ASSESSMENT OF IMPACT ON SURFACE AND GROUND WATER QUALITY DUE TO COMMUNITY TOILET - A CASE STUDIES

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ABSTRACT

The present case study is based on work carried out on the assessment of impact on Ground water quality due to percolation of certain pollutants from community toilet based on Soakpit System. The Community Toilet which was selected for this study was located nearby Downstream of the Har Ki Pauri, i.e. Rodibelawala at Hardwar and is used by large number of tourists.

In order to assess the ground water quality due to Community Toilets, borewells were digged at the Upstream and the Downstream of the Soak Pit of Community Toilet. The samples were collected for the Ground water from the shallow borewells at a depth of about 4 to 5 feets deeps and the Deep bore wells about 100 feet deep. The surface water from Ganga in the vicinity of community toilets was also collected. The ground water and surface water quality was analysed for the relevant parameters.

Based on studies on Assessment of Impact on Surface and Groundwater due to Community Toilets, the following were the finding :

1. There was no effect on the surface water quality of Ganga river due to Septic Tank effluent. All the parameters of surface water was under permissible limits of "class B" river at Rodibelwala bathing ghat. Similar surface water quality was observed in river before Rodibelwala also.

2. The deep well groundwater was not affected due to Septic Tank effluent and was fit for drinking purposes. All the parameters were under permissible limits.

3. The ground water quality of shallow bore wells were found to be unfit for drinking purposes which are situated within 40 meters from the septic tank and about 4 meters deep only. It could be inferred that the ground water of borewells get contaminated by septic tank effluent, as there is no other source of pollution in the area.

4. The septic tank design in this area needs modification as geographically these soakpits are located in the sandy soil. The porosity of this soil is ranged from 47.20 to 67.62% .

5. It is essential that Geographical conditions should be considered while designing soak pit system for the sewage disposal of community toilets.

1.0 INTRODUCTION

Various community toilets (Sulabh Shauchalayas) were constructed with the funding from National River Conservation Directorate to control the contamination of Ganga water sources from human wastes. Most of these toilets were linked with the sewerage system for proper treatment and disposal of these wastes. However in certain cases, due to non availability of sewerage systems; Septic Tanks and Soak Pits were constructed for efficient and proper disposal of wastes.

The basic septic tank system consists of a buried tank and a subsurface soil absorption system (Figure 1.1). Waste water is initially directed to buried tank which acts as sedimentation as well as digestion tank. The waste water is allowed to retain in the tank for some period where Scum, grease and settlable solids are removed from the waste water. Anaerobic digestion of organic settled solids takes place. The clarified effluent then proceeds to the subsurface drain system where it percolates into the soil. The performance of the septic tank system depends on the system design, construction techniques, waste water characterisation, hydraulic loading, climatic conditions of the area, hydro-geology & soil composition and proper maintenance scheduling.

The treated effluent from septic tank still contains pathogenic organisms, organic matter and solids. This effluent if allowed to percolate into the soil represents a potential source of ground water contamination.

Septic tank system that are properly located, designed, constructed and maintained represents an efficient and economical sewage disposal alternative without threatening ground water resources. However poor system design, improper construction & maintenance and wrong system location may lead to ground water pollution. Another concern in many locations is septic tank density exceeding the natural ability of the subsurface soil to absorb and purify the effluent. Excessive septic tank densities in the area may degrade ground water quality with high concentration of bacteria, nitrates and organic contaminants. One reason for this degradation is rapid downward movement of pollutant. The soils having high permeability can be overloaded resulting in rapid downward migration of organic and inorganic substances and microorganisms. These high seepage rate do not allow the physical, chemical and biological mechanisms of soil to operate on the percolating effluent.

