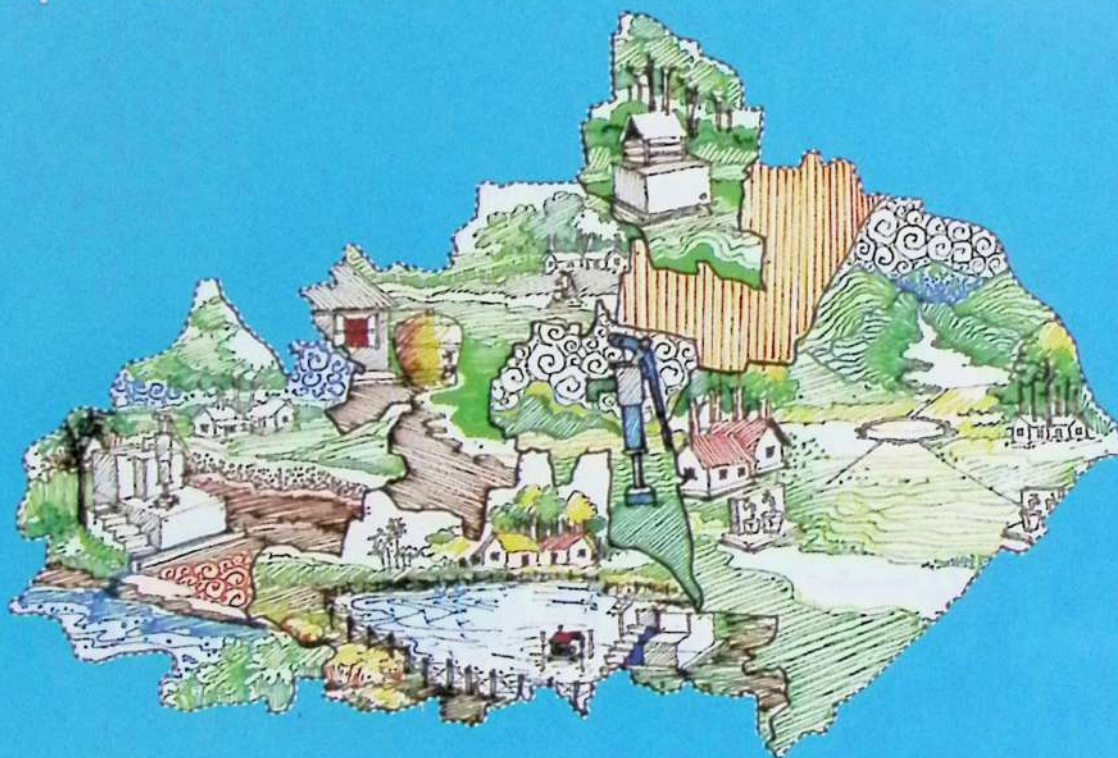




Government of the People's Republic of Bangladesh
Department of Public Health Engineering (DPHE)



Union Wise Water Supply Technology Mapping
Circle: Chittagong
District: Cox's Bazar



June 2018

Union Wise Water Supply Technology Mapping
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District: Cox's Bazar

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FOREWORD

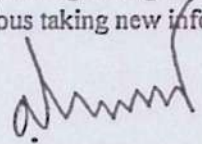
Rural water supply in Bangladesh is primarily depends on groundwater, using low cost tube well technology. The groundwater received importance for drinking purpose particularly due to its safety on microbial content. But the presence of arsenic in groundwater mostly in shallow aquifer posed a threat 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/hydrogeological 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 project 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 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, Additional Chief Engineer (Planning), DPHE and Mr. Md. Saifur 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, Mr. Md. Didarul Alam Tusher, Executive Engineer to complete the field work and data management. Mr. A.H.M. Khalequr Rahman, Executive Engineer, R&D Division and Ms. Firoza Akhter, Deputy Project Director, National Sanitation Project (Phase – III) 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 updating and revision of this document would be obvious taking new information and field experience into account.



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Table of Content

1.0	Introduction	1
2.0	Objective	1
3.0	Methodology	1
4.0	Present challenges in drinking water supply	2
5.0	Alternative water supply options	2
5.1	Different alternative water supply options	3
5.1.1	Dug well (DW)	3
5.1.2	Pond Sand Filter (PSF)	4
5.1.3	Improved deep tubewell	5
5.1.4	Rain Water Harvesting System (RWHS)	6
5.1.5	Arsenic removal technologies (ART)	7
6.0	Low water table technology	7
7.0	Iron removal technology	9
8.0	Salinity issues	9
9.0	Union wise technology	9
10.0	Use of union wise technology mapping documentation	10
	Annex – A Union wise Technology maps and data files	11

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 may 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 have been 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 is 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:

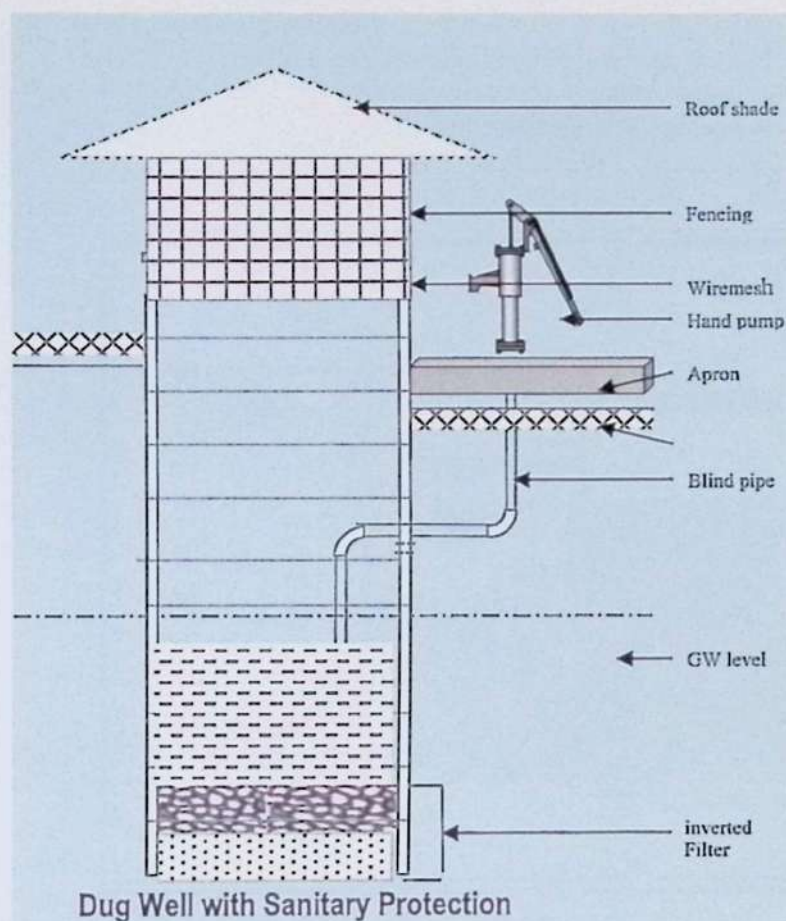
The project has given importance on arsenic mitigation approach as arsenic contamination emerges as a great concern for ground water based rural water supply system in Bangladesh. The project area and arsenic contamination is shown in Map as Annex- B. Different Arsenic mitigation options has been discussed 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:



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 coastal belt
- # Areas of stony hills
- # Area of peaty soil should be avoided for DW as these cause an unpleasant taste and smell.

Design Requirements:

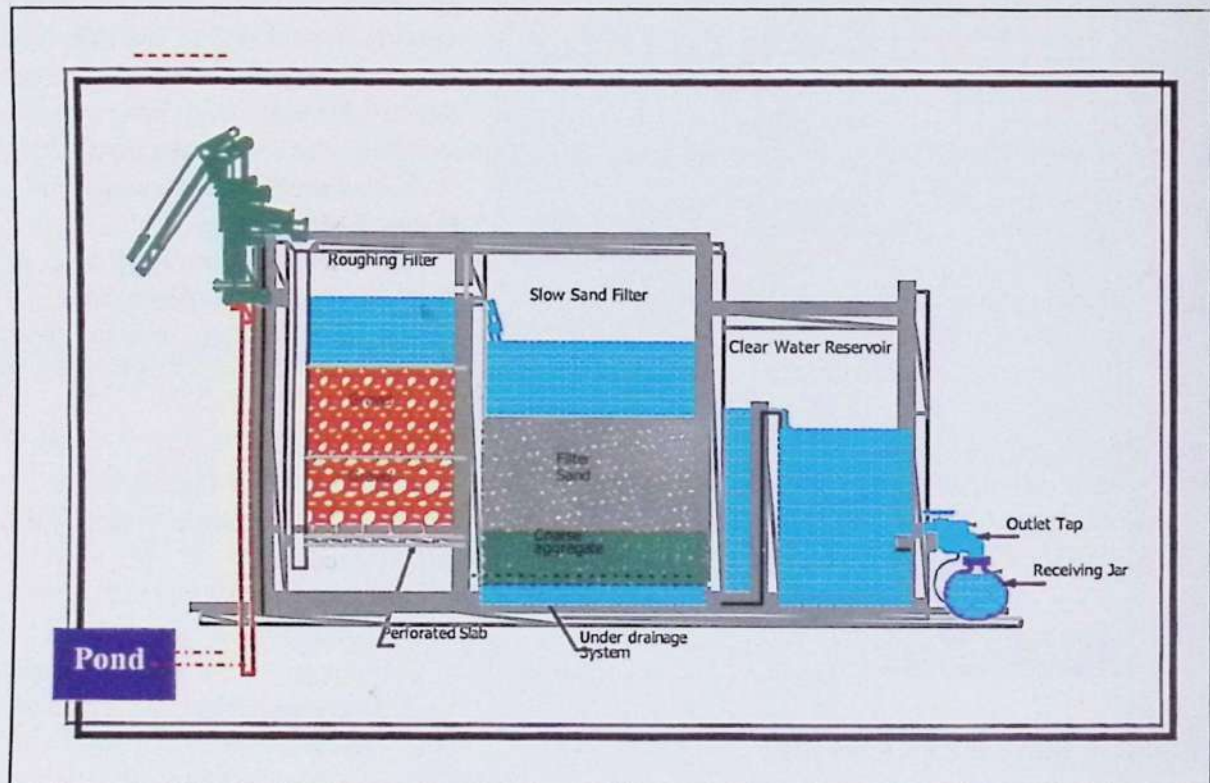
- # Concrete rings of 1.0 to 1.2 m in diameter used as lining.
- # Wells should be at least 1.0 to 1.5 m deeper than the lowest water table in the driest month.
- # Dug well should be constructed in the dry season to ensure availability of water round the year.

- # 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.



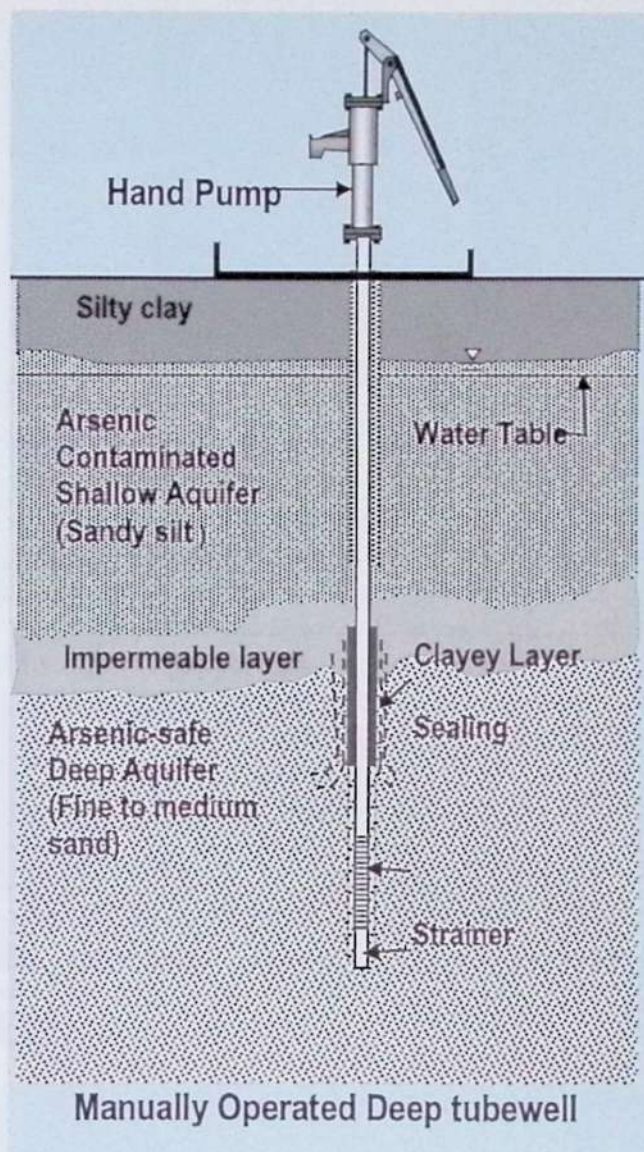
Raw water from pond is pumped up from a pond; the turbidity gets down through the roughing filter and then discharged into the filtration unit. The water is filtered and then collected in a clear water reservoir by an under drainage system. PSF is a good option for arsenic mitigation as well as for salinity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

**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 pathway 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.

Design Requirements:

- 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

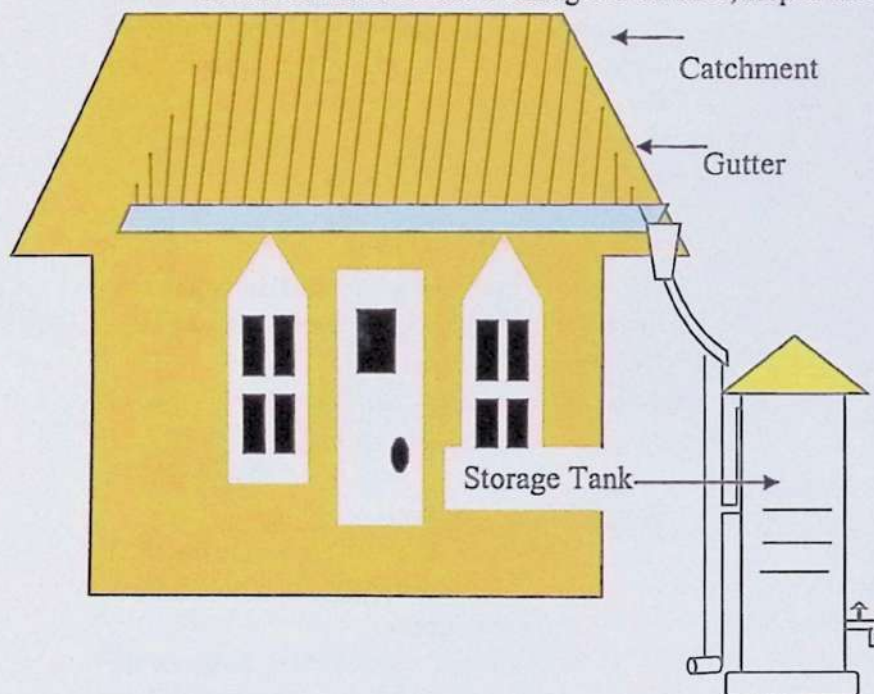
Feasible where average rainfall is 1600 mm per annum.

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 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.

