CHAPTER III

RESULTS AND DISCUSSIONS

Drinking water analysis in selected sites

Based on the field observations of the pilot survey, two representative study sites were identified at each of the six study villages where most people received their drinking water supply, The water sample testing was carried out in two seasons in a year i.e. pre monsoon (December – May) and post monsoon (June – December) period of the years 2013 and 2014. From each of the selected sampling site in a village, two water samples were collected. Likewise, a total of 12 samples were analysed in the department laboratory in pre and post monsoon.

Since monsoon has major influence on various physicochemical and microbial parameters, the changes in drinking water quality in study areas were investigated in Pre monsoon and Post monsoon season. For this analysis a total of 15 physico-chemical and microbial parameters namely pH ,Temperature, EC, Turbidity, Hardness, Ca++, Mg++, Total Solids ,TDS, TSS, Chlorides, Nitrates, SPC, MPN and Fecal Coliforms were selected. The water samples were collected, preserved and analysed as per the procedure given in the manual of American Public Health Association (APHA, 2001).

Sampling sites and their drinking water quality

The first study area identified for the household drinking water sample analysis was Ambewadi village in Karveer Taluka, (Figure No.2.2, 2.3). The major sources of drinking water supply in the village were well and tap water. The sampling sites selected for the study were Tap water (S1) and well water (S2) respectively. Results of the pre monsoon and post monsoon period water quality analysis in both these sites are given in Table no. 3.1.

Table No.3.1. Results of water sampling analysis from the sites S1 and S2 in Ambewadi village, during pre and post monsoon season of years 2013-14 giving average values and SD for each of the fifteen parameters.

Sr. No.	Ambewadi Village	Pre monsoon		Post monsoon		Pre monsoon		Post monsoon	
	Parameters	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
1.	pH	7.1 ±0.5	7.1 ±0.1	7.2 ±0.3	7.3 ±0.1	7.1 ±0.2	7.2 ±0.21	7.1 ±0.2	7.1 ±0.2
2.	Temperature °C	28.1 ±0.2	27.1 ±0.5	26.1 ±0.10	25.7 ±0.2	24.2 ±0.21	21.2 ±0.3	24.2 ±0.2	25.1 ±0.5
3.	EC (µS/cm at 20°C)	87.1 ±0.1	78.2 ±0.51	82.1 ±0.3	98.2 ±0.2	56.2 ±0.2	62.3 ±0.4	74.5 ±0.2	83.1 ±0.2
4.	Turbidity (NTU)	**10.5 ±0.1**	**14.2 ±0.2**	**16.3 ±0.01**	**22.1 ±0.5**	**12.3 ±0.5**	**15.4 ±0.2**	**17.2 ±0.1**	**18.1 ±0.2**
5.	Hardness (mg/l)	70.6 ±0.1	87.5 ±0.5	65.2 ±0.20	125.8 ±0.2	78.1 ±0.3	65.9 ±0.2	70.6 ±0.2	69.2 ±0.2
6.	Ca++ (Mg/l)	37.2 ±0.5	25.1 ±0.1	27.3 ±0.5	47.2 ±0.2	25.4 ±0.4	18.9 ±0.2	19.4 ±0.3	21.1 ±0.5
7.	Mg++ (mg/l)	6.68 ±0.1	12.4 ±0.2	7.58 ±0.5	13.56 ±0.2	10.54 ±0.5	9.4 ±0.5	10.24 ±0.1	9.62 ±0.1
8.	Total Solids (mg/l)	181.5 ±0.5	178.6 ±0.5	179.2 ±0.5	139.1 ±0.1	192.4 ±0.2	120.2 ±0.4	210.1 ±0.2	187.2 ±0.2
9.	TDS (mg/l)	102.4 ±0.5	98.9 ±0.1	125.3 ±0.5	79.3 ±0.1	98.6 ±0.6	79.6 ±0.5	105.6 ±0.1	94.5 ±0.2
10.	TSS (mg/l)	79.1 ±0.5	79.7 ±0.2	53.9 ±0.1	59.8 ±0.2	93.8 ±0.6	40.6 ±0.2	104.5 ±0.2	92.7 ±0.2
11.	Chlorides (mg/l)	27.2 ±0.5	24.3 ±0.6	25.5 ±0.2	26.1 ±0.2	18.6 ±0.6	27.2 ±0.2	22.4 ±0.3	26.2 ±0.5
12.	Nitrates (mg/l)	10.2 ±0.6	9.8 ±0.4	11.6 ±0.5	12.6 ±0.2	10.3 ±0.2	11.2 ±0.6	8.7 ±0.5	11.5 ±0.4
13.	SPC (CFU)	445 ±23.2	321 ±32.2	658 ±21.2	265 ±19.2	467 ±0.07	492 ±0.6	338 ±0.2	118 ±0.8
14.	MPN/100ml	**46 ±1.5**	**64 ±11.2**	**58 ±23.1**	**75 ±22.3**	**56 ±5.2**	**65 ±6.2**	**48 ±11.2**	**52 ±22.3**
15.	Fecal Coliforms per 100ml	**23 ±12.2**	**54 ±22.1**	**35 ±11.2**	**58 ±16.3**	**39 ±22.3**	**54 ±35.6**	**84 ±22.1**	**59 ±22.3**

Bold numbers indicate parameter value above the prescribed WHO limit

The Table no. 3.1 indicates seasonal changes in drinking water quality during pre monsoon and post monsoon season, except some physicochemical parameters like water Temperature and pH, which did not register any change in pH value of (7.1) However, had little change in water temperature minimum of 21.2 (S2) in 2014 in post monsoon and maximum of 28.1 (S1) in 2013 in pre-monsoon season. The average value for the parameter was 25.4°C.

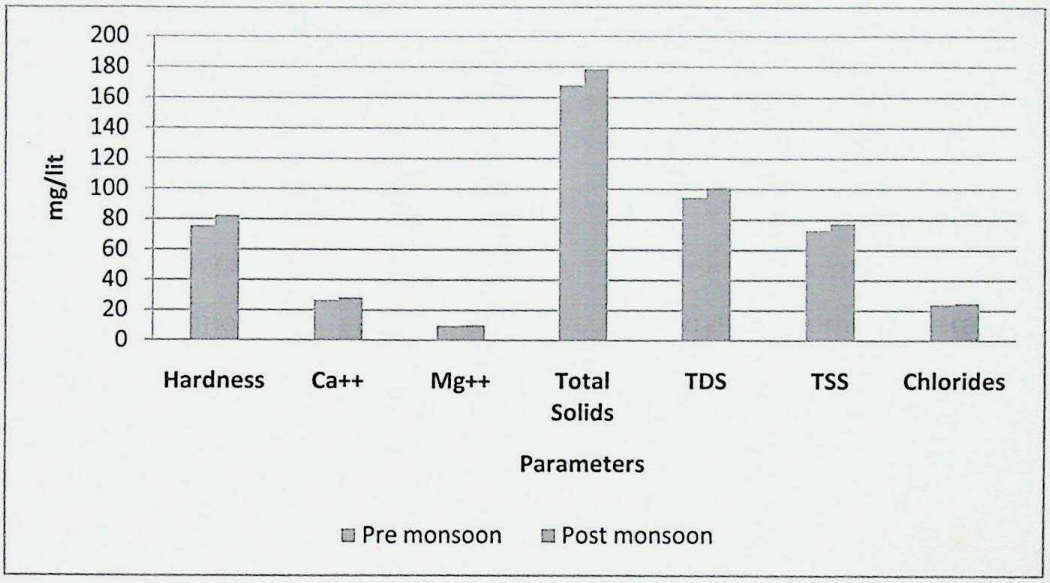


Figure 3.1 Changes in the values of the seven parameters in the drinking water during pre and post monsoon period in Ambewadi village

Figure no. 3.1 shows changes in average values of different water quality parameters during Pre monsoon and Post monsoon seasons in Ambewadi village in both the study years. The figures indicate major changes in the parameters namely Hardness, Total Solids (TS), Total Dissolved Solids (TDS) and Total Suspended Solids (TSS). Where as in the parameters Ca, Mg and chlorides, the changes were not prominent. There was a general increasing trend in the values of all the seven chemical parameters in post monsoon season. However, despite this rise in the values, all the water quality parameters studied were well within the prescribed limit of World Health Organization (WHO) for quality of drinking water. While the fluctuations were more apparent in the values of the parameters namely Turbidity, Standard Plate Count (SPC), Most Probable Number (MPN) and faecal coli forms, which were above the drinking

water standard limit of the WHO. It is clear from the Table no. 3.1 that the values of Turbidity, SPC, MPN and Faecal coliforms had increasing trend during the post monsoon season.

