.25 2.5 7.5 10
Kilometers

Arsenic Contamination Map - 1
District: Rajbari
Upazilla: Rajbari Sadar





Arsenic Contamination Map - 2
District: Rajbari
Upazila: Rajbari Sadar
89°35'30"E
89°41'0"E
23°51'0"N
23°45'30"N
23°40'0"N
23°34'30"N
N
S
E
W
Khanganj
Mizanpur
Chandani
Barat
Rajbari Sadar Paurashava
Dadshi
Ramkantapur
Panchuria
Alipur
Khankhanapur
Banibaha
Shahid Wahabpur
Mulghar
Basantapur
Sultanpur
Legend
% of Arsenic Contaminated Water Points
(As per NWMP*)
Shallow Aquifer
(<= 150m)
N/D
<= 20%
> 20% - <=40%
> 40% - <=60%
> 60% - <=80%
> 80% - <=100%
Deep Aquifer
(>150m)
N/D
<= 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
*NWMP = Nationwide Water Public Point Mapping, 2006 - 2012
0
1.25
2.5
10
Kilometers


89°35'30"E
89°41'0"E
23°51'0"N
23°45'30"N
23°40'0"N
23°34'30"N
Chloride Concentration Map
District: Rajbari
Upazila: Rajbari Sadar
N
W
E
S
Khanganj
Mizanpur
Chandani
Barat
Rajbari Sadar Paurashava
Dadshi
Ramkantapur
Panchuria
Alipur
Khankhanapur
Banibaha
Shahid Wahabpur
Mulghar
Basantapur
Sultanpur
Legend
% of Chloride Contamination
Shallow Aquifer (<= 150m)
Deep Aquifer (> 150m)
N/D
<= 20%
> 20% - <= 40%
> 40% - <= 60%
> 60% - <= 80%
> 80% - <= 100%
N/D
<= 20 %
> 20 % - <= 40%
> 40 % - <= 60%
> 60 % - <= 80%
> 80 % - <= 100%
0 1.25 2.5 5 7.5 10
Kilometers

Ground Water Circle
Department of Public Health Engineering