MONITORING ARSENIC CONTAMINATION IN DRINKING WATER OF DISTRICT RAHIM YAR KHAN

By

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Abstract

Arsenic contamination was observed in the drinking water of Pakistan in different studies conducted by the national and international agencies. It was observed that southern Punjab and central Sindh are the most affected areas in Pakistan. For the first time in Pakistan UNICEF took initiative and conducted Arsenic Testing Survey in 1998. It was decided to have blanket survey in the affected areas and collect and analyze 24088 water samples from the three Tehsils of district Rahim Yar Khan in the year 2005.

In the present study drinking water sources were monitored in those union councils which were found contaminated with Arsenic in the previous study. 31 union councils were monitored out of total 122 UCs from three tehsils of district Rahim Yar khan covering a total of 599 villages/basties. These were the union councils (except Amin Ghar and Jeetha Bhuta) where arsenic above 50 ppb was found in drinking water sources (2004). Three Tehsils of district Rahim Yar Khan i.e. Rahim Yar Khan, Sadiqabad and Khan Pur were monitored. All the samples were collected by the Health Department field staff with the collaboration of HRDS and supported by UNICEF. Local community was also involved in this activity. Three different Arsenic field testing kits were used i.e. Merck, Wegtech and PCRWR. All the data collected by the field teams was stored in DHO Office Rahim Yar Khan. 23234 samples were tested by the kits in field where as 1141 samples collected for validation and sent out to PCRWR Bahawalpur laboratory.

Out of 7438 samples 25% drinking water sources were found with Arsenic above 50 ppb. 44% of the total tested sources were found to be safe according to WHO guideline value i.e. 10 ppb Arsenic. Bahoudi Pur Qureshian, Rajan Pur Kalan and Murtazabad were the highly contaminated union councils with 44%, 36% and 36% of the total tested sources having Arsenic above 50 ppb respectively. Five percent of total water samples tested in the field was sent to PCRWR laboratory for analysis on AAS to validate the results of field testing kits and the results were found satisfactory.

INTRODUCTION

Background

Arsenic contamination is detected in ground water resources of south Asian countries amongst which Bangladesh and India are the most affected countries. For evaluating the Arsenic contamination in drinking water of Pakistan a study was conducted jointly by PCRWR and UNICEF in 2002-2003 which shows the ground water of southern Punjab and Sindh is contaminated with Arsenic according to WHO guideline values i.e. 10 ppb. It was found that 18% of the samples from Bahawalpur district have Arsenic value above 10 ppb and 3% above than 50ppb. Whereas 18% of samples from district Rahim Yar Khan where found with Arsenic value greater than 10ppb and 2% higher than 50 ppb.

For the first time in Pakistan, UNICEF took initiative and conducted Arsenic Testing Survey in 1998. On the basis of that survey, it became obvious that out of 34 districts of Punjab, districts like Rahim Yar Khan were found having Arsenic contaminated drinking water.

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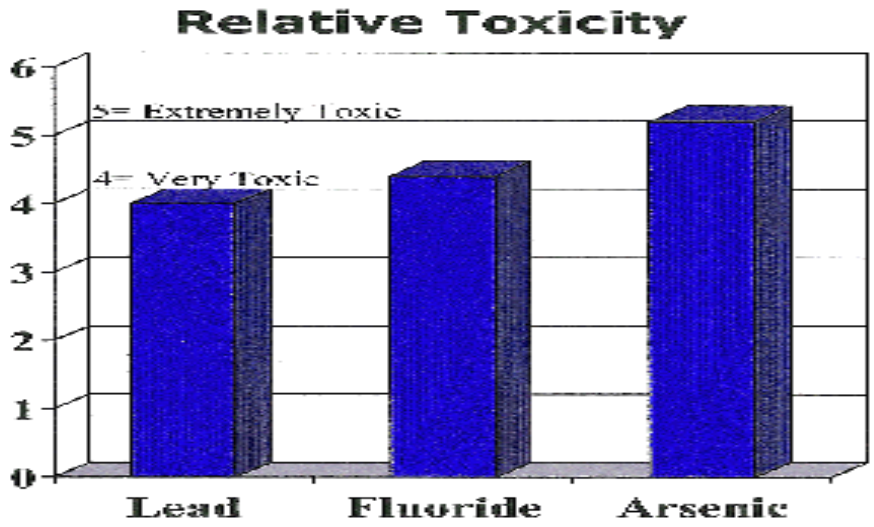
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General Occurrence of Arsenic and Toxicity

Arsenic is the 20th most common element in nature, widely distributed throughout the earth's crust and found in the atmosphere, soils, rocks, organisms and natural water.

Arsenic found in both organic and inorganic forms. Inorganic Arsenic is more toxic as it deposited in the body, get concentrated by the passage of time and cause long term health damage. Arsenic is relatively more toxic as compared with lead and fluoride with a toxicity rating of 5 [extremely toxic which has been used as a poison throughout history.



Source : Clinical Toxicity of Commercial Products : 1250 data – 1984

Arsenic Testing In Pakistan

In 2001 UNICEF Pakistan initiated arsenic testing of drinking water sources countrywide. The testing was carried out by Local Government & Rural Development department & public Health engineering Department. The sensitive Merck field test kits were used for the testing at the site. The supervisors carried out follow-up tests from 10 test percent water sources for validation of tests and also tested from laboratory for validation.

During sampling, efforts were made to collect representative sample i.e. one from each source. Samples were collected from communal sources whether in residential area, commercial area or inside a school. If there were more than 5 sources of water, then, the sample water was extracted from variable depths as detailed out below:

For the monitoring purpose, water samples were collected from following sources:

- UNICEF / LG&RDD installed hand - pumps (HP)
- PHED Tube Well (TW)
- Private Wells
- Springs
- Tap / Water Tanks (WT)
- Ponds

(1) 60% samples from shallow wells (i.e. three samples)

(2) 20% samples from deep well (i.e. one sample)

(3) 20% samples from surface water (i.e. one sample)

Besides this, it was also kept in mind that the distance between two sources would not exceed 0.5 km if there were more than 5 sources of water and they were widely spread, from where the water was intended to be extracted.

UNICEF provided field testing kits to Local Government to implement the survey as per the guidelines. The objectives of the survey were to:

- Identify the high risk areas
- Promote use of Household Filters developed by PCRWR
- Build the capacity of District / Tehsil Officials
- Raise awareness at community level
- Work for Advocacy with the private sector for the replication of Arsenic Removal Filters developed by PCRWR

In Punjab Local Government & Rural Development department carried out the survey with the technical and financial support of UNICEF-Punjab. The field staff of department i.e. project manager, and secretary union councils were trained on collection of samples and how to use the arsenic testing kits.

All union councils were covered and 5 samples were collected from each UC to screen and analyze the arsenic contamination in underground drinking water by adopting the following procedure:

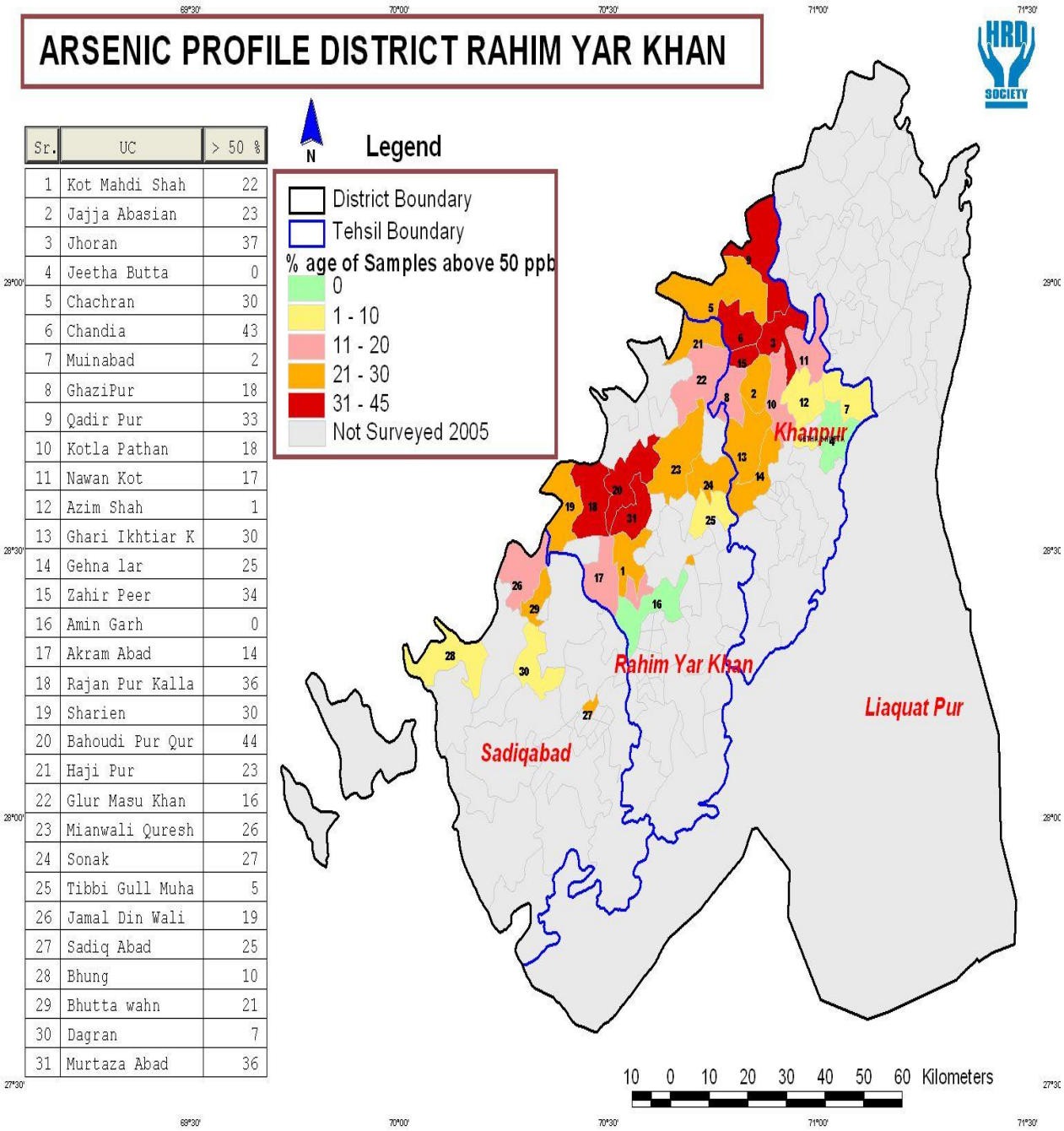
- Secretary UCs visited all union councils taking samples
- different sources were tested for arsenic contamination(locations of sampling from all 4 sites and middle of the UC)
- Water sources found contaminated (> 50 ppb) with arsenic marked with red paint
- The arsenic level found < 50 ppb, marked green
- The house holds marked red paint were advised not to use water for drinking and cooking.
- Advocacy to use water from the sources painted green.

Survey Area - Rahim Yar Khan District

The Rahim Yar Khan District is located in the south of Punjab. According to 1998 census, Rahim Yar Khan has a population of about 3.15 million with an area of 11,880 Sq. km. It has four Tehsils namely Khanpur, Liaqatpur, Rahim Yar Khan and Sadiqabad. Rahim Yar Khan District lies between 27^{o}-40' to 29^{o}-16' north latitudes and 60^{o}-45' to 70^{o}-01' east longitudes. The climate of the district is hot and dry in the summer and cold and dry in the winter. Canals and the tube wells are the main water sources followed by wells, extensively used for irrigation purpose. The average rainfall is about 100 millimeter.

The map of district Rahim Yar Khan showing level of Arsenic contamination is given in figure 1.

Fig. 1: Map of District Rahim Yar Khan



Sr.	UC	> 50 %
1	Kot Mahdi Shah	22
2	Jajja Abasian	23
3	Jhoran	37
4	Jeetha Butta	0
5	Chachran	30
6	Chandia	43
7	Muinabad	2
8	GhaziPur	18
9	Qadir Pur	33
10	Kotla Pathan	18
11	Nawan Kot	17
12	Azim Shah	1
13	Ghari Ikhtiar K	30
14	Gehna lar	25
15	Zahir Peer	34
16	Amin Garh	0
17	Akram Abad	14
18	Rajan Pur Kalla	36
19	Sharien	30
20	Bahoudi Pur Qur	44
21	Haji Pur	23
22	Glur Masu Khan	16
23	Mianwali Quresh	26
24	Sonak	27
25	Tibbi Gull Muha	5
26	Jamal Din Wali	19
27	Sadiq Abad	25
28	Bhung	10
29	Bhutta wahn	21
30	Dagran	7
31	Murtaza Abad	36

Arsenic Testing in District Rahim Yar Khan

UNICEF shared this problem of Arsenic contamination with Local Government and they agreed to have the monitoring of the water quality in project districts. RAhim Yar Khan was one of the districts where UNICEF was sponsoring under the WES project.

UNICEF / LG & RDD proposed the strategy that whole district should be monitored for arsenic

contamination. Guidelines proposed that all the union councils of the district should be monitored by taking 5 samples from different sources. Then in 2nd phase 5 samples should be taken from affected villages (where contamination was found) and in 3rd phase all the drinking water sources must be screened 100% in arsenic contaminated villages.

Based on this policy UNICEF provided all the technical and financial support to carry out the survey in district Rahim Yar khan. LG&RDD started sampling in 122 UCs. 610 water sources were checked by the secretaries UCs with the field kits and found 84 spots arsenics contaminated above the limits, details given in Table 1.

Table 1: Arsenic testing in District Rahim Yar Khan 2001

Union councils	122
Total Samples (5/UC)	610
Hotspots sites detected	84

Survey 2003

In phase 2, in 2003 five samples were collected from each village in contaminated union council. UNICEF provided support to LG&RDD and the implementation was carried out by the assistant Director local Government through his UCs secretaries. The details are as follows: The survey technique was the same as in phase 1(marking/coding). Number of samples tested and villages detail given in Table 2.

Table 2: Arsenic testing in District Rahim Yar Khan 2003

Hotspots sites detected	84
No. of villages monitored	1116
Total Samples (5/village)	5580

Survey 2004

In 2004 partial blanket testing was carried out in the villages in contaminated union council as identified in the survey report 2003. For the first time Human Resource Development Society (HRDS) was involved in Arsenic monitoring activities in district Rahim Yar Khan. Only three thousand water samples were tested in identified union councils. Sampling and testing was carried out by Local Government, secretary union councils, HRDS played monitoring role. 10% samples were tested by Atomic Absorption Spectrophotometer (AAS) in PCRWR laboratory Islamabad. It was partial blanket testing due to lack of resources; most of the villages were not monitored, completely. Table 3 shows the summary of sampling carried out in 2004 at district Rahim Yar khan.

Table 3: Arsenic testing in District Rahim Yar Khan 2004

S #	District	Tehsil	No. of Union Councils	No. of Villages	# of Tests	Total Tests
1.	Rahim Yar Khan	Rahim Yar Khan	11	15	1240	3002
		Khanpur	3	5	510	
		Liaquatpur	4	5	655	

		Sadiqabad	3	8	597	

Arsenic Monitoring 2005

Due to lack of resources 100% blanket testing was not carried out in 2004, only selected villages were covered. To cover the maximum area blanket testing was planed in 2005.

UNICEF / LG & RDD in collaboration with HRDS arranged 100% village coverage detailed survey in district Rahim Yar Khan. 5% samples collected during this round were sent to Pakistan Council of Research in Water Resources (PCRWR) Islamabad for verification, authentication and evaluation of results of field testing kits through analysis on Atomic Absorption Spectrophotometer. Table 4 gives the details of sampling in year 2005.

Table 4: Arsenic testing in District Rahim Yar Khan 2005

S #	District	Tehsil	No. of Union Councils	No. of Villages	# of Tests	Total Tests
1.	Rahim Yar Khan	Rahim Yar Khan	12	211	7438	24375
		Khanpur	14	354	14597	
		Sadiqabad	5	34	1199	
2.	Validation samples				1141	

Once again whole of the district was not covered due to limited resources, some of the villages were tested 100% where as some were partially covered. Tehsil Liaqatpur was not monitored, which was included in next year plan.

Sampling Points

The samples from each village were collected from communal sources (e.g. school, mosque, market, bus stand etc), one each from sources of water as under:

- UNICEF/LG installed hand pumps
- PHED/PWD tube well
- Open well
- Spring
- Tap/water tank
- Pond

Fig. 2



Awareness-Raising Campaign:

Since communicating messages to the communities is an integral part of working with the community/community development. Therefore, in order to create awareness among masses regarding Arsenic contamination an awareness campaign was launched. This awareness raising campaign consisted of holding stage shows for Arsenic mitigation. A special script for these stage shows in fig. 2 titled *'Aik Kahani Bohat Purani'* was created and got approved from UNICEF. The primary purpose of holding these shows was to:

- Raise awareness among Arsenic contamination affected communities

- Motivate affected communities to drink safe water rather than Arsenic contaminated water

- Promotion of local made filters

- Motivate and organize affected communities that they become ready to work on self help basis for safe drinking water.

