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*Full Length Research Paper*

# Evaluation of water quality in Abeokuta, Southwest Nigeria

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**Groundwater is an economic resource and more than 85% of the public water for consumption in Nigeria is obtained from groundwater. This source of water is of great use for domestic, industrial, and agricultural purposes. Groundwater in Abeokuta is largely derived from the aquifers within coastal plain. The water in this formation is however not always suitable due to urban waste disposal and sea water intrusion. Water samples from 1,712 wells, streams and boreholes within Abeokuta metropolis were sampled for chemical and physical parameters. Results showed low values of Total Dissolved Solids and Electrical Conductivity implying that samples tested largely fall in the category of fresh water. The conductivity values showed some level of impurity but at the level that may not pose serious health risk to human health.**

**Key words:** Electrical conductivity, total dissolved solids, control chart, groundwater.

## INTRODUCTION

Nigeria is the largest country on the West coast of Africa with an estimated population of 140 million people, with about 43 % of the populace living in cities or urban areas (Charles, 2011). The rate of urbanization in Nigeria is alarming and the major cities are growing at rates between 10 to 15% yearly. Most well water in Abeokuta, the capital city of Ogun state, Nigeria obtains water from the aquifers within the coastal plain (Adampson, 1996). The water in this formation is however not always potable due to urban waste disposal and sea water intrusion (Vrba, 2011). Other possible sources of dissolved solids in groundwater include atmosphere inputs in the form of wet and dry deposition and weathering of minerals in soils which can often dominate the water chemistry (Asfaw, 2010).

Water is an essential natural resource for sustainability of life on earth. Humans may survive for several weeks without food, but barely few days without water because constant supply of water is needed to replenish the fluid lost through normal physiological activities such as respiration, perspiration and urination (Shalom et al., 2011). Many infectious diseases are transmitted by water through oral route while diseases contacted through drinking water kill about 5 million children annually and make 1/6$^{th}$ of the world population sick (Shittu et al., 2008). Groundwater which is widely distributed under the ground is a renewable resource and includes all water found beneath the earth's surface. Groundwater is an economic resource and more than 85% of the public water for consumption is obtained from groundwater. According to Houston (1995) the bedrock over much of Africa is of Precambrian formations, which are dominated by relatively impermeable crystalline rocks such as granites, schist, gneiss and quartzite. It was often necessary to drill 60 to 80 m deep, with wells often yielding less than 2 m$^3$/day (Dijon, 1981). Selby (1985) reported that rocks often break down quickly, producing a zone of weathered materials of laterite and the surface soils are often underlain by red-brown silty clay, which does not function as a good aquifer. (Ufoegbune et al. (2009) reported that all groundwater can be said to originate as atmospheric or surface water and principal sources of natural recharge of groundwater are falling precipitation that eventually percolates, and seepage from the stream flow in channels, lakes and reservoirs.

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This surface water, which is the major source of water consumption in Abeokuta, has a very low output especially during the dry season when the evaporation rate is high (and precipitation is lower than annual average). Most sachet water industries depend on the water from the state water corporations and this has increased the problem of water scarcity especially during dry season. Hand dug wells is usually a common alternative during rainy season, but poses problem during dry season because the required depth would not have been reached due to the terrain. Borehole is usually not affordable for most of the population being very expensive to drill.

Ground water should have been an alternative source of water but there is a great problem about locating high productive aquifers in different parts of Abeokuta which lies within the basement complex rocks. The rocks are of Precambrian age to early Palaeozoic age and they extend from the North-Eastern part of the Ogun state (which Abeokuta belongs) running South-Westward and dipping towards the coast Ufoegbune et al. (2009). The common metamorphic rocks encountered are gneiss, schist, quartzite and amphiboles. Abeokuta occupies about 40.63 $km^2$ area lying between latitudes 7° 10'N and 7° 15'N and longitudes 3° 17'E and 3° 26'E, and is characterized by various rock types ranging from, granite granitic gneiss and pegmatite. Though good drinking water quality is essential for the well-being of people, yet in many developing countries has become heavily contaminated, with attendant impact on the health and economic status of the population (Akoto and Adiyiah, 2007). Contaminants such as heavy metals, nitrates and salt have often found their ways into water supplies as a result of inadequate or inappropriate treatment and disposal of waste (human and livestock), industrial discharges and overuse of limited water resources (Akoto and Adiyiah, 2007).

