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SEARCH OF SUITABLE QUALITY DRINKING WATER HAND PUMPS: A CASE STUDY FROM FOUR BLOCKS (RAIPUR, SARENGA, RANIBUNDH, SIMAPAL) OF BANKURA DISTRICT IN WEST BENGAL, INDIA.

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ABSTRACT:

This paper ardently deals with the assessment of comparatively best water sources from hand pumps in 04 blocks of Bankura Districts in West Bengal. The water quality was tested according to the guidelines provided by APHA (1998). A total of 228 hand pumps drinking water out of selected 230 were analyzed for important physicochemical parameters to select suitable hand pumps for further use in a rural water supply scheme (Dual Use Solar Pump Pipe Water Supply) of PHED, Bankura. Different parameters like physical parameters i.e., pH, turbidity and total dissolved solids (TDS) and chemical parameters i.e., alkalinity, total hardness, iron and fluoride were analyzed for assessment of drinking water. Results showed that turbidity of 19.74%, total dissolved solids of 0.44%, total hardness of 4.39%, iron of 67.98% and fluoride of 0.88% selected hand pumps were not in the permissible ranges specified by the BIS standards of drinking water.

KEYWORDS: Drinking Water, Fluoride, Iron, Physicochemical.

INTRODUCTION:

Water is a vital source of life and safe drinking water is most essential thing for good health of human. Being a basic need of human development, health all wellbeing, safe drinking water is an internationally accepted human right (WHO, 2001). With the increased human activities in urban, rural, industrial and agricultural sectors surface and ground water has altered its natural properties. According to Pandey (2005) some natural processes also cause the changes in groundwater quality, directly or indirectly. Even in developing nation majority of population is suffering from health problems associated with either shortage of drinking water or

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contaminated water. Every year more than 250 million new cases of waterborne diseases are reported, resulting in death of 10 million people (Mc Feters, 1990). The relationships between water quality and health problems are very complex which have both positive and negative effects (Tebbut, 1983). Inferior quality of groundwater results in high sanitation cost and potential health hazards. Moreover the district of Bankura is known as drought-prone and majority of the shallow wells go to dry or retain scanty water, which dry up during winter and mostly in summer Nag and Ghosh (2011). Therefore, the present study was aimed to find out comparatively better water quality sources for further use in a rural water supply scheme (Dual Use Solar Pump Pipe Water Supply) of PHED, Bankura.

MATERIALS AND METHODS:

STUDY AREA:

Geographically Bankura district is situated between plains of Bengal on the east and Chhota Nagpur plateau on the west (220 38' N to 230 36' N and 860 36' E to 870 46' E). In the area of 6,788 square kilometers its north-east part is separated by Damodar river from Bardhman district. Its south-east part is bounded by Hoogly district, on the south by Paschim Medinipur district and the western part is covered by Purulia district. Rivers in the district flow from north-east to the south-west in course roughly parallel to one another. The most characteristic geological feature of the district is the area of laterite and associated rocks of sand and gravel. Administratively Bankura district is one of the seven district of Burdwan division in the Indian state of West Bengal. The district comprises three subdivisions Bankura sadar, Khatra and Bisanpur. Khatra subdivision consists of eight community development blocks Indpur, Khatra, Hirbandh, Raipur, Sarenga, Ranibundh, Simlapal and Taldangra. Present study was carried out in four different blocks *i.e.*, Raipur, Sarenga, Ranibundh and Simapal.

SAMPLING SITE:

Locations of hand pump were pre selected uniformly to cover all four blocks by the Public Health Engineering Department (PHED), Bankura Division, for the purpose to select hand pumps for the installation of dual use solar pump pipe water supply. The sampling was performed in course of survey in the month of February, 2014. On site, water samples were collected in such a manner that neck of collection bottle is below the hand pump to assure safe sampling. After adding preservative; water samples brought to the district water testing laboratory of PHED Bankura for physicochemical analysis. Using a satellite based instrument (GPS Meter) GPS location of each site was recorded and S. Sl. No (Survey Serial Number) was marked over each hand pump. Survey and sampling was performed by two different teams of surveyors, therefore, S. Sl. No. marked over hand pumps are not in a row and serial in locality. A total 230 sites were surveyed and 228

samples were collected at two sites the hand pump was temporarily not functioning.

PHYSICAL TEST OF WATER:

Physical analysis of water was carried out by standard methods for the examination of drinking water and waste water (APHA, 1998). The pH of all samples was determined by using digital pH meter (Model 335, Systronics). Turbidity was determined by Nephalo turbidity meter (Model 132, Systronics). Total Dissolved Solids were determined by using a digital TDS Meter (Hi Media's TDS-3).

CHEMICAL TEST OF WATER:

Chemical analysis of drinking water was carried out by standard methods for the examination of water and waste water (APHA, 1998). Total Hardness was determined titrimetrically through 0.01 N of ethylene diamine tetraacetic acid (EDTA) in presence a of ammonia buffer solution in sample water by using Erichromr black T indicator. Alkalinity was also determined titrimetrically by using phenolphthalein and methyl orange indicators, the total alkalinity in water samples were estimated with 2.5 x 10-2 M Hydro chloric acid. Iron was determined spectrophotometrically with Ferrospectral reagent which forms an orange red complex with ferrous iron in the pH range 2.0 to 3.5. Ferric iron is reduced to ferrous condition with hydroxylamine to determine total iron. Fluoride content was analyzed with the help of Orion Research Analyzer Model 407 A, fluoride ion selective electrode. Using the standard fluoride solution the Ion analyzer instrument was calibrated. The known quantity of water samples were added with 5 ml of TISAB buffer (Total Ionic Strength Adjustment Buffer) in a polythene container and then the concentration of fluoride was estimated by ion analyzer.

Table-1: DRINKING WATER SPECIFICATION: IS: 10500, 1991

Sl. No.	Parameter	IS: 10500 Requirement (Desirable Limit)	Undesirable effect outside the desirable limit	IS: 10500 Permissible limit in the absence of alternate source
01	pH	6.5 – 8.5	Beyond this range the water will affect the mucous membrane and / or water supply system	No relaxation
02	Turbidity (NTU)	5	Above 5, consumer acceptance decreases	10
03	Total Dissolved solids (mg/l)	500	Beyond this palatability decreases and may cause gastro intentional irritation	2000
04	Alkalinity (mg/l)	200	Beyond this limit taste becomes unpleasant	600
05	Total Hardness as $CaCO_3$ (mg/l)	300	Encrustation in water supply structure and adverse effects on domestic use	600
06	Iron as Fe, (mg/l)	0.30	Beyond this limit taste/ appearance are affected, has adverse effect on domestic uses and water supply structures, and promotes iron bacteria	1.0
07	Fluoride (mg/l)	1.0	Fluoride may be kept as low as possible. High fluoride may cause fluorosis	1.5

RESULTS AND DISCUSSION:

Hydrogen Ion Activity (pH):

pH is the expression of hydrogen ion concentration, more precisely, the hydrogen ion activity. It is an important parameter in assessing the water quality. Acidic state will prevail as pH value decreases and alkaline state will prevail as the pH value increases. The BIS (1991) limit for drinking water is 6.5 to 8.5 shown in Table 1. Out of 228 sites 70.62% sites were having pH under desirable limits and 29.38% sites below desirable limits. Block wise in Raipur 4.68%, Sarenga 18.42%, Ranibundh 38.09% and Simlapal 52.38% studied hand pumps having pH below desirable limit. The low pH does not cause any harmful effect (Boominathan and Khan, 1994). pH more than 8.0 are not suitable for effective disinfection while less than 6.5 enhances corrosion in plumbing system. Low pH leads to bitter metallic taste and corrosion, high pH leads to slippery feel and soda taste (http://www.epa.gov/safewater/index.htm). The range of pH of analyzed water samples varied between different sites is depicted in table 2 to 5.

