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The Effect of Penurious Sanitation facilities (septic tanks/latrine) on groundwater infrastructures in the Cowfield Community, Duport Road, Liberia

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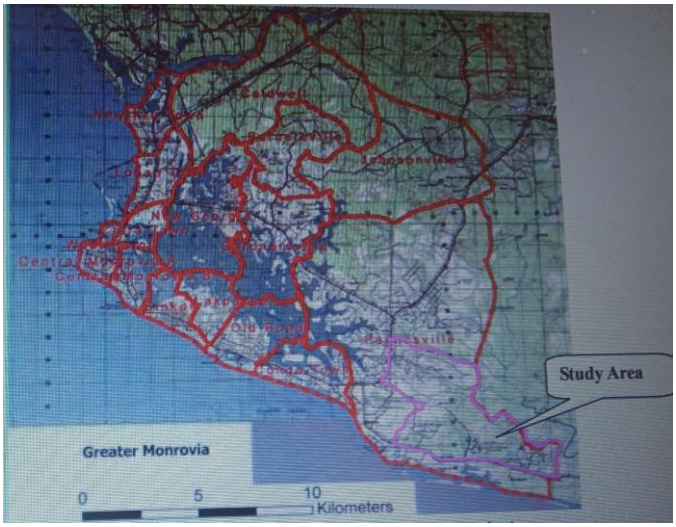
Abstract Groundwater is an important source of drinking water for most countries in Sub-Saharan African with Liberia being no exception. About 90% of families in the Cowfield Community, Duport Road located in the Paynesville belt rely heavily on groundwater for their drinking water and other domestic usage. This research focused on the evaluation of the level of contamination in water samples collected and also to assess the impact initiated by the construction of pit latrine and septic tanks close to groundwater infrastructures in the Cowfield Community, Duport Road, Liberia. Water samples from six hand dug wells were collected at stratified random sampling using tricplicate and taken to the White plains water treatment plant laboratory to analyze the various water quality parameters. Measurements were taking from pollution sources (pit latrine/septic tanks) to groundwater sources (wells) in order to determine the level of biological contamination. Spectrophotometer DR890 (Hach) was used for the analysis of pH, Nitrate and nitrite. High concentration of microbaterial was present in all of the six hand dug wells causing all the wells to be contaminated. None of the wells met the full requirement of drinking water quality guidelines for the World Health Organization and Liberia Water Quality Standards. All of the water infrastructures are highly vulnerable to contamination most especially during the rainy season where there is huge infiltration of storm water. The water infrastructures are in close proximity to pit latrine/septic tanks and therefore affected the water quality negatively.

***Key Words*: Cowfield Duport Road, hand dug well, Measurement; latrine; septic tank, Groundwater infrastructure, contamination**

1. INTRODUCTION

Due to population growth and increasing water demand, the use of freshwater sources such as groundwater resources has become very important. On the other hand, human activities such as agriculture, urbanization and industry are deteriorating the quality of groundwater (Kazakis and Voudouris2015). Groundwater is one of the most important sources of renewable water on the planet, accounting for about 30.1% of freshwater, of which only 0.86% is freshwater and all available water is 0.022%. Compared to surface water, groundwater is a relatively safe and reliable source of water. Contamination is not easy, but once contaminated, it is thoroughly costly, time consuming, very difficult to remove and replenish lost integrity, and sometimes undo it. Groundwater (GW) is an essential resource for domestic consumption, agricultural and industrial activities, and ecosystem services [CHEN et al. 2018; HOWARD 2014]. This research focused on finding the level of pollution/effluent load in the water samples collected from hand dug wells in Cowfield Community, Duport Road and also discuss its impact caused by building a septic tank /pit latrine in close proximity to groundwater sources. The suburb east of Monrovia that is geographically larger than the city of Monrovia and expands eastward along the Robertsfield Highway and northeastward beyond Red Light Market, one of the largest market areas in Liberia is Paynesville. Duport Road is one of the communities in the city of Paynesville that are undergoing rapid urbanization due to its ideal location. The Cowfield Community lies in the south-west part of Duport Road near the Du River. Shara and Cowfield are adjacent each other and also shared common boundary within the Duport Road Belt. This region was used for cattle/cow raising long before the Liberian Civil Crisis in 1990. This area is a low/flat land comprising of sand, silts and clay and the inhabitants heavily depend on groundwater as main source of drinking water. Based on the nature of this area, it also prone to flooding which is due to man-made causes, such construction of structures in the waterways and lack of proper drainages. During the rainy season, some part of the study area experienced flooding due to the heavy downpour of rainfall which results to flooding thereby contaminating groundwater for its inhabitants. The Du River discharged into the Atlantic Ocean and sometimes experienced sea rise which also make the area to experienced flooding. There is a vast swamp land that inhabitants use for agricultural activities that give some economic gains and it is close to the Paynesville Market hub (Red Light Market) that many people from different parts of the country come to do commercial activities. The Cowfield Community is one of the fastest growing areas in the Duport Road area and is mostly residential with a population over 12,000.

