

# Assessment of Quality of Ground Water in Some Villages of Gurgaon District, Haryana (India): Focus on Fluoride.

Manjeet<sup>\*,1</sup>, B. P. Singh<sup>#,2</sup>, J.K.Sharma<sup>§,3</sup>

<sup>\*</sup>Doctorial Research Scholar, DCRUST, Murthal, Haryana, India

<sup>#</sup>Dean Academic Affairs, DCRUST, Murthal, Haryana, India

<sup>§</sup>Pro-vice Chancellor, JECRC University, Jaipur, India

**Abstract:** Ground water quality of Gurgaon district was assessed for its suitability for drinking purposes. The fluoride concentration in underground water was determined in various villages of Gurgaon district of Haryana state (India). The fluoride concentration in the underground water of these villages varied from 0.02-6.4 mg/l. Various other water quality parameters, viz., pH, total dissolved salts, total hardness, total alkalinity, calcium and magnesium hardness were also measured. Majority of the samples do not comply with Indian as well as WHO standards for most of the water quality parameters measured. Overall water quality was found unsatisfactory for drinking purposes. Fluoride content was higher than permissible limit in more than 23% samples.

**Key words:** Fluoride, Underground water, Drinking water, Total hardness, Water quality standards

## I.INTRODUCTION

Ground water is a replenishable source of human water supply and it is estimated that approximately one third of the world's population use ground water for drinking **1**. Presence of more than 200 chemical constituents in groundwater has been documented including approximately 175 organic and more than 50 inorganic and radionucleotides. The sources of these chemicals are both natural and anthropogenic **2**. Ground water has been contaminated for hundred of years due to their slow movement in water aquifers. Aquifers are the large reservoirs of fresh water surrounded by rock. Ground water has long been considered as the purest form of the water. The quality of ground water is the resultant of all the processes and reaction that act on the water from the moment it condensed in the atmosphere to the time it is discharged by a well as spring and varies from place to place and with the depth of the water table **3**. The ground water is more cleaner and pollution free as compared to surface water. But during last decade, this is observed that ground water get polluted drastically because of increased human activities **4-7**. Consequently number of cases of water born diseases has been seen which a cause of health hazards **8-11**. In India, approximately 62 million people including 6 million children suffer from fluorosis because of consumption of water with high fluoride concentrations **12**. As per WHO (1997) **13** permissible limit for fluoride in drinking water is 1.0 mg/l, while as per Indian standards it is 1.5 mg/l **14**. Seventeen states in India have been identified as endemic for fluorosis and Haryana is one of them. Though fluoride enters the body through food, water, industrial exposure, drugs, cosmetics, etc., drinking water is the major contributor (75-90% of daily intake) **15**. Due to its strong electronegativity, fluoride is attracted by positively charged calcium in teeth and bones causing dental fluorosis, teeth mottling, skeletal fluorosis and deformation of bones in children as well as in adults **16**. The major sources of fluoride in groundwater are fluoride bearing rocks such as fluorospar, cryolite, fluorapatite and hydroxylapatite **17**. In some parts of India, the fluoride levels are below 0.5 mg/l, while at certain other places, fluoride levels are as high as 30 mg/l have been reported **18**. It is emerging as a social problem in many parts of northern India. Therefore monitoring the quality of water is one of the essential issues of drinking water management **19**. Considering the above aspects an attempt has been made under the present study to assess the various physical and chemical properties of ground water of Gurgaon district including fluoride, which is mainly used for drinking and other domestic purposes.

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## Experimental: Site specification and sampling:

Gurgaon, 32 km away from south-west of New Delhi, is the Cyber City of [Haryana](#) lies between the 27° 39' and 28° 32' 25" North latitudes, and 76° 39' 30" and 77° 20' 45" East longitudes as shown in fig-1. The district has a total geographical area of 1254 square kilometers and a support a population of 8,70,539. The climate of the district can be classified as tropical steppe, semi-arid and hot which is mainly characterized by the extreme dryness of the Air except during monsoon months, intensely hot summers and cold winters. The average annual rainfall is 569 mm. The pre-monsoon depth to water level in the district ranges from 7.45 mbgl to 52.10 m bgl. During the postmonsoon the water levels range between 7.80 to 51.10 m.bgl. The predominant geological formation is Alluvium.