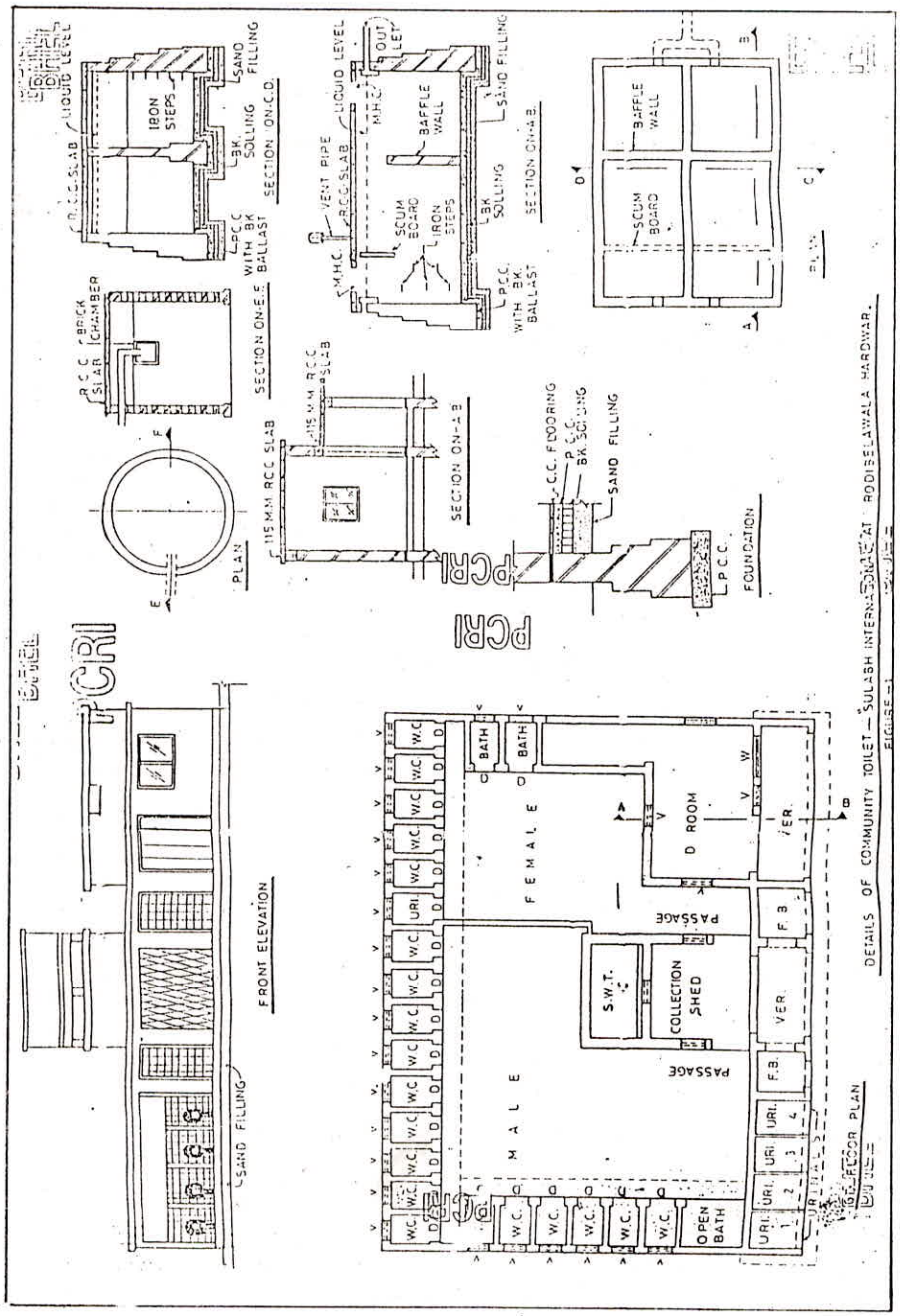

Figure 1.1 : Details of Community Toilet – "Sulabh International" Rodibelwala, Hardwar

The present case study is aimed at assessment of impact on Ganga and Ground water quality due to percolation of certain pollutants from community toilet system at Rodibelwala. The main objectives of the studies are were follows :

i. To monitor the Ganga water and Ground water quality at Downstream of Har Ki Pouri (Rodibelwala) region near the vicinity of septic tank based community toilets.

ii. To assess the effect of various pollutants on surface/ground water on the basis of river/ground water monitoring.

2.0 METHODOLOGY

2.1 Survey of Community Toilets

The information on the locations of Community Toilets in Hardwar was obtained from Municipality and Sulabh International authorities.There are 59 Community Toilets at various places in Hardwar out of 59 Toilets 7 are Soak Pit based system and remaining are connected with the sewer. The Rodibelwala Community Toilets is having environmental importance since it is located at Downstream of the Har Ki Pouri. This Community Toilet is 20 seated capacity and having Soakpit System . Therefore this Community Toilet was selected for the studies.

