Paper ID 2002999

Impact of production operations on ground water with respect to Heavy metals in Assam Asset

S.K.Chattopadhyay, R.Sitaraman, Krishnamurthy, Ajit Kumar

ONGC, IPSHEM, P.O. VELIM, BETUL, SOUTH GOA – 403723

Presenting autor, Email: chattopadhyay_sk1@ongc.co.in

Abstract

Assam Asset, the largest on-shore Asset of ONGC, is located in the Sivasagar district. The oil fields at Geleki, Lakwa, Rudrasagar and North Bank are situated at approximately 20 to 30 kms from Nazira. ONGC struck oil in Assam on 7th December, 1960 at Rudrasagar-1. Since then, ONGC has made 17 major discoveries in Assam and drilled about 1225 wells. Currently, Assam Asset operates 65 production installations, 24 drilling rigs and 19 workover rigs. In addition, there is a network of 230 kms of trunk pipelines and 2000 kms of flow lines. Assam Asset produced 1.262 MMT of crude oil and 458.31 MMSCM gas during financial year 2013-14. Currently, the growth strategy of Assam Asset is focused on (a) find new Reserves (b) increase production (c) renewal of infrastructure and facilities. Assam Asset has initiated exploration in deeper geological formations like Tura- in Lakwa, Geleki, Nazira & Mekeypore areas along with accelerated development of new oil fields like Laiplinggaon and Changmaigaon. The Asset plans to drill more development wells and use new drilling technology for production enhancement. More than 200 wells are planned in the next five years.

The Assam asset has been in operation for decades and in order to determine the effect of operations on the environment, notably on ground water quality, a simple and straightforward strategy was employed. Water samples were collected from nearby tubewell and compared against the produced water of the respective field. Samples were collected from Galeki, Lakwa and Rudrasagar fields. Water samples were also collected from tubewells located near these installations. The samples were analysed for Barium (Ba), Cadmium (Cd), Chromium (Cr), Iron (Fe), Manganese (Mn), Lead (Pb) and Zinc (Zn). Reviewing the results, there were only five heavy metals that were detected out of the seven heavy metals that were analysed in the 6 samples (3 samples were of produced water and 3 ground water samples from nearby borewells). Chromium and Cadmium was absent in all samples. Based on the results of the samples analyzed, there isn't any cause for concern about the possibility of environmentally hazardous materials being introduced into the ground water as a result of the project activities. All the reported results are below the required limits, thus showing that all heavy metals tested for are at natural or non-detectable levels. This position is arrived at based on the comparative levels vis a vis the Drinking water standards and the results.

