# Investigating the Effect of Tannery Effluent Discharge on Groundwater Quality in Challawa, Kano State, Nigeria

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**Abstract:** ***This study examined the effect of tannery effluent discharge on quality of ground water in challawa industrial area, Kano. The laboratory analysis of samples was done as per standard methods prescribed by WHO. Samples of tannery effluent were collected from the industry while samples of hand-dug well water were also collected from nearby (100m) and very far distance (1km) from the industry. The findings revealed that the volume of the effluent discharge from the industry was found to be 180000 litres per operation and 540000 litres weekly. Composition of the effluent was found to have the following concentrations: $P^H$ (9.8), colour (1647pt. co), BOD (365mg/l), COD (259.12mg/l), E. C (1490US), TDS (1087mg/l), and Pb (0.0115). average concentration of parameters tested for the ground water was found have the following: $P^H$ (7.95), temperature (28.4$^o$), colour (62.5pt. co), turbidity (82.5NTU), E. C (675US), total hardness (220mg/l), TDS (488.5mg/l), Ca (0.094), Mg (5.894), Fe (0.943), Pb (0.508), Cr (0.009). The analysed concentrations of the composition were found to be above WHO permissible. The study recommended that the government should ensure proper treatment of effluents by the tannery industries before discharging them into the environment. The polluter pays principle should also be introduced by the concerned government authorities to discourage reckless contamination of the environment.***

**Keywords:** Tannery, Effluents, Turbidity, Hand-dug well, Pollution

## 1. Introduction

### 1.1 Introduction

Water is one of the renewable resources essential for sustaining all forms of life, food production, economic development, and for general wellbeing (FAO, 2017). It is impossible to substitute for most of its uses, difficult to de-pollute, expensive to transport, and it is truly a unique gift to mankind from nature. Water is also one of the most manageable natural resources as it is capable of diversion, transport, storage, and recycling. All these properties impart to water its great utility for human beings (Sundaradive and Vigneswaran, 2004). Although about 70% of our planet earth is covered by water, 97% is basically saltwater while 3% is freshwater. Only 1% of the global freshwater is available for human consumption as 70% of that fresh water is frozen in icecaps of Antarctica and Greenland; most remaining is present as soil moisture, or lies in deep underground aquifers as groundwater not easily accessible to human use (Ali and Tarfa, 2012).

The surface water and groundwater resources of the country play a major role in agriculture, hydropower generation, livestock production, industrial activities, forestry, fisheries, navigation, recreational activities etc. It is important that the water which people drink and use for other purposes is clean water. This means that water must be free of germs and chemicals and be clear. Disease-causing germs and chemicals can find their way into water supplies as a result of industrial activities such as leather production. When this happens, the water becomes polluted and when people drink it or come in contact with it in other ways, they can become very sick (Corrales, Lana, Izurieta, Ricardo and Christine, 2006).

Leather sector occupies a very important place in the development of our economy on account of its substantial export earnings, potential for creation of employment opportunities and favorable conditions for its sustained growth. The Leather Industry holds a prominent place in the global economy. This sector is known for its consistency in high export earnings. Among the factors that are responsible for establishing tannery industries are footwear, leather garments, bags, belts etc. (Neeraj, 2016)

Tannery waste is characterized by its strong colour (reddish to dull brown), high BOD, high pH and high dissolved solids. Tannery effluents, puerile, when discharged untreated, pollute the receiving stream and if allowed to percolate into the ground for a prolonged period seriously affect the groundwater table of that locality (Saritha, 2018). The other major chemical constituents of waste from tanneries are sulphide and chromium (Essays, 2018). These chemicals mixed with water are discharged from the tanneries. They pollute the groundwater permanently and make it unfit for drinking, irrigation and for general consumption. It has been established that a single tannery can cause pollution of groundwater around a radius of 7 to 8 km (Mondal, 2005). The impact of the effluents is so stupendous that the water then becomes unfit for drinking and irrigation. Sodium chloride is the major dominant chemical present in groundwater, which makes it unsuitable for drinking and irrigation (USGS, 2019). Among the dissolved constituents, $Na^+$, $Ca^{2+}$, $Mg^{2+}$, $HCO^{-3}$ and $SO_2^{-4}$ are in excess of the levels recommended for either drinking or irrigation. In view of these, it is required to assess the quality of groundwater in the area.