2.2 Selection of sites for Detailed Studies

The community toilets situated on the left bank of the Ganga canal are not connected through sewer lines. For the treatment of sewage septic tanks have been provided. The septic tank is a combined sedimentation and digestion tank where sewage is held for some period. The suspended solids settle down to the bottom of tank followed by anaerobic digestion of sludge and liquid. This results in appericiable reduction in the volume of sludge and release of gases. The treated effluent however still contains cosiderable amount of dissolved and suspended organic solids and pathogens. The soak pits are used for the disposal of this effluent. After passing through soak pits the effluent may still contain organic matter and pathogens. This effluent may ultimately join ground water table or surface water stream. Therefore the sampling sites for surface water and ground water have been selected upstream and down stream to the septic tank.

2.3 Importance of Rodibelwala Area

This area is situated in between field of Rodibelwal and Neel-Parbat of the chandi Devi Tample.It is Down stream to the Har-ki-Pauri,an important religious place located on the bank of Ganga. Rodibelwala is also main parking place for the tourist vehicles.The load of many tourists and other persons always remain at this site due to location of Har ki Pouri. There is only one Sulabh International Sauchalaya with soakpit which is used by majority of these tourists. This is

the only source of pollution at this site. In order to study the impact of this toilet effluent on Ground water and surface water, this area was selected for the present study.

2.4 Frequency of Sampling

Sampling was carried out four times in a month (once in a week) regularly. Apart from the routine sampling, the special bathing days like Dashahra, Diwali, Somvati Amavas etc. have also been identified when large number of pilgrims assemble to take bath in the Ganga. Ground water samples were collected from shallow hand pumps at specified locations. Ground water samples were also taken deep wells, used by UP Jal Nigam. The surface water samples have been collected from the Ganga river/canal at selected sites. Standard sampling methods had been used for sample collection. A questionarre/data sheet has been prepared for collection of data during sampling. The data sheet is filled during sampling and data so collected is compiled.

The sampling were done from June'96 to June'97 on weekly basis on every Monday. Alongwith this the samples were also collected on important bathing days which included Warth Purnima, Mass Shivratri, Naghpanchmi, Suryaasthi, Pandma Akadashi, Ganesh Chaturthi vrat, Akadeshi Shrad, Chaturdeshi Shrad, Papandkush Akadesh Ramtrith Jayanti, Annakut, Gopa Asthami, Pradosh, Panchak Prarambh, Maker Shankranti, Ganesh Vart, Shat Tila Akadeshi, Moini Amawashya, Vasant Panchmi, Maghi Purnima, Maha Shivratri, Fagh, Somvati Amawashya ,Ramnavami, Shankracharya Jayanti, Ganga Saptami, Ganga Deshhara and Nirjala Akadeshi.

2.5 Details of sampling locations at Rodibelwala Region

The following sites and sampling points were selected for the present study :

1.	Ground water sample, upstream to septic tank	(RGUP)
2.	Surface water sample, upstream to septic tank	(RSUP)
3.	Ground water sample, downstream to septic tank	(RGDN)
4.	Surface water sample, downstream to septic tank	(RSDN)
5.	Ground water sample, middle location (mid point between upstream & down stream to septic tank)	(RGMID)
6.	Ground water sample, Existing Well of UP Jal Nigam	(RGE)

2.6 Analysis of Parameters

Standard Methods as described in "Standard Methods, for water and Waste Water, APHA, 1992" for the analysis of samples were followed.

The surface water and ground water samples are analysed regularly for the following parameters: pH, Total Dissolved Solids, Total Suspended Solids, Biochemical Oxygen Demand, Chemical Oxygen Demand, Ammonical Nitrogen, Nitrates, Phosphate, Total Kjeldhahl Nitrogen, Nitrite Nitrogen, Total coliform, Fecal coliform, Sodium, Potassium, Magnesium, Manganese, Calcium, Chloride, Sulphate and Trace Metals (Cadmium, Lead, Arsenic, Zinc, Tin, Copper and Iron)

The surface water samples are compared with IS : 2296 for class B rivers while ground water samples are compared with IS :10500.

