

BEFORE THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH,
NEW DELHI

O.A. 728/2023

IN THE MATTER OF:

SUOMOTO CASE TITILEUN" UN PREDICTS GROUND WATER LEVEL
IN INDIA

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Through



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Place : New Delhi
Date : 06.02.2024

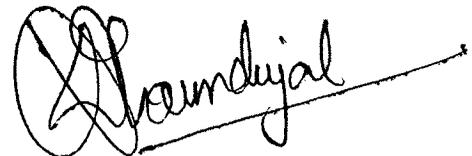
BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI.

O.A. NO. 728/2023

Suomoto Case "Arsenic found in Ground Water in 25 States and Flouride in 27 States"

FURTHER REPORT ON BEHALF OF CENTRAL GROUND WATER AUTHORITY

1. That Principle Bench of the Hon'ble National Green Tribunal, New Delhi took Suo Moto cognizance on the news report titled "Arsenic found in Ground Water in 25 states and Flouride in 27 states" and issued notice to Central Ground Water Authority.
2. That the Central Ground Water Authority filed a report dt.18.12.23 which this Hon'ble Tribunal take note and issued notice to the affected states.
3. That the Central Ground Water Authority which comes under Ministry of Jal Shakti is doing its best for improving the quality of the Ground Water as per the mandate given in the rules and regulations. A fresh report containing mitigation of Arsenic and Fluoride in ground water, mitigation of Arsenic and Fluoride contamination, remedial measures for Arsenic and Fluoride and steps taken by Central Ground Water Board towards Mitigation of Arsenic and Fluoride Contamination is enclosed as **Annexure –A**.



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Mitigation of Arsenic and Fluoride in Ground Water

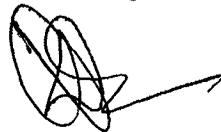
1. Introduction

The contamination of ground water by Arsenic and Fluoride in the country are in general geogenic in nature. Such contaminants in ground water are naturally occurring from the breakdown of rocks and soils or weathering and deposition of atmospheric particles. Their occurrence in natural water is affected by the type of rocks, climatic conditions, nature of hydrogeological strata and time of contact between rock and the circulating ground water.

Insoluble Arsenic-bearing minerals such as arsenopyrite (FeAsS) are rapidly oxidized when exposed to atmosphere, releasing soluble arsenite [As(III)] and added to ground water. The dissolution of these Arsenic containing minerals happens in oxidizing environment and generally associated with shallow aquifers. The Arsenic contamination in Ganga-Bhagirathi alluvial tract covering parts of Uttar Pradesh, Bihar and West-Bengal are mostly confined to shallow aquifers. The excess arsenic may cause sufficient damage to human health like respiratory distress and cardiac diseases. Anaemia and leucopenia are other common effects of arsenic poisoning.

Similarly Fluoride is commonly found in minerals such as fluorspar, cryolite, fluorite [CaF_2] and fluorapatite which are constituent of primary rock types which got mobilized and introduced in to the ground water. Presence of other ions, particularly bicarbonate and calcium ions also affect the concentration of fluoride in ground water. It is well known that small amounts of fluoride (less than 1.0 mg/L) have proven to be beneficial in reducing tooth decay. However, high concentrations such as 1.5 mg/L of F and above have resulted in staining of tooth enamel while at still higher levels of fluoride ranging between 5.0 and 10 mg/L, further pathological changes such as stiffness of the back and difficulty in performing natural movements may take place.

The maximum permissible limit of Arsenic for drinking purpose is 0.01 mg/L (or 10 ppb) as per BIS (Bureau of Indian Standards) Drinking Water Standards (IS 10500:2012). The BIS permissible limit of Arsenic was revised from 0.05 mg/L (50 ppb) to 0.01 mg/L (10 ppb) in the year 2015. BIS has recommended an upper desirable limit of 1.0 mg/L of F as desirable concentration of fluoride in drinking water, which can be extended to 1.5 mg/L of F in case no alternative source of water is available. Water having fluoride concentration of more than 1.5 mg/L are not suitable for drinking purposes.