Ammonia, total dissolved solids (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), sodium and total chromium are the composition of tannery effluent.

**1.2 Statement of the Problem**

Kano is the most populous city in Nigeria, and it is also a commercial city. Due to the high population, there is high demand consumable products such as footwears, leather garments, bags, paddles, belts etc. which lead to the establishment of tannery industries in the city. Such industries include those in Bompai industrial area, Challawa, Tokarawa, and Sharada. The hazardous effect of the effluent flows from the industries into environment is a cause for concern. The release of untreated effluent affects the natural water bodies, flora and fauna of the ecosystem and increases the effect on human health and environment especially ground water.

Pollution of water with heavy metals is of grave consequence because both terrestrial and aquatic lives may be poisoned. It may cause diseases due to the presence of some hazardous substances which may distort the water quality, add odors, and significantly hinder the economic activities.

In Challawa there is a discharge of industrial effluent on the environment which affect ground water quality and poses effects on human health such as: typhoid fever, skin irritation, cholera, pulmonary oedema, disruption of endocrine system, birth defects etc. This becomes a problem because the waste ought to be discharged to a sewer treatment plant before being discharged finally into the environment. This is to help reduce the intensity of the wastewater. It is therefore pertinent to ascertain the composition of these effluents and relating it with the effect they have on the environment. This is so because if it not ascertained the environment will be exposed to lots of risks.

**1.3 Aim and Objectives of the Study**

**1.3.1 Aim**

To examine the effect of tannery effluent discharge on quality of ground water in Challawa industrial area, Kano.

**1.3.2 Objectives of the Study**

i. To determine the composition of the effluent in comparison with the WHO acceptable standard.
ii. To compare the physical and chemical parameters of the ground water in comparison with the WHO acceptable standard for drinking water.

## 2. Methodology

**2.1.1 Study Area**

The study area is Challawa industrial layout, Kumbotso local government. The Challawa industrial area is located at longitude $8^{O}$ 25'E - $8^{O}$ 40' and latitude 11 54'N - $12^{O}$N Kano State with a population of 409, 500 people.