Turbidity:

The optical property of water in which the light is scattered by the present particles is expressed in term of turbidity which is a principal physical characteristic of water. The range of desirable and permissible limit for turbidity in drinking water set by BIS is 5 to 10 NTU. In studied 228 sites 64.03% hand pumps having turbidity under desirable limit, 16.23% hand pumps under permissible limit and 19.74% hand pumps were having turbidity beyond to permissible limit. In Raipur 7.81%, Sarenga 23.68%, Ranibundh 30.15% and Simlapal 19.01% studied hand pumps having turbidity beyond permissible limit. The range of Turbidity of analyzed water samples varied between different sites is depicted in tables 2 to 5. Turbidity in drinking water is caused by suspended matters, such as clay, silt, finely divided organic and inorganic matter, soluble coloured organic compounds. High turbidity shows presence of large amount of suspended solids (Mariappan and Vasudevan, 2002).

Total Dissolve Salts (TDS):

Total dissolved solids are a general indicator of overall water quality. It denotes mainly the various kinds of mineral present in the water. The electrical conductivity of water samples correlates with the concentration of dissolved minerals or with what is commonly known as the total dissolved salts of water samples. Total dissolved solids give an estimation of the organic and inorganic salts dissolved in drinking water. The acceptable range of TDS is 500 mg/l and permissible range is 2000 mg/l. Allover 85.96% studied hand pumps having TDS under desirable limit, 13.59% hand pumps having under permissible limit and only one site in Simlapal was beyond permissible limit. Remarkably 26.98% hand pumps of Ranibundh blocks were under permissible limit in absence of other safe source of drinking water. The

range of TDS of analyzed water samples varied between different sites is depicted in table 2 to 5. Water with high dissolved solids generally is inferior in quality. Higher TDS may cause bad odour and test to drinking water, as well as cause scaling of pipes and corrosion. High TDS level is also an indicative of hardness in drinking water.

Total Alkalinity (TA):

Total alkalinity indicates acid neutralizing capacity of water. The alkalinity of groundwater is mainly due to carbonates and bicarbonates. The acceptable limit of alkalinity is 200 mg/l and in the absence of alternate water source, alkalinity up to 600 mg/l is acceptable for drinking as per BIS (1991). Total alkalinity of studied hand pumps were 62.72% under desirable limit and 37.28% under permissible limit but not beyond the permissible limit. Block wise 26.56% Raipur, 57.89% Sarenga, 53.97% Ranibundh and 19.04% Simlapal hand pump water were under permissible limit. It is itself not harmful to human being (Pande and Sharma, 1999) but high alkalinity imparts bitter taste in water. High alkaline water reacts with certain cations as a result accessories of water distribution system can corrode. The range of total Alkalinity of analyzed water samples varied between different sites is depicted in tables 2 to 5.

Total Hardness (TH):

In groundwater hardness is mainly contributed by bicarbonates, carbonates, sulphates and chlorides of calcium and magnesium. A positive reaction was observed between total hardness and alkalinity explained by Sharma (2001). The acceptable limit of total hardness is 200 mg/l. In all 04 blocks total hardness of analyzed hand pump water 65.79% under desirable limit, 29.82% under permissible limit and 4.39% beyond permissible limit. Block wise Raipur 6.25%, Sarenga 2.63%, Ranibundh 6.35% and Simlapal 1.59% hand pumps observed containing total hardness beyond permissible limit. In Ranibundh comparatively increased numbers of hand pumps (60.32%) were having hardness under permissible limit. The range of Total Hardness of analyzed water samples varied between different sites is depicted in tables 2 to 5. Hard water causes harmful effect upon the health of consumer. Use of hard water causes excessive soap consumption in home, laundries, textile and paper industries (De A. K., 1994).

Iron (Fe):

Iron is an essentially required trace element in human nutrition and metabolism. The minimum daily requirement of iron is ranged from about 10 to 50 mg/day (FAO/WHO 1988). Iron is easily dissolved in water, natural water contains variable amounts of iron despite its universal distribution and abundance. Iron in ground water is normally present in the ferrous or bivalent from (Fe^{++}) or insoluble Iron urban exposure to air. It is partially responsible for oxygen transport mechanism in the blood of all vertebrate and some invertebrate animals. Taste thresholds of

iron in water 0.1 mg/l for ferrous iron and 0.2 mg/l ferric Iron, giving a bitter or an astringent taste. The desirable limit of Fe in drinking water is 0.3 mg/l and maximum permissible limit is 1.0 mg/l. From all 04 blocks Iron of analyzed hand pump water were 8.33% under desirable limit, 23.89% under permissible limit and maximum 67.98% beyond permissible limit. Block wise Raipur 75%, Sarenga 86.84%, Ranibundh 58.73% and Simlapal 58.73% hand pumps observed containing Iron beyond permissible limit. Only 32.22% hand pumps of all studied were found either under desirable or permissible limit and in each block majority of sites was containing Iron beyond to permissible limit. The range of Iron of analyzed water samples varied between different sites is depicted in tables 2 to 5.

Fluoride (F):

Higher concentration of fluoride causes bone and dental fluorosis, however, less than 0.8 mg/l leads to dental caries. Recently in Bankura district the severe dental fluorosis 15.79% in boys and 35% in girls (>10 year groups) was reported by Das, *et al.*, (2013). The BIS (1991) desirable limit for fluoride in groundwater is 1.0 mg/l as given in Table 1. However, in temperate region this limit is 1.5 mg/l, where, water intake is low. The content of fluoride in hand pump of all blocks varied 94.3% under desirable limit, 4.82% under permissible limit and 0.88% beyond to permissible limit. Raipur and Sarenga blocks observed 100% sites having fluoride under desirable limit. In Ranibundh and Simlapal blocks 9.52% and 7.94% respectively sites were under permissible limit. Only in Ranibundh block 3.18% hand pump water were found beyond to the permissible limit. The range of Fluoride of analyzed water samples varied between different sites is depicted in tables 2 to 5. Earlier reports on excess fluoride content in drinking water and hand pumps of Bankura district has been reported by Chakrabarti and Bhattacharya (2013) and in different reports of the PHED West Bengal.

CONCLUSION:

In the present study, some variation in different water test of all sites may be due to domestic waste water contamination through different aquifers in the underground water. This results also supported by Mane et al., (2005) and Ruj (2001). The most important and first indicative physical parameter of drinking water is pH, this was found under the range of BIS: 10500, 1991, in study area, however at 29.38% sites it was slightly below to the desirable limit. Comparative Total Dissolved Solid of all sites was found satisfactory. On the basis of desirable and permissible limit, the range of drinking water alkalinity was also satisfactory. It was analysed that four blocks of Bankura district have uniform problem there was excess Iron content in drinking water which is followed by turbidity and hardness. Total studied sites of Raipur and Sarenga were observed

Table 2a: Site for water collection from Hand pumps of Raipur Block for physicochemical properties of drinking water.