Introduction

Assam Asset, the largest on-shore Asset of ONGC, is located in the Sivasagar district. The operational Headquarters of Assam Asset is located about 16 KM from the Sivasagar town at Nazira. The Assam Asset oil fields at Geleki, Lakwa, Rudrasagar and North Bank are situated at approximately 20 to 30 kms from Nazira. The Asset operations are spread across a vast area. ONGC struck oil in Assam on 7th December, 1960 at Rudrasagar-1 within 3 years after it started the search for oil in Assam in 1957. This discovery of oil at Rudrasagar -1, Assam, was the third success for ONGC after its maiden discovery of oil at Lunej, Cambay Basin on 5th September'1958 followed by a major discovery at Ankleshwar in Gujarat, in early 1960. Since then, ONGC has made 17 major discoveries at Assam and drilled about 1225 wells. ONGC offices were set up at Nazira in 1962 after acquiring this site from the Assam Company Ltd. in 1959. Sivasagar, also an important activity centre of ONGC, houses some of the important operational work units of the Asset such as Drilling Services, Well Services, Logistics, Regional Training Institute and Central Workshop, the largest workshop in the Eastern India. Currently, Assam Asset operates 65 production installations, 24 drilling rigs and 19 workover rigs. In addition, there is a network of 230 kms of trunk pipelines and 2000 kms of flow lines. All operational installations have been accredited with QHSE (Quality, Health, Safety and Environment) certifications, conforming to statutory guidelines. The total number of regular manpower posted at Assam Asset is 5383. Assam Asset produced 1.262 MMT of crude oil and 458.31 MMSCM gas during financial year 2013-14. The monthly production of effluent from the various fields ranged from 160760 m^3 to 174480 m^3. In Lakwa and Galeki field the effluent water was used for water injection, some quantity was evaporated, some was used internally and the rest was disposed in Effluent disposal wells. Currently, the growth strategy of Assam Asset is focused on (a) find new Reserves (b) increase production (c) renewal of infrastructure and facilities. Assam Asset has initiated exploration in deeper geological formations like Tura- in Lakwa, Geleki, Nazira & Mekeypore areas along with accelerated development of new oil fields like Laiplinggaon , Changmaigaon. The Asset plans to drill more development wells and use new drilling technology for production enhancement. Assam Asset is at the threshold of a turnaround due to the implementation of various measures such as induction of state-of-art technology and revamping of surface facilities. The Assam Renewal Project (ARP) is the largest investment by ONGC in Assam for modernization of surface facilities and enhancement of operational efficiency. ARP also heralds highest standards of safety and environment production in the predominant processing of Oil & Gas in Assam. In Phase-I, the work for revamping of Installations & Associated pipeline Network of Lakwa and Lakhmani fields and Moran CTF has been awarded on 17th March, 2009, at a value of Rs.2378.86 Crore with a completion schedule of 48 months. The scope of work is also being finalized for Geleki and Rudrasagar field under the ARP group B&C. The massive ONGC investment under Assam Renewal Project shall spur all-round growth and development of the region and oil-field operational areas. The fact that ONGC is making such a massive investment at Assam Asset under Assam Renewal Project reflects ONGC's commitment to Assam and to improve oil and gas production from the State.

Experimental details

The Assam asset has been in operation for decades and in order to determine the effect of operations on the environment, notably on ground water quality, a simple and straightforward strategy was employed. Water samples were collected from nearby tubewell and compared against the produced water of the respective field. Samples were collected from Galeki, Lakwa and Rudrasagar fields. Water samples were also collected from tubewells located near these installations. The samples were analysed for Ba, Cd, Cr, Fe, Mn, Pb and Zn. Inductively Coupled Plasma – Optical Emission Spectrometer (ICP-OES) Perkin Elmer model OPTIMA 2000 D was used for the determination of heavy metals. The samples were digested in 5% HNO_3 solution to bring the metals in aqueous media. Digested samples were introduced through nebulizer using Argon gas of 99.99 % purity. Argon gas was also used for plasma and as auxillary gas. The individual metal ion emissions were detected by Optical Emission Spectroscopy.

Name of element	Ba	Cd	Cr	Fe	Mn	Pb	Zn
Measurement Wavelength (nm)	233.527	228.802	267.716	238.204	257.610	220.353	206.200

Table 1 presents the concentration of heavy metals in the water samples collected from Geleki, Lakwa and Rudrasagar area.

Results and Discussion

Barium is fatal to humans in high doses (more than 550 milligrams). No study appears to have been made of the amounts of barium that can be tolerated in drinking water, but because of its toxic effects on the heart, blood vessels and nerves, a level with a large safety factor has been set. Barium can accumulate in the liver, lungs and spleen. It can cause nervous system disorders, heart disease and circulation impairment. Barium varied between 33 and 37 μg/l at RDS and Lakwa whereas the corresponding values for ground water was 8.7 and 4.1 μg/l. At Geleki, the Barium concentration was 189 μg/l as compared to 8.1 μg/l from nearby tubewell water sample (Figure 1). Barium as a heavy metal has been proposed in the draft specification for drinking water and the concentration is kept at 700 μg/l which is quite high than the values determined.