Total dissolved solids (TDS) in water originates from natural sources, sewage, urban and agricultural run-off, and industrial waste water. Salt used for road de-icing can also contribute to the TDS loading of water supplies. Concentrations of TDS from natural sources have been found to vary from less than 30 mg/L to as much as 600 mg/L, depending on the solubility of minerals in different geological regions (WHO/UNEP, 1989). Electrical conductivity (EC) is a measure of the ease with which electrical current can pass through water, and is usually measured using a portable conductivity probe and metre.

Potable water from the water supply board in Abeokuta is inadequate for the teeming populace and fears of contamination is high since water treatment and distribution is fast becoming difficult. According to Yusuf (2007), only 29% of people that lives in cities have access to improved water source making a large percentage (over 70%) of the population of the neighbourhoods studied to depend on groundwater from their private wells as the main source of drinking water.

With this in mind, a study of the quality of the Abeokuta ground water was carried out to determine variations in physical and chemical concentrations using electrical conductivity and total dissolved solids as critical parameters. The objective was therefore to evaluate the quality of water in Abeokuta as a function of Total Dissolved Solids and Electrical Conductivity. This was with a view to contributing to the sparse literature on urban ground water pollution in developing countries.

## MATERIALS AND METHODS

Ground water samples were collected from 500 wells across the city at depths ranging from 5 to 80 m during the months of July to September 2010 using 100 ml polyethylene bottle. Electrical Conductivity and Total Dissolved Solids (TDS) were measured using conductivity meter (3000 µS/cm). Samples were unfiltered, and as such, the concentrations reported were probably in excess of true dissolved values but close to the total concentration imbibed by the consumers.

The three sources of water selected for this work (wells, streams and boreholes) form the major sources of water in Abeokuta especially because public water supply is erratic and unpredictable. More wells exist in the area than boreholes owing to relative cheapness. Streams occur naturally and some inhabitants especially in the suburbs still rely on them for drinking. Water samples were collected and analysed on local government basis for convenience of grouping. Each local government was sub-divided into twelve areas for ease of collection and analysis.

### Description of the study area

The climate of Nigeria, including that of the study area is tropical with an annual rainfall of approximately 1408 mm. Eighty percent of the annual rainfall (1160 mm) falls during the South West monsoon (April-October) and the remaining twenty percent (250 mm) falls during the North East monsoon (November-March). The air is very humid throughout the year, with monthly average temperatures ranging from 28°C in July/August to 32°C in February/March.

## RESULTS AND DISCUSSION

The physical and chemical parameters of water from the 1,712 wells, streams and boreholes sampled in Abeokuta were analysed using control chart to evaluate the suitability of the groundwater for human consumption.

### Control chart

A control chart is a statistical tool used to distinguish between variation in a process resulting from common causes and variation resulting from special causes. It presents a graphical display of process stability or instability (Doh, 2011). Process stability is defined as a state in which a process has displayed a certain degree of consistency in the past and is expected to continue to do so in the future. This consistency is characterised by a stream of data falling within control limits based on plus or minus 3 standard deviation (3 sigma) of the centre line (Wheeler and Chambers, 1992). Control chart is also used to monitor process variation overtime, differentiate between special cause and common cause variation, assess the effectiveness of changes to improve a process and communicate how a process performs during a specific period. In general, the chart contains a centre line that represents the mean value for the in-control process and two other horizontal lines, called the Upper Control Limit (UCL) and the Lower Control Limit (LCL). These control limits are chosen so that almost all of the data points will fall within these limits as long as the process remains in-control (NIST, 2011). A data outside the control limits implies that the process is probably out of control and that an investigation is warranted to find and eliminate the cause. “In-control” implies that all points are between the control limits and form a random pattern (NIST, 2011).