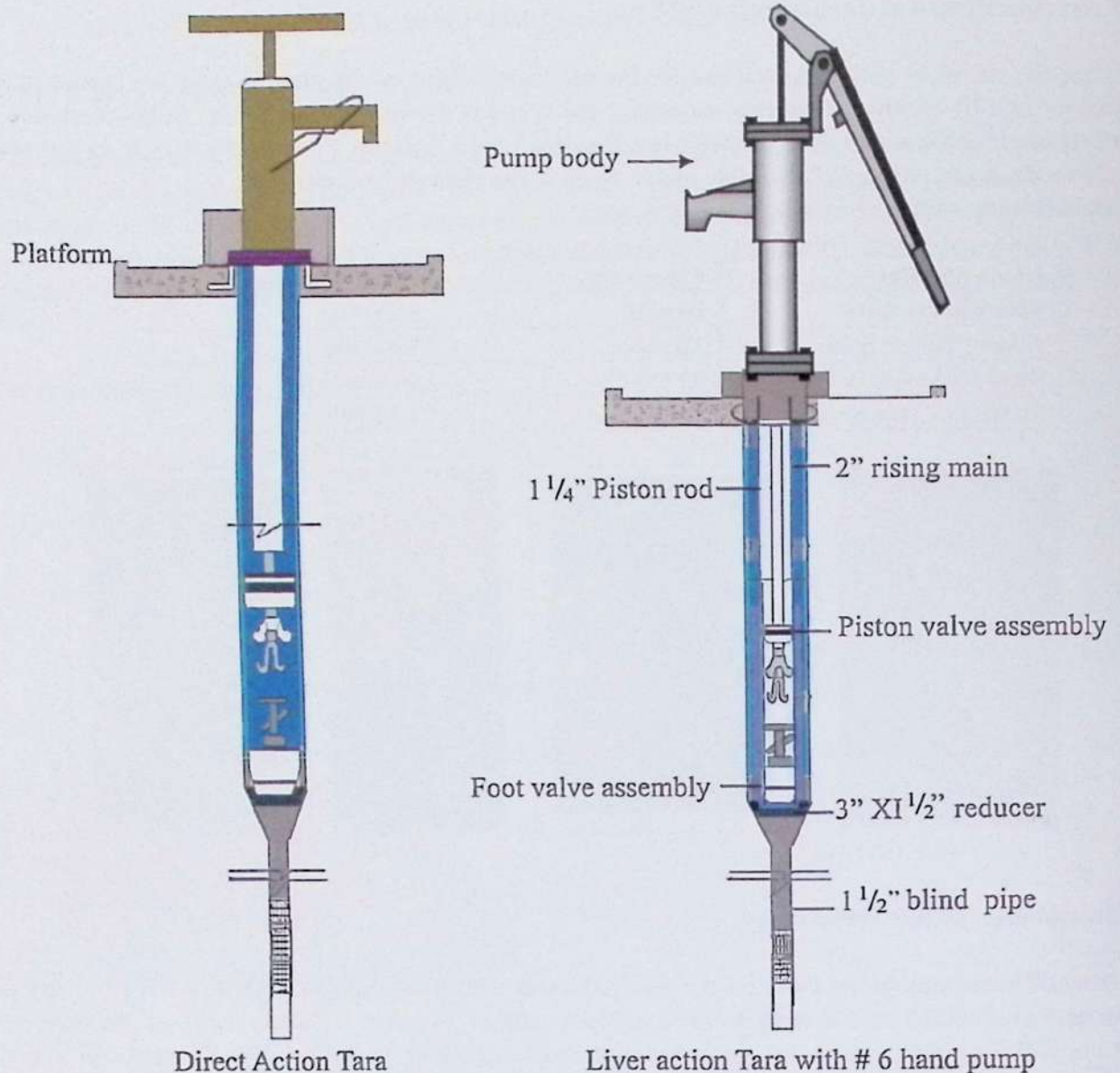
The main features of the ARTs are given below:

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:

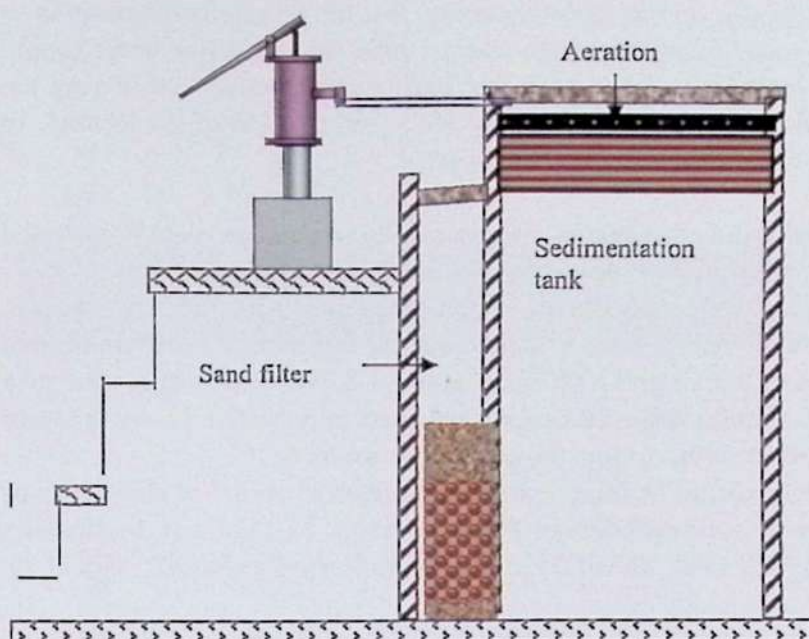
Lowering of water table is big issue for the tubewell based rural water supply. In view of low cost, easy to O&M and availability in the market, suction mode number 6 pump is widely used as the tubewell technology. But its limitation is that it can not abstract water beyond the 26 ft depth of water table. 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-dev head pump (lever action) is being used which can abstract water upto 80-90 ft depth of water table. The component of direct action & Tara dev pumps are shown as below:



In selecting the areas of low water table in the project upazilas, the study on forecasting groundwater level declination in Bangladesh conducted in 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 into 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 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 project 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 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 brought 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 >0.01 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 : Chittagong
District: Cox's Bazar

Serial No	Name of District	Name of Upazila	No. of Union	Page No.
1	Cox's Bazar	Chakaria	19	A-1
2		Cox's Bazar Sadar	10	A-6
3		Kutubdia	6	A-11
4		Maheshkhali	9	A-16
5		Pekua	7	A-21
6		Ramu	11	A-26
7		Teknaf	6	A-31
8		Ukhia	5	A-36
	Total	8	73	

District: Cox's Bazar

Upazila:

Chakaria

Cox's Bazar Sadar

Kutubdia

Maheshkhali

Pekua

Ramu

Teknaf

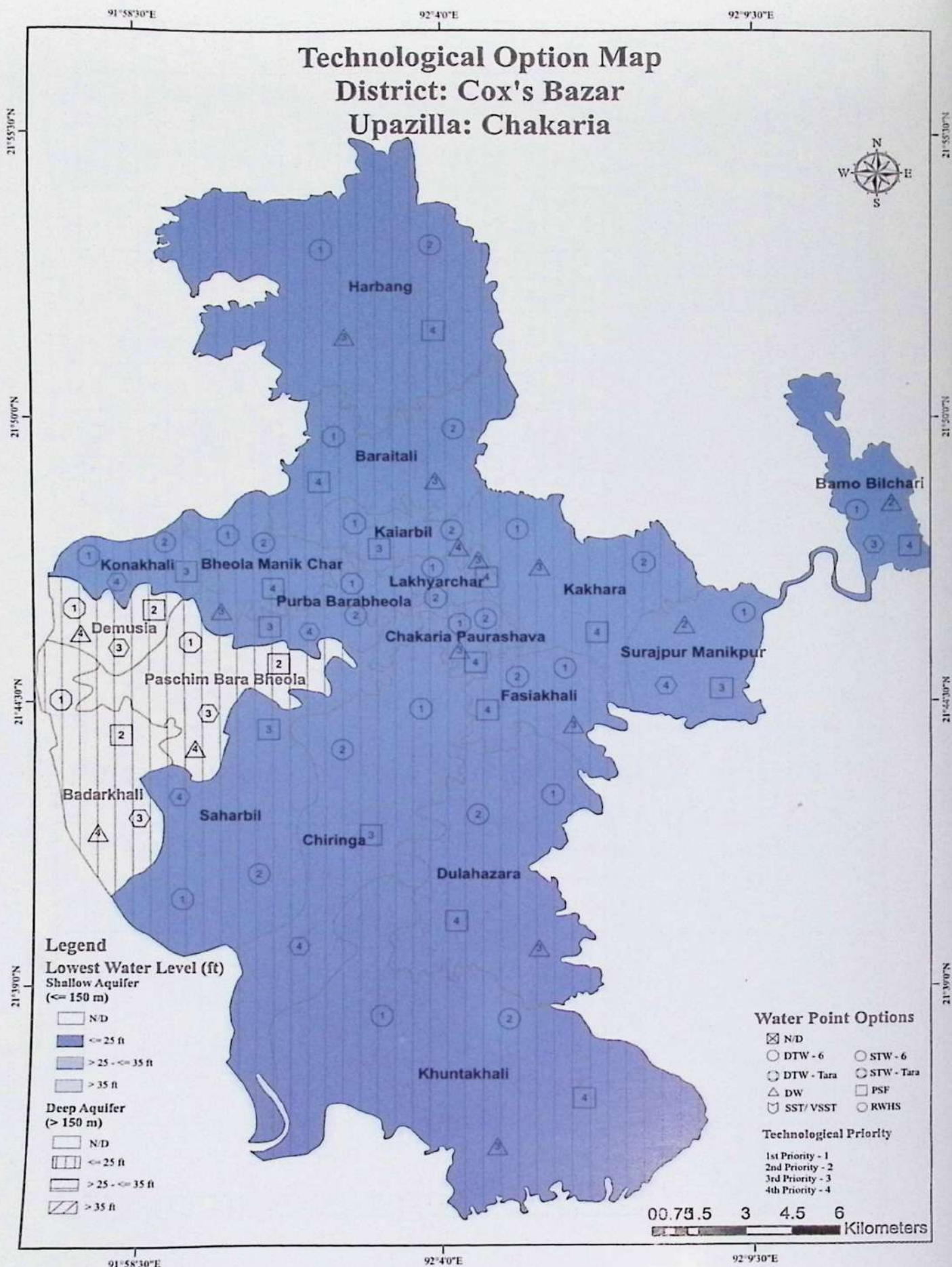
Ukhia

Table for mapping union wise Water Supply Technology
Chakaria, Cox's Bazar

SL	District	Upazila	Union	5		6		7		8		9		10		11				Remark
				STW		STW		STW		STW		STW		STW		1	2	3	4	
				DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	
1				10	10	N/D	N/D	N/D	N/D	45	20	0	0	750	N/D	DTW - 6	STW - 6	DW	PSF	
2				11	10	N/D	N/D	0	0	25	5	0	0	750	N/D	DTW - 6	STW - 6	DW	PSF	
3				11	10	N/D	N/D	N/D	N/D	5	10	0	0	650	N/D	DTW - 6	STW - 6	PSF	DW	
4				11	10	N/D	N/D	N/D	N/D	20	5	0	0	650	N/D	DTW - 6	DTW - 6	DW	PSF	
5				10	10	N/D	N/D	N/D	N/D	10	10	0	0	650	N/D	DTW - 6	DTW - 6	DW	PSF	
6				11	N/D	N/D	N/D	N/D	N/D	20	N/D	0	N/D	N/D	45	STW - 6	DW	PSF	RWHS	
7				11	N/D	N/D	N/D	0	0	20	N/D	0	N/D	N/D	50	STW - 6	DW	RWHS	PSF	
8				11	10	N/D	N/D	N/D	N/D	30	20	0	0	750	N/D	STW - 6	DTW - 6	DW	PSF	
9				13	10	N/D	N/D	0	0	30	20	0	0	750	40	DTW - 6	STW - 6	DW	PSF	
10	Cox's Bazar			9	10	N/D	N/D	N/D	N/D	20	30	0	0	780	N/D	DTW - 6	STW - 6	DW	PSF	
11				11	10	N/D	N/D	0	0	10	2	0	0	750	N/D	DTW - 6	STW - 6	PSF	RWHS	
12				11	10	N/D	N/D	N/D	N/D	50	20	0	0	750	N/D	DTW - 6	STW - 6	PSF	RWHS	
13				11	10	N/D	N/D	N/D	N/D	20	4	0	0	800	N/D	DTW - 6	STW - 6	PSF	RWHS	
14				N/D	10	N/D	N/D	N/D	N/D	2	3	0	0	750	N/D	DTW - 6	PSF	RWHS	DW	
15				11	10	N/D	N/D	N/D	N/D	10	20	0	0	780	N/D	DTW - 6	STW - 6	DW	PSF	
16				11	10	N/D	N/D	N/D	N/D	2	2	0	0	750	N/D	DTW - 6	STW - 6	PSF	RWHS	
17				N/D	10	N/D	N/D	0	0	2	3	0	0	750	N/D	DTW - 6	PSF	RWHS	DW	
18				N/D	10	N/D	N/D	0	0	2	10	0	0	750	N/D	DTW - 6	PSF	RWHS	DW	
19				10	10	N/D	N/D	N/D	N/D	30	20	0	0	750	N/D	DTW - 6	STW - 6	DW	PSF	

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

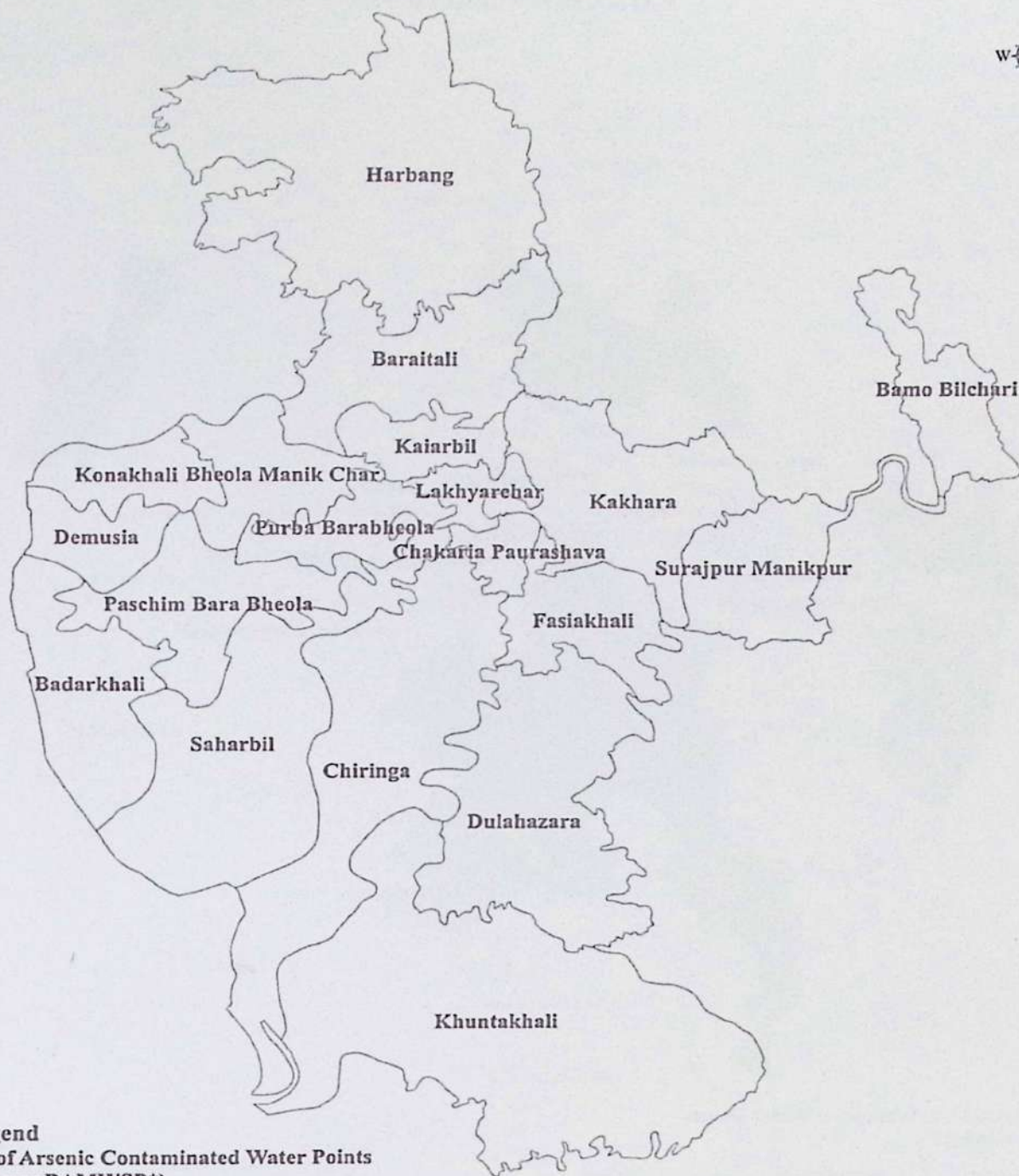
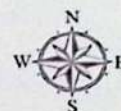
N/D = No Data



Arsenic Contamination Map - 1

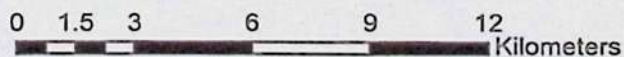
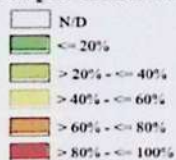
District: Cox's Bazar