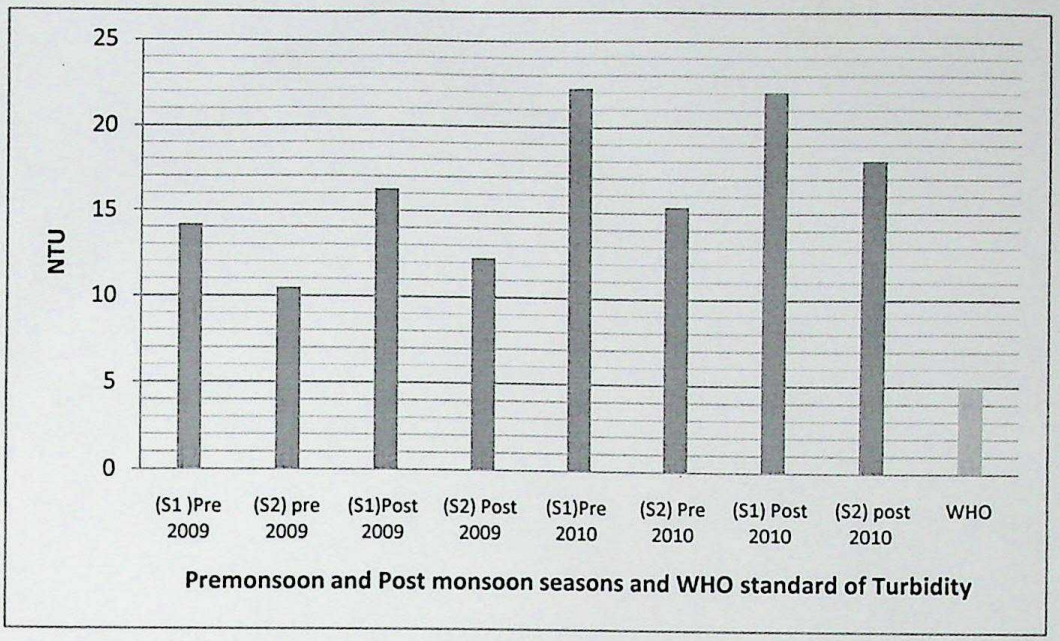


Figure No. 3.2 Changes in the Turbidity values in drinking water during Pre and Post monsoon period in Ambewadi in years 2013 -14.

The changes in the average values of turbidity are shown in Figure no. 3.2 Turbidity in water is due to colloidal and extremely fine dispersions, suspended matter, such as clay, silt, finely divided organic, inorganic matter and microorganisms. Sample no.S1 (Tap water) had more turbidity than in sample no. S2 (Well water). The changes are more in Post monsoon season, may be due to rise in total solids in river water, after rainy season, which is the prime source of drinking water to Ambewadi village. It was observed that the maximum and minimum values of Turbidity in the village water samples i.e. 10.5 – 22.5 NTU was above the standard limit of WHO (Figure no. 3.2).

In case of microbial parameters, it was observed that the Standard Plate Count was in between 118- 658 CFU, Most Probable Number (MPN) /100 ml was in between 46- 75/ 100 ml and fecal coli forms count was in between 23- 85 / 100 ml. All values of microbial parameters were above the standard limit of 0 fecal coliforms prescribed by

WHO for potable drinking water. This clearly indicated that the water samples from the village were not of potable standard.

The second area in the drinking water study was Kandalgaon village in Karveer Taluka, located at Latitude 16"38'and Longitude 74"15' at height of 630 meter MSL, and about 4 km east of Kolhapur city (Figure No.2.4).The population of the village was 3864 according to Census of 2011.The major source of drinking water supply to the village was well water, therefore the sampling sites selected i.e. no. S3 and S4 were well water supplied to households. Results of the pre monsoon and post monsoon water quality analysis from both these sites in the village are given in Table no. 3.2.

Table No.3.2 Results of water samples analysis from the sites S3 and S4 in Kandalgao village during pre and post monsoon season of 2013-14

Sr. No.	Kadalgao Village	Pre monsoon		Post monsoon		Pre monsoon		Post monsoon	
	Parameters	*Site 3*	Site 4	*Site 3*	Site 4	*Site 3*	Site 4	*Site 3*	Site 4
1.	pH	7.1 ±0.1	6.9 ±0.5	7.2 ±0.5	7.1 ±0.1	7.2 ±0.5	7.1 ±0.1	7.2 ±0.1	7.1 ±0.1
2.	Temperature °C	26.3 ±0.1	27.2 ±0.5	26.4 ±0.2	27.4 ±0.5	27.5 ±0.5	27.2 ±0.2	26.2 ±0.2	25.8 ±0.5
3.	EC (µS/cm at 20°C)	94.2 ±0.3	102.3 ±0.3	114.2 ±0.9	112.5 ±0.6	106.2 ±0.2	115.3 ±0.15	117.1 ±0.5	103.7 ±0.6
4.	Turbidity (NTU)	**5.6 ±1.5**	**8.4 ±.0.1**	**8.3 ±0.1**	**9.4 ±0.2**	**7.8 ±0.5**	**9.8 ±0.1**	**5.1 ±0.1**	**4.9 ±0.1**
5.	Hardness (mg/l)	350 ±1.5	370 ±0.5	337 ±0.1	410 ±0.4	347 ±0.4	383 ±0.4	338 ±0.4	388 ±0.5
6.	Ca++ (Mg/l)	77.3 ±0.8	86.8 ±0.2	87.6 ±0.1	92.3 ±0.5	87.2 ±0.1	90.1 ±0.1	98.4 ±0.3	94.3 ±0.3
7.	Mg++ (mg/l)	65.4 ±0.4	67.9 ±0.3	59.85 ±0.2	76.2 ±0.3	62.3 ±0.0	70.2 ±0.6	81.5 ±0.4	70.4 ±0.5
8.	Total Solids (mg/l)	235.1 ±1.5	125.3 ±0.5	253.2 ±0.8	230.2 ±0.4	134.1 ±0.5	122.1 ±0.4	205.4 ±0.5	195.1 ±0.5
9.	Total Dissolved Solids(mg/l)	105.1 ±0.9	95.6 ±0.5	115.3 ±0.5	126.5 ±0.7	98.2 ±0.6	65.9 ±0.9	99.2 ±0.1	102.5 ±0.6
10.	Total	130	29.7	137.9	103.7	35.9	56.2	106.2	92.6

	Suspended Solids (mg/lit)	±1.2	±0.5	±0.9	±0.4	±0.5	±0.3	±0.5	±0.5
11.	Chlorides (mg/l)	24.5 ±0.3	19.5 ±0.1	22.3 ±0.1	17.21 ±0.1	24.6 ±0.5	18.6 ±0.3	22.9 ±0.5	18.3 ±0.1
12.	Nitrates (mg/l)	10.5 ±0.3	12.3 ±0.5	9.7 ±0.5	11.8 ±0.5	10.2 ±0.2	10.5 ±0.1	9.6 ±0.5	11.1 ±0.5
13.	SPC (CFU)	**356 ±11.2**	**815 ±11.3**	**236 ±21.6**	**498 ±15.3**	**232 ±21.3**	**252 ±21.2**	**365 ±14.2**	**425 ±16.5**
14.	MPN/100ml	**60 ±32.1**	**48 ±21.3**	**45 ±14.2**	**39 ±11.2**	**65 ±16.3**	**70 ±23.5**	**74 ±36.2**	**85 ±21.2**
15.	Fecal coliform/100 ml	**23 ±14.2**	**28 ±12.5**	**42 ±11.3**	**32 ±14.2**	**45 ±32.5**	**61 ±35.2**	**53 ±11.2**	**67 ±14.5**

Bold numbers indicates parameter value above the prescribed WHO limit

Since the source of water from Kandalgao village was well water, it showed less seasonal fluctuations in most of the parameters studied from the samples. It is revealed from Table no.3.2 that though the physicochemical parameters were within the WHO standards, there was problem of microbial contamination during pre monsoon as well as post monsoon at the village well water sources.

The contamination was increased in all the samples the year 2013 as compared to 2014, where MPN values had some declining trend in both the sampling sites S3 and S4 respectively. Interestingly values of both the parameters, particularly of MPN than fecal coliform at the two sites in the village increased in 2014. It is more probable that the only source, well in the village was further contaminated and thus both the samples reflected uniform increase in MPN and fecal coliform contamination, except decrease in MPN values in both the samples during post monsoon season . Also, it is seen that the MPN/100 ml values ranges between 39 – 85 / 100 ml and faecal coli forms/100 ml values ranges between 23 – 97 which obviously was not acceptable for drinking purpose as per WHO standards.

The third area for study of household drinking water was Nagdevwadi village in Karveer Taluka, located at Latitude 16"41' and Longitude 74"10' at height of about 548 meter MSL, and 9 Km west from Kolhapur city (Figure no.2.5). The population of the village was 3,449 as per Census of 2011. The major sources of drinking water supply

to this village were tap water and well water, and respectively the samples (S5) and (S6) were collected from these sources. The main water treatment plant of Kolhapur city, situated at the upstream of Panchaganga River, is the major water source to the city and is located adjacent to this village. Results of the pre monsoon and post monsoon water quality from both the sites in this village are given in Table no. 3.3.