## RESULTS ANALYSIS

Each Local Government is divided into 12 areas but not all data collected were available in all the 12 areas of each Local Government. Charts were plotted using the mean and range while the range control chart is basically to validate the mean control chart.

### Total dissolved solids (TDS) in water from wells, streams and borehole in Odeda Local Government

The average TDS in water from wells in the Local Government is 170.8133 mg/L while the LCL is 106.8668 mg/L and the UCL is 234.7596 mg/L. Figure 1a showed that Areas 7, 9 and 11 violated the control rule having TDS values falling outside the control limits thus suggesting that water from Odeda Areas 7, 9 and 11 wells may not be suitable for human consumption. However, Figure 1b showed that only Area 7 violated the control rule using the range control chart. This confirms that well water from Area 7 has excess TDS which makes it not suitable for consumption. Well water from Areas 9 and 11 may still be tolerated as they did not violate the control rule (Figure 1b). The average TDS in water from streams in the Local Government is 100.5432 mg/L while the LCL is 82.9079 mg/L the UCL is 138.1785 mg/L. Figure 2a showed that Areas 2, 3 and 6 violated the control rule having TDS values falling outside the control limits thus suggesting that water from streams in these Areas may not be suitable for human consumption. Since none of the Areas violated the control rule in the range control chart shown in Figure 2b, water from streams in these Areas may not pose serious threat to human health. The average TDS in water from borehole in the Local Government is 178.5714 mg/L while the LCL is -19.0941mg/L and the UCL is 376.2370 mg/L. Figure 3a showed that no area violated the control rule since all the TDS values fall within the control limits. However, only water from Area 5 violated the control rule using the range control chart shown in Figure 3b. This does not necessarily invalidate the earlier observation as the mean control chart is the real test of validity. It could be seen from Figures 1a to 3b that water from boreholes and wells has values of TDS very close with water from streams having the least. This might be due to the fact that same amount of mineral deposit in the area are within the depth of the wells and boreholes.

### Total dissolved solids (TDS) in water from wells, streams and borehole in Obafemi Owode Local Government

The average TDS in water from wells in the Local Government is 203.6548 mg/L while the LCL is 153.2505 mg/L and the UCL is 254.0590 mg/L. Figure 4a showed that Areas 3 and 4 violated the control rule having TDS values falling outside the control limits. This suggests that water from Obafemi Owode Areas 3 and 4 wells may not be suitable for human consumption. However, figure 4b showed that the areas did not violate the control rule suggesting that water from wells in these areas could still be tolerated. The average TDS in water from stream in the Local Government is 161.4127 mg/L while the LCL is 118.4128 mg/L and the UCL is 204.4126 mg/L. Figures 5a and 5b showed that no Area violated the control rule since all the TDS values fall within the control limits. This shows that water from streams in the Local Government is safe for human consumption. The average value of TDS in the Local Government is 131.5000 mg/L while the LCL is 96.3304 mg/L and the UCL is 166.6696 mg/L. Figures 6a and 6b showed that no Area violated the control rule since all the TDS values fall within the control limits. This shows that water from borehole in the Local Government is safe for human consumption. It could be seen from figures 4a to 6b that water from borehole in the Local Government has the least TDS values (131.500 mg/L) followed by water from streams with water from wells having the least values. This suggests that TDS in the Local Government is depth dependent.