Upazilla: Chakaria

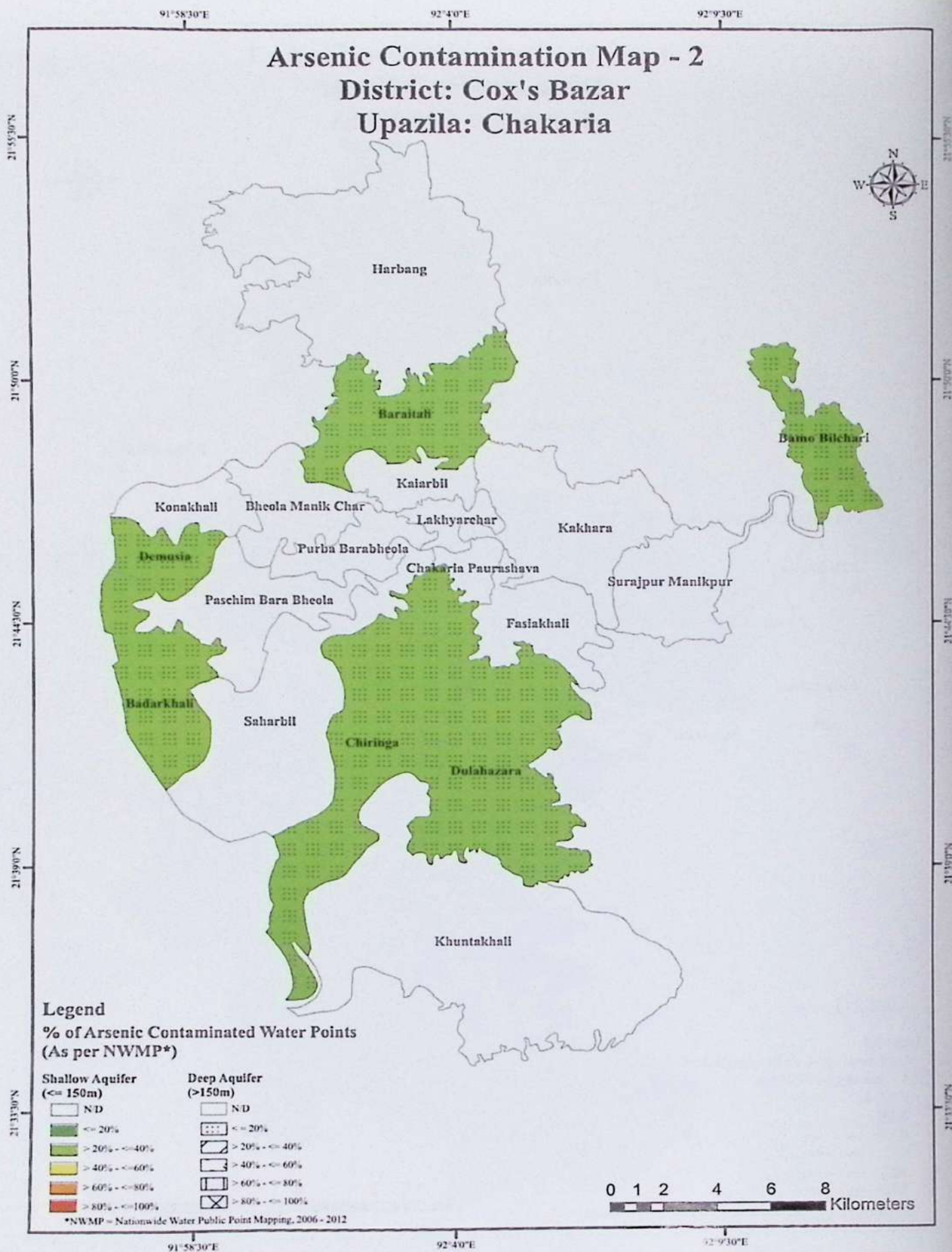


Legend

% of Arsenic Contaminated Water Points
(As per BAMWSP*)



*BAMWSP = Bangladesh Arsenic Mitigation Water Supply Project, 2003



Chloride Concentration Map

District: Cox's Bazar

Upazila: Chakaria

21°55'30"N
21°50'0"N
21°44'30"N
21°39'0"N
21°33'30"N

21°55'30"N
21°50'0"N
21°44'30"N
21°39'0"N
21°33'30"N

91°58'30"E

92°40"E

92°53'30"E

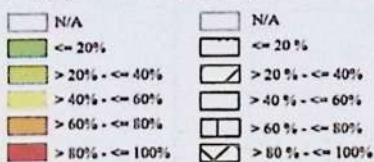
91°58'30"E

92°40"E

92°53'30"E



Legend
% of Chloride Contamination
Shallow Aquifer (<= 150m) Deep Aquifer (> 150m)



0 1.25 2.5 5 7.5 10 Kilometers

Table for mapping union wise Water Supply Technology
Cox's Bazar Sadar, Cox's Bazar

SL	District	Upazila	Union	Lowest Water Table of the Union in the year 2017, ft	As contaminant on Status (% of Contaminant TW as per NAMIC, BAMVSP 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	12	13	14	15	16	17	18	19	20	21	22
				STW DTW	STW	STW	STW	STW	STW	STW	STW	STW	STW	STW	STW	STW	STW	STW	STW	STW	STW
1			Islampur	25	19	26.67	21.43	25	10	0	0	0	0	0	0	0	0	0	0	0	0
2			Pokkhali	N/D	23	0	0	N/D	2	N/D	0	N/D	0	N/D	0	N/D	0	N/D	0	N/D	0
3			Islamabad	26	18	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
4			Idgaon	21	N/D	0	0	10	N/D	0	0	0	0	0	0	0	0	0	0	0	0
5			Jalalabad	18	15	0	0	1	8	0	0	0	0	0	0	0	0	0	0	0	0
6			Chaufaldandi	N/D	26	0	0	N/D	5	0	0	0	0	0	0	0	0	0	0	0	0
7			Bharuakhali	40	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8			Patali Machhuakhali	12	18	0	0	30	4	0	0	0	0	0	0	0	0	0	0	0	0
9			Khurushkul	18	N/D	0	0	15	N/D	12	0	0	0	0	0	0	0	0	0	0	0
10			Jhilwanja	22	20	0	0	20	10	3	1	0	0	0	0	0	0	0	0	0	0

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

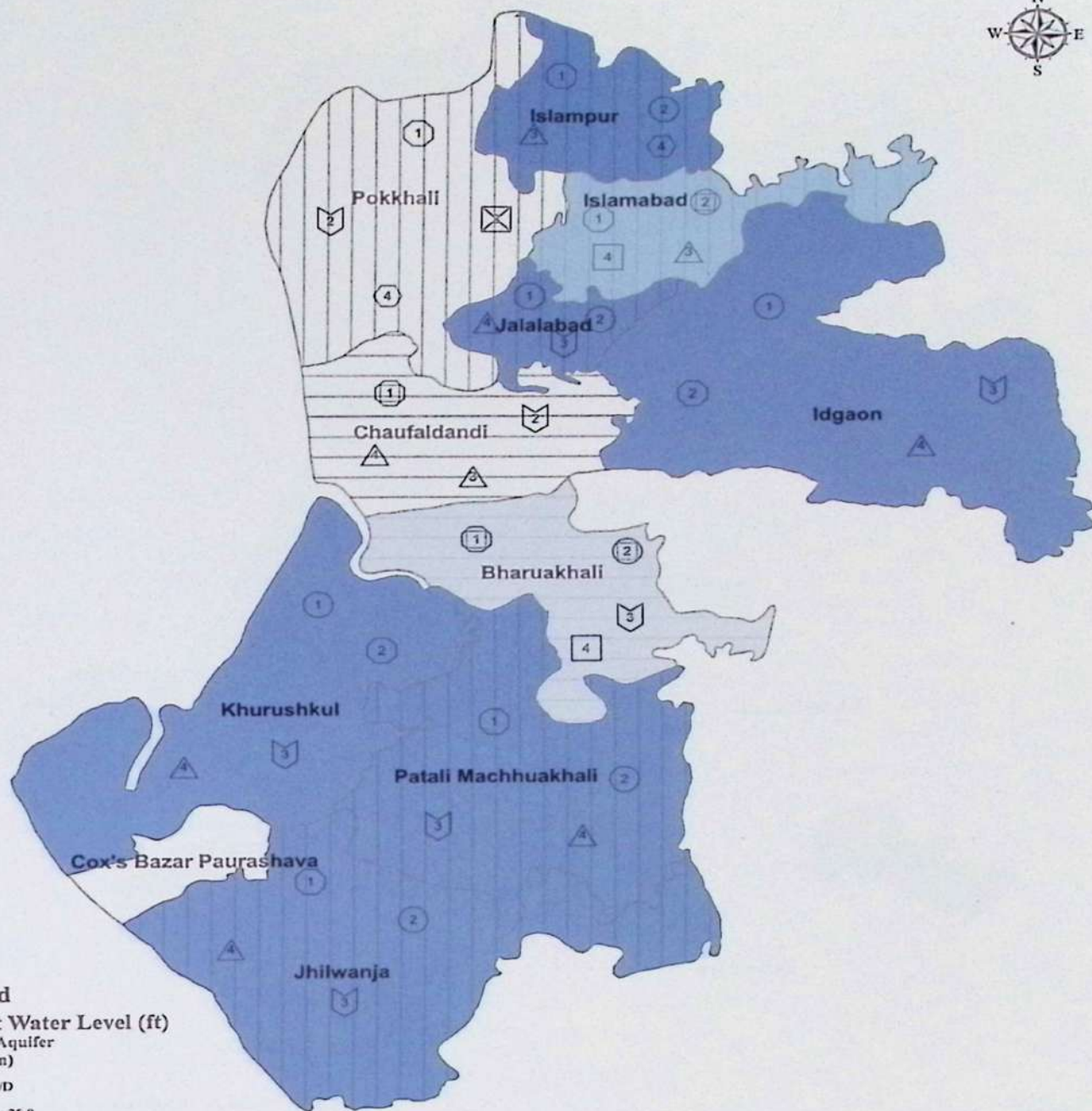
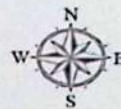
91°58'30"E

92°40'E

Technological Option Map

District: Cox's Bazar

Upazilla: Cox's Bazar Sadar



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
- DTW - Tara
- △ DW
- ⊞ SST/VSST
- STW - 6
- STW - Tara
- PSF
- RWHS

Technological Priority

- 1st Priority - 1
- 2nd Priority - 2
- 3rd Priority - 3
- 4th Priority - 4

0.51 2 3 4
Kilometers

91°58'30"E

92°40'E

Arsenic Contamination Map - 1

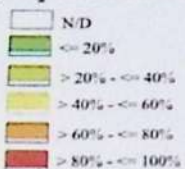
District: Cox's Bazar

Upazilla: Cox's Bazar Sadar

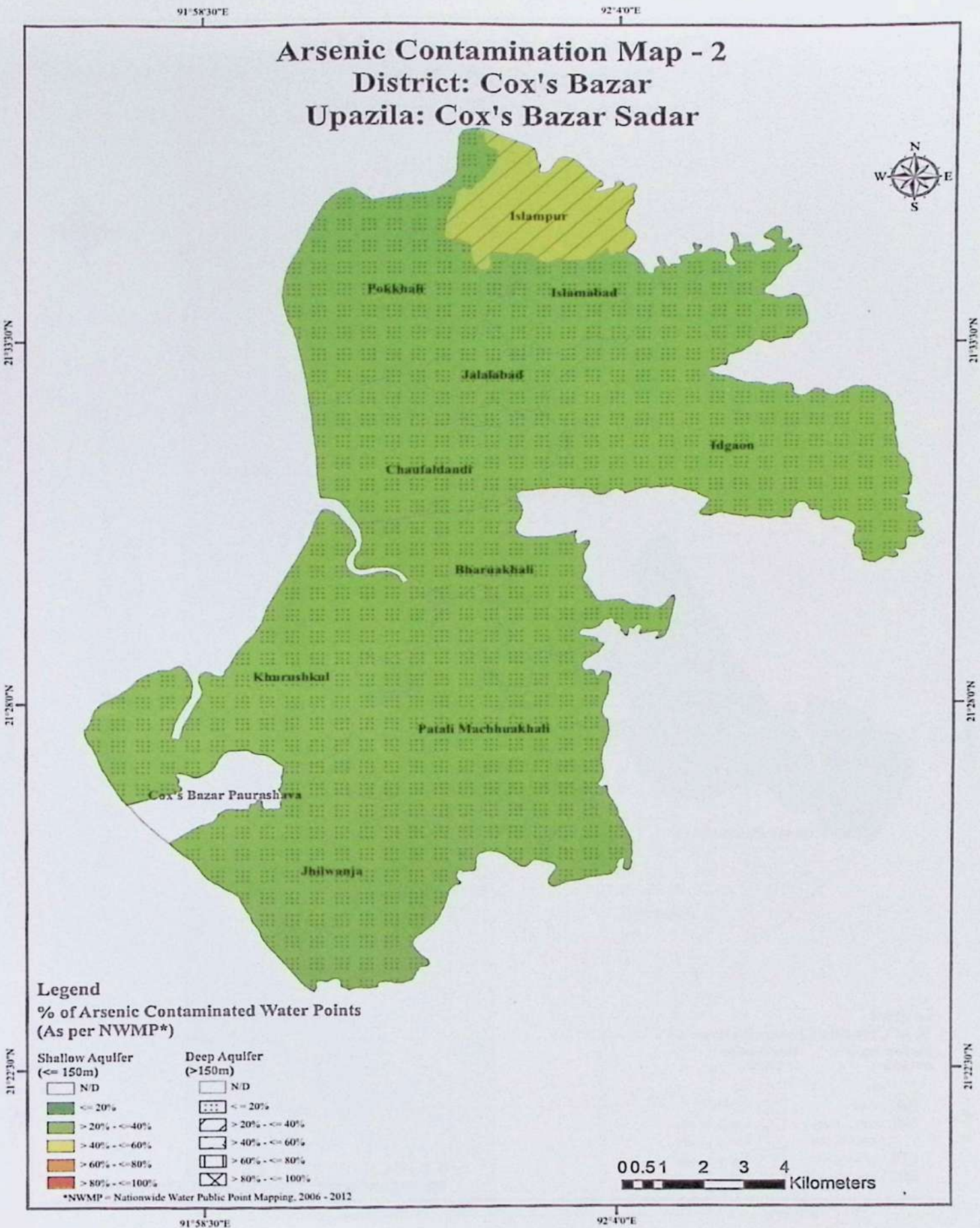


Legend

% of Arsenic Contaminated Water Points
(As per BAMWSP*)



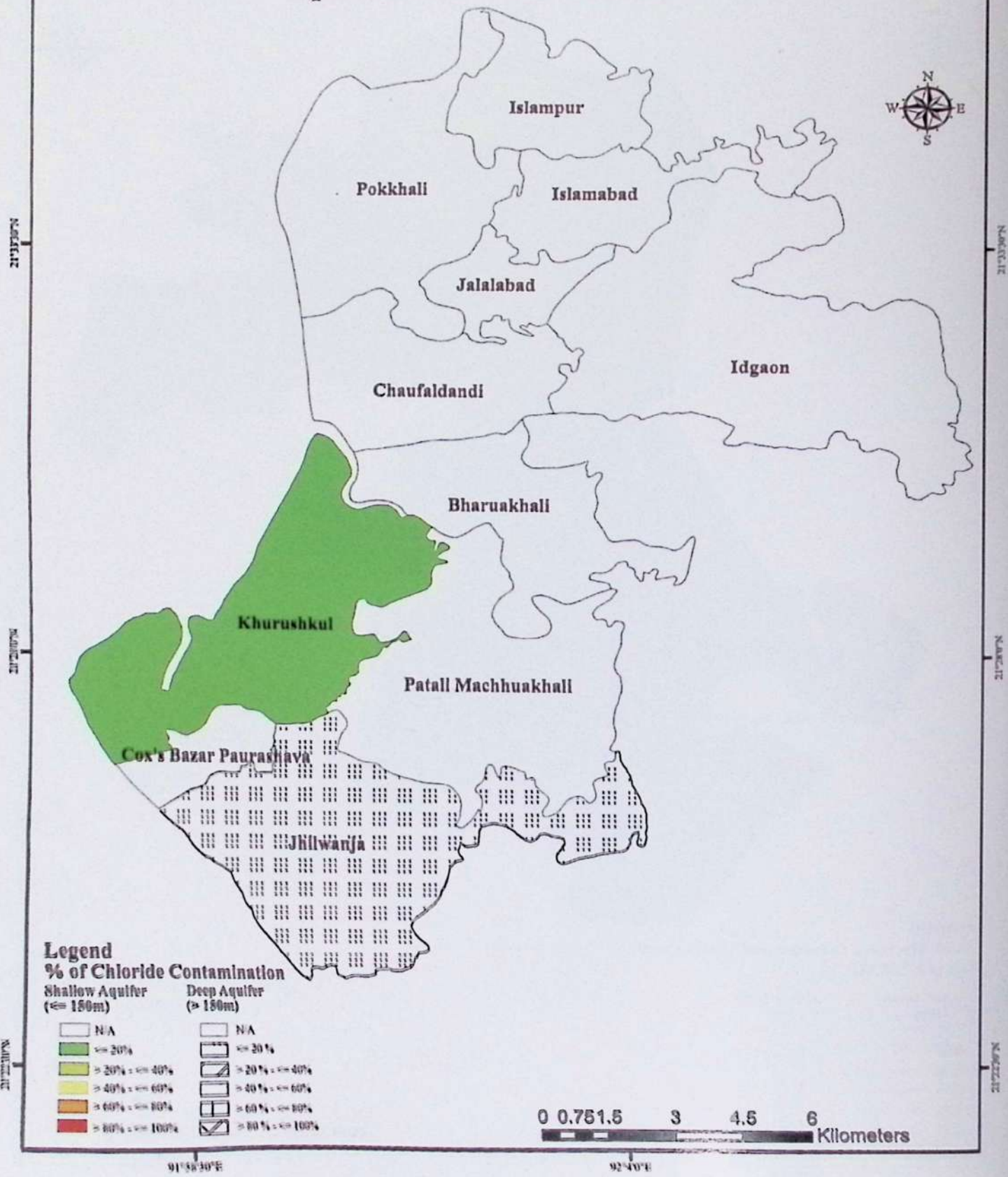
*BAMWSP = Bangladesh Arsenic Mitigation Water Supply Project, 2003



