International Journal of Advanced Scientific Research
www.allscientificjournal.com
ISSN: 2456-0421
Received: 14-06-2026, Accepted: 14-07-2026, Published: 29-07-2026
Volume 11, Issue 3, 2026, Page No. 23-25

Distribution and analysis of the heavy metals in well water of Mathura district of U.P.(India)

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Abstract
Well water for residents around the TPA is the main source of water for the community because all water needs are met from well water, whether for drinking, cooking, bathing, washing, feeding livestock and other needs. Any change in water quality due to the influence of leachate from the TPA will affect well water users, especially for their health. People in this environment are very at risk of health problems, especially due to soil pollution from leachate from the landfill. This research aims to determine the distribution of lead (Pb), mercury (Hg) and copper (Cu) metal content in community wells around the Goverdhan, Chhata landfill in Mathura district of U.P.(India). This research method is to apply exploratory descriptive method. The results of the measurement of metal content were then analyzed by comparing the measurement result data with quality stones concerning Requirements for Drinking Water Quality and Government Regulation concerning Management of Water Quality and Control of Water Pollution in Class I. The concentration of Hg in well 1 and well 2 is <0.0004 mg/L. While the threshold set by the government is 0.001 mg/L and 0.002 mg/L. The concentration of lead metal (Pb) in well 1 and well 2 is <0.003 mg/L, while the quality standards set by the government are 0.01 mg/L and 0.03 mg/L. The measurement of the concentration of copper metal (Cu) in well 1 and well 2 is <0.006 mg/L, while the quality standards set are 2 mg/L and 0.02 mg/L. The metal content test results showed that all the wells were still below the established quality standards.

Keywords: AAS, Cu, Hg, Pb, heavy metals, well water, Mathura, India

Introduction

The requirements for the quality of drinking water must comply with the provisions contained in the Decree of the Minister of Health of the Govt. of India, where each component contained in drinking water must comply with the stipulated regulations / requirements. Drinking water as an essential need also has the potential to transmit diseases, poisoning. According to the Ministry of Health, Govt. of India drinking water must meet health requirements that have been determined by the maximum limit. Drinking water parameters are divided into several parts, including the following: physical parameters include odor, amount of dissolved solids, turbidity, taste, temperature and color [1]. Chemical parameters include mercury, barium, iron, cadmium, chloride, chromium, manganese and others. Biological parameters include coliform, pathogenic bacteria and viruses. Radioactivity parameters, including α and β rays [2].

To meet the community's need for clean water for drinking, water treatment is carried out from water sources, one of which is well water. Well water can be classified into shallow groundwater (0 - 40 m) and deep ground water (> 40 m). Generally, people use well water that comes from shallow groundwater. The decline in groundwater quality is indicated by the detection of several heavy metal pollutants such as chromium (Cr), copper (Cu), mercury (Hg), lead (Pb) and other metals from industrial waste, landfills (TPA), and use of fertilizers. Excessive and domestic waste is categorized as a source of direct contaminants, while the source of indirect contaminants is the seepage of surface water that enters groundwater or the atmosphere in the form of rain [3].

Waste management in Indonesia is a real problem in line with the increasing population growth rate which results in an increase in the amount of waste produced. Therefore, this problem means that waste must be managed properly. An example of a landfill in Indonesia is the Goverdhan and Chhata landfill in Mathura District India, which still uses the Open Dumping method. Around this TPA there are residential areas less than 200 meters away, and there is also the Yamuna river. It was conducted research on the Yamuna river water which is flowed by leachate from the Goverdhan, Chhata landfill, this research proves that the river water has been contaminated with heavy metals Cu [4].

Heavy metals are divided into two types, namely, essential heavy metals which are metals in certain amounts that are needed by organisms. However, these metals can cause toxic effects if in excessive amounts, for example Zn, Cu, Fe, Co, Mn, and others. Non-essential heavy metals are metals whose benefits are unknown in the body, even if they are toxic, for example: Hg, Cd, Pb, Cr, and others. The presence of heavy metals in the landfill is very dangerous to the environment around the landfill because these heavy metals are toxic. Heavy metals that come from leachate have the potential to seep into the soil which will contaminate groundwater. If this heavy metal has polluted ground water, it will pollute wells around the population which are generally used by residents for their daily needs.