### Total dissolved solids in water from wells, streams and borehole in Abeokuta South Local Government

The average value of TDS in water from wells in the Local Government is 138.5833 mg/L while the LCL is 102.7185 mg/L and the UCL is 174.4481 mg/L. Figure 7a showed that water from wells in Area 11 violated the control rule having values of TDS outside the control limits. However, figure 7b showed that Area 11 did not violate the control rule suggesting that the TDS values of water in the Area could still be tolerated. The average

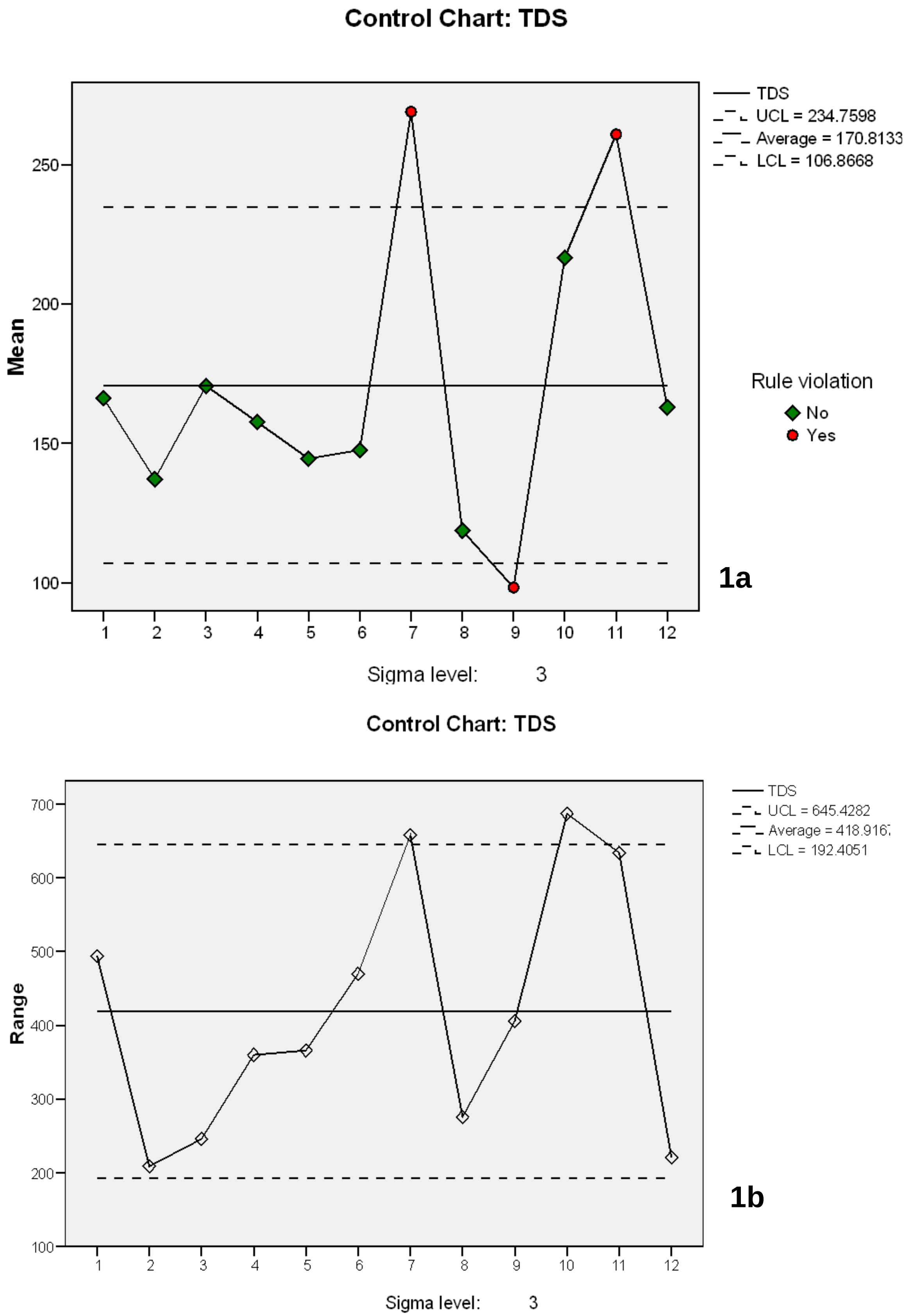



**Figure 1.** Total dissolved solids (TDS) control chart for wells in Odeda Local Government (1a) using mean and (1b) using range.