Chloride Concentration Map

District: Cox's Bazar

Upazila: Cox's Bazar Sadar



**Table for mapping union wise Water Supply Technology
Kutubdia, Cox's Bazar**

SL	District	Upazila	Union	Lowest Water Table in the year 2017, ft	As contaminated on Status (% of Contaminated TW as per NAMIC, BAMWSP 2003)	As Contaminated on 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
									8	9	10	1	2	3	4	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Cox's Bazar	Kutubdia	Uttar Dhurung	N/D	N/D	0	N/D	2	N/D	0	N/D	DTW - 6	PSF	RWHS	DW	
2			Dakshin Dhurung	N/D	N/D	N/D	N/D	10	N/D	0	N/D	DTW - 6	PSF	RWHS	DW	
3			Lemsikhali	N/D	N/D	0	N/D	20	N/D	0	N/D	DTW - 6	PSF	RWHS	DW	
4			Kaiyabil	12	N/D	N/D	20	N/D	200	N/D	N/D	DTW - 6	PSF	RWHS	DW	
5			Baraghop	12	9	5.26	20	20	200	0	850	DTW - 6	STW - 6	PSF	RWHS	
6			Ali Akbar Deil	12	9	0	5	4	200	0	850	DTW - 6	STW - 6	PSF	RWHS	

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

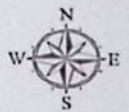
91°47'30"E

91°53'0"E

Technological Option Map

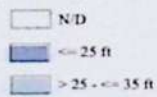
District: Cox's Bazar

Upazilla: Kutubdia

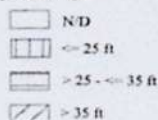


Legend

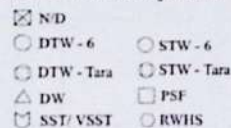
Lowest Water Level (ft)
Shallow Aquifer
(≤ 150 m)



Deep Aquifer
(> 150 m)

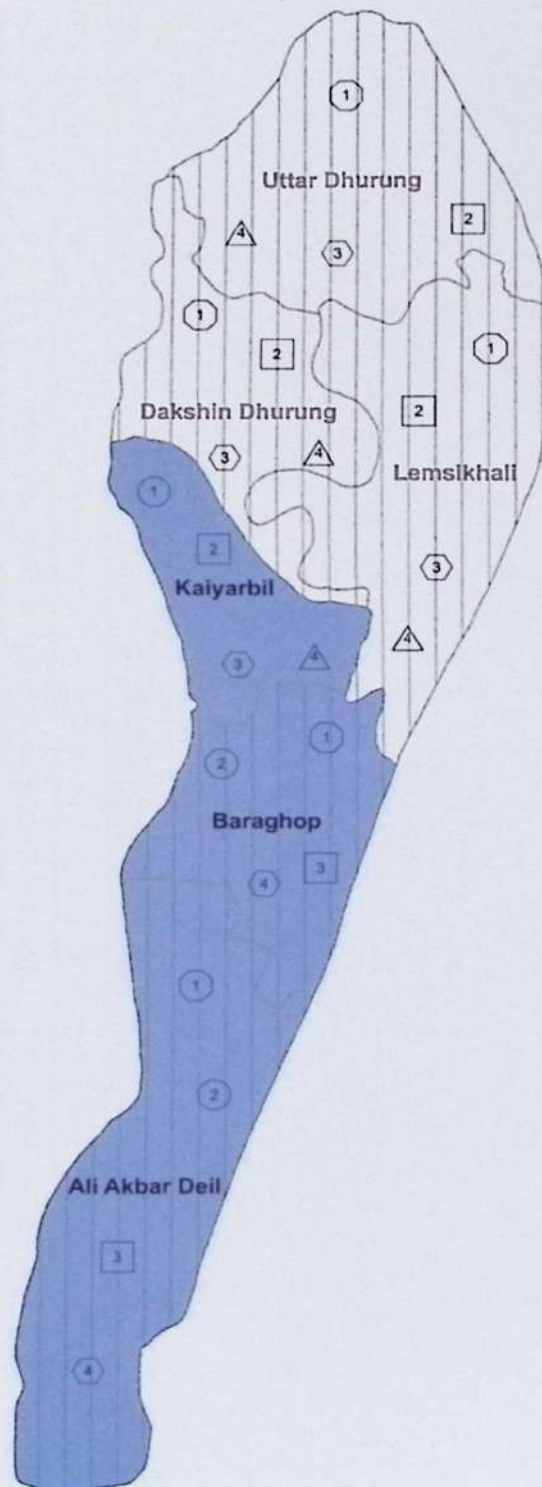


Water Point Options



Technological Priority

1st Priority - 1
2nd Priority - 2
3rd Priority - 3
4th Priority - 4



0.47595 1.9 2.85 3.8
Kilometers

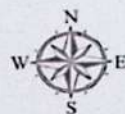
91°47'30"E

91°53'0"E

Arsenic Contamination Map - 1

District: Cox's Bazar

Upazilla: Kutubdia



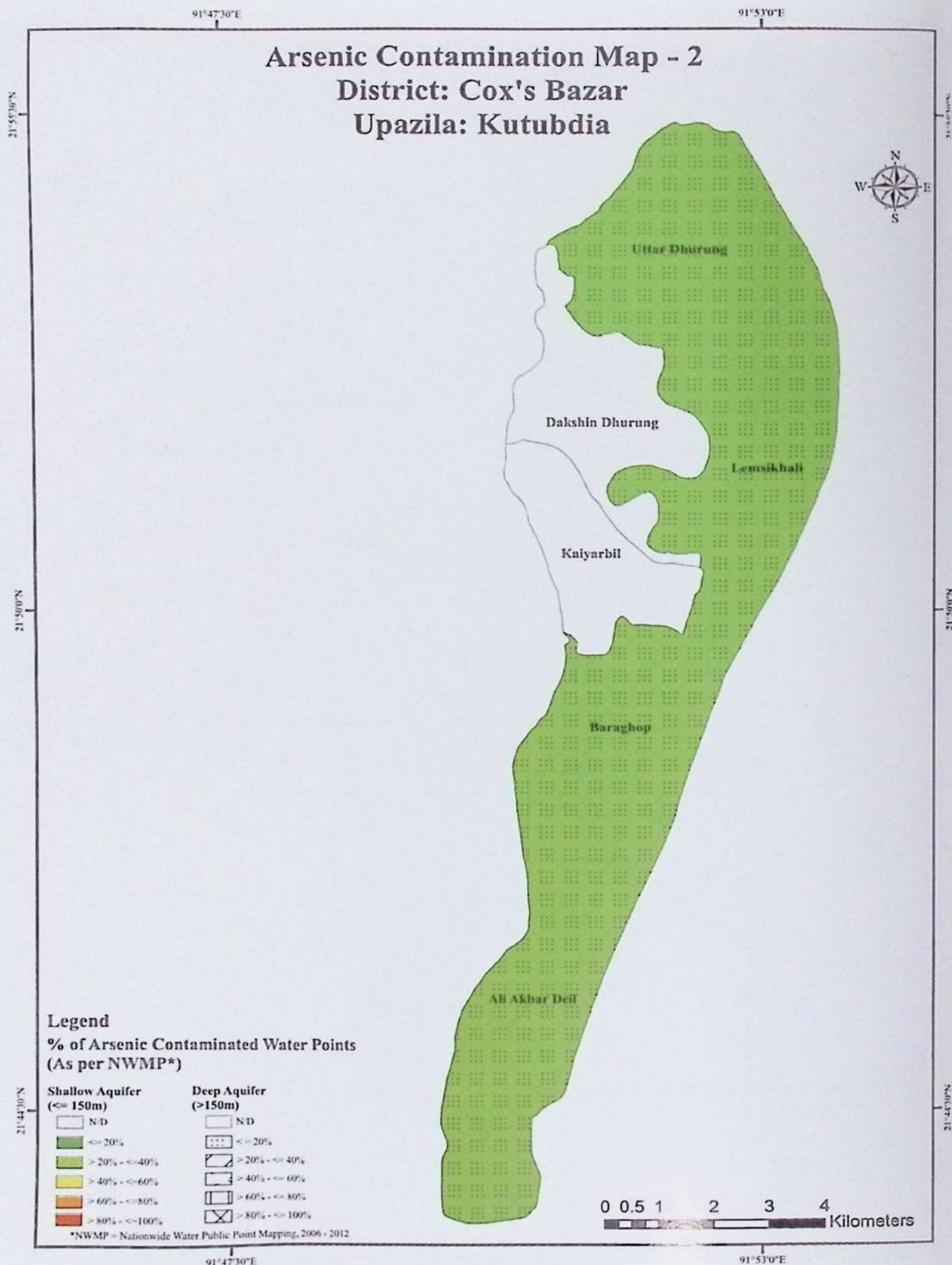
Legend

% 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 0.5 1 2 3 4 Kilometers



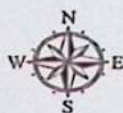
91°47'30"E

91°53'0"E

Chloride Concentration Map

District: Cox's Bazar

Upazila: Kutubdia



Uttar Dhurung

Dakshin Dhurung

Lemsikhali

Kaiyabil

Baraghop

Ali Akbar Deil

Legend

% of Chloride Contamination

Shallow Aquifer (<= 150m)

Deep Aquifer (> 150m)

N/A	N/A
<= 20%	<= 20%
> 20% - <= 40%	> 20% - <= 40%
> 40% - <= 60%	> 40% - <= 60%
> 60% - <= 80%	> 60% - <= 80%
> 80% - <= 100%	> 80% - <= 100%

0 0.75 1.5 3 4.5 6 Kilometers

91°47'30"E

91°53'0"E

Table for mapping union wise Water Supply Technology
Maheshkhali, Cox's Bazar

SL	District	Upazila	Union	Lowest Water Table of the Union in the year 2017, ft	As contaminated on Status (% of Contaminant TV as per NAMIC, BANWSP 2003)	As Contaminated on Status (> 50ppb) (% of DPHE Water Points Installed during 2006-12)	Fe Problem (> 50ppm) (% 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	12	13	14	15	16	17	18
1			Kutubjom	8	N/D	0	90	0	200	650	N/D	DW	DTW - 6	DTW - 6	DTW - 6	DTW - 6	RWHS
2			Bara Maheshkhali	7	N/D	0	40	0	200	450	50	DW	DTW - 6	DTW - 6	DTW - 6	DTW - 6	PSF
3			Chhota Maheshkhali	8	N/D	N/D	20	0	200	N/D	50	DW	DTW - 6	DTW - 6	DTW - 6	DTW - 6	PSF
4			Saflapur	10	N/D	0	90	0	200	750	50	DW	DTW - 6	DTW - 6	DTW - 6	DTW - 6	PSF
5	Cox's Bazar	Maheshkhali	Hoanok	8	N/D	0	90	0	N/D	700	50	DW	DTW - 6	DTW - 6	DTW - 6	DTW - 6	PSF
6			Kalarmarchhara	8	N/D	0	N/D	0	N/D	750	50	DW	DTW - 6	DTW - 6	DTW - 6	DTW - 6	PSF
7			Matarbari	8	N/D	0	N/D	0	200	750	N/D	DW	DTW - 6	DTW - 6	DTW - 6	DTW - 6	RWHS
8			Dhalghata	8	N/D	0	N/D	0	N/D	650	N/D	DW	DTW - 6	DTW - 6	DTW - 6	DTW - 6	DW
9			Maheshkhali Paurashava	10	N/D	N/D	10	50	200	650	50	DW	DTW - 6	DTW - 6	DTW - 6	DTW - 6	PSF

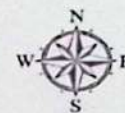
Note: Iron and Chloride contamination derived based on people's perception, 2014

N/D = No Data

Technological Option Map

District: Cox's Bazar

Upazilla: Maheshkhali



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
- DTW - Tara
- △ DW
- SST/VSST
- STW - 6
- STW - Tara
- PSF
- RWHS

Technological Priority

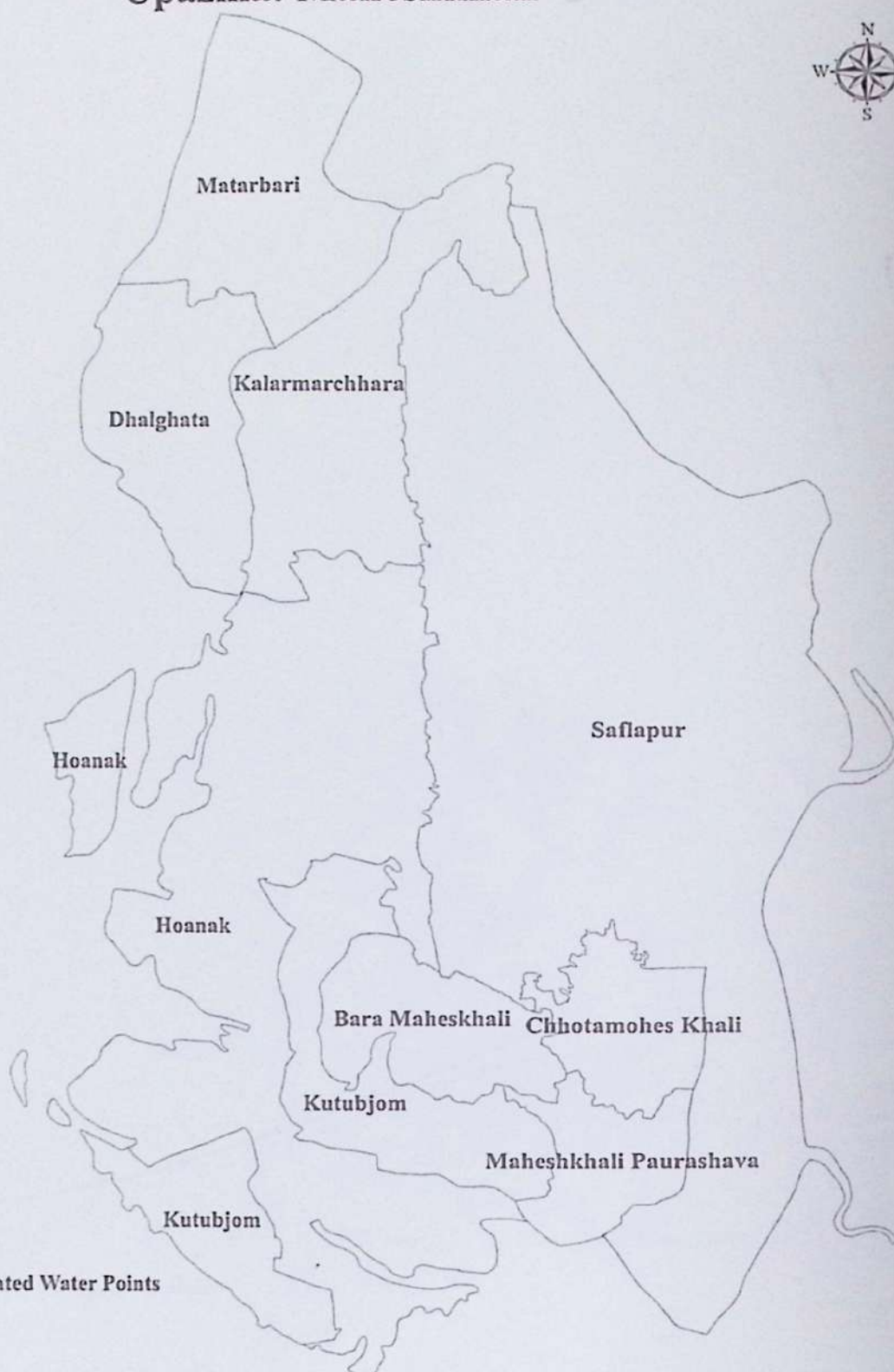
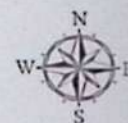
- 1st Priority - 1
- 2nd Priority - 2
- 3rd Priority - 3
- 4th Priority - 4

