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Groundwater analysis of Mayiladuthurai, Nagapattinam district, Tamilnadu, India nearby municipal solid waste dumpsite

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Abstract

Ground Water samples from various bore wells of different points from the open dumpsite of Municipal Solid Waste (MSW) of Mayiladuthurai, Tamilnadu, India were taken to find the impact of leachate flow on groundwater quality by physico chemical analysis. Parameters like, Iron, Nitrate, Sulphate, Fluoride, Phosphate, Chemical Oxygen Demand were determined. These values were compared with permissible limit. Higher value were found in water sample near the dumpsite area when compared to other site. Mild to high Iron concentration found in most samples, which are higher than Indian standard limit of 1.0mg. The higher value of COD indicates inorganic chemicals pollute that ground water. Therefore, the soil parameters in study area have some influenced leachate migration.

Keywords: Municipal Solid Waste, Leachate, Groundwater.

Introduction

Municipal solid wastes (MSW) undergo chemical and physical reaction with ground water and rain water to form brownish black colour precipitate called leachate. This leachate discharge into acquifer. The ground water passes through wastes carry organic and inorganic compounds from the wastes and subside at the bottom of the landfill. This poisonous liquid are toxic and defiant. Municipal and industries disposed their wastes born leachate[1]. The decomposition of organic matter take place via anaerobic process produces some additional water, and other hydrocarbon gases like methane, carbon dioxide, higher carbon containing organic acids, aliphatic aldehydes, aromatic alcohols like phenols and sugars, combined in the leachate. The rainwater plays important role in generation of leachate by percolate inside solid wastes. Various chemical and biological reaction takes place[2-4]. Highly concentrated leachate leads to hazardous effect on adjacent soil, subsoil, water bodies, and aquifer along the water table[5]. The percentage of the toxicity composition of the landfill leachate changes with the age of the landfill. The increasing age of landfill leads to decrease in, organic content and increase in ammonical nitrogen concentration. The main stream of leachate to the environment is mainly due to the surface runoff through the unsaturated soil layers to the ground water, by hydraulic current to surface water. Pollution of groundwater also due to discharge of leachate by treatment plants or direct flow of untreated or partially treated leachate[6].

Groundwater is the point source of water supply in this study area and most of the people in the area depend on borewell. Pollution of ground water is a major environmental prosperity. The study of these areas was undertaken with the grail of assessing the most impact of leachate flow on groundwater quality in the nearby nonlined MSW landfill at Anananthandavapuram, Mayiladuthurai.

Study area: Mayiladuthurai is a holistic town situated in Nagapattinam district, in the state of Tamil Nadu. The town is located in the Cauvery delta basin. The area is covered by residential and commercial units, and served by a population of more than a lakh. The landfill is located between 11º6'N latitude and 79º39'E longitude along the coast of Bay of Bengal. The landfill operations were started during the 1983 and till it is being operated. The landfill operations were started over an extent of 4.62acres now extended to more than 10.0 acres. The open dumping site is surrounded by many human dwellings, water bodies and cultivable lands. Nearly 33 to 60tons (based on actual measurement) of Municipal Solid Waste is being dumped per day. Sample have been collected from five places and they are named as Sample 1, Sample 2, Sample 3, Sample 4 and Sample 5 respectively.

Materials and methods

The Analysis was carried out in Anandathandavapuram, Mayiladuthurai, Nagapattinam District. The dumpsite was located in this area. The analysis were carried out during pre-monsoon September. The five samples were taken from different points around dumpsite and collected around 2 liters in sterilized polyethylene bottles, properly labeled with details of the source, date of sampling, time and address and immediately sent to the laboratory within 8 hours to 10 hours for analysis. Water samples were analyzed for various physicochemical parameters as per standard methods.

Results and discussion

The details of the chemical examinations of samples are listed in the Table-1.

Table-1: Chemical examination of sample around MSW dumpsite.

