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Evaluation of Marondera urban area borehole water for human consumption in Zimbabwe

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Abstract

The increasing reliance on borehole water due to erratic municipal supply is a major global concern in relation to access to safe drinking water in urban communities across different countries and regions with climate change worsening the challenge. A quantitative and qualitative study was done between August and October 2024 in urban areas of Marondera town of Zimbabwe. The objective of this study was to map using QGIS and evaluate the quality of Marondera Urban borehole water, focusing on its suitability for human consumption. Thirty-one boreholes were mapped with 20% possibly under threat from open contamination sources. The majority (70%) of the water seekers at boreholes collect more than 100 litres/day/household for domestic use, with 60% being female, and with the elderly (over 60 years) and children (under 18) also participating. Water samples collected from six threatened boreholes were analysed for chemical, and microbiological parameters. The results for chemical analysis indicated that there was no significant difference in the presumed bad and good borehole water. Microbiological analysis did not detect any form of contamination. In support, the majority (60%) of the population in Marondera viewed borehole water as clean. However, 37% of the population viewed it as of poor quality and not safe to drink. However, most residents (77%) also have little knowledge about borehole drilling by-laws, making the community's health at risk due to lack of knowledge on proper siting of household boreholes. This study indicated that the community boreholes in Marondera urban are properly sited and the water is clean and safe to drink. Regular monitoring that includes community perceptions in the water management plan is critical for the supply of quality drinking water in Marondera Urban.

Keywords: Community perceptions, contaminations, drilling by-laws, patriarchal culture

1. Introduction

Water quality and access to safe drinking water is a global concern that affects communities across different countries and regions (WHO, 2015) ^[108]. While some countries have well-established water supply systems, many African countries still face challenges in providing clean and safe drinking water, particularly in high-density areas. As of 2019, an estimated 785 million people globally lacked access to basic drinking water (WHO, 2019) ^[110] and in the wake of climate change disrupting rainfall (Gosling, 2016) ^[38] and disruption of wetland recharge functions more people are likely to be affected. This water scarcity has driven desperate residents to sink boreholes and wells (Hofstra, 2016) ^[44]. In 2020, of the 79% of the African population that had access to basic drinking water service, only 29% had access to safely managed drinking water (UNICEF and WHO, 2022) ^[114]. This water scarcity in urban areas is mainly driven by population growth, rural to urban migration and urbanization (Dos Santos *et al.*, 2017) ^[30]. Before major urbanization and rural-urban migration induced population increase, water supply and water treatment plants were adequate for the initial urban planned population. However, the population explosion subsequently overwhelmed reticulation service provision and maintenance. Most of the reticulation pipes were made of cast iron and plastic that, with time, were rusting and weakening, respectively, leading to bursting. Such a burst would contaminate piped water and underground aquifers (Emmanuel, 2022) ^[117]. A combination of contaminated unsafe water, inadequate sanitation, and poor hygiene practices contributes to the spread of waterborne diseases, such as diarrhea, cholera, and typhoid (Thomas *et al.*, 2020) ^[99]. According to the Zimbabwe National Statistics Agency's Multiple Indicator Cluster Survey (2019), approximately 77% of households in Zimbabwe had access to water sources like piped water, boreholes, protected wells, and

protected springs. However, in terms of water it must be beyond access. There is a need to consider the quality of accessed water for human consumption. As such, the UN (2015) ^[102] indicated that access to clean and safe drinking water is of paramount importance for human health. These contaminated water sources harbor various pathogens like bacteria, viruses, and parasites posing a significant health risk. According to Mukucha (2019) ^[68] and Akpan (2016) ^[118], clean and safe drinking water is essential for the prevention of waterborne diseases such as Diarrhoea, Cholera, Typhoid fever, and Hepatitis A. Furthermore, the risk is even higher for infants, young children (with a developing immune system) and those people with immunocompromised defense systems (Ferguson *et al.*, 2017) ^[34]. Contaminated ground water sources can also lead to malnutrition and growth stunting, which can have long-lasting effects on child development (Ashbolt, 2015) ^[11]. All these problems necessitate a thorough investigation on the suitability of borehole water for human consumption.

The water crisis in Marondera is exacerbated by the increasing strain on the existing water infrastructure. As the population has grown and urbanization has accelerated (with several new phases of residential development such as Rusike Phase 2 and Rusike Phase 3), the demand for water has outpaced the capacity of the municipal water supply system. This has led to frequent water shortages and unreliable access to piped water, especially in the town's old residential low-income suburbs. In response to the water scarcity, many households, businesses, non-governmental

organisations and the Municipality of Marondera have turned to drilling boreholes for the community. However, the household borehole drilling is haphazard, unregulated and unsustainable, raising concerns about the long-term viability and quality of the underground water supply (Mukute *et al.*, 2020) ^[68]. If contaminated, the consumption of borehole water can lead to the intake of heavy metals or spread of waterborne diseases such as cholera, diarrhea and typhoid which can have significant public health implications (UN, 2010; 2015) ^[101, 102]. There is a lack of comprehensive information and research regarding the quality and safety of borehole water in high-density suburbs in Marondera. This study will address these concerns by providing evidence-based data on the suitability of borehole water for human consumption, thereby promoting informed decision-making among residents and the local authority. At the same time, there is a need to check the community's level of awareness on borehole drilling by-laws.

1.1 Materials and Methods

1.1.1 Study area

The study was conducted in Marondera urban which has a population of 66,204. Marondera is a town in Mashonaland East, Zimbabwe, located about 72 kilometers east of Harare (Figure 1). Marondera Urban gets its water from Rufara Dam and Wenimbi Dam which are 5 and 20.8 km, respectively from Marondera Town. Generally, Marondera lies in Zimbabwe's agro-ecological region IIa which receives about 700-800 mm of rainfall annually.