Sl. N0.	S.SL. No.	Gram Panchayat	Name of Village	JL No.	GPS Location	
					Longitude	Latitude
01	AI 1	DEKO	GOLOR	332	22° 39'821" N	86° 55'722" E
02	AI 3	DEKO	PHUTIBERYA	337	22° 41'512" N	86° 56'049" E
03	AI 4	DEKO	KATAPAL	339	22° 41'307" N	86° 57'309" E
04	AI 5	DEKO	GOPALPUR	336	22° 40'069" N	86° 57'330" E
05	AI 6	DUNDAR	KHATANGA	61	22° 51'059" N	86° 55'319" E
06	AI 7	DUNDAR	KESA	4	22° 53'289" N	86° 53'461" E
07	AI 8	DUNDAR	BANKANALI	13	22° 53'476" N	86° 55'279" E
08	AI11	DHANARA	INDRAPUR	276	22° 43'705" N	86° 58'534" E
09	AI 12	DUNDAR	INDRAGHORE	14	22° 52'912" N	86° 55'649" E
10	AI 170	DEKO	BANDARBONI	338	22° 40'743" N	86° 57'551" E
11	AI 171	DEKO	DHEKO	330	22° 38'915" N	86° 56'137" E
12	AI 172	DHANARA	BAHERABONI	344	22° 42'487" N	86° 58'892" E
13	AI 173	DHANARA	FULBERIA	278	22° 44'029" N	86° 58'500" E
14	AI 174	DUNDAR	GUMKIHATA	63	22° 51'240" N	86° 55'025" E
15	AI 175	DUNDAR	MANHARA	75	22° 50'693" N	86° 53'474" E
16	AI 176	DUNDAR	KHEJURBEDIA	82	22° 51'595" N	86° 52'487" E
17	AI 177	DUNDAR	KALPATHER	2	22° 54'038" N	86° 53'276" E
18	AI 178	DUNDAR	RAIDIHI	12	22° 53'222" N	86° 55'091" E
19	AI 179	DUNDAR	BIRUDI	80	22° 52'078" N	86° 53'464" E
20	AI 180	SONAGARA	KARAMBERIA	88	22° 49'133" N	86° 50'902" E
21	AI 181	SONAGARA	KADMAGAR	91	22° 48'951" N	86° 48'283" E
22	AI 182	SONAGARA	DHENGAM BARAPAR	93	22° 48'312" N	86° 50'171" E
23	AI 183	PHOLKUSHMA	BARAGARI	256	22° 43'449" N	86° 50'863" E
24	AI 184	PHOLKUSHMA	DEBASOL	250	22° 43'498" N	86° 49'904" E
25	AI 185	PHOLKUSHMA	RASPAL	249	22° 43'810" N	86° 49'426" E
26	AI 186	PHOLKUSHMA	GHATUSOL	251	22° 43'260" N	86° 48'867" E
27	AI 187	PHOLKUSHMA	BARAPAYA	255	22° 42'351" N	86° 50'632" E
28	AI 188	PHOLKUSHMA	NAMASOL	314	22° 42'267" N	86° 51'338" E
29	AI 189	PHOLKUSHMA	BANSINALA	253	22° 42'104" N	86° 49'572" E
30	AI 190	PHOLKUSHMA	PAKADIHI	318	22° 41'033" N	86° 52'183" E
31	AI 191	PHOLKUSHMA	DHAU	316	22° 40'919" N	86° 51'309" E
32	AI 192	MELERA	GOCHDA	325	22° 39'504" N	86° 53'494" E
33	AI 193	MELERA	BORKOLA	320	22° 39'958" N	86° 52'055" E
34	AI 194	MELERA	KAMALPUR	259	22° 42'503" N	86° 52'746" E
35	AI 195	MELERA	KRISHNANAGAR	309	22° 42'150" N	86° 53'703" E
36	AI 196	MELERA	GAMDA	307	22° 41'807" N	86° 55'400" E
37	AI 197	MELERA	LURKA	324	22° 40'284" N	86° 54'577" E
38	AI 198	MONDOLKULI	AMRITPAL	245	22° 43'991" N	86° 51'844" E
39	AI 199	MONDOLKULI	BELPAHARI	244	22° 44'705" N	86° 53'408" E
40	AI 200	MONDOLKULI	MADANPUR	242	22° 44'319" N	86° 53'879" E
41	AI 201	MONDOLKULI	DHEKIKATA	261	22° 43'513" N	86° 53'797" E
42	AI 202	MONDOLKULI	CHAPAPAL	260	22° 43' 083" N	86° 53'988" E
43	AI 203	MONDOLKULI	AMCHURYA	236	22° 44'372" N	86° 57'052" E
44	AI 204	MONDOLKULI	BANSKANA	265	22° 42'777" N	86° 56'471" E
45	AI 205	MONDOLKULI	DANGARSAI	262	22° 44'121" N	86° 54'217" E
46	AI 206	SHYAMSUNDAR	MAGRA	247	22° 44'521" N	86° 50'228" E
47	AI 207	SHYAMSUNDAR	KUCHIPAL	155	22° 45'180" N	86° 49'701" E
48	AI 208	SHYAMSUNDAR	JARKA	153	22° 46'413" N	86° 50'697" E
49	AI 209	SHYAMSUNDAR	TURUBANDH	94	22° 47'779" N	86° 50'699" E
50	AI 210	SHYAMSUNDAR	NISCHINTIPUR	95	22° 47'278" N	86° 51'729" E
51	AI 211	SHYAMSUNDAR	JAJANATHPUR	151	22° 46'340" N	86° 52'050" E
52	AI 212	MOTEGODA	ANARA	203	22° 46'355" N	86° 56'845" E
53	AI 213	MOTEGODA	DANAPARA	204	22° 46'097" N	86° 57'283" E
54	AI 214	MOTEGODA	BARAPARA	202	22° 46'205" N	86° 57'398" E
55	AI 215	MOTEGODA	KARGALI	205	22° 45'803" N	86° 57'696" E
56	AI 216	SONAGARA	SAGARBHANGA	92	22°48' 544" N	86° 49' 365" E
57	AI 217	SONAGARA	PUKHURIA	89	22°49' 037" N	86° 49' 219" E
58	AI 218	SONAGARA	MURKUMBARADANGA	90	22°50' 072" N	86° 48' 808" E
59	AI 219	SONAGARA	DANGAR SAI	96	22°48' 125" N	86° 51' 645" E
60	AI 220	SONAGARA	MASRA	97	22°48' 331" N	86° 52' 377" E
61	AI 221	SONAGARA	BHADLI	86	22°48' 693" N	86° 53' 040" E
62	AI 222	SONAGARA	JHARI	87	22°49' 213" N	86° 52' 188" E
63	AI 223	SONAGARA	LOHAMARA	84	22°49' 608" N	86° 53' 596" E
64	AI 224	SONAGARA	SONAGARA	83	22°50' 526" N	86° 52' 244" E

Table 2b: Hand pumps of Raipur Block showing site information and physicochemical properties of drinking water.