The results[5] of stated that the lead content in the monitoring well water of the Mathura TPA on average 0.152 ppm with a maximum limit of 0.05 mg / l and an average leachate pool content of 0.141 ppm with a maximum limit of 0.1 mg / l. The results of research [6] stated that the content of cadmium (Cd) in pond 1 was 0.029 ppm, pool 2 was 0.044 ppm, pool 3 was 0.045 with a maximum limit of 0.010 mg / l and content mercury (Hg) in pool 2 was 0.013 ppm, pool 3 was 0.021 ppm with a maximum limit of 0.001 and the monitoring wells were all contaminated with Cd but not Hg. The results of showed[7] that the lead content in the dug wells of residents around the Mathura TPA was 26.9% exceeding the quality standard and the results of research stated that the cadmium content in the dug wells around the Mathura TPA was 80% exceeding the environmental quality standard.

Therefore, the potential for groundwater contamination by heavy metals is very likely to occur. Therefore, this research is important to do to determine the level of heavy metal concentration in groundwater. The purpose of this study was to identify the level of heavy metal concentration (Cu, Pb, and Hg) in the well water around the Goverdhan Chhata landfill. The expected benefit from this research is an effort to control groundwater pollution caused by the Goverdhan Chhata landfill and as a material for recommendations and considerations for the local government, regarding the feasibility of the Goverdhan Chhata landfill location in Goverdhan Chhata Village of Mathura District, U.P. (India).

Materials and Method

Time and Location of Research: This research was conducted for 3 months starting from February-April 2022. The research sample was taken in Goverdhan Chhata Village, Mathura District U.P. (India). Testing of heavy metal levels (Pb, Cu and Hg) was carried out at Research Laboratory, Mathura, U.P. (India).

Tools and Materials: The tools used in this study were the atomic absorption spectrophotometer (AAS), 300 mL white plastic bottles, 10 ml and 50 mL volumetric pipettes, volumetric flasks, Erlenmeyers, vacuum devices, 0.45 µm membrane filters, and analytical scales. The materials in this study were dug well water, distilled water, HNO3 (p), HNO3 0.05M, HNO3 5%, Pb, Cu and Hg metals, aethylene gas. (SNI 6989.8-2009; SNI 6989.6-2009 and SNI 06-2462-1991).

Research Procedure

Sampling Technique: The sampling technique for the well water test was purposive sampling by considering the distance between the well and the TPA. The test samples were taken from 2 points with a distance of 100 meters and 300 meters from the landfill. Water samples were taken by varying the depth of the well, namely the bottom, middle and top, so that the analyzed water sample is expected to represent the water body. Water samples were taken 300 ml with a white plastic bottle. Before being taken to the laboratory, water samples were preserved by adding concentrated HNO_3 to pH <2.

Analysis of Metal Content in Samples with AAS: The determination of Pb, Cu and Hg metal content in the sample was carried out according to the SNI 6989.8-2009 procedure; SNI 6989.6-2009 and SNI 06- 2462-1991. 50ml of sample was put into 100 ml Erlenmeyer, added 5ml of concentrated HNO_3 then covered with a funnel. It is heated slowly until the remaining volume is 15ml-20ml, if the digestion is not complete (not clear) then add another 5 ml of concentrated HNO_3 then cover and heat again (not boiling) until all the metal dissolves. Pb, Cu and Hg levels were tested by testing the test samples one by one into the AAS device with a wavelength of 283.3 nm. Furthermore, the metal absorption of Pb, Cu and Hg was carried out.

Data Analysis: Measurement of heavy metal levels of Pb, Cu and Hg in well water obtained from the test results is then compared with the standard well water quality standards set by the Government, concerning Drinking Water Quality Requirements and Government Based on the measurement results, the concentration of Lead, Copper and Mercury in the dug well water of the respondents in this study concerning Management of Water Quality and Class I Water Pollution Control. Environmental lead is a bound particle with low mobility and bioavailability. Lead is not an essential substance for living things. Lead can cause biological effects that vary with dose and duration of exposure. The impact can only be in the form of enzyme inhibition that causes morphological changes to the most severe in the form of death. Children are more susceptible to the adverse effects of lead than adults [8]. The effects that can occur due to lead exposure are anemia, increased blood pressure, kidney damage, decreased IQ in children, decreased sperm motility movement and pregnancy disorders. However, lead has not been shown to cause cancer. The lead content in surface water and groundwater depends on the source of the pollutant. Lead found from water can be sourced from waste materials for batteries, ammunition, metal products (sheet metal, solder and pipes), medical equipment (radiation protection and surgical instruments), paints, ceramics, scientific / practical equipment [9].