3.0 EXPERIMENTAL STUDIES

The experimental studies have done at different sites to monitor and collection of samples on Normal & Special Bathing Days for Surface & Ground Water. The reference point was been taken for Existing Wells which are 100 meter deep. The results and observations are as follows :

3.1. Characterisation of surface water quality at Rodibelwala Region during normal days

The annual average of surface water quality at Rodibelwala Region are given in Table 2 which shows that all the parameters are well within permissible limits of Classs "A" and class "B" river as per IS:2296, 1982. This indicates that the water is sutaible for bathing purpose. There is no effect of Septic tank effluent on surface water quality at this part of Ganga in the normal days during the year.

3.2 Characterisation of surface water quality at Rodibelwala Region during special bathing days

The avarage of parameters during special bathing days of surface water quality at Rodibelwala Region are given in Table 3 which shows that all the parameters except Total and Fecal Coliforms are well within permissible limits of Classs "A" and class "B" river as per IS:2296, 1982. The exceeding limits of Total and Fecal Coliforms indicates that this may be due to mass bathing of people and using community toilet of this region during special bathing days on various fastivals, the surface water quality at this part of Ganga is effected by the bateriological contaimination.

3.3 Characterisation of ground water quality at Rodibelwala Region

The annual average of Ground water quality at Rodibelwala Area of Hardwar are given in Table 4 which shows that all the parameters of existing well are within permissible limits of Drinking Water as per IS:10500, 1991. This indicates that the water of exisiting well is sutaible for drinking purpose at this region. There is no effect of Septic tank effluent on ground water quality of well in this part of Rodibelwala in the normal days during the year.

Table 2 : Characterisation of surface water quality Rodibelwala Region of Hardwar (Annual average 96-97 during normal days)

SN	PARAMETER	UNIT	UPSTREAM OF SEPTIC TANK	DOWNSTREAM OF SEPTIC TANK
01	pH		8.2	8.2
02	Tot.Suspended Solids	mg/l	37.9	52.0
03	Tot.Dissolved Solids	mg/l	144.1	146.1
04	Dissolved Oxygen	mg/l	9.2	8.8
05	B.O.D.	mg/l	1.3	1.4
06	C.O.D.	mg/l	4.7	4.8
07	Ammonical Nitrogen	mg/l	0.1	0.10
08	Nitrate-Nitrogen	mg/l	0.42	0.49
09	Tot.Kjeldal Nitrogen	mg/l	1.2	1.53
10	Sulphate	mg/l	36.2	37.7
11	Hardness	mg/l	96.1	98.5
12	Calcium	mg/l	28.8	29.6
13	Magnissium	mg/l	9.82	10.9
14	Chloride	mg/l	1.89	1.99
15	Phosphate	mg/l	0.46	0.54
16	Copper	mg/l	0.10	0.12
17	Iron	mg/l	0.13	0.21
18	Total Coliform	MPN/100 ml	427	497
19	Fecal Coliform	MPN/100 ml	136	216

All the prameters except Total and Fecal Coliforms are well within permissible limits. The exceeding limits of Total and Fecal Coliforms may be due to the reasons the borewells are shallower than the Existing well and are located very near to the septic tank.

Thus the effluent from the septic tank might have contaminated the water in shallower borewell at this region . The water in these tube well is not sutaible for drinking purposes.

3.4 Cheracterisation of ground water quality at Rodibelwala Region during special bathing days

The avarge of parameters during special bathing days of Ground water quality at Rodibelwala area of Hardwar are given in Table 5 which shows that all the parameters of existing well are well within permissible limits of Drinking Water as per IS:10500, 1991. This indicates that the water of exisiting well is sutaible for drinking purpose at this region. There is no effect of Septic tank effluent on ground water water quality of well at this part of Rodibelwala in the special bathing days during the year.

