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Ground Water Quality Analysis of an Industrial Area of Baddi-Brotiwala-Nalagarh (Himachal Pradesh)

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Abstract: ***Groundwater is a main source of fresh drinking water in both the rural and urban area of India. The groundwater quality has decreased in recent times, due to the percolation of polluted water into the soils from wastewater drains. This study deals with the groundwater pollution in the Baddi Industrial Area in Solan district, Himachal Pradesh. Groundwater samples were collected from 8 locations in Baddi- Brotiwala- Nalagarh region and tested for heavy metals and physico-chemical parameters concentration in water. Groundwater samples were collected from hand pumps and tube wells in the area. The results obtained have been compared with BIS standards for drinking water (IS 10500:2012). During the study a total of 6 heavy metals parameters of water such as : lead, arsenic, chromium, copper, iron and manganese and physico- chemical parameters such as pH, Electrical-conductivity, cations (Ca^{+2}, Mg^{+2}, Na^{+}), anions (Cl^{-}, $S04^{-2}$, No^{-3},F^{-}), TDS, TH, Alkalinity etc. were tested. Some of the heavy metals and parameters were found to be exceeding the limit prescribed in IS 10500:2012. The reason behind the presence of heavy metals could be disposal of untreated wastewater from the industries in the area. The study revealed that due to groundwater is polluted in this area and the ground water is not fit to be used as drinking water.***
Keywords: Groundwater, Baddi, Heavy metals, Lead, Arsenic.

I. INTRODUCTION

In order to assess the ground water and surface water quality, water samples were collected from different sources to analyse the physico-chemical parameters and some expected heavy metals. The results show that surface water is affected by industrial effluents which have high concentration of COD. This makes the groundwater quality in the catchments area of study is found to be severely polluted and moderately polluted in respect of heavy metal concentration.

A. Study Area

The present study deals with the groundwater pollution in the BBN Industrial Region in Solan district of Himachal Pradesh. Nalagarh-Baddi-Barotiwala core area has been declared an Industrial Area by the Govt. of Himachal Pradesh and Govt. Of India has given a special industrial package. BBN is the leading industrial area of Himachal Pradesh with an estimated presence of around 2000 industrial units. The average elevation of the region ranges between 300 m to 3000 m above MSL. This region is drained by river Sirsa, a tributary of river Sutluj and lies in Shiwalik belt of Himalayas. Maximum precipitation occurs during the months from July to September. Average annual rainfall in the district is about 1450 mm with average of 64 rainy days. In the winter season precipitation as snowfall also occurs in the higher reaches up to 1000 m elevation and as rainfall in low hills and valleys of the district.

Table 1: Number of Industries (2020)

Electronics	Electricals	Pharmaceuticals	Plastics	Food processing	Packaging	Others
400	350	300	300	100	200	1100

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II. MATERIALS AND METHODS

Samples from 8 different locations were collected and tested for different parameters. Samples were collected from hand pumps and shallow tube wells using good quality standard sampling bottles. A total of 6 heavy metals (such as lead, arsenic, chromium, copper, manganese and iron) and some physic -chemical parameters such ac pH, EC,TSS,TDS, Hardness, Alkanity, Chlorides were analysed using methods as prescribed in standard methods (18th addition). All the parameters were analysed in laboratories and the results were compared with the respective acceptable limits as mentioned in IS 10500:2012. Atomic absorption spectrometry was used to analyse the heavy metals concentration in the samples. For this purpose AAS-5EA analytic gas spectrometer was used and Ion Chromatography was used to analyse the anions and cations in the water samples.

Table 2: Cations concentration at different locations obtained by Ion Chromatography

Sampling sites	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	Na^{+} (mg/L)
Brotiwala Tube-well	100	35	78
Katha Hand – Pump	120	69	59
Baddi hand-pump	102	120	56
Sandholi hand pump	108	130	35
Malku majra H.P.	78	100	98
Manipura Tube well	79	78	67
Bagbania H.P.	200	98	58
Nalagarh H.P.	220	56	100

Table 3: Anions concentration at different locations obtained by Ion Chromatography

Sampling sites	Cl^{-} (mg/L)	SO_4^{-2} (mg/L)	No^{3-} (mg/L)	F^{-} (mg/L)
Brotiwala Tube-well	6.289	198.678	13.503	0.192
Katha Hand Pump	47.459	134.567	59.814	0.155
Baddi Hand Pump	20.075	358.789	0.167	0.135
Sandholi Hand Pump	23.239	667.890	15.456	0.137
Malku majra Hand Pump	33.567	234.567	18.453	0.158
Manipura Tube well	38.987	178.987	60.782	0.200
Bagbania Hand Pump	100.565	345.789	55.687	0.121
Nalagarh Hand Pump	125.109	123.567	5.584	0.149

III. RESULTS AND DISCUSSIONS

Samples from 8 locations were tested for 6 heavy metals. Tabulated results are given in table 4 and table 5.