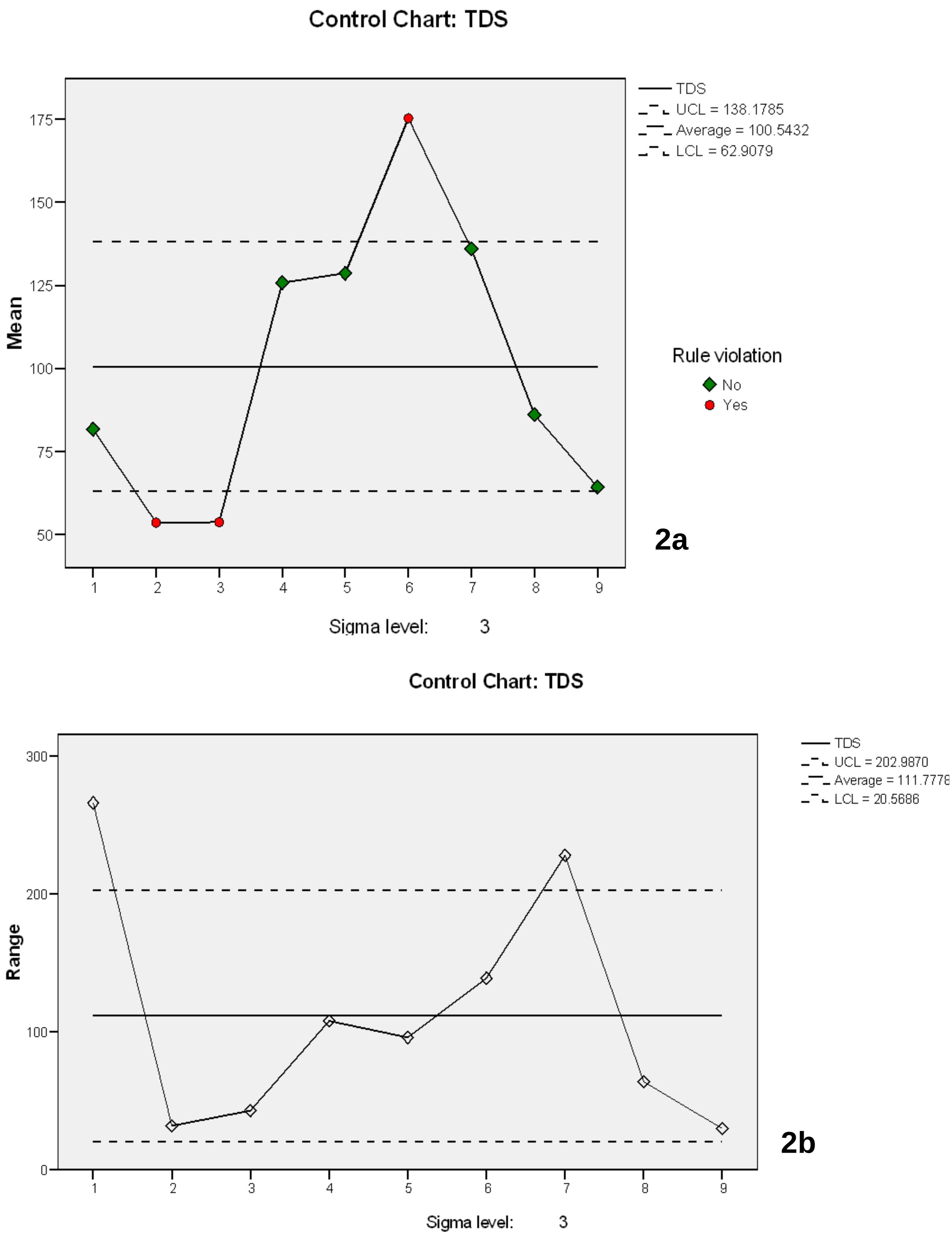



**Figure 2.** Total dissolved solids (TDS) control chart for streams in Odeda Local Government (2a) using and (2b) using range.

