Investigation of The Effect of an Open Waste Site on Groundwater Contamination

SIMEON OLUSEGUN ADENIRAN
Department of Pure and Applied Physics, Faculty of Pure and Applied Sciences, Ladoke Akintola University of Technolgy, Ogbomoso, Nigeria.

Abstract- This project work focuses on ascertaining the effect of open waste site on groundwater contamination. In the process, an investigation was carried out at different dumpsites, while soil and water samples were collected at those dumpsites and analyzed at the laboratory. Meanwhile, this necessitated the investigation of the nearness of some hand-dug wells to the area where the dumpsites are situated and the effect on the residents. In conclusion, from the result of the analysis the concentration of all the pararneters analyzed shows that there was a minimal effect. But if the result of our own assessment does not guarantee a continuous minimal effect in the future except there is further assessment on the sites.

I. INTRODUCTION

1.0 PREAMBLE

Ground water is a vital natural resource, which is essential for a variety of purposes. The quality varies for its many uses, which include drinking and other domestics uses, power generation agriculture but waste disposal gets the groundwater contaminated. Water of good quality has characteristics that make it suitable for the needs of the users.

The quality of water is an important factor to consider fortunately groundwater does not only serve as consumption for man but also for aquatic animals, which is their own habitation.

Groundwater gets contaminated when even seemingly harmless materials and waste are improperly handled. Contamination of groundwater may be as a result of different chemicals and pathogens like bacteria and viruses of course there are many number of materials that can still contaminate groundwater, they are; pesticide, paints, acids, sanitary sewage and fuels etc. one groundwater is contaminated, it might be difficult and expensive to clean up.

Sometimes it is impossible to clean it up for drinking purpose.

1.1. Effects of a Waste Disposal Site

Waste disposal site and the waste dumped has generally become a concern in this country and effective waste treatment system seems too vague to be pursued. The poor treatment system obtained in the country has contributed immensely to the pollution problem.

The wellbeing of human and animals is independent on environment. The major effect of the waste disposal site is the destabilization of human and animal health through pollution. Contaminated water is any liquid discharged from processing industry which contain large quantities of raw materials, Solvent, products processing chemical dissolved and decomposed to release organic component that are toxic and hazardous to environment. Waste generation is an inevitable consequence of industrialization, the problem of poor treatment of both industrial and domestic waste has been the main source of concern in the environment (Horon, N. 1996). Organic component dispersed ions in the waste which are Independent of the other and rendered it useless and may bioaccumulate in the tissue of organisms or human which causes problem.

The harmful and hazardous effect of industrial effluents on natural resources and human because of unsound disposal practices and far accidental discharge into the environment have been well documented over accidental discharge into the environment have been well documented over the fears in both developing countries. Various international bodies have also raised an alarm that there is a lack of adequate quality of water of good

quality to support human population and aquatic ecosystem. Contaminated or polluted water is responsible for the death of over 5million people animally. The federal government of Nigeria promulgated decree 58 of 1988, which was later amended by decree 59 of 1992 to establish the federal Environment protection Agency (FEPA) as the apex institution for Environmental protection and natural resource conversation in the country. After a review of the backlog of environment problem in the country FEPA identified industrial pollution as one of the environment problem which requires urgent attention for the purpose of case study, there dump sites were visited, to investigate the effect of the waste disposal site to the groundwater in the area not too far from the dumping sites.

The places are Arada Market at Ora-gada, Aguodo dump site Adjacent Ebenezer Baptist Church and olokoko dumpsite near general hospital Ogbomosho Oyo State.

The Observation we made was the nearness of wells i.e. hand dug well close to the three sites choosing the water and soil in the area can then be investigated the project is actually based on getting the soil samples and {likewise the water sample to carry out the analysis and test on to know if the dumpsite contaminates the water.