Analysis	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Iron as Fe mg/L	0.47	2.68	0.00	0.32	0.94
Nitrate as NO_3 mg/L	7	3	7	3	5
Fluoride as F mg/L	0.4	0.6	0.4	0.4	0.6
Sulphate as SO_4 mg/L	25	32	31	45	38
Phosphate as PO_4 mg/l	0.36	0.00	0.49	0.62	0.00
COD	24	18	22	22	19

Iron: The observed values of Iron at different points were 0.47, 2.68, 0.00, 0.32, and 0.94 respectively. According to BIS standard for drinking water, these values were above the desirable limits and permissible limit except Sample 3 and Sample 4. The desirable limit and permissible limit for iron is 0.3mg/L. The maximum value was recorded in Sample 2 and water in all this point is non-potable due to exceeds of iron except, Sample 3 and Sample 4.

The maximum permissible limit of Iron value in potable water is 1.0 mg/L. If the value exceeds in drinking water leads to lethal effect. These values were higher than the desirable limit and permissible limit, hence, unfit for drinking[8,9]. The WHO explained the range of Iron values 1 to 3mg/L is permissible in drinking waters above which is disagreeable odor. The presence of Iron changes the ground water colour. The higher values of iron content in drinking water than the prescribed limit leads to goiter for adults[9,10]. The maximum level of Iron in the leachate sample clearly shows that Iron and steel discarded metal for reprocessing are also stored in the site. The unpleasant, dark brownish black color of the leachate is mainly due to the conversion of ferrous to ferric form and the creation of ferric hydroxide sol, combine with humus[11]. Iron values at Sample locations are represented in the Figure-1.