00.51 2 3 4
Kilometers

Arsenic Contamination Map - 1

District: Cox's Bazar

Upazilla: Maheshkhali

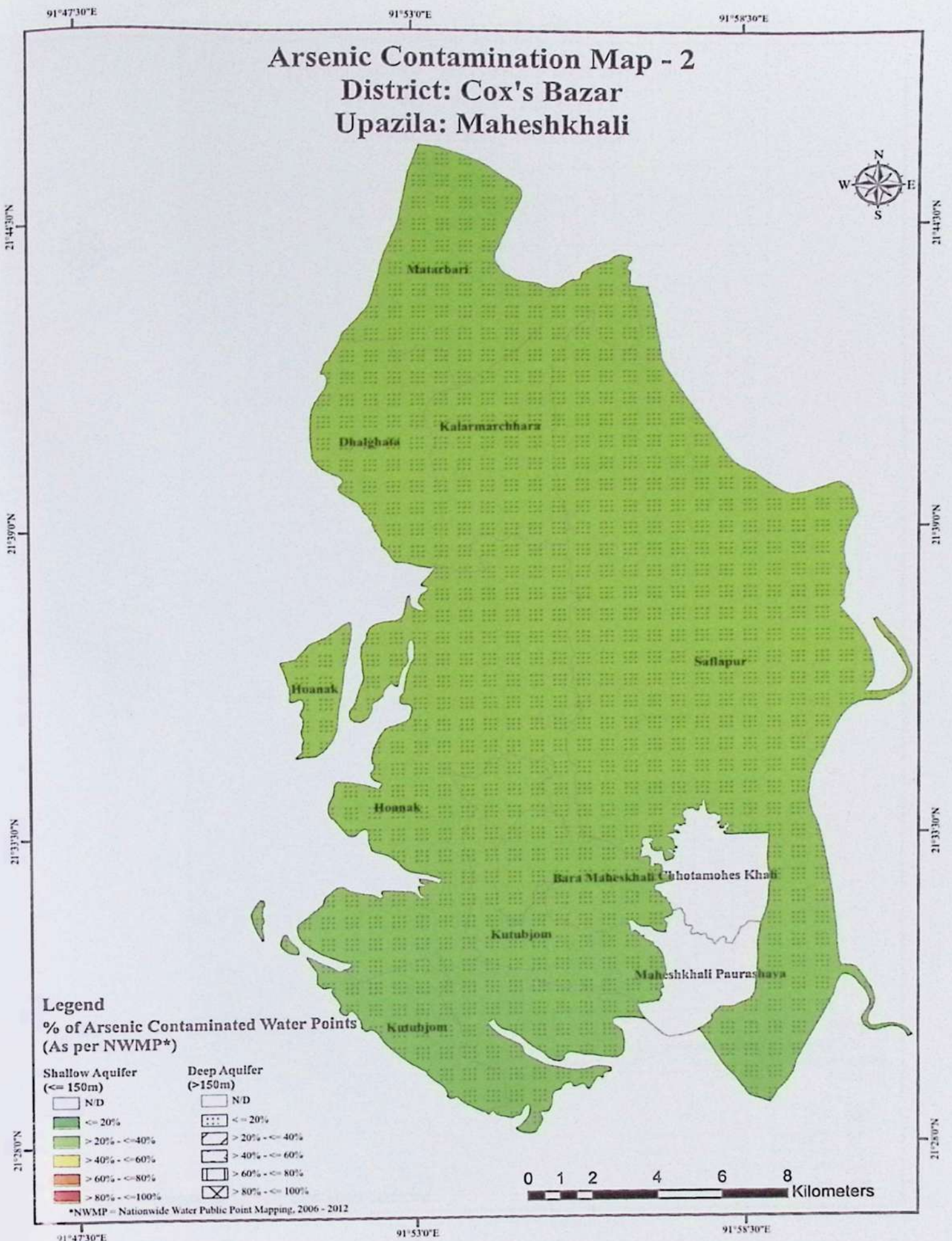


Legend
% of Arsenic Contaminated Water Points
(As per BAMWSP*)

- N/D
- <= 20%
- > 20% - <= 40%
- > 40% - <= 60%
- > 60% - <= 80%
- > 80% - <= 100%

*BAMWSP - Bangladesh Arsenic Mitigation Water Supply Project, 2003

0 0.75 1.5 3 4.5 6
 Kilometers



Chloride Concentration Map

District: Cox's Bazar

Upazila: Maheshkhali

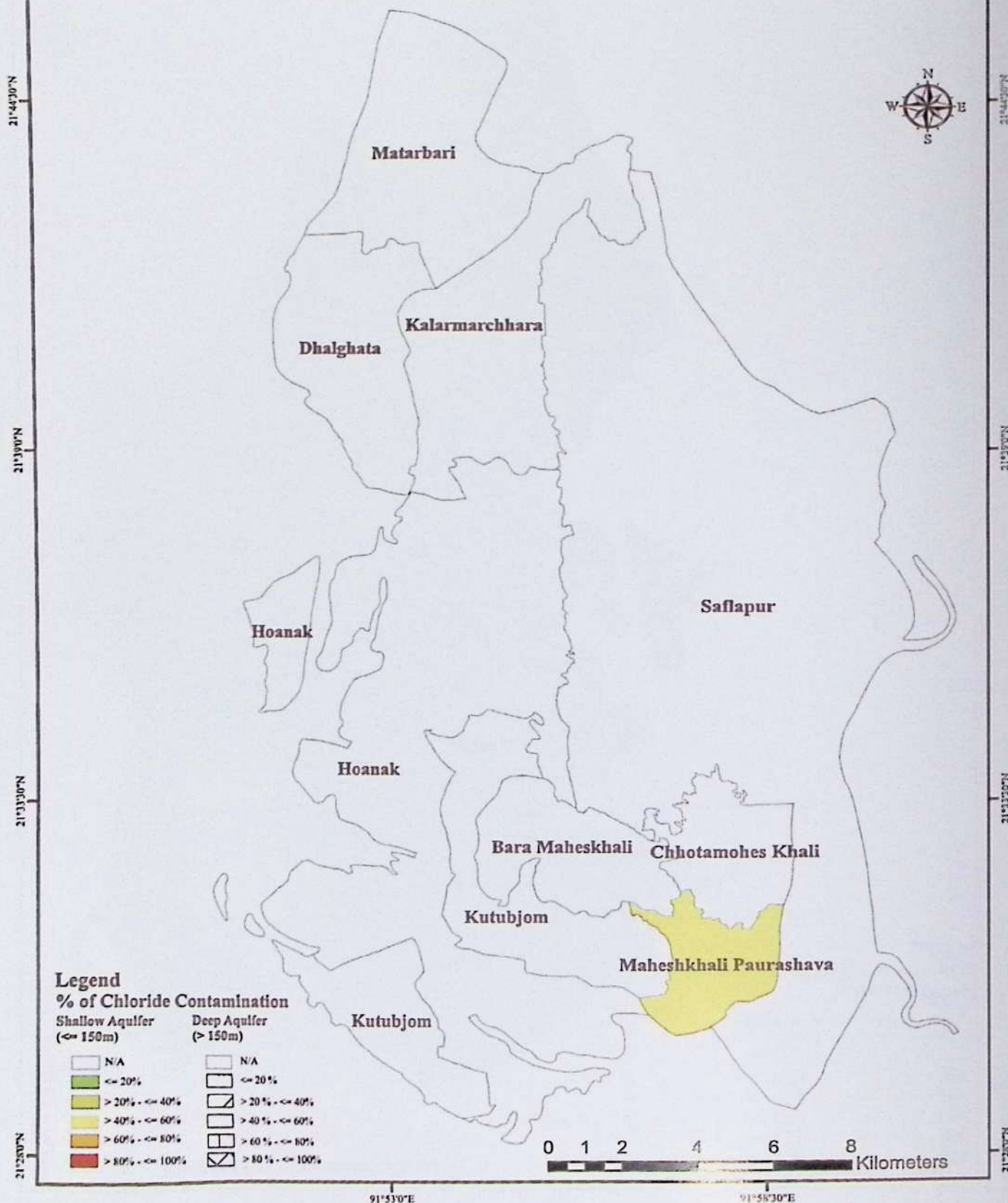
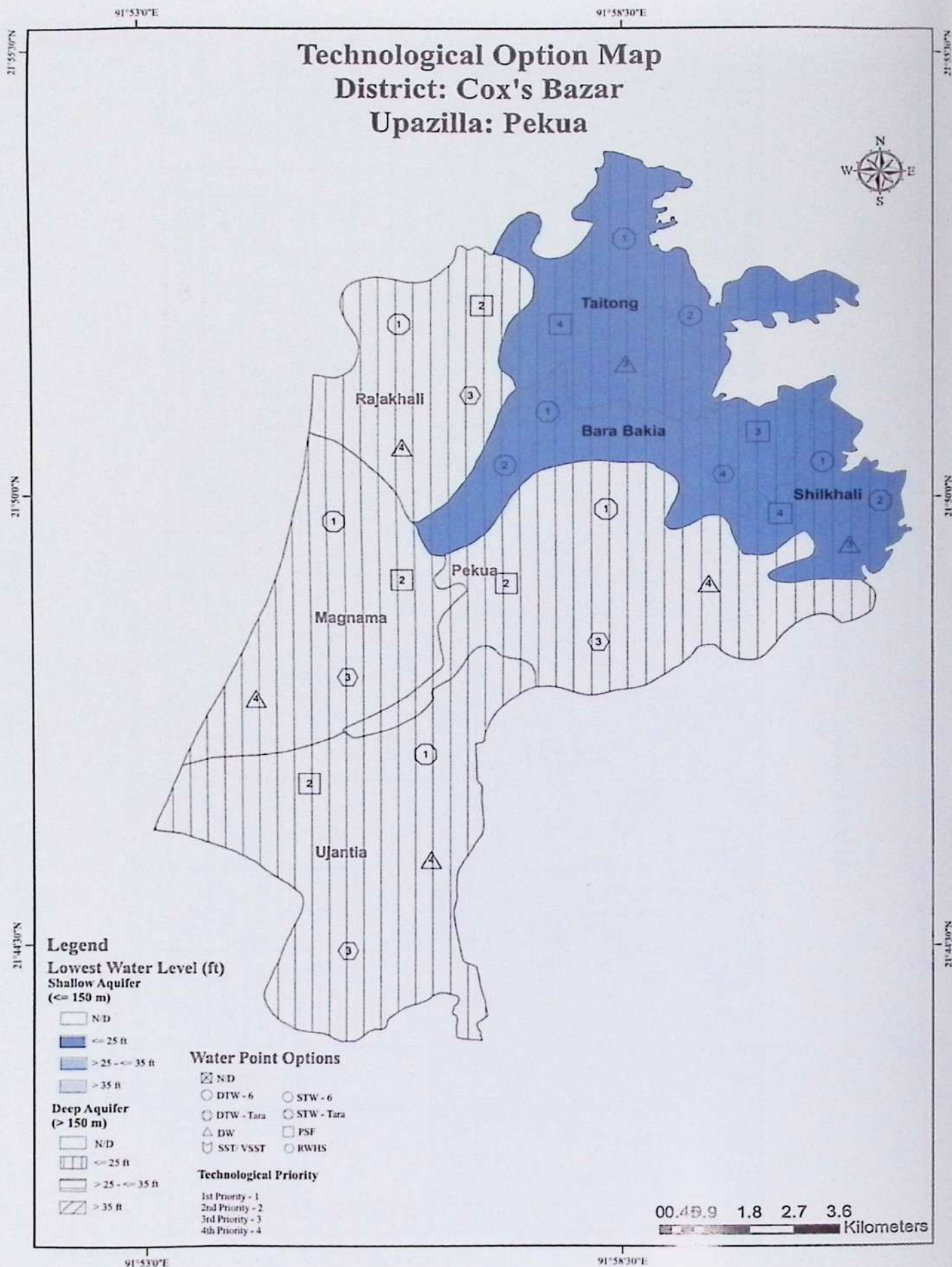


Table for mapping union wise Water Supply Technology
Pekua, Cox's Bazar

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				
										10					11			
										STW	DTW	STW	DTW		STW	DTW	STW	DTW
1	Cox's Bazar	Pekua	Rajakhali	N/D	N/D	0	0	N/D	2	N/D	1	DTW - 6	PSF	RWHS	DW			
2				11	6	N/D	0	0	0	60	40	0	0	DTW - 6	STW - 6	DW	PSF	
3				11	6	N/D	0	0	0	60	30	0	0	DTW - 6	STW - 6	PSF	RWHS	
4				11	6	N/D	0	0	0	60	30	0	0	DTW - 6	STW - 6	DW	PSF	
5				N/D	10	N/D	0	0	N/D	5	N/D	0	0	DTW - 6	PSF	RWHS	DW	
6				N/D	10	N/D	0	0	N/D	60	N/D	0	0	DTW - 6	PSF	RWHS	DW	
7				N/D	10	N/D	N/D	20	N/D	10	N/D	600	N/D	DTW - 6	PSF	RWHS	DW	

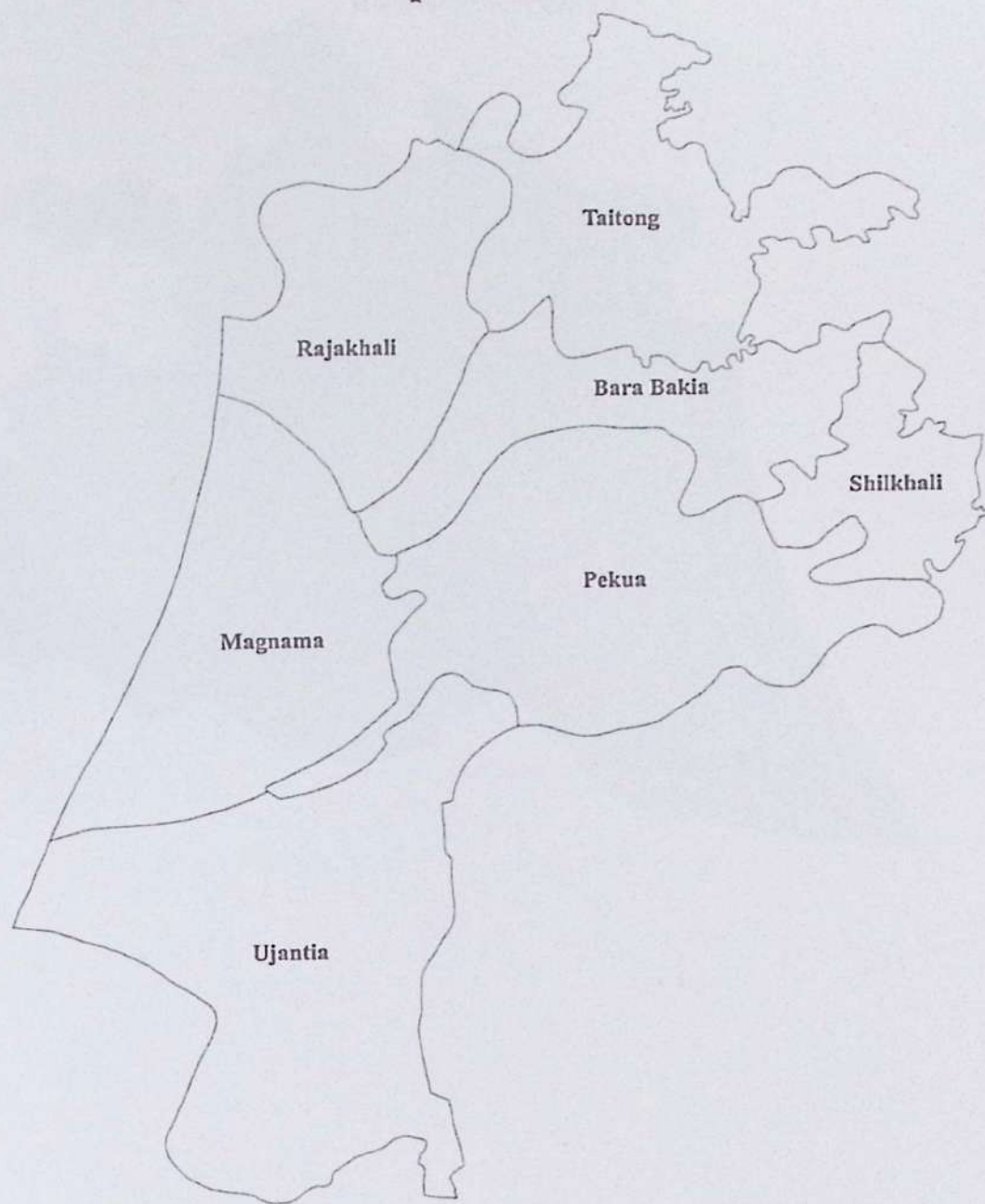
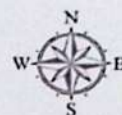
Note: Iron and Chloride contamination derived based on people's perception, 2014
N/D = No Data