Table No.3.3 Results of the tests on water samples from the two sites S5 and S6in Nagdevwadi village during pre and post monsoon season of 2013-14

	Nagdevwadl Village	Pre monsoon		Post monsoon		Pre monsoon		Post monsoon	
Sr. No.	Parameters	*Site 5*	Site 6	*Site 5*	Site 6	*Site 5*	Site 6	*Site 5*	Site 6
1.	pH	7.1 ±0.15	6.9 ±0.05	7.2 ±0.05	7.1 ±0.15	7.2 ±0.05	7.1 ±0.15	7.2 ±0.15	7.1 ±0.15
2.	Temperature °C	26.3°C ±0.1	27.2° ±0.05	26.4°C ±0.28	27.4° ±0.05	27.5° ±0.05	27.2 ±0.28	26.2° ±0.25	25.8° ±0.05
3.	EC (µS/cm at 20°C)	94.2 ±0.37	102.3 ±0.30	107.2 ±0.92	112.5 ±0.68	106.2 ±0.02	115.3 ±0.15	117.1 ±0.05	103.7 ±0.68
4.	Turbidity (NTU)	4.4 ±1.05	3.5 ±.0.11	4.8 ±0.15	4.2 ±0.2	4.1 ±0.05	4.3 ±0.19	4.2 ±0.18	4.5 ±0.19
5.	Hardness (mg/l)	89.3 ±1.05	120.2 ±0.57	78.3 ±0.11	115.5 ±0.49	78.4 ±0.40	88.4 ±0.40	72.3 ±0.45	85.3 ±0.55
6.	Ca++ (Mg/l)	18.3 ±0.80	24.3 ±0.25	17.6 ±0.17	22.3 ±0.05	17.2 ±0.15	20.1 ±0.19	18.4 ±0.35	24.3 ±0.36
7.	Mg++ (mg/l)	17.32 ±0.47	23.39 ±0.35	14.81 ±0.22	22.74 ±0.39	17.37 ±0.06	14.22 ±0.06	13.15 ±0.45	12.44 ±0.56
8.	Total Solids (mg/l)	178.1 ±1.58	153.3 ±0.05	167.1 ±0.86	189.2 ±0.40	126.1 ±0.55	118.1 ±0.40	115.4 ±0.05	175.1 ±0.58
9.	Total Dissolved Solids(mg/l)	87.1 ±0.95	67.6 ±0.05	85.3 ±0.55	97.5 ±0.77	72.2 ±0.06	56.9 ±0.95	89.2 ±0.15	73.5 ±0.66
10.	Total Suspended Solids (mg/lit)	91 ±1.21	85.4 ±0.05	81.8 ±0.94	91.7 ±0.49	53.8 ±0.05	61.2 ±0.32	26.2 ±0.56	101.5 ±0.05
11.	Chlorides (mg/l)	24.5 ±0.35	19.5 ±0.11	22.3 ±0.15	17.21 ±0.01	24.6 ±0.05	18.6 ±0.32	22.9 ±0.05	18.3 ±0.15
12.	Nitrates(mg/l)	10.5 ±0.37	12.3 ±0.05	9.7 ±0.05	11.8 ±0.05	10.2 ±0.20	10.5 ±0.12	9.6 ±0.05	11.1 ±0.54
13.	SPC (CFU)	**120 ±11.2**	**109 ±11.3**	**127 ±21.6**	**98 ±15.3**	**62 ±21.3**	**73 ±21.2**	**75 ±14.2**	**103 ±16.5**
14.	MPN/100ml	**37 ±32.1**	**48 ±21.3**	**45 ±14.2**	**39 ±11.2**	**65 ±16.3**	**49 ±23.5**	**21 ±36.2**	**25 ±21.2**
15.	Fecal coliform/100 ml	**23 ±14.2**	**28 ±12.5**	**42 ±11.3**	**32 ±14.2**	**45 ±32.5**	**21 ±35.2**	**13 ±11.2**	**27 ±14.5**

Bold numbers indicate parameter value above the prescribed WHO limit

It is revealed from the Table no. 3.3 that though there were seasonal changes, all the fifteen physicochemical parameter values, except turbidity were within the WHO standards. Since Sample (S6) was well water, it showed comparatively higher values of Hardness, Calcium and Magnesium than parameters from sample S5. This site also had the problem of microbial contamination. The sample S5 showed maximum Standard Plate Count (SPC) as 127 CFU and Minimum as 62. The Figure no. 3.3 gives idea about the of MPN and coliform value levels in drinking water at Nagdevwadi village

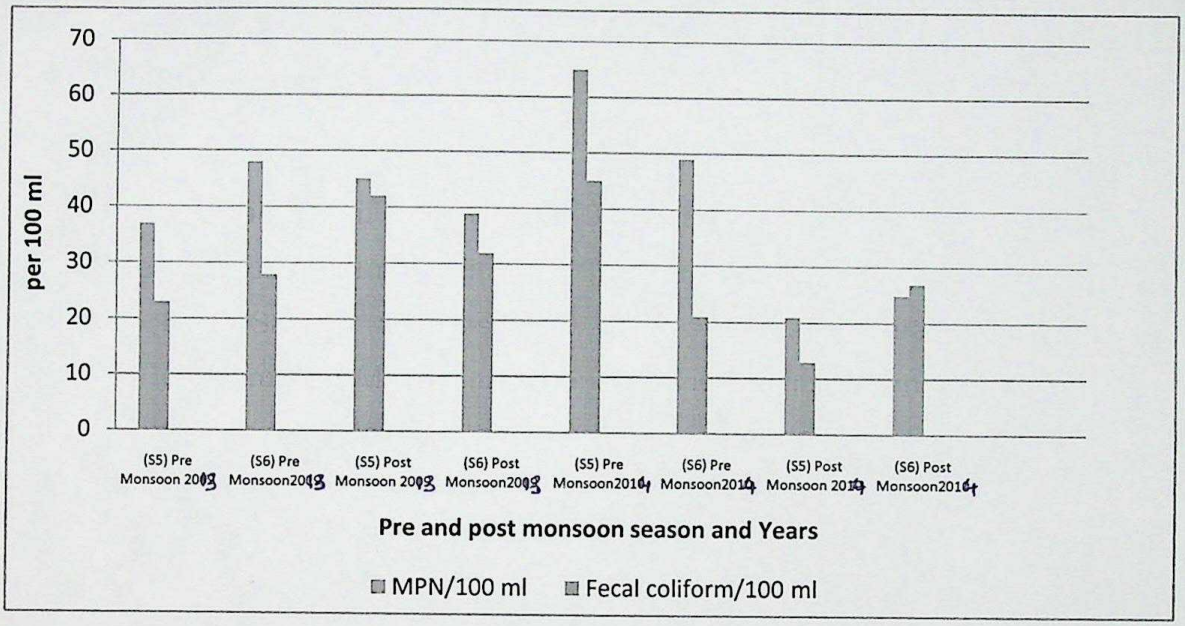


Figure 3.3 MPN and Fecal coliform values per 100ml in drinking water in Nagdevwadi village

It is seen from the figure that Sample S5 shows high number of coliform bacteria during pre monsoon of 2014 than S6. The MPN/100 ml values were in between 21 - 65 and fecal coli forms/100 ml were in between 13- 45 which should be 0 as per the standard limits of WHO for potable drinking water. Therefore, strictly speaking the water from the sampling sites was not potable.

The fourth study area for household drinking water sample analysis was Sarnobatwadi village in Karveer Taluka, located at Latitude 16"41' and Longitude 74"16' at a height of 579 meters MSL and about 4 Km east from Kolhapur city (Fig.No.2.6). The population of the village was 3,722 as per Census of 2011. The village is largely supplied by well and bore water sources .The selected sites of drinking water for the

study purpose were well water (S7) and bore water (S8). Results of the water quality analysis from both the sites in Sarnobatwadi village during pre monsoon and post monsoon season are given in Table no. 3.4

Table No.3.4 Results of water of samples from the sites S7 and S8 in Sarnobatwadi village during pre and post monsoon season of 2013-14

	Sarnobatwadi Village	Pre monsoon		Post monsoon		Pre monsoon		Post monsoon	
Sr. No.	Parameters	Site 7	Site 8	Site 7	Site 8	Site 7	Site 8	Site 7	Site 8
1.	pH	6.9 ±0.1	7.2 ±0.02	7.1 ±0.2	7.3 ±0.5	7.2 ±0.5	7.3 ±0.2	7.1 ±0.5	7.4 ±0.1
2.	Temperature °C	26.9 ± 0.2	27.9 ±0.2	28 ±0.3	27.6 ±0.4	26.4 ±0.2	24.7 ±0.2	28.1 ±0.1	27.2 ±0.2
3.	EC (µS/cm at 20°C)	87.4 ±0.5	112.2 ±0.5	98.2 ±0.2	110.1 ±0.2	74.6 ±0.2	87.6 ±0.1	99.3 ±0.2	132.1 ±0.22
4.	Turbidity (NTU)	**9.1 ±0.5**	**7.8 ±0.6**	**12.1 ±0.2**	**11.3 ±0.4**	**7.3 ±0.11**	**8.3 ±0.2**	**9.4 ±0.1**	**10.4 ±0.2**
5.	Hardness (mg/l)	153 ±0.2	162 ±0.5	159.4 ±0.5	170 ±0.4	182 ±0.1	166.2 ±0.1	169.6 ±0.21	183.1 ±0.2
6.	Ca++ (Mg/l)	57 ±0.1	49 ±0.2	62.4 ±0.3	52 ±0.5	69.2 ±0.2	43.6 ±0.2	59.6 ±0.2	38.9 ±0.1
7.	Mg++ (mg/l)	23.4 ±0.1	27.5 ±0.2	24.3 ±0.25	28.7 ±0.5	27.5 ±0.23	29.9 ±0.2	26.8 ±0.5	35.1 ±0.4
8.	Total Solids (mg/l)	523 ±0.2	176 ±0.2	360 ±0.2	270 ±0.3	250.7 ±0.2	169.3 ±0.1	360.7 ±0.5	410.7 ±0.1
9.	Total Dissolved Solids(mg/l)	154 ±0.5	109 ±0.2	182 ±0.1	130 ±0.2	137 ±0.2	132.5 ±0.1	245.6 ±0.5	273.8 ±0.1
10.	Total Suspended Solids (mg/lit)	69 ±0.2	67 ±0.1	178 ±0.2	140 ±0.3	113.7 ±0.2	36.8 ±0.1	115.1 ±0.5	136.9 ±0.1
11.	Chlorides (mg/l)	95 ±0.2	164 ±0.2	80.94 ±0.5	183 ±0.1	89.7 ±0.2	74.3 ±0.2	65.3 ±0.3	84.5 ±0.1
12.	Nitrates(mg/l)	11.5 ±0.5	13.7 ±0.2	11.4 ±0.3	12.8 ±0.3	10.4 ±0.2	15.6 ±0.1	13.2 ±0.2	14.1 ±0.1
13.	SPC (CFU)	**525 ±22.3**	**541 ±11.6**	**821 ±10.5**	**753 ±12.3**	**625 ±21.3**	**552 ±19.3**	**785 ±32.5**	**964 ±18.2**
14.	MPN/100ml	**115 ±21.1**	**86 ±11.5**	**101 ±10.2**	**116 ±23.2**	**124 ±11.2**	**58 ±12.3**	**214 ±15.2**	**96 ±14.2**
15.	Fecal coliform/100 ml	**70 ±12.6**	**74 ±11.4**	**65 ±35.6**	**28 ±11.2**	**98 ±13.2**	**44 ±36.2**	**68 ±25.2**	**52 ±36.2**

Bold numbers indicate parameter value above the prescribed limit

It was observed from the Table no. 3.3 that Sample S7 and Sample S8 showed less variation in their values particularly during Post monsoon season. This may have been due to the fact that ground water i.e. well water and bore water was used as source of drinking water sample.