Fig.3



Monitoring Of Project Activities:
In order to keep the study results unbiased, authenticated and transparent so that every stakeholder own the results monitoring of field work was done at following levels:

(1) Government

(2) UNICEF

(3) HRDS

(1) *Monitoring at Government Level:*
The Director General, Local Government and Rural Development did surprise visits to the field to monitor and evaluate work done by the field staff. He also gave instructions regarding marking of sources. He advised not to paint the source as red, it would create turbulence conditions among the community. He further indoctrinated only write codes on the source with the relevant color i.e. write code in red color in case of positive result and write code in green color in case of negative result. Assistant Director, Local Government and Rural Development supervised the survey team. Being head of survey team, he monitored the survey teams and verified the tests for validating the results. He took 20% validation samples and sent to PCRWR for analysis.

(2) *Monitoring at UNICEF Level:*
The WES Chief, UNICEF Islamabad made monitoring visits to the project areas to inspect field activities. During field visits he gave tips to the field staff, and like the DG, and advised not to paint the sources as red to avoid social instability amongst the people. In the light of his instructions, red color was used to write code on sources showing positive results and green color was used to write code on sources showing negative results.

The Project Officer, UNICEF Islamabad participated in district and tehsil level orientation workshops to have insight about the fieldwork. He also attended stage shows held for awareness-raising in Rahim Yar Khan.

(3) *Monitoring at HRDS Level:*
The HRDS appointed field coordinators that were regularly involved in monitoring of the fieldwork. They visited the project areas with concerned secretary union council to facilitate them, check the accuracy of the samples taken and tests conducted. They also traveled with ADLGs during the validation survey. The HRDS head office Project Coordinator fully monitored

and participated in surveys, trainings, collection of samples and subsequent delivery of these samples to PCRWR.

Methodology

SAMPLING

It was decided to collect and analyze 25000 water samples from the three Tehsils of district Rahim Yar Khan in year 2005-2006. In the recent study all the sources were monitored in those villages which were found contaminated with Arsenic in the previous study. Sampling was conducted with collaboration of Health Department and Local Government. Field staff of Health Department was trained for this purpose. Three Tehsils of district Rahim Yar Khan were monitored i.e. Rahim Yar Khan, Sadiqabad and Khanpur.

All the samples were collected by Health Department Rahim Yar Khan. Two teams for each tehsil were made and each team consists of four members. One day training was conducted for these teams on sampling and analysis of arsenic by using field testing kits. Three types of kits were used for this purpose i.e. Wegtech, Merck and PCRWR.

Initially 10% sources of each village were tested if the results found with 60% Arsenic higher than 50 ppb than all the water sources of the village were monitored. Community meetings were called by the team leader in each village for introduction and awareness about the Arsenic contamination and the relevant literature distributed among the villagers.



Fig 4: Community meeting

Two volunteers from each community were inducted in the survey teams which help the teams for door to door sampling. Arsenic analysis survey coupon books were printed for detailed information about the sample and sampling site, each coupon has two parts with same information one part remain with survey team for record while the other with owner of the water source to be sampled. A sample of filled coupon is given in Annexure III.

Team leader with help of volunteers distribute the coupon to every house of the village and than all the villagers bring their water to the survey team for analysis, after analysis the results were recorded on the coupons. All the sources were marked with red paint having Arsenic concentration greater than 50ppb where as green paint was used for safe sources.

The residents of all the houses marked with red paint were instructed not to use this water for drinking purpose. Field survey record sheet is given in Annexure IV. Field activities were monitored by DHO and HRDS field engineers. 105 of all the samples were sent to PCRWR laboratory for validation of results.



Fig 5: DHO Rahim Yar Khan monitoring the field team

Five water samples were tested from each village in the previous study 1/2 Km of distance was maintained between the two sampling points. In the recent study all the sources are monitored in those villages which were found contaminated with Arsenic in the previous study. Sampling was conducted with collaboration of Health Department and Local Government. Field staff of Health Department was trained for this purpose. Three Tehsils of district Rahim Yar Khan were monitored i.e. Rahim Yar Khan, Sadiqabad and Khan Pur, detail of samples collected given in table-5.

Table 5: Sampling Detail

Specification	**No. of Samples Collected**
Tehsil Rahim Yar Khan	7438
Tehsil Sadiqabad	1199
Tehsil Khan Pur	14597
Validation Samples	1141
Total	**24375**

METHOD OF ANALYSIS

Three different field testing kits for Arsenic testing were used in the present survey. The field analysis through Field testing kits is shown in fig 6.



Fig 6: Field analysis with Arsenic Testing Kit.

Wegtech Kit

The Wegtech kits were imported by UNICEF for full scale sampling purpose, shown in figure 7. It is highly sophisticated and sensitive it having digital meter which give results very close to laboratory results. It is best to reconfirm the results in the field monitoring activities.



Fig 7: Wegtech Kit

PCRWR Kit

The PCRWR kits were developed locally by the PCRWR laboratory in Pakistan, shown in figure 8. The objective of using these kits was to compare its monitoring results with other results and its promotion after evaluating its level of effectiveness. Although its results were good but it has been observed that there are many constraints in its mass production.



Fig 8: PCRWR Kit

Merck Kit

The Merck kits were used due to shortage of Wegtech and PCRWR kits for monitoring purpose, shown in figure 9.



Fig 9: Merck Kit

VALIDATION

5% samples of the total tested samples were sent out to PCRWR laboratories for their tests on Atomic Absorption Spectrophotometer (AAS).

MAPING

After completion of survey in a union council a map was made and all the record saved in DHO office. The monitoring sites on the maps were marked by using ArcView software. The maps of monitored union councils are given in the annexure as per description of the respective area in the report.

Results and Discussions

GUIDELINES

Guideline value for Arsenic in drinking water is as under;

1. World Health Organization (WHO) 10 ppb
2. Pakistan Standards & Quality Control Authority (PSQCA) 10 ppb

In the present report data is evaluated on the basis of 50 pbb, as high risk areas need to be addressed on priority basis.

ARSENIC CONTAMINATION IN DISTRICT RAHIM YAR KHAN

Overall 23234 drinking water sources were tested from the three Tehsils of district Rahim Yar Khan. Out of 23234 drinking water sources, 26% drinking water sources found with above 50 ppb Arsenic. Whereas 74% samples having Arsenic below 50 ppb. 40% of the total tested sources were found to be safe as compared with WHO guideline value i.e. 10 ppb Arsenic. Tehsil Khanpur is relatively more contaminated as compared to the other two tehsils as indicated in the table 6.

Table: 6.1 Tehsil wise Arsenic Contamination in District Rahim Yar Khan

Tehsil	Arsenic Samples	<=50 ppb			>50 ppb			Grand Total
		<=10	11-50	Sub total	51-100	>100	Sub total	
Khan Pur	No of Sample	5449	5099	10548	2622	1427	4049	14597
	%age of Sample	37.33	34.93	72.26	17.96	9.78	27.74	
Rahim Yar Khan	No of Sample	3302	2244	5546	1080	812	1892	7438
	%age of Sample	44.39	30.17	74.56	14.52	10.92	25.44	
Sadiq Abad	No of Sample	546	422	968	174	57	231	1199
	%age of Sample	45.54	35.20	80.73	14.51	4.75	19.27	
Rahim Yar Khan Total	No of Sample	9297	7765	17062	3876	2296	6172	23234
	%age of Sample	40.01	33.42	73.44	16.68	9.88	26.56	

In total 31 union councils were monitored from three tehsils of district Rahim Yar khan covering a total of 599 villages/basties. 14 union councils from Khan Pur, 12 of Rahim yar Khan and 5 from Sadiqabad Tehsil. These are the union councils selected for monitoring on the basis of results of survey conducted in 2004. These are the union councils where above 50ppb drinking water sources had been reported in 2004 except Amin Ghar and jeetha Bhuta which are arsenic free. All the area not surveyed in 2005 is clear having no water source above 50 ppb as per previous studies except Liaqat Pur tehsil which is not monitored in the current study 2005 as shown in the map in figure 3. Blanket testing was carried out only in eight union councils out of 31 monitored UCs rest of 23 union councils were randomly tested about 10 to 20 percent due to lake of resources. Number villages, UCs and sampling details given in Table: 6.2.

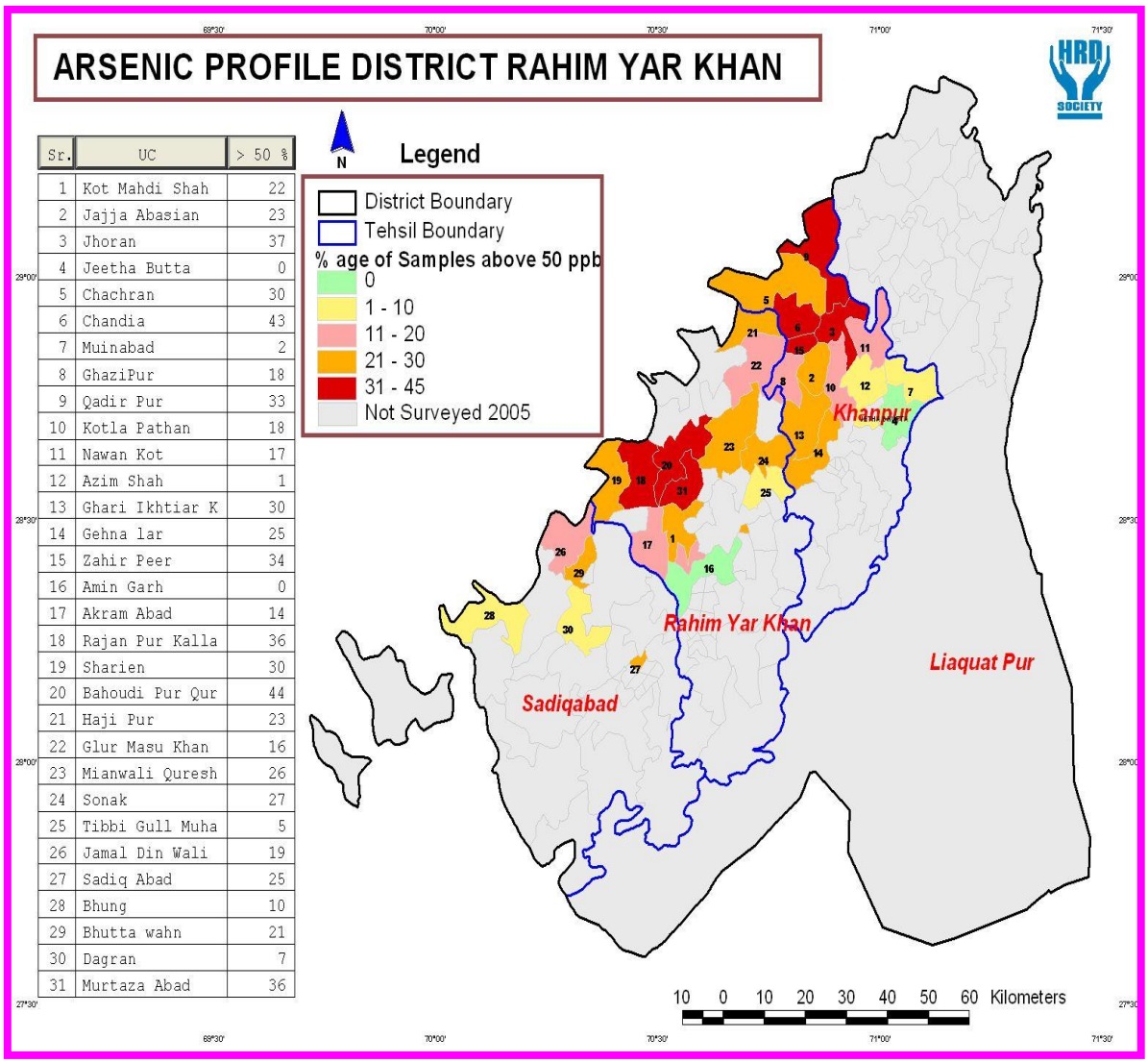
Table:6.2 Number of samples tested from selected UCs of District Rahim Yar Khan

Tehsil	Sr. #	Union Council	No. of Villages/basties	No. of Samples	Survey Status
Khan Pur	1	Azim Shah	13	220	Selected
	2	**Chachran**	**61**	**2883**	**Blanket**
	3	Chandia	9	485	Selected
	4	Gehna lar	7	453	Selected
	5	**Ghari Ikhtiar Khan**	**32**	**1477**	**Blanket**
	6	GhaziPur	19	690	Selected

	7	**Jajja Abasian**	**47**	**2284**	**Blanket**
	8	Jeetha Butta	1	20	Selected
	9	Jhoran	21	774	Selected
	10	**Kotla Pathan**	**30**	**1046**	**Blanket**
	11	Muinabad	6	122	Selected
	12	Nawan Kot	33	584	Selected
	13	**Qadir Pur**	**43**	**1495**	**Blanket**
	14	**Zahir Peer**	**32**	**2064**	**Blanket**
Khan Pur Total			**354**	**14597**	
Rahim Yar Khan	1	Akram Abad	67	871	Selected
	2	Amin Garh	6	37	Selected
	3	Bahoudi Pur Quraishian	10	237	Selected
	4	Glur Masu Khan	6	148	Selected
	5	Haji Pur	2	40	Selected
	6	Kot Mahdi Shah	10	501	Selected
	7	**Mianwali Qureshian**	**46**	**1935**	**Blanket**
	8	Murtaza Abad	2	183	Selected
	9	Rajan Pur Kallan	29	810	Selected
	10	**Sharien**	**12**	**1434**	**Blanket**
	11	Sonak	12	723	Selected
	12	Tibbi Gull Muhammed	9	519	Selected
Rahim Yar Khan Total			**211**	**7438**	
Sadiq Abad	1	Bhung	2	20	Selected
	2	Bhutta Wahn	9	557	Selected
	3	Dagran	15	151	Selected
	4	Jamal Din Wali	6	250	Selected
	5	Sadiq Abad	2	221	Selected
Sadiq Abad Total			**34**	**1199**	
Grand Total		**Villages/Bsties**	**599**	**23234**	
		Union councils	**31**		
Blanket Testing				**08 Union Councils**	
Random Testing				**23 Union Councils**	

Overall status of arsenic contamination in drinking water of district Rahim Yar Khan is shown in map Figure 10. All the data collected from field was analyzed and interpreted on map through GIS system. The data is evaluated on the basis of number of water sources found with above 50 ppb. This map shows level of arsenic contamination in each of the monitored union councils labeled with different colors based on percentage of water sources with >50 ppb. All the union councils are categorized in five groups with five different colors from zero to 45% of the sample contaminated with >50 ppb of arsenic. The area not surveyed in 2005 also indicated in the map is arsenic free based on the results of previous studies. Tehsil Liaqat pur not covered in the current study.

Fig: 10 Arsenic contamination in district Rahim Yar Khan



Sr.	UC	> 50 %
1	Kot Mahdi Shah	22
2	Jajja Abasian	23
3	Jhoran	37
4	Jeetha Butta	0
5	Chachran	30
6	Chandia	43
7	Muinabad	2
8	GhaziPur	18
9	Qadir Pur	33
10	Kotla Pathan	18
11	Nawan Kot	17
12	Azim Shah	1
13	Ghari Ikhtiar K	30
14	Gehna lar	25
15	Zahir Peer	34
16	Amin Garh	0
17	Akram Abad	14
18	Rajan Pur Kalla	36
19	Sharien	30
20	Bahoudi Pur Qur	44
21	Haji Pur	23
22	Glur Masu Khan	16
23	Mianwali Quresh	26
24	Sonak	27
25	Tibbi Gull Muha	5
26	Jamal Din Wali	19
27	Sadiq Abad	25
28	Bhung	10
29	Bhutta wahn	21
30	Dagran	7
31	Murtaza Abad	36

ARSENIC IN TEHSIL RAHIM YAR KHAN

In total 7438 drinking water sources were tested from different villages in 12 union councils of Tehsil Rahim Yar Khan to magnify the problem of Arsenic contamination in drinking water sources. Out of 7438 samples 25% drinking water sources found with above 50 ppb Arsenic. Whereas 75% samples having Arsenic below 50 ppb. 44% of the total tested sources were found to the safe as compared with WHO guideline value i.e. 10 ppb Arsenic. Out of 12 surveyed union councils Bahoudi Pur Qureshian, Rajan Pur Kalan and Murtazabad are the highly contaminated union councils with 44%, 36% and 36% of the total tested sources having Arsenic above 50 ppb respectively. Amin Garh is the only union council having no water source with > 50 ppb. Table 7 shows the status of arsenic contamination in drinking water sources of