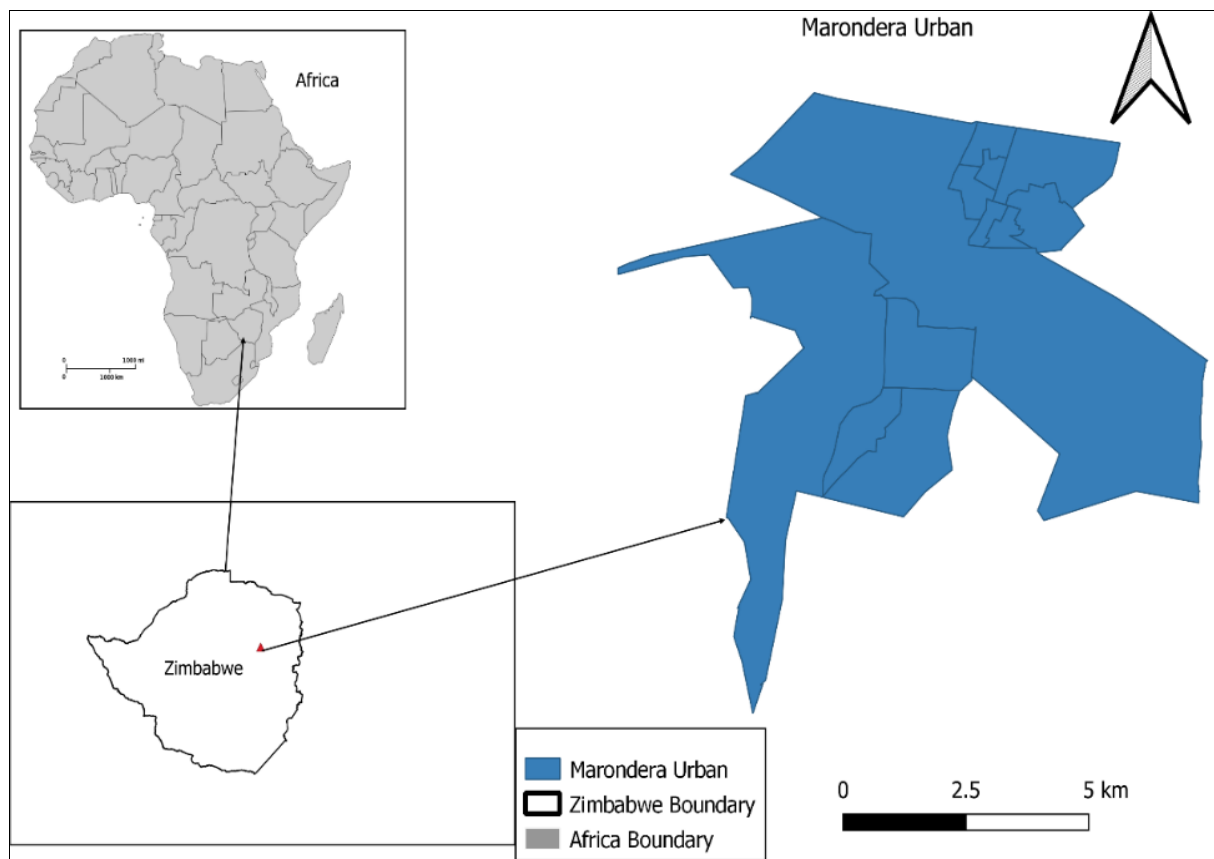


Fig 1: The study site map of Marondera town

1.2 Research Design: Both qualitative and quantitative methods were used in this research. Questionnaires were used to conduct in-depth interviews with households who directly use the borehole water. The questionnaires explored

water usage patterns, primary source for drinking water, water quality perceptions, and any issues or concerns they have experienced regarding borehole water (Appendix 1). Interviews were targeted at key stakeholders, such as

Municipality of Marondera, Environmental Management Agency (EMA) and GOAL, to gather their perspectives, concerns, and priorities regarding the borehole water and groundwater management. The interviews explored how the use and management of groundwater resources are influenced by social, economic, and environmental factors. To complement the qualitative data, quantitative data on water quality was determined following mapping of the borehole and water sampling. QGIS was used in mapping boreholes and possible contaminants sites, collecting the geographic coordinates (latitude and longitude) of the locations. Targeted suburbs were Rejeko, Dombotombo, Paradise Park, Nyameni and Cherutombo. Boreholes were randomly selected for water sampling from Dombotombo and Rujeko high density areas of Marondera town, representing the two oldest residential areas. The water samples were analysed at the Scientific Industrial Research and Development Centre (SIRDC) laboratories in Harare.

1.3 Water samples collection for chemical analysis: From the mapped boreholes (Figure 1), three from potentially contaminated sites and three from possible uncontaminated sites were collected. Clean 1litre bottles made of high-density polyethylene were used for water collection (Hounslow, 2018) ^[45]. Before collecting samples, the borehole was purged to remove stagnant water and water was allowed to flow for at least 5-10 minutes, ensuring a representative sample was obtained (Richardson *et al.*, 2018) ^[87]. The sampling containers were rinsed three times with the borehole water, discarding the rinsate to minimize contamination. The container was filled to about 80% capacity to allow for any expansion and care was taken to avoid touching the inside of the container or the cap during collection.

Once filled, the container was sealed immediately and labeled with waterproof labels with all relevant information, including date, time, and location (Csuros, 2018) ^[27]. In order to prevent contamination during the sampling process, new pairs of gloves were used for each sample. Collected samples were placed in an iced-cooler bag to keep them at a temperature of 4 °C and were sent to the laboratory within 6 hours (Palamuleni, 2015) ^[77, 78].