Physicochemical Quality of Hand pump Water							
Sl. N0.	pH	Turbidity (NTU)	T.D.S (mg/l)	Alkalinity (mg/l)	Total Hardness (mg/l)	Iron (mg/l)	Fluoride (mg/l)
01	8.2	0.77	200	82	160	1.8687	0.322
02	7.4	13.6	200	240	300	4.5396	0.794
03	7.8	0.92	200	98	184	1.2574	0.384
04	6.9	2.96	200	88	120	1.3146	0.304
05	7.1	9.5	200	104	160	4.2621	0.594
06	7.6	5.71	300	120	176	4.7172	0.382
07	7.4	79.3	200	134	180	0.2336	0.618
08	6.9	1.81	100	210	296	1.2815	0.292
09	6.9	1.23	100	108	156	2.4224	0.331
10	6.5	6.02	300	428	520	1.8888	0.301
11	6.5	2.73	300	220	280	1.1727	0.488
12	6.5	2.28	200	192	224	0.6768	0.321
13	6.4	2.08	200	196	216	1.3749	0.36
14	6.5	34.5	300	160	260	5.0247	0.687
15	6.8	2.18	300	172	236	0.7833	0.805
16	6.2	3.59	1100	598	624	2.7111	0.231
17	6.5	7.9	900	322	496	5.1692	0.343
18	6.7	2.75	1400	520	704	1.7364	0.291
19	6.7	2.09	600	318	420	1.2807	0.706
20	6.5	4.78	500	292	320	2.9251	0.228
21	6.8	1.32	300	128	296	0.9551	0.38
22	6	4.28	400	212	332	1.7597	0.192
23	7.6	4.72	100	86	116	2.8099	0.239
24	7.2	6.8	300	92	120	1.7942	0.202
25	6.8	7.68	300	32	68	4.2322	0.12
26	6.9	2.78	100	40	76	4.0096	0.133
27	7.7	2.08	200	46	88	3.7005	0.199
28	7.5	2.69	100	36	80	4.4504	0.14
29	7.2	7.5	600	40	80	1.8069	0.254
30	6.9	6.8	300	98	172	3.8763	0.286
31	6.8	3.21	100	100	140	3.2013	0.827
32	6.5	2.69	200	105	204	1.6565	0.431
33	7.5	4.78	300	160	340	4.2035	0.318
34	6.9	1.68	100	124	228	0.4044	0.486
35	7.2	2.78	300	146	396	0.4046	0.279
36	7.5	6.8	600	106	268	3.5389	0.714
37	7.8	2.56	200	104	236	2.9969	0.271
38	6.9	3.21	100	120	232	0.2883	0.176
39	6.5	3.69	100	98	104	3.6562	0.145
40	7.8	2.56	200	68	116	0.3187	0.41
41	7.2	2.35	300	32	72	3.1737	0.172
42	6.9	1.89	100	34	76	1.1837	0.0942
43	6.8	3.25	200	228	328	4.0756	0.299
44	7.5	6.5	600	120	220	0.4545	0.196
45	6.8	2.68	100	98	152	1.8462	0.339
46	7.5	1.29	100	100	156	1.6694	0.175
47	7.6	0.53	100	30	60	0.3551	0.073
48	7.2	0.26	100	428	628	0.7184	0.132
49	6.5	1.26	200	104	236	0.7228	0.265
50	6.9	0.35	100	120	244	0.7494	0.243
51	6.8	0.29	100	62	84	0.5325	0.198
52	7.7	1.53	200	98	180	0.9622	0.218
53	7.2	1.26	300	100	136	0.4576	0.198
54	6.8	0.32	100	110	212	1.3139	0.21
55	6.5	0.15	100	120	192	1.8581	0.29
56	6.9	1.26	200	120	264	1.263	0.526
57	7.2	0.35	100	356	612	2.5542	0.467
58	7.6	10.23	600	252	532	1.6852	0.45
59	6.9	0.96	100	220	368	3.0724	0.401
60	6.5	1.25	100	106	200	2.507	0.378
61	7.6	1.23	200	130	220	2.2249	0.392
62	7.2	1.32	300	210	392	1.9831	0.436
63	7.5	10.96	900	220	420	2.6359	0.342
64	6.5	2.35	200	180	300	1.2919	0.454

Table 3a: Site for water collection from Hand pumps of Sarenga Block for physicochemical properties of drinking water.

Sl. N0.	S.SL. No.	Gram Panchayat	Name of Village	JL No.	GPS Location	
					Longitude	Latitude
01	AI-82	GARGARIA	AMPATA	351	22° 43'053" N	86° 02'141" E
02	AI-83	BIKRAMPUR	KADMA	291	22° 43'541" N	87° 02'448" E
03	AI-84	BIKRAMPUR	DAKHRANG	290	22° 43'822" N	87° 02'846" E
04	AI-86	BIKRAMPUR	JAMSOLE	285	22° 44'649" N	87° 01'024" E
05	AI-88	BIKRAMPUR	BHALUKKUNA	221	22° 45'447" N	87° 01'790" E
06	AI-89	BIKRAMPUR	KHAERPAHARI	220	22° 45'877" N	87° 02'698" E
07	AI-90	SARENGA	NEKRAPAHARI	192	22° 47'256" N	87° 02'300" E
08	AI-91	CHILTORE	PANCHBERIA	173	22° 48'233" N	86° 58'147 E
09	AI-92	CHILTORE	GHUNGIA	182	22° 47'604" N	86° 58'976" E
10	AI-93	CHILTORE	BELIAKALA	192	22° 49'738" N	86° 58'998" E
11	AI-94	GOYALBRI	HABRA	124	22° 49'738" N	87° 03'362" E
12	AI-95	GOYALBRI	BHALUKCHIRA	189	22° 48'420" N	87° 03'235" E
13	AI-96	GOYALBRI	CHATIASOL	120	22° 49'958" N	87° 00'605" E
14	AI-97	NETURPUR	DALAMBHIJA	17	22° 53'800" N	86° 56'050" E
15	AI-98	NETURPUR	BAILGUMA	18	22° 54'423" N	86° 56'634" E
16	AI-99	NETURPUR	BENACHAPARA	31	22° 52'592" N	86° 58'763" E
17	AI-100	NETURPUR	BARAAMLATATORA	43	22° 51'137" N	86° 59'149" E
18	AI-101	NETURPUR	CHHOTAMLATORA	41	22° 51'364" N	87° 00'038" E
19	AI-225	BIKRAMPUR	JETPARA	280	22° 44'983" N	86° 59'583" E
20	AI-226	NETRPUR	BARDI	16	22° 53'418" N	86° 56'342" E
21	AI-227	NETERPUR	BARDI KALAPATHAR	15	22° 52'223" N	86° 56'586" E
22	AI-228	NETERPUR	BHANGADEULI	20	22° 53'858" N	86° 57'418" E
23	AI-229	NETERPUR	PARYASOL	30	22° 53'182" N	86° 59'638" E
24	AI-242	GARGARIA	DANGARPARA	293	22° 42'998" N	87° 01'513" E
25	AI-243	GARGARIA	SITARAMPUR	352	22° 42'479" N	87° 04'967" E
26	AI-244	GARGARIA	AGAYA	250	22° 42'785" N	87° 01'371" E
27	AI-245	GARGARIA	GARGARIA	349	22° 42'971" N	87° 00'438" E
28	AI-246	GARGARIA	NIBRA	253	22° 42'260" N	87° 00'872" E
29	AI-247	GARGARIA	MAKARKOL	365	22° 41'167" N	87° 01'037" E
30	AI-248	GARGARIA	BELAPAL	368	22° 40'511" N	87° 00'419" E
31	AI-249	GARGARIA	JUKHANALA	366	22° 40'644" N	87° 00'818" E
32	AI-250	GARGARIA	BAISHPATRA	367	22° 40'527" N	87° 00'795" E
33	AI-251	GARGARIA	BEGIDANGA	372	22° 40'268" N	87° 01'060" E
34	AI-252	SARENGA	NEKRAPAHARI	192	22° 47'243" N	87° 01'925" E
35	AI-253	SARENGA	KULDIHA	211	22° 46'887" N	87° 01'833" E
36	AI-254	SARENGA	BAMNISOL	192	22° 46'643" N	87° 03'419" E
37	AI-255	SARENGA	SALUKA	213	22° 46'529" N	87° 02'687" E
38	AI-256	SARENGA	MURKU	210	22° 46'217" N	87° 00'876" E
39	AI-257	SARENGA	NIMDANGRA	226	22° 45'773" N	86° 59'962" E