As far as it is known, C<u>admium</u> is biologically a nonessential, non-beneficial element of high toxic potential. Evidence for the serious toxic potential of cadmium is provided by:

a. Poisoning from cadmium-contaminated food and beverages;
b. Epidemiological evidence that cadmium may be associated with renal arterial hypertension under certain conditions;
c. Epidemiological association of cadmium with "Itai-itai" disease in Japan
d. Long-term oral toxicity studies in animals.

The health effects of long-term exposure appear to be from diet, cigarette smoking and seepage into the groundwater from industrial plants, especially wastewater. Cadmium is believed to be mutagenic but not carcinogenic. Cadmium has been found to be 0 in produced water from Galeki, Lakwa and Rudrasagar as well as the borewell water from these areas. The Cd concentration is drinking water is set at 10 μg/l.

<u>Chromium</u> is toxic to humans, produces lung tumors when inhaled and causes skin irritations. Long-term exposure may cause skin and nasal ulcers. Chromium accumulates in the spleen, bones, kidney and liver. It occurs in some foods, in air (including cigarette smoke) and in some water supplies. The level of chromium that can be tolerated over a lifetime without adverse health effects is still undetermined. Chromium is involved in use of blood sugar and is considered an essential nutrient. Chromium has been found to be 0 in produced water from Galeki, Lakwa and Rudrasagar as well as the borewell water from these areas. The Cr concentration is drinking water is set at 50 μg/l.

<u>Iron</u> occurs naturally in many groundwater supplies. It is essential in human and animal diets, but levels above the level mentioned above may impart an objectionable taste or odour to water and cause red staining of porcelain fixtures and laundry. Animals may be sensitive to changes in iron concentrations in their drinking water. Dairy cows may not drink enough water to maintain optimum milk production if the water is high in iron. Dissolved iron in water used for washing and sanitizing milk-handling equipment may impart an oxidized or cardboard-like flavour to the milk. Iron-contaminated water often causes reddish-brown stains to develop on bathtubs, sinks and toilet bowls. It can also stain laundry a pink or reddish colour. These stains are very difficult to remove with ordinary cleaning compounds. Frequently, water with dissolved iron also shows evidence of iron bacteria. These organisms use the iron as a source of energy and accumulate in masses that may plug well screens, pumps and pipelines. In time, a rust-coloured, jelly-like mass will break loose and enter the plumbing system. Iron bacteria coat nearly everything, including toilet tank, pipes and storage tank. Decaying dead bacteria impart a bad taste to the water and leave stains that are very difficult to remove. Tube well water from Geleki showed 184 μg/l whereas the water from Geleki field showed only 6.9 μg/l. Similar low values (less than 5 μg/l) were found at Lakwa and Rudrasagar fields 4.9 and 2.5 μg/l; borewell water samples had values of 1.0 and 3.2 μg/l (Figure 2). The Fe concentration in drinking water is set at 300 μg/l.

Excess <u>Manganese</u> may produce a black or grey colour in laundered goods and may impair the taste of tea, coffee and other beverages. Concentrations above the standard may also cause a dark stain on porcelain plumbing fixtures. As with iron, manganese may form a coating on distribution pipes which may slough off, causing dark stains on laundered clothing or black particles in the water. Manganese stains can be even more difficult to remove than iron stains. The concentration of Mn in the produced water from Lakwa showed 354 μg/l and in the nearby borewell water Mn could not be detected. In

Geleki, Mn values varied between 35.5 (produced water) and 42.5 μg/l (Ground water). The RDS produced water had a value of 0.63 whereas the borewell water showed 15.5 μg/l (Figure 3). The value as per drinking water standard is 100 μg/l.