1.4 Water samples collection for biological analysis

For the boreholes sampled for chemical analysis, another set of water samples were collected for biological characterization. Sterile glass bottles (provided by SIRDC) with a volume of 200 ml were used. Disinfectant wipes and sanitizer were gathered for cleaning hands and surfaces prior to collection. A new pair of gloves was worn at each sample to minimize contamination during the sampling process and between each borehole. Prior to sample collection, the borehole was purged for 5-10 minutes to remove stagnant water and ensure a fresh sample. Each sterile container was rinsed with borehole water three times, discarding the rinsate to minimize the risk of contamination. The sample was collected by filling the container to the top without leaving any air space, ensuring no contaminants were introduced and care was taken to avoid touching the inside of the cap or the container during the process. Immediately after collection, the container was sealed and labeled with all relevant information, including the date, time, and location of collection. Samples were placed in the cooler with ice packs to keep them at a temperature of 4 °C and were transported within 6 hours of collection to the laboratory (Moyo, 2013) ^[64].

Table 1: Water analytical methods used in the study

Parameter (units)	Test method	Reference
pH @ 25°C	pH meter; calibrated with buffers pH 4, 7 and 10	Palamuleni <i>et al.</i> , 2015 ^[77, 78]
Electrical conductivity @25°C	Conductivity meter calibrated with 0.1 M KCl	Moenga, 2020 ^[63]
Carbonates and bicarbonates (ppm)	Carbonates and bicarbonates used titration with 0.05N H ₂ SO ₄ with phenolphthalein and methyl orange indicator, respectively	Abdella <i>et al.</i> , 2013 ^[1]
Chlorides (ppm)	Mohr titration with 0.2M AgNO ₃	Agwu <i>et al.</i> , 2024 ^[5]
Potassium and Sodium (ppm)	K and Na were read at 766.5 nm and 589.0 nm wavelength respectively basing on atomic emissions using the atomic absorption spectrometer with calibration standards in the range 5-20 ppm	Maimuna, 2018 ^[58]
Magnesium and Calcium (ppm)	Mg and Ca were read at 285.2 nm and 422.7 nm wavelength respectively basing on atomic absorption using the atomic absorption spectrometer with calibration standards in the range 5-20 ppm	Maimuna, 2018 ^[58]
Manganese, Zinc, Iron, Copper (ppm)	Mn, Zn, Cu and Fe were read at 279.5 nm, 213.9 nm, 324.8 nm, 248.3 nm wavelength respectively basing on atomic absorption using the standards calibrated in the range 0.5-3 ppm	Moenga, 2020 ^[63] ; Wafi, 2015 ^[104]
Heavy metals (Chromium, Cadmium, Lead, Cobalt, Nickel) (ppm)	Cr, Cd, Pb, Co and Ni were read at 357.9 nm, 228.8 nm, 283.3 nm, 240.7 nm, 232.0 nm wavelength respectively basing on atomic absorption using the standards calibrated in the range 0.5-3 ppm	Wafi, 2015 ^[104]
Total viable count	Cultured on plate count agar and incubated at 37 °C for 24 hrs.	Liao <i>et al.</i> , 2018 ^[56]
Total coliform count	Cultured on violet red bile agar at 37 °C for 24 hrs.	Adogo <i>et al.</i> , 2015 ^[4]
Fecal coliforms	Cultured on violet red bile agar at 44 °C for 24 hrs.	Juthi, 2016 ^[47]
<i>E. Coli</i>	Cultured on tryptone bile X-glucuronide (TBX) agar at 37 °C for 24 hrs.	Zouhri <i>et al.</i> , 2019 ^[116]

2. Results

2.1 Source of drinking water and quantity of water abstracted

Apart from municipal water, borehole water is a major

(83%) source of drinking water for people in Marondera urban (Figure 2). About 70% of the water seekers at boreholes collect more than 100 litres of water each day for domestic use (Figure 3). General observations in the area

showed increased pressure and long queues at boreholes during these early morning and late afternoon hours. It was also noted that 54% of people who fetch water at public boreholes were between the ages of 18-45 (Figure 4). The

elderly (over 60 years) and children (under 18) also take part in fetching water at these boreholes. The majority (60%) of these people who mostly fetch water at boreholes were female (Figure 4).