Table 3b: Hand pumps of Sarenga Block showing site information and physicochemical properties of drinking water.

Physicochemical Quality of Hand pump Water							
Sl. N0.	pH	Turbidity (NTU)	T.D.S (mg/l)	Alkalinity (mg/l)	Total Hardness (mg/l)	Iron (mg/l)	Fluoride (mg/l)
01	7.9	7.94	200	282	304	2.4559	0.544
02	7.8	73.6	100	220	236	3.0651	0.263
03	7.3	28.5	100	254	288	3.6425	0.49
04	6.9	7.2	200	240	296	2.1181	0.655
05	6.6	54.9	200	316	244	3.5643	0.665
06	6.5	2.18	100	218	240	1.1656	0.0796
07	6.2	219	100	256	272	3.1893	0.1
08	6.2	8.63	200	180	204	2.7036	0.5
09	6.4	50.3	200	280	300	1.7998	0.495
10	6.6	24.1	100	164	200	2.2081	0.216
11	NF	NF	NF	NF	NF	NF	NF
12	6.3	98.4	100	240	284	3.8686	0.138
13	6.3	3.84	100	246	272	3.6645	0.0724
14	6.2	7	200	292	312	3.7821	0.144
15	6.2	4.63	100	180	212	1.2827	0.313
16	6.1	0.81	100	156	180	0.3717	0.003
17	6.0	113	100	258	296	3.7798	0.0627
18	7.9	9.2	200	152	188	0.7396	0.71
19	6.9	1.03	200	220	364	4.3079	0.229
20	7.6	0.57	100	136	256	1.3094	0.293
21	7.2	2.35	300	180	284	1.997	0.683
22	6.9	2.15	300	128	228	3.2901	0.166
23	6.8	1.32	100	110	168	5.0436	0.251
24	6.9	0.68	100	520	1100	0.2731	0.25
25	6.5	0.38	200	126	248	3.3775	0.607
26	6.8	0.39	100	220	424	2.6335	0.25
27	7.5	8.32	300	136	252	4.259	0.392
28	7.3	10.52	300	170	284	5.1031	0.276
29	6.5	1.32	200	228	364	2.2751	0.43
30	6.9	2.56	100	270	348	3.4374	0.328
31	6.8	6.58	100	230	344	2.7323	0.363
32	6.5	2.56	100	220	336	4.4976	0.324
33	7.5	0.92	300	240	256	1.5958	0.337
34	7.3	1.36	600	130	188	2.428	0.142
35	6.8	1.82	300	228	304	5.0954	0.158
36	6.5	2.38	200	136	256	4.7414	0.205
37	6.8	3.68	100	130	236	4.7355	0.224
38	6.5	0.58	100	136	268	0.6386	0.328
39	7.7	0.38	100	120	240	0.4237	0.211

Table 4a: Hand pumps of Block showing site information and physicochemical properties of drinking water.

Table 4a: Site for water collection from Hand pumps of Ranibundh Block for physicochemical properties of drinking water.