Exposure to Lead in water, either brief or prolonged, can seriously injure health. Prolonged exposure to relatively small quantities (more than 0.05 milligram per day) may affect health. Lead exposure occurs from air, food and water sources. All exposure is additive. Lead accumulates in the bones, resulting in elevated levels in the blood. Known effects range from subtle biochemical changes at low levels of exposure to severe neurological and toxic effects and even death at much higher levels. As with several other water contaminants, children, infants and foetuses are especially vulnerable to lead. Infants and children absorb a much greater portion of lead intake than adults and their immature, developing bodies and central nervous systems are much more sensitive to its effects. A child's mental and physical development can be irreversibly stunted by over-exposure to lead. Health effects include reduced mental capacity (even mental retardation), interference with kidney and neurological functions and hearing loss in children. The above mentioned standard should be followed whenever pregnant women, infants or children are consuming water. Water may be contaminated by lead from rocks and soil. The lead concentration in the produced water from Geleki, Lakwa and Rudrasagar showed 0.76, 0.07 and 0 μg/l whereas the borewell water showed values of 2.72, 1.28 and 1.35 μg/l (Figure 4). The value as per drinking water standard is 5 μg/l.

Zinc is found in some natural waters, most frequently in areas where it is mined. It is not considered detrimental to health unless it occurs in very high concentrations. However, it does give an undesirable taste and appearance to drinking water, which is the reason for the secondary standard classification. The tubewell water at Lakwa showed Zn concentration at 40.65 μg/l and all other samples had very very low Zn concentration ranging between 0.23 and 2.44 μg/l (Figure 5). The concentration of Zn as per drinking water standard is 5000 μg/l which is way above the levels detected.

Conclusion

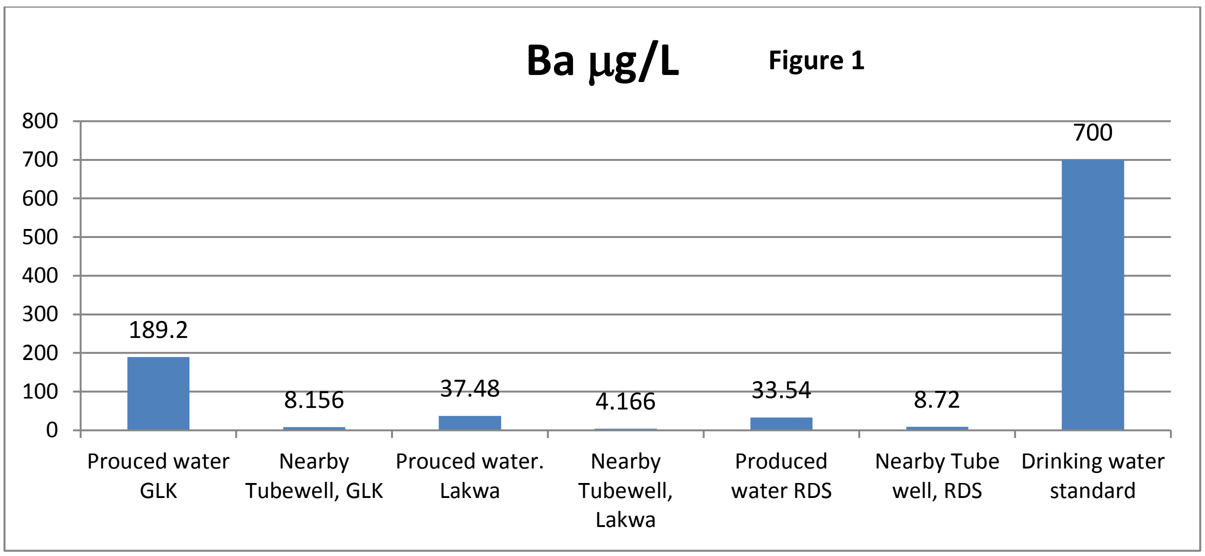
Reviewing the results, there were only five heavy metals that were detected out of the seven heavy metals that were analysed in the 6 samples (3 samples were of produced water and 3 ground water samples from nearby borewells). Chromium and Cadmium was absent in all samples. Based on the results of the samples analyzed, there isn't any cause for concern about the possibility of environmentally hazardous materials being introduced into the ground water as a result of the project activities. All the reported results are below the required limits, thus showing that all heavy metals tested for are at natural or non-detectable levels. This position is arrived at based on the comparative levels vis a vis the Drinking water standards and the results.