Results and Discussion

Lead, Copper and Mercury in Dug Well Water: Meet the quality standards of Permenkes 492/ Menkes Per /IV/2010 Government regulation and results are shown in Table-1.

Table 1: Measurement results of heavy metals in well water 1 and 2.

Parameter	Test Results		
	Results	**Unit**	**Method**
Mercury	<0,0004	mg/L	SNI 6989.8-2009
Lead	<0,003	mg/L	SNI 6989.8-2009
Copper	<0,006	mg/L	SNI 06-2462-1991

Biologically and chemically mercury can be transformed into methyl mercury and dimethyl mercury. Methyl mercury has bio accumulative properties while dimethyl mercury is volatile and can move to very far. Mercury and its compounds are heavy metals that are highly toxic to humans. Mercury's toxicity depends on the type of mercury. In general, organic mercury is more dangerous than the inorganic form. Mercury can cause central nervous system disorders such as mental retardation, deafness, blindness, speech problems and kidney damage [10].

The presence of the element copper (Cu) in nature can be found in the form of free metals, but is more commonly found in compounds. Cu is included in the essential metal group, where in low levels it is needed by organisms as a coenzyme in the body's metabolic processes, its toxicity only appears in high levels concentration of 0.01 ppm phytoplankton will die because Cu inhibits enzyme activity in phytoplankton cell division. Cu concentrations in the range of 2,5-3,0 ppm in water bodies will kill fish[11]. The waste management system at the Goverdhan Chhata landfill can potentially pollute groundwater because the garbage dumped in the TPA will rot along with rainwater and will produce leachate. Copper (Cu) content in waste and leachate can easily spread following the movement of water flow in the soil and Results are given in Table-2 and Table-3.

Table 2: Water Quality Standards Class I

Parameters	Highest Levels	
	Value	**Unit**
Mercury	0,001	mg/L
Lead	0,03	mg/L
Copper	0,02	mg/L

Table 3: Requirements for Drinking Water Quality.

Parameters	Highest Levels	
	Value	**Unit**
Mercury	0,001	mg/L
Lead	0,01	mg/L
Copper	2	mg/L

The concentration of Pb in well water table-1 and 2 from the test results is <0.003 mg/L, this value is still below the threshold set by the government, namely 0.03 mg/L and 0.01 mg /L. The results of measuring Cu metal content also showed that the Cu metal content was still below the established threshold, namely <0.006 mg/L, while the threshold levels were 0.02 mg/ L and 2 mg/L. Furthermore, the results of measuring the Hg metal content are <0.0004 mg/L, this value is still below the threshold set by the government, namely 0.001 mg/L. The threshold that becomes the reference in comparing the level of heavy metal pollution is Government Regulation Number 82 Year 2001 and Permenkes 492/Menkes/Per/IV/2010. The results showed that the condition of the well water of the residents around the Goverdhan Chhata landfill has not experienced heavy metal pollution, but if the open dumping method is still applied to the Goverdhan Chhata landfill, it will damage the surrounding environment.

Conclusion

Based on the research that has been done, it can be concluded that the metal content of Copper (Cu), Tmbal (Pb) and Mercury (Hg) in dug 1 well water and 2 dug well water around the Goverdhan, Chhata landfill of Mathura District, U.P. (India) if viewed from the parameters the metal content has not crossed the threshold. for drinking water purposes, in other words, it can be categorized as clean water because it does not pass the threshold levels as clean water and drinking water, where the threshold for Pb (0.03 mg/L and 0.01 mg/L), for Cu metal (0.02 mg/L and 2 mg/L) and for Hg metal (0.001 mg/L).

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