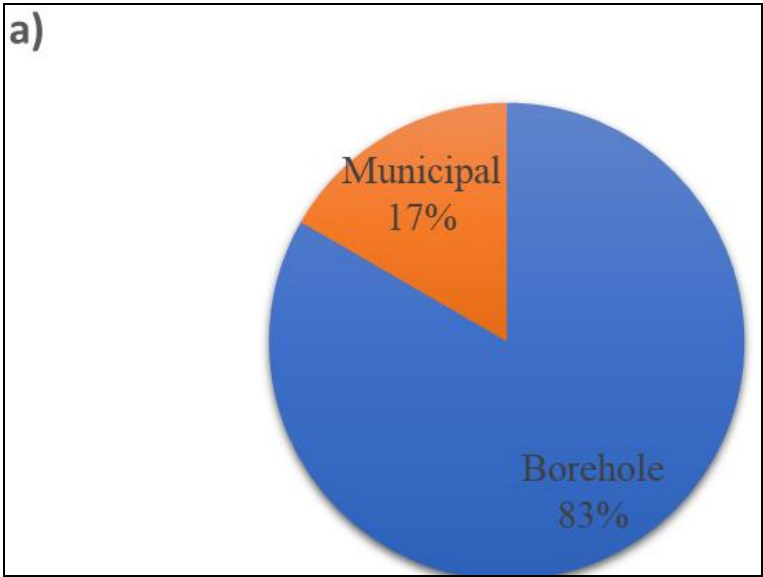


Fig 2: Sources of drinking water for Marondera Urban residents in October 2024

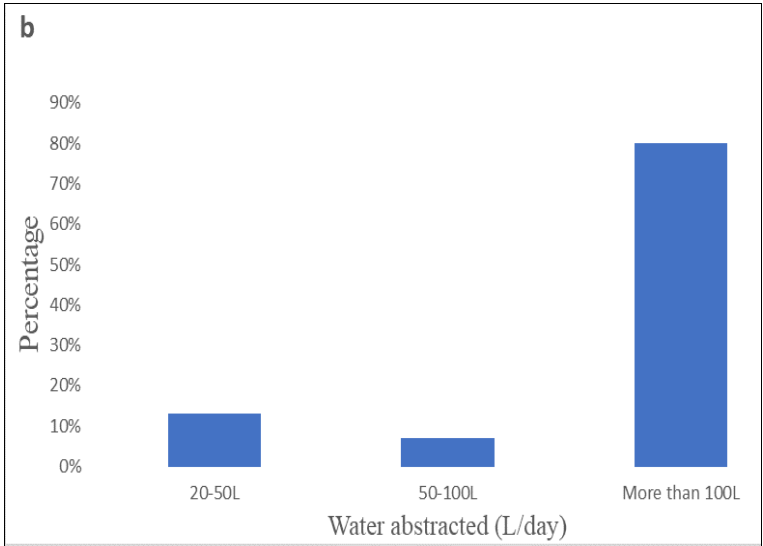
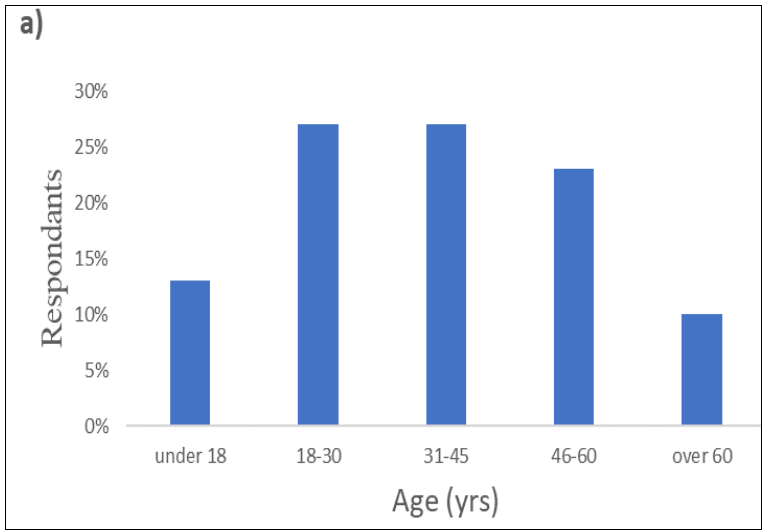


Fig 3: Quantity of water abstracted daily per household from boreholes in October 2024



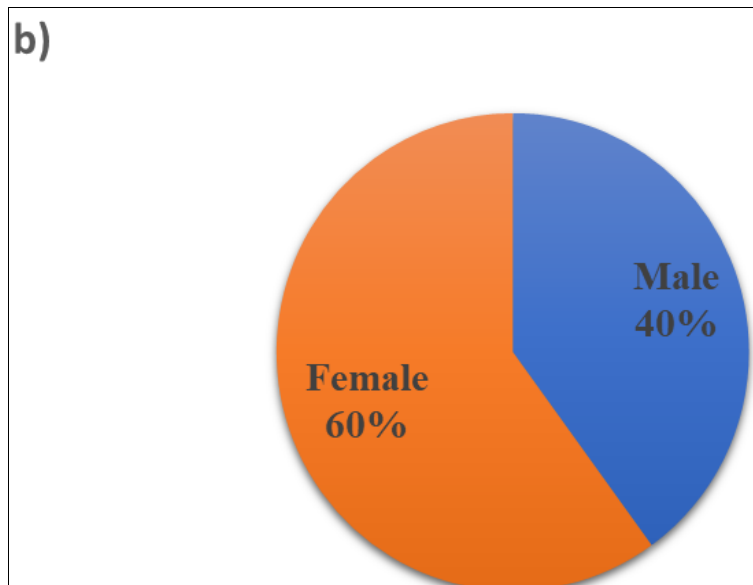


Fig 4: Age and gender of people who fetch water at boreholes- October 2024

2.2 Mapping of borehole and potential sources of contaminants Marondera urban

Thirty-one boreholes and six possible contamination sources were mapped (Figure 5). Boreholes were clustered in Wards 1-7 and associated with many possible sources of contaminants. Burst sewage pipes and blocked lines were

the main potential sources of contaminants. On the other hand, wards 8-12 had sparsely spaced boreholes and without any visible source of contaminants within the vicinity. As such, some of the boreholes were marked as good and bad sites as related to proximity to possible contaminants.