Fig-1 Location of Gurgaon in Haryana, India

There are a total of 271 villages in Gurgaon District. For the present study a total of 97 water sample were collected from different sources like tube well and shallow hand pumps. From every sites thee water sample were collected for checking the physico-chemical status of ground water. Water sample were collected during and taken in pre-cleaned polyethylene bottles from the selected sites.

## II.METHODOLOGY USED IN THE DETERMINATION OF PHYSICO-CHEMICAL PARAMETERS

The collected samples were analyzed for following major physical and chemical parameters:

1. pH was determined by Eutech instruments pH tutor.
2. Total dissolved solid(TDS) was determined by gravimetric analysis method. **20**
3. Total hardness (TH),  $Ca^{2+}$  and  $Mg^{2+}$  hardness was determined by titrimetric method using standard EDTA solution. **20**
4. Total alkalinity (TA), was determined by titrimetric method using standard sulphuric acid solution. **20**
5. F<sup>-</sup> ion was determined by fluoride ion-specific electrode and using a reference pH-meter ((Hanna Instruments Model=Hi 3222-02). **21**

All the chemicals used were of Analytical Grade. All the experiments were carried out in triplicate and the results were found reproducible with  $\pm 3\%$  error

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**Table - 1:** Comparison of ground water quality of the villages under study with drinking water standards (Indian and WHO)

| Parameters       | Minimum | Maximum | Indian standard | WHO     |
|------------------|---------|---------|-----------------|---------|
| TDS              | 60      | 3731    | 500-1500        | 500     |
| TH               | 50.47   | 2984.2  | 200-600         | 500     |
| Ca <sup>2+</sup> | 9       | 481     | 200-1000        | 500     |
| Mg <sup>2+</sup> | 6.8     | 2922    | 200-400         | 50      |
| TA               | 102     | 582     | 200-600         | -       |
| pH               | 5.6     | 8.4     | 7.0-9.2         | 6.5-9.2 |
| F-               | 0.02    | 6.4     | 1.0-1.5         | 1.0     |

Except pH all parameters are expressed in mg/lit.

### III.RESULT AND DISCUSSION

The groundwater has no colour, odour and turbidity. Taste of the water was slightly brackish at most of the locations. The minimum and maximum values of various physico-chemical parameters for the selected sites are provided in Table-1. The results indicate that the quality of water varies considerably from location to location.

pH Varies from 5.6 to 8.4. This shows that all samples are existed within the minimum and maximum tolerable limit of WHO and BIS. The water samples were found to be slightly basic in nature. Hardness is measured in terms of total hardness and calcium hardness. Total hardness varies from 50.47-2984.2 mg/lit, mostly exceeds the maximum permissible limits of WHO. Ca<sup>2+</sup> varies from 9-481 mg/lit which were within the WHO and Indian Standard. Mg<sup>2+</sup> concentration varies from 6.8-2922 mg/lit which were very high compared with the WHO and Indian Standard. Alkalinity varies from 102-582 mg/lit. (As shown in table no 2)

The major natural resource of fluoride is amphiboles, apatite, fluorite and mica. It's concentration in natural waters generally should not exceed 10mg/lit **22**. The factor responsible for ground water contamination with fluoride are geological factors such as weathering of minerals, rock dissolution and decomposition Containing fluoride over a long period of time resulting in the leaching it into ground water **23**. An anthropogenic factor such as industrial process liberates higher concentration of fluoride into atmosphere. The concentration of fluoride in the studied Water samples varies from 0.02 to 6.4 mg/lit. The analyzed fluoride concentration of the sites shows that around 24% samples have the fluoride levels higher than 1.5 mg/l (as shown in fig2 and fig 3). Taking into account the BIS recommended fluoride concentration (1.5 mg/l) in drinking water, people in these localities should be advised to adopt some defluoridation technique prior to use of groundwater for drinking purposes. On the other hand, in about 43% samples F<sup>-</sup> content was lesser than (0.7 mg/l) recommended fluoride concentration for caries control.