Table 4: Concentrations of Heavy metals and their limits

Parameter	Minimum value	Maximum value	Acceptable limit	Permissible limit
Lead (mg/L)	0.001	0.047	0.01	NR
Iron (mg/L)	0.001	0.58	0.3	NR
Copper (mg/L)	0.001	1.27	0.05	1.5
Manganese (mg/L)	0.00	4.2	0.1	0.3
Arsenic (mg/L)	0.002	0.056	0.01	0.05
Chromium (mg/L)	0.007	0.025	0.05	NR

* NR= No Relaxation

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Table 5: Concentrations of various Physico-chemical parameters obtained at various locations and their limits

Parameter	Minimum value	Maximum value	Acceptable limit	Permissible limit
pH	6.94	7.66	6.5-8.5	-
TDS (mg/L)	40	680	300	500
HARDNESS (mg/L)	398	940	200	600
CHLORIDES (mg/L)	38	329	250	600
HCO_3 ALKANITY (mg/L)	260	330	500	-

The concentrations of various heavy metals obtained is graphically represented and based on obatained results the various comments were made.

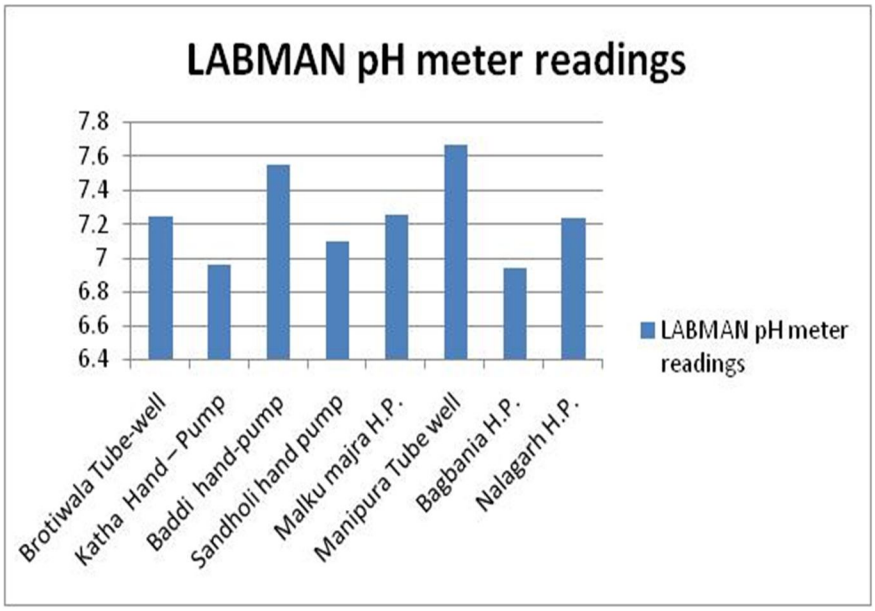

Fig 1: Variation of pH at different sampling sites

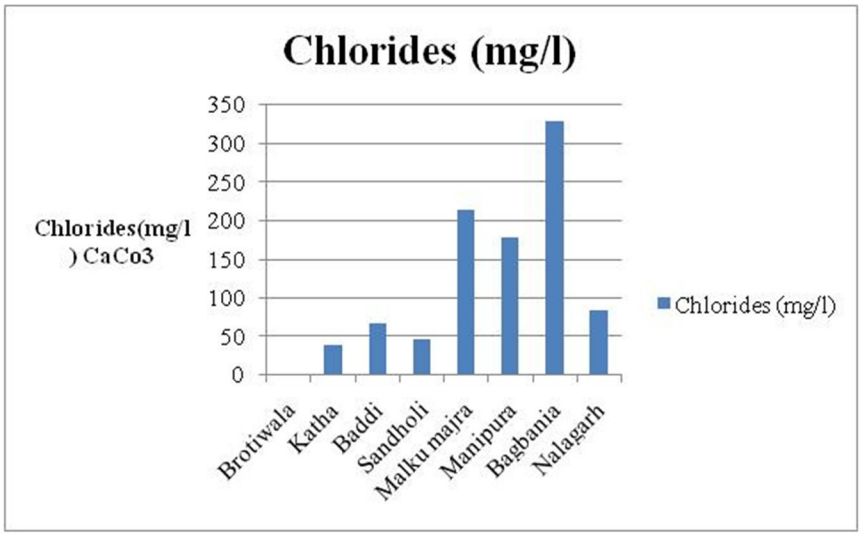

Fig 2: Variation of Chlorides at different sampling sites

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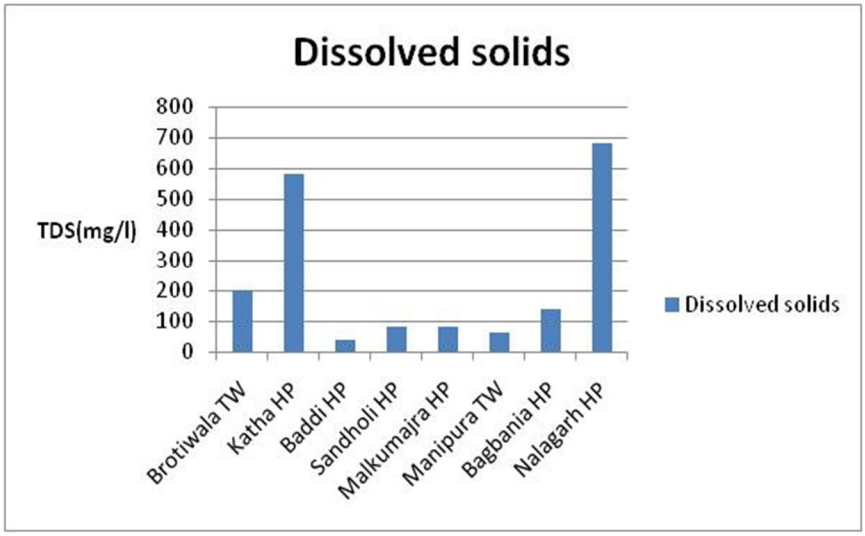