1.2 AIM AND OBJECTIVES OF STUIDY

1.2.1 To investigate the effect of a waste disposal site on ground contamination.

1.2.2 Objectives of study

- To test the permeability of the soil samples
- To test the porosity of the soil samples collected from the three dumpsites.
- To analyze the texture of those soil samples collected at the dump ground (Sand, loamy, clay)
- To know the chemical oxygen demand (COD) in water
- To know the Biological Oxygen demand (BOD) present in water.
- To test for the ph.
- To test for the electrical conductivity of the water
- To test for the metals present (e.g. Cd, Fe, Mg, Mn, Zn, Al, Co, Pb and others)

1.3 SCOPE OF STUDY

The project is limited to Analyzing the BOD, COD, the metals present in the water samples, the conductivity of the water samples, the p, the porosity, the permeability and the texture of the soil samples.

1.4 SIGNIFICANCE OF THE STUDY

All the industrial, agricultural and domestic wastes affect the normal occurring existence of the water bodies like the lake and river in many ways, when the outflow are sufficient to render the water unfit for its best usage.

This engender the treatment before its being use for commercial and domestic purpose. This has to be done to meet the Standard of Environmental Protection Agency (EPA).

II. LITERATURE REVIEW

Himco Dump historically was an unlicensed, unlined 60-acre land fill located in an unincorporated area northeast of Elkhart, Indiana, Indiana was operated privately by Himco Waste- Away Services, which collected and received commercial, Industrial, medical waste and general refuse from 1968 till 1979, Both open dumping and trench disposal occurred at the landfill.

In 1971, the Indiana State Board of Health responded to residents' complaints that identified the site as an open dump. Residents living approximately 400 feet down gradient of the site experienced discoloration and foaming in their water thought to be caused by migration of landfill leachate. Deeper private wells were installed, however, sample results detected very high levels of Sodium. The residents were connected to the Elkhart Municipal water supply in 1990 by himco waste. Away and milesinc.

During an inspection in 186 U.S. EPA (EPA) observed leachate seeps and landfill gas odours, sampling results indicated that volatile organic compounds (VOC's) semi-VOCs, and metal were in the ground water at the site. Additional groundwater samples collected in 1990, 1991 and 1993 detected low-levels

of the same groundwater contaminants outside the landfill boundaries.

The site was then addressed through Federal Superfund program actions. It is anticipated that the potentially responsible parties (PRPS), will conduct additional work under the federal enforcement action. In 1993, a pre-design investigation was conducted to analyze the potential adverse health effects from exposure to the soils, shallow groundwater, and soil vapor potentially migrating from the landfill toward the residents south of the landfill in the construction debris area (CDAO), towards the residence.

From the investigation total chlorinated ethenes and many others migrating from the landfill. The concentration of the gas was very high the area, causing a health hazard to the resident. Meanwhile, all the residents who were tested and then discovered that one compound 1,2 - Di chloropropane exceeded the maximum contamination level (MCL) for drinking water were using bottled water and water softness on their own volition because of high level of natural occurring iron in that area.

Since groundwater contaminated by open dumpsite affects the environment in many ways. Several methods had been use over time to remove or demineralize organic component which include phase separation screening, filtration and sedimentation) and coagulation but after a certain period of time microorganisms acted on it and rendered it useless.

2.1 ANALYSIS OF GROUNDWATER CONTAMINATION

Toxic Organic materials in groundwater contamination might contain chlorinated compound which cannot be treated biologically, also with many constituents that must be analyzed before treated. Various methods are available for analyzing contaminated or wastewater.

These methods are standard procedures and the result of the analysis presume the type and extent of treatment to be given to such contaminated water before it can be allowed to be consumed by the residents.

2.2.1 Physical processes of groundwater contaminated treatment

The methods involved in these processes depend solely on the physical properties of the water being contaminated e.g. size, density, taste, odor, turbidity, and color.

The methods are:

a) Phase separation e.g. screening, filtration, sedimentation

b) Phase transfer e.g. coagulation

2.2.2. Filtration of Soil

The process involved in the filtration of soil are:

- Oven Dry: This is to reduce the water content and the weight of the soil particles, which is very necessary before analysis on soil is done.
- Sieving is another process involved in the filtration of soil, it involves the extraction of external participles e.g. stone and tiny roots in the soils to be filtered.
- Air dry is the next step involved after a soil had been sieved. Air drying of soil simply means that the soil sample to be analyzed will be put in a flat plates where there will be cool air, it could be there for 5 days
- The final process in the second sieving, this sieving is done to extract the main tiny particles of the soil samples needed to be filtered.