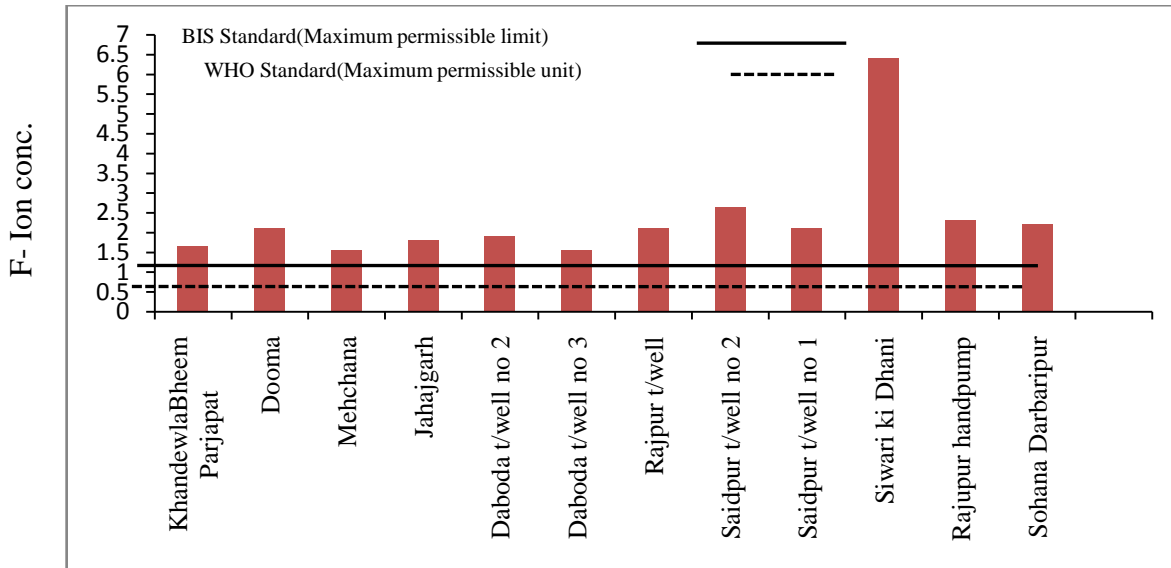


Fig-2 Sampling Sites

High fluoride concentration causes dental fluorosis and more skeletal fluorosis **24** whereas the low concentration or absence of fluoride in drinking water results in dental caries in children particularly when the fluoride concentration is less than 0.5 mg/lit **25**. The fluoride content in the groundwater is a function of many factors such as availability and solubility of fluoride minerals, velocity of flowing water, temperature, pH, concentration of calcium and bicarbonate ions in water, etc. **26**.

