Assessment of Physiochemical Parameter of Illegitimate Dumping Sites of Alibaug, Raigad District, Maharashtra, India

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ABSTRACT

Study physicochemical parameters of groundwater in surrounding area of illegitimate dumping site of Alibaug town by taking water samples from three different stations. The study was carried out by collecting groundwater samples near to dumpsite Koliwada east area (hand pump), Ramnath lake (motor operated) dumping site and Koliwada township area (hand pump) during June 2017- October 2017. The results were compared with standards prescribed by WHO and BIS. Total 19 parameters were analyzed. It was found that the underground water was contaminated and not at all within the standards of WHO (2012) and BIS (2012).

Keywords— Illegitimate dumping yard, Physiochemical parameters, Alibaug dumping site

1. INTRODUCTION

The by-product of drastic development and transformation in behaviour of human action is creating a corpus of solid waste which is creating unease position in world and India. Per capita resource consumption in urban areas of India is more related to rural areas of India which is also producing the waste in the same proportion. Wastes placed in landfills are subject to either groundwater underflow or infiltration from precipitation and as water percolates through the waste, it picks up a variety of inorganic and organic compounds, flowing out of the wastes to accumulate at the bottom of the landfill. The resulting contaminated water is termed 'leachate' and can percolate through the soil. Municipal landfill leachate are highly concentrated complex effluents which contain dissolved organic matters; inorganic compounds such as ammonium, calcium, magnesium, sodium, potassium, iron, sulphates, chlorides and heavy metals such as cadmium, chromium, copper, lead, zinc, nickel; and xenobiotic organic substances. Leachate varies widely in composition depending on many interacting factors such as the composition and depth of waste, availability of moisture and oxygen, landfill design, operation and age. [1]

Improper solid waste management (SWM) is a major environmental concern due to the absence of modern engineered landfills, therefore posing serious contamination risk to both groundwater and surface water. Landfills are considered one of the major threats to groundwater. The scale of this threat depends on the concentration and toxicity of contaminants in leachate, type and permeability of geologic strata, depth of water table and the direction of groundwater flow. Groundwater is the major source of potable water supply in India and in the study area (Alibag) and its contamination is a major environmental and health concern. This study was therefore undertaken with the objective of assessing the possible impact of municipal solid waste on groundwater quality in the vicinity of an MSW landfill at Alibag. [2]

2. METHODOLOGY

The Primary data will be obtained from all the three illegitimate sites i.e. dumping site Koliwada east area, Ramnath lake dumping site and Koliwada township area dumping ground and Alibaug Nagar Parishad and correlated with the present investigation. The research work includes the efforts for study of comparative analysis of physiochemical parameters of all three illegal sites. Initially samples will be collected at various locations and the data analysis & reporting will be done on the bases of data obtained on investigation.

2.1 Location of Samples

Details of the sampling points are presented in Table 1.

Table 1: Site specification for groundwater samples

Sr. No.	Sampling Location	Type	Depth (m)	Nearby Dumping Site	Distance from landfill site (Km)
1.	Dairy Farm	Hand Pump	09	Near Koliwada East	0.8
2.	Ramnath Colony	Motor Operated	19	Ramnath LakeWater Dumping Yard	0.4
3.	Poultry Market	Hand Pump	08	Koliwada Township Water Dumping Yard	1.0

2.2 Collection and Transportation of Samples

The samples were collected in plastic bottle of two litter capacity without any air bubbles as per standard procedure. The water samples were collected from the sampling location in acid-cleaned plastic bottles and immediately transferred to the lab and were store in cold room (4 ^{o}C). [3]

As the distance of various sample locations are quite enough distant, so samples were not collected on the same day.

2.3 Physiochemical Parameters

All the samples were analysed for selected relevant physico-chemical parameters, heavy metals according to standard accepted procedures as per IS: 3025 and standard methods of APHA, 2005. All the water quality parameters studied in the project are specified with the method used to determine the parameters are mentioned in Table 2.

Table 2: Physiochemical Parameters and Methods Adopted for the Analysis

Sr. No.	Analysis Parameters	Method used
01	Potential of Hydrogen	pH meter, IS: 3025 (part – 11 – 2): Reaff. 2012
02	Chemical Oxygen Demand	IS: 3025 (part – 58): Reaff. 2014
03	Biochemeical Oxygen Demand @ 27 ºC, 3 days	IS: 3025 (part – 44): Reaff. 2014
04	Oil and Grease	IS: 3025 (part – 39- 5): Reaff. 2014
05	Turbidity	Nephelometer, IS: 3025 (part – 10): Reaff. 2012
06	Conductivity	Conductivity meter IS: 3025 (part – 14): Reaff. 2013
07	Total Dissolved Solids	Gravimetric Metrhod, IS: 3025 (part – 16): Reaff. 2012
08	Total Hardness	Titrimetric Method, IS: 3025 (part – 21- 2): Reaff. 2014
09	Calcium	Titrimetric Method, IS: 3025 (part – 40- 5): Reaff. 2014
10	Magnesium	Titrimetric Method, IS: 3025 (part – 46- 6): Reaff. 2014
11	Total Alkalinity	Titrimetric Method, IS: 3025 (part – 23): Reaff. 2014
12	Chloride	Titrimetric Method, IS: 3025 (part – 32- 2): Reaff. 2014
13	Sulphate	Spectrometer, IS: 3025 (part – 24- 4): Reaff. 2014
14	Iron	Spectrometer, IS: 3025 (part – 53- 6): Reaff. 2014
15	Lead	Atomic Absorption, APHA 3111 - D
16	Zinc	Atomic Absorption, APHA 3111 - D
17	Dissolved Oxygen	Atomic Absorption IS: 3025 (part – 44): Reaff. 2003
18	Mercury	Atomic Absorption, APHA 3111 - D
19	Nitrate	IS 3025 (Part 34): Reaff. 2014

The collected samples were transfer to the laboratory on the same day with necessary precautionary measures for their physicochemical analysis. The pH, Turbidity, Conductivity were determined by pH meter, by Nephelometer and conductivity meter. MSW was analysed for total Dissolved solid, total hardness, calcium, magnesium, total alkanity. TDS was analysed by gravimetric method and Total hardness, Ca, Mg, total alkanity, Cl by titrimetric method. Spectrophotometer (by BaCl2 method) was used for sulphate and Iron analysis. COD and BOD were determined at 27 ºC for 03 days condition by IS: 3025(Part-58): Reaff. 2014 and IS: 3025(Part-44): Reaff. 2014 method. By using atomic absorption method Lead, Zinc and Mercury were examined.

2.4 Drinking Water Specifications IS 10500: 2012 and WHO (2012)

Being a basic need of human development, health and well-being, safe drinking water is an internationally accepted human right (WHO, 2001). It is necessary to know details about physico-chemical parameters, in this section drinking water Specifications of all the parameters studied in project as per IS-10500 : 2012 and WHO (2012) are given in the Table 3.

Table 3: Drinking Water Specifications IS 10500: 2012 and WHO (2012)

Sr. No.	Water Quality Parameter	IS 10500: 2012	WHO (2012)
1.	pH	6.5 – 8.5	7.5 – 8.5
2.	COD (mg/lit)	NS	NS
3.	BOD (mg/lit)	NS	NS
4.	Oil and Grease (mg/lit)	NS	NS
5.	Turbidity (NTU)	5	5
6.	Conductivity (µS/cm)	300	300
7.	Total Dissolved Solids (mg/lit)	500	500
8.	Total Hardness (mg/lit)	200	200
9.	Calcium (mg/lit)	75	75
10.	Magnesium (mg/lit)	30	50
11.	Total Alkalinity (mg/lit)	200	200
12.	Chloride (mg/lit)	250	200
13.	Sulphate (mg/lit)	200	200
14.	Iron (mg/lit)	0.3	0.3
15.	Lead (mg/lit)	0.01	0.01
16.	Zinc (mg/lit)	5	NS
17.	Dissolved Oxygen (mg/lit)	NS	NS
18.	Mercury (mg/lit)	0.001	0.006
19.	Nitrate (mg/lit)	45	NS

Note: - NS: Not specified

3. ANALYSIS AND RESULT

Water samples were collected from three different locations that is Dairy farm (near Koliwada east) which is 0.8 km from Koliwada dumping yard area, Ramnath Colony which is 0.4 km apart from Ramnath lake dumping yard and Poultry market (near Koliwada Township) area which are close Koliwada township dumping yard area. Water sample were collected from June 2017 to October 2017. Samples were occupied in 2 liter capacity pre-cleaned plastic bottles. Analysis was carried out for various water quality parameters such as Potential of Hydrogen (pH), Chemical Oxygen Demand (COD), Biochemeical Oxygen Demand (BOD), Oil and Grease, Turbidity, Conductivity, Total Dissolved Solids (TDS), Total Hardness(as CaCO3), Calcium (Ca), Magnesium(Mg), Total Alkalinity, Chloride (Cl), Sulphate, Iron (Fe), Lead (Pb), Zinc (Zn), Dissolved Oxygen (DO), Mercury (Hg). The reagents used for the analysis were AR grade and double distilled water was used for preparation of solutions. Out of three samples two samples are hand pump and one sample is from motor

operated as specified in methodology part. The result arrived after laboratory testing is tabulated in Table 4.

Table 4: Ground Water Quality Analysis of Illegitimate Sites

Water Quality Parameter	Koliwada East	Ramnath Lake Water	Koliwada Township Water
pH	7.64	7.11	7.02
COD (mg/lit)	1620.32	186.82	895.16
BOD (mg/lit)	63.4	78.15	395.8
Oil and Grease (mg/lit)	7	8	19
Turbidity (NTU)	3050	68	208
Conductivity (µS/cm)	2695	385	1692
TDS (mg/lit)	1620	232	1210
Total Hardness (mg/lit)	720	131.84	319.3
Calcium (mg/lit)	272	32.96	57.68
Magnesium (mg/lit)	9.6	11.87	42.02
Total Alkalinity (mg/lit)	830	144.3	458.25
Chloride (mg/lit)	334.75	26.4	240.46
Sulphate (mg/lit)	71.77	3.54	6.51
Iron (mg/lit)	313.13	16.07	489.79
Lead (mg/lit)	ND	ND	ND
Zinc (mg/lit)	0.22	0.93	0.97
DO (mg/lit)	<1	<1	<1
Mercury (mg/lit)	ND	ND	ND
Nitrate (mg/lit)	ND	ND	ND

On the basis of result obtained from analysis of physicochemical composition of groundwater samples are presented in below section.

pH:- The pH value of water is very important indicator of its quality. The pH values of water are controlled by the amount of dissolved carbon dioxide, carbonate and bicarbonates. pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. The pH values of water samples varies between 7.02 to 7.64 and were found within the limit prescribed by BIS and WHO.

Chemical Oxygen Demand (COD):- Is an indicative measure of the amount of oxygen that can be consumed by reactions in a sample solution. It is commonly expressed in mass of oxygen consumed over volume of solution which in SI units is milligrams per litre (mg/L). A COD test can be used to easily quantify the amount of organics in water. The concentration of COD varied from 186.82 mg/l to 1620.32 mg/l. High COD value in ground shows the presence of oxidizable organic materials that had leached from domestic refuse in the landfill site [4]

The leachate generated at the landfill site carries considerable amount of organic matter, percolated through the soil and entered into ground water showing increase in COD value. Ground free of dissolved oxygen tend to dissolve iron and manganese from the geological strata of the aquifer material and also ground waters with depleted oxygen promote the conversion of sulphate to H_2S which is highly obnoxious. High COD concentration in ground water samples indicates the presence of organic contaminants in the water to a large extent. Such a high value of COD symbolizes a direct leakage of leachate into the underground water.

Biochemeical Oxygen Demand (BOD):- Also known as biological oxygen demand is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. The BOD value in this study has been expressed in milligrams of oxygen consumed per litre of sample during 3 days of incubation at 27 °C. BOD concentration of these three samples is ranged from 63.4 mg/l to 395.8 mg/l. The leachate generated at the landfill site carries

considerable amount of organic matter, percolated through the soil and entered into ground water showing increase in BOD value. Ground free of dissolved oxygen tend to dissolve iron and manganese from the geological strata of the aquifer material and also ground waters with depleted oxygen promote the conversion of sulphate to H_2S which is highly obnoxious. High BOD concentration in ground water samples indicates the presence of organic contaminants in the water. Such a high value of COD signifies a direct leakage of leachate into the underground water.

Oil and Grease: - Oil and grease is also a major threat to surface and ground water through infiltration and seepage, thereby reducing the quality of the affected resources. Oil and grease on land are more readily containable but is also deadly due to infiltration which could percolate the underlying soil layers and thereby contaminating the groundwater. Oil and grease concentration is ranged from 7 mg/l to 19 mg/l. it has been observed that the concentration is very high in the sample taken nearby GCB township area which shows that the underground water is not only influenced by dumping site but also by the nearby small scale grease industry in surrounding area.

Turbidity: - Turbidity in water is the reduction of transparency due to the presence of particulate matter such as clay or slit, finely divided organic matter etc. These can cause light to be scattered or absorbed rather than transmitted in straight lines through the sample. The turbidity was due to the colloidal fine dispersion of suspended solids. Some microorganism might also contribute the turbidity. In present study turbidity was found between 208 NTU to 3050 NTU. The values were found with high values than that prescribed by IS: 10500

Conductivity: - The conductivity values varied between 385 µs/cm to 2695 µs/cm. Electrical conductivity gives an idea about the concentration of ions in solution that determines the quality of water for drinking and irrigation purposes. The sample collected near GCB township area shows very higher EC value. It was noticed that groundwater samples collected at near GCB township area station contain more soluble salts.

Total Dissolved Solids (TDS):- TDS is generally considered not as a primary pollutant, but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants. Total dissolved solids indicate the salinity behavior of groundwater. TDS of ground water is mainly due to vegetable decay, evaporation, disposal of effluent and chemical weathering of rocks and inappropriately discarding of municipal solid waste. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500 mg/L is also allowed. The amount of Total Dissolved Solids varied from 232 mg/lit to 1620 mg/L which with the permissible limit of BIS (2013).

Total Hardness: - Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water. Hardness is one of the important properties of groundwater from utility point of view for different purposes. In ground water, hardness is primarily due to presence of carbonates, bicarbonates, sulphates and chlorides of calcium and magnesium. For potable water the TH should be limited up to 300 mg/L and maximum permissible value is 600 mg/L. If the hardness is less than 50 mg/l the water will be soft. If the hardness is from 50 mg/lit to 100 mg/l, the water will be moderate soft. If the hardness is from 101 mg/lit to 200 mg/l and more than 200 mg/l, the water will be slightly hard and quite hard, respectively. In the analysis total hardness values were ranged between 131.84 to 720 mg/L. All the samples are within the permissible limit of BIS accept sample collected from GCB township area. Again the study confirmed the excess quantity of hardness creating cations and anions were present in and around the water samples.

Calcium: - Calcium is the most abundant of the alkaline earth minerals. Calcium is directly related to hardness. The concentration up to 100 mg/l of calcium is capable of forming scales in pipes and boiler; fortunately it has no adverse physiological manifestation on human system. Calcium is the third most abundant metal in the earth's crust. Excess of ca ions causes concretions in the kidney and causes irritation and pain in the urinary passages. The Ca concentration was ranged between 57.68 mg/lit – 272 mg/lit and found below permissible limit, except the sample collected from near Koliwada East.

Magnesium: - The WHO standards prescribed the limit for the presence of magnesium in water is 50 mg/l. But the water samples collected over the GCB township area crosses the limit and the values were given in the Table 4. The

concentration of magnesium ranged between 9.6 to 42.02 mg/l. The values found below permissible limit of International standard.

Total Alkalinity: - Alkalinity of water is its capacity to neutralize a strong acid and it is normally due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium. Total alkalinity values for all the investigated samples were found between 144.3 mg/l to 830 mg/l and it is within the maximum permissible limit of BIS except the sample collected from Koliwada East area.

Chloride: - Chloride is naturally occurring anion found almost in all types of water. Chloride is the major constituent of earth's crust but a major dissolved constituent of most natural waters. The presence of chloride in large amounts may be due to natural processes, or it may be an indication to pollution from seawater or industrial or domestic. Chloride is a good indicator of sewage and manure inputs & has been extensively used to identify sources of contamination from anthropogenic activities. Chlorides are not usually harmful to people however, the sodium part of table salt has been linked to heart and kidney disease. Sodium chloride may impart a salty taste at 250 mg/L. People accustomed to higher chloride in water are subjected to laxative effects. In the present analysis, chloride concentration was found in the range of 26.4 mg/L to 334.75 mg/L. The values found below permissible limit.

Sulphate: - Sulphate can be found in almost all natural water. The origin of most sulphate compounds is the oxidation of sulphite ores, the presence of shales, or the industrial wastes. Sulphate is one of the major dissolved components of rain. High concentrations of sulphate in the water we drink can have a laxative effect when combined with calcium and magnesium, the two most common constituents of hardness. The Sulphates concentration of groundwater samples ranged between is 3.54 mg/L to 71.77 mg/L and found within the prescribed limit.

Iron: - High iron concentrations generally cause a bitter and astringent taste. It also clogs and pits pipes, discolours clothes and plumbing fixtures and causes scaling which encrusts pipes. The values for all the investigated samples were found to be in the range of 16.07 mg/L to 489.79 mg/L which is very high as compare to the permissible limit of BIS and WHO (i.e. 0.3 mg/L). The high iron concentration is possibly due to rusty pumps and reduced condition in the aquifer and the high concentration of metal present the solid waste.

Lead: - Lead can enter drinking water when service pipes that contain lead corrode, especially where the water has high acidity or low mineral content that corrodes pipes and fixtures and even through the sewage from dumping yard in the form of leachate seepage into ground water. Lead is a toxic metal that is harmful to human health; there is no safe level for lead exposure. The degree of exposure depends on the concentration of lead, route of exposure, current medical condition, and age. It has been estimated that up to 20 % of the total lead exposure in children can be attributed to a waterborne route, i.e., consuming contaminated water. The permissible limit BIS and WHO (i.e. 0.01 mg/L). In the study area analysis the lead has not been detected.

Zinc: - Zinc is an essential mineral, including to prenatal and postnatal development. Zinc deficiency affects about two billion people in the developing world and is associated with many diseases. In children, deficiency causes growth retardation, delayed sexual maturation, infection susceptibility, and diarrhoea. Consumption of excess zinc can cause ataxia, lethargy and copper deficiency. The concentrations of Zn are between 0.22 mg/L to 0.97 mg/L and found within the prescribed limit.

Dissolved Oxygen: - Dissolved oxygen is important parameter of water quality assessment and reflects the physical and biological processes prevailing in the water. The DO values indicate the degree of pollution in water bodies. In the analysis all the samples, the concentrations of DO in ground water collected around the Govind Bandar dump yard were very low (i.e. < 1) than the permissible limit.

Mercury: - Naturally occurring mercury has been widely distributed by natural processes such as volcanic activity. The use of mercury in industrial processes is also significantly increased. The solubility of mercury compounds in water varies: elemental mercury vapour is insoluble, mercury chloride is readily soluble and mercury sulphide has a very low solubility. The permissible limit BIS and WHO are 0.001 mg/L and 0.006 mg/L respectively. In the study area analysis the mercury has not been detected.

Nitrate: - Groundwater contains nitrate due to leaching of nitrate with the percolating water. Groundwater can also be contaminated by sewage and other wastes rich in nitrates. It is one of the most common groundwater contaminant. The excess levels can cause methemoglobinemia, or "blue baby"

disease. Although nitrate levels that affect infants do not pose a direct threat to older children and adults, they do indicate the possible presence of other more serious residential or agricultural contaminants, such as bacteria or pesticides. The permissible limit for the nitrate is 45 mg/L. The concentration of nitrates in groundwater samples was not detected.

4. CONCLUSIONS

Alibaug town is generating more than 7 MT of waste per day, and the quantity of waste is considerable as compare to extent & development of city. In the study it has been found out that illegitimate landfill facility for disposal of waste is contaminating the ground water of surrounding area. Analysis of water samples to determine the physiochemical parameters of ground water and possible impairment due to incongruous discarding the municipal solid waste in dumping yard.

Although, in case of illegal dumping site (near Koliwada east, near Ramnath lake water, near Koliwada township area) the concentrations of few contaminants like COD, BOD, turbidity and Iron exceeded drinking water standard even then also the ground water quality represent a significant threat to public health and need to be treated. So, It is recommended that the water should be used after proper treatment.

ACKNOWLEDGMENT

I would like to thanks Prof. Chetan More for his truthful and illuminating view on number of issues related to subject. I would like to thank Alibaug officials, rag pickers at landfill site and grampanchayat officials for their co-operation.

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