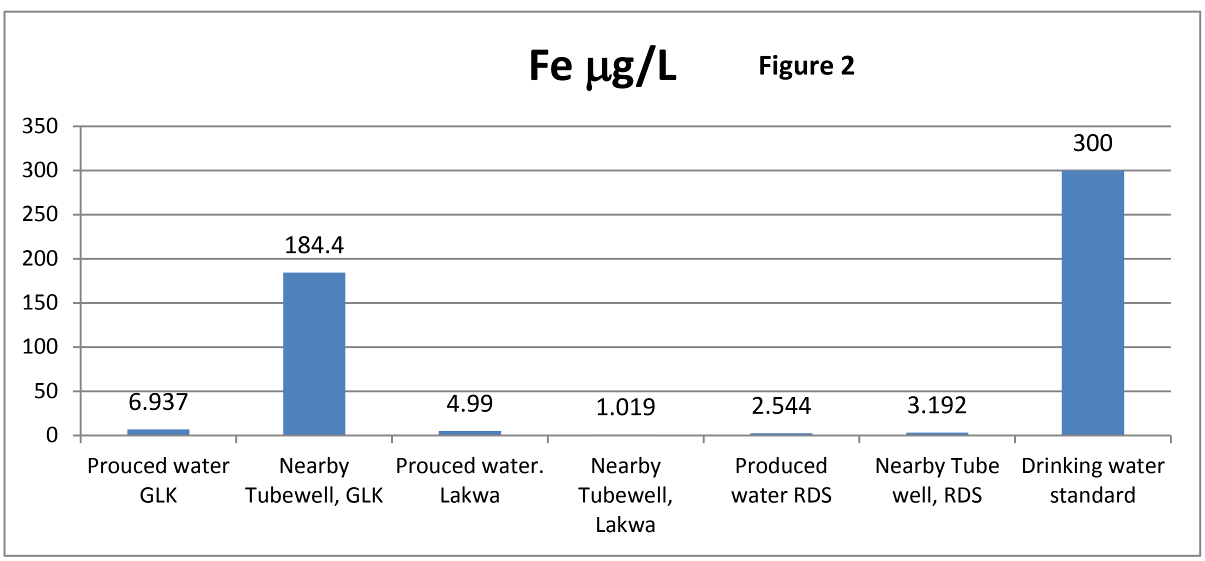
References

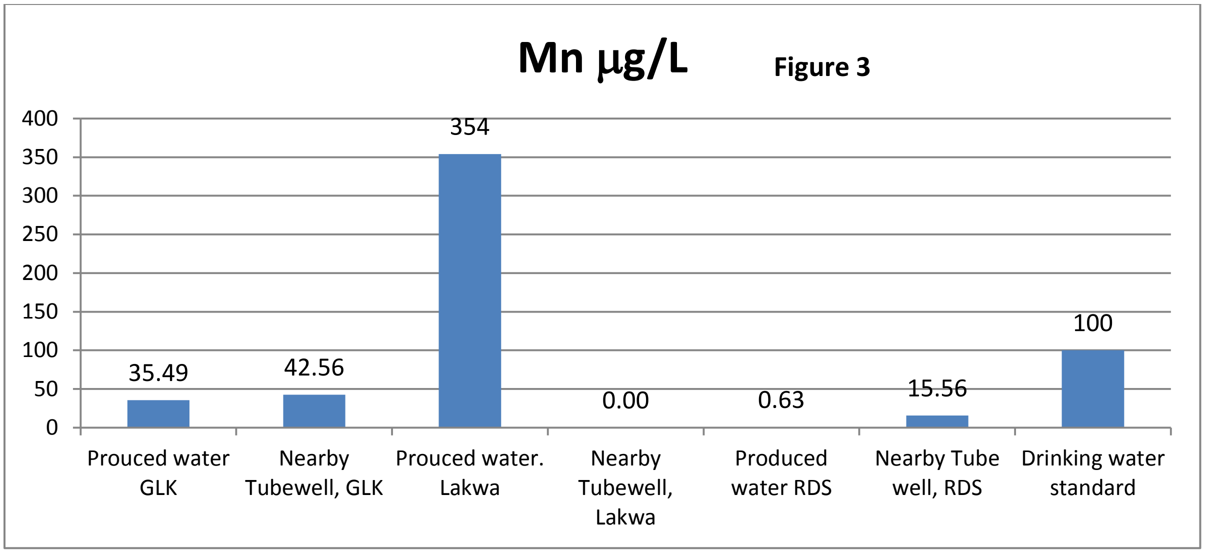
1. ONGC Bulletin Special Issue, Proceeding 3rd Seminar, Petroliferous Basin of India, Volume 48, March 2013
2. Annual report, Production operations, 2013-14, Assam Asset
3. ICP – Optical Emission WinLab32 Instrument Control Software, Perkin Elmer, USA
4. Hazards of heavy metal contamination, British Medical Bulletin, Volume 68, Issue 1, pp 167-182
5. Human Health Effects of Heavy Metals, Environmental Science and Technology Briefs for Citizens, Center for Hazardous Substance Research, Kansas State University, Issue 15, March 2009