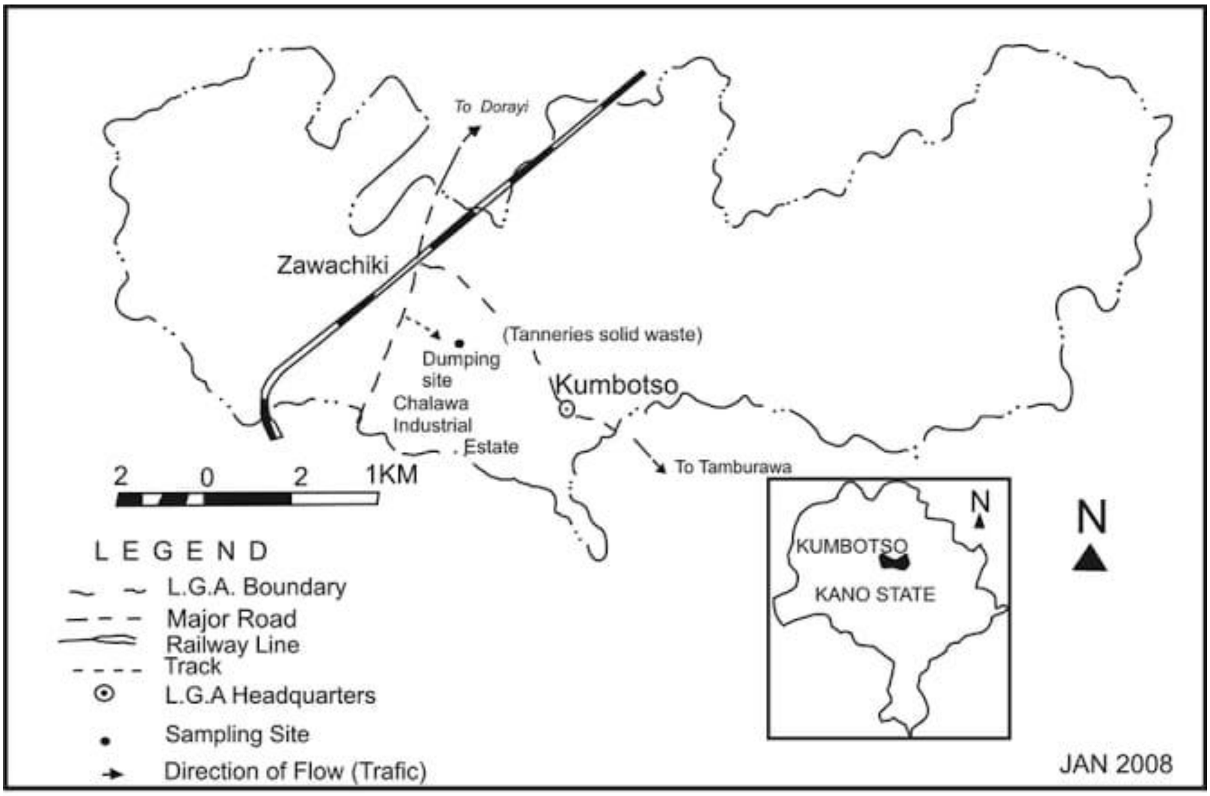


Figure 1: Kumbotso L.G.A.Showing The Sampling Sites

**2.1.2 Method of data collection**

The tannery effluent was collected from a leather industry at Challawa industrial zone in Kano, Nigeria while samples of hand dug well water were also collected from a



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nearby (100m) and very far distance (1km) from the industry. Water samples were collected from Challawa industrial area and treated tannery effluent was also collected from a sluice area where it passes. The treated tannery effluent was first filtered through Whitman filter paper No.1 to remove the suspended particles. The concentrations were used for physio-chemical analysis.

The laboratory analysis of samples was done as per standard methods prescribed by WHO. The following parameters were considered for assessment: pH, colour, electrical conductivity, TDS, Lead Pb, total Cr, Iron, magnesium, calcium, total hardness, turbidity, and temperature.

## 3. Results and Discussion

**Table 1:** Physical and chemical parameters of the effluent with their concentration

| Parameters | Composition | WHO |
|---|---|---|
| Colour | 1647pt. co | 550pt. co |
| Electrical Conductivity | 1490US | 1000US |
| TDS | 1087mg/l | 500mg/l |
| $p^H$ | 9.8 | 6.0 – 9.0 |
| Chromium | _ | 2.0mg/l |
| Lead | 0.0115 | 1.0mg/l |
| BOD | 365mg/l | 30mg/l |
| COD | 259.12mg/l | 160mg/l |