It is also seen that in case of Total solids, Sample from site S7 shows more fluctuations than S8.The maximum Total Solids value was 523 mg/lit while the lowest is 176 mg/lit respectively. The Total Dissolved Solids ranges in between 109 – 273.8 mg/lit while Total Suspended Solids ranges between 67 – 178 mg/lit. The Total Hardness ranges in between 159.4-183.1 mg/lit. and Chlorides in between 65.3-95 g/lit., this may be due to the source is ground water. Though there were variations in the values of these parameters, they were safe as within the WHO standards for potable water. The other parameters like Turbidity, Standard Plate Count (SPC), MPN/100 ml and fecal coli form/100 ml were higher and thus above the permissible standards of WHO. As can be seen from the Table no. 3.4 that the Turbidity values ranged in between 7.3 -12.1 NTU, SPC values between 525 – 964 CFU, MPN value between 58 - 214 and Fecal coli forms value between 28 -115/100 ml.

The fifth area for household drinking water study was Shiroli village in Karveer taluka, located at latitude 16"45' and longitude 74"16' at a height of 573 MSL, and about 8 km distance north of Kolhapur city (Figure no. 2.7).The population of the village was 5285 as per the Census, of 2011. The sources of water selected for the study purpose were tap water (S9) and bore water (S10). Results of the pre monsoon and post monsoon water quality analysis in both the sites from Shiroli village are given in Table no. 3.5

Table No. 3.5 Results of water sampling analysis from the two sites S9 and S10 in Shiroli village during pre and post monsoon season 2013-14

	Shiroli village	Pre monsoon		Post monsoon		Pre monsoon		Post monsoon	
Sr. No.	Parameters	Site 9	Site 10	Site 9	Site 10	Site 9	Site 10	Site 9	Site 10
1.	pH	7.4 ±0.05	7.3 ±0.10	7.2 ±0.23	7.3 ±0.01	7.1 ±0.02	7.2 ±0.05	7.3 ±0.04	7.4 ±0.10
2.	Temperature (°C)	28.4 ±0.02	27.2 ±0.01	26.2 ±0.10	25.7 ±0.23	26.1 ±0.14	24.9 ±0.05	28.1 ±0.05	28.4 ±0.05
3.	EC (µS/cm at 20°C)	114.2 ±0.10	96.4 ±0.15	126.2 ±0.20	98.2 ±0.24	67.3 ±0.05	115.6 ±0.10	98.8 ±0.21	164.3 ±0.01
4.	Turbidity (NTU)	**8.6 ±0.02**	**9.6 ±0.05**	**13.4 ±0.52**	**12.1 ±0.05**	**11.1 ±0.10**	**9.6 ±0.23**	**10.2. ±0.21**	**8.2 ±0.25**
5.	Hardness (mg/l)	65.2 ±0.21	112.1 ±0.23	70.3 ±0.21	125.8 ±0.25	72.5 ±0.05	110.5 ±0.01	72.3 ±0.10	115.4 ±0.22
6.	Ca++ (Mg/l)	29.4 ±0.05	65.2 ±0.23	24.1 ±0.54	70.2 ±0.21	30.1 ±0.20	58.3 ±0.23	27.4 ±0.21	49.1 ±0.10
7.	Mg++ (mg/l)	0.873 ±0.10	11.46 ±0.05	11.27 ±0.20	13.56 ±0.25	10.34 ±0.23	12.73 ±0.21	10.95 ±0.10	16.17 ±0.22
8.	Total Solids (mg/l)	530 ±0.25	438.4 ±0.30	630.2 ±0.05	139.1 ±0.01	519.2 ±0.40	109.3 ±0.21	456 ±0.23	126.2 ±0.21
9.	Total Dissolved Solids(mg/l)	212.4 ±0.21	104.2 ±0.25	115.2 ±0.22	79.3 ±0.10	165.3 ±0.22	59.2 ±0.41	120 ±0.22	64.1 ±0.22
10.	Total Suspended Solids(mg/lit)	313.6 ±0.05	334 ±0.21	515 ±0.15	59.8 ±0.20	354.1 ±0.21	50.1 ±0.10	336 ±0.31	62.2 ±0.22
11.	Chlorides (mg/l)	29.2 ±0.22	56.1 ±0.23	26.2 ±0.21	62.1 ±0.22	27.3 ±0.45	59.2 ±0.11	29.6 ±0.21	54.3 ±0.22
12.	Nitrates (mg/l)	6.9 ±0.21	12.2 ±0.11	5.8 ±0.14	11.6 ±0.22	5.4 ±0.25	10.9 ±0.31	5.3 ±0.05	11.4 ±0.21
13.	SPC (CFU)	**636 ±11.1**	**585 ±12.5**	**654 ±23.2**	**424 ±21.2**	**314 ±23.1**	**256 ±32.1**	**564 ±15.2**	**794 ±16.5**
14.	MPN/100ml	**456 ±23.5**	**524 ±26.5**	**301 ±19.8**	**630 ±14.2**	**265 ±20.1**	**198 ±11.1**	**102 ±14.2**	**223 ±13.2**
15.	Fecal coliform/100ml	**128 ±23.1**	**96 ±14.2**	**105 ±13.2**	**201 ±14.2**	**115 ±14.2**	**109 ±15.2**	**135 ±14.1**	**145 ±12.3**

Bold numbers indicate parameter value above the prescribed limit

It is revealed from the Table No.3.5 that Sample S9 which was Tap water and Sample S10 10 which was bore water showed minor seasonal variations. Some parameters values like Turbidity (8.2-13.4), MPN/100ml (102-524) and fecal coli forms/100 ml (96-145) were, as expected, above the prescribed limit of WHO. The seasonal variations in Turbidity are clear from the Figure no. 3.4.

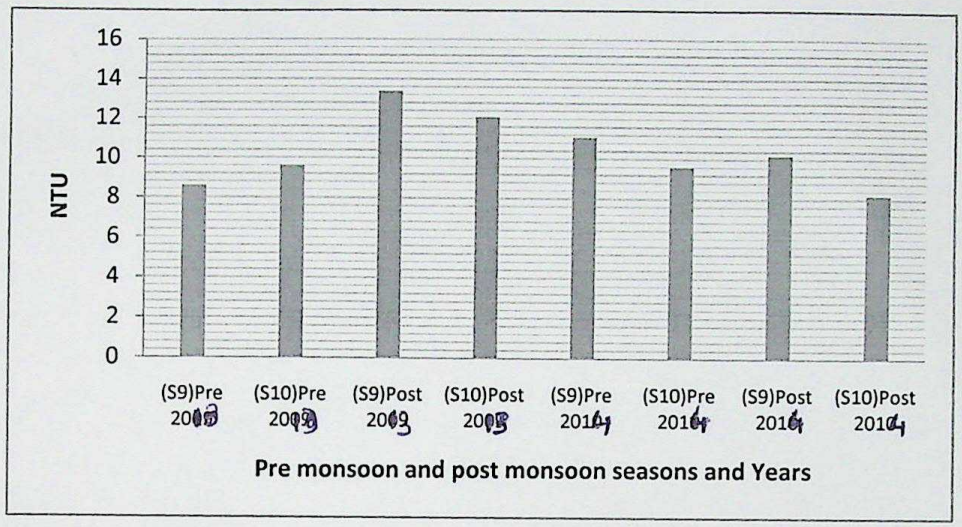


Figure No. 3.4 Seasonal changes in drinking water Turbidity at Shiroli

The figure indicates that the tap water source (S9) showed higher Turbidity value than the bore water source (S10) in post monsoon season in 2013. This may be due to increased amount of colloidal matter in water after rainy season which was not the case in the bore water sample (S10). Higher densities of indicator organisms during post-monsoon season might be due to percolation as well as seepage of domestic sewage through the soil. Shiroli is one of the crowded villages with high population which is responsible generation of sewage.

The sixth and the last study area for household drinking water analysis during this study was Tamgao village in Karveer taluka, located at latitude 16''38' and longitude 74''18' at height of 569 meters MSL, located at 12 km North of Kolhapur city (Figure no. 2.8).The population of the village was 4,189 (Census, 2011).The drinking water sources selected for study purpose were both bore water samples S11 and S12. Results of the pre monsoon and post monsoon water quality in the sites from Tamgao village are given in Table no. 3.6.