Table 3 : Characterisation of surface water quality Rodibelwala Region of Hardwar (Annual average 96-97 during special bathing days)

SN	PARAMETER	UNIT	UPSTREAM OF SEPTIC TANK	DOWNSTREAM OF SEPTIC TANK
01	pH		8.1	8.2
02	Tot.Suspended Solids	mg/l	41.6	72.6
03	Tot.Dissolved Solids	mg/l	145.8	147.0
04	Dissolved Oxygen	mg/l	8.8	8.6
05	B.O.D.	mg/l	1.4	1.9
06	C.O.D.	mg/l	4.7	5.4
07	Ammonical Nitrogen	mg/l	ND	ND
08	Nitrate-Nitrogen	mg/l	0.58	0.6
09	Tot.Kjeldal Nitrogen	mg/l	1.1	2.64
10	Sulphate	mg/l	39.1	46.3
11	Hardness	mg/l	94.7	99.5
12	Calcium	mg/l	27.1	28.8
13	Magnissium	mg/l	10.23	12.36
14	Chloride	mg/l	2.44	2.64
15	Phosphate	mg/l	0.81	1.05
16	Copper	mg/l	0.07	0.07
17	Iron	mg/l	0.32	0.35
18	Total Coliform	MPN/100 ml	630	680
19	Fecal Coliform	MPN/100 ml	230	250

All the prameters except Total and Fecal Coliforms are well within permissible limits. The exceeding limits of Total and Fecal Coliforms may be due to the following reasons that the borewells are shallower than the Existing well and are located very nearer to the septic tank. Thus the ground water might have get contaiminated by septic tank effluent . Due to these reasons the Ground water of borewell at this region was found to be not sutaible for drinking purpose at this region.

3.5 Standard for surface water quality

Table 1 gives the standard limits for surface water quality for various parameters :

4.0 DISCUSSION :

4.1 Transport and fat of biological contaminants

The potential for biological contamination of groundwater by percoloation from such sources as surface spreading of untreated and treated wastewater, sludge landspreading, spetic tank systems

and landfill leachates is high (Vilker, 1978). Biological contaminants (pathogens) have a wide variety of physical and biological characteristics, including wide rages in size, shape, surface properties and die-away rates.

Table 1: Classification of river water

SN	Parameter	Unit	Classification of River	
			A CLASS	B CLASS
01	pH		6.5 - 8.5	6.5 - 8.5
02	Total Dissolved Solids	Mg/l	500	-
03	Dissolved Oxygen	Mg/l	6.0	5.0
04	B.O.D.	Mg/l	2.0	3.0
05	Total Coliform	MPN/ 100ml	-	500

Table 4 : Characterisation of ground water quality at Rodibelwala Region (annual average 96-97 during normal days)

SN	PARAMETERS	UNIT	U/S OF COM. TOILET	M/S OF COM. TOILET	D/S OF COM. TOILET	G.W. OF EXITING WELL
01	pH		7.8	8.1	8.2	8.0
02	Tot.Suspended Solids	mg/l	32.8	35.2	36.7	24.4
03	Tot.Dissolved Solids	mg/l	191.0	205.1	222.0	170.0
04	B.O.D.	mg/l	1.1	1.2	1.4	0.8
05	C.O.D.	mg/l	4.9	5.6	5.9	4.0
06	Ammonical Nitrogen	mg/l	0.2	0.3	0.6	ND
07	Nitrate-Nitrogen	mg/l	0.58	1.5	1.02	0.42
08	Sulphate	mg/l	39.1	39.4	39.6	34.7
09	Hardness	mg/l	128.0	153.0	176.0	126.0
10	Calcium	mg/l	46.0	43.0	55.0	36.0
11	Magnisium	mg/l	13.0	13.0	19.0	11.4
12	Chloride	mg/l	23.1	19.8	7.98	3.1
13	Phosphate	mg/l	0.40	0.42	0.51	0.31
14	Lead	mg/l	0.02	0.02	0.03	0.02
15	Copper	mg/l	0.13	0.14	0.15	0.04
16	Iron	mg/l	0.24	0.37	0.70	0.27
17	Total Coliform	MPN/100 ml	25	77	408	6
18	Fecal Coliform	MPN/100 ml	10	40	142	2

Table 5 : Characterisation of ground water quality at Rodibelwala Region (average 96-97 during special bathing days)