2. Mitigation of Arsenic and Fluoride Contamination

The following points are important while considering the mitigation of ground water contamination:

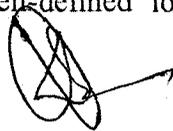
- Fluoride and Arsenic contaminations are mostly geogenic in nature and less commonly due to anthropogenic causes involving human activities such as uses of fertilizers and pesticides and due to industrial pollution.
- In case of anthropogenic contamination, mitigation may be done through by adopting proper preventive measure.
- Geogenic contamination can not be undone as the contamination is in the aquifer which is the source of the ground water. However, it can be diluted through measures such as artificial recharge of aquifer. Conjunctive use of surface and ground water will also play an important role in ground water contaminated areas.
- When ground water sources are used for drinking and domestic purposes, it's always advisable to find alternate safe sources for supply in the ground water contaminated area. The level of fluoride in drinking water can be reduced by blending with fluoride free water.
- Identified contaminated sources or ground water utilization sources such as dug wells, bore wells, tube wells are to be marked and their utilization is to be prohibited and public should be made aware about these prohibited sources.
- There are standard scientifically proven techniques to remove the Arsenic or Fluoride from drinking water, which should only be used in case of no alternate source for ground water supply.

2.1 Remedial Measures for Arsenic

(a) **Precipitation processes:** Adsorption, co-precipitation with hydrolysing metals such as Al^{3+} and Fe^{3+} is the most common treatment technique for removing arsenic from water. Sedimentation followed by rapid sand filtration or direct filtration or microfiltration is used to remove the precipitate. To improve efficiency of this method, a prior oxidation of As (III) to As (V) is advisable. Hypochlorite and permanganate are commonly used for the oxidation.

(b) **Adsorptive processes-** Adsorption on to activated alumina, activated carbon and iron/manganese oxide based or coated filter media. Adsorptive processes involve the passage of water through a contact bed where arsenic is removed by surface chemical reactions. The activated alumina-based sorptive media are being used in India. Granular ferric hydroxide is a highly effective adsorbent used for the adsorptive removal of arsenate, arsenite, from natural water.

(c) **Ion-exchange processes-** This is similar to that of activated alumina, however, in this method the medium is synthetic resin of relatively well defined ion exchange capacity. In these



processes, ions held electrostatically on the surface of a solid phase are exchanged for ions of similar charge dissolved in water. Usually, a synthetic anion exchange resin is used as a solid. Ion exchange removes only negatively charged As (V) species.

(d) Membrane processes- This includes nano-filtration, ultrafiltration, reverse osmosis and electrodialysis in which synthetic membranes are used for removal of many contaminants including arsenic. They remove arsenic through filtration, electric repulsion, and adsorption of arsenic-bearing compounds.

2.2 Remedial Measures for Fluoride

The following methods are normally used for defluoridation of contaminated water.

(a) Adsorption and ion exchange

This technique functions on the adsorption of fluoride ions onto the surface of an active agent such as activated alumina, red mud, bone char, brick pieces column, mud pot and natural adsorbents where fluoride is removed by ion exchange or surface chemical reaction with the solid bed matrix.

Activated alumina: Activated alumina is a highly porous aluminium oxide exhibiting high surface area. Alumina has a high preference for fluoride compared to other anionic species, and hence is an attractive adsorbent. The crystal structure of alumina contains cation lattice discontinuities giving rise to localized areas of positive charge which makes it attract various anionic species. The maximum absorption capacity of activated alumina for fluoride is found to be 3.6 mg F/g of alumina.

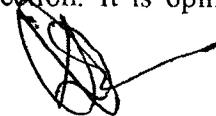
Ion-Exchange resins: Synthetic chemicals, namely, anion and cation exchange resins have been used for fluoride removal. Some of these are Polyanion (NCL), Tulsion A - 27, Deacedite FF (IP), Amberlite IRA 400, LewatitMIH - 59, and AmberliteXE - 75. The fluoride exchange capacity of these resins depends upon the ratio of fluoride to total anions in water.

(b) Coagulation-precipitation

Precipitation methods are based on the addition of chemicals (coagulants and coagulant aids) and the subsequent precipitation of a sparingly soluble fluoride salt as insoluble. Fluoride removal is accomplished with separation of solids from liquid. Aluminium salts (eg. Alum), lime, Poly Aluminium Chloride, Poly Aluminium Hydroxy sulphate and Brushite are some of the frequently used materials in defluoridation by precipitation technique. The best example for this technique is the famous Nalgonda technique (NEERI).