Table No. 3.6 Results of the tests of water samples from the two sites in Tamgaon village during pre and post monsoon season 2013-14

	Tamgao Village	Pre monsoon		Post monsoon		Pre monsoon		Post monsoon	
Sr. No.	**Parameters**	**Site 11**	**Site 12**	**Site 11**	**Site 12**	**Site 11**	**Site 12**	**Site 11**	**Site 12**
1.	pH	7.2 ±0.01	7.3 ±0.05	7.1 ±0.10	7.2 ±0.05	7.4 ±0.02	7.1 ±0.02	7.2 ±0.10	7.3 ±0.23
2.	Temperature °C	25.6 ±0.32	28.1 ±0.10	26.1 ±0.10	26.1 ±0.05	26.1 ±0.02	25.1 ±0.20	26.1 ±0.10	28.2 ±0.12
3.	EC (µS/cm at 20°C)	112.5 ±0.10	125.3 ±0.20	132.5 ±0.10	129.2 ±0.20	109.5 ±0.10	110.5 ±0.05	117.5 ±0.02	126.2 ±0.10
4.	Turbidity (NTU)	**8.1 ±0.05**	**6.3 ±0.04**	**8.2 ±0.25**	**7.2 ±0.20**	**5.4 ±0.21**	**6.2 ±0.02**	**5.6 ±0.01**	**5.3 ±0.10**
5.	Hardness (mg/l)	85.4 ±0.20	173.8 ±0.40	79.5 ±0.20	148.6 ±0.10	77.2 ±0.14	160.5 ±0.23	85.1 ±0.25	155.2 ±0.05
6.	Ca++ (mg/l)	35.2 ±0.14	79.2 ±0.20	27.8 ±0.01	72.4 ±0.23	28.1 ±0.14	80.1 ±0.05	24.1 ±0.32	77.8 ±0.21
7.	Mg++ (mg/l)	12.24 ±0.02	23.08 ±0.05	12.61 ±0.02	18.59 ±0.03	11.98 ±0.05	19.52 ±0.04	14.88 ±0.01	20.56 ±0.05
8.	Total Solids (mg/l)	177.9 ±0.01	163.2 ±0.01	169.8 ±0.20	175.6 ±0.10	135.2 ±0.20	146.2 ±0.30	158.2 ±0.20	162.3 ±0.25
9.	Total Dissolved Solids (mg/l)	98.2 ±0.20	77.5 ±0.05	89.6 ±0.04	83.2 ±0.01	46.2 ±0.05	55.2 ±0.06	69.2 ±0.02	55.8 ±0.03
10.	Total Suspended Solids (mg/l)	79.1 ±0.05	85.7 ±0.04	80.2 ±0.01	92.4 ±0.02	89 ±0.03	91 ±0.01	89 ±0.05	106.5 ±0.02
11.	Chlorides (mg/l)	23.1 ±0.04	38.3 ±0.02	25.1 ±0.05	36.2 ±0.05	28.9 ±0.03	38.7 ±0.01	36.4 ±0.05	32.1 ±0.02
12.	Nitrates (mg/l)	18.2 ±0.02	14.6 ±0.03	16.8 ±0.02	14.3. ±0.05	18.4 ±0.05	13.5 ±0.02	14.8 ±0.05	14.8 ±0.05
13.	SPC (CFU)	**326 ±22.3**	**245 ±11.6**	**162 ±10.5**	**253 ±12.3**	**125 ±21.3**	**152 ±19.3**	**285 ±32.5**	**264 ±18.2**
14.	MPN/100 ml	**98 ±21.1**	**106 ±11.5**	**115 ±10.2**	**87 ±23.2**	**84 ±11.2**	**65 ±12.3**	**74 ±15.2**	**86 ±14.2**
15.	Fecal coliform/100ml	**46 ±12.6**	**56 ±11.4**	**85 ±35.6**	**38 ±11.2**	**78 ±13.2**	**45 ±36.2**	**68 ±25.2**	**52 ±36.2**

Bold numbers indicate parameter value above the prescribed limit

It is clear from the Table no. 3.6 that despite being bore water samples, which are expected to be clear and have less surface contamination, the four parameters i.e. Turbidity, MPN/100 ml, fecal coliform and SPC were above the prescribed limit. The Standard Plate Count (SPC) observed was in between 125 – 326 CFU rendering the water unfit for potable purpose. The seasonal variations in MPN/100 ml and fecal coli forms are shown in figure no. 3.5.

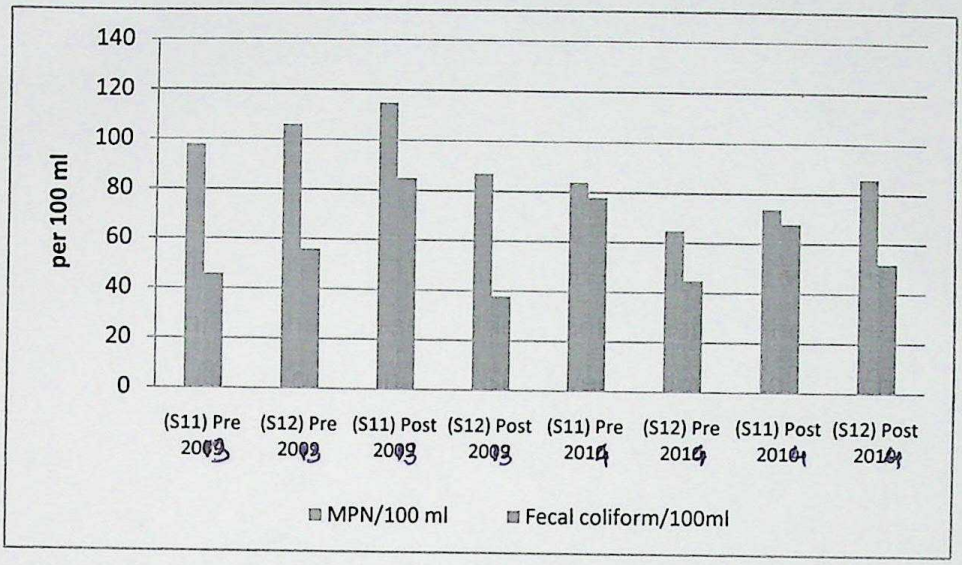


Figure No.3.5 Changes in the values of MPN and fecal coliformsin drinking water from Tamgao village during 2013-14

It is clear from the Figure no. 3.5 that Sample no. S11 showed highest level of MPN and fecal coli form than Sample no. S12 in post monsoon season of 2013. Also, it is seen from the figure that the MPN ranges in between 74 – 115 and fecal coli forms ranges in between 38 – 85 per 100 ml.

3.3 Comparison of physicochemical and microbial parameters of the water samples in the study area

It was observed that each water sample, collected at both the sampling sites in every study village, showed different pre and post monsoon seasonal variations and reflected either in lower or higher values. However, it was difficult to summarize the values because of their different sources of origin. Yet since the local people are ultimately concerned about the quality of drinking water they get, average values of all

the samples tested at a village during the study period of two years were compared. Table no. 3.7 gives an idea about average values of the physicochemical and microbial parameters in drinking water quality at six villages in the study area.

Table No.3.7 Average values of physicochemical and microbial parameters in household drinking water in six villages and study area around Kolhapur city

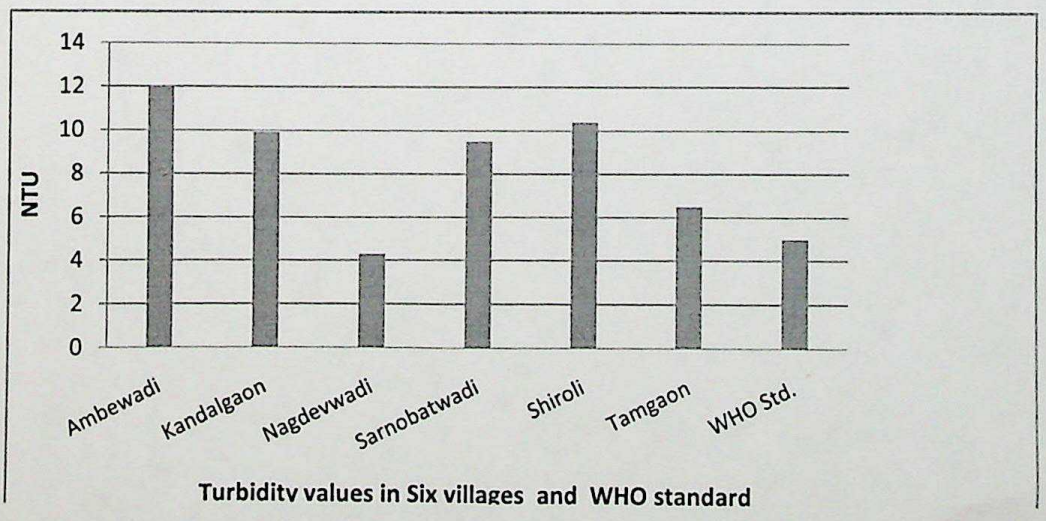
Sr. No.	Parameter	Ambewadi village	K'gaon village	N'wadi village	Sarnobatwadi village	Shiroli village	Tamgaon village	Average Value
1.	pH	7.2	7.1	7.1	7.2	7.3	7.2	7.2
2.	Temperature (°C)	25.2	26.8	25.8	27.1	25.1	26.4	26.1
3.	EC (µS/cm at 20°C)	77.7	108.2	107.3	100.2	110.1	120.4	103.8
4.	Turbidity (NTU)	15.8	9.9	4.3	9.5	10.4	6.5	9.4
5.	Hardness (mg/l)	79.1	377.9	91.0	168.2	29.0	120.7	144.3
6.	Ca++ (mg/l)	27.7	89.3	20.3	54.0	44.2	53.1	48.1
7.	Mg++ (mg/l)	10.0	69.2	16.9	27.9	10.9	16.7	25.3
8.	TS (mg/l)	173.5	187.6	152.8	277.6	367.9	161.1	220.1
9.	TDS (mg/l)	98.0	101.0	78.7	170.5	115.0	71.9	105.9
10.	(TSS) (mg/l)	75.5	86.5	74.1	107.1	253.1	89.1	114.2
11.	Chlorides (mg/l)	24.7	67.1	21.0	104.6	43.0	32.4	48.8
12.	Nitrates (mg/l)	10.7	10.7	10.7	12.8	8.7	15.4	11.5
13.	SPC (CFU)	388.0	397.4	95.8	695.8	528.4	339.0	407.4
14.	MPN/100 ml	58.0	65.0	58.2	125.6	337.4	89.1	122.2
15.	Fecal coliform/100ml	50.0	55.1	25.1	68.3	129.3	134.0	77.0