SN	PARAMETERS	UNIT	U/S OF COM. TOILET	M/S OF COM. TOILET	D/S OF COM. TOILET	G.W. OF EXITING WELL
01	pH		8.0	8.1	8.1	7.9
02	Tot.Suspended Solids	mg/l	37.5	44.2	68.7	20.0
03	Tot.Dissolved Solids	mg/l	154.0	188.0	214.0	139.0
04	B.O.D.	mg/l	0.9	1.4	2.2	0.6
05	C.O.D.	mg/l	3.5	5.2	6.0	2.6
06	Ammonical Nitrogen	mg/l	0.1	0.3	0.9	0.1
07	Nitrate-Nitrogen	mg/l	0.85	0.95	0.96	0.47
08	Sulphate	mg/l	40.7	43.20	102.0	37.4
09	Hardness	mg/l	116.0	122.0	146.5	96.0
10	Calcium	mg/l	36.0	36.8	37.4	26.0
11	Magnisium	mg/l	12.0	12.5	17.3	6.5
12	Chloride	mg/l	3.12	6.38	7.1	2.38
13	Phosphate	mg/l	0.55	0.58	1.0	0.44
14	Lead	mg/l	0.02	0.02	0.11	0.03
15	Copper	mg/l	0.08	0.09	0.10	0.02
16	Iron	mg/l	0.03	0.29	0.55	0.20
17	Total Coliform	MPN/100 ml	20	85	606	6
18	Fecal Coliform	MPN/100 ml	9	40	454	2

Bacteria

Brown etal (1979) studied the movement of fecal coliforms and coliphages from a septic tank system through undisturbed soil to ground water. Samples taken 1 and 2 years after system start-up indicated limited mobility and survival of fecal coliforms in the soils.

Gerba (1975) studies on the distance of travel of bacteria through soil is considerable significance since contaimination of ground or surface water supplies may present a health hazard. A number of environmental factors can influence the transport rate, and certain design considerations can be based on experimetal results and stidies of removal mechanisms. Environmental factors include rainfall; soil moisture, temperature and pH and availability of organic matter. Design considerations are related to soil type and depth as well as the hydraulic

loading rate from the soil adsorption system. Gerba (1975) have summarized movement of bacteria through soil as follows in Table 6 :

Table 6 : Movement of Bacteria Through Soil

SN	Nature of Pollutants	Organisms	Media	Maximum Observed Distance Travel (in feet)
1.	Canal Water on percolation bed	E.Coli	Sand Dune	10
2	Sewage introduce through perforated pipes	Coliform	Fine grained sand	06
3	Oxidation pond effluent	Coliform	Sand Gravel	2490
4	Secondary Sewage Effluent percolation beds	Fecal Coliform	Fine loamy sand gravel	30
5	Dilution Settled Sewage into injected well	Coliforms	Sand and Pea gravel aquifer	100
6	Tertiary Treated Wastewater	Coliform	Fine to medium sand	20
7	Tertiary Treated Wastewater	Fecal Coliform & Streptococcus	Coarse grave	11500
8	Primary Treated Sewage Effluent	Coliform	Fine sandy loam	13
9	Secondary Sewage	Coliform	Sandy gravel	03

On comparision of the present studies with the studies made by Gerba (1975) it was observed that the total and fecal coliform were found in the shallow borewell ground water more then the permissible limits whereas it was within permissible limits in the existing deep wells. This may be due to the following facts :

a. The experimental borewells were shallow (Only 4 meter depth) and nearer to the septic tank system (14.0 to 38 meter distance from septic tank).

b. The existing wells are deeper (8 to 10 meters depth) and far away from the septic tank system (35 to 175 meters distance).

These observations indicated that the distance and depth of travel of bacteria through soil is considerable significance to reduce bacterial contamination to the ground water table. as evidence by Geroba (1975).

So it may be inferred that the Ground water quality of existing deep wells are suitable for drinking purpose while the shallow borewell ground water can be used for drinking purposes after disinfection only.

4.2 Transport and fate of inorganic contaiminants

Potantial inorganic contaiminants from septic tank systems include Phosphorus, Nitrogen Chloride and Metals.

Phosphorus

While phosphorus can move through soils underlying soil adsorption systems and reach groundwater, this has not been a major concern. Since phosphorus can be easily retained in the underlying soils due to chemical changes and adsortion. In a study by Jones etal (1977) it was observed that phosphorus from septic tank wastewater disposal system effluent is not usually transported through the soil to ground water.