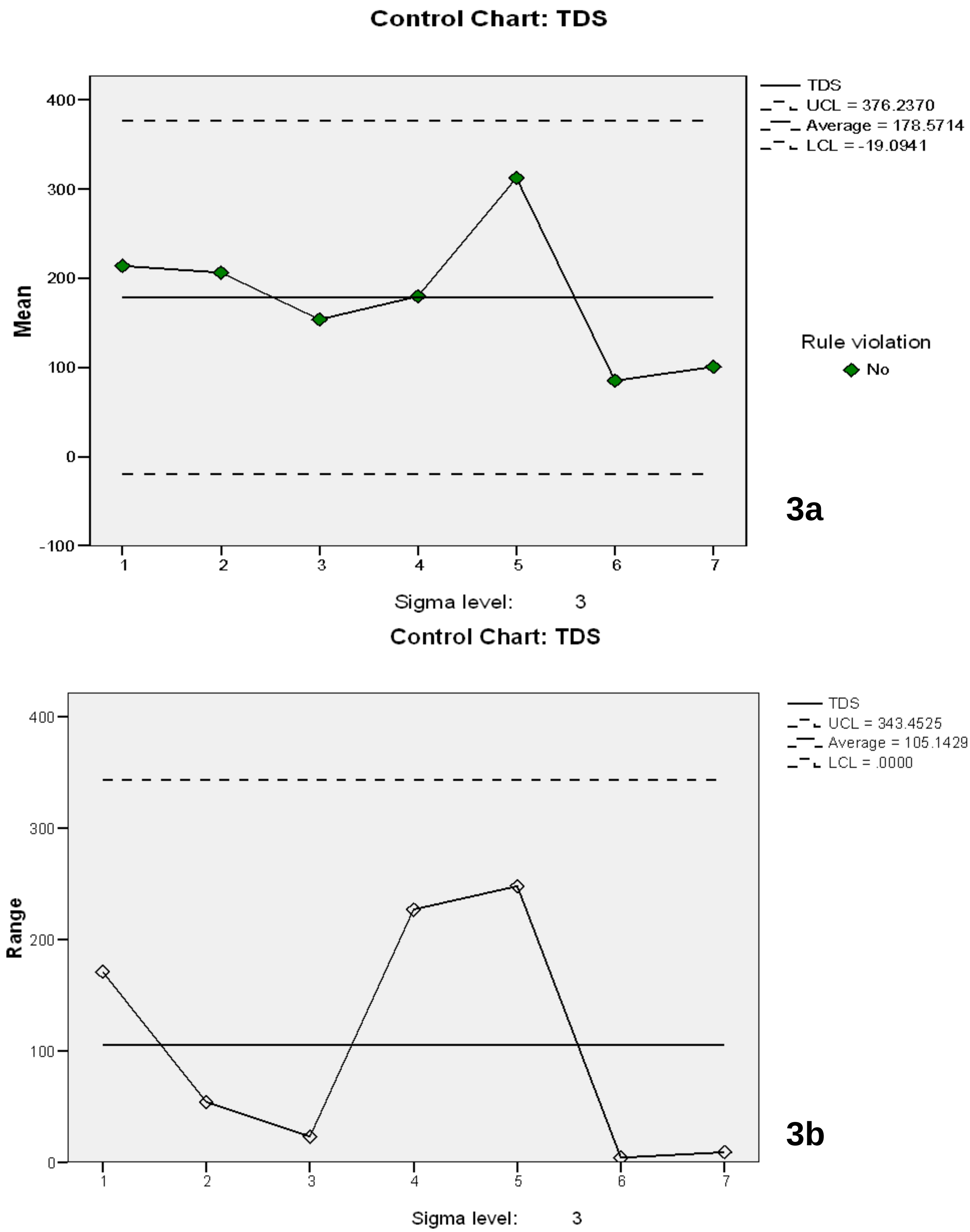



**Figure 3.** Total dissolved solids (TDS) control chart for borehole in Odeda Local Government (3a) using mean and (3b) using range.