2.3 SINGLE- PASS SAND FILTER

A single - pass and filter system pre-treats septic tank effluent by filtering it through sand before sending it to a soil treatment system. Various sand filter types and designs have been extensively tested and used in the United States. Other waste water treatment filters used pea gravel, crushed glass, or other experimental media, but sand is the best understood and the most predictable. Treatment mechanisms in a sand filter include physical filtering of solids, ion exchange excessive organic loading from lack of maintenance.

2.3.1 Working Operation of Sand Filters

Sewage flows from the house into one or several septic tanks, depending upon the size of house and local requirement. Effluent from the septic tanks, flows into a pump or lift tank.

A pump introduced the effluent at the top of the water tight sand filter, using pressure distribution to apply the waste water evenly to the filter surface to maximize treat merit. A timer is used to close the entire surface of the filter intermittently with wastewater. This is the oxygen from the atmosphere through the sand medium and its ınicrobial community.

The effluent is treated by physical, chemical and biological processes. Suspended solids are removed by mechanical straining due to enhanced contact and sedimentation.

Treatment occurs through the bacteria that colonizes the sang grains. Microorganisms use the organic matter aıd nutrients in the effluent for growth and reproduction.

2.4 DIRECTION OF FLOW OF WATER AND CHEMICALS

The direction of flow of water and chemicals will mainly base on how porous and permissive the soil samples are:

2.4.1 Porosity of Soil

Porosity is the amount of air space in the soil. There are two types of porosity, which are called total porosity and water porosity. From any own personal research and investigation there are two different methods of calculating porosity the first experiment enables me to calculate water holding porosity and the total porosity of the soil.

I will expect clay soils (very small particles) to have the largest water holding porosity and therefore also the highest total porosity. I will expect sands and sandy oils (large particles) to have the lowest water holding porosity and therefore the lowest total porosity. Silty soils should have a water holding porosity and total porosity, that are greater than sand but less than clay. I am basically predicting that the smaller the particle size of the soil, the greater the porosity.

2.5 PERMEABILITY OF SOIL

Permeability refers to the propensity of a material to allow fluid to move through its pofes or interstices, permeability is an important soil parameter for any project where flow of water through soil or rock is a matter of concern. For example, seepage through or under a dam, drainage from subgrades or back fills, knowing the rate at which a well can recharge" and dewatering for construction projects under or near the water table.

2.5.1 Factors Influencing Permeability of Soil

There are several factors that influence the permeability of a soil (or rock material), the viscosity of its water (which is slightly influenced by temperature) size and shape of the soil particles degree of saturation and void ration. The void ratio is slightly different from density of a material.

The void ratio is the ratio of volume of voids to volume of solids. However, for a given soil permeability is inversely proportional to soil density. The more tightly the material particles are packed the tendency for the material to allow water to flow through it is reduced. Highly permeable soil will require a pumping system with a comparatively large capacity for construction while a low permeable soil may not require any pumping.

The fundamental description of permeability is based on the equation

q = Va which takes the familiar form like river discharge. The valuable

q is the discharge (Vo/Time) V is the apparent velocity, and A is the area that is related to the geometry of the situation.

Now, Darcy's law describes the factors important in determining the value of V, which is.

V=Ki

Where K is a constant for the material ad is called the coefficient of permeability and i is the hydraulic gradient which is' related to the water pressure.

The following table lists of some/Permeability's Soil Permeability Relative permeability

Soil	Permeability Coefficient, K (m/sec)	Relative permeability
Coarse gravel	$>10^{-1}$	High
Sand, clean	190^{-1}-10^{-3}	Medium
Sand, dirty	$10^{-3} – 10^{-7}$	Low

Silt	10^{-5} - 10^{-7}	Very low
Clay	< 10^{-3}	Impervious

Some methods used for the determining of those permeability a material include the following:

1) Falling - Head laboratory test
2) Constant Head lab test
3) An in- field pumping test

2.7 CONTROL OF GROUNDWATER CONTAMINATION

Prevention is the best way to minimize groundwater contamination. The proposed remedy modifications are more protective of human health and the environment from open waste sites.