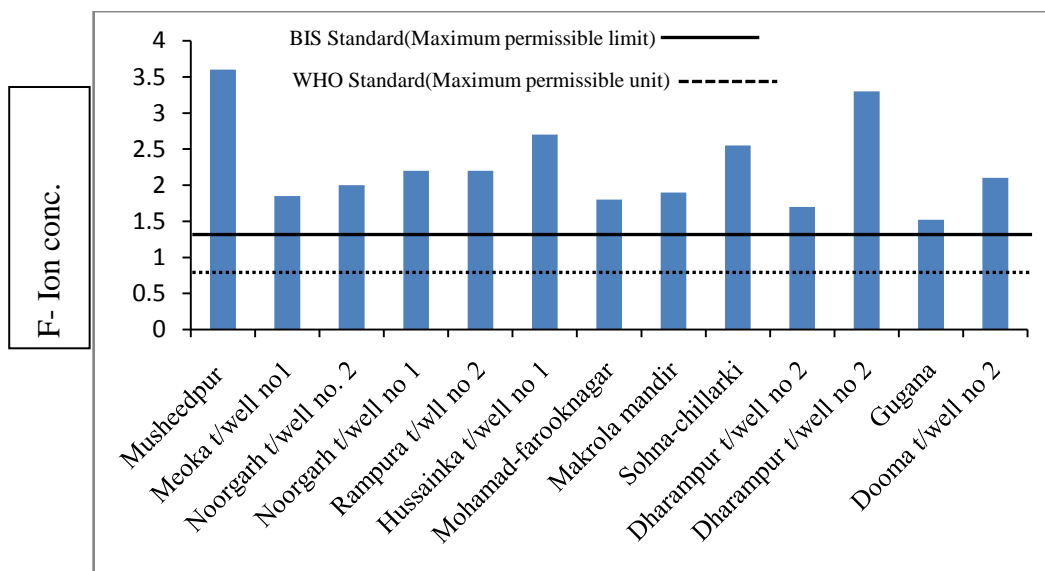


Fig-3 Sampling Sites

Khaiwal, R. and V.K. Garg had observed uneven distribution of fluoride in the groundwater of Hisar city which was due to uneven distribution of fluoride containing minerals in the rocks. Fluoride was not significantly correlated with any of the analyzed water quality parameter.

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On the basis of physicochemical analysis of the studied water sources in sixty villages of Gurgaon district (India), it has been concluded that the groundwater and dug well water quality varied spatially. Water at most of the locations is not suitable for drinking purposes as per WHO guidelines. Hardness and fluoride were major health related issues. It is further suggested that some kind of treatment for hardness and fluoride removal is immediately required in the studied villages to avoid waterborne health problems in residents.