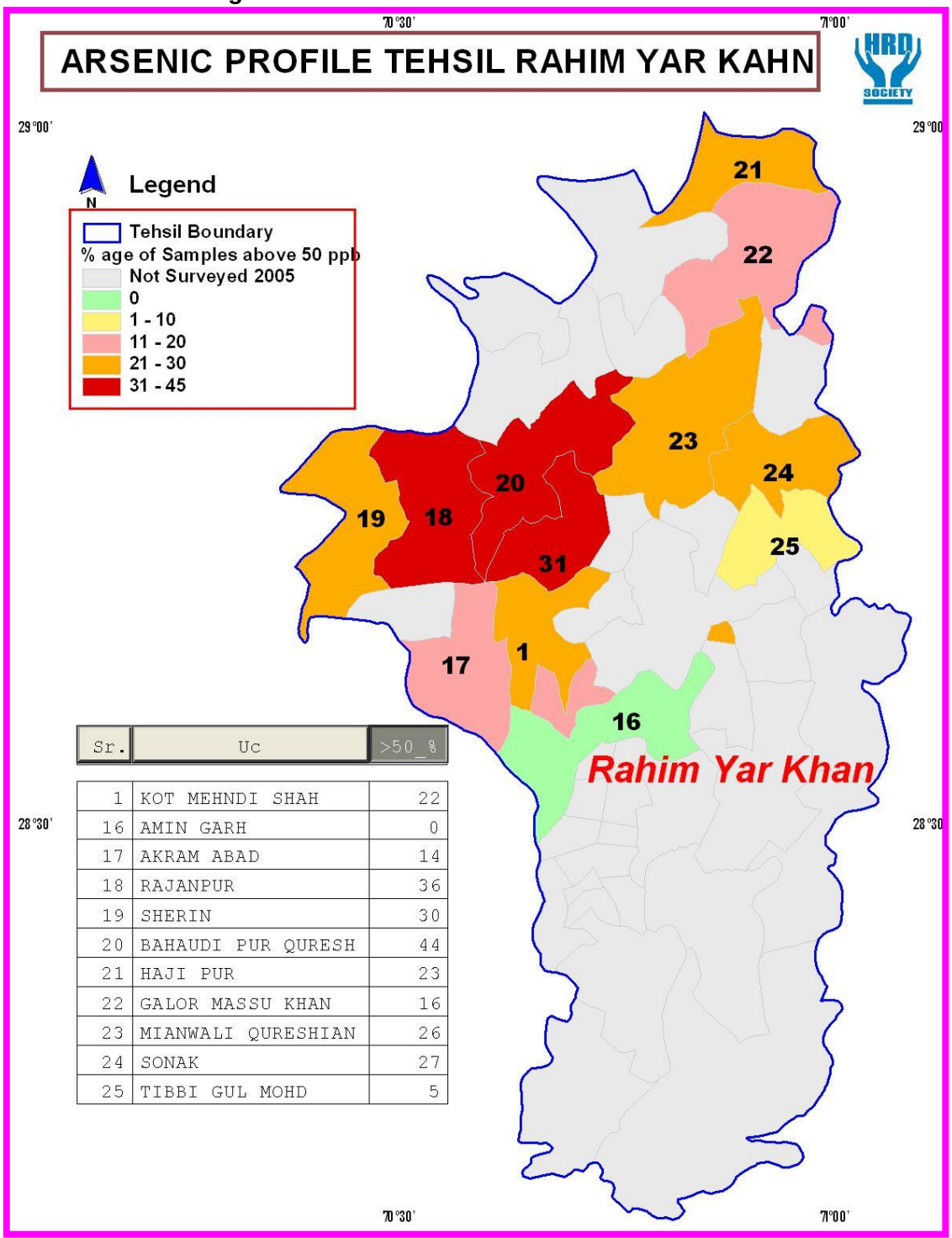
each surveyed union council of Tehsil Rahim Yar Khan whereas village level detail is given in annexure-III. Map in Figure 3.2 shows the pattern of arsenic contamination in Tehsil Rahim Yar khan. Figure 3.3 to 3.12 shows arsenic contamination on maps in different union councils of Rahim Yar Khan tehsil.

Table: 7 Level of Arsenic Contamination in Drinking Water of Tehsil Rahim yar Kahn

Union Council	Arsenic Samples	<=50 ppb			>50 ppb			Grand Total
		<=10	11-50	Sub total	51-100	>100	Sub total	
Akram Abad	No of Sample	270	476	746	67	58	125	**871**
	%age of Sample	31.00	54.65	85.65	7.69	6.66	14.35	
Amin Garh	No of Sample	23	14	37	0	0	0	**37**
	%age of Sample	62.16	37.84	100	0.00	0.00	0	
Bahoudi Pur Quraishian	No of Sample	64	69	133	62	42	104	**237**
	%age of Sample	27.00	29.11	56.12	26.16	17.72	43.88	
Glur Masu Khan	No of Sample	85	39	124	9	15	24	**148**
	%age of Sample	57.43	26.35	83.78	6.08	10.14	16.22	
Haji Pur	No of Sample	18	13	31	5	4	9	**40**
	%age of Sample	45.00	32.50	77.5	12.50	10.00	22.5	
Kot Mahdi Shah	No of Sample	245	146	391	65	45	110	**501**
	%age of Sample	48.90	29.14	78.04	12.97	8.98	21.96	
Mianwali Qureshian	No of Sample	867	566	1433	286	216	502	**1935**
	%age of Sample	44.81	29.25	74.06	14.78	11.16	25.94	
Murtaza Abad	No of Sample	59	58	117	40	26	66	**183**
	%age of Sample	32.24	31.69	63.93	21.86	14.21	36.07	
Rajan Pur Kallan	No of Sample	333	183	516	158	136	294	**810**
	%age of Sample	41.11	22.59	63.70	19.51	16.79	36.30	
Sharien	No of Sample	664	337	1001	218	215	433	**1434**

	%age of Sample	46.30	23.50	69.80	15.20	14.99	30.20	
Sonak	No of Sample	260	265	525	153	45	198	**723**
	%age of Sample	35.96	36.65	72.61	21.16	6.22	27.39	
Tibbi Gull Muhammed	No of Sample	414	78	492	17	10	27	**519**
	%age of Sample	79.77	15.03	94.80	3.28	1.93	5.20	
Tehsil Rahim Yar Khan Total	No of Sample	3302	2244	5546	1080	812	1892	**7438**
	%age of Sample	44.39	30.17	74.56	14.52	10.92	25.44	

Fig: 11 Arsenic contamination in Tehsil Rahim Yar Khan



Sr.	Uc	>50 %
1	KOT MEHNDI SHAH	22
16	AMIN GARH	0
17	AKRAM ABAD	14
18	RAJANPUR	36
19	SHERIN	30
20	BAHAUDI PUR QURESH	44
21	HAJI PUR	23
22	GALOR MASSU KHAN	16
23	MIANWALI QURESHIAN	26
24	SONAK	27
25	TIBBI GUL MOHD	5

Fig. 12: Arsenic contamination at village level at Union Council Bahoudi Pur Quraishian