Sl. N0.	S.SL. No.	Gram Panchayat	Name of Village	JL No.	GPS Location	
					Longitude	Latitude
01	AI 10	BARIKUL	CHALKIGARA	174	22° 47’382” N	86° 48’370” E
02	AI 18	AMBIKANAGORE	JORAKEND	55	22° 55’591” N	86° 45’933” E
03	AI 20	AMBIKANAGORE	NISCHINTIPUR	37	22° 54’616” N	86° 43’066” E
04	AI 21	AMBIKANAGORE	DULALPUR	32	22° 55’923” N	86° 44’124” E
05	AI 22	AMBIKANAGORE	NISCHINTIPUR	37	22° 54’217” N	86° 43’027” E
06	AI 24	AMBIKANAGORE	RAJSOLE	41	22° 54’923” N	86° 45’378” E
07	AI 25	PUDDY	PARESHNATH	16	22° 57’378” N	86° 44’841” E
08	AI 26	PUDDY	DHANARA	36	22° 55’440” N	86° 42’799” E
09	AI 27	PUDDY	DHANARA	36	22° 54’441” N	86° 42’159” E
10	AI 30	RUDRA	BETHUALA	72	22° 52’429” N	86° 44’577” E
11	AI 31	BARIKUL	JANTADUMUR	178	22° 46’338” N	86° 49’189” E
12	AI 32	BARIKUL	SATNALA	166	22° 44’964” N	86° 44’933” E
13	AI 35	BARIKUL	SATNALA	166	22° 45’354” N	86° 44’574” E
14	AI 36	HALUDKANALEE	JALNEJA	88	22° 54’883” N	86° 51’427” E
15	AI 37	HALUDKANALEE	TUNGCHARRA	108	22° 52’537” N	86° 51’610” E
16	AI 38	HALUDKANALEE	BHALUKADUNGRI	103	22° 52’305” N	86° 52’708” E
17	AI 42	RUDRA	CHALTHA	71	22° 51’522” N	86° 44’047” E
18	AI 43	RUDRA	CHALTHA	71	22° 51’596” N	86° 44’443” E
19	AI 45	RUDRA	KOMO	65	22° 53’103” N	86° 43’699” E
20	AI 46	RUDRA	KOMO	65	22° 53’381” N	86° 43’991” E
21	AI 47	RUDRA	RUDRA	38	22° 53’897” N	86° 44’801” E
22	AI 48	RUDRA	RUDRA	38	22° 54’084” N	86° 45’121” E
23	AI 49	RUDRA	KULYAM	67	22° 52’233” N	86° 42’535” E
24	AI 51	RUDRA	KULYAM	67	22° 52’235” N	86° 42’150” E
25	AI 52	RUDRA	BETHUALA	72	22° 52’622” N	86° 45’037” E
26	AI 53	RUDRA	PANIJIA	73	22° 52’162” N	86° 46’121” E
27	AI 54	RUDRA	PANIJIA	73	22° 52’093” N	86° 45’627” E
28	AI 55	RUDRA	PILHAGERIA	74	22° 52’529” N	86° 46’373” E
29	AI 57	RANIBUNDH	JAMGERIA	117	22° 50’227” N	86° 45’722” E
30	AI 58	ROWTORA	CHURKU	144	22° 48’800” N	86° 41’163” E
31	AI 59	BARIKUL	CHALKIGARA	174	22° 47’120” N	86° 48’129” E
32	AI 61	BARIKUL	DHANJHAR	164	22° 46’893” N	86° 46’097” E
33	AI 62	BARIKUL	MURKUM CHOTOTUNG	167	22° 44’733” N	86° 44’954” E
34	AI 63	BARIKUL	DUDHYANALA	184	22° 48’803” N	86° 47’728” E
35	AI 64	BARIKUL	SIMGLAHAR	168	22° 44’089” N	86° 46’025” E
36	AI 65	BARIKUL	MADANKATA	176	22° 47’243” N	86° 49’757” E
37	AI 69	RAJAKATA	CHAITANDIHI	49	22° 55’443” N	86° 48’213” E
38	AI 70	RANIBUNDH	MOULA	118	22° 50’305” N	86° 45’881” E
39	AI 71	ROWTORA	GOBINDASOL	141	22° 49’049” N	86° 40’549” E
40	AI 72	ROWTORA	CHURKU	144	22° 49’244” N	86° 41’058” E
41	AI 73	ROWTORA	MUCHIKATA	143	22° 48’555” N	86° 41’058” E
42	AI 74	ROWTORA	MUCHIKATA	143	22° 48’258” N	86° 41’617” E
43	AI 75	ROWTORA	MADHABPUR	138	22° 46’836” N	86° 40’146” E
44	AI 76	ROWTORA	TILABANI	136	22° 47’565” N	86° 40’146” E
45	AI 77	RANIBUNDH	PUNSHYA	161	22° 48’386” N	86° 47’166” E
46	AI 78	RANIBUNDH	PUNSHYA	161	22° 48’651” N	86° 46’768” E
47	AI 79	RANIBUNDH	BOIRIPAL	156	22° 49’732” N	86° 46’712” E
48	AI 80	RANIBUNDH	JAMGERIA	117	22° 49’814” N	86° 46’580” E
49	AI 81	RANIBUNDH	MITHAM	122	22° 49’903” N	86° 45’447” E
50	AI 119	RAJAKATA	BUDHKHILA	60	22° 52’779” N	86° 47’252” E
51	AI 148	BARIKUL	BAGDUBI	149	22° 46’403” N	86° 44’355” E
52	AI 149	BARIKUL	BAGDUBI	149	22° 46’095” N	86° 43’275” E
53	AI 151	BARIKUL	BHULAGARA	154	22° 48’165” N	86° 45’659” E
54	AI 152	BARIKUL	BHULAGARA	154	22° 48’630” N	86° 45’903” E
55	AI 153	BARIKUL	BARIKUL	179	22° 46’251” N	86° 48’533” E
56	AI 154	BARIKUL	BARIKUL	179	22° 45’859” N	86° 48’356” E
57	AI 159	BARIKUL	MURKUM CHOTOTUNG	167	22° 44’881” N	86° 45’235” E
58	AI 160	BARIKUL	PIURNAPANI CHOTOTUNG	170	22° 45’157” N	86° 46’935” E
59	AI 164	RAJAKATA	BIKRAMDIHI	81	22° 54’064” N	86° 47’522” E
60	AI 168	RAJAKATA	DEULI	53	22° 54’393” N	86° 46’500” E
61	AI 169	RAJAKATA	BUDHKHILA	60	22° 53’191” N	86° 46’493” E
62	AI 269	HALUDKANALEE	SUKNIBASA	91	22°53’602” N	86°49’942” E
63	AI 270	HALUDKANALEE	DHADKIDHI	92	22°53’275” N	86°50’364” E

Table 4b: Hand pumps of Ranibundh Block showing site information and physicochemical properties of drinking water.

Physicochemical Quality of Hand pump Water							
Sl. N0.	pH	Turbidity (NTU)	T.D.S (mg/l)	Alkalinity (mg/l)	Total Hardness (mg/l)	Iron (mg/l)	Fluoride (mg/l)
01	6.2	13.5	300	198	308	3.0314	1.22
02	6.4	1.88	500	210	412	0.993	0.5
03	7.2	1.67	400	220	442	0.621	0.8927
04	7.2	2.39	900	308	548	1.7185	0.441
05	6.5	5.11	700	220	520	0.6117	0.827
06	6.5	3.24	100	320	640	0.4948	0.861
07	6.9	0.85	700	100	268	1.4327	0.786
08	6.4	1.63	300	256	528	1.3834	0.786
09	6.7	20.7	600	184	384	4.9546	0.326
10	6.4	7.1	200	190	376	4.4362	1.06
11	6.3	10.4	200	240	324	3.4582	0.367
12	6.3	7.63	400	210	364	0.8355	0.632
13	6.3	76.1	300	192	328	5.9675	0.811
14	6.3	7.71	200	100	216	9.9657	1.46
15	6.2	38.1	800	260	524	4.0887	0.371
16	6.2	4.02	1800	450	956	6.6331	1.13
17	6.3	2.34	500	220	500	1.4520	0.99
18	6.9	4.82	300	148	388	4.6921	0.63
19	6.2	3.26	200	100	260	2.985	0.54
20	6.4	4.93	1200	98	180	0.2176	344
21	6.3	2.23	1400	460	900	1.1511	344
22	6.7	2.29	700	310	560	0.8409	0.329
23	6.6	3.77	500	222	456	2.9696	0.683
24	6.1	29.5	1200	422	840	3.4726	0.329
25	6.6	3.41	400	232	420	0.4272	1.33
26	6.6	1.56	500	242	428	0.3049	0.811
27	6.7	0.13	500	184	424	0.1516	0.617
28	6.6	6.72	300	222	436	0.9651	1.33
29	6.7	2.55	200	160	268	0.1581	0.771
30	6.5	22.4	300	312	553	2.7431	0.287
31	6.5	139	100	246	368	0.598	0.802
32	6.9	47.1	100	102	244	0.921	0.195
33	6.6	15.1	300	220	400	1.66	0.257
34	6.7	31.8	100	160	276	0.2099	0.203
35	6.2	54.8	300	192	276	0.4539	0.419
36	6.4	6.11	300	170	304	0.153	0.49
37	6.5	9.4	700	320	556	0.2325	0.326
38	6.6	40.1	500	228	424	2.486	0.375
39	6.4	16.4	100	120	220	0.8499	0.251
40	6.4	1.46	800	428	580	0.4917	0.505
41	6.6	0.89	500	216	416	0.23	0.265
42	6.6	7.65	300	222	424	0.2463	0.351
43	6.4	1.68	600	192	360	0.2332	0.603
44	6.7	7.15	100	262	468	1.4331	0.881
45	6.4	7.89	200	64	105	1.5477	0.3
46	6.5	14.7	300	120	280	1.4215	0.309
47	6.2	19.6	100	160	284	1.1852	0.305
48	6.1	31.7	200	190	360	1.6635	0.263
49	6.4	5.3	300	196	356	0.161	0.462
50	6.8	2.59	100	106	232	2.652	0.731
51	7.0	6.04	200	132	248	1.3006	0.374
52	6.7	3.41	200	212	252	2.6743	0.284
53	6.9	0.44	1000	460	568	2.5199	0.438
54	7.1	4.25	400	196	296	2.528	0.332
55	7.3	5.81	700	332	436	1.1201	0.385
56	7.2	0.35	100	260	460	0.5604	0.502
57	6.7	25.7	200	156	260	4.2218	0.336
58	6.9	1.32	100	128	192	0.8428	0.594
59	6.6	4.75	800	420	560	4.7147	0.273
60	6.6	4.67	100	152	180	4.5156	0.282
61	6.5	7.53	300	212	240	2.7215	0.315
62	7.5	12.67	900	162	240	4.8008	0.517
63	7.6	0.57	100	220	336	3.641	0.478

Table 5a: Site for water collection from Hand pumps of Simlapal Block for physicochemical properties of drinking water.