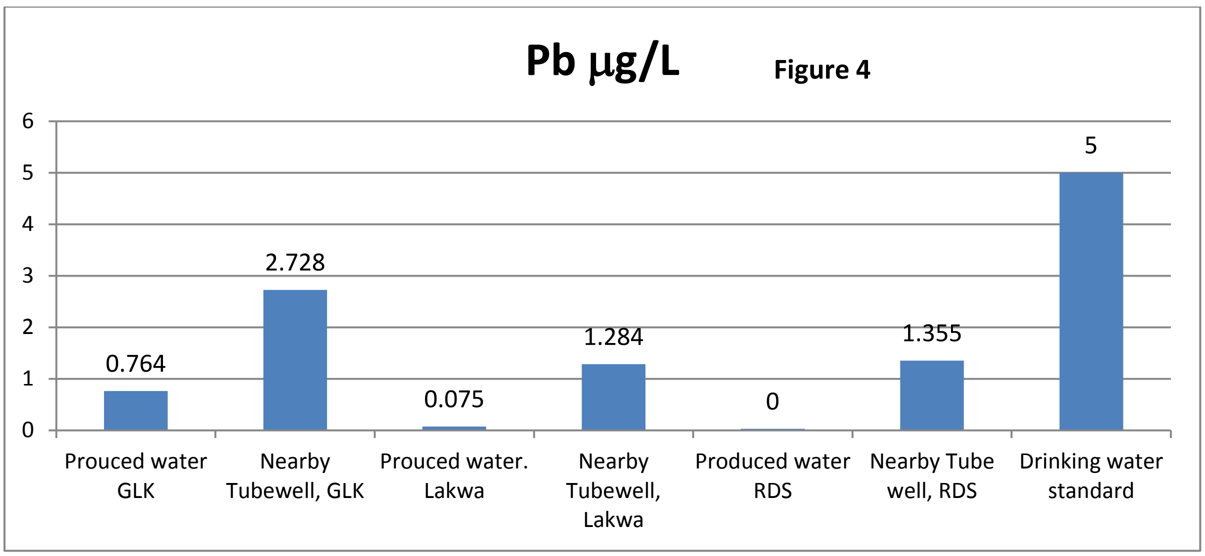
Table 1 Heavy metal concentration of water samples (3 produced water, 3 tubewell)