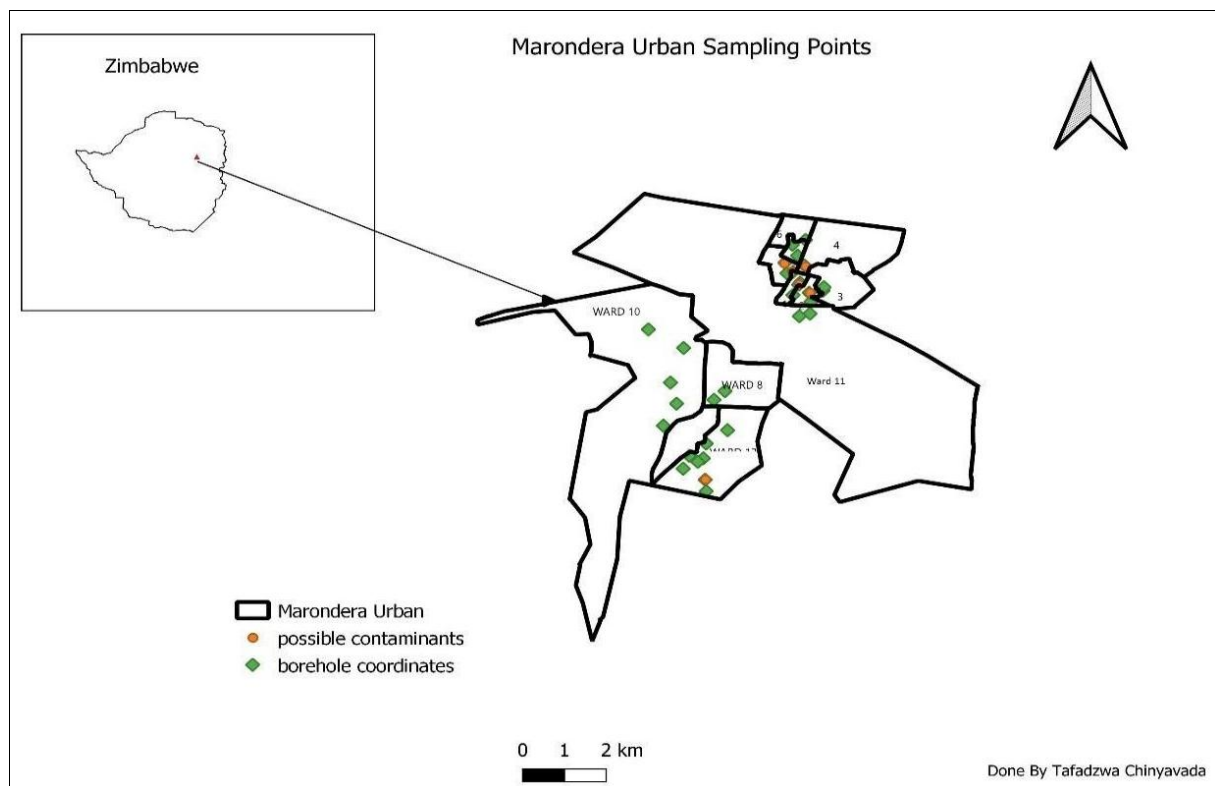


Fig 5: Marondera town borehole and possible contaminants site map

2.3 Water quality assessment results

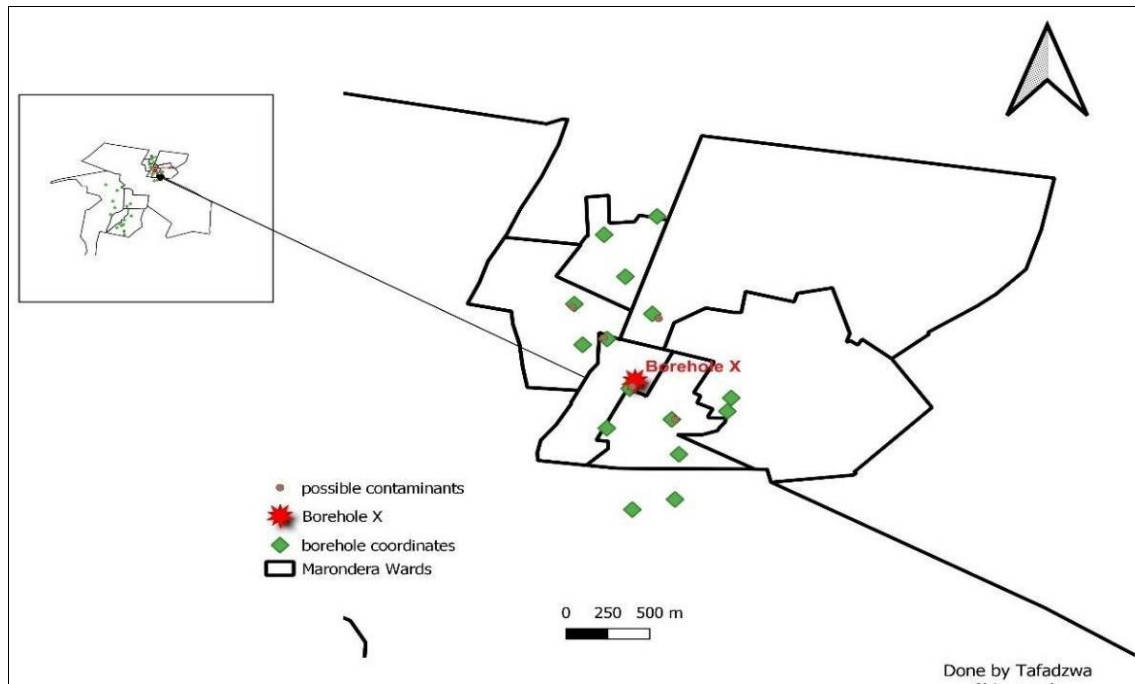
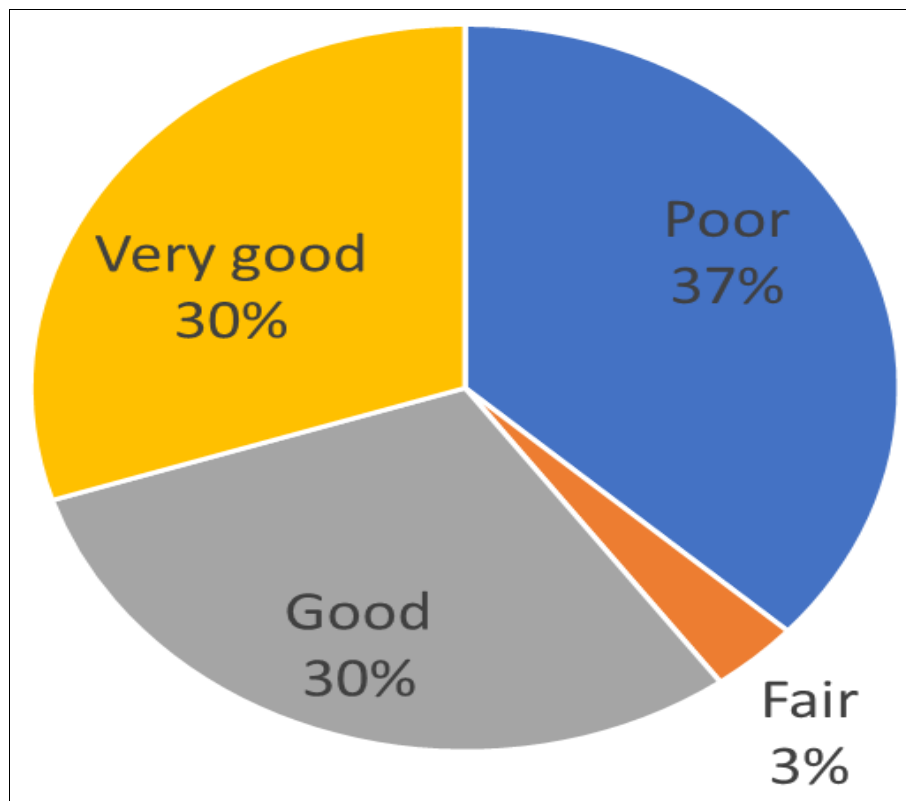
There was no significant difference in the presumed bad and good borehole water (Table 1). However, there was borehole X that had abnormally higher Fe than other boreholes (Figure 6) which was somehow diluted in the analysis. There were no microbial contaminants across all sampled boreholes in urban Marondera (Supplementary