Sl. N0.	S.SL. No.	Gram Panchayat	Name of Village	JL No.	GPS Location	
					Longitude	Latitude
01	AI 14	DUBRAJPUR	KHAMARDANGA.	161	22° 54’062” N	87° 05’511” E
02	AI 16	BIKRAMPUR	ASNA	72	22° 54’062” N	87° 05’511” E
03	AI 17	BIKRAMPUR	KANTASOLA	77	22° 52’023” N	87° 03’695” E
04	AI 103	DUBRAJPUR	HATIBARI	166	22° 51’531” N	87° 05’432” E
05	AI 104	DUBRAJPUR	SUSUNIA	165	22° 52’376” N	87° 05’059” E
06	AI 105	DUBRAJPUR	SUSUNIA	165	22° 51’230” N	87° 05’059” E
07	AI 107	DUBRAJPUR	DUBRAJPUR	168	22° 51’764” N	87° 06’460” E
08	AI 108	DUBRAJPUR	DUBRAJPUR	168	22° 51’734” N	87° 06’981” E
09	AI 112	DUBRAJPUR	PITHABAKRA	174	22° 53’453” N	87° 08’889” E
10	AI 113	DUBRAJPUR	JHUMKA	156	22° 53’698” N	87° 08’634” E
11	AI 114	DUBRAJPUR	JHUMKA	156	22° 53’801” N	87° 08’215” E
12	AI 115	DUBRAJPUR	NATUNGRAM	157	22° 53’165” N	87° 07’315” E
13	AI 116	DUBRAJPUR	PUIPAL	160	22° 54’170” N	87° 06’705” E
14	AI 117	DUBRAJPUR	PUIPAL	160	22° 53’907” N	87° 06’160” E
15	AI 118	DUBRAJPUR	KHAMARDANGA.	161	22° 54’386” N	87° 05’390” E
16	AI 120	DUBRAJPUR	LAKSHMIPAL	158	22° 53’836” N	87° 07’299” E
17	AI 121	DUBRAJPUR	KUSTORA	162	22° 53’579” N	87° 05’369” E
18	AI 122	DUBRAJPUR	KUSTORA	162	22° 53’541” N	87° 05’513” E
19	AI 123	DUBRAJPUR	SHALDANGA	167	22° 52’522” N	87° 05’636” E
20	AI 124	BIKRAMPUR	KALABATI	79	22° 52’774” N	87° 04’622” E
21	AI 125	BIKRAMPUR	KALABATI	79	22° 52’167” N	87° 04’252” E
22	AI 126	BIKRAMPUR	NEMAIPUR	80	22° 52’193” N	87° 04’043” E
23	AI 127	BIKRAMPUR	NEMAIPUR	80	22° 52’648” N	87° 03’846” E
24	AI128	BIKRAMPUR	KUMARDOBA	82	22° 53’260” N	87° 03’807” E
25	AI 130	BIKRAMPUR	BARAMAKARKOLE	70	22° 51’603” N	87° 02’366” E
26	AI 131	BIKRAMPUR	BHURRUBAID	69	22° 51’232” N	87° 02’505” E
27	AI 132	BIKRAMPUR	BARAMAKARKOLE	70	22° 51’718” N	87° 02’057” E
28	AI 133	BIKRAMPUR	GORAKATA	66	22° 52’196” N	87° 01’436” E
29	AI 134	BIKRAMPUR	PATHARKATA	67	22° 51’564” N	87° 01’346” E
30	AI 135	BIKRAMPUR	KATAJURIA	60	22° 53’671” N	87° 02’103” E
31	AI 136	MANDALGRAM	JALASWAR	153	22° 54’366” N	87° 08’505” E
32	AI 137	MANDALGRAM	MATHURAKATA	155	22° 53’985” N	87° 07’960” E
33	AI 138	MANDALGRAM	LAKSHMANPUR	154	22° 54’699” N	87° 08’692” E
34	AI 139	MANDALGRAM	KUSHMI	195	22° 54’195” N	87° 10’436” E
35	AI 140	MANDALGRAM	SHYAMPUR	185	22° 54’060” N	87° 11’540” E
36	AI 141	MANDALGRAM	KUSHBAKRA	198	22° 54’655” N	87° 11’908” E
37	AI 142	MANDALGRAM	BARISOLE	200	22° 53’876” N	87° 11’794” E
38	AI 143	MANDALGRAM	KAYOTDHARA	189	22° 55’755” N	87° 12’084” E
39	AI 144	MANDALGRAM	BARAKHULIA	188	22° 56’364” N	87° 11’971” E
40	AI 145	MANDALGRAM	JAMBEDIA	179	22° 54’502” N	87° 09’514” E
41	AI 147	MANDALGRAM	JAMBEDIA	179	22° 54’543” N	87° 09’104” E
42	AI 230	PARASOLA	RAJBANDH	15	22° 56’209” N	86° 56’832” E
43	AI 231	PARASOLA	BARADHARA	17	22° 55’802” N	86° 56’021” E
44	AI 232	PARASOLA	GILIRPAHARI	19	22° 54’132” N	86° 56’015” E
45	AI 233	PARASOLA	PARASALA	28	22° 54’925” N	86° 58’658” E
46	AI 234	PARASOLA	KALSULI	22	22° 54’887” N	86° 57’956” E
47	AI 235	PARASOLA	BARANIMDIHA	13	22° 56’188” N	86° 57’811” E
48	AI 236	LAKSHMISAGAR	KHARIKA	27	22° 54’350” N	86° 59’192” E
49	AI 237	MACHATORA	KARAKANALI	119	22° 58’951” N	87° 05’195” E
50	AI 238	MACHATORA	KANSACHORA	116	22° 58’129” N	87° 03’329” E
51	AI 239	MACHATORA	SHUSHUNIA	118	22° 57’647” N	87° 02’326” E
52	AI 240	MACHATORA	BANSKANLI	108	22° 57’828” N	87° 00’282” E
53	AI 241	MACHATORA	KAHARAN	99	22° 56’865” N	87° 02’293” E
54	AI 258	SIMLAPAL	KUSUMDUNRI	139	22° 56’546” N	87° 04’843” E
55	AI 259	SIMLAPAL	KOLDOBA	121	22° 57’256” N	87° 05’202” E
56	AI 260	SIMLAPAL	PATHARDOBA	122	22° 58’214” N	87° 05’912” E
57	AI 261	SIMLAPAL	BALARAMPUR	123	22° 58’359” N	87° 06’301” E
58	AI 262	SIMLAPAL	MASATKHAL	124	22° 58’197” N	87° 06’986” E
59	AI 263	SIMLAPAL	RAMBANI	125	22° 57’697” N	87° 07’075” E
60	AI 264	SIMLAPAL	DUDHIA DOBA	126	22° 57’354” N	87° 07’029” E
61	AI 265	SIMLAPAL	NAMADUDHIA DOBA	127	22° 57’075” N	87° 08’121” E
62	AI 266	SIMLAPAL	MUKUNDAPUR	152	22° 54’701” N	87° 07’712” E
63	AI 267	SIMLAPAL	ROSANA	151	22° 54’630” N	87° 07’254” E
64	AI 268	SIMLAPAL	KAYMA	150	22° 54’922” N	87° 06’989” E

Table 5b: Hand pumps of Simlapal Block showing site information and physicochemical properties of drinking water.