Arsenic Contamination Map - 1

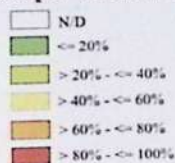
District: Cox's Bazar

Upazilla: Pekua

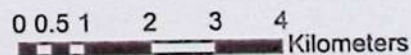


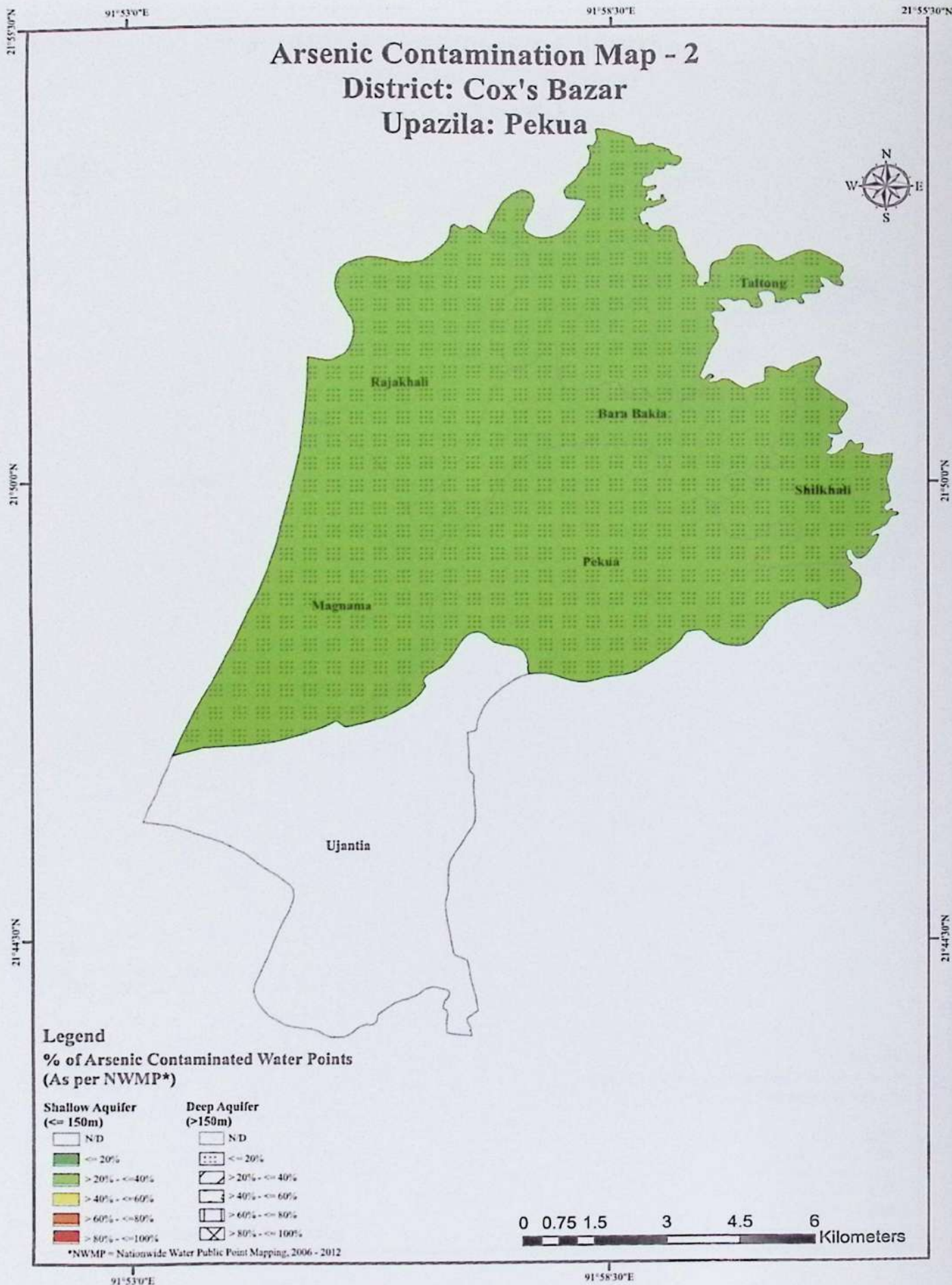
Legend

% of Arsenic Contaminated Water Points
(As per BAMWSP*)



*BAMWSP = Bangladesh Arsenic Mitigation Water Supply Project, 2003





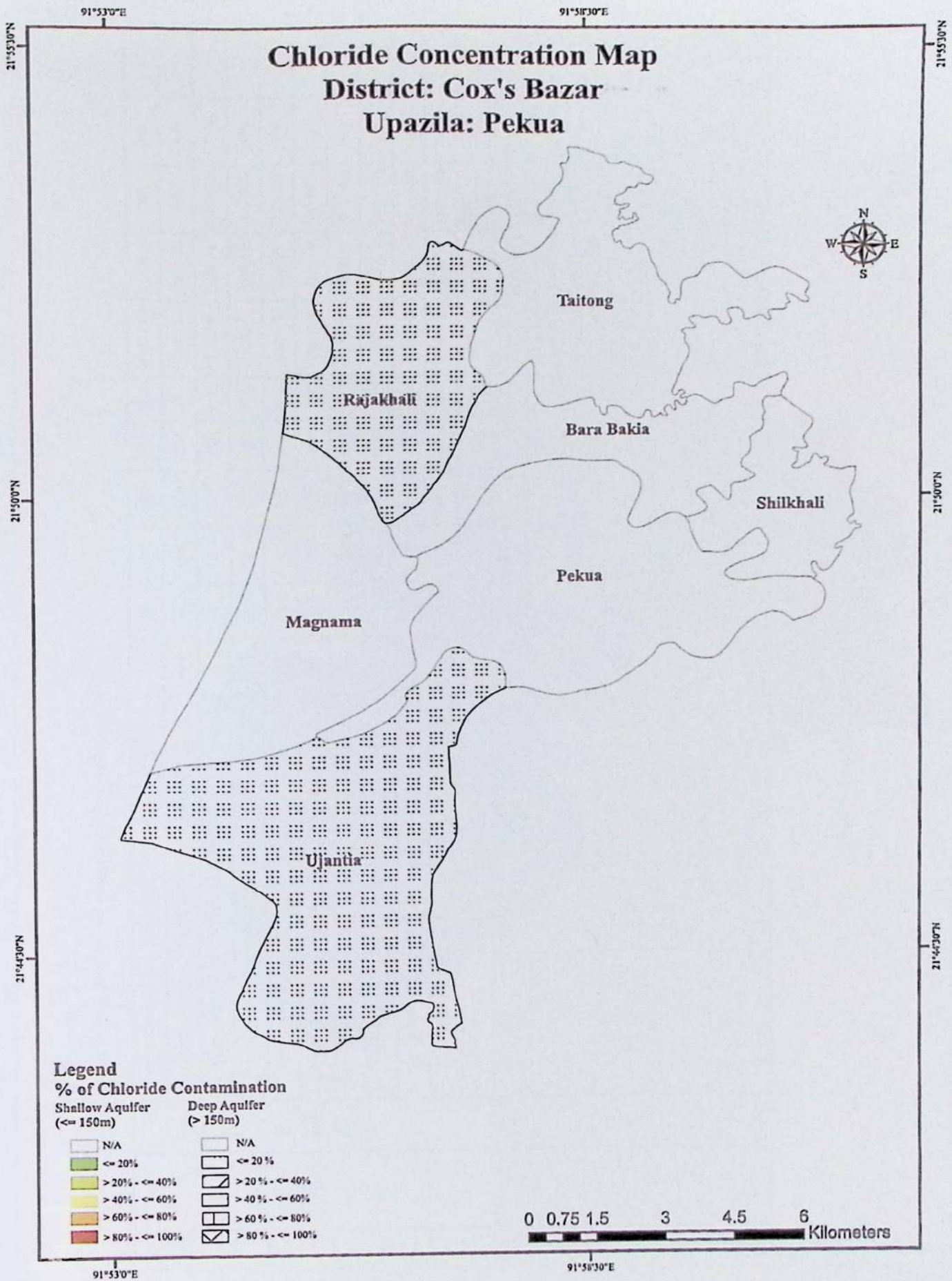
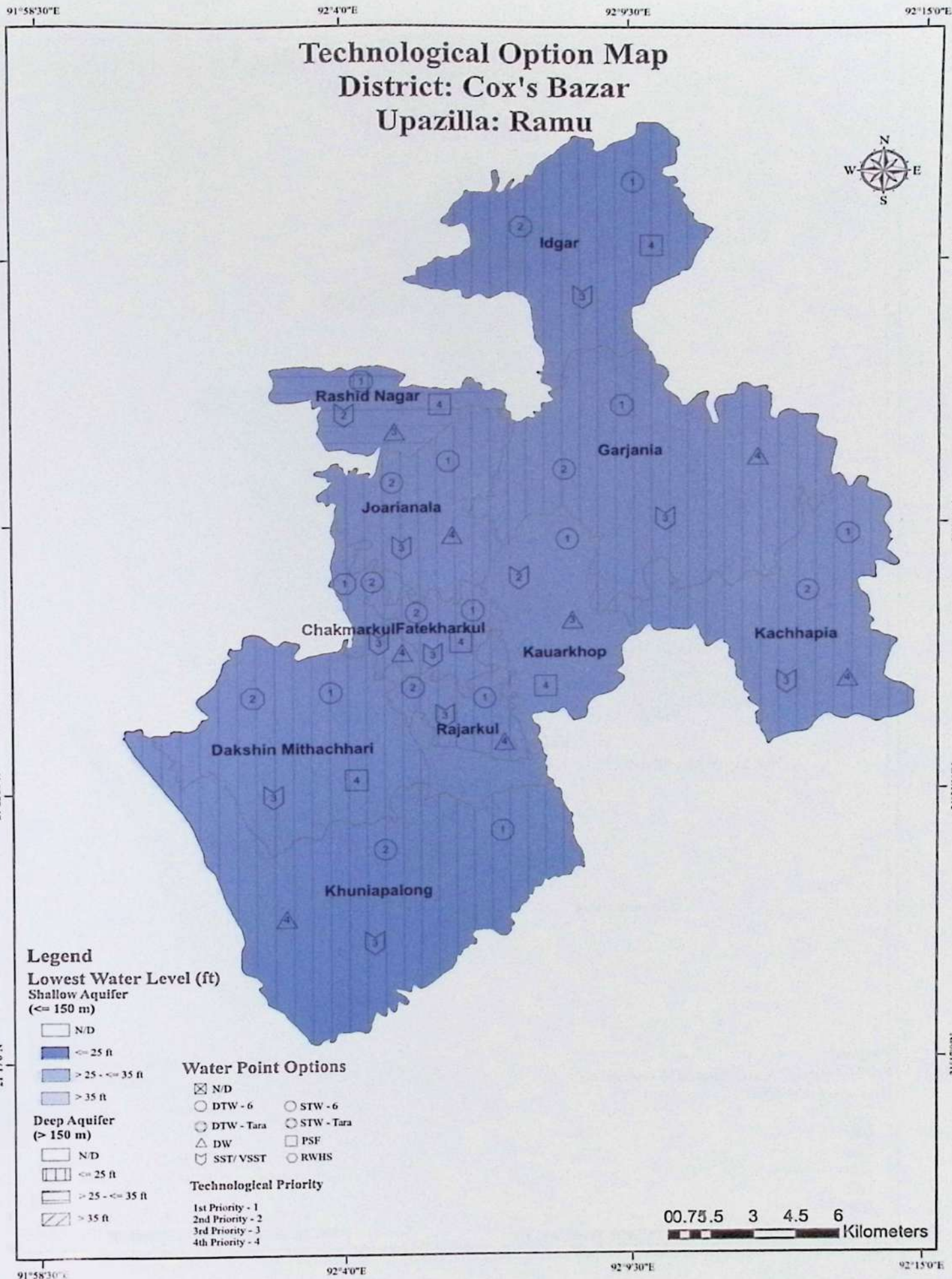


Table for mapping union wise Water Supply Technology
Ramu, Cox's Bazar

SL	District	Upazila	Union	Lowest Water Table of the Union in the year 2017, ft	As Contaminant on Status (% of Contaminant TW as per BAMWSP 2003)	As Contaminant on 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
							STW	DTW	STW	DTW	STW	DTW	DW	11		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1			Fatekharkul	15	N/D	0	10	12	0	0	280	850	N/D	DTW - 6	STW - 6	DTW - 6
2			Joarianala	15	N/D	0	8	7	0	0	220	850	N/D	DTW - 6	STW - 6	DTW - 6
3			Idgar	15	N/D	0	2	0	0	0	200	850	55	DTW - 6	STW - 6	DTW - 6
4			Rajarkul	16	N/D	N/D	6	1	0	0	220	800	N/D	DTW - 6	STW - 6	DTW - 6
5			Dakshin Mithachhari	21	N/D	N/D	10	75	0	N/A	280	N/D	N/D	DTW - 6	STW - 6	DTW - 6
6	Cox's Bazar	Ramu	Kachhapia	19	N/D	0	3	25	0	0	200	900	55	DTW - 6	STW - 6	DTW - 6
7			Khuniapalong	20	N/D	0	3	0	0	0	150	900	55	DTW - 6	STW - 6	DTW - 6
8			Garjanja	18	N/D	0	2	0	0	0	150	900	N/D	DTW - 6	STW - 6	DTW - 6
9			Chakmarkul	14	N/D	0	10	2	0	0	300	800	N/D	DTW - 6	STW - 6	DTW - 6
10			Kauarkhop	19	N/A	N/D	8	N/A	0	N/A	100	N/A	55	STW - 6	STW - 6	STW - 6
11			Rashid Nagar	20	N/D	0	2	3	50	0	N/D	900	N/D	DTW - Tara	STW - 6	DTW - 6

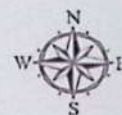
Note: Iron and Chloride contamination derived based on people's perception, 2014
N/D = No Data



Arsenic Contamination Map - 1

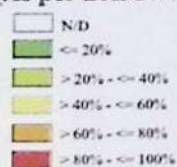
District: Cox's Bazar

Upazilla: Ramu

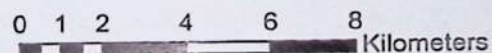


Legend

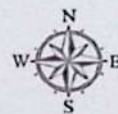
% of Arsenic Contaminated Water Points
(As per BAMWSP*)



*BAMWSP = Bangladesh Arsenic Mitigation Water Supply Project, 2003



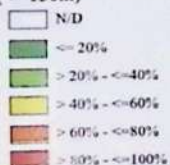
Arsenic Contamination Map - 2 **District: Cox's Bazar** **Upazila: Ramu**



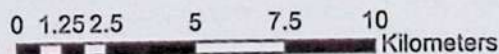
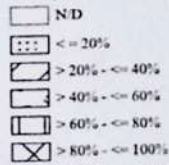
Legend