Nalgonda Technique (NEERI)

Nalgonda technique involves addition of Aluminium salts, lime and bleaching powder followed by rapid mixing, flocculation, sedimentation, filtration and disinfection. It is opined that this



technique is preferable at all levels because of the low price and ease of handling, is highly versatile and can be used in various scales from household level to community scale water supply. The Nalgonda technique can be used for raw water having fluoride concentration between 1.5 and 20 mg/L and the total dissolved solids should be <1500 mg/L, and total hardness < 600 mg/L. The alkalinity of the water to be treated must be sufficient to ensure complete hydrolysis of alum added to it and to retain a minimum residual alkalinity of 1 - 2 meq/L in the treated water to achieve a pH of 6.5 - 8.5 in treated water.

(c) Membrane techniques

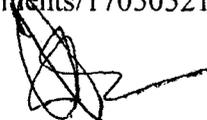
Reverse osmosis, nanofiltration, dialysis and electro dialysis are physical methods that have been tested for defluoridation of water. Though they are effective in removing fluoride salts from water, however, there are certain procedural disadvantages that limit their usage on a large scale.

2.3 Work Done by CGWB towards Mitigation of Arsenic and Fluoride Contamination

Various steps have been taken by the Central Government for facilitating ground water quality improvement/ remediation of contamination in the country, as given below:

1. Central Ground Water Board is doing ground water exploration in the country since its establishment and has constructed large number of borewells and tubewells in all states, irrespective of the hydrogeological conditions. The water samples from each of these wells undergo chemical analysis and successful wells free from any contaminants were handed over to state ground water departments for their use for community drinking water supply.
2. Data on ground water quality available with CGWB along with information on ground water contamination are shared with concerned State Governments for taking necessary remedial measures.
3. Awareness generation programs/ workshop on various aspects of ground water including preventing ground water pollution and safe use of contaminated water are being conducted by CGWB periodically.
4. Based on the findings of the studies and experience of ground water exploration, CGWB has developed certain methods for constructing fluoride and arsenic free wells by employing suitable designing of wells and cement sealing techniques. Such techniques of construction of contaminant free bore wells/ tube wells are shared with the state ground water departments to use them in similar terrains.
5. Under the National Aquifer Mapping Programme (NAQUIM) of CGWB, special attention is being given to the aspect of ground water quality including contamination by toxic substances such as Arsenic in ground water.
6. CGWB in collaboration with NIH, Roorkee prepared a vision document on "*Mitigation and Remedy of Ground water Arsenic Menace in India*" in June 2010 which is available for online access at:

<https://cgwb.gov.in/cgwbpnm/public/uploads/documents/17050521771636797339file.pdf>



7. Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti has issued guidelines for control and regulation of groundwater extraction with pan-India applicability notified on 24 September 2020. The guidelines include clauses on 'Measures to be adopted to ensure prevention from pollution in the plant premises of polluting industries/projects'. It is pointed out that ground water in and around polluting industries like Tannery, Slaughter Houses, Dye, Chemical, Coal-washery, other hazardous units, etc. and is generally observed to be polluted. In order to prevent further deterioration of ground water quality in such places, it is essential to take necessary measures for well head protection, such as Tube well/ bore well to be constructed at the place which is hygienically maintained, RCC (Reinforced Concrete Cement) grouting around tubewell, no recharge measures within the plant premises etc.

2.3.1 Well Construction for Tapping Arsenic safe Alternate Aquifer (CGWB)

This technique advocates tapping of safe alternate aquifers right within the affected areas. In India except at Rajnandgaon in Chhatisgarh state, the vast Asaffected areas in the Gangetic Plains covering Bihar and Uttar Pradesh as well as Deltaic Plains in West Bengal are marked by multi aquifer systems. All the arsenic affected districts in UP and in Bihar are aligned along the linear track of the river Ganga, so is the position in West Bengal where it is along the eastern side of river Bhagirathi. The sedimentary sequence is made up Quaternary deposits, where the aquifers made up of unconsolidated sands which are separated by clay/sandy clay, making the deeper aquifer/aquifers semi-confined to confined. The contamination is confined to the upper slice of the sediments, within the depth of 80 m and affecting the shallow aquifer system. At places, like Maldah district of West Bengal, single aquifer exists till the bed rock encountered at 70-120 m bgl.