Figure 1-Map of Paynesville indicating the study area



Source: Final Report for Groundwater Development in Paynesville

2. Methodology

Six hand dug wells were selected at random and measurements were taking from pollution sources closed to the groundwater sources (wells) in order to determine the level of contamination within the cowfield Community. Measurements were taking between each hand dug well to the nearest septic or latrine and also the total depth and water table of the water infrastructure with a 100-meter measuring tape. All of the six hand dug wells sampled in the study area surpass the threshold of the Liberia Water Sanitation and Hygiene Authority and the Ministry of Public Work's recommended minimum distance requirement of 30 meters from a water infrastructure to a latrine or septic tank (WASH/MPW, 2010). After measuring the distances, water samples were collected from the six hand dug wells following standard operating procedures for water quality analysis. The water samples were observed for more than 12 hours after collection.The physio-chemical parameters analyzed at the water treatment plant were Turbidity, pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Iron (Fe), Sulfate, Phosphate, Hardness, Cupper, bacteria Count and Nitrate.

Table 1.0 Water quality parameters equipment

Water Quality Parameter	Testing Equipment
pH	pH Meter
Turbidity (NTU)	Turbidity Meter
Total Dissolved Solids (TDS)	Wegtech Conductivity Meter
Electrical Conductivity	Wegtech Conductivity Meter
Hardness	Palintest Photometer
Sulfate	Palintest Photometer
Iron	Palintest Photometer
Nitrate	Palintest Photometer
Copper	Palintest Photometer
TBC (ufc/100ml)	Palintest kit

3.0 Results and Discussion

The research appraised the impact of construction of latrine/septic tank in close proximity to hand dug wells or other water infrastructures specially taking into account the six hand drug well samples that were collected within the Cowfield Community, Duport Road. Measurements were taking from water infrastructures to pit latrine/septic tanks indicated in table 1. The results of these measurements proved that all of the hand dug wells in the study area fell below the 30 meters of the World Health Organization (WHO) and Liberia Water Quality Standards (LWQS) standards.

In relation to physio-chemical properties in table 2 (pH, Turbidity, Total Dissolved Solids, Bacteria Count, Electrical Conductivity and Hardness), the results is shown in table 3. The pH value ranged from 6.40 to 7.5 and only two of the six hand dug wells (5 and 6) fell below the WHO/LWQS standards.

Turbidity samples analyzed ranged from 4 to 12 NTU, the test result showed that wells (1, 2 and 3) were above the requirement of the WHO/LWQS standards for drinking water.

Total Dissolved Solids ranged from 89 to 120 mg/l, wells (2, 5 and 6) were above the WHO and LWQS standards.

Electrical Conductivity ranged from 98 to 200 S/m, wells (1, 2, 3, 4, and 5) were unfit for drinking and did not meet WHO and LWQS standards.

Bacteria Count ranged from 3/100 to 8/100 (ppm), all the wells were contaminated thus making them unfit to meet the requirement of the WHO and LWQS standards for drinking water.

Hardness ranged from 20 to 50 ppm, all the wells suit the requirement of the WHO/ LWQS standards for drinking water.

Sulfate ranged from 39 to 60 mg/l, all the wells met the criteria of the WHO/ LWQS standards for drinking water.

Iron ranged from 0.015 to 0.80 ppm, five of the wells fit within the limit of WHO and LWQS standards except well 1. Phosphate ranged from 0.003 to 0.7 mg/l, well (3, 5 and 6) have high concentration thereby not meeting WHO and LWQS standards.