**% of Arsenic Contaminated Water Points
 (As per NWMP*)**

**Shallow Aquifer
 (<= 150m)**



**Deep Aquifer
 (>150m)**



*NWMP = Nationwide Water Public Point Mapping, 2006 - 2012

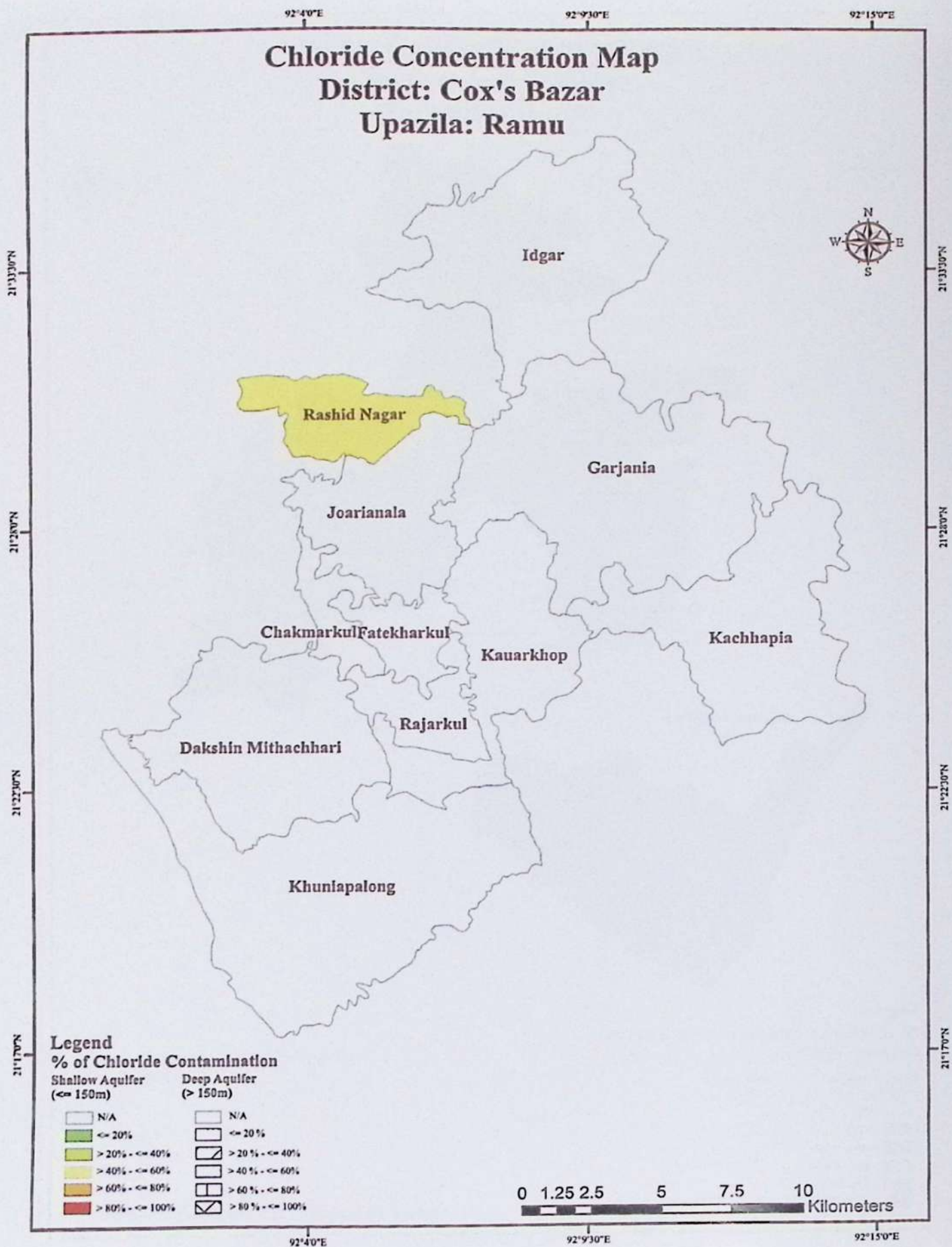
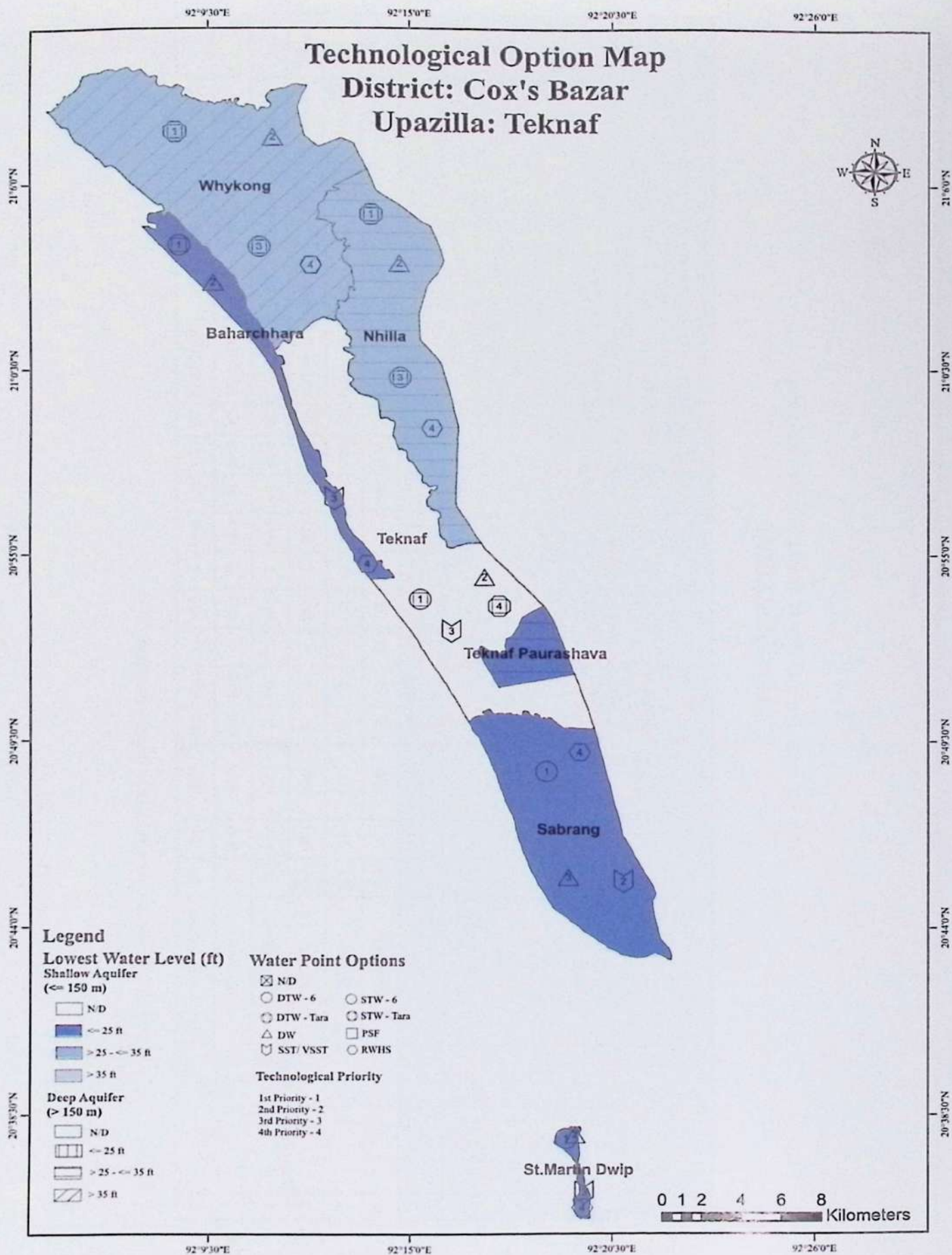


Table for mapping union wise Water Supply Technology
Teknaf, Cox's Bazar

SL	District	Upazila	Union	Lowest Water Table of the Union in the year 2017, ft		As contaminati on Status (% of Contaminat ed TW as per NAMIC, BAMWSP 2003)	As Contaminati on 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							
				5	6						7	8	9	10		11						
1	2	3	4	STW	DTW	STW	DTW	STW	DTW	STW	DTW	1	2	3	4							
1	Cox's Bazar	Teknaf	Whykong	29	45	N/D	0	0	40	23	2	8	180	575	50	DTW - Tara	DW	STW - Tara	RWHS			
2			Nhilla	27	35	N/D	0	0	45	25	3	10	180	575	60	DTW - Tara	DW	STW - Tara	RWHS			
3			Sabrang	20	N/A	N/D	0	0	5	N/A	1	N/A	1	N/A	120	N/A	40	STW - 6	SST/ VSST	DW	RWHS	
4			St.Martin Dwip	18	N/A	N/D	0	0	4	N/A	1	N/A	1	N/A	40	N/A	45	STW - 6	DW	SST/ VSST	RWHS	
5			Baharchhara	20	N/A	N/D	N/D	3	N/A	2	N/A	40	N/A	45	STW - Tara	DW	SST/ VSST	RWHS				
6			Teknaf Paurashava	25	30	N/D	N/D	23	N/D	1	N/D	400	80	STW - Tara	DW	SST/ VSST	DTW - Tara					

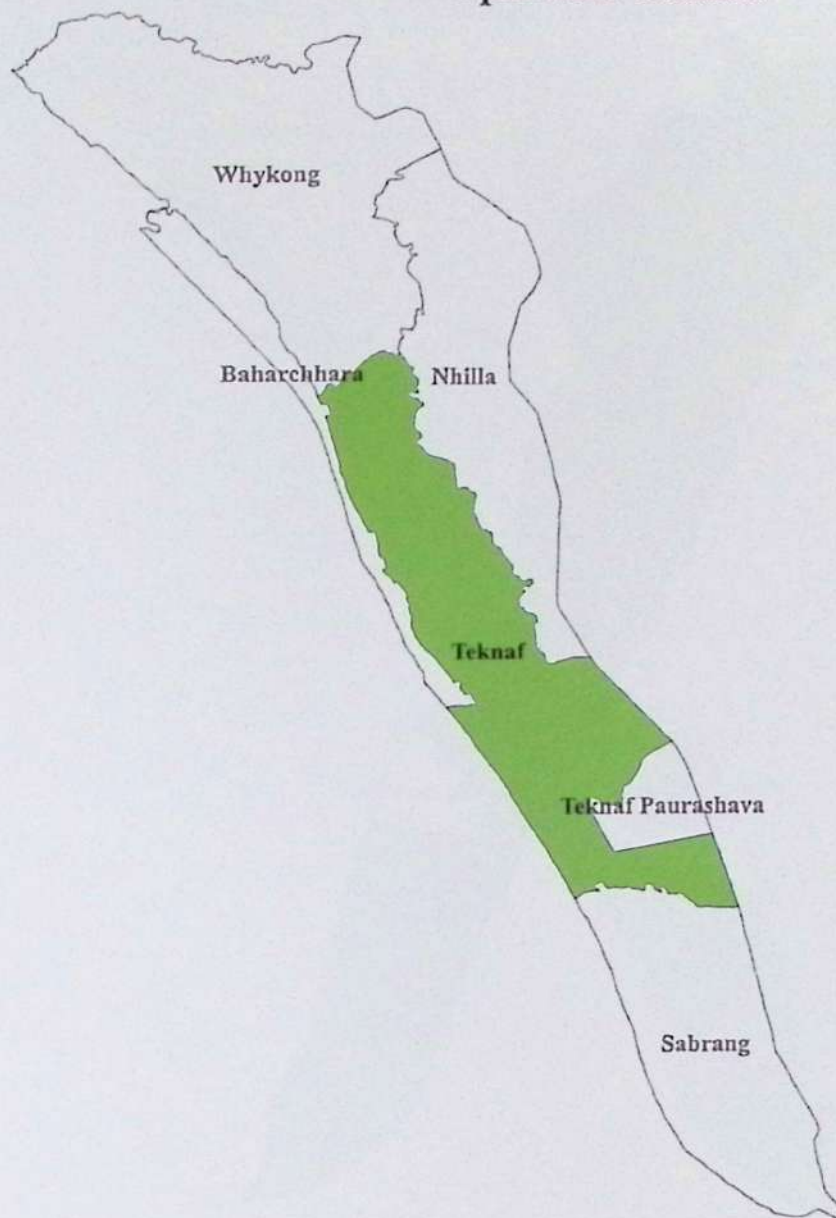
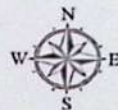
Note: Iron and Chloride contamination derived based on people's perception, 2014
N/D = No Data



Arsenic Contamination Map - 1

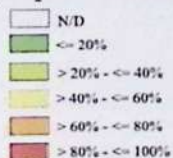
District: Cox's Bazar

Upazilla: Teknaf



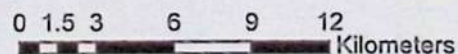
Legend

% of Arsenic Contaminated Water Points
(As per BAMWSP*)



*BAMWSP = Bangladesh Arsenic Mitigation Water Supply Project, 2003

St. Martin Dwip





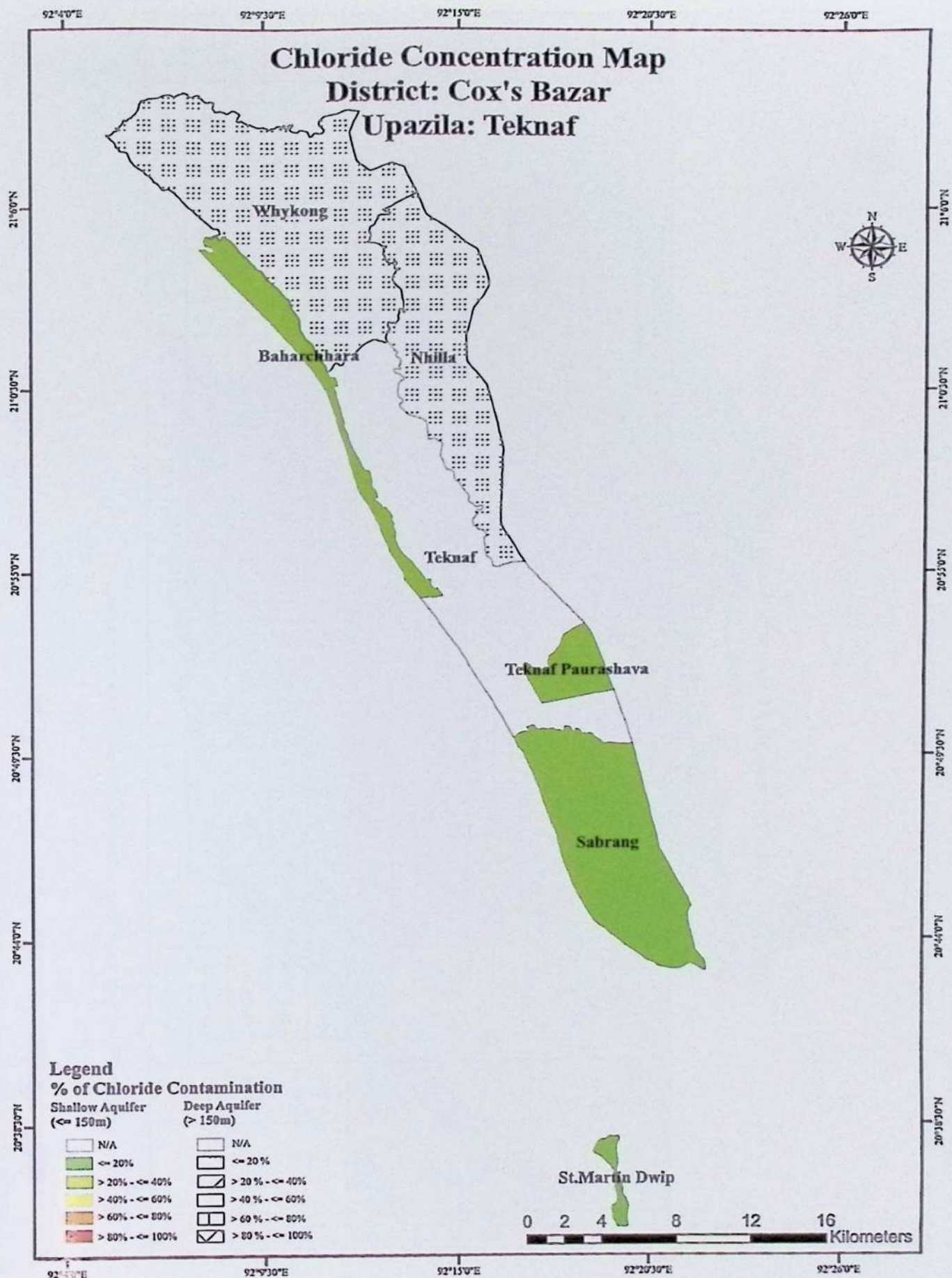
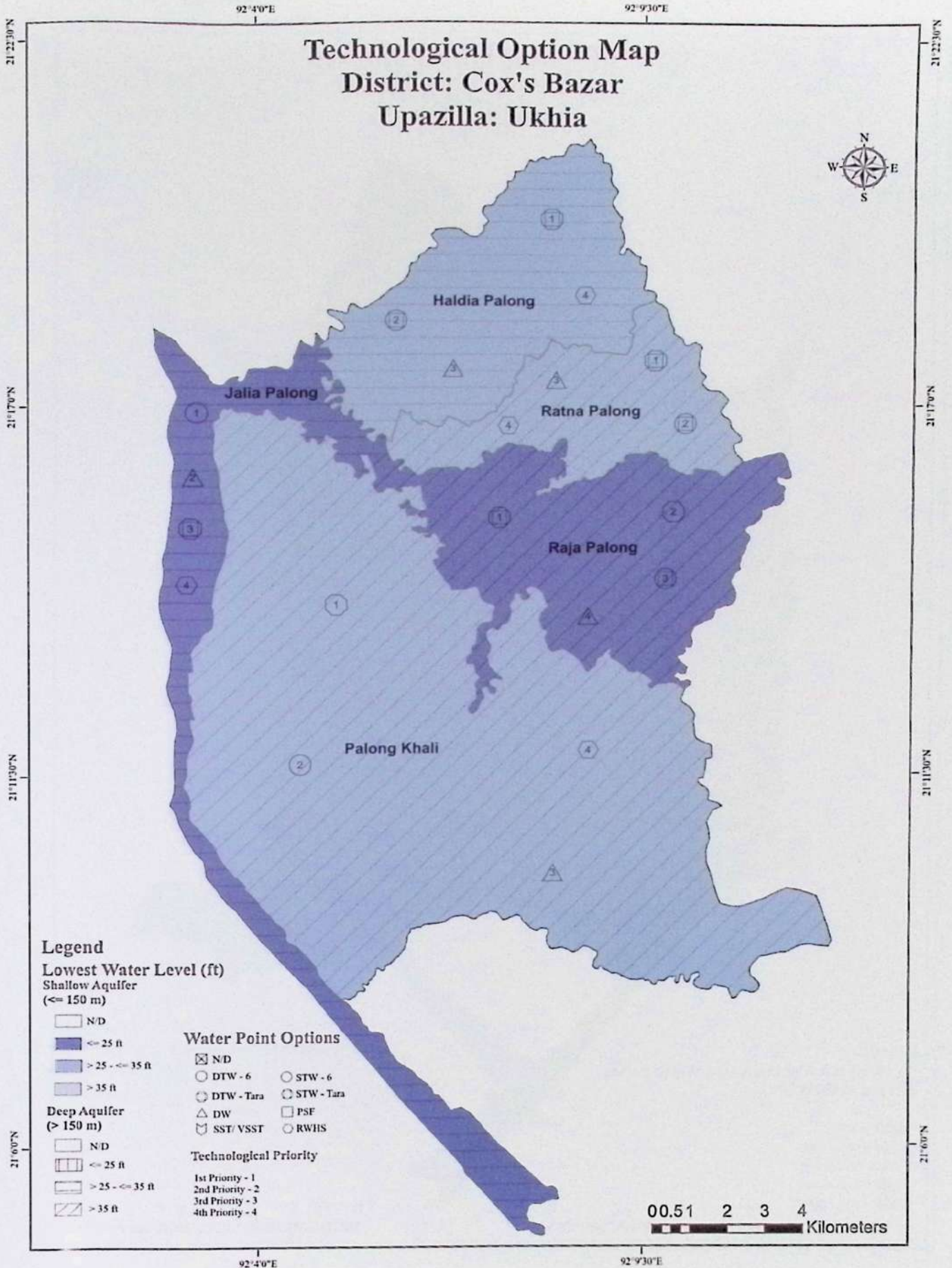