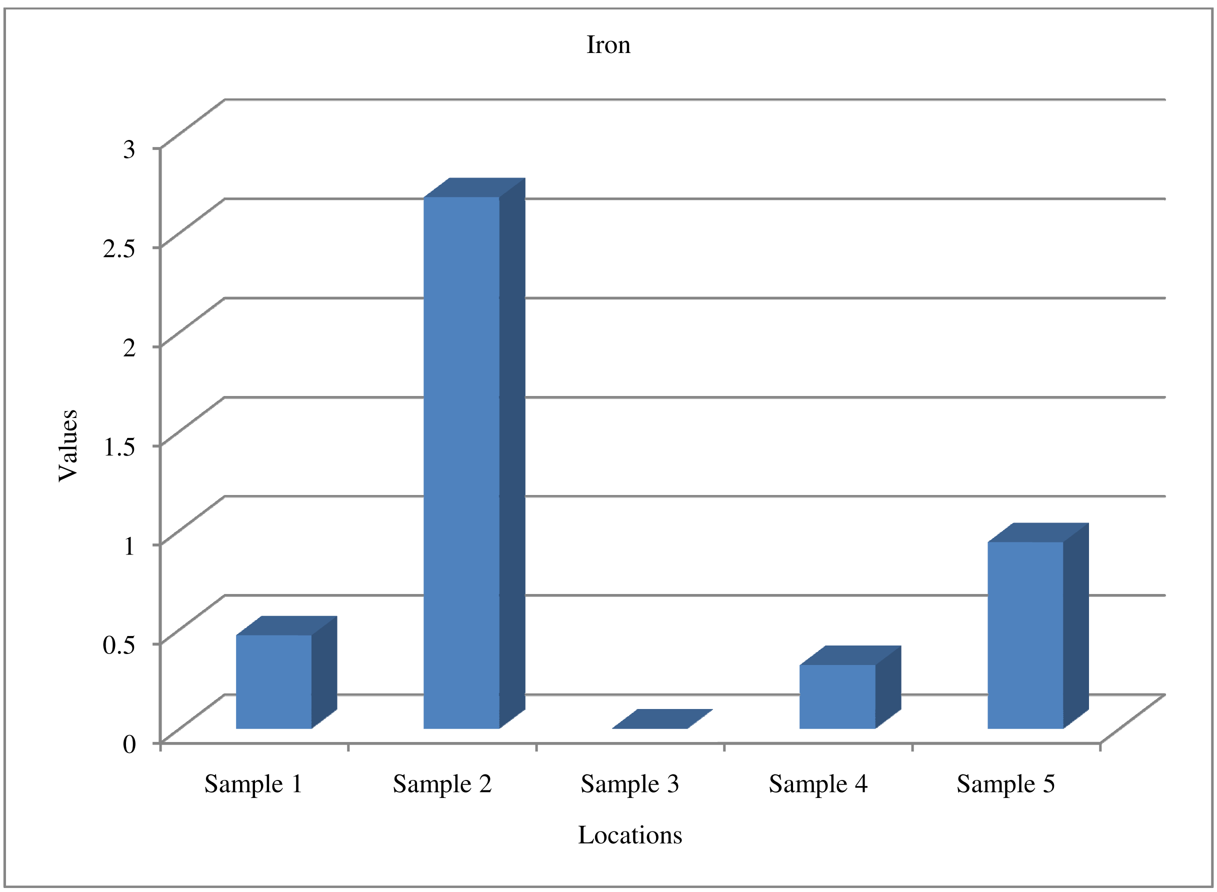

Figure-1: Iron values at Sample locations.

Nitrate: Nitrate is present in rainwater, groundwater and infiltration wells, in the form of N_2 compound (of its oxidizing state). Nitrate is emerging from chemical and fertilizer factories, agricultural fields, domestic sewage. The nitrate was measured by quantity of UVS pectrophotometer. As per IS: 10500-2012, the observed values of Nitrate as NO_3 mg/L were 7,3,7,3,5 respectively. According to BIS standard for drinking water, these values below the desirable and permissible limits. The desirable limit and permissible limit for Nitrate were 45 and 45 respectively. The general flow of Nitrate in water are due the toxic leachates from the landfill sites, due to flow of viscous fluid in which particles move in parallel and constant velocity to adjacent layers[7].

The organic nitrogeneous matter present in municipal solid waste undergo aerobic decomposition, which convert nitrogen compound to nitrate. Only small amount of nitrate is present in natural water. The nitrobacter bacteria present in air converts nitrite to nitrate very quickly. For farm fertilizer and crop production nitrate plays very crucial role. These nitrates are washed by rainfall and enters in groundwater by infiltration, percolation and by seepage, leads to increase in nitrate level, which is unfit for drinking. Nitrate levels also increased by leakage of septic tanks to the soil, leachate flow from non-lined landfills and manure from farm livestock, animal, human wastes. The maximum limit of Nitratein drinking water was in the range 10 mg/L- 50 mg/L. Nitrate concentration level higher than these limits unfit for drinking[12,13].

Nitrate values at Sample locations are represented in the Figure-2.

Fluoride: The desirable limit for fluoride in drinking water is 1.0 and Permissible limit is1.5 mg/l as per. IS: 10500-2012 standard. The recorded value in sampling site were found to be 0.4 to 0.6mg/l. All the samples of Fluoride concentration were comes under the desirable limits. Dental caries was prevented by use of low concentration of fluoride in drinking water. But at the same time high concentration of Fluoride consumption in potable water creates dental fluorosis (tooth mottling) and skeletal fluorosis. The excessive Fluoride absorption by the body occur through only by intake of Fluoride rich content groundwater and crops that grow in Fluoride containing water. Continuous ingestion of excess of Fluoride will cause osteosclerosis, allergies, calcification of tendons and ligaments and bone deformations, affect kidney, abdominal pain, excessive saliva, nausea and vomiting. Sensations and muscular atrophy leads to mongolism.

Fluoride values at Sample locations are represented in the Figure-3.