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**Table-2**

| Village                |                                 | Physical Parameter/Value   |   |                   |                   |                 |      |              |
|------------------------|---------------------------------|----------------------------|---|-------------------|-------------------|-----------------|------|--------------|
|                        |                                 | Total Dissolved Solid(ppm) | Total Hardness as CaCO <sub>3</sub> (ppm) | Ca Hardness (ppm) | Mg Hardness (ppm) | Alkalinity(ppm) | pH   | Fluoride (F) |
| Sohna Nainwal          | tubewell no 1                   | 651                        | 256.8                                     | 41                | 37.5              | 535             | 7.6  | 0.5          |
|                        | tubewell no 2                   | 373                        | 184.3                                     | 26                | 29                | 323             | 7.6  | 0.4          |
|                        | tubewell no 3                   | 378                        | 137.2                                     | 21                | 20.6              | 313             | 7.5  | 0.36         |
| Sohna Dhana            | tubewell no 1                   | 651                        | 256.8                                     | 41                | 37.5              | 535             | 7.6  | 0.5          |
|                        | tubewell no 2                   | 572                        | 254.7                                     | 41                | 37                | 472             | 7.6  | 0.8          |
| Sohna Langra           | tubewell no 1                   | 535                        | 254.7                                     | 41                | 37                | 331             | 7.7  | 0.4          |
|                        | tubewell no 2                   | 451                        | 165.2                                     | 33                | 20.1              | 302             | 7.6  | 1.0          |
|                        | tubewell no 3                   | 385                        | 145.6                                     | 25                | 20.2              | 273             | 7.6  | 0.53         |
| Sohna bhangrola        | tubewell no 1                   | 559                        | 262.4                                     | 33                | 43.7              | 542             | 7.6  | 0.5          |
|                        | tubewell no 2                   | 566                        | 304.2                                     | 41                | 49                | 582             | 7.8  | 0.6          |
|                        | tubewell no 3                   | 814                        | 304.2                                     | 41                | 49                | 522             | 7.6  | 0.8          |
|                        | tubewell no 4                   | 835                        | 244.8                                     | 41                | 34.6              | 482             | 7.9  | 0.7          |
|                        | tubewell no 5                   | 306                        | 265.9                                     | 42                | 39.1              | 252             | 7.7  | 0.6          |
| Sohna Begampur khatola | tubewell no 2                   | 572                        | 172.0                                     | 25                | 26.6              | 502             | 7.7  | 0.4          |
| Sohna Teekri           | tubewell no 1                   | 572                        | 102.6                                     | 18                | 14                | 433             | 7.7  | 1.0          |
|                        | tubewell no 2                   | 1190                       | 331.7                                     | 40.5              | 56                | 221             | 7.9  | 0.4          |
| Mandpur                | tubewell no 1                   | 387                        | 204.8                                     | 21                | 37                | 242             | 7.6  | 0.3          |
| Budhera                | tubewell no 1                   | 629                        | 330.1                                     | 41                | 55.3              | 391             | 7.7  | 0.8          |
|                        | tubewell no 2                   | 209                        | 220.5                                     | 24                | 39                | 183             | 7.6  | 0.8          |
|                        | tubewell no 3                   | 192                        | 185.1                                     | 25                | 29.8              | 162             | 7.7  | 0.6          |
| Kaliawas               | tubewell no 1                   | 284                        | 254.2                                     | 21                | 49                | 191             | 7.5  | 0.85         |
| Muhamadpur-faruqnagar  | tubewell no 1                   | 3310                       | 2784.8                                    | 322               | 481               | 292             | 8.2  | 1.8          |
| Makrola                | mandir handpump                 | 282                        | 254.7                                     | 41                | 37                | 211             | 8    | 1.9          |
| Sohna Basunda          | tubewell no 2                   | 278                        | 191.6                                     | 21                | 33.8              | 162             | 7.6  | 0.7          |
| Garhi                  | tubewell no 1                   | 531                        | 508.4                                     | 42                | 98                | 192             | 7.7  | 0.7          |
|                        | tubewell no 2                   | 391                        | 316.5                                     | 42                | 51.4              | 222             | 7.6  | 0.7          |
| Sadhrna                | (Harijan Moholla) tubewell no 1 | 293                        | 254.7                                     | 41                | 37                | 202             | 7.6  | 0.6          |
|                        | (Balmiki Moholla)               | 282                        | 182.2                                     | 21                | 31.5              | 182             | 7.55 | 0.65         |
|                        | tubewell no 1                   | 295                        | 222.6                                     | 42                | 28.6              | 252             | 7.6  | 0.6          |
|                        | tubewell no 2                   | 576                        | 467.6                                     | 41                | 88.7              | 202             | 7.6  | 0.35         |
| Khandewla              | Bheem parjapat handpump         | 2315                       | 707.2                                     | 82                | 122               | 382             | 8    | 1.65         |
|                        | submersible                     | 186                        | 225.5                                     | 25                | 39.6              | 102             | 7.5  | 0.3          |
| Basunda                | panchayti                       | 1175                       | 275.3                                     | 41                | 42                | 532             | 7.8  | 0.5          |