Table for mapping union wise Water Supply Technology
Ukhia, Cox's Bazar

SL	District	Upazila	Union	Lowest Water Table in the year 2017, ft	As contaminati on Status (% of Contaminat ed TW as per NAMIC, BAMWSP 2003)	As Contaminati on 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	DTW	STW	DTW	STW	DTW	STW	DTW	STW	DTW	1	2	3	4		
1	Cox's Bazar	Ukhia	Raja Palong	25	38	0.17	3.7	0	65	10	1	2	220	820	45	DTW - Tara	DTW - 6	STW - Tara	DW		
2			Ratna Palong	30	45	0.86	0	0	40	12	1	5	230	880	45	DTW - Tara	STW - Tara	DW	RWHS		
3			Haldia Palong	27	35	2.93	0	0	52	10	1	5	180	760	45	DTW - Tara	STW - Tara	DW	RWHS		
4			Jalia Palong	25	30	2.96	0	0	30	7	1	0	140	740	55	STW - 6	DW	DTW - Tara	RWHS		
5			Palong Khali	27	42	0	0	0	30	8	1	0	150	750	45	DTW - 6	STW - 6	DW	RWHS		

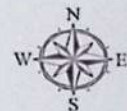
Note: Iron and Chloride contamination derived based on people's perception, 2014
N/D = No Data



Arsenic Contamination Map - 1

District: Cox's Bazar

Upazilla: Ukhia



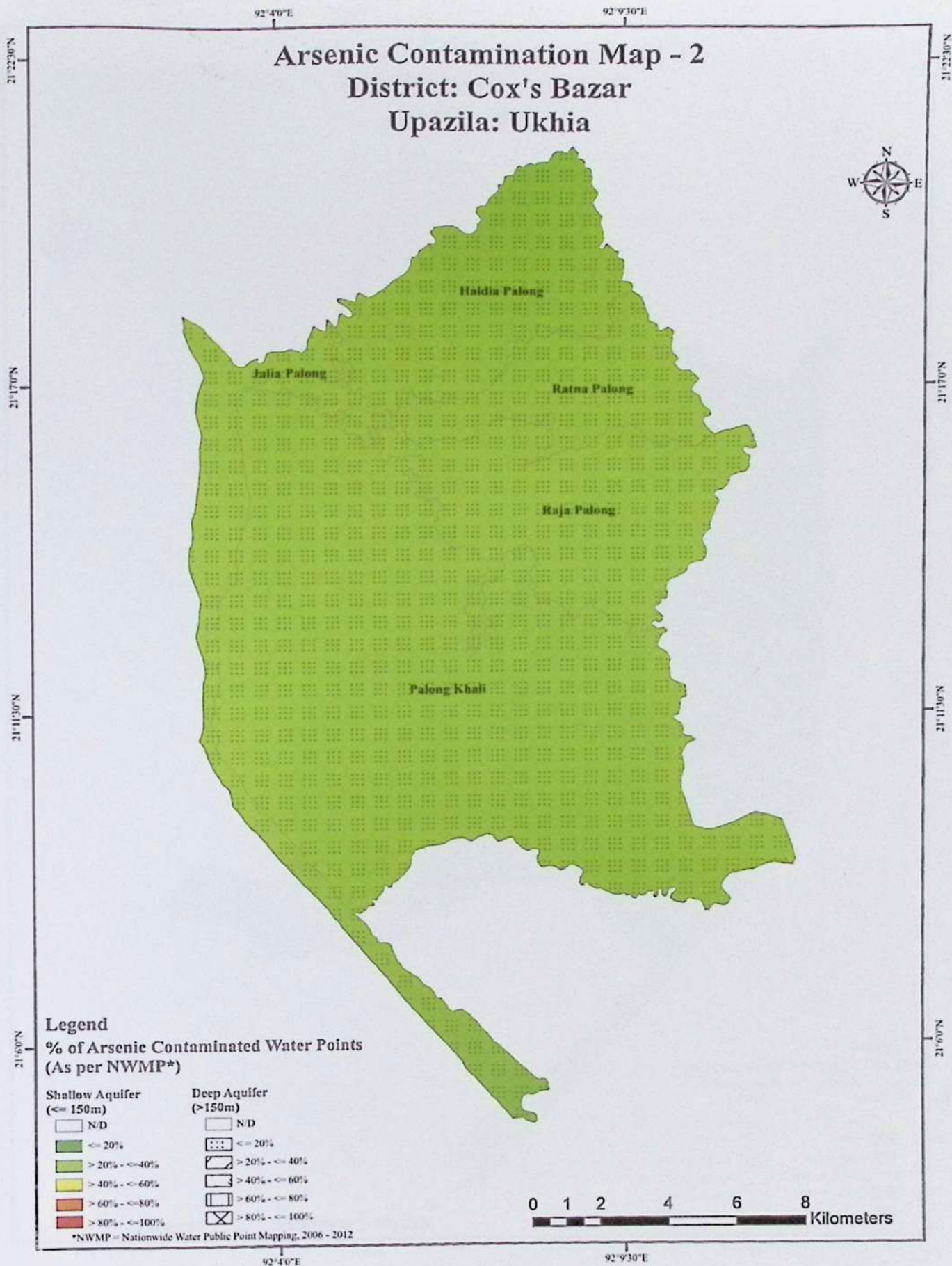
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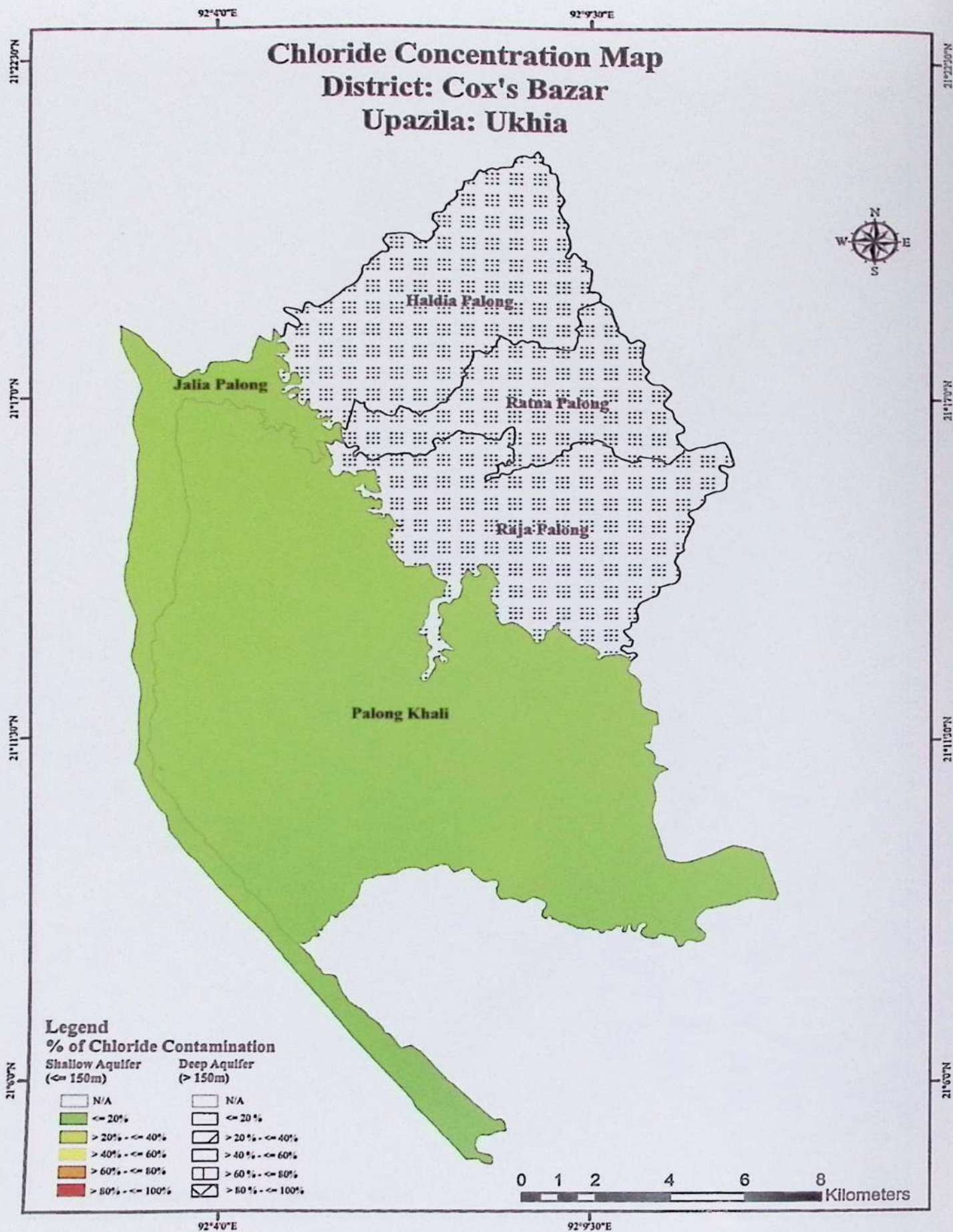
% of Arsenic Contaminated Water Points
(As per BAMWSP*)

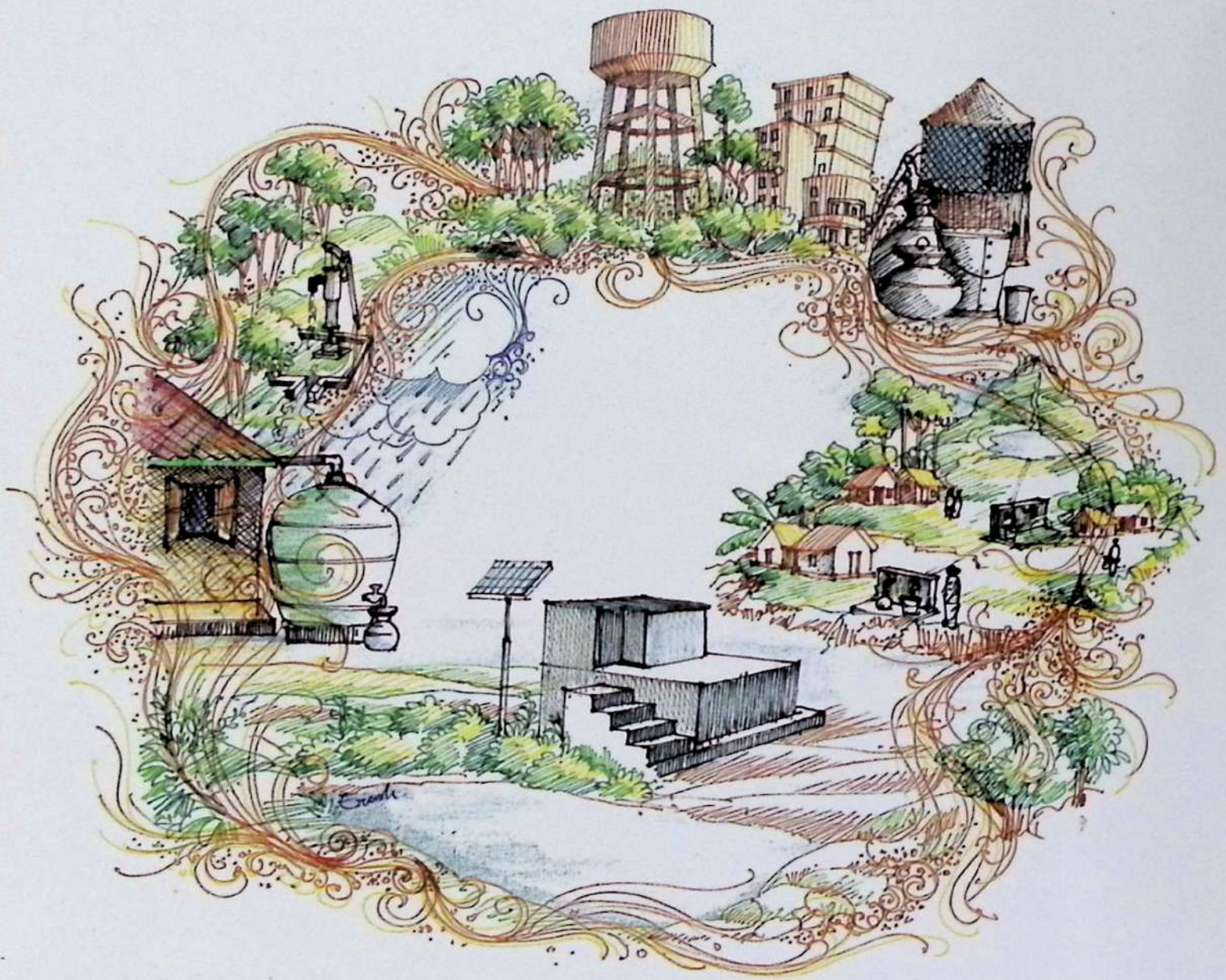
- ND
- <= 20%
- > 20% - <= 40%
- > 40% - <= 60%
- > 60% - <= 80%
- > 80% - <= 100%

*BAMWSP - Bangladesh Arsenic Mitigation Water Supply Project, 2003

0 0.75 1.5 3 4.5 6 Kilometers







Ground Water Circle
Department of Public Health Engineering