- Spraying of chemicals near open water, like agricultural chemicals that are toxic to aquatic life, should be discouraged by individuals.
- Disposition of items that contain hazardous materials should be incinerated but not in a dumpsite.
- There should be a management that will perform long term groundwater monitoring
- Incinerators should be mounted to different places as to burn any waste that might be dumped anyhow by the residents.
- Waste management board (EPA) should always inspect any open waste site in the community where there residences to enlighten people living in the area and proper sensitization should be done to prevent the dumping of wastes in nearby places.

2.7.1 Methods of Preventing Groundwater Contamination

- Pesticides should be used only when necessary
- Avoid over-spraying ground
- Measure carefully
- Application should be done at right time.
- Leaches should be avoided
- Identification of nearby water sources
- İdentification of soil type should be done.

III. METHODOLOGY

The project work was caried out at Arada market area, Aguodo near Ebenezer Baptist Church and Olukoko dumping site close to Ogbomosho general Hospital Ogbomoso.Oyo State.

3.1 REASONS FOR CHOOSING THE THREE AREA

The main reason for choosing the three dumping sites is:

- The three dumping sites are the main dumping sites in Ogbomosho.
- These three sites, people have been dumping waste there for more than 20 years and above.
- The near mess to a hand dug well (Open well) in those area.

3.2 THE MATERIALS USED IN THE SITES ARE

- Digger
- Shovel
- Hoe
- Measuring tape
- Nose cover
- Polythene bags
- Bottles used to collect the water samples
- Atomic absorption spectrophotometer is (AAS)
- pH meter
- Conductivity meter

3.3 COLLECTION OF SAMPLES

The objective of sampling was to collect a portion of small in volume of soil sample and waters to be transported conveniently and handled in the laboratory while still accurately representing the whole material being sampled.

This objective implies that the relative proportion or concentration of all components will be the same in the samples as in the material being sampled.

The objective of sampling is to determine compliance with specific regulatory requirement.

3.4 SOIL SAMPLES

9 samples were collected at 3 different dump site while three samples were collected each from the site with a proper labeling.

3.5 WATER SAMPLES

3 samples were collected at the three different locations where the dump site was located. 9samples each were collected in a small water packed bottle.

3.5.1 Method

- The digging of the ground took place at the three choosing sites.
- 3 samples of soil were collected from each of the sites. Measurement of the depth at while the soil was collected was properly done.
- The samples were packed in small polythene bags and transported to the laboratory for analysis and testing.
- Water samples from a nearby dug-well were collected for analysis.
- The equipment used for the analysis is Atomic Absorption spectrophotometer (AAS)

(Alteration of components by building and releasing their components), a decomposition organic waste by soil-dwelling bacteria. A properly operating sand filter should produce high quality effluent with less than 10ngl liter. BOD (Biological Oxygen Demand, a measure of Organic material) less than omg/liter TSS (Total Suspended Solids) and less than 200c fu/l00ml fecal coliform bacteria and indicator of viruses and pathogens.

3.5.2 Application of Sand Filters

Since wastewater leaves and filter system as high-quality effluent, the soil in the trench mound soil treatment systemı nay be better able to accept it and the system should last longer. Sand filters produce clearer water, they are useful for sites that have been compacted, cut, or filled and for environmentally sensitive areas like those near lake in shallow bedrock areas, aquifer recharge areas and well head protection areas. Pretreatment may allow a reduction in the three foot separation required between the soil treatment system and limiting soil layer. Researchers in several states are testing reduced separation distances in soil treatment systems receiving wastewater pretreated in sand filter.