Fig 3: Variation of TDS at different sampling sites

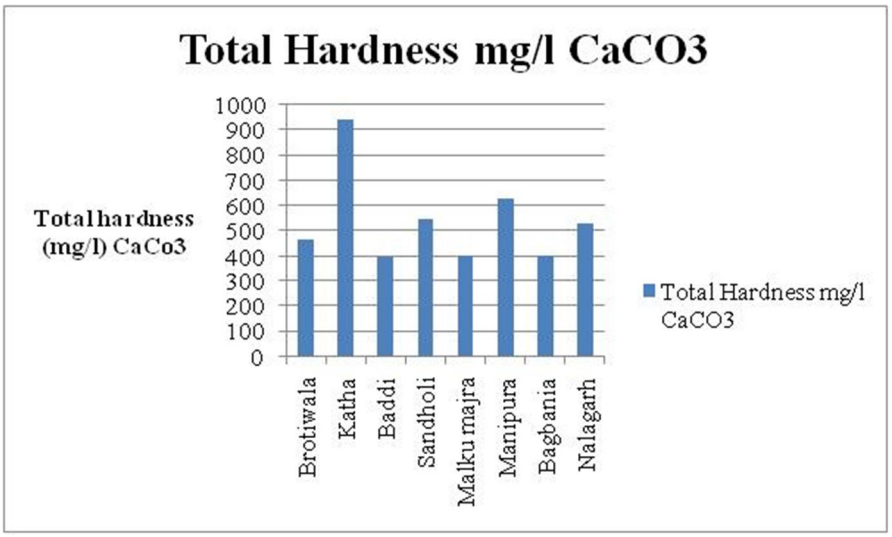

Fig 4: Variation of Total Hardness at different sampling sites

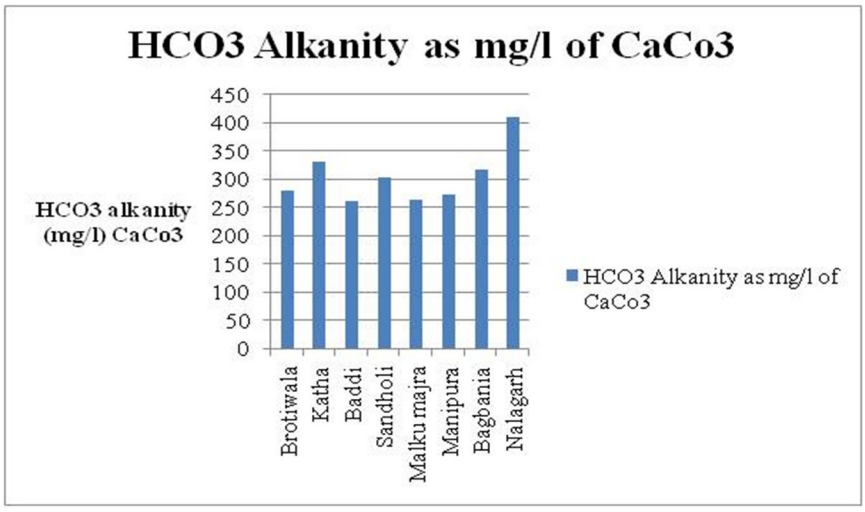

Fig 5: Variation of Alkalinity at different sampling sites

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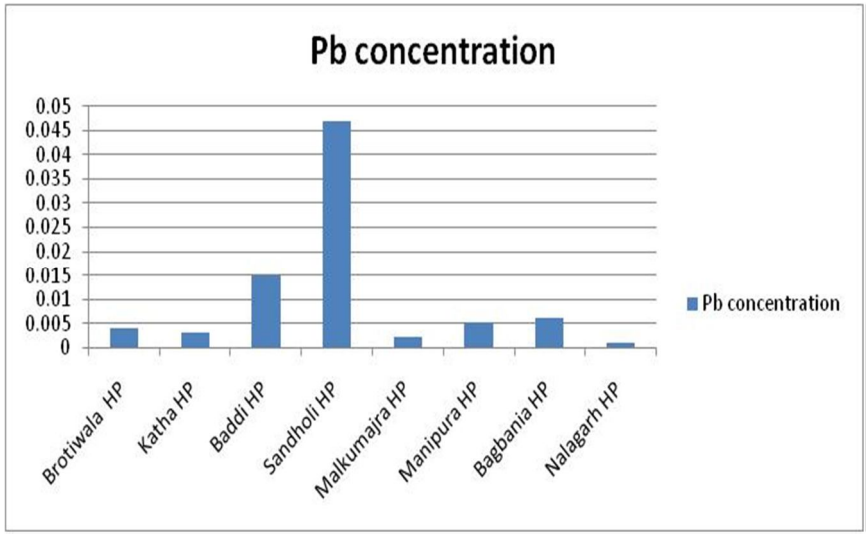