Table 1). The majority (60%) of the population indicated that the water was clean and safe to drink. However, 37% of the population viewed the water to be of poor quality and not safe to drink (Figure 7). Henceforth, some members of the community mentioned the need for pretreatment of the water before use (Box 1).

Table 1: Chemical analytical results of borehole water collected in October 2024

Perceived status	pH	EC	Cl ⁻	K	Mg	Ca	Na	Zn	HCO ₃ ⁻	Fe	Mn, CO ₃ ²⁻ , Co, Cu
Good	6.13	237	36.7	7.85	3.54	8.8	19.5	0.29	4.07	0.54	**
Bad	5.63	158	19.7	6.57	2.20	5.4	14.8	0	1.02	0.11	**
P Value	0.302	0.234	0.125	0.548	0.314	0.307	0.245	0	0.101	0.355	**

N.B ** negligible

**Fig 6:** Borehole X with high levels of Fe**Fig 7:** Human perspective on quality of water from boreholes

Residents of Marondera urban have faced a challenging water crisis that profoundly impacts their daily lives. Many families reported that they are struggling with erratic municipal water supply, often going days without access to clean tap water. This situation is forcing them to rely on boreholes, a necessary alternative that is not always safe or reliable, leading to concerns about contamination and health risks. Many households reported that they are receiving water with a brownish hue, even after boiling, raising serious concerns about its safety and potability. This discoloration is often attributed to sediment, rust, and other contaminants, which not only makes the water unappealing but also poses health risks. For parents and children, the crisis means spending hours each week fetching water, which detracts from time spent on work or education, respectively. Moreover, the emotional stress of uncertainty about when water will be available adds to the burden. Community members often expressed frustration over the lack of adequate infrastructure and maintenance, underscoring the urgent need for effective solutions to ensure consistent and safe water access for everyone.

Box 1: Experience of water crisis in Marondera

2.4 The community's awareness on by-laws about borehole drilling

The majority (77%) of the population were not aware of

policy and guidelines for borehole drilling. Only 23% of the population has some knowledge about borehole drilling by-laws (Figure 8).

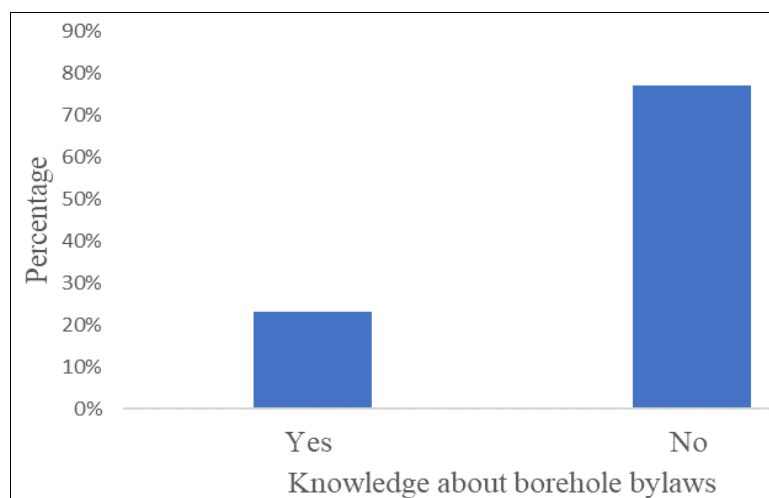


Fig 8: Community's awareness on borehole drilling by-laws

3. Discussion

3.1 Source of water, quantity, age and gender

The majority of people (83%) in Marondera Urban fall back on borehole water as their primary source of drinking water linked to erratic supply of municipal water. Given the value of water at the household level, people tend to find alternative sources of water for their survival. Aging infrastructure and inadequate maintenance result in piped water provision disruptions, prompting residents to seek alternative sources (Pamdimukkala *et al.*, 2021; Thompson *et al.*, 2024) ^[79, 119] as noted in this study. The approval of well-sited borehole drilling with Marondera urban indicates their commitment to water provision as a basic human right (Mukucha, 2019) ^[67]. Dube (2019) ^[31] identified complex challenges within Marondera Municipality in its efforts to provide reliable and safe piped water to households, which shows that these boreholes are critical for the residents. The fact that most people within these residential areas travel less than 500 m to fetch water (Supplementary Figure 1) confirms the municipality's commitment to human rights adherence in terms of water supply. This also supports

access to clean water as articulated under Sustainable Development Goal 6. The abstraction of more than 100 litres of water daily per household is indicative of the erratic supply of piped water. Such a high requirement of water per household correlates well with the long queues in the early morning and late afternoon hours, similar to the observation by Omaghomi *et al.* (2020) ^[76]. On the other hand, the availability of a high volume of water from the boreholes each day is indicative of proper siting of the boreholes by the Municipality and NGO. However, in the wake of climate change-induced disruption of water recharge (with low seasonal rainfall amount), there is a need for regular monitoring of groundwater levels for making informed decisions regarding groundwater management (Thomman *et al.*, 2022) ^[98]. Traditionally, water collection has been viewed as a task primarily undertaken by women and girls (Wallace *et al.*, 2020) ^[105]. This trend was evident in Marondera Urban, where a significant percentage of water collectors were female (60%). In African countries particularly rural areas, cultural expectations dictate that women are responsible for fetching water (Akanle *et al.*,