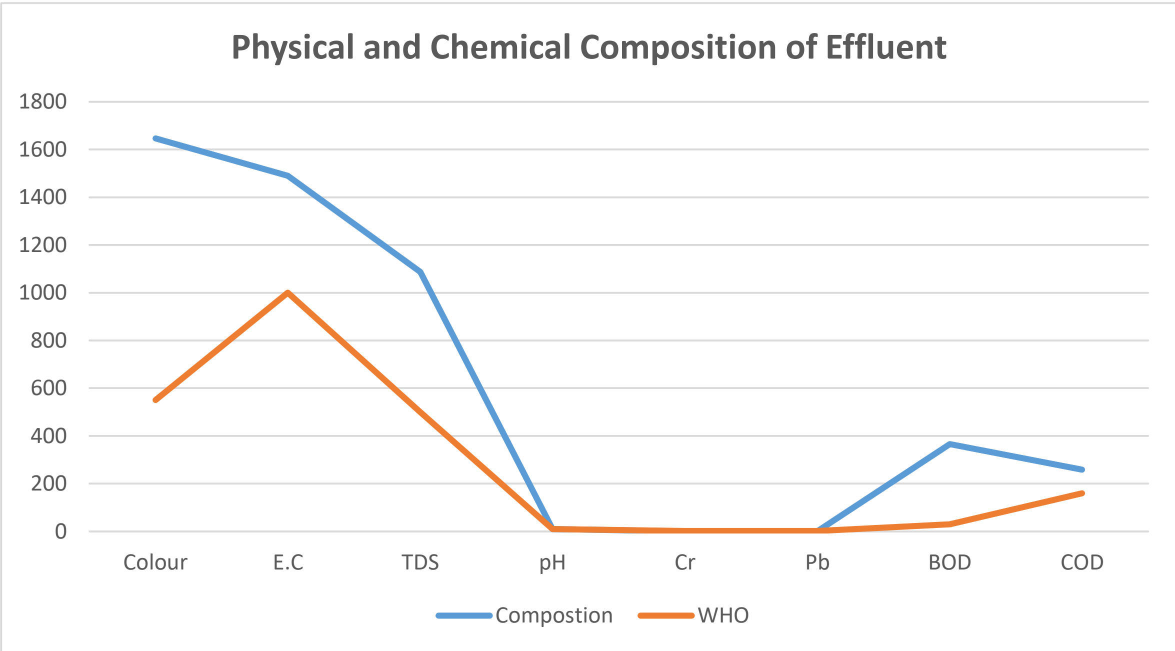


**Figure 2:** Physical and chemical parameters of the effluent with their concentration

The table 1 and Fig 2 shows the Physical and chemical parameters of the effluent discharge with their respective concentrations. The results indicates that the TDS has a value of 1087ppm far above the WHO permissible level, the BOD with a value of 365mg/l also exceeded the WHO permissible level while the value of the COD is 259.51mg/l. The pH value of the effluent is 9.8 and is an essential factor in formation of algal blooms noticed around the discharge channel of the effluent. The Electrical Conductivity was also found to be very high in the effluent with a value of 1490US, Lead (pb) was also high above the WHO permissible level with a value of 0.0115 but no Chromium was detected in the effluent.

The high TDS is due to the presence of carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, calcium, sodium, potassium etc while the alkaline nature of tannery effluent may be due to presence of high concentration of salts.

**Table 2:** Average parameters of water samples from near (100m) and very far away (1km) hand-dug wells from Tannery industries in comparison with the permissible limits of (WHO)

| Parameters | Well 1 (100m) | Well 2 (1km) | Mean | WHO |
|---|---|---|---|---|
| Temperature | $27.8^o$c | $29^o$c | $28.4^o$c | $27^o$c |
| Colour | 89pt. co | 36pt. co | 62.5pt. co | 15pt. co |
| Turbidity | 10NTU | 155NTU | 82.5NTU | 5NTU |
| E. Conductivity | 1190mg/l | 160mg/l | 675mg/l | 1000US |
| Total Harness | 120mg/l | 320mg/l | 220mg/l | 150mg/l |
| TDS | 865US | 122US | 493.5US | 500mg/l |

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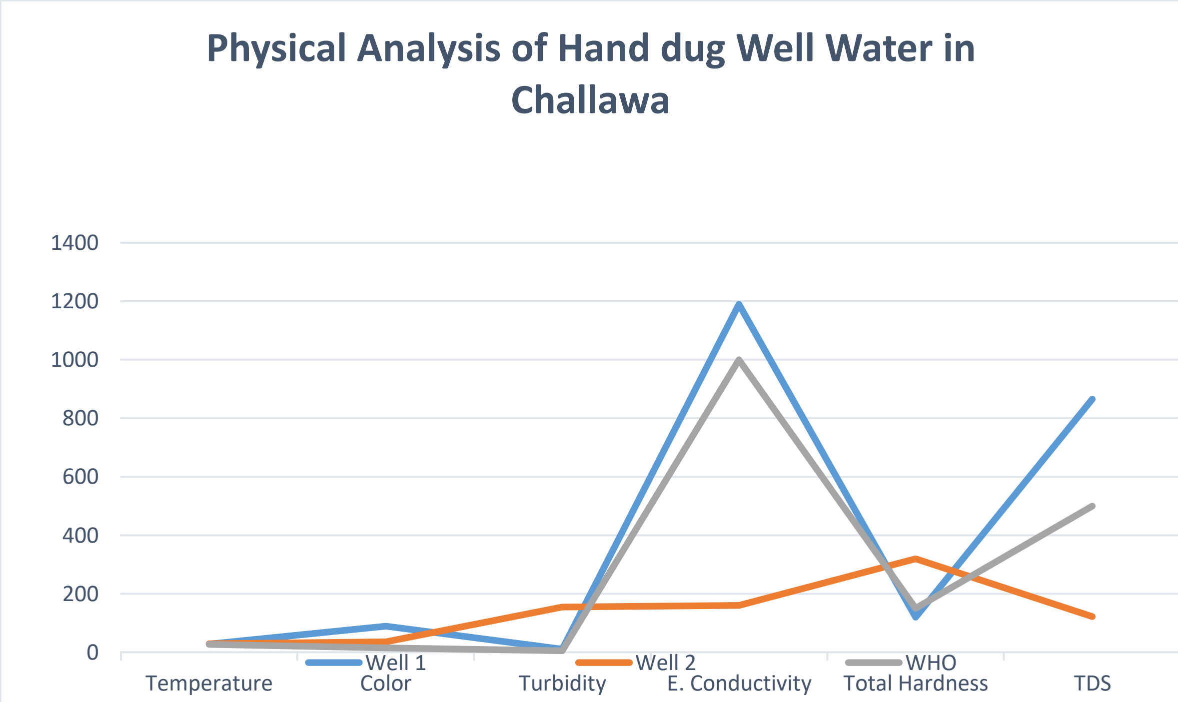