Copper ranged from 0.35 to 1.22 mg/l, well 1, 3 and 4 did not meet WHO and LWQS standards.

Nitrite ranged from 0.002 to 0.012 mg/l, all of the wells did not meet WHO and LWQS standards due to the high increase in its concentration.

Table 2: Results of the measurement of the six hand dug wells indicating well type(WT), depth of well (DOW), water table (WT), distance from a point source (DPS) for a septic tank or pit latrine from), World Health Organization(WHO)/ Liberia Water standards (LWQS) and Culvert lining (CL)of well.

Sample #	WT	DOW (m)	WT (m)	D.P.S (m)	WHO/LWQS Standards	CL	Comment
Well#1	H.DW	5.30	3.8	14.50	30	NO	Not Safe
Well#2	HDW	6.18	3.5	12.90	30	NO	Not Safe
Well#3	HDW	4.92	3	15.0	30	NO	Not Safe
Well#4	HDW	5.15	4	11.0	30	NO	Not Safe
Well#5	HDW	6.80	4.5	14.50	30	NO	Not Safe
Well#6	HDW	6.70	5.4	16.50	30	NO	Not Safe
Ave.		5.84	4.08	14.07	≤30m		Below Standard

Table 3: Results of physio-chemical parameters of water samples analyzed at the water treatment plant of the six hand-dug wells in the Cowfield Community, Duport Road indicating power of Hydrogen (pH), Turbidity, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Bacteria Count, Hardness, Well Type (WT) and Hand Dug Well (HDW)

Sample #	WT	pH	Turbidity (NTU)	TDS Mg/L	EC S/m	BC Cfu/ml	Hardness (ppm)
Well#1	H.DW	7.50	10	98	200	3/100	20
Well#2	HDW	7.40	12	102	120	4/100	45
Well#3	HDW	6.85	6	89	150	5/100	50
Well#4	HDW	7.0	5	95	205	8/100	25
Well#5	HDW	6.40	4	120	100	4/100	40
Well#6	HDW	6.50	5	100	98	6/100	30
WHO Standards		≤ 8.5	≤ 5	<100	<100	0/100	<500
LWQS Standar#1		≤ 8.5	≤ 5	<100	<100	0/100	<500

Table 4: Results of metallic parameters of sample water analyzed from hand dug wells at the water treatment plant indicating Sulfate (S), Iron (Fe), Phosporous (P), Copper (Cu) and Nitrite (N)

Sample	Well Type	S Mg/l	Fe ppm	P Mg/l	Cu Mg/l	N Mg/l
Well#1	H.DW	39	0.80	0.003	1.22	0.002
Well#2	HDW	42	0.05	0.04	0.35	0.003
Well#3	HDW	50	0.06	0.6	1.00	0.008
Well#4	HDW	45	0.015	0.08	0.65	0.012
Well#5	HDW	60	0.04	0.7	0.5	0.005
Well#6	HDW	55	0.09	0.65	0.4	0.006
WHO Standards		<250	≤0.1	≤0.05	≤0.5	≤0.001
LWQS Standar#1		<250	≤0.1	≤0.05	≤0.5	≤0.001

4.0 Conclusion

This research was carried out from December 2021 to March 2022, discovered that the location of pit latrine/septic tanks was in close proximity to hand dug wells in the study area thus affecting the groundwater quality within the Cowfield Community, Duport Road, Liberia. The level of contamination was fully analyzed by mean of water quality parameters (physio-chemical, metallic and measurement of closeness of water infrastructures to pit latrine/septic tanks in the study area. Due to the clones of the six hand dug wells to pit latrine/septic tanks, all of the wells were contaminated with micro- bacteria rending them unsafe for human consumption. There were high level of bacteria present in all the wells surpassing the World Health Organization and Liberia Water Quality Standards. All of the six hand dug wells meet the requirements of both physio-chemical and metallic properties of WHO/LWQS standards for drinking water. The six water infrastructures were unprotected (lack culvert lining) causing it to be more contaminated during the rainy season.

Finally, the research concluded that the close proximity of all the six hand dug wells to the pit latrine/septic tanks seriously affected the water quality. During the rainy season of every year, these wells are vulnerable to high contamination therefore creating major health issues to users within the study area. It is therefore suitable to maintain the 30 meters minimum distance requirement and protect the wells from infiltration of storm water during the time of flooding.

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