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|---------------------------|----------------------------|------|--------|-----|-------|-----|------|------|
|                           | handpump                   |      |        |     |       |     |      |      |
| Mehchana                  | panchayti bore             | 2382 | 1438.7 | 248 | 199   | 415 | 8.3  | 1.55 |
| Karola                    | handpump(Ja smal)          | 1482 | 614.9  | 83  | 99    | 573 | 7.9  | 0.9  |
|                           | panchayti bore             | 793  | 495.0  | 62  | 82.6  | 448 | 5.6  | 0.7  |
| Tripari                   | Panchayat Submersible pump | 831  | 314.0  | 41  | 51.4  | 363 | 7.7  | 0.25 |
|                           | chitra hand pump           | 875  | 324.0  | 41  | 53.8  | 383 | 7.55 | 0.35 |
| Basunda                   | tubewell                   | 2333 | 1653.8 | 250 | 250   | 420 | 8    | 0.9  |
| Rajpura                   | tubewell                   | 2540 | 1331.5 | 210 | 196   | 395 | 8.4  | 2.1  |
| Menchana                  | tubewell                   | 3398 | 1257.4 | 210 | 178   | 445 | 8.4  | 1.4  |
| Saidpur                   | tubewell no 2              | 2364 | 1022.0 | 185 | 136   | 415 | 7.9  | 2.64 |
|                           | tubewell no 1              | 1944 | 1113.1 | 205 | 146   | 466 | 8    | 2.1  |
| Khantawas                 | tubewell no 1              | 1313 | 871.6  | 102 | 149.8 | 352 | 7.7  | 0.5  |
|                           | tubewell no 2              | 2600 | 2012.4 | 326 | 291   | 233 | 8.3  | 0.35 |
| Mohamdpur                 | tubewell no 1              | 2233 | 1403.2 | 242 | 194   | 153 | 7.9  | 0.74 |
|                           | tubewell no 2              | 2468 | 1798.1 | 321 | 242   | 202 | 8.3  | 0.27 |
| Patli                     | Hajipur tubewell           | 1859 | 1812.5 | 244 | 292.2 | 420 | 8.1  | 0.31 |
|                           | tubewell                   | 165  | 217.2  | 22  | 39.4  | 112 | 7.5  | 0.25 |
| Tajnagar                  | tubewell                   | 2610 | 1594.2 | 241 | 241   | 133 | 8.1  | 1.0  |
| Daboda                    | tubewell no 1              | 716  | 264.6  | 41  | 39.4  | 232 | 7.6  | 0.14 |
| Khandewla                 | tubewell no 3              | 670  | 289.0  | 42  | 44.7  | 278 | 7.6  | 0.4  |
| Taj nagar                 | tubewell at panchayat      | 416  | 235.0  | 41  | 32.2  | 295 | 7.7  | 0.43 |
| Khurampur                 | Panchayat h/pump           | 1474 | 610.8  | 83  | 98    | 244 | 7.9  | 0.9  |
| Siwari -Ki - Dhani        | tubewell                   | 2666 | 2449.0 | 331 | 394   | 133 | 8.0  | 6.4  |
| Jarola                    | Govt. tubewell             | 1453 | 837.2  | 110 | 136.6 | 175 | 7.9  | 0.7  |
| Mohamadpur (Farukh nagar) | tubewell no 3              | 3108 | 2125.3 | 330 | 316   | 155 | 8.3  | 0.60 |
| Rajupur                   | handpump                   | 2320 | 1507.0 | 244 | 218   | 363 | 8.1  | 2.3  |
| Siwari panchayat          | tubewell                   | 617  | 432.1  | 51  | 74    | 132 | 7.65 | 0.58 |
| Musheadpur                | h/pump                     | 572  | 439.6  | 49  | 77.2  | 452 | 7.7  | 0.82 |
|                           | h/pump mandir              | 1280 | 343.5  | 45  | 56.2  | 510 | 7.9  | 3.6  |
| Siwari                    | h/pump near chopal         | 1984 | 1624.8 | 212 | 266   | 192 | 8.3  | 0.82 |
| Sahara mall               | tubewell                   | 297  | 285.6  | 26  | 53.6  | 192 | 7.6  | 0.55 |
| Meoka                     | tubewell no1               | 556  | 162.8  | 22  | 26.2  | 512 | 7.6  | 1.85 |
| Noorgarh                  | tubewell no 2              | 3162 | 1323.3 | 210 | 194   | 372 | 8.4  | 2.0  |
|                           | tubewell no1               | 3110 | 1603.0 | 322 | 194   | 272 | 8.4  | 2.2  |
| Rampura                   | tubewell no 2              | 1899 | 604.2  | 82  | 97    | 471 | 7.6  | 2.2  |