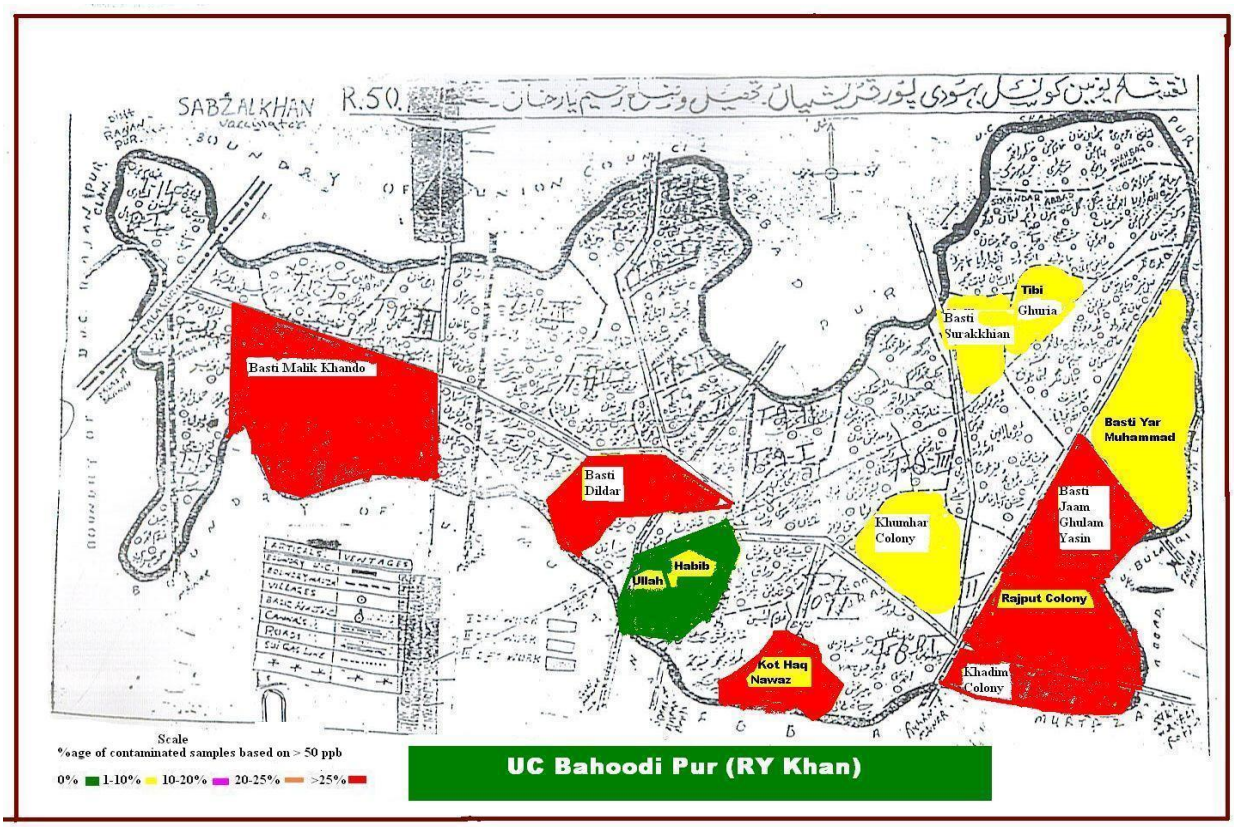


Fig. 13: Arsenic contamination at village level at Union Council Rajan Pur Kalan

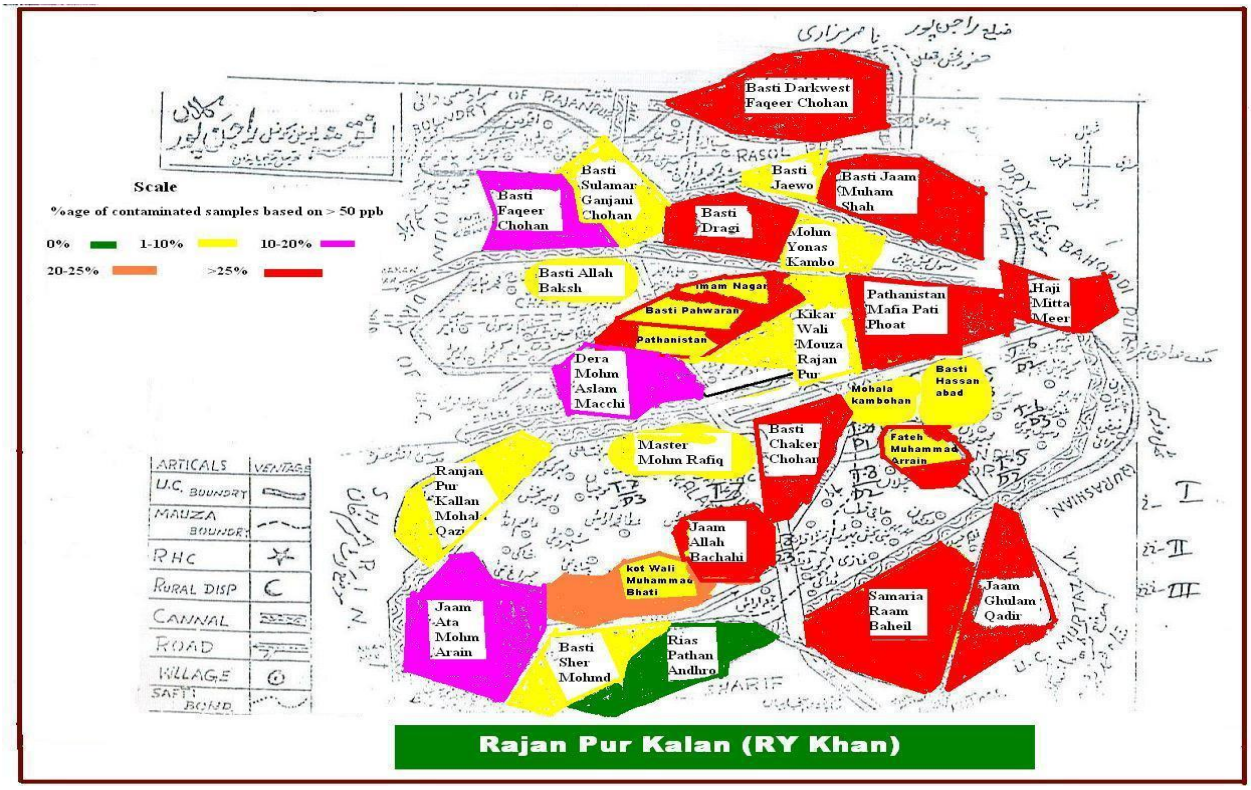


Fig. 14: Arsenic contamination at village level at Union Council Murtaza Abad

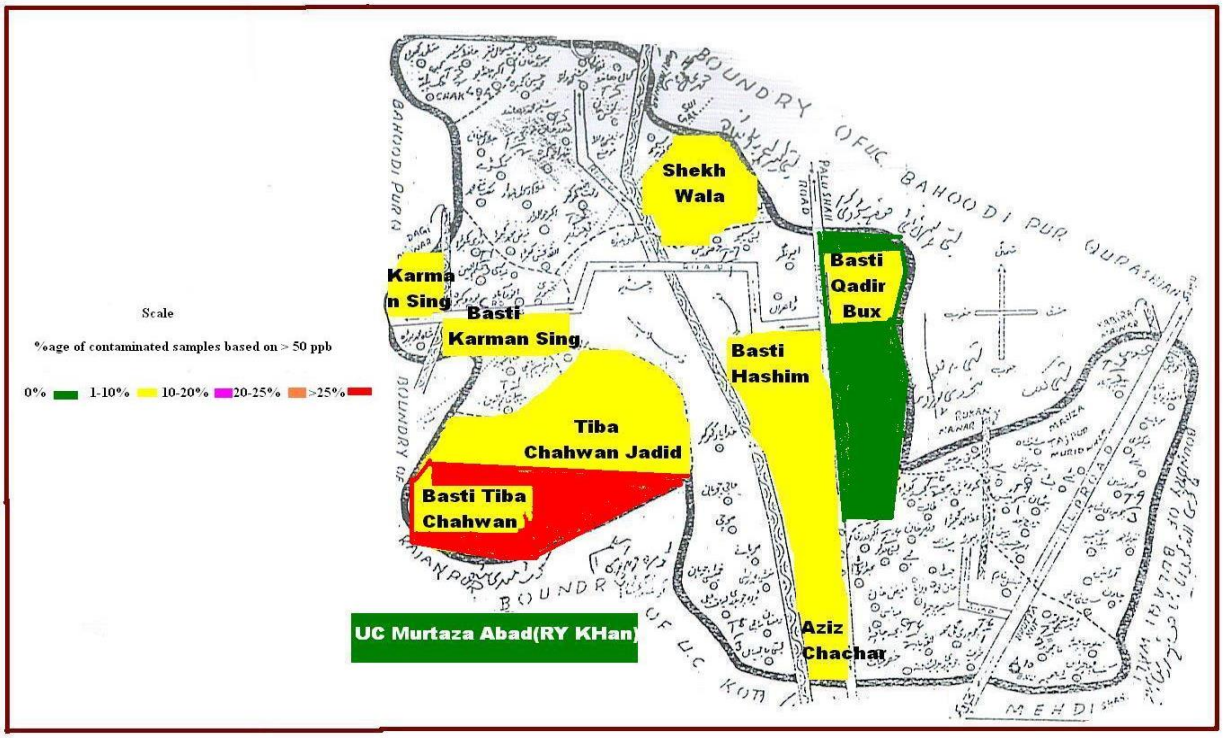


Fig. 15: Arsenic contamination at village level at Union Council Sharien

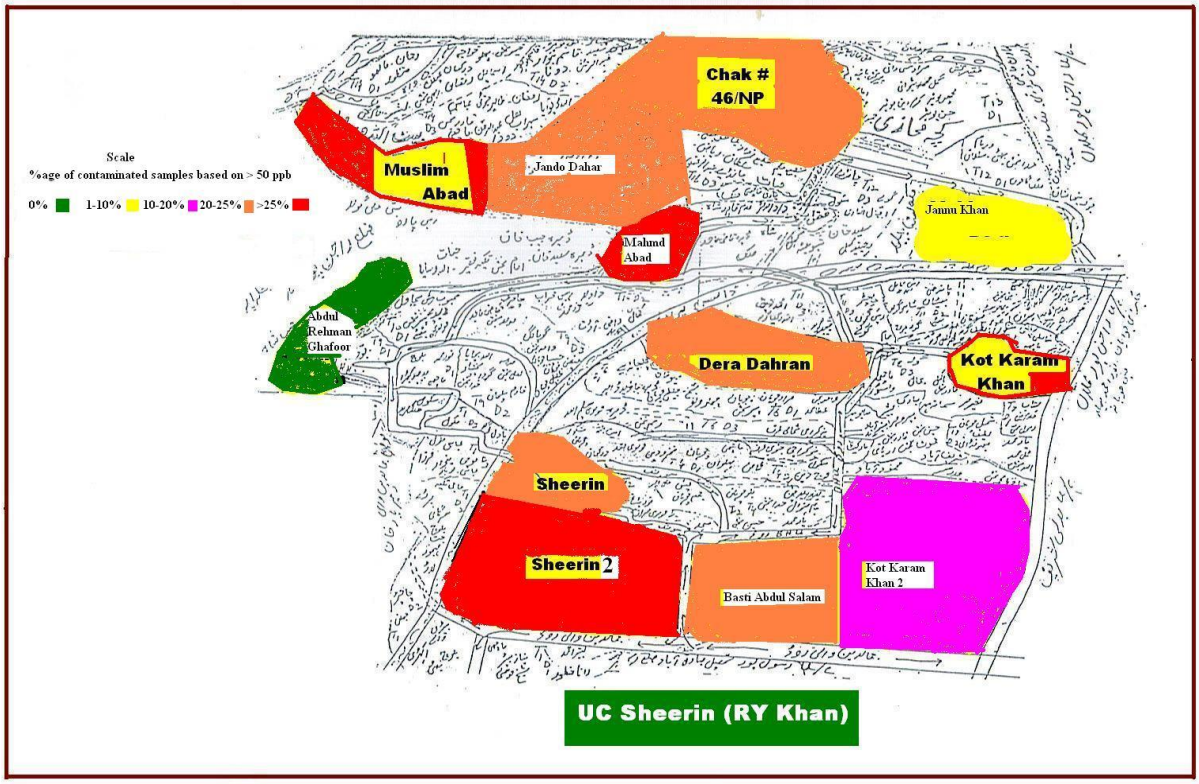


Fig. 16: Arsenic contamination at village level at Union Council Haji Pur

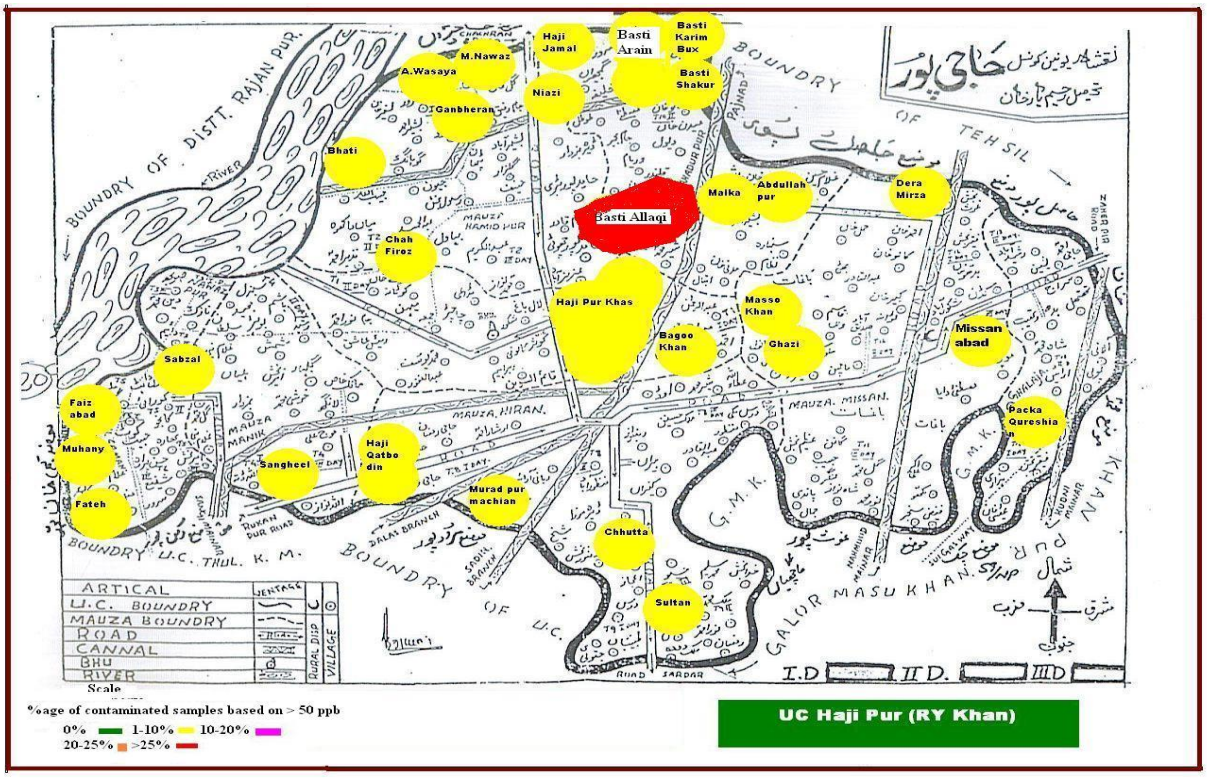


Fig. 17: Arsenic contamination at village level at Union Council Sonak

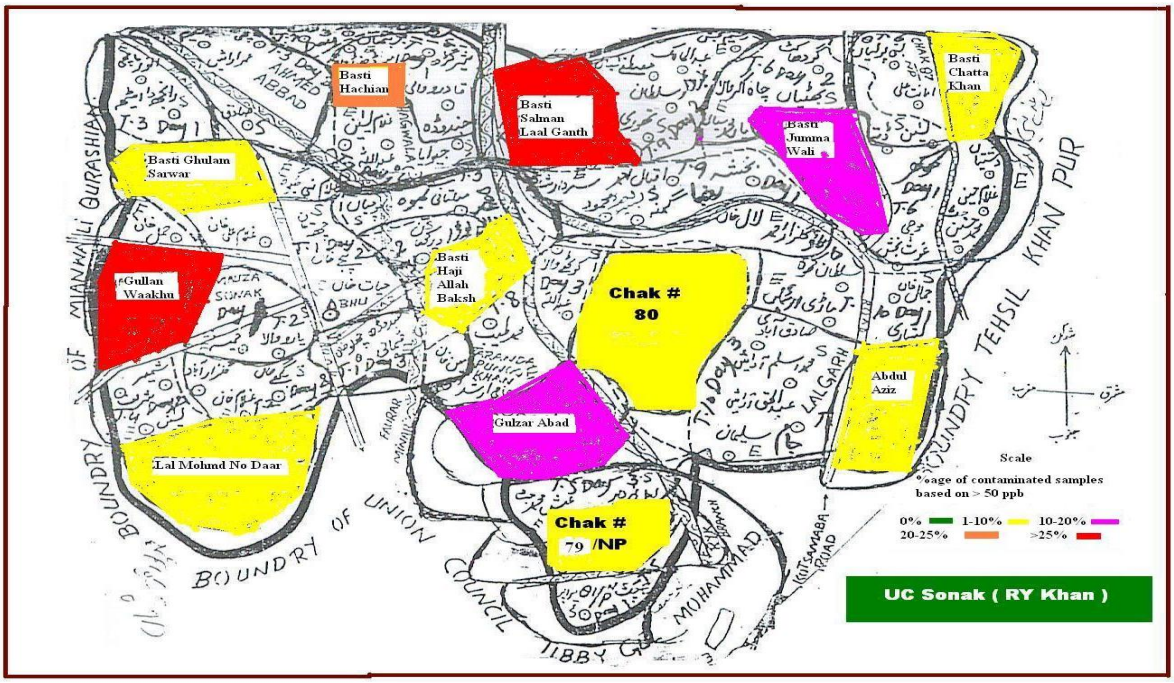


Fig. 18: Arsenic contamination at village level at Union Council Mian Wali Quraishian

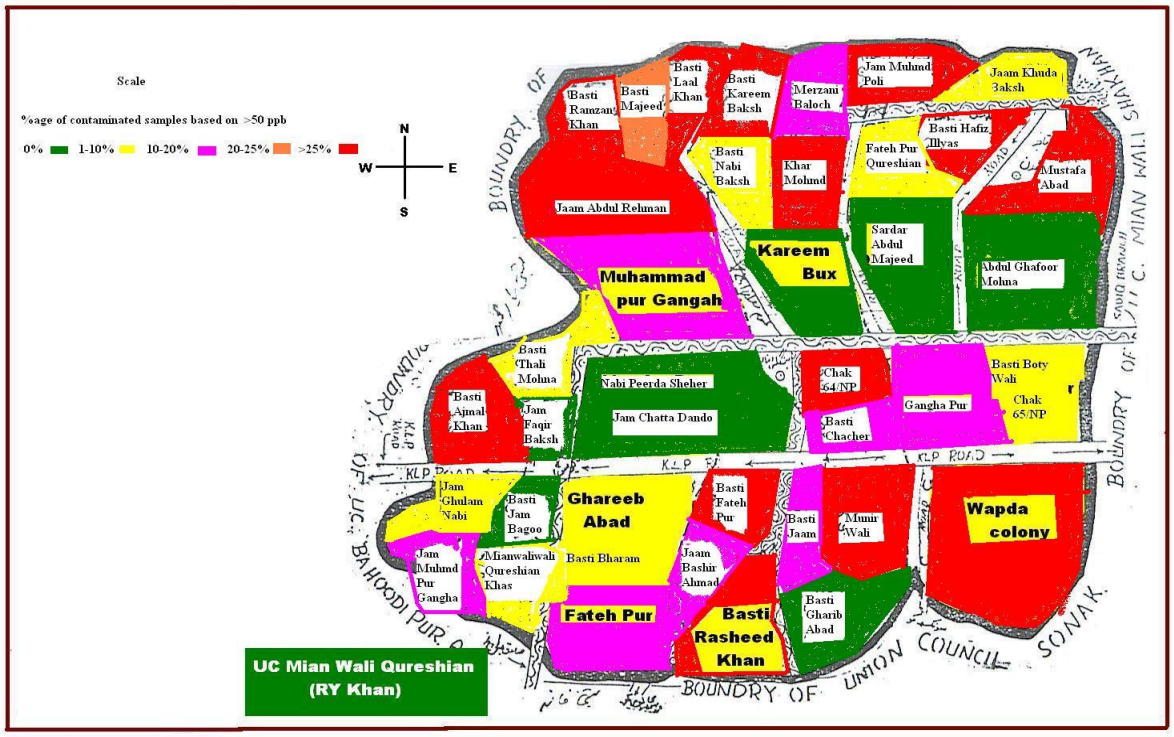


Fig. 19: Arsenic contamination at village level at Union Council Kot Mehdi Shah

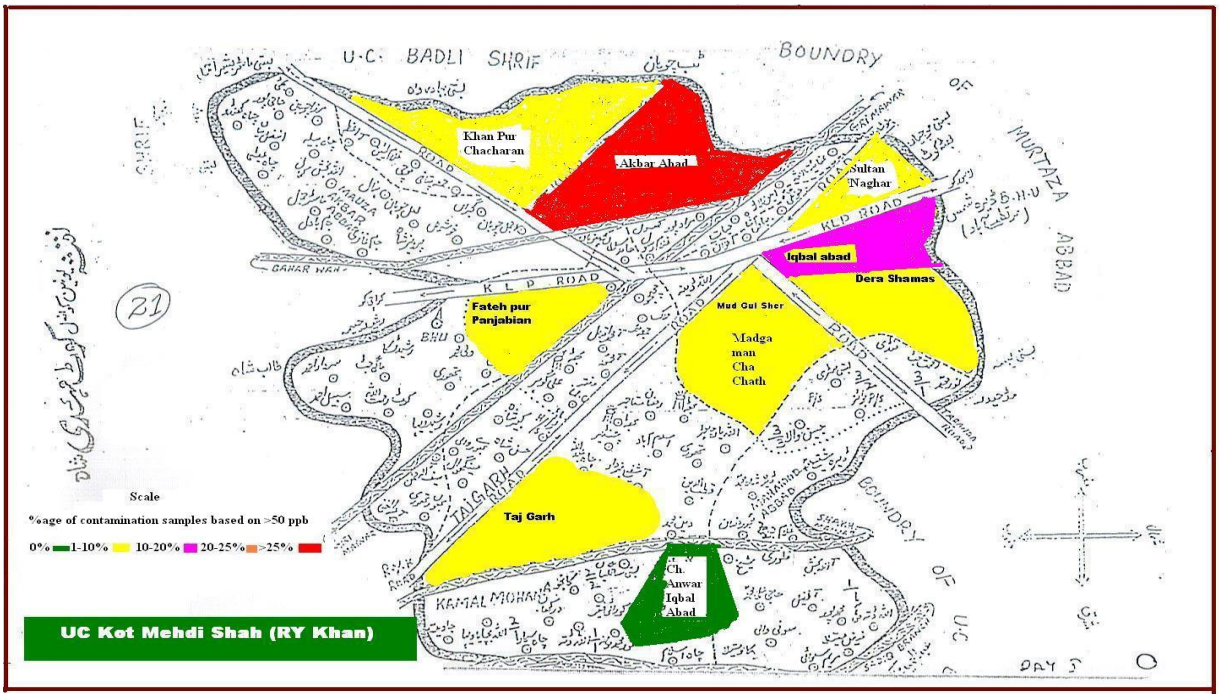


Fig. 20: Arsenic contamination at village level at Union Council Akram Abad

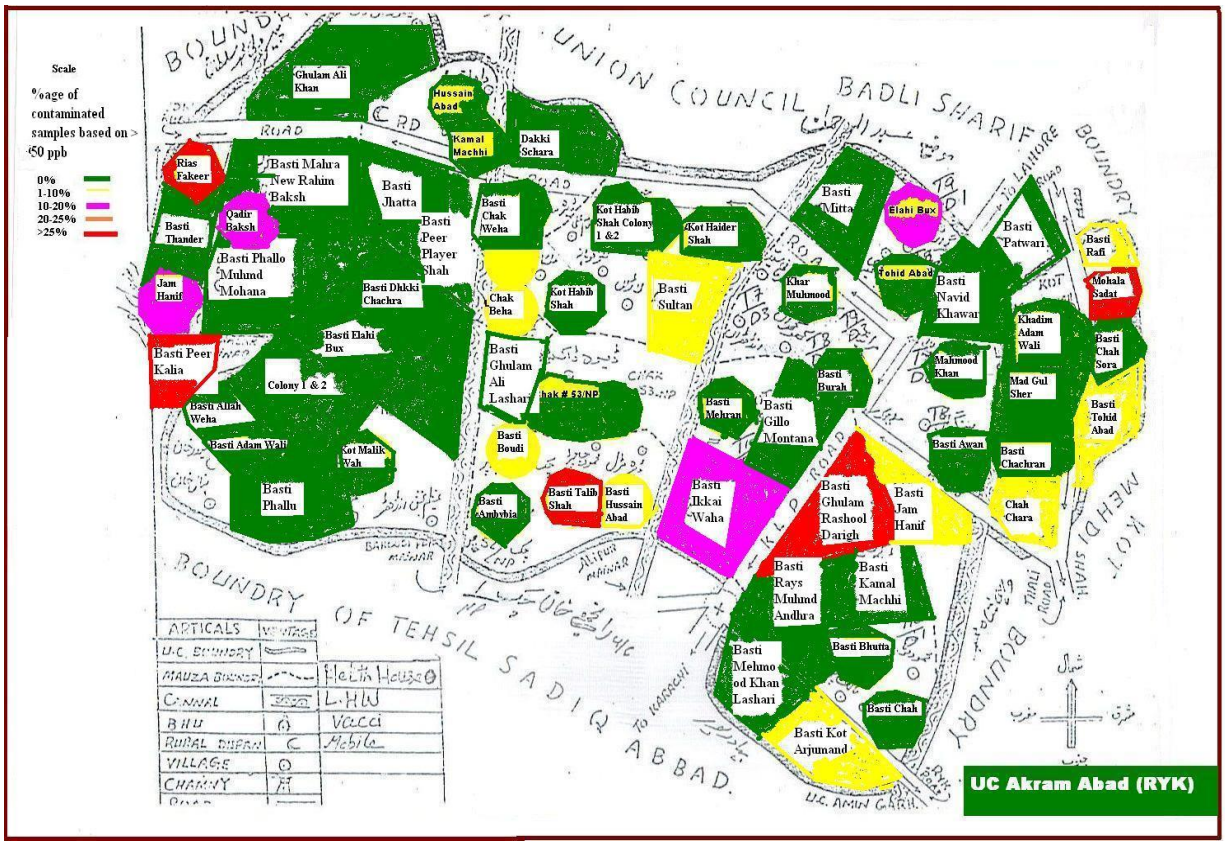
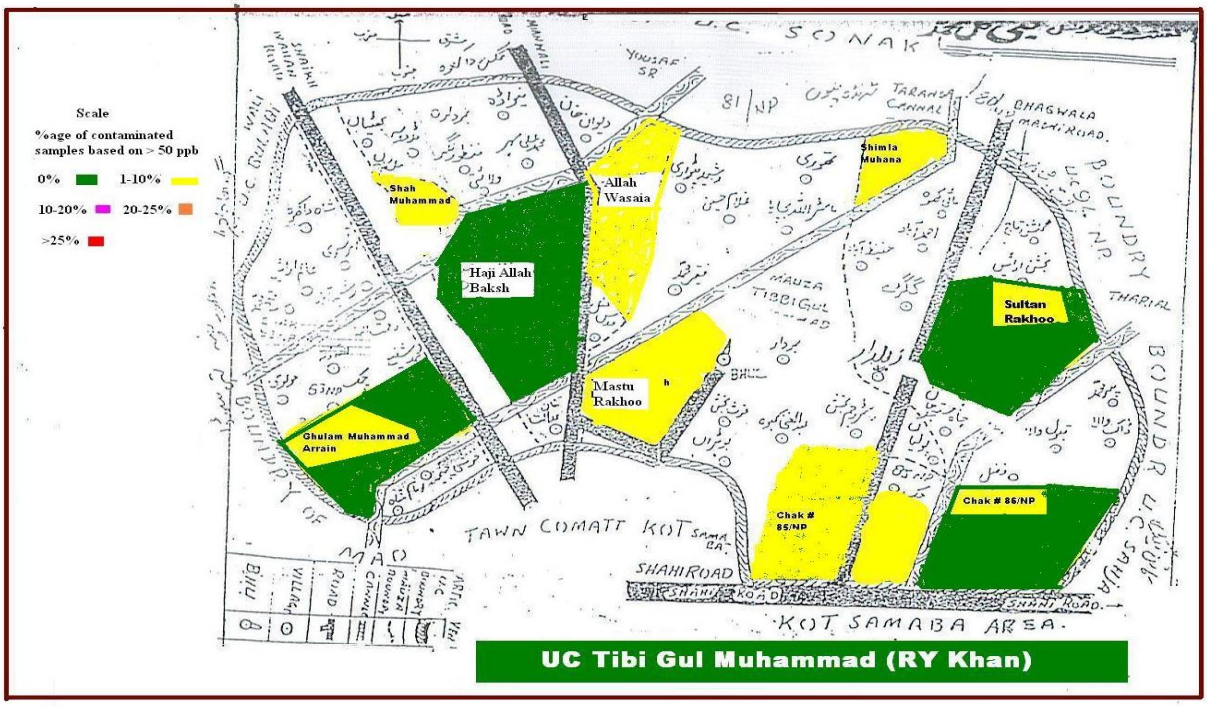


Fig.21: Arsenic contamination at village level at Union Council Tibbi Gul Muhammad



ARSENIC IN TEHSIL KHAN PUR

A total of 14597 drinking water sources were tested from different villages in 14 union councils of tehsil Khan Pur to magnify the problem of Arsenic contamination in drinking water sources. Out of 14597 samples 28% drinking water sources found with above 50 ppb Arsenic. Whereas 72% samples having Arsenic below 50 ppb. 37% of the total tested sources were found to the safe as compared with WHO guideline value i.e. 10 ppb Arsenic. Out of 14 surveyed union councils Chandia, Johran and Zahir pir are the highly contaminated union councils with 43%, 37% and 34% of the total tested sources having Arsenic above 50 ppb respectively. Jeetha Bhutta, Minibabad and Azim Shah are the union councils having no arsenic contamination. Table 8 shows the status of arsenic contamination in drinking water sources of each surveyed union council of Tehsil Khan Pur whereas village level detail is given in annexure-III. Map in Figure 22 shows the pattern of arsenic contamination in Tehsil khan pur. Figure 23 to 3.25 shows arsenic contamination on maps in different union councils of Khan Pur tehsil.