Bold numbers indicate parameter value above the prescribed limit

The pH is affected not only by the reaction of carbon dioxide but also by organic and inorganic solutes present in water and any alteration in water pH is accompanied by the change in other physicochemical parameters. The WHO limit of pH for drinking water is between 6.5 - 8.5. In the present study, the average pH values of drinking water samples in the six villages was 7.2 with very little fluctuations in value during the study period.

Temperature impacts the physical and microbial characteristics of water. A rise in temperature of water leads to the speeding up of the chemical and microbial reactions in the water (Agrawal and Rajwar, 2010 and Sharma et al, 2008).The drinking water samples for the study purpose were collected from different households where it was normally stored in steel, aluminium or plastic containers. Therefore, temperature of drinking water sample in study area reflects the ambient air temperature in the surrounding. This ambient air temperature may depend upon the type and material used in construction of house or kitchen, type of container, volume of water, etc. It was observed that the average temperature of water samples was 25.2 °C and very few alterations were observed in case of water temperature in study area. The maximum temperature value recorded was 27.1°C in case of Sarnobatwadi samples village and a minimum of 25.1°C was observed in Shiroli village.

Turbidity is a measure of the cloudiness of water or penetration of light through aquatic medium. The degree of turbidity in drinking water may also be used as measure of the intensity of pollution. Surface runoffs and domestic wastes mainly contribute to the increase in turbidity in water (Agrawal and Rajwar, 2010). Reduction in turbidity is associated with reduction in the suspended matter i.e. sand



Turbidity values in Six villages and WHO standard

particles, plankton, detritus and microbes and it may not have any direct health effects. However, turbidity can interfere with disinfection and provide a medium for microbial growth and it may indicate presence of disease causing organisms. These organisms include bacteria, viruses, and parasites that can cause symptoms such as nausea, cramps, diarrhoea, and associated headaches (UNICEF/WHO,(2010)). The average values of Turbidity in drinking water samples from all the six sites are shown in figure no.3.6.

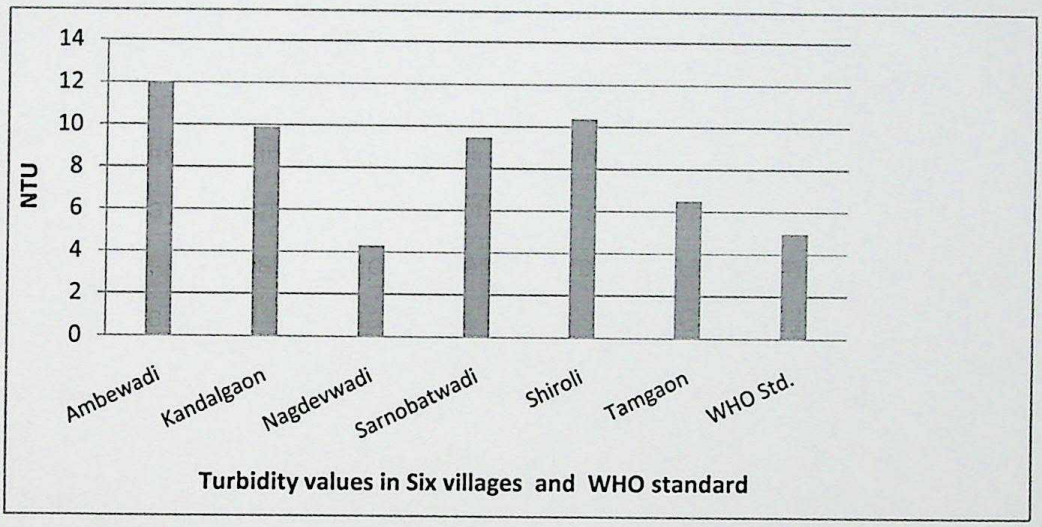


Figure No.3.6 The Average Turbidity values in drinking water from the six study villages and the turbidity standard of WHO

The Turbidity values of all the sites fluctuated between 4.3 -15.8 NTU with average of 9.4 NTU. Minimum value of 4.3 was reported in Nagdevwadi village whereas the maximum turbidity value (15.8 NTU) was noted in Ambewadi village. All the samples, except Nagdevwadi village, showed turbidity values greater than the permissible value of 5 NTU as per WHO guidelines for drinking water. Not surprising that the main intake of water supply to Kolhapur city is located at Nagdevwadi. The results of the study indicate that water collected from the remaining five villages in the study is unfit for drinking on account of high Turbidity.

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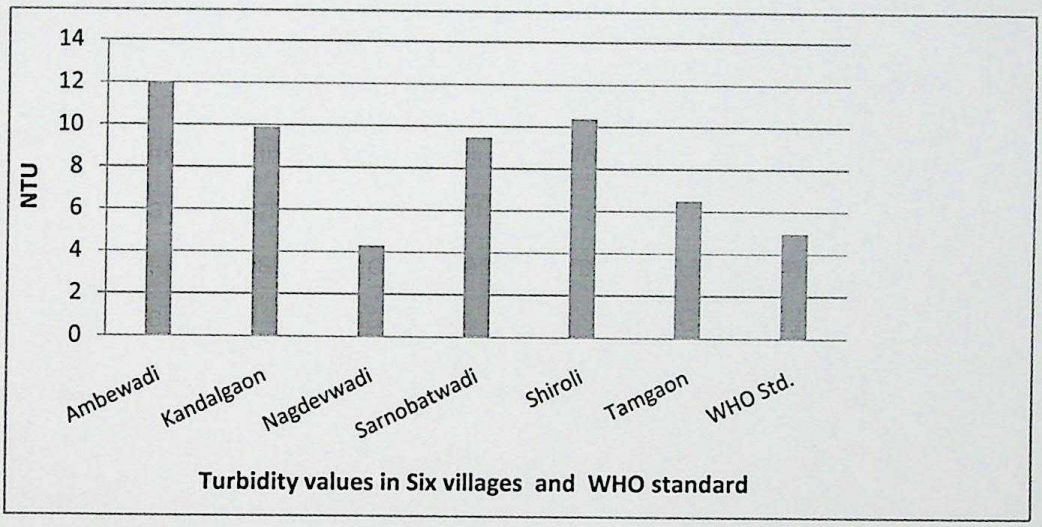


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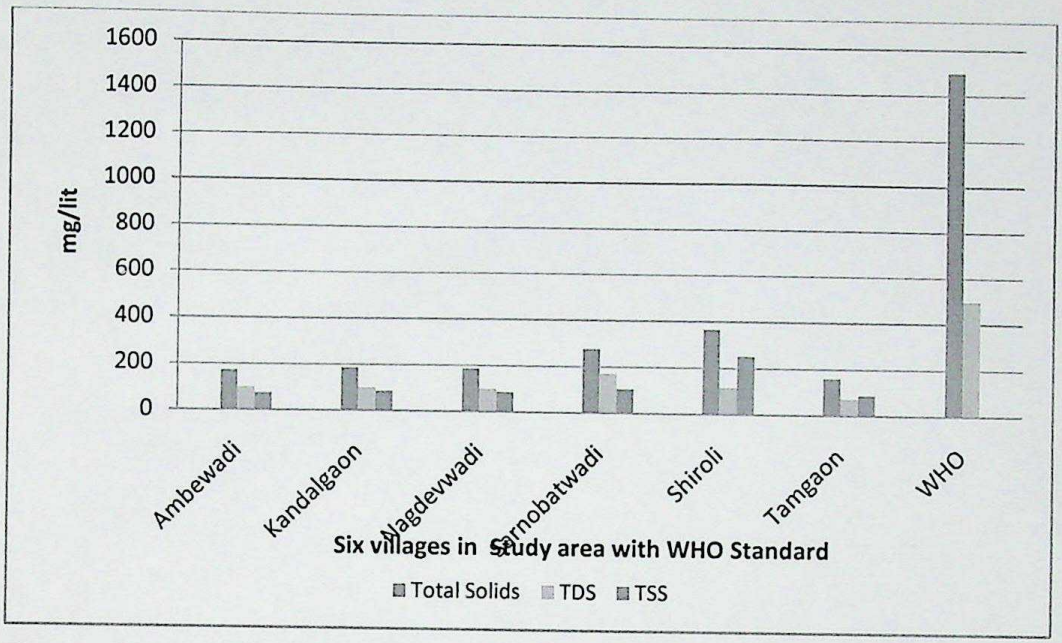


Figure No. 3.7 The average values of Total Solids, Total Dissolved Solids and Total Suspended Solids in drinking water samples of the six study villages

A Total Solid (TS) is a term applied to the material residue left in the vessel after evaporation of a sample and its subsequent drying in an oven at defined temperature. The average values of TS in the water samples from the study villages are seen in figure no.3.9. During the study it was observed that among all the sites, the maximum level of TS value i.e. 367.9 was observed in Shiroli village while the minimum value of i.e. 152.8 was observed for Nagdevwadi village. However, all the TS values in the study villages were much lower than the permissible level of TS by WHO.