Sulphate: Sulphate ions are highly soluble in ground water. The ground water contains sulphate ion by the oxidation of sulphur ores, and by the discharge of untreated industrial wastes into the water streams. As per the Indian standard, the desirable limit of sulphate is 200, and permissible limit is 400. The observed values of Sulphate in all the sampling sites comes under both desirable and permissible limit. High concentration of sulphate can cause catharatic action and respiratory illness.

Sulphate values at Sample locations are represented in the Figure-4.

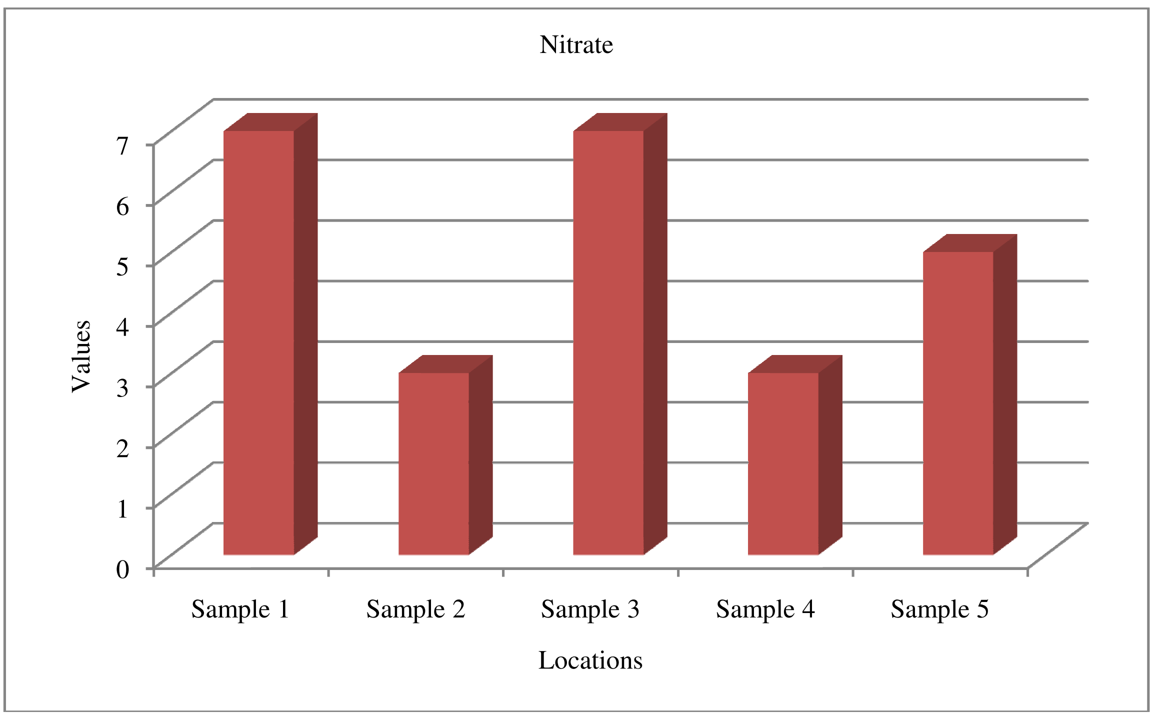

Figure-2: Nitrate values at sample locations.