Groundwater data collected from 1978 to 2000, showed that the Himco Dumpsite continues to contribute to the degradation of ground water quality. Ground water data collected from 1996 through 2000, confirmed previous sampling result which indicated consistent pattern of low parts of billions of volatile Organic Compounds and metals contamination at the site.

The following chemicals were detected in the ground water benzene, 1,2 - Di chloropropane, trichloroethene, 1,1 - dichloroethane cis 1, 2 - dichloroethane, antimony, arsenic, chromium, iron, manganese, and thallium.

Soils samples. were collected from a privately owned residential area called the construction Debris Area (CDA) sample results indicated that presence of polynuclear aromatic hydrocarbons (PHAS) and the following aluminum, antimony, arsenic, copper, manganese, mercury, led and nickel which may have been associated with construction dumping activities at the site.

VOCs detected in the soil include 1,- dichloroethane, benzene and ethylbenzene. Xylene was detected in one samples i, one samples with no other site-related volatile organic compound reported.

In 1990, an alternative water supply was extended to residents with private wells living south of the landfill. On May 7, 1992, a contractor for Himco waste. Away services conducted a site assessment. During this site assessment toluene, Xylene, 2 - hexatone, 4 4 - methyl - 2- pentane and ethylbenzene were detected in concentration ranging from 480,000ppm to toluene to 6,400ppm for ethylbenzene. The contaminant was from buried leaking drums.

In 1992, an emergency removal action was initiated following the detection of approximately 50 percent toluene and other VOC contaminants in a leachate sample. Seventy-one 55-gallon drums and 50 cubic yards of contaminated soil were removed in 1992 by Himco Waste away services under removal action consent order.

IV. RESULTS AND ANALYSIS

4.1 RESULT

The result obtained for this experiment work for the different samples analyzed are presented in table 4.1

for water samples collected from the three dumpsites and table 4.2 represent the soil sample analyzed.

Table 4.1 Geophysical analysis data for some hand dug wells in Ogbomosho and its environs.

WATER SAMPLES

Sampling Points	Arada HW	Agurodo HW	Oukoko HW
Parameters			
Pb	0.00ppm	0.67ppm	0.77ppm
Cd	0.964ppm	1.086ppm	0.074ppm
Fe	36.4ppm	12.4ppm	10.2ppm
Cu	1.65ppm	10.47ppm	3.11ppm
Mn	3.11ppm	0.82ppm	1.77ppm
Ni	0.50ppm	0.40ppm	0.00ppm
Mg	89.19ppm	121.12ppm	62.17ppm

Table 4.1 Showing the water Samples

4.1.1 Discussion

The table above depicted the results of the three different water samples analyzed, which is the reflection of the two categories of the elements presents in the research work.

The first set of elements include Iron (Fe), Copper (Cu) and Magnesium (Mg).

All these elements have higher concentration compare to the other elements in the sample analyzed, because they are inorganic salt that must be present in the blood. Iron (Fe) helps in the formation of cells and contraction of muscles and the deficiency result in anemia.

Copper (Cu) is present in all human tissues for the formation of cells also.

Magnesium (Mg) occurs widely in all mineral sources, and it is present in human tissues, it is also a cation present in the extra-cellular fluid electrolyte i.e part of the body fluid which helps in maintaining acid-base balance for normal cellular activities and that is the main reason for having higher concentration of Magnesium in all the three samples of water analyzed. The second set of elements comprises of Lead (Pb), Cadmium (Cd), Manganese (Mn), Nickel (Ni) and Zinc (Zn) Vith lower concentration result of their poisonous effect if it is too much in the body. If the presence of all the elements mentioned is much in the body the following symptoms like, malaise, diarrhea, vomiting and at times encephalitis are observed.

The lower concentration of the second set of elements are depicted in the table is a much preferred concentration the body needs for proper growth without any ailment

4.2 CONDUCTIVITY

Ağurodo water sample is the sample with the highest conductivity due to the presence of some impurities like soil particles and so on the other two samples have almost the same conductivity and that is to tell us that the two samples have almost the same soil particles compared with the former.