It has been observed that shallow aquifers are having more arsenic contaminations in comparison to the deep aquifers. Therefore, deep wells were constructed to tap deeper zones of arsenic free ground water. In the multi aquifer system the cement sealing technique was adopted to prevent the mixing of arsenic contaminated water with arsenic free ground water. The design of construction of Arsenic free Tube well with cement sealing technology is shown at Fig.1

So far, 522 exploratory wells tapping arsenic safe aquifers have been constructed under NAQUIM programme including 40 in Bihar, 188 in West Bengal and 294 in Uttar Pradesh with this technique. The innovative cement sealing technique of CGWB has been shared with the state agencies to utilize to construct arsenic free wells.

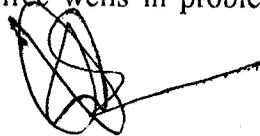
2.3.1 Successful Case Study in Mandla District, Madhya Pradesh for Sustainable Fluoride free water supply- (CGWB)

Mandla district in Madhya Pradesh is severely affected with fluoride having high concentration of fluoride more than 4.5mg/l. Finding fluoride free ground water source in the district is quite

difficult. The area is dominated by basaltic formation followed by Lametas and Granite. The deeper basaltic aquifers are potential aquifers but their fluoride content is high. The aquifers within the Lametas are fluoride free but tapping these aquifers is challenging due to collapsible nature of formation and also they are not sustainable in summer season. PHED Mandla has also adopted many defluorization (use of chemical) techniques developed by NEERI which were not successful due to its maintenance and other environmental issues.

On request of PHED, CGWB has given technical advice/training taking the above factors into consideration and suggested construction of wells tapping the shallow water table aquifer comprising of colluvium, alluvium and weathered section of granitic/basaltic area ranging from 18-30 meters, in the vicinity of surface water bodies like checkdam, stop dam, percolation tank, canal command area, river section, Amrit Sarovar, Pushkar Talab etc which will naturally recharge the upper layer of unconfined aquifer. Construction of wells having diameter 22 inches drilled upto depth of 18 - 30 m in weathered section with slotted assembly of 8 inches dia and annular space filled with gravel to act as a mini collector well and further drilling of 10 to 15 m in hard rock is suggested and a schematic diagram of the well design is given at **Fig-2**. Accordingly, 63 such wells were constructed which proved successful in providing sustainable fluoride free water supply at various habitations of Mandla district. PHED, Mandla has given feedback to CGWB in a letter given in the **Annexure-I**.

The details of such case study has also been shared with DDWS for use of the method in the Jal Jeevan Mission for construction of fluoride free wells in problematic areas in similar terrains.