Figure no. 3.7 also indicates that the value of maximum Total Dissolved Solids TDS i.e.170.5 mg/lit, was recorded in Sarnobatwadi village and minimum of 71.9 mg/lit was from Tamgao village. In case of Total Suspended Solids (TSS), the maximum value of 253.1 mg/lit was seen in Shiroli village and minimum of 74.1 mg/lit was recorded at village Nagdevwadi. It is clear from figure no 3.7 that all the values of Total Solids and Total Dissolved Solids were within the WHO standards. However, in case of Total Suspended Solids (TSS) there is no specific WHO guideline or IS 10500 standard for its upper limit in drinking water.

Generally estimation of hardness is important for ground water, which is harder than surface water. Principle cations imparting hardness are calcium and magnesium.

However, other cations such as strontium, iron and manganese also contribute to the hardness. The ions responsible for hardness are mainly bicarbonates, carbonates, sulphates, chlorides, nitrates and silicates.

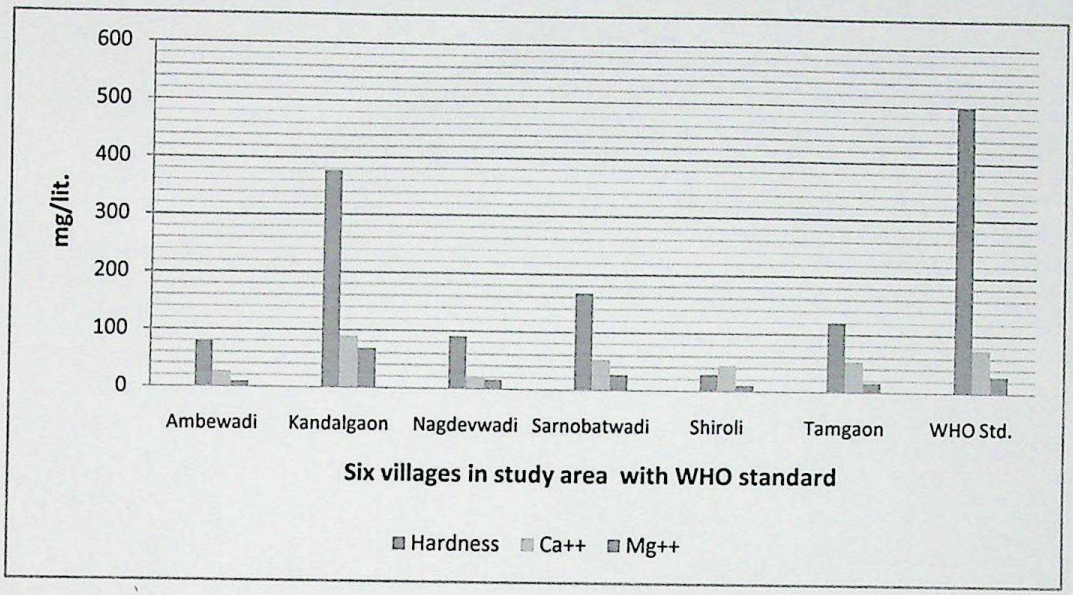


Figure No 3.8 The average values of Hardness, Calcium and Magnesium values in drinking water samples in six study villages

Figure no.3.8 indicates, the hardness value of water from Kandalgao i.e.377.9 mg/lit was maximum while the minimum value of 29 mg/lit was seen for Shiroli village. Both the samples tested from Kandalgao households were from well water, while the samples from Shiroli village were from tap water and bore water sources. Therefore, the Kandalgao village water samples show maximum Hardness in the study villages. Total Hardness (TH) of water mainly depends upon the amount of calcium or magnesium salts or both. The permissible limits of TH in potable water ranged within 500 mg/lit as per WHO limit. The analysis showed that all the water samples tested during this study were within WHO permissible limit 377.9 mg/lit. - 29 mg/lit.

Chlorides, in the form of Cl^- ion, are one of the major inorganic anions in water. The salty taste produced by chloride concentrations is variable and dependent on the chemical composition of water. The figure no. 3.10 indicates the average chloride values in all the six study villages.

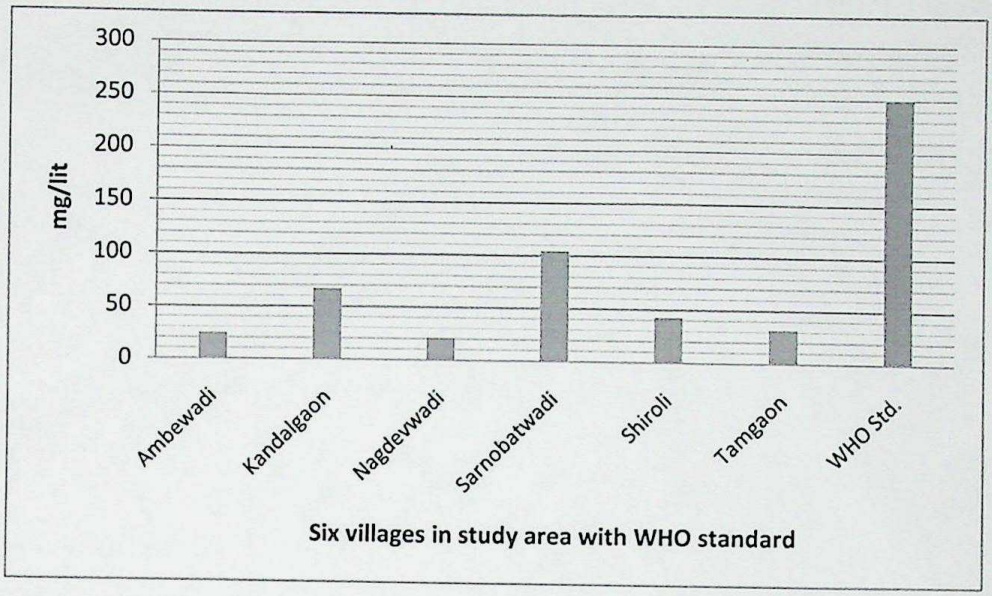


Figure No. 3.9 The Average values of Chlorides in drinking water samples from the six study villages

Figure No.3.10 indicates that the highest Chloride concentration of 104.6 mg/lit was in Sarnobatwadi village and the minimum value of 21 mg/lit. was from Nagdevwadi village. Whereas the average Chloride value in the study area was 48.8 mg/lit.

Standard Plate Counts (SPC) are based on the assumption that microbial cells present in a sample mixed with an agar medium will grow into visible, separated colonies, and that each cell gives rise to a single colony. The nature and quantity of microbes in the water samples determine the health risk of consumer after consuming the water. (Parsons, 2000). However, there is no specific standard for presence of total viable bacteria in drinking water as per WHO norms. It was observed during the study that all the water samples tested were not able to comply with the standard for microbial quality of water for human consumption given by European Council (EC) that only allowed not more than 10 cfu/ ml in potable drinking water. As per the Food Act ,1983 and most countries do not state the limit of total viable count for drinking water, therefore the EC criteria was used to make comparison in this study.

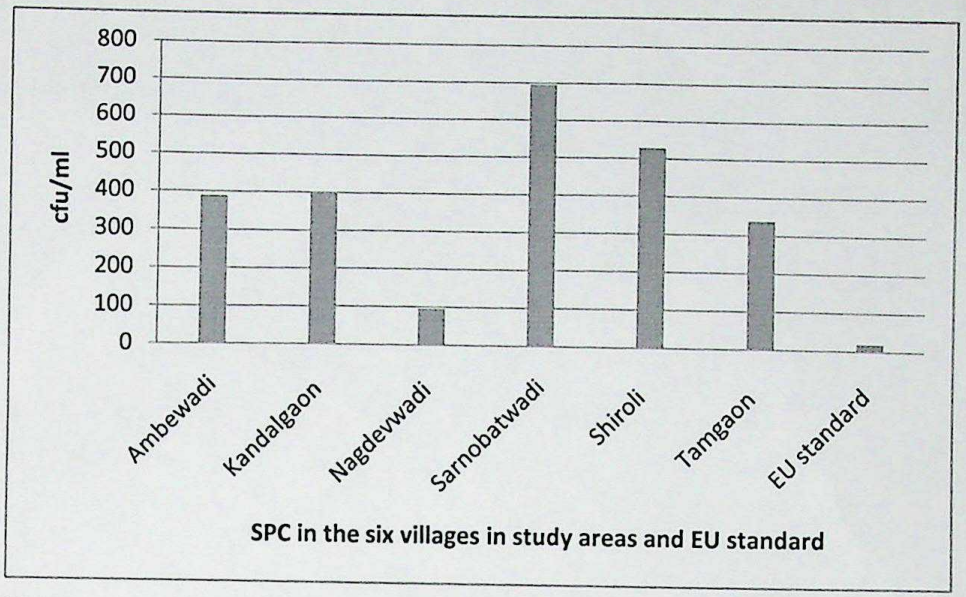


Figure 3.10 The Average values of Standard Plate Count (SPC) in drinking water samples from the six study villages

The Standard Plate Count (SPC) of all the study sites ranged between 95.8 – 695 cfu/ml. Minimum Standard Plate Count of 95.8 cfu/ml was observed in Nagdevwadi sample while Maximum value of 695 cfu/ml was observed in Sarnobatwadi sample. The average SPC count for the region was 407.4 cfu/ml, and all the samples reported values much higher than EU standard for potable water.