Table 4.2 shows the result of the soil samples analyzed

SOIL SAMPLE

Soil sample	%	%	%	Electrical conductivity	Electrical resistivity	% porosity
Sample Arada	80	09	11	1.90	0.526	14
Sample C Arada	76	09	15	1,26	0.794	16
Sample A Agurodo	76	07	17	0.41	2.439	32
Sample B Agurodo	69	09	22	0.34	2.941	24
Sample C Agurodo	74	11	15	2.79	0.358	25
Sample A Olukoko	70	15	15	0.39	2.778	20

Sample B Olukoko	70	13	17	0.39	2.564	15
Sample C Olukoko	68	21	11	0.44	2.272	22

4.2.1 Discussion

Tables 4.2 shows the result of the soil samples analyzed, we have different conductivity value of the soil samples, the reason is that the proportion of the organic matters present in the soil are not of the same content.

Sample B; Arada have the highest conductivity of about 3.88 followed by sample Agurodo (2.79) while sample A Arada and sample C Arada have related conductivity; 1.90 and 1.26 respectively.

Other soil samples with less than 1.00 electrical conductivity did not have much quantity of organic matter in them.

The proportion of the soil texture depicted in the table in percentage helps in knowing the water holding capacity of the soil samples analyzed.

The porosity of Agurodo dumpsite is the highest i.e. the amount of air space present in the soil is much compared to Arada samples and the likes.

In conclusion another key factor to be considered in the contamination of water is the direction of the flow of the contaminants. If the direction of flow of contaminants is towards the direction of where the well is being dug, the water will be contaminated but if otherwise, i.e. it does not flow towards the well there will be less or little effect.

It was observed that in the three sites considered the direction of flow of the contaminants are not towards the well that is why the elements are found in their normal concentration and the water has minimal effects on the residents

4.3 ANALYSIS OF SAMPLE COLLECTED

The samples of the water collected was analyzed using Atomic Absorption Spectrophotometer (AAS)
Model- Alpha 4
Serial no 4200 which is basically used to determine metals present in water.
AAS is segmented into three parts;

We have the:

- Cathode lamp part - which senses the type: of metal present. In this part, different lenses are used for different metals to be analyzed.
- Flame Part- In the flame part, the lighter is used to light the part and transfer it to the cathode part after the burning of the parameter to be analyzed.
- Electrical Part - This is where the electrical cable is connected to the system connected to the AAS where the results of the analysis is being depicted.

Standard value is used to compare the result with results gotten from the Atomic Absorption Spectrophotometer.

V. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Based on the result of the samples of water and soil analyzed, I will like to conclude that there is no effect of the dumpsites on the waters and soil likewise which shows that the people consuming the waters are not subjected to any dangers. But l like to say that there is no total assurance that there might not be dangers in future to the people consuming the water.
because there might be toxic waste latter on discharged to those dump sites which may lead to health problem except there is continuous assessment of those sites as to know the concentration of those metals present and at what quantities would the people consuming the waters might be affected.

5.2 RECOMMENDATION

Continuous assessment of the dumpsites helps the residents to be rest assured that they can keep on consuming the waters or not, it is therefore recommended that:

1. Wastes water discharges should be strictly controlled by enforcing effluent standard and discharge permits in manufacturing companies that discharge effluents.

2. FEPA should make it a point of duty to visit industries often to check the standard of effluent discharged.

REFERENCES

[1] Hammer, MF. (1977), Water and waste Technology (2nd edition). Academic Press: New York: Pp 30| -316.

[2] Horon, N. (1996), waste management, An (1996), Environmental European perspective (2nd edition) John Wiley and Sons, London, Pp. 7 - 25.

[3] Hexon: Environmental Consultant: and Engineers (March 1991), Environmental Audit Report for Dn Meyer Plc, pg. 38 - 40.

[4] Waste Technology (February, 2000). Journal of the natural Institute of Environmental Health Science Volume 108/No 2 pp. A 69 - A70.

[5] Waste Technology (March 2004), lon Exchanger Total Water Management Vol. 2/No. 20. Pp. 1110- 1269

[6] www.gogle.com

[7] www.dimcowaste.away.org