In the present studies the Phosphate-Phosphorus concentration was ranged from 0.04 to 1.98 mg/l in the surface water, 0.12 to 1.86 mg/l in the shallow borewell ground water at upstream of septic tank, whereas in the existing well which are deeper and faraway from the septic tank system the phosphate- phosphorus concentration was ranged from 0.02 to 1.5 mg/l. The same trend was found at downstream of septic tank in the surface and ground water.

This clearly indicates that phosphorus in septic tank system effluent is effectively retained in underlying soils and only low concentrations is typically introduced into the ground water.

Nitrogen

Schoemaker and Porter (1978) have reported Ntrogen contamination of ground water has occured as a result of septic tank systems. Nitrogen is a key nutrient of concern because it contributes to eutrophication of surface water and excess nitrogen reaching ground water can be health hazards.

In the present studies it was found that concentration of Total Kjeldal nitrogen (TKN) was ranged from 0.2 to 2.8 mg/l in surface water upstream of Septic Tank . The concentration of and Nitrate 0.05 to 1.1 mg/l and 0.13 to 0.7 mg/l was observed in borewell ground water and existing well ground water respectively at upstream of septic tank Whereas 0.6 to 4.0 mg/l TKN, and Nitrate ND to 1.85 mg/l and 0.13 to 0.7 mg/l was observed in Surafce water, borewell ground water and existing well ground water at downstream of septic tank. This clealy indicates that the transport of TKN from surface to ground water might have taken place. Since the existing wells are deeper and far away from the the septic tank, the TKN values were lower due adsorption

effect of soil and does not effected the groundwater qulity. All the values are under permissible limit and does not effect the water quality in the region.

Chloride

Chloride are natural constituents in surface and ground water and they are also found in household and community wastewaters. Both septic tank systems and conventional community wastewater treatment plants are ineffective for chloride removal. The chlorides concentrations in septic tank system effluents will be variable depending on natural quality of water supply.

In the present studies it was seen from the 2 to 5 that chloride concentration ranged from ND to 5.0 mg/l , 1.0 to 36.5 mg/l and 0.5 to 6.0 mg/l in Surface water, borewell ground water and existing well ground water respectively at upstream of septic tank Whereas it ranged from 1.0 to 11.0 mg/l , 10.0 to 28 mg/l and 0.5 to 19.91 mg/l in Surafce water, borewell ground water and existing well ground water respectively at downstream of septic tank. The chloride concentration was more at downstream in comparision to upstream waters. This is further indicated that due to soil adsoption effect from upper strata to lower strata of water table the chloride has not effected the groundwater quality.

Metals

A review of the transport and fate of heavy metals in the subsurface environment has been prepared by Bates (1980). The four major reactions that metals may be involved in with soils are adsorption, ion exchange, chemical precipi-tation and complexation with organic substances. Out of these, adsoption seems to be most important for fixation of heavy metals. This can clealy be seen in the present studies.

In the present studies the avarge range of metals concentartion are given in table 2 to 5 which indicates that the adsoption Effect on Heavy Metal Concentration From Surface to Ground Water at Downstream of Septic Tank System . This may be due to the fact that the borewells are shallow and nearer to the septic tank, the range of heavy metals concentration are higher than the surface water and existing wells (deep wells). This may be due to soil adsorption effect as reported by Bates (1980).

5.0 CONCLUSIONS

Based on studies on Assessment of Impact on Ganga and Groundwater due to Community Toilets at Rodibelwala the following conclusion are drawn :

(i) The surface water quality of Ganga river is not affected due to Septic Tank effluent and it is fit for bathing purpose. All the parameters are under permissible limits of "class B" river.

(ii) Mass bathing of piligramies during different festivals in a year affected the surface water quality of Ganga.

(iii) The deep well groundwater is not affected due to Septic Tank effluent and it is fit for drinking purposes. All the parameters are under permissible limits.

(iv) The ground water quality of shallow bore wells (hand pumps) is not fit for drinking purpose which are situated within 14 to 38 meter from the septic tank and 4 meter deep only. The ground water of borewells also get contaminated by septic tank effluent, as there is no other source of pollution in the region.

(v) The septic tank design needs modification as geographically all the soakpits are located in the sandy soil. The porosity of this soil is ranged from 47.20 to 67.62% .

(vi) Geographical conditions should be considered while designing soak pit system for the sewage disposal of community toilets.

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