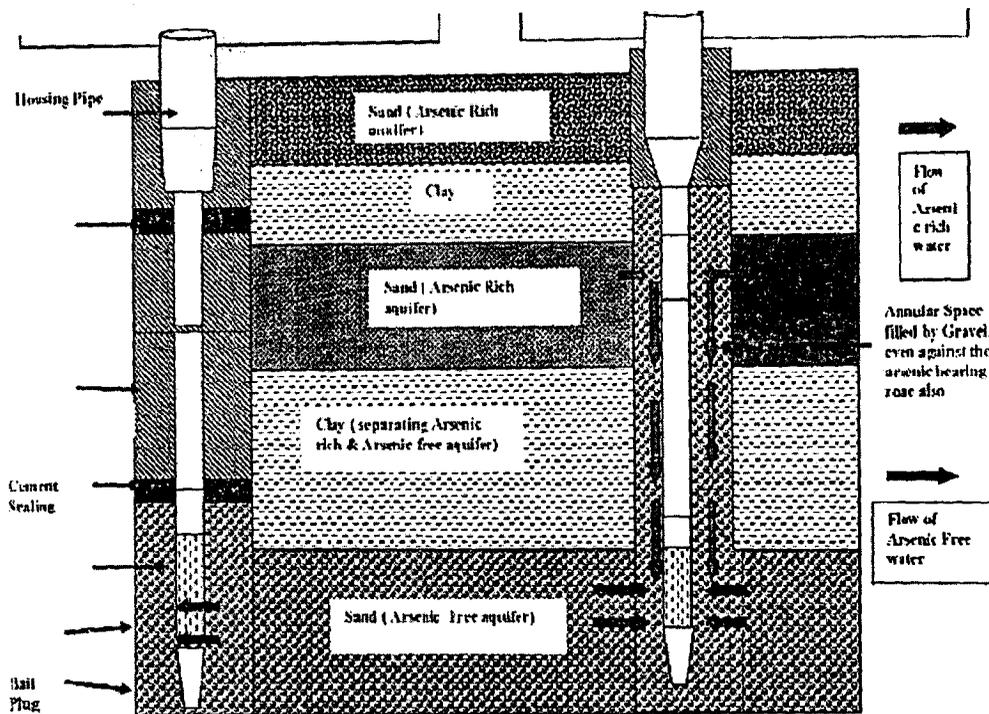


Fig.1: Tube-well design of a deep tube tapping arsenic safe deeper aquifer (the well on the left shows a properly designed tube well tapping deeper aquifer while the one on the right shows an improperly designed well).

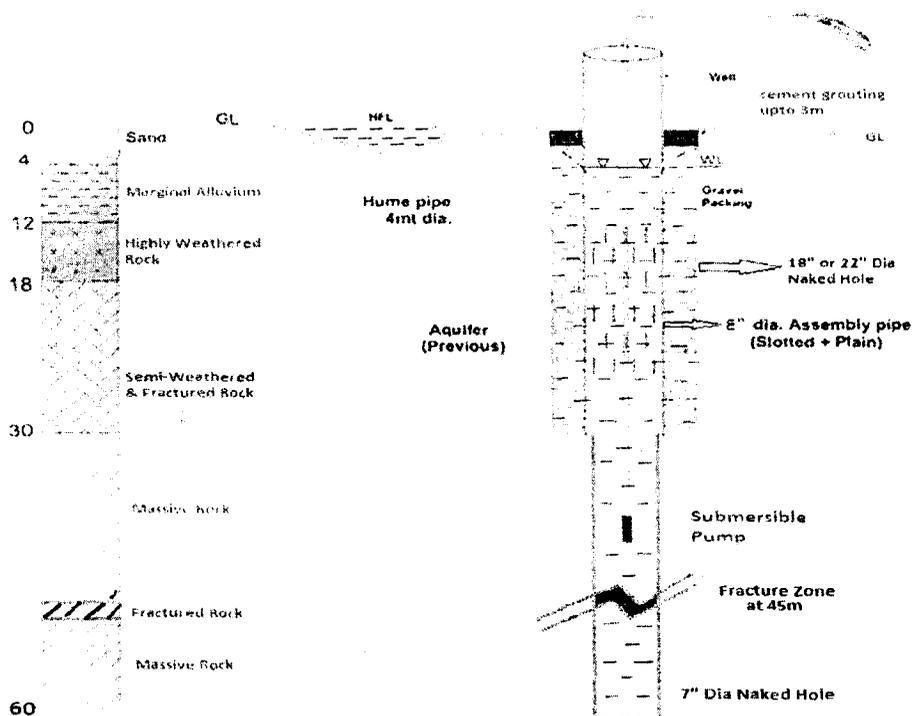


Fig. 2: Design of construction of bore well with mini collector well model

Office Executive Engineer
Public Health Engineering Department (M.P.)
 Phone No- 07642-252443 Fax No. 07642-253622 E-mail eephedmal@mp.nic.in
 No. 345 /TS/EE/PHED/2022 Mandla, Dated. 26-03-2022

To,

The Regional Director
 NCR, Bhopal

Subject: Construction of fluoride free wells in Mandla district (M.P.)

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This is to inform you that PHED Mandla has constructed 63 Nos. of Borewell (soft well/collector well) with hand pump for water supply as per the design provided by CGWB fitted in the fluoride affected area. The wells constructed are having fluoride within the permissible limit and are being utilized for water supply.

No /TS/EE/PHED/2022

Copy To:

The Engineer In Chief, PHED Bhopal for information and necessary action.

Executive Engineer

PHED Mandla(M.P.)

Mandla, Dated.....

Executive Engineer

PHED Mandla(M.P.)

Letter 2021

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