Table: 8 Level of Arsenic Contamination in Drinking Water of Tehsil Khan Pur

Union Council	Arsenic Samples	<=50 ppb			>50 ppb			Grand Total
		<=10	11-50	Sub total	51-100	>100	Sub total	
Azim Shah	No of Sample	74	143	217	3	0	3	220
	%age of Sample	33.64	65.00	98.64	1.36	0.00	1.36	
Chachran	No of Sample	961	1052	2013	513	357	870	2883
	%age of Sample	33.33	36.49	69.82	17.79	12.38	30.18	
Chandia	No of Sample	141	137	278	128	79	207	485
	%age of Sample	29.07	28.25	57.32	26.39	16.29	42.68	
Gehna lar	No of Sample	224	116	340	64	49	113	453
	%age of Sample	49.45	25.61	75.06	14.13	10.82	24.94	
Ghari Ikhtiar Khan	No of Sample	605	435	1040	241	196	437	1477
	%age of Sample	40.96	29.45	70.41	16.32	13.27	29.59	
GhaziPur	No of Sample	312	257	569	87	34	121	690
	%age of Sample	45.22	37.25	82.46	12.61	4.93	17.54	
Jajja Abasian	No of Sample	846	904	1750	397	137	534	2284
	%age of Sample	37.04	39.58	76.62	17.38	6.00	23.38	
Jeetha Butta	No of Sample	20		20	0	0	0	20
	%age of Sample	100.00	0.00	100	0.00	0.00	0	
Jhoran	No of Sample	257	227	484	157	133	290	774
	%age of Sample	33.20	29.33	62.53	20.28	17.18	37.47	
Zahir Peer	No of Sample	464	392	856	161	29	190	1046
	%age of Sample	44.36	37.48	81.84	15.39	2.77	18.16	
Muinabad	No of Sample	95	24	119	2	1	3	122

	%age of Sample	77.87	19.67	97.54	1.64	0.82	2.46	
Nawan Kot	No of Sample	271	216	487	91	6	97	**584**
	%age of Sample	46.40	36.99	83.39	15.58	1.03	16.61	
Qadir Pur	No of Sample	578	431	1009	293	193	486	**1495**
	%age of Sample	38.66	28.83	67.49	19.60	12.91	32.51	
Zahir Peer	No of Sample	601	765	1366	485	213	698	**2064**
	%age of Sample	29.12	37.06	66.18	23.50	10.32	33.82	
Khan Pur Total	No of Sample	5449	5099	10548	2622	1427	4049	**14597**
	%age of Sample	37.33	34.93	72.26	17.96	9.78	27.74	

Fig: 22 Arsenic contamination in Tehsil Khan Pur

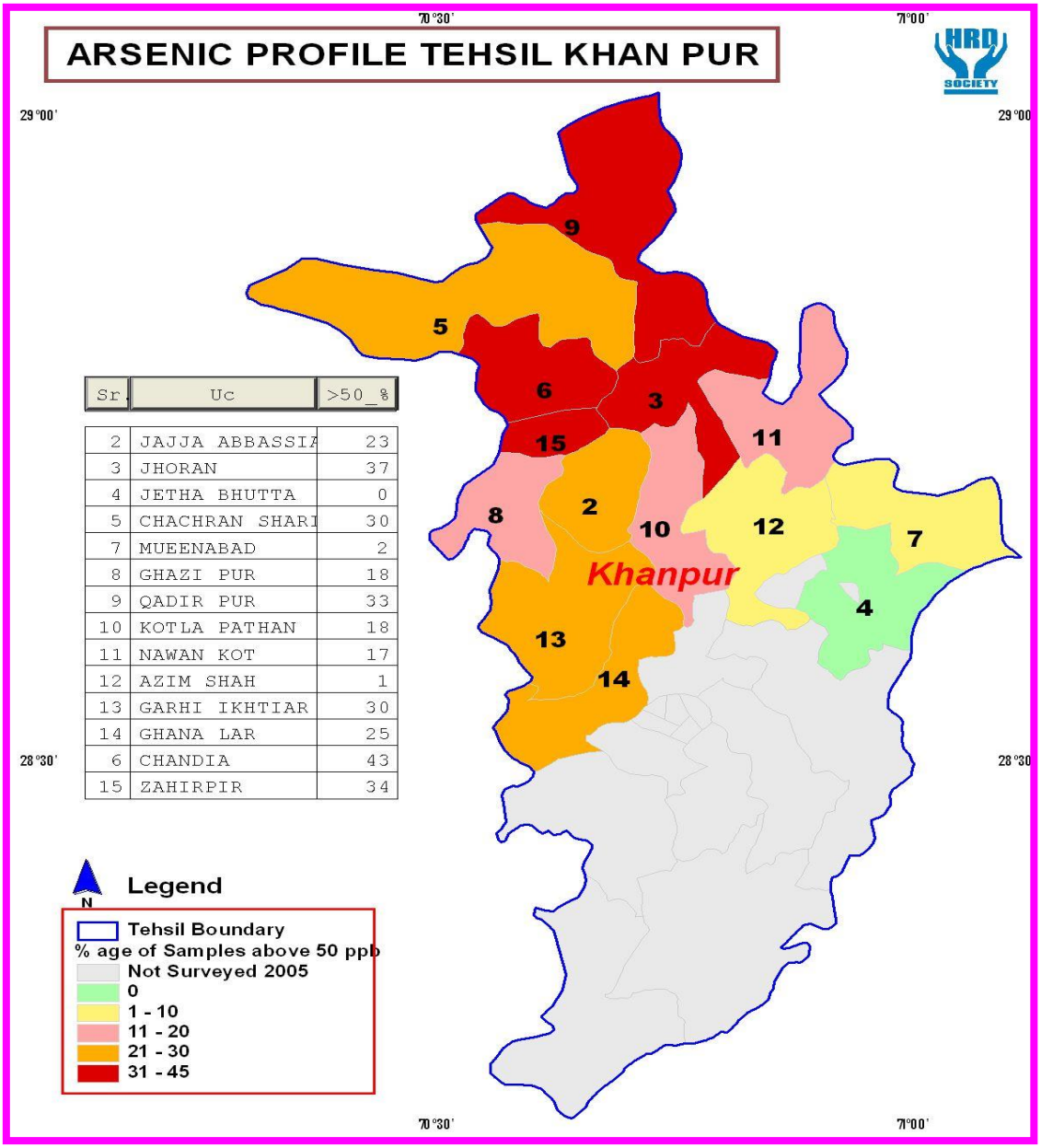


Fig. 23: Arsenic contamination at village level at Union Council Chandia

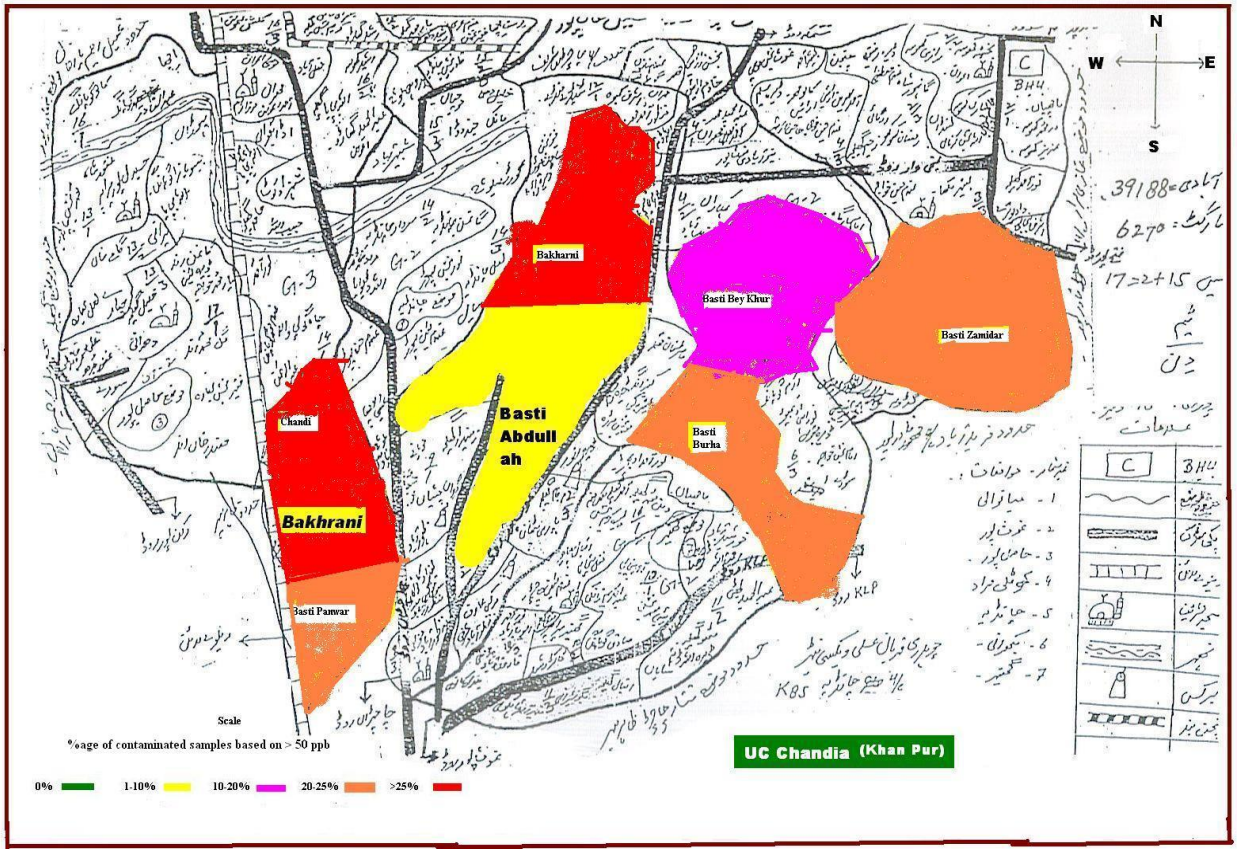


Fig. 24: Arsenic contamination at village level at Union Council Joharun

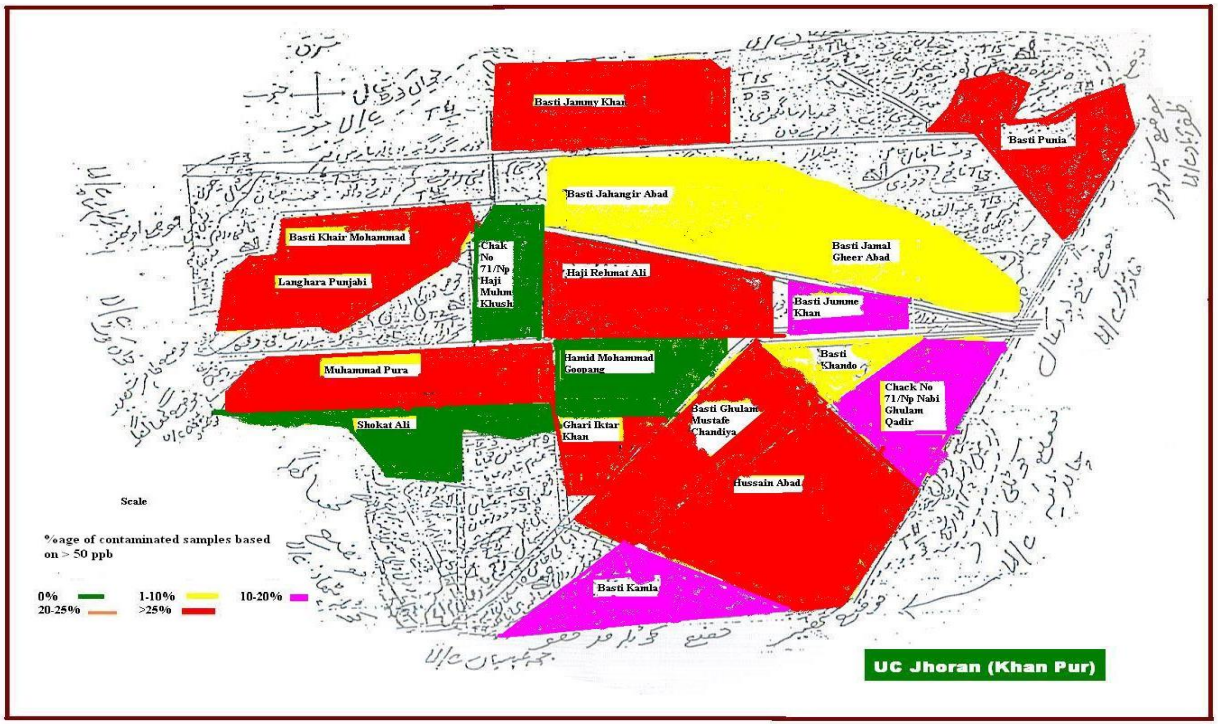


Fig. 25: Arsenic contamination at village level at Union Council Qadir Pur

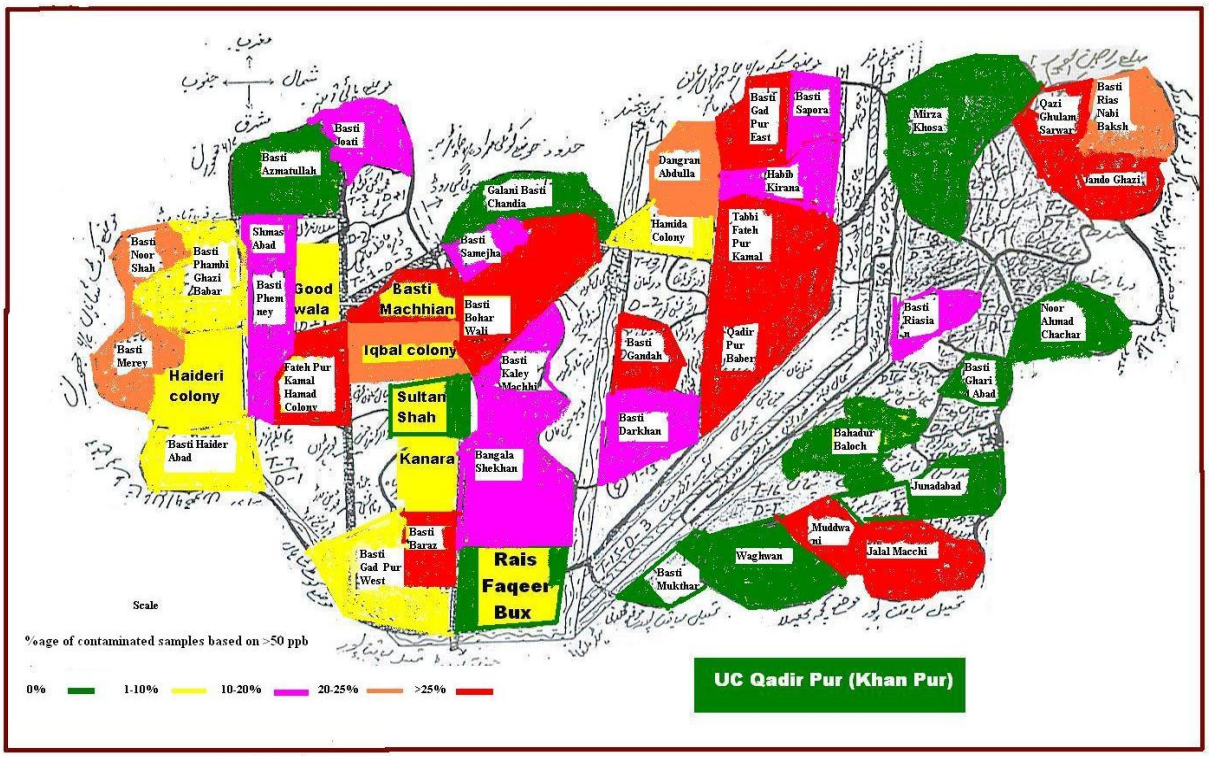


Fig. 26: Arsenic contamination at village level at Union Council Ghari Ikhtiar Khan