Fig 6: Variation of Pb Concentration at different sampling sites

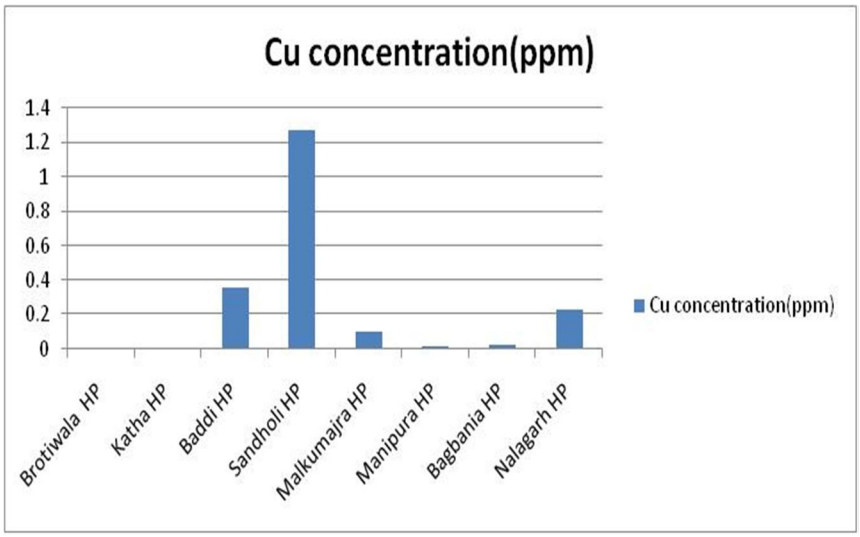

Fig 7: Variation of Cu Concentration at different sampling sites

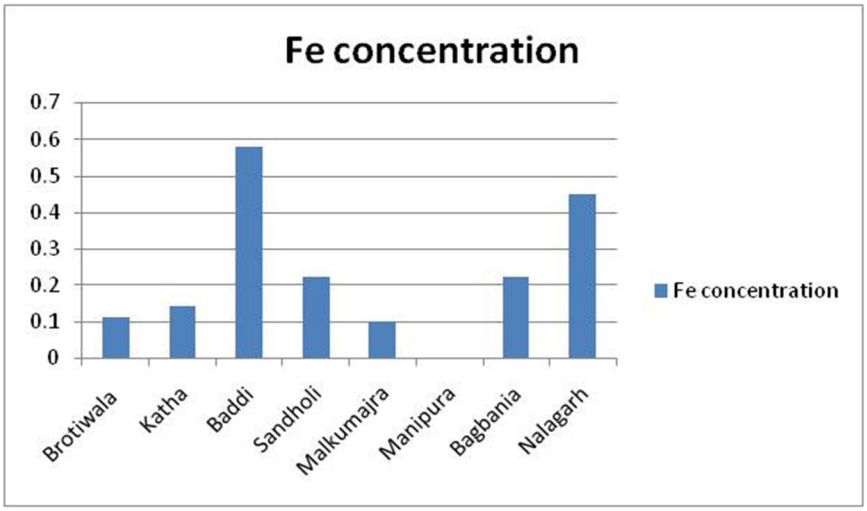

Fig 8: Variation of Fe Concentration at different sampling sites

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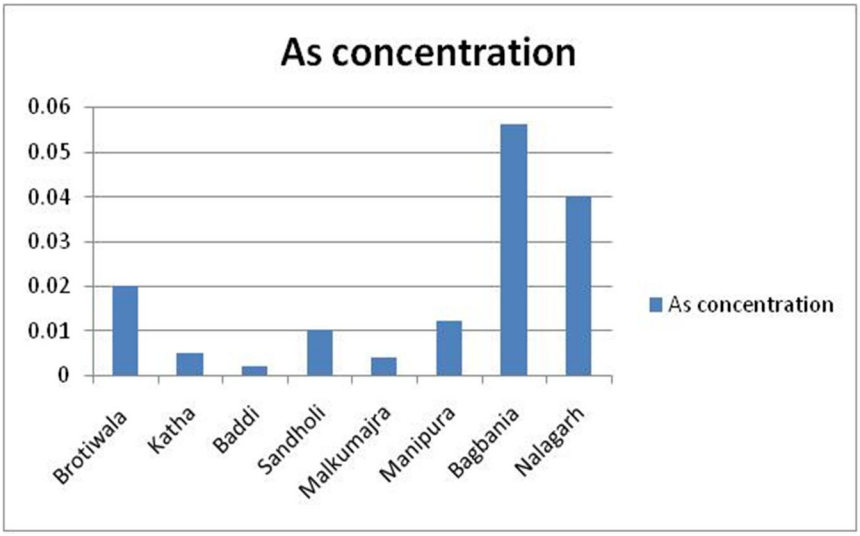