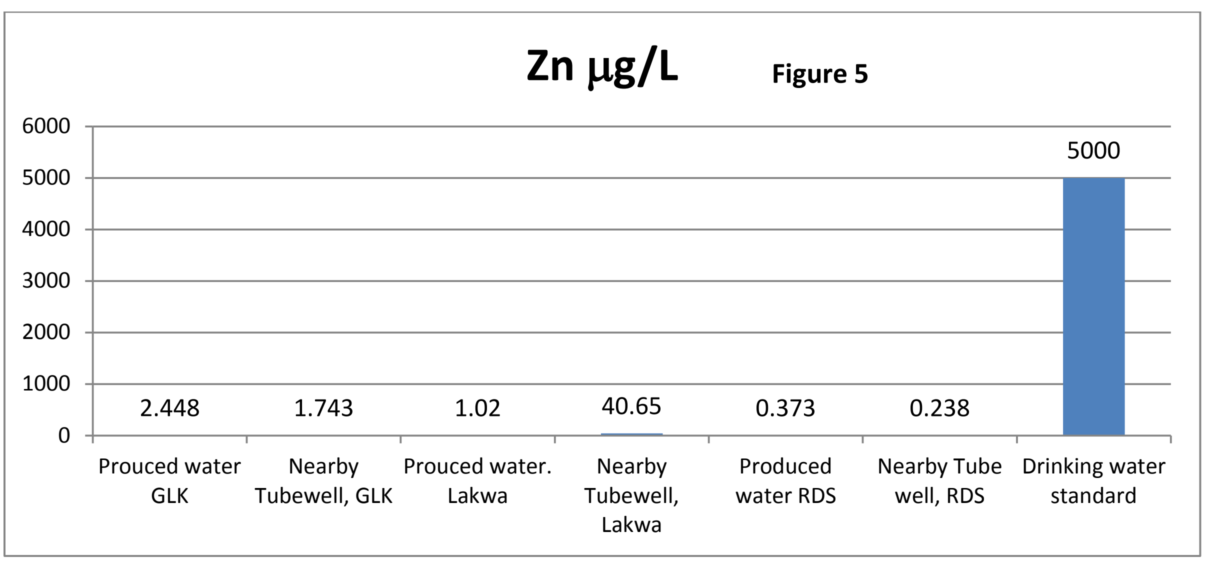
S.No.	Name of element	Ba	Cd	Cr	Fe	Mn	Pb	Zn
	Concentration	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1	Prouced water GLK	189.20	0.00	0.00	6.937	35.49	0.764	2.448
2	Nearby Tubewell, GLK	8.156	0.00	0.00	184.40	42.56	2.728	1.743
3	Prouced water. Lakwa	37.48	0.00	0.00	4.99	354.00	0.075	1.02
4	Nearby Tubewell, Lakwa	4.166	0.00	0.00	1.019	0.00	1.284	40.65
5	Produced water RDS	33.54	0.00	0.00	2.544	0.63	0.00	0.373
6	Nearby Tube well, RDS	8.72	0.00	0.00	3.192	15.56	1.355	0.238
7.	Drinking water standard	700.00	10.00	50.00	300.00	100.00	5.00	5000.00






Mn µg/L
Figure 3
400
350
300
250
200
150
100
50
0
35.49
42.56
354
0.00
0.63
15.56
100
Prouced water GLK
Nearby Tubewell, GLK
Prouced water. Lakwa
Nearby Tubewell, Lakwa
Produced water RDS
Nearby Tube well, RDS
Drinking water standard


Pb µg/L
Figure 4
6
5
4
3
2
1
0
0.764
2.728
0.075
1.284
0
1.355
5
Prouced water GLK
Nearby Tubewell, GLK
Prouced water. Lakwa
Nearby Tubewell, Lakwa
Produced water RDS
Nearby Tube well, RDS
Drinking water standard


Zn µg/L
Figure 5
6000
5000
4000
3000
2000
1000
0
2.448
1.743
1.02
40.65
0.373
0.238
5000
Prouced water GLK
Nearby Tubewell, GLK
Prouced water. Lakwa
Nearby Tubewell, Lakwa
Produced water RDS
Nearby Tube well, RDS
Drinking water standard