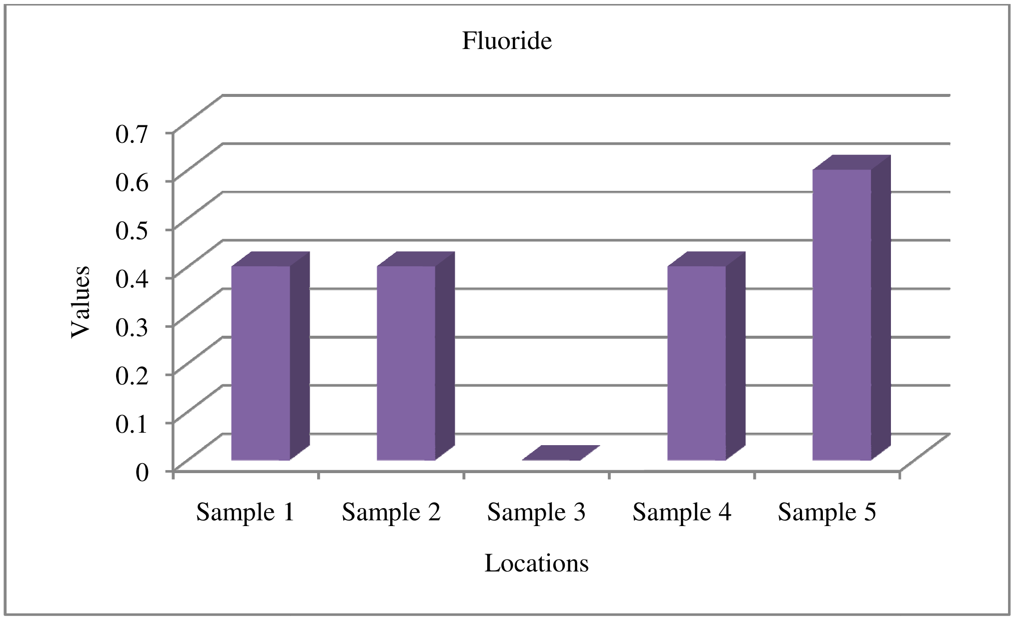

Figure-3: Fluoride values at sample locations.

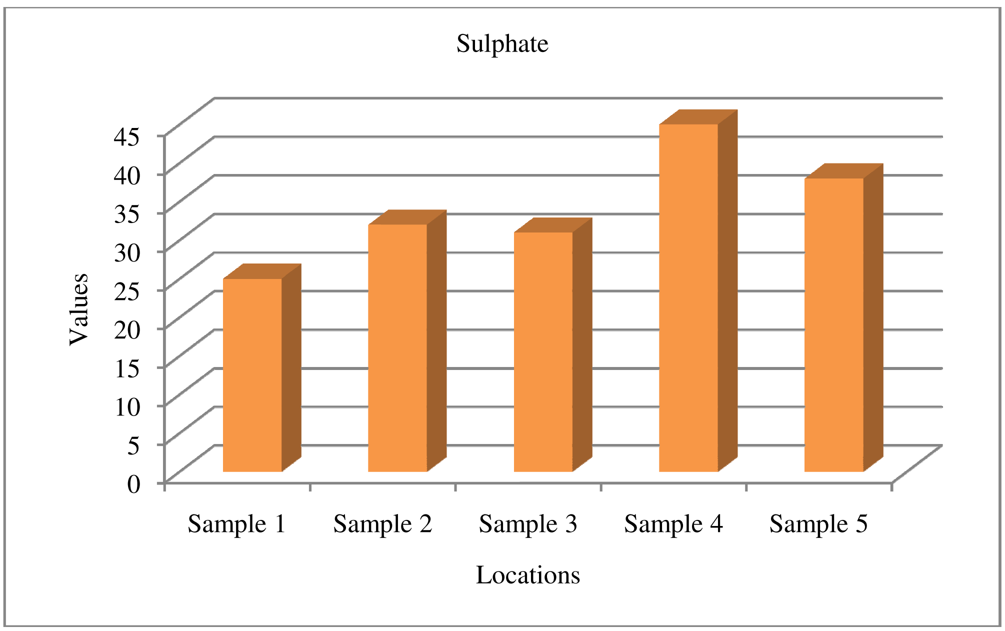

Figure-4: Sulphate values at sample locations.