Fig 9: Variation of As Concentration at different sampling sites

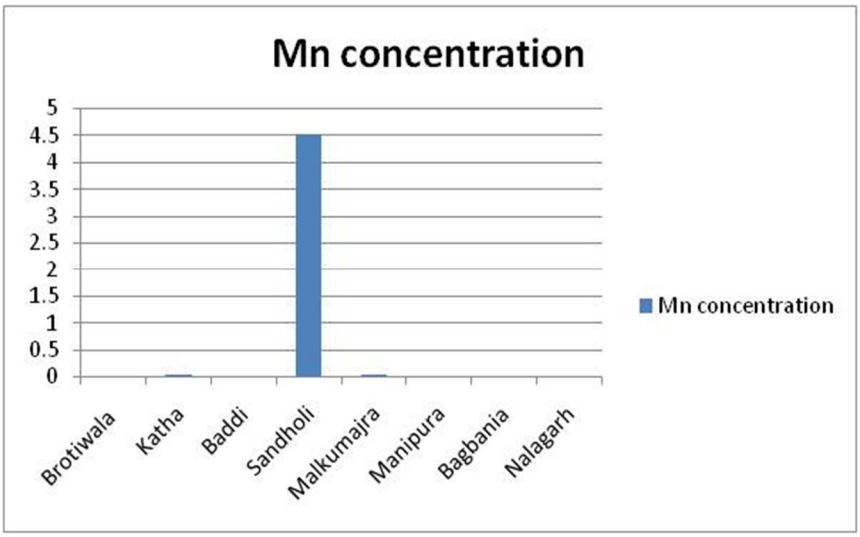

Fig 10: Variation of Mn Concentration at different sampling sites

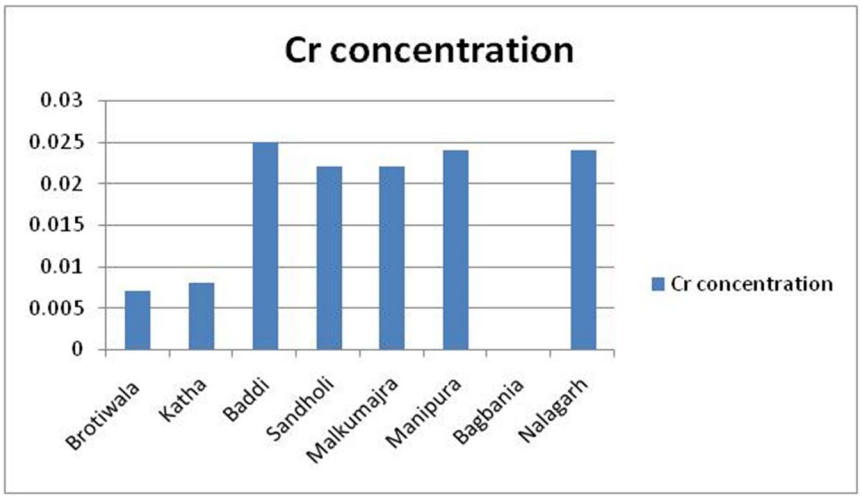

Fig 11: Variation of Cr Concentration at different sampling sites

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A. Comments

1) The constration of Ca^{+2} was within the permissible limit 200mg/L except at Nalagarh location. (Table 2)

2) Mg^{+2} was also within the permissible value 100 mg/L except at two locations Baddi and Sandholi. (Table 2)

3) Similary Na^{+} also exceeds the permissible limit 60 mg/L at 4 locations such as Brotiwala, Malkumajra , Manipura and Nalagarh. So this water of BBN region was not suitable for drinking purpose without giving suitable treatment.

4) The concentration of chloride and sulphates was within the permissible limit at all sampling site. (Fig. 2) NO_3- exceeds the acceptable limit 45 mg/l at 4 locations which is very harmful to health. Flouride was within the permissible limit at all sampling sites.(Table 3)

5) Hardness exceeds the permissible limit 600 mg/L at two locations such as Katha and Manipura which is harmful. (Fig. 4)

6) Lead is toxic metal whose concentration in drinking water should not be more than 0.01 mg/L. Limit for lead was breached at two locations Baddi and Sandholi. (Fig. 6)

7) Although copper was within permissible limit (1.5 mg/L) at all locations but it exceeded the acceptable limit (0.05mg/L) at 4 locations. (Fig. 7)

8) Permissible limit (0.3mg/L) for iron was exceeded at two places Baddi and Nalagarh (0.58 and 0.47 mg/L respectively). (Fig. 8)

9) Manganese concentration exceeded the permissible limit (0.3 mg/L) at one location only: Sandholi (4.2mg/L). (Fig. 10)

10) Arsenic was exceeding the permissible limit (0.05mg/L) at one location only Bagbania but the acceptable limit (0.01mg/L) for arsenic was exceeded at 4 locations. (Fig. 9)

11) Chromium was within its acceptable limit at all 8 locations. (Fig. 11)

IV. CONCLUSIONS AND RECOMMENDATIONS:

Heavy metals were irregular in their appearance. Heavy metals exceeded the prescribed limits only at 4 sample sites: Baddi, Sandholi, Bagbania and Nalagarh. Each of these sites had some heavy metals breaching the prescribed limits. Manganese was highest at Sandholi. Iron was highest at Baddi .Arsenic exceeded limit only in Bagbania. Chromium was found to be within limits at each site. Therefore, the study reveals that groundwater in the Baddi Industrial area does not conform to the drinking water standards adopted in India. So it is not fit for consumption as drinking water without treatment. This water can be used for any other purpose e.g. for irrigation purpose subjected to its fulfilment of standards. The periodic analysis of the hand pumps in the area should be made compulsory and the result of the analysis should be documented properly and published for awareness among people.