**Figure 3:** Physical analysis of water samples from hand-dug well very near to the tannery (W1) water samples from hand-dug well very far away from the tannery (W2)

Table 2 and Fig 3 shows the physical analysis of water samples from hand-dug well very near to the tannery (W1) water samples from hand-dug well very far away from the tannery (W2). The TDS result obtained shows that W1 had 865 mg/L while W2 had 122 mg/L which the nearby well was slightly above 500 mg/L permissible limit whereas the very far well was below 500 mg/L permissible limit of WHO. The major part of the TDS is consistent with $HCO^{-3}$, $SO_2^{-4}$ and chlorides of $Ca^{2+}$, $Mg^{2+}$ and $Na^{+}$. These ions usually comprised about 90% of the TDSs. Turbidity is high in which W1 is having 10NTU whereas W2 is having a turbidity of 155NTU indicating a high BOD because turbidity can provide food and shelter for pathogens. If not removed, the high turbidity can promote regrowth of pathogens in the water, leading to water-borne disease outbreaks in the study area. Total hardness of W1 showed a value of 120mg/L which is within the permissible limit 150mg/L of WHO whereas W2 was 320mg/L which exceed the permissible limit of WHO and this is caused by compounds of calcium and magnesium and by variety of other metals. Ranges of hardness of 61-180mg/L is considered as moderately hard, whereas 180mg/L and above as very hard.

**Table 3:** Chemical Analysis of Hand Dug Wells in Challawa

| Parameters | Well 1 (100m) | Well 2 (1km) | Mean | WHO |
|---|---|---|---|---|
| Calcium ($Ca^{2+}$) | 0.038 | 0.150 | 0.094 | 70 |
| Magnesium ($Mg^{2+}$) | 0.998 | 10.790 | 5.894 | 0.20 |
| Total Iron ($Fe^{2+}$) | 0.216 | 1.669 | 0.943 | 0.30 |
| Lead ($Pb^{6+}$) | 0.526 | 0.489 | 0.508 | 0.001 |
| Chromium ($Cr^{6+}$) | 0.0082 | 0.0094 | 0.009 | 0.05 |
| $P^{H}$ | 8.9 | 7.0 | 7.95 | 7.0 |

The table 3 above shows the various Chemical parameters tested from W1 and W2 in Challawa. Some of the parameters tested indicate a significant increase or decrease levels of concentration compared to WHO standards. Magnesium permissible limit is 0.20 mg/L of WHO but the level of concentration shows that W1 have 0.998 mg/L whereas W2 have 10.790 mg/L. The permissible limit of Chromium is 0.05 mg/L whereas W1 have 0.0.0082mg/L and W2 have 0.0094 mg/L. The result also indicated that Lead concentration in both hand-dug wells (W1 and W2) exceeded the maximum permissible level by WHO. W1 has a Lead concentration value of 0.526mg/ while W2 has a Lead concentration value of 0.489mg/L. Similarly, the total iron concentration in both hand-dug wells (W1 and W2) also exceeded the maximum permissible level by WHO. While that of W1 is 0.216mg/L, W2 had a value of 1.669mg/L. The pH results obtained from water samples shows that the two wells were above the permissible limit of WHO. W1 had 8.9 whereas W2 had 7.0.

## 4. Conclusion

The results of the study revealed that the effluent discharged from Challawa tannery industry have altered the physio-chemical quality of the groundwater in the area as most of the parameters tested were above the WHO drinking water standards. The volume of the effluent discharged from Challawa industries is also very high, hence have negatively impacted the quality of the groundwater.

## 5. Recommendations

The government should ensure proper treatment of effluents by the tannery industries before discharging them into the environment. The polluter pays principle should also be introduced by the concerned government authorities to discourage reckless contamination of the environment.

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