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|--------------------------|----------------------|------|--------|------|-------|-----|------|------|
| Sohna                    | Dadawas tubewell     | 2292 | 1197.9 | 201  | 169   | 481 | 7.66 | 0.6  |
| Haliyaki                 | tubewell             | 1952 | 1098.0 | 161  | 169   | 452 | 8    | 1.5  |
| Manwaki                  | tubewell no 1        | 2870 | 1830.7 | 245  | 296   | 482 | 8.2  | 1.5  |
| Rajpura                  | tubewell no 1        | 1964 | 811.1  | 122  | 123   | 481 | 8.2  | 1.8  |
| Balewa                   | tubewell no 4        | 1650 | 759.9  | 81   | 135.4 | 322 | 8.1  | 0.4  |
|                          | tubewell no 2        | 1429 | 615.0  | 83   | 99    | 323 | 7.6  | 0.45 |
| Hussainka                | tubewell no 1        | 1434 | 324.1  | 49   | 49    | 451 | 7.7  | 2.7  |
| Sohna Chhillarki         | tubewell no 2        | 3697 | 1794.0 | 321  | 241   | 208 | 8.4  | 1.1  |
|                          | tubewell no 1        | 1278 | 385.5  | 34   | 73    | 462 | 7.8  | 2.55 |
| Muhamdpur                | Jharsa tubewell no 2 | 1113 | 261.4  | 42   | 38    | 384 | 7.7  | 0.82 |
| DLF colony               | Jet pump             | 1180 | 211.4  | 22   | 38    | 313 | 7.9  | 0.18 |
| Garhi                    | tubewell no 2        | 337  | 187.6  | 26   | 29.8  | 305 | 7.65 | 1.2  |
| Dharampur                | tubewell no 2        | 3731 | 1508.4 | 205  | 242   | 558 | 8.4  | 1.7  |
|                          |                      | 2970 | 904.2  | 123  | 145   | 551 | 8.2  | 3.3  |
| Harsaru                  | tubewell no 2        | 1476 | 476.4  | 46   | 87.8  | 391 | 7.83 | 0.96 |
| Gugana                   | tubewell             | 2232 | 1108.1 | 203  | 146   | 422 | 8.1  | 1.52 |
| Dooma                    | tubewell no 2        | 458  | 357.7  | 41   | 62    | 282 | 7.6  | 1.1  |
| Jori                     | tubewell no 1        | 918  | 389.2  | 49   | 64.8  | 421 | 7.6  | 1.45 |
| Sohna Sahiawas           | tubewell no 2        | 415  | 218.1  | 25   | 37.8  | 351 | 7.6  | 0.48 |
| Sohna Nainwal            | tubewell no 1        | 445  | 122.0  | 17   | 19.3  | 331 | 7.6  | 0.28 |
| Sohna Ghanghola          | tubewell no 2        | 3692 | 2984.2 | 481  | 433   | 161 | 8.4  | 1.2  |
| Sohna Nanerhera          | tubewell             | 472  | 239.7  | 33   | 38.2  | 281 | 7.5  | 1.41 |
| Sohna Alipur             | tubewell             | 1116 | 497.4  | 59   | 85    | 291 | 7.8  | 0.19 |
| Patel Nagar              | tubewell             | 339  | 183.3  | 17   | 34.2  | 321 | 7.67 | 0.02 |
| Sohna Darbaripur         | tubewell no 1        | 516  | 119.4  | 16.5 | 19    | 351 | 7.7  | 2.2  |
| Jahajgarh                | tubewell             | 2000 | 618.7  | 40   | 126   | 510 | 8    | 1.8  |
| chanakyapuri guest house | tubewell             | 60   | 50.5   | 9    | 6.8   | 110 | 7.5  | 0.02 |
| Daboda                   | tubewell no 3        | 1070 | 206.7  | 30   | 32    | 510 | 7.9  | 1.55 |
| Sohna Dhani              | tubewell             | 610  | 415.6  | 51   | 70    | 421 | 7.65 | 0.65 |
| Hasanpur                 | t/well no 1          | 770  | 319.0  | 42   | 52    | 150 | 7.6  | 1.09 |