Physicochemical Quality of Hand pump Water							
Sl. N0.	pH	Turbidity (NTU)	T.D.S (mg/l)	Alkalinity (mg/l)	Total Hardness (mg/l)	Iron (mg/l)	Fluoride (mg/l)
01	7.1	7.28	200	126	172	0.1643	1.01
02	6.3	23.1	100	220	324	3.7132	0.0809
03	6.0	0.38	100	96	160	0.5094	0.0882
04	5.7	80.7	7200	246	284	0.6745	0.193
05	6.8	1.34	100	320	336	1.0577	0.214
06	6.9	87.4	300	292	320	4.2588	0.174
07	5.4	20.2	100	188	208	1.7084	1.34
08	5.6	3.53	300	288	316	1.1263	0.261
09	5.8	10.5	100	232	264	2.1341	0.409
10	5.8	65.7	300	320	336	3.5241	0.397
11	5.8	6.48	100	116	180	2.4074	0.587
12	NF	NF	NF	NF	NF	NF	NF
13	5.9	12	200	152	184	3.2918	0.144
14	5.9	4.05	200	300	3036	0.7218	0.365
15	7.5	3.18	200	120	284	1.9962	1.35
16	6.8	0.52	300	132	240	2.2183	1.48
17	6.5	0.27	100	96	220	0.6069	0.327
18	6.4	47.8	100	104	208	1.6929	0.39
19	6.2	2.82	100	98	168	1.1217	0.444
20	6.2	0.61	100	120	220	0.1864	0.264
21	5.7	0.24	100	144	232	0.1697	0.212
22	5.6	0.29	200	98	192	3.12	0.18
23	5.8	177	600	100	204	3.6839	0.241
24	6.1	6.34	100	104	192	0.7039	0.462
25	6.1	54.6	100	220	368	2.1337	0.166
26	5.7	1.37	600	130	236	0.2494	0.164
27	5.7	0.5	100	168	288	0.1882	0.204
28	5.6	0.6	100	98	172	0.4164	0.166
29	5.5	1.66	100	100	180	1.8687	0.299
30	5.6	1.31	100	160	280	0.9387	0.48
31	5.9	2.5	200	108	240	0.1572	0.421
32	6.0	2.71	200	144	280	2.2774	0.865
33	6.0	1.69	100	96	160	0.597	0.167
34	6.2	2.88	500	210	384	1.497	0.335
35	5.0	2.88	100	100	220	0.8484	0.212
36	5.4	2	100	98	240	0.7642	0.139
37	5.5	1.63	100	104	216	1.4884	0.15
38	5.6	6.37	100	92	196	0.3536	0.187
39	5.0	2.53	100	104	180	1.6935	0.0919
40	5.8	3	100	98	156	0.6637	0.116
41	7.3	0.31	100	128	200	0.5433	0.2
42	6.5	0.58	100	128	192	3.2159	1.26
43	7.5	0.35	100	110	164	1.8215	0.403
44	7.2	1.25	200	130	272	0.753	0.38
45	6.9	1.36	200	162	328	3.6034	0.37
46	6.5	1.1	200	98	180	0.3594	0.489
47	7.6	0.56	100	120	260	0.8118	0.356
48	7.5	0.32	200	108	200	0.4364	0.463
49	6.8	1.32	100	132	248	3.239	0.157
50	6.5	1.39	200	120	196	2.3065	0.176
51	6.9	1.25	100	132	150	1.6359	0.203
52	7.7	1.35	300	116	230	3.042	0.327
53	7.2	0.59	200	22	40	1.9718	0.224
54	7.6	0.65	100	138	248	0.6105	0.12
55	7.2	2.72	200	98	192	2.7853	0.121
56	7.6	0.82	100	130	240	0.3937	0.128
57	7.3	0.76	100	120	160	1.6257	0.169
58	6.8	0.65	100	220	300	1.6865	0.231
59	7.5	11.32	600	210	320	4.4177	0.184
60	7.2	2.59	200	98	180	1.9165	0.148
61	6.8	1.68	100	130	200	3.9379	0.235
62	6.9	3.25	200	136	212	3.4341	0.313
63	7.5	1.68	200	110	208	0.8599	0.301
64	7.2	13.25	700	98	180	3.2671	0.268

Table 06: Summary of physicochemical quality of hand pumps water as per BIS.

Sl No.	Parameters		Raipur (64 Sites)	Sarenga (38 Sites)	Ranibundh (63 Sites)	Simlapal (63 Sites)	Total (228 Sites)
01	**pH** DL- 6.5-8.5 PL- No relaxation	Below Desirable Limit	03	07	24	33	67
		Under Desirable Limit	61	31	39	30	161
		Under Permissible Limit	--	--	--	--	--
		Beyond Permissible Limit	--	--	--	--	--
02	**Turbidity** DL- 5 NTU PL-10 NTU	Under Desirable Limit	49	20	30	47	146
		Under Permissible Limit	10	09	14	04	37
		Beyond Permissible Limit	05	09	19	12	45
03	**T.D.S.** DL- 500 mg/l PL- 2000 mg/l	Under Desirable Limit	55	37	46	58	196
		Under Permissible Limit	09	01	17	04	31
		Beyond Permissible Limit	--	--	--	01	01
04	**Alkalinity** DL- 200 mg/l PL- 600 mg/l	Under Desirable Limit	47	16	29	51	143
		Under Permissible Limit	17	22	34	12	85
		Beyond Permissible Limit	--	--	--	--	--
05	**Total Hardness** DL- 300 mg/l PL- 600 mg/l	Under Desirable Limit	48	28	21	53	150
		Under Permissible Limit	12	09	38	09	68
		Beyond Permissible Limit	04	01	04	01	10
06	**Iron (Fe)** DL- 0.3 mg/l PL- 1.0 mg/l	Under Desirable Limit	02	01	10	06	19
		Under Permissible Limit	14	04	16	20	54
		Beyond Permissible Limit	48	33	37	37	155
07	**Fluoride (F)** DL- 1.0 mg/l PL- 1.5 mg/l	Under Desirable Limit	64	38	55	58	215
		Under Permissible Limit	--	--	06	05	11
		Beyond Permissible Limit	--	--	02	--	02

safe from fluoride contamination but 12.7% hand pumps of Ranibundh and 7.94% hand pumps of Simlapal need immediate attention for removal of fluoride. On the basis of standard limits of drinking water several other earlier workers Singh, et al., (2014), Gupta, *et al.*, (2014), Chakrabarti and Bhattacharya (2013), Rout and Sharma (2011), Napacho and Manyele (2010) etc also has drawn attention for removal of different pollutants from drinking water.

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