2016)^[120]. This study also showed the deep-rooted patriarchal culture in Zimbabwe that extends into urban areas, affecting girls and women. According to Naiga *et al.*, (2024)^[121] such a system will continue side-lining women from education and decision-making spaces. This reinforces gender roles and can limit women's opportunities for education and employment. Women often bear the primary responsibility for family health and well-being, leading them to prioritize water collection as a vital task (Caruso *et al.*, 2022)^[17]. Carrying heavy loads of water can also pose physical health risks for women, including musculoskeletal injuries (Greere, 2020)^[122]. There is a need to educate men on the importance of helping women to fetch water so as to relieve women from the burden of fetching water at boreholes daily (Apatinga *et al.*, 2024)^[9].

Adults, mainly women aged 18-45, are the primary collectors of water at Marondera Urban public boreholes. However, even the elderly participate in water collection, often due to the physical demands placed on younger family members or when they lack alternative water sources. Older women who continue to fetch water may experience physical strain, affecting their health and well-being. As such, the municipal authorities must come up with ideas to assist the elderly in this respect. It was also noted that children (under 18 years) fetch water at boreholes before they go to school and after school on a daily basis. Children who fetch water before school may arrive late, missing important lessons and instruction (Cooper *et al.*, 2024)^[25]. Again, the time spent collecting water after school reduces the time available for homework and study, potentially impacting academic performance. As such, there is a need for some funding to be allocated to upgrading of the water treatment plant and replacement of the water conveyance system for the provision of piped water.

3.2 Boreholes water quality in Marondera urban

Despite the identified possible contaminants, and clustered boreholes in Dombotombo and Rujeko residential areas, there was no microbial contamination while the heavy metals were within the WHO guidelines. This could be attributed to the dry season, where little erosion and leaching were taking place. The analytical results (chemical and biological) aligned with the WHO guidelines (Appendix 4) showing that the water is not contaminated and is safe for human consumption. It also confirms proper borehole siting made by the NGOs and the Municipality of Marondera. However, the high iron at borehole X is most likely linked to old rusting casing since another nearby borehole was of good quality. Such high iron in borehole water can be linked to natural sources and steel pumps (Samuel *et al.*, 2018; Mutshamwa *et al.*, 2024)^[69, 91]. There is a need for casing replacement of the borehole to reduce iron contamination. Most of the boreholes had pH < 6.5, which can be attributed to carbon dioxide release by microbes that react with water to form carbonic acid subsequently acidifying the water (Hussain *et al.*, 2017)^[42]. To curb this problem, the council must conduct thorough inspections of existing borehole casing to evaluate their condition, identifying sections that are deteriorating or at high risk of contamination. Despite the council having a detailed inventory of all sewer infrastructure, including age, material, and condition, to prioritize areas needing immediate attention, the issue of finance remains a challenge. Engaging with other stakeholders for funding or utilisation of the devolution funds from the government of Zimbabwe would ease the water situation in Marondera. Apart from chemical and biological analysis for water quality assessment, the social

aspect is also critical in water quality assessment. Water quality directly affects community health (Strosnider, 2017)^[94]. Thus, understanding social factors, such as demographics and health disparities, helps identify vulnerable populations at greater risk from poor water quality. Assessing social conditions helps determine whether communities have equitable access to safe drinking water and sanitation, which is fundamental for quality of life (Ezrhake *et al.*, 2019)^[33]. Community attitudes towards water quality can influence usage patterns and acceptance of water sources, impacting overall well-being. The differential views on water quality by the community indicate the need for public awareness and education.

3.3 Borehole drilling by-laws

Borehole drilling has become an increasingly common practice in Marondera due to the growing need for reliable water sources, particularly in the face of inconsistent municipal supply. However, this trend raises important questions regarding the establishment and enforcement of borehole drilling by-laws. By-laws can help regulate the number and placement of boreholes to prevent over-extraction and ensure the sustainable use of groundwater resources (Retsheditswe *et al.*, 2024)^[85]. The majority of people in Marondera urban are not aware of the by-laws which govern the drilling, the importance of adhering to them, and the siting of boreholes, leading to improper drilling practices and potential resource depletion. The council must make sure that by-laws on borehole drilling are publicized. Involving community members in the development and enforcement of borehole regulations can foster a sense of ownership and responsibility for local water resources. According to Samukwo *et al.* (2021)^[96], the by-laws should cater beyond drilling with aspects of maintenance and monitoring to be covered. Results from routine water analyses also need to be published as this increases confidence from the community.

4. Conclusion

The study showed that Marondera urban has many public boreholes and 31 of these boreholes were mapped from 5 suburbs. Six possible contamination sources were mapped that translated to 20% of the mapped boreholes to be under threat. Water analysis of endangered boreholes did not detect any form of contamination for microbial and chemical tests except for one borehole X which showed high levels of iron. This indicated that the boreholes in Marondera urban are properly sited and the water is clean and safe to drink. Most residents also have little knowledge about borehole drilling by-laws, making the community's health at risk due to lack of knowledge on proper siting of these boreholes. However, there are many private boreholes (at residential stands) which exist in the community which have not been assessed for quality.