Most coliforms are present in large numbers among intestinal flora of humans and other warm-blooded animals, and are thus found in faecal wastes (Dorothy, 1998). As a consequence, coliforms, detected in higher concentrations than pathogenic bacteria, are used as an index of the potential presence of entero-pathogens in water environments (Rompré, 2002). Coliforms are also routinely found in diversified natural environments, as some of them are of telluric origin, but drinking water is not a natural environment for them. As a result, their presence in drinking water must be considered as harm to human health. Positive presence of coliforms in treated water which usually indicates treatment ineffectiveness. The overall average values of MPN/100 ml in all the study villages in the area is shown in figure no. 3.12.

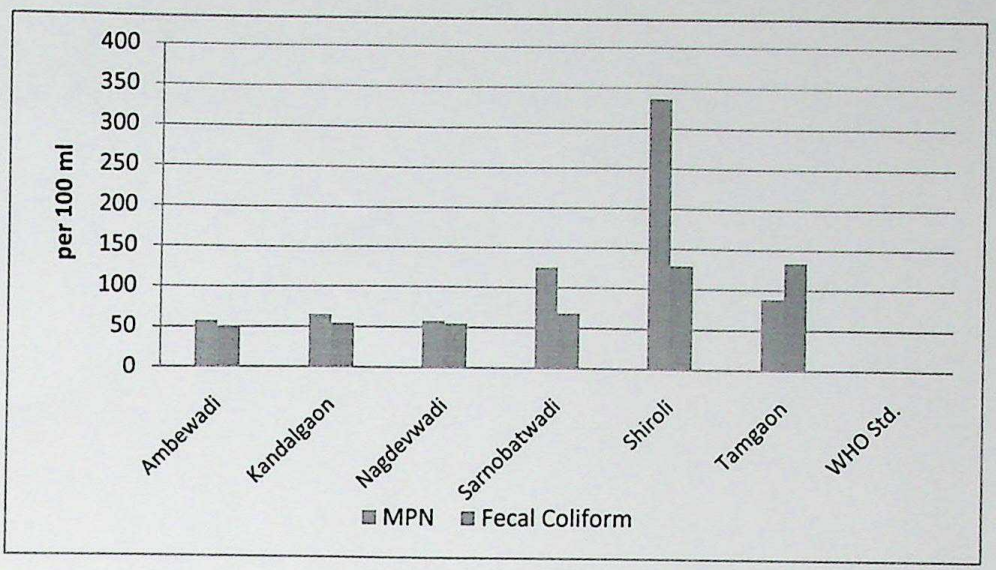


Figure No.3.11 The average values of MPN and Fecal coliforms in drinking water samples from the six study villages

It is revealed from the above figure that the maximum Most Probable Number (MPN) value among the six villages was 337.4 /100 ml in Shiroli village and minimum of 58/100 ml was seen in Ambewadi village. The presence of coliform in drinking water samples indicate either improper chlorination treatment in the common water storage tank of village or mixing of sewage in pipeline supply or unhygienic conditions during storage of drinking water in households.

Any value of Fecal coliforms according WHO standard is indication of fecal pollution in water and it is not potable. A subset of coli form bacteria are able to grow at 44.5°C. *E.coli* is able to grow at this temperature while most of the coliforms of sanitary significance are not able to grow at this temperature. Fecal coliform bacteria are gram-negative, non-spore-forming rods that are found in the intestines and faeces of humans and other warm-blooded animals. The predominant fecal coli form is *E. coli.* Since coliforms from other sources often cannot produce gas under these conditions, this criterion is used to define the fecal component of the coli form group.

It is observed from the figure 3.11 that the maximum fecal coliform value among six villages was 134 /100 ml which was from Shiroli village samples and minimum of 25.1/100 ml was recorded in Ambewadi village. Since the Shiroli water samples show maximum coliform which indicates that either the Tap water was contaminated due

improper storage and handling at households or improper drinking water purification treatment.

Correlation between physicochemical and microbial parameters

The correlation between physicochemical and microbial parameters of drinking water in six villages of study area is given in Table no. 3.8. A large number of factors and geological conditions influence the correlations between different pairs of physicochemical parameters of water samples directly or indirectly. All the physicochemical parameters of drinking water samples from selected sites were taken for pre monsoon and post monsoon for year 2013 – 14 and were within the desirable limit prescribed by WHO. Except turbidity and microbial parameters recorded high values in both seasons, pre monsoon and pre monsoon season respectively, beyond permissible limit norms of WHO.

It is seen from the Table that Turbidity and Total Suspended Solids are correlated to each other (0.67). The correlation value is not very strong. It was observed that the parameter values of Turbidity and Standard Plate Count (SPC) were positively correlated with each other i.e. (0.80). The colloidal and extremely fine dispersions, clay particles, finely divided organic and inorganic matter is responsible for assemblage of microorganisms in water. Therefore, the increase in Turbidity value is responsible for increase in Standard Plate Count (SPC) which is indicated through the correlation between Turbidity and Standard Plate count value in Table No. 3.9.

Similarly, the correlation between Turbidity and Most Probable Number (MPN) (0.85) shows positive correlation between each other. Also, it is observed that Turbidity is positively correlated with faecal coliform (0.86) in water. It is known that a turbidity >5 NTU in drinking water is considered unhealthy. Turbidity can interfere with disinfection and provide a medium for microbial growth (US EPA, 2003). The parameter Most Probable Number in the samples reveals the presence of coliform bacteria in drinking water which in turn indicates the presence of disease causing organisms including bacteria, viruses, and parasites responsible for waterborne diseases.

Generally, estimation of hardness is important for ground water, which is usually more than the surface water. The Table no. 3.9 also shows that the Total Hardness and Calcium (0.86) and Total Hardness and Magnesium (0.98) values of drinking water in six villages were highly correlated with each other. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both which are the principle cations imparting hardness. Similarly, positive correlation is also been observed between Calcium and Magnesium (0.87).

The present study also indicate that Total Solids and Total Suspended Solids are proportional to each other i.e. (0.92). The Total Solids are composed of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter, salt , volatile components, and other particles. The rise in Total Solids is directly proportional to the rise in Total Suspended Solids.

Similarly, Total Solids and Standard Plate Count (0.91) show significant correlation between each other. Since the bacteria are attached to the suspended particles in water, the number of viable bacteria able to form colonies on nutrient media increases. Correlation is also seen in case of Total Dissolved Solids and Chlorides (0.82).Since Chlorides are one of the part of Total Dissolved Solids, both are positively correlated with each other. .

It is observed from the Table that the microbial parameters i.e. Most Probable Number (MPN) and fecal coliform are positively correlated with each other (0.84).Since both of them are dependent on each other this correlation is seen from the table.

The other parameters like pH and Nitrate (-0.14),Electrical Conductivity and Standard Plate Count (SPC)(-0.18), Electrical Conductivity and MPN (-0.63), Electrical Conductivity and Fecal coliform (-0.64),Nitrate and Standard Plate Count (SPC)(-0.56) shows negative correlation with each other.

Table No. 3.9 Correlation between Physicochemical and Microbial Parameters of Drinking Water in the study area

Parameters	pH	Temperature	EC	Turbidity	Hardness	Ca++	Mg++	T S	TDS	TSS	Chlorides	Nitrate	SPC	MPN/100ml	Fecal Coliform
pH	1.00	0.46	0.01	0.93	0.64	0.19	0.59	0.72	0.18	0.77	0.03	-0.14	0.81	0.72	0.72
Temperature		1.00	0.33	0.12	0.72	0.66	0.66	0.23	0.37	0.46	0.75	0.59	-0.48	0.17	0.16
EC			1.00	0.23	0.13	0.35	0.17	0.13	-0.24	0.27	0.04	0.35	-0.18	-0.63	-0.64
Turbidity				1.00	0.41	0.09	-0.39	0.65	0.21	**0.67**	0.25	0.15	**0.80**	**0.83**	**0.86**
Hardness					1.00	**0.86**	**0.98**	0.34	0.05	0.43	0.49	0.12	0.42	0.41	0.43
Ca++						1.00	**0.87**	0.00	0.07	0.04	0.59	0.16	0.01	0.06	0.05
Mg++							1.00	0.21	0.07	0.29	0.49	0.02	0.02	0.38	0.40
Total Solids								1.00	0.57	**0.92**	0.37	0.51	**0.91**	0.42	0.43
TDS									1.00	0.20	**0.82**	-0.16	0.20	0.24	0.22
TSS										1.00	0.04	0.54	-0.99	0.62	0.62
Chlorides											1.00	0.14	0.05	0.11	0.11
Nitrates												1.00	-0.56	0.27	0.28
SPC													1.00	0.40	0.60
MPN/100ml														1.00	**0.84**
Fecal Coliforms															1.00