Phosphate: Phosphorus is an essential plant nutrient. The phosphate ion was less soluble, so the ground water contains very low amount of phosphate as pollutants. The pollution of high level of phosphate in natural water leads to eutrophication[14]. In ground water, the high level of phosphate presence was due to both anthropogenic and agricultural activities. Phosphorus is present in fertilizers diff use into the soil joining the water table by surface runoff. Phosphorus can also move from one place to another with groundwater flows[15]. So the surface water was also contaminated by phosphorous. The high level of phosphorus as phosphate ion affect the groundwater quality. In low levels phosphates are not likely cause any harm to human, but if phosphate is consumed in excess phosgene gas is produced in our gastro intestinal tract on reaction with gastric juice.

Phosphate toxicity in excess cause cellular and tissue injuries higher occurrence of vascular calcification and low level of vitamin D. The recorded values of phosphate in all the points were 0.36, 0.00, 0.49, 0.62 and 0.00 respectively, which comes under permissible limit according to BIS standard.

Phosphate values at Sample locations are represented in the Figure-5.

Chemical oxygen demand: Chemical Oxygen Demand is an important parameter to evaluate the water quality with respect to the presence of organic and inorganic pollutants. Higher COD levels mean a greater amount of oxidizable organic material in the sample, which will reduce dissolved oxygen (DO) levels. During the decomposition of organic matter, oxygen was used and the oxidation of inorganic chemicals such as ammonia and nitrite takes place. The COD levels of the samples were 24, 18, 22, 22, and 19 respectively, the COD values were higher in sample 1 indicates the presence of inorganic chemicals in water table due to migration of leachate from landfills. For drinking water the COD should not exceed 2.5mg/l and potable water with COD of 7.5mg/l. Minimum of COD 18mg/l observed in Sample 2 and the maximum COD 24mg/l was in Sample 1 indicating that the ground water is polluted by in-organic compounds. The max COD level in the groundwater samples varied from 24 to 18 mg/L. COD values at Sample locations are represented in the Figure-6.

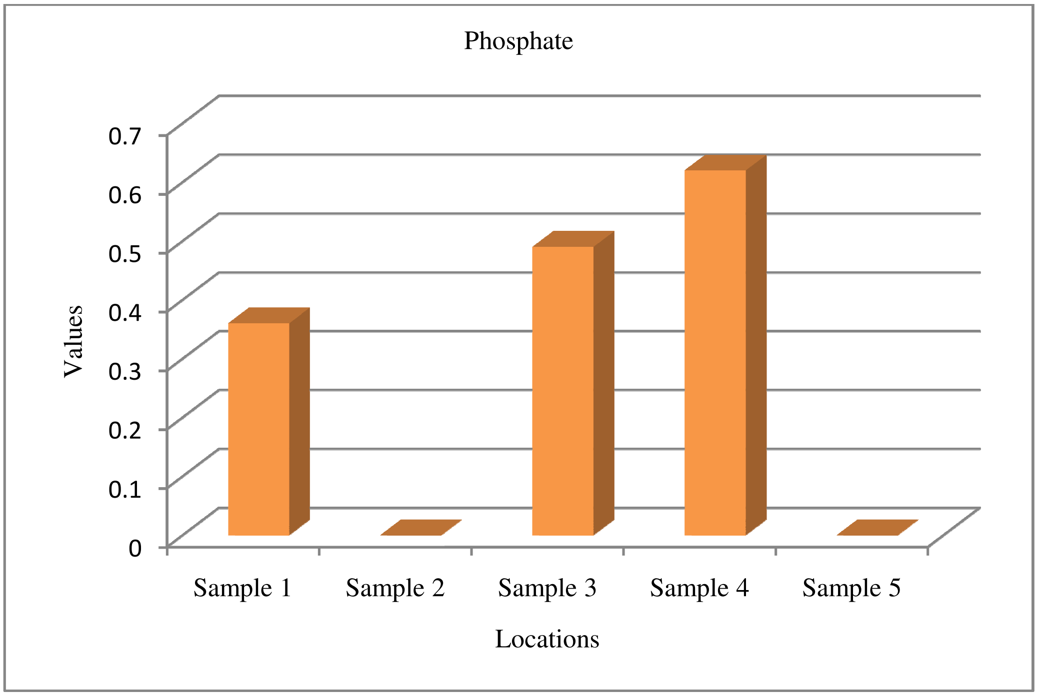

Figure-5: Phosphate values at sample locations.