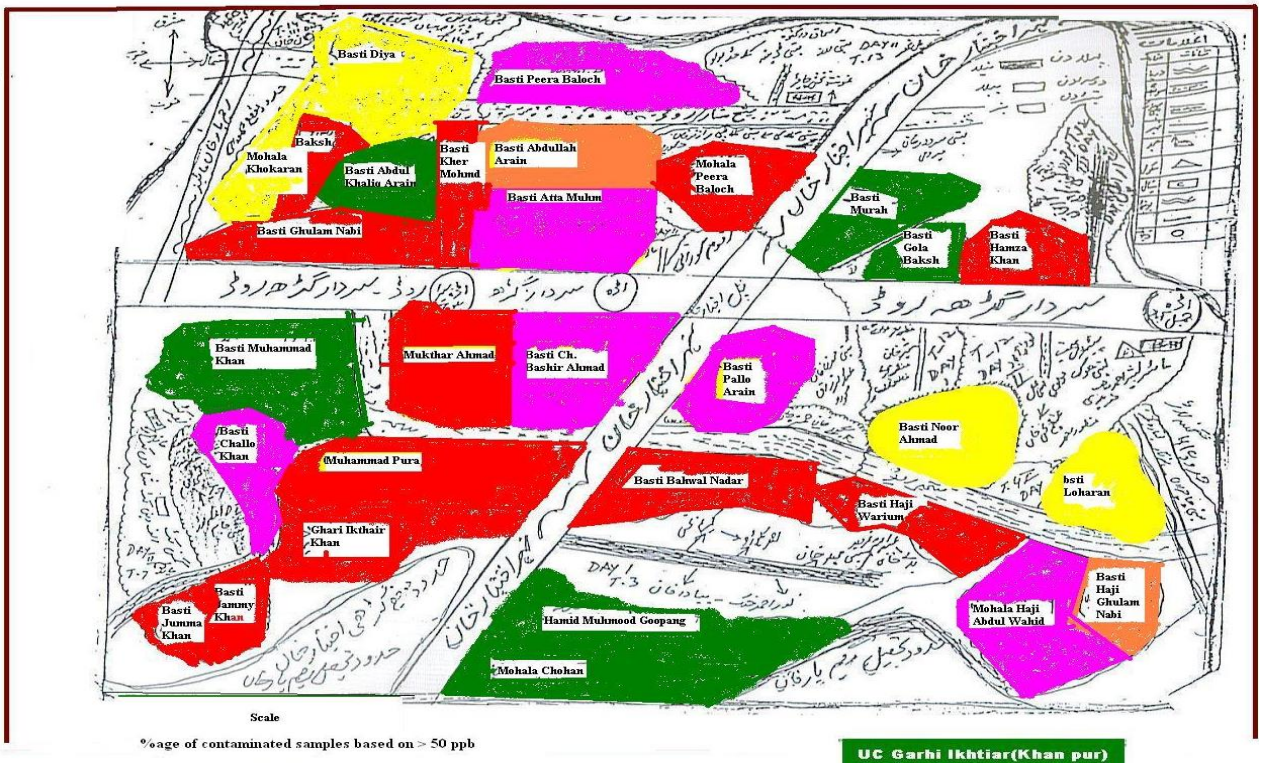


Fig. 27: Arsenic contamination at village level at Union Council Chacharn

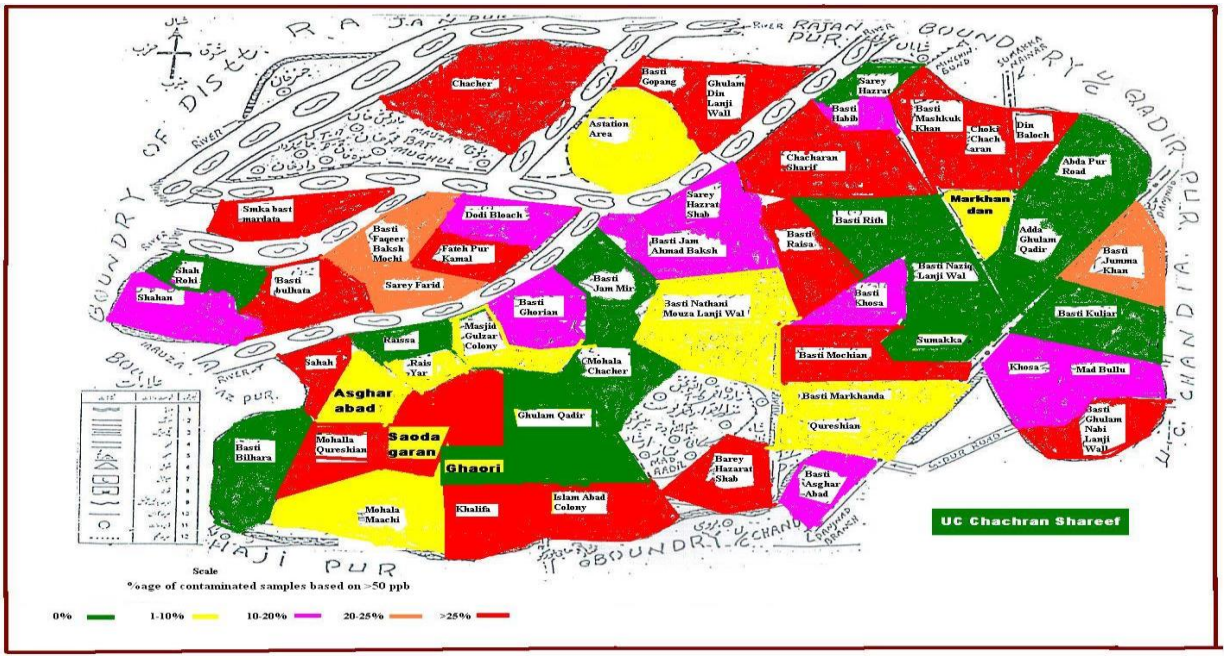


Fig. 28: Arsenic contamination at village level at Union Council Jajja Abbassian

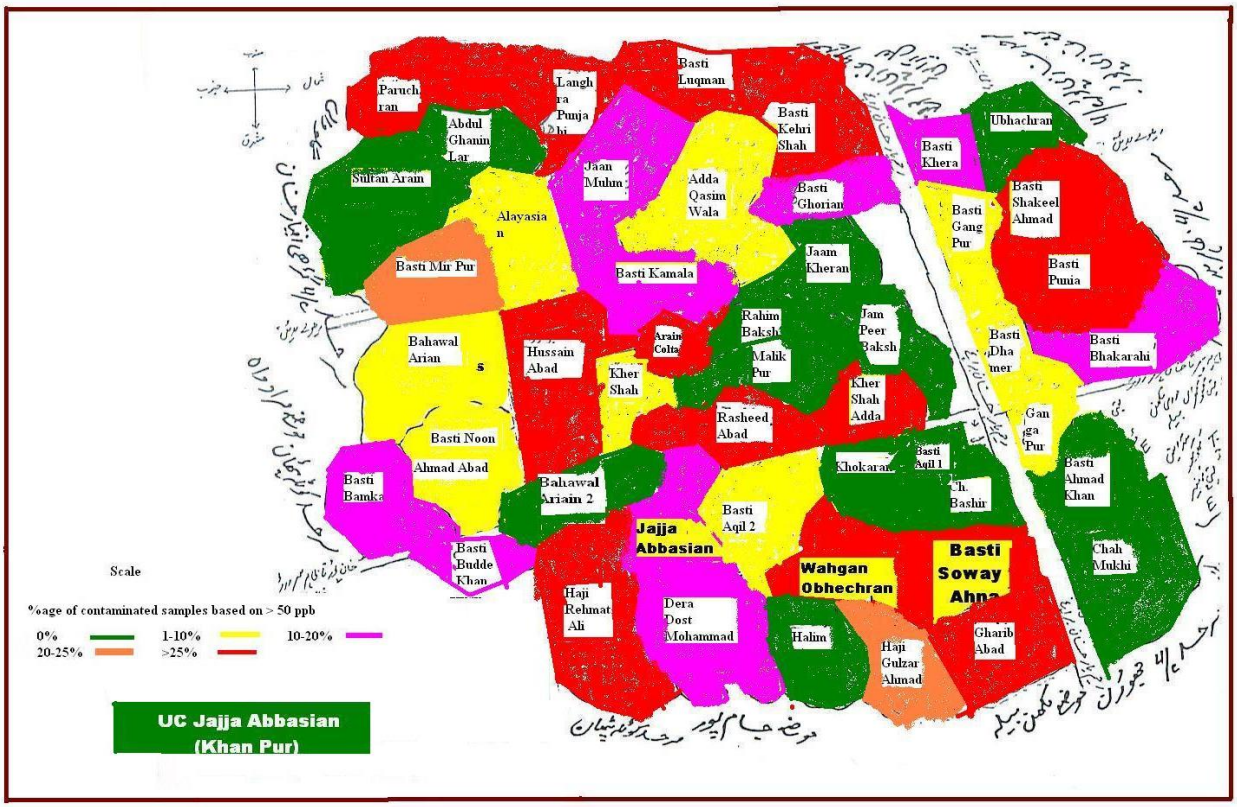


Fig. 29: Arsenic contamination at village level at Union Council Gehna Lar

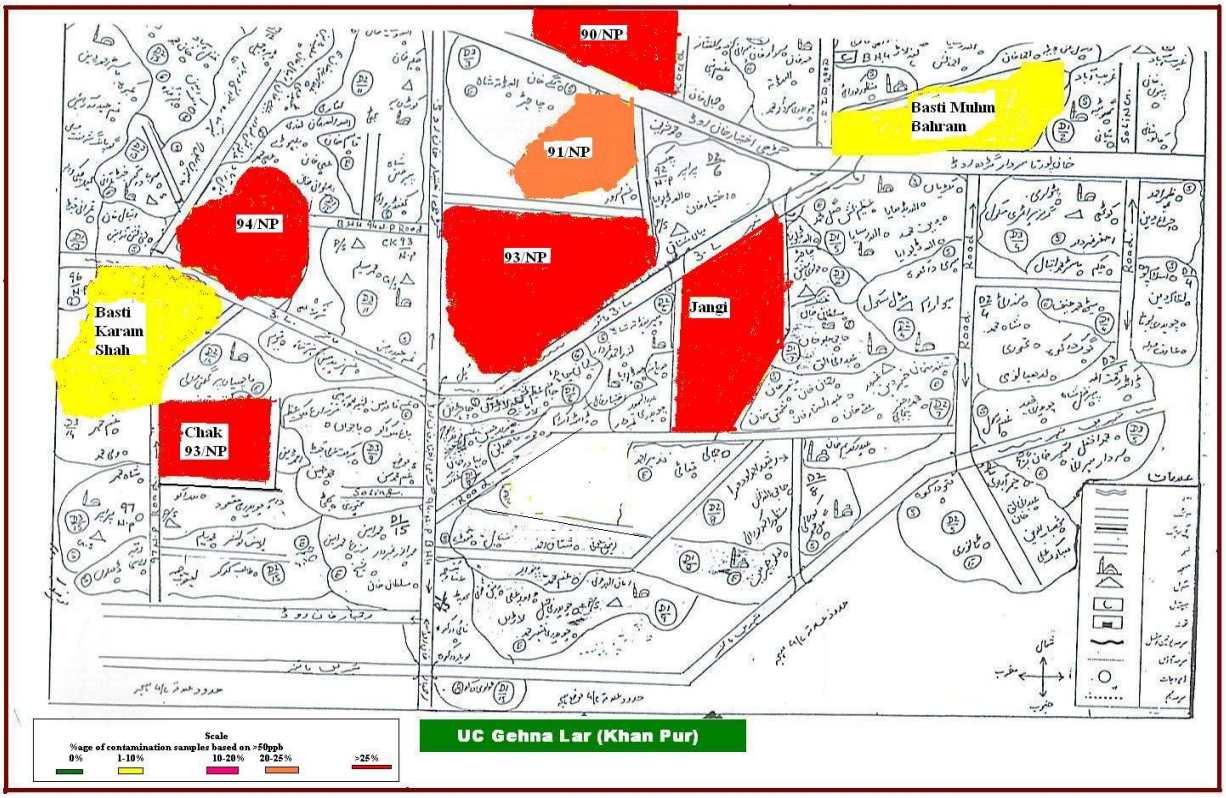


Fig. 30: Arsenic contamination at village level at Union Council Zahir Pir

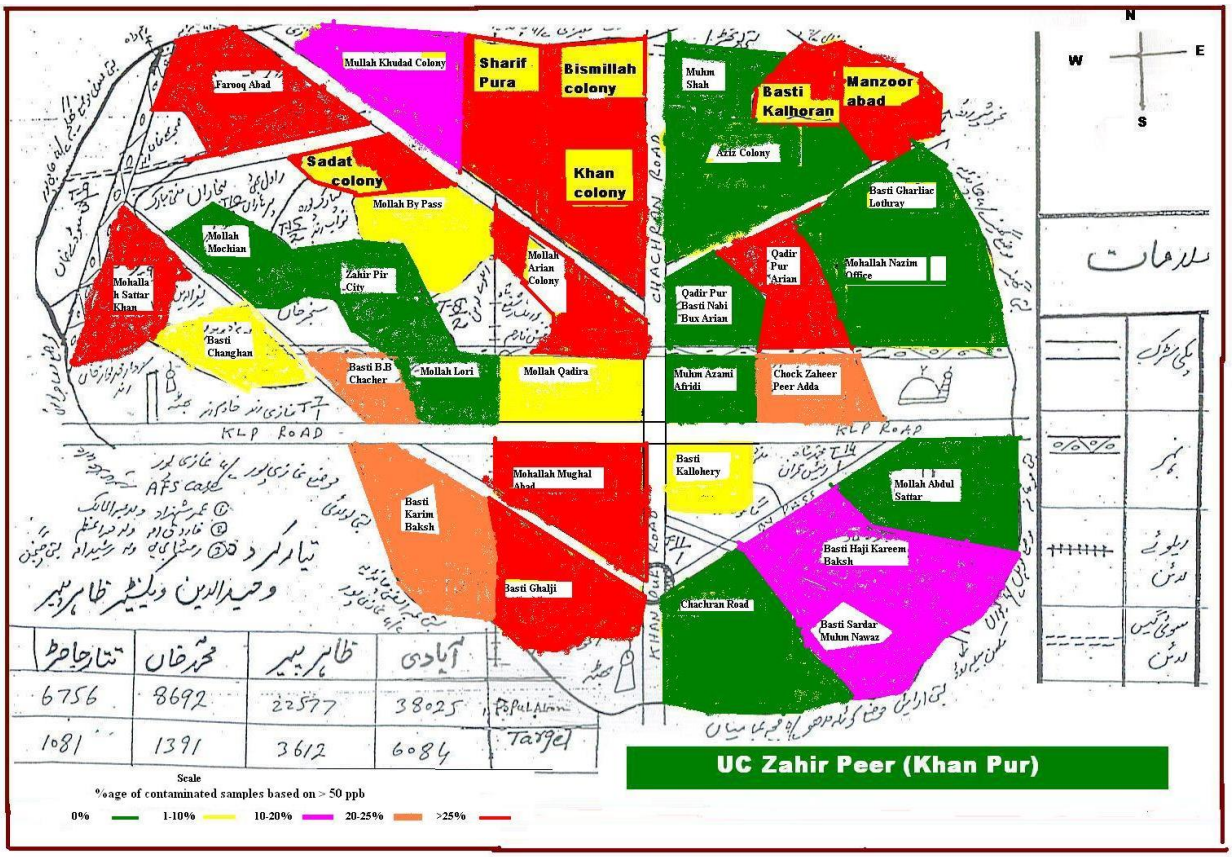


Fig. 31: Arsenic contamination at village level at Union Council Ghazi Pur

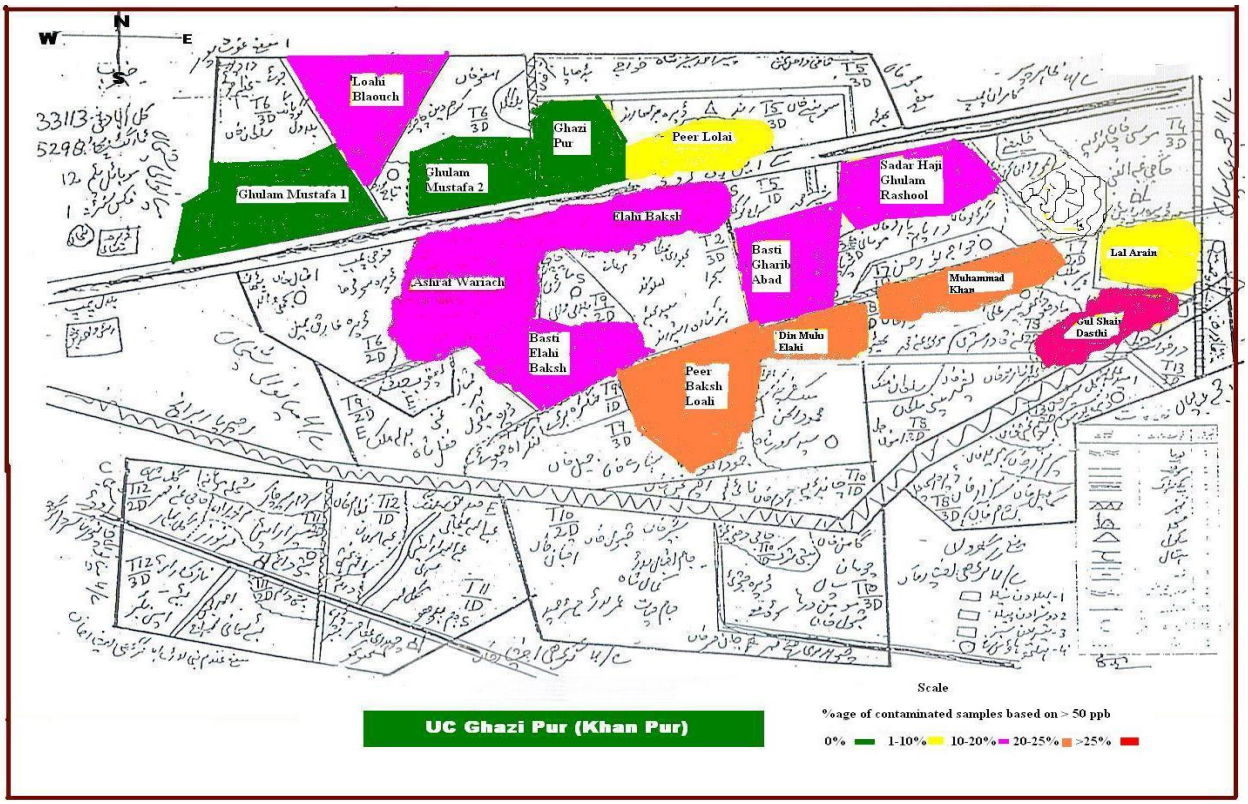


Fig. 32: Arsenic contamination at village level at Union Council Nawan Kot

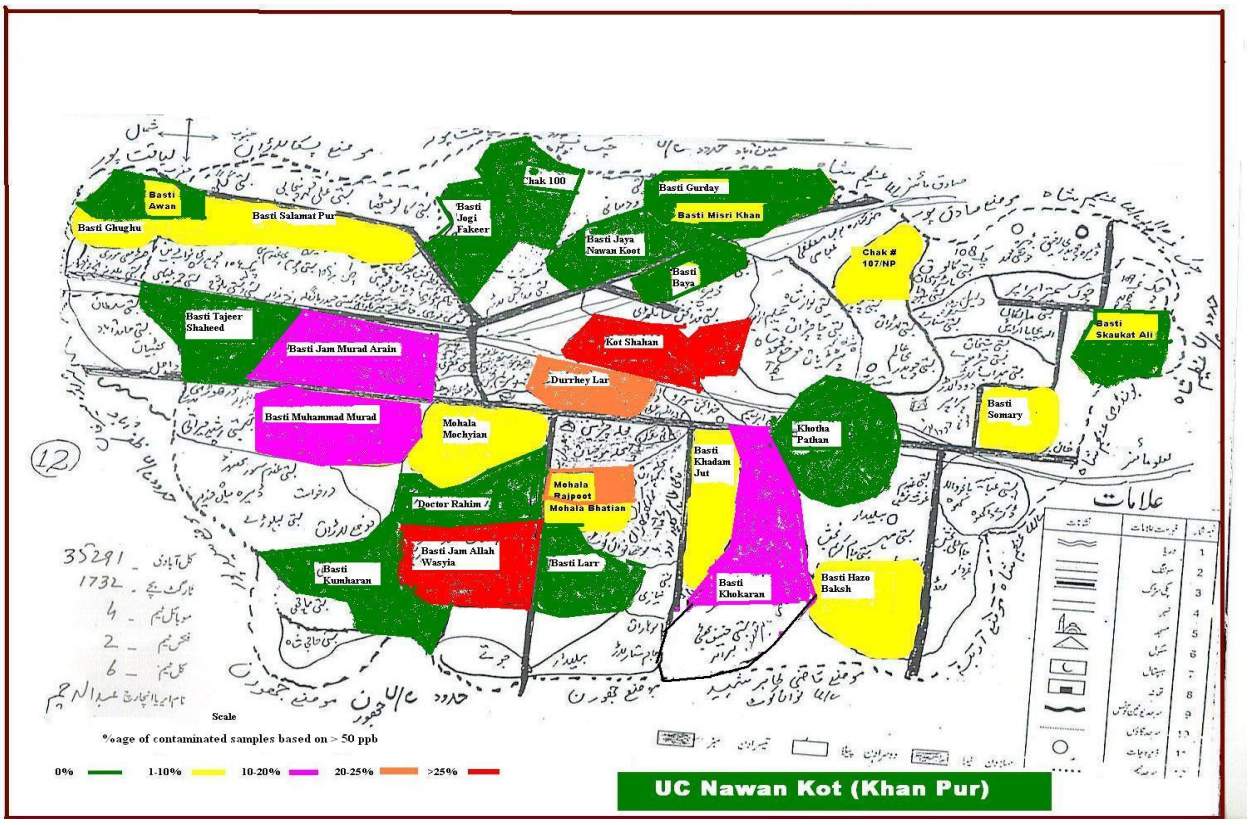


Fig. 33: Arsenic contamination at village level at Union Council Kotla Pathan

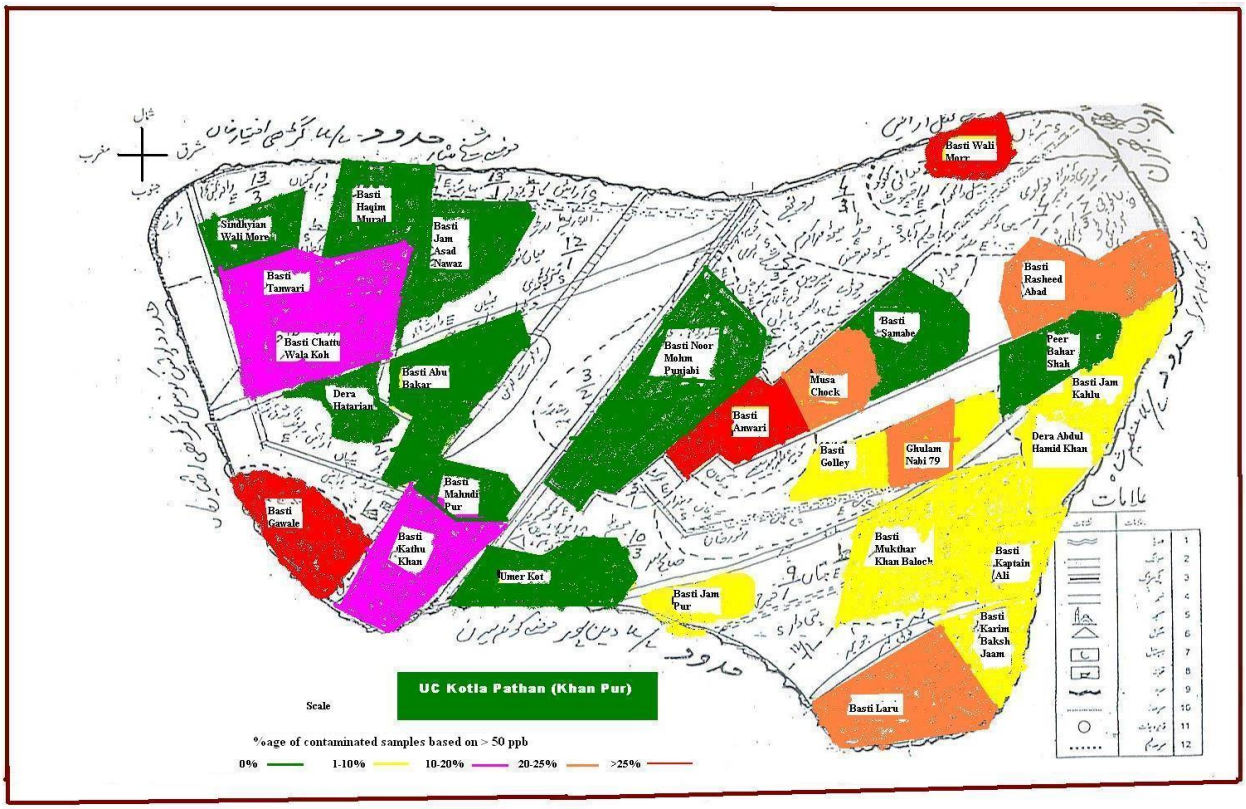
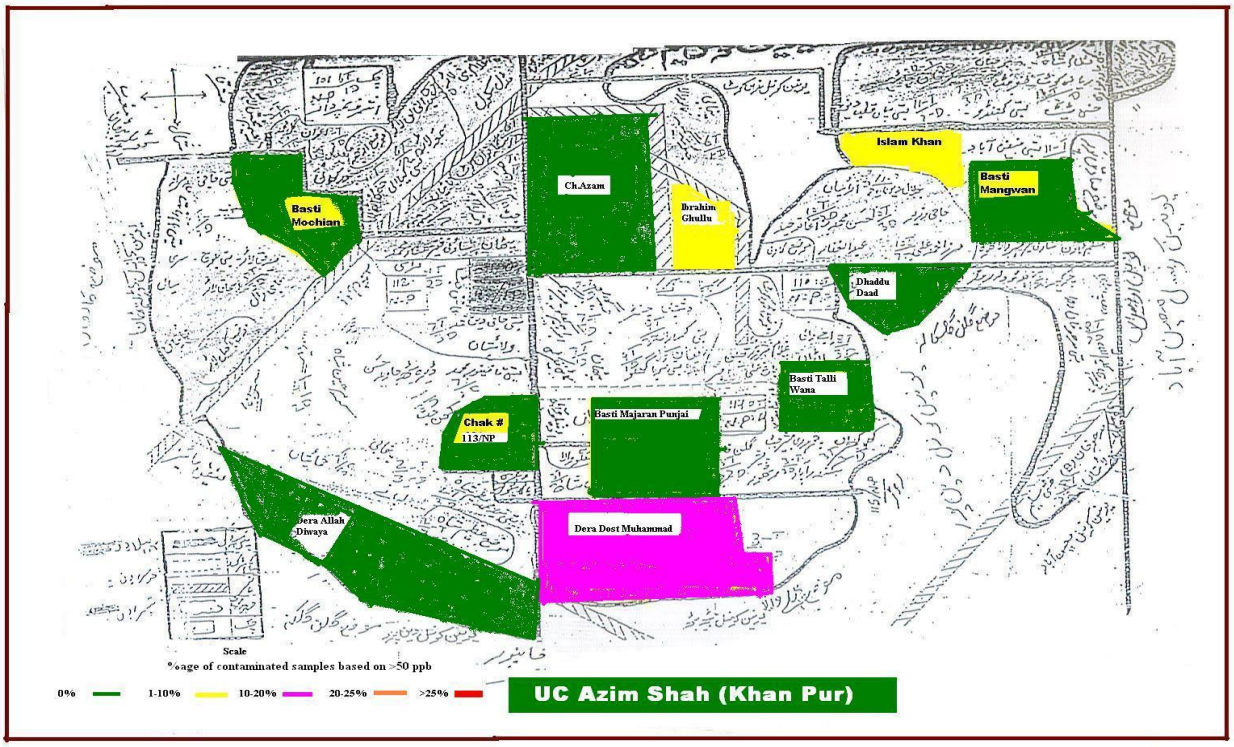


Fig. 34: Arsenic contamination at village level at Union Council Azim Shah



ARSENIC IN TEHSIL SADIQ ABAD

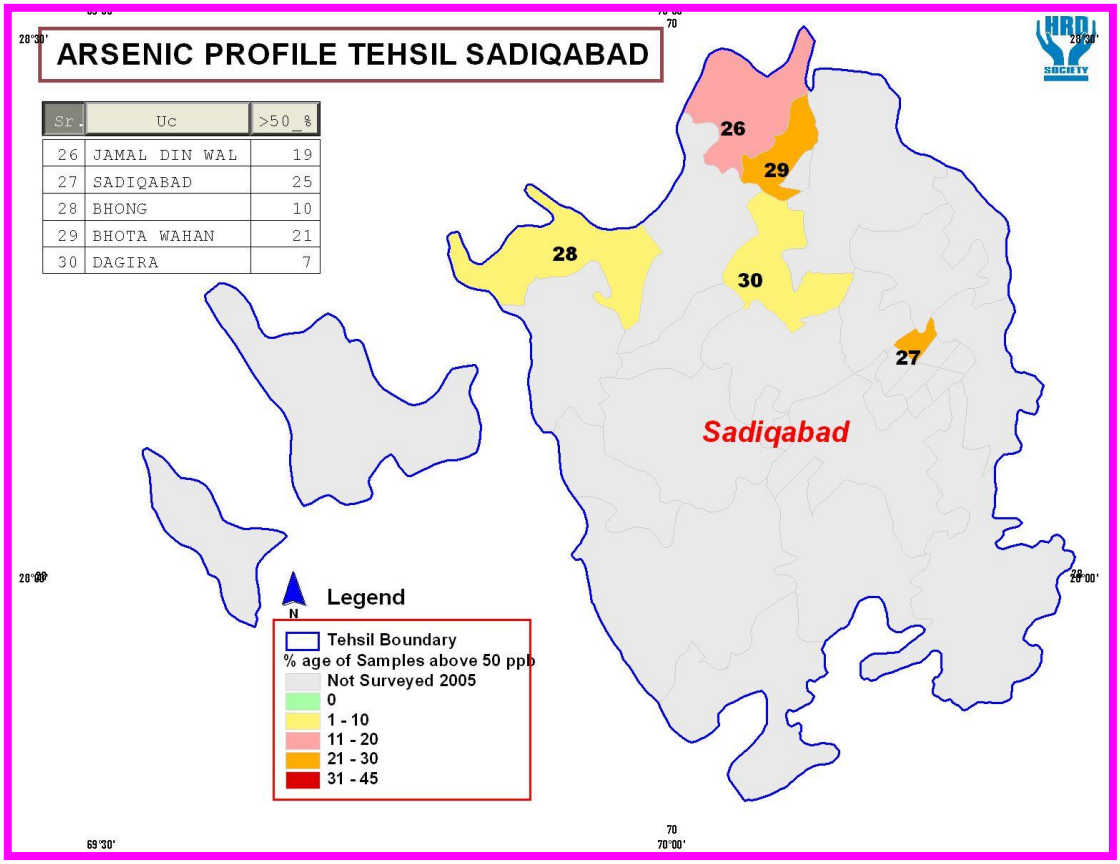
A total of 1199 drinking water sources were tested from different villages in 5 union councils of tehsil Sadiqabad to quantify the problem of Arsenic contamination in drinking water sources. Out of 1199 samples 19% drinking water sources found with above 50 ppb Arsenic. Whereas 81% samples having Arsenic below 50 ppb. 46% of the total tested sources were found to the safe as compared with WHO guideline value i.e. 10 ppb Arsenic. Out of 5 surveyed union councils Sadiqabad and Bhutta Wahn are the highly contaminated union councils with 25 and 21% of the total tested sources having Arsenic above 50 ppb respectively. Dagran