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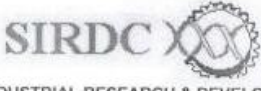
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Appendices

FQF 7.8/2



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Analytical Services

Test Report No. MIC/ Q0072 Page 1 of 2

MICROBIOLOGY TEST REPORT FORM

Sample details:				Customer details:			
Sample Laboratory reference number: Q0072				Customer name: Tafadzwa Chinyavada			
Sample description: Drinking water				Customer contact person: Tafadzwa Chinyavada			
Date sample received: 08/10/2024				Customer address: 2888 Roosevelt, Winston Park, Marondera			
Date sample tested: 08/10/2024				+263 77 287 9433			
Date of issue: 08/10/2024							

Test results:

Sample Identity	Test parameter	Total viable count		Total coliform count		Fecal coliforms		E. Coli	
		Test method	Plate count	Test method	Plate count	Test method	Plate count	Test method	Plate count
Lab number	Customer reference	Sample result (cfu/ml)	WHO Guideline	Sample result (cfu/ml)	WHO Guideline	Sample result (cfu/ml)	WHO Guideline	Sample result (cfu/ml)	WHO Guideline
Q0072(7)	Methodist Church	NOT DETECTED	1.0 X 10 ²	NOT DETECTED	0	NOT DETECTED	0	NOT DETECTED	0
Q0072(8)	Horwe	NOT DETECTED	1.0 X 10 ²	NOT DETECTED	0	NOT DETECTED	0	NOT DETECTED	0
Q0072(9)	Tsimba Shops	NOT DETECTED	1.0 X 10 ²	NOT DETECTED	0	NOT DETECTED	0	NOT DETECTED	0
Q0072(10)	Sungano	NOT DETECTED	1.0 X 10 ²	NOT DETECTED	0	NOT DETECTED	0	NOT DETECTED	0

DISCLAIMER: "These results relate only to the sample as received by the Laboratory, FBTI accepts no liability for the traceability or Quality of samples prior to receipt by the laboratory, either of which may compromise the quality of test results generated"

FBTI ASI Test Report FQF 7.8/2 Revision 0 Date of Issue: 01/05/2023

FQF 7.8/2

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Test Report No. MIC/ Q0072

Q0072(11)	Dombotombo Market	NOT DETECTED	1.0 X 10 ⁶	NOT DETECTED	0	NOT DETECTED	0	NOT DETECTED	0
Q0072(12)	Mahwata Flats	NOT DETECTED	1.0 X 10 ⁶	NOT DETECTED	0	NOT DETECTED	0	NOT DETECTED	0

Analyzed by: P. Mhizha (P. Mhizha) Analyst Date: 09/10/2024

Approved by: T. Ndhlovu (T. Ndhlovu) Technical Signatory Date: 9/10/2024

Authorized by: N.H. Paul (N.H. Paul) Director -FBTI Date: 09/10/2024

DISCLAIMER: "These results relate only to the sample as received by the Laboratory. FBTI accepts no liability for the traceability or Quality of samples prior to receipt by the laboratory, either of which may compromise the quality of test results generated"

FBTI ASL Test Report FQF 7.8/2 Revision 0 Date of Issue: 01/05/2023

Appendix 1: microbiological test report form

8FQF06

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Analytical Services

Test Report No. WC/Q0072 Page 1 of 2

WATER CHEMISTRY TEST REPORT FORM

Sample details:		Customer details:	
Sample Laboratory reference number: Q0072		Customer name: Chinyavada Tafadzwa	
Sample description: Water		Customer contact person: Chinyavada Tafadzwa	
Date sample received: 08/10/24		Customer address: 2888 Roosevelt Wiston Park, Marondera	
Date sample tested: 09/10/24- 15/10/24			

Test results:

Parameter (units)	Test Method	Q0072 -1 Horwe Rujeko	Q0072 -2 Mahwata Flats	Q0072 -3 Tsimba Shops	Q0072 -4 Methodist Church	Q0072 -5 Sungano	Q0072 -6 Domboto mbo Market	WHO Guidelines: Drinking water
pH@25°C	pH meter	5.04	6.21	6.22	6.51	5.65	5.66	6.50 - 8.50
Electrical conductivity @25°C (µS/cm)	Conductivity meter	150.30	100.40	246.00	308.00	223.00	157.00	3000
Carbonates (ppm)	Phenolphthalein titration	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	250
Bicarbonates (ppm)	Methyl orange titration	<0.01	<0.01	3.05	6.10	3.05	3.05	1000
Chlorides (ppm)	Mohr Titration	18.00	12.00	49.00	37.00	29.00	24.00	250
Potassium (ppm)	Atomic Emission	6.17	4.64	7.19	10.71	8.91	5.65	12
Magnesium (ppm)	Atomic Absorption	1.94	1.21	2.60	5.44	3.46	2.57	50
Calcium (ppm)	Atomic Absorption	5.10	2.53	5.57	13.60	8.41	7.31	100
Manganese (ppm)	Atomic Absorption	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.5
Zinc (ppm)	Atomic Absorption	<0.01	<0.01	<0.01	0.47	<0.01	0.40	3.00
Copper (ppm)	Atomic Absorption	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	2.00
Sodium (ppm)	Atomic Emission	15.29	10.88	22.88	21.68	18.18	14.04	200
Iron (ppm)	Atomic Absorption	0.03	0.08	0.26	1.34	0.21	0.01	1.00
Cobalt (ppm)	Atomic Absorption	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	Not mentioned

These results relate only to the samples tested.
This test report shall not be reproduced except in full and with the written authority of FBTI

Analytical Services Test Report Form TF-REC-5.10 Revision 0

Appendix 2: Water chemistry test report form