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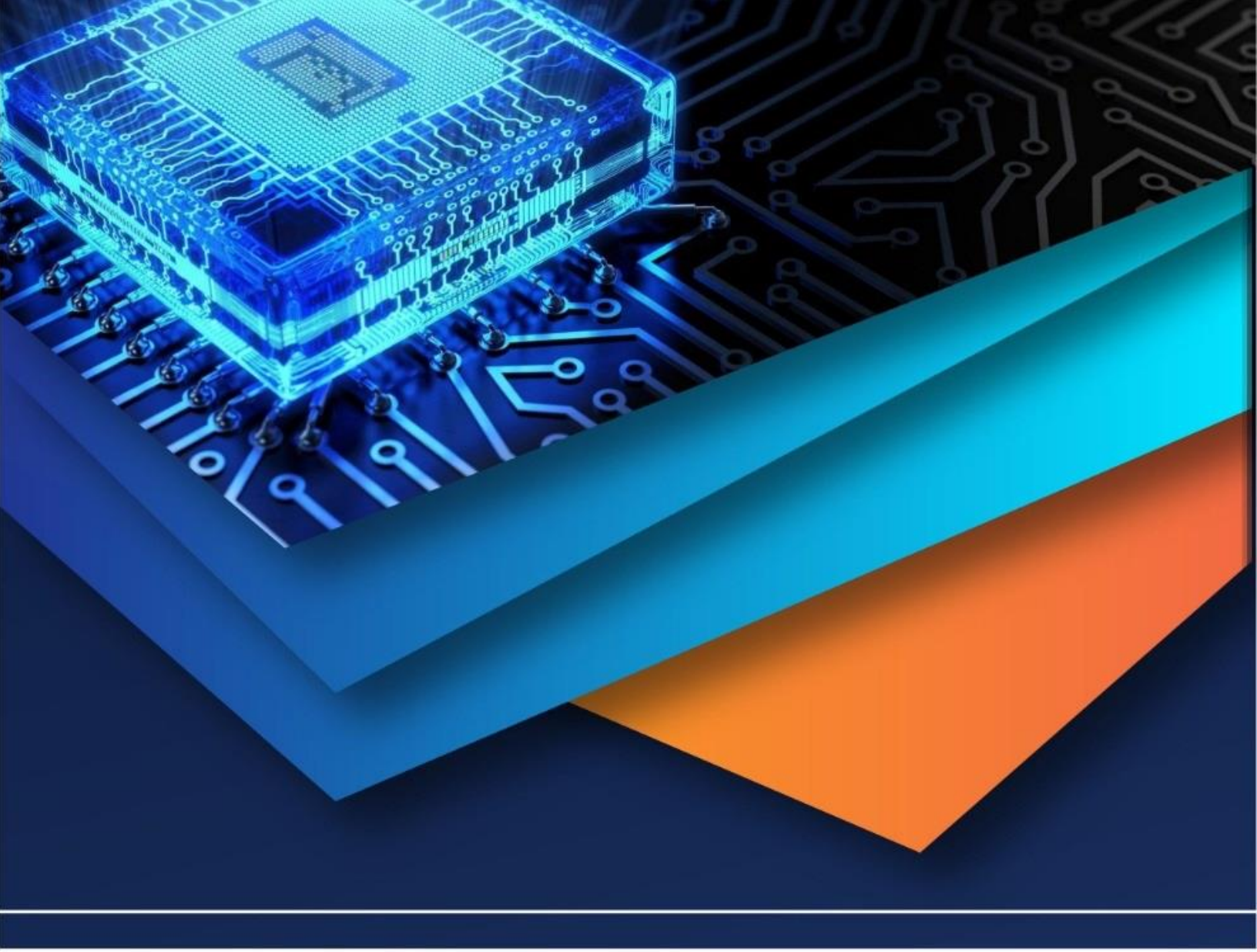

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