and Bhung are the union councils having low arsenic contamination. Table 9 shows the status of arsenic contamination in drinking water sources of each surveyed union council of Tehsil sadiqabad whereas village level detail is given in annexure-III. Map given in Figure 35 shows the distribution of arsenic contamination in different UCs of Sadiqabad tehsil.

Table: 9 Level of Arsenic Contamination in Drinking Water of Tehsil Sadiq Abad

Union Council	Arsenic Samples	<=50 ppb			>50 ppb			Grand Total
		<=10	11-50	Sub total	51-100	>100	Sub total	
Bhung	No of Sample	7	11	18	2	0	2	20
	%age of Sample	35.00	55.00	90	10.00	0.00	10	
Bhutta Wahn	No of Sample	241	200	441	93	23	116	557
	%age of Sample	43.27	35.91	79.17	16.70	4.13	20.83	
Dagran	No of Sample	80	61	141	10	0	10	151

	%age of Sample	52.98	40.40	93.38	6.62	0.00	6.62	
Jamal Din Wali	No of Sample	136	67	203	27	20	47	**250**
	%age of Sample	54.40	26.80	81.2	10.80	8.00	18.8	
Sadiq Abad	No of Sample	82	83	165	42	14	56	**221**
	%age of Sample	37.10	37.56	74.66	19.00	6.33	25.34	
Sadiq Abad Total	No of Sample	546	422	968	174	57	231	**1199**
	%age of Sample	45.54	35.20	80.73	14.51	4.75	19.27	

Fig: 35 Arsenic contamination in Tehsil Sadiqabad



VALIDATION

Overall 23234 drinking water samples were collected for Arsenic testing. All the samples were tested by using Field Testing Kits. The data of field testing has been evaluated and presented through this report whereas 1141 samples were collected for cross analysis / validation purpose through laboratory test methods on atomic absorption spectrometer (AAS). The overall results are satisfactory that shows acceptable level of reliability and accuracy of kit results.

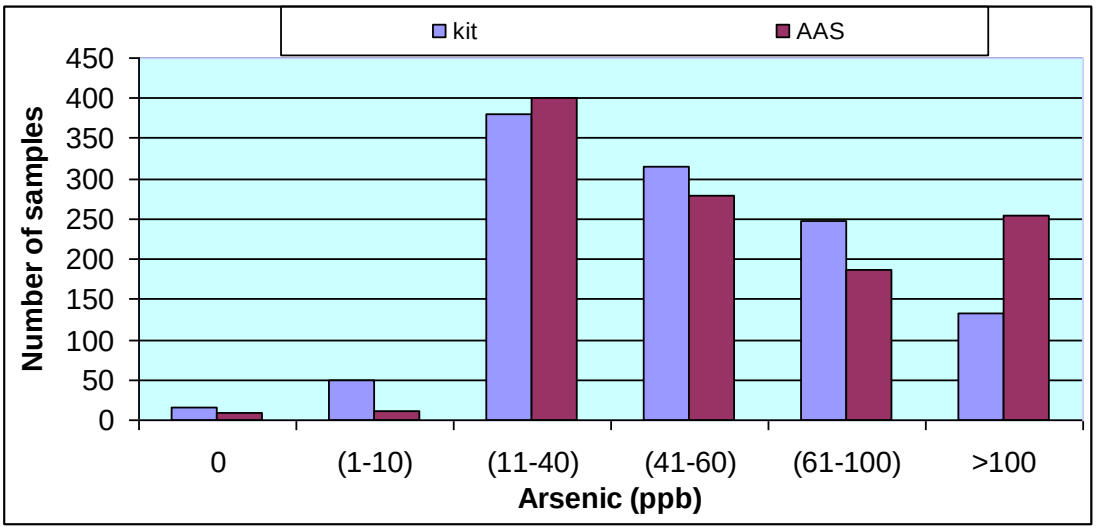
Comparison of Analytical Techniques for Arsenic Detection

A total of 1141 samples were tested from District RY Khan to determine the degree of the Arsenic contamination in drinking water sources by using the two different techniques Atomic Absorption Spectrometer (AAS) and Arsenic Kit. The comparison of analytical data by two different techniques showed difference of results on negative and positive side within the acceptable limits (Annexure-I). Out of the 1141 samples, 1% samples were found 0 ppb with AAS and arsenic testing kit. Results of AAS shows that 1% samples falls in the range of 1-10 ppb whereas kit results showed 4% samples in the same range. 33% samples were found in the range of 11-40 ppb by Arsenic testing kits on the other hand AAS results showed 35% samples in this range. According to the results of AAS, 24% samples have arsenic concentration in the range of 41-60ppb and 28% samples in the same rage with field testing kits. Analysis results on AAS showed that 16% samples fall in the range of 61-100ppb where as kits results were 22% in this range. AAS analysis showed 22% samples in range of $\geq$ 100 ppb where as Kit results indicate 12%. Table 10 show the overall comparison of results by AAS and field kits in different ranges where as detail results are given in annexure-I and A-I. Figure 36 represent graphically the comparison of results by analysis on AAS and field testing kits.

Table-10: Comparison of results of AAS and Arsenic testing Kits

S.No.	Arsenic (ppb)	Description	kit	AAS
1	0	No. samples	15	9
		%age	1	1
2	(1-10)	No. samples	49	12
		%age	4	1
3	(11-40)	No. samples	381	400
		%age	33	35
4	(41-60)	No. samples	315	278
		%age	28	24
5	(61-100)	No. samples	248	187
		%age	22	16
6	>100	No. samples	133	255
		%age	12	22

Fig: 36 Comparison of analysis results on AAS and Arsenic testing Kits



Difference in the results of AAS and arsenic testing kits is due to the following factors;

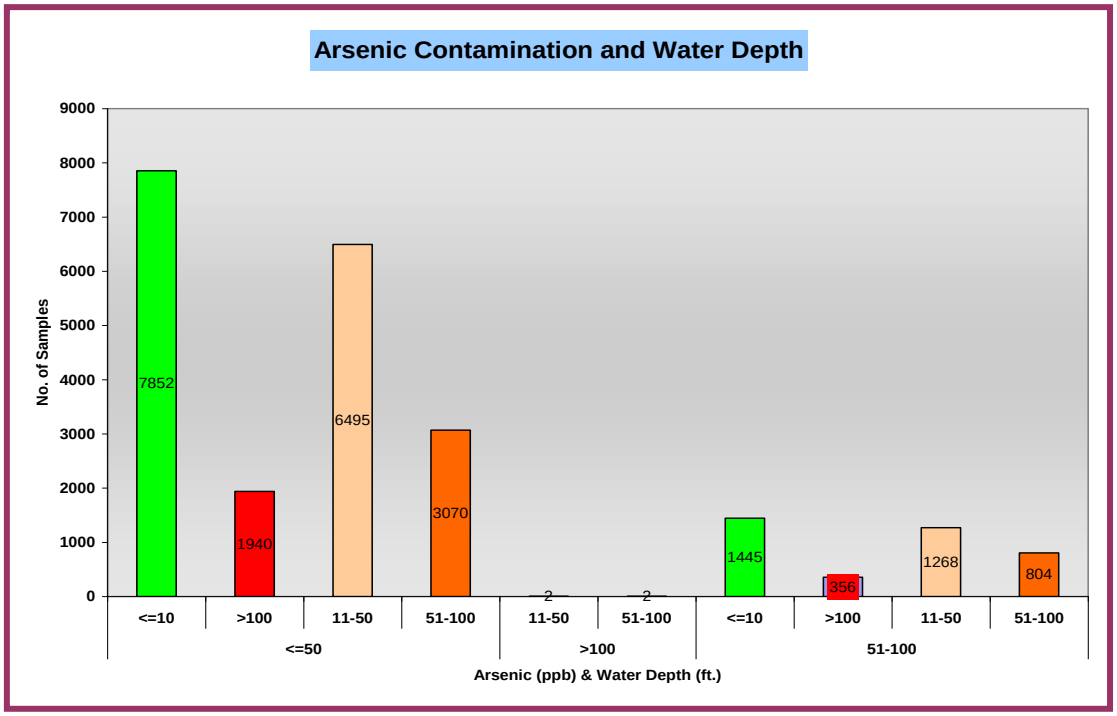
Kit is based on color comparison and eye sight may vary from person to person slightly make differ in the results. It always gives results in whole numbers and different ranges. It is good technique for estimation/testing in the field but accuracy is not comparable with AAS because AAS with Hydride mod is the best available Arsenic testing method based on atomic absorption. It is capable to reading trace amount of arsenic accurately in water samples. Due to the major difference in the principle of arsenic testing techniques by AAS and Arsenic kits it recommended to analyze at least five percent of samples on AAS to check the accuracy, reliability and actual contamination level.

Arsenic Contamination & Water Depth

Data was collected about the depth of each water source tested in the field. Most of the population in district Rahim Yar Khan use ground water from their own water source like hand pump or motor pump. Most of the population in the rural areas is poor and having no concept of water contamination that's why they do not bore deeply. Most of the bore in the surveyed area are below 50 ft. Water table is quite high even in some areas it if up to 20 ft. All the water sources were classified in three groups according to their depth i.e. less & equal to 50 ft. 51-100 ft and above 100 ft. After analysis of data it was found that 19357(70%) sources have depth of ≤ 50 ft. out of total 23234 water sources, 3873(30%) sources at 51-100 ft whereas only 4 water sources above 100ft. Table 11 and figure given below shows the level of contamination at different water depth.

Table-11: Arsenic contamination with relation to water depth

Depth (ft.)	AS-ppb	No. of water samples
<=50	<=10	7852
	>100	1940
	11-50	6495
	51-100	3070
	Total	**19357**
>100	11-50	2
	51-100	2
	Total	**4**
51-100	<=10	1445
	>100	356
	11-50	1268
	51-100	804
	Total	**3873**



PROBLEMS / CONSTRAINTS FACED

Followings were the different problems faced during the implementation of the project activities for sampling:

- Color comparator chart provided with Wegtech was not properly printed and it delayed the sampling for about 2 months.

- Field teams of Health department were very slow and volunteers were hired by HRDS on the request of DHO for sampling purpose.

- A delayed supply of Field Testing Kits by UNICEF was also the major reason for delay in project activities.

- Results of validation samples from PCRWR laboratory received very late after the completion all the field work, which could not help us to guide for the improvement of analysis in the field.

- Accurate village data is not available village reported in census report not matched with the actual village names in some cases. Some villages are very small comprising of only 4 to 5 houses every family have its own village or basti.

RECOMMENDATIONS

Following are the recommendations made on the basis of the results of Arsenic testing in district Rahim Ray Khan:

- Tehsil Liaqatpur should also be monitored comprehensively.

- Mitigation works need to be initiated in an effective way in all the Arsenic contaminated identified areas.

- It has been observed that there had been almost very little variations in results of samples validation through laboratory methods and Field Testing Kits. The level of precision through Field Testing Kits could be further enhanced through repeated trainings and working orientations of field staff on field analytical techniques.

- The HRDS now has the capacity to produce the Field Testing Kits. If the production of these Kits at NGO level could be encouraged then the delays in monitoring activities would be overcome in future.

- House hold and user friendly Arsenic mitigation methods need to be promoted in the affected areas.

- Mitigation awareness campaign needs to be launched to save people from Arsenic hazards through community organization.

- Alternative safe drinking water sources needs to be searched out in the surrounding of the affected villages and water supply schemes to the population.

- Identification of Arsenicosis patients in the identified Arsenic contaminated areas must be initiated.

- Further areas should be monitored to identify the drinking water quality problems

- Bacteriological contamination of drinking water is another major issue in Pakistan. Bacteriological monitoring and mitigation practices should be started along with Arsenic monitoring for ensuring safe and healthy nation.

Tehsil Level Analysis of Arsenic Contamination(ppb) District Rahim Yar Khan								
Tehsil	Arsenic Samples	<=50 ppb			>50 ppb			Grand Total
		<=10	11-50	Sub total	51-100	>100	Sub total	
Khan Pur	No of Sample	5449	5099	10548	2622	1427	4049	14597
	%age of Sample	37.33	34.93	72.26	17.96	9.78	27.74	
Rahim Yar Khan	No of Sample	3302	2244	5546	1080	812	1892	7438
	%age of Sample	44.39	30.17	74.56	14.52	10.92	25.44	
Sadiq Abad	No of Sample	546	422	968	174	57	231	1199
	%age of Sample	45.54	35.20	80.73	14.51	4.75	19.27	
Rahim Yar Khan Total	No of Sample	9297	7765	17062	3876	2296	6172	23234
	%age of Sample	40.01	33.42	73.44	16.68	9.88	26.56	
Tehsil Khan Pur								
Union Council	Arsenic Samples	<=50 ppb			>50 ppb			Grand Total
		<=10	11-50	Sub total	51-100	>100	Sub total	
Azim Shah	No of Sample	74	143	217	3	0	3	220
	%age of Sample	33.64	65.00	98.64	1.36	0.00	1.36	
Chachran	No of Sample	961	1052	2013	513	357	870	2883
	%age of Sample	33.33	36.49	69.82	17.79	12.38	30.18	
Chandia	No of Sample	141	137	278	128	79	207	485
	%age of Sample	29.07	28.25	57.32	26.39	16.29	42.68	
Gehna lar	No of Sample	224	116	340	64	49	113	453
	%age of Sample	49.45	25.61	75.06	14.13	10.82	24.94	
Ghari Ikhtiar Khan	No of Sample	605	435	1040	241	196	437	1477
	%age of Sample	40.96	29.45	70.41	16.32	13.27	29.59	
Ghazi Pur	No of Sample	312	257	569	87	34	121	690
	%age of	45.22	37.25	82.46	12.61	4.93	17.54	

	Sample							
Jajja Abasian	No of Sample	846	904	1750	397	137	534	**2284**
	%age of Sample	37.04	39.58	76.62	17.38	6.00	23.38	
Jeetha Butta	No of Sample	20		20	0	0	0	**20**
	%age of Sample	100.00	0.00	100	0.00	0.00	0	
Jhoran	No of Sample	257	227	484	157	133	290	**774**
	%age of Sample	33.20	29.33	62.53	20.28	17.18	37.47	
Zahir Peer	No of Sample	464	392	856	161	29	190	**1046**
	%age of Sample	44.36	37.48	81.84	15.39	2.77	18.16	
Muinabad	No of Sample	95	24	119	2	1	3	**122**
	%age of Sample	77.87	19.67	97.54	1.64	0.82	2.46	
Nawan Kot	No of Sample	271	216	487	91	6	97	**584**
	%age of Sample	46.40	36.99	83.39	15.58	1.03	16.61	
Qadir Pur	No of Sample	578	431	1009	293	193	486	**1495**
	%age of Sample	38.66	28.83	67.49	19.60	12.91	32.51	
Zahir Peer	No of Sample	601	765	1366	485	213	698	**2064**
	%age of Sample	29.12	37.06	66.18	23.50	10.32	33.82	
Khan Pur Total	No of Sample	5449	5099	10548	2622	1427	4049	**14597**
	%age of Sample	37.33	34.93	72.26	17.96	9.78	27.74	

Tehsil Rahim Yar Kahn

Union Council	**Arsenic Samples**	**<=50 ppb**			**>50 ppb**			**Grand Total**
		<=10	**11-50**	**Sub total**	**51-100**	**>100**	**Sub total**	
Akram Abad	No of Sample	270	476	746	67	58	125	**871**
	%age of Sample	31.00	54.65	85.65	7.69	6.66	14.35	
Amin Garh	No of Sample	23	14	37	0	0	0	**37**
	%age of Sample	62.16	37.84	100	0.00	0.00	0	
Bahoudi Pur Quraishian	No of Sample	64	69	133	62	42	104	**237**
	%age of Sample	27.00	29.11	56.12	26.16	17.72	43.88	
Glur Masu Khan	No of Sample	85	39	124	9	15	24	**148**
	%age of	57.43	26.35	83.78	6.08	10.14	16.22	

	Sample							
Haji Pur	No of Sample	18	13	31	5	4	9	**40**
	%age of Sample	45.00	32.50	77.5	12.50	10.00	22.5	
Kot Mahdi Shah	No of Sample	245	146	391	65	45	110	**501**
	%age of Sample	48.90	29.14	78.04	12.97	8.98	21.96	
Mianwali Qureshian	No of Sample	867	566	1433	286	216	502	**1935**
	%age of Sample	44.81	29.25	74.06	14.78	11.16	25.94	
Murtaza Abad	No of Sample	59	58	117	40	26	66	**183**
	%age of Sample	32.24	31.69	63.93	21.86	14.21	36.07	
Rajan Pur Kallan	No of Sample	333	183	516	158	136	294	**810**
	%age of Sample	41.11	22.59	63.70	19.51	16.79	36.30	
Sharien	No of Sample	664	337	1001	218	215	433	**1434**
	%age of Sample	46.30	23.50	69.80	15.20	14.99	30.20	
Sonak	No of Sample	260	265	525	153	45	198	**723**
	%age of Sample	35.96	36.65	72.61	21.16	6.22	27.39	
Tibbi Gull Muhammed	No of Sample	414	78	492	17	10	27	**519**
	%age of Sample	79.77	15.03	94.80	3.28	1.93	5.20	
Tehsil Rahim yar Kahn Total	No of Sample	3302	2244	5546	1080	812	1892	**7438**
	%age of Sample	44.39	30.17	74.56	14.52	10.92	25.44	

UC Level Analysis of Arsenic Contamination(ppb)

Tehsil Sadiq Abad

Union Council	Arsenic Samples	<=50 ppb			>50 ppb			Grand Total
		<=10	11-50	Sub total	51-100	>100	Sub total	
Bhung	No of Sample	7	11	18	2	0	2	**20**
	%age of Sample	35.00	55.00	90	10.00	0.00	10	
Bhutta Wahn	No of Sample	241	200	441	93	23	116	**557**
	%age of Sample	43.27	35.91	79.17	16.70	4.13	20.83	
Dagran	No of Sample	80	61	141	10	0	10	**151**
	%age of Sample	52.98	40.40	93.38	6.62	0.00	6.62	

Jamal Din Wali	No of Sample	136	67	203	27	20	47	**250**
	%age of Sample	54.40	26.80	81.2	10.80	8.00	18.8	
Sadiq Abad	No of Sample	82	83	165	42	14	56	**221**
	%age of Sample	37.10	37.56	74.66	19.00	6.33	25.34	
Sadiq Abad Total	No of Sample	546	422	968	174	57	231	**1199**
	%age of Sample	45.54	35.20	80.73	14.51	4.75	19.27	

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