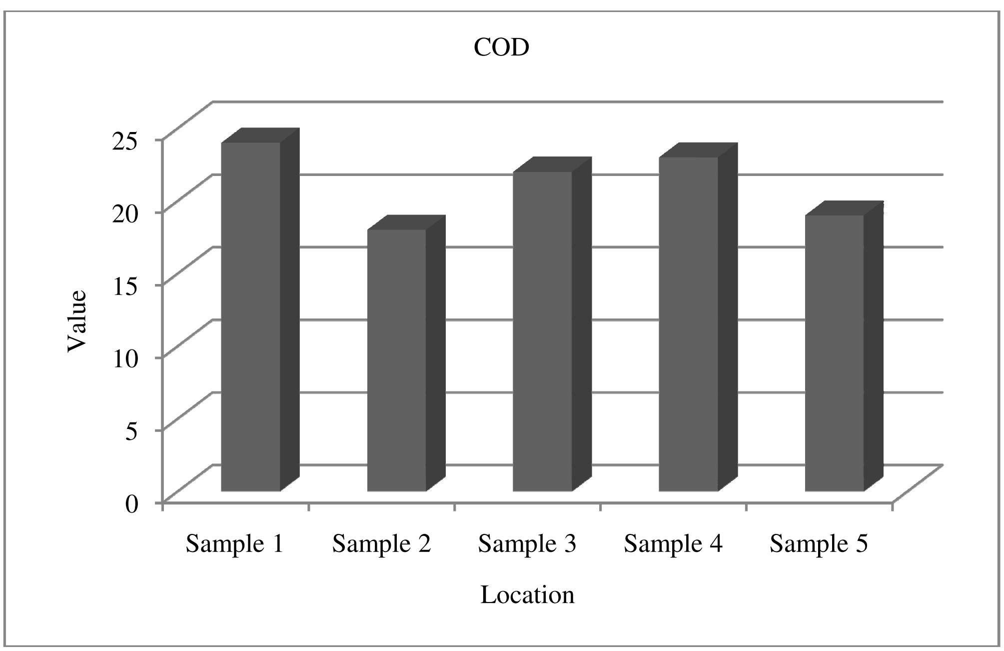

Figure-6: COD values at sample locations.

Conclusion

The concentration of Iron in Sample 1, Sample 2 and Sample 4 were high clearly indicates that municipal solid waste dumpsite near to the sample point location. The high level of iron concentration shows that some leachate percolation from dumpsite to ground water surface. However, the recorded value of Fluoride, Phosphate, Nitrate and Sulphate values were comes under permissible and acceptable limit of BIS standard. The COD levels of the samples were higher indicates the presence of inorganic chemicals in water table due to impact of migration of leachate from landfills.

In the dumpsite there is no leachate collection and treatment system. The dumpsites walls were unlined and non-planned construction. So the leachate flows its own way to the acquifer. The unsegregated waste dumped in unlined landfill may cause adverse effect on water quality. If the dumpsite continuous its operation for more than decade of years, the acquifer will not come to recoverable condition. Toxic chemicals like iron, nitrate and phosphate, fluoride, orginates from waste in the soil can stream through a garbage and pollute both ground and surface water. It is essential to upgrade the Landfill site through innovative scientific method to prevent further contamination of groundwater. Most of the water samples in this area were unfit for drinking. The water quality in the study area is found to be suitable for drinking only in few areas, while other area must be subjected to antecedent treatments. It must be pointed out that a periodical water analysis must be done to fortify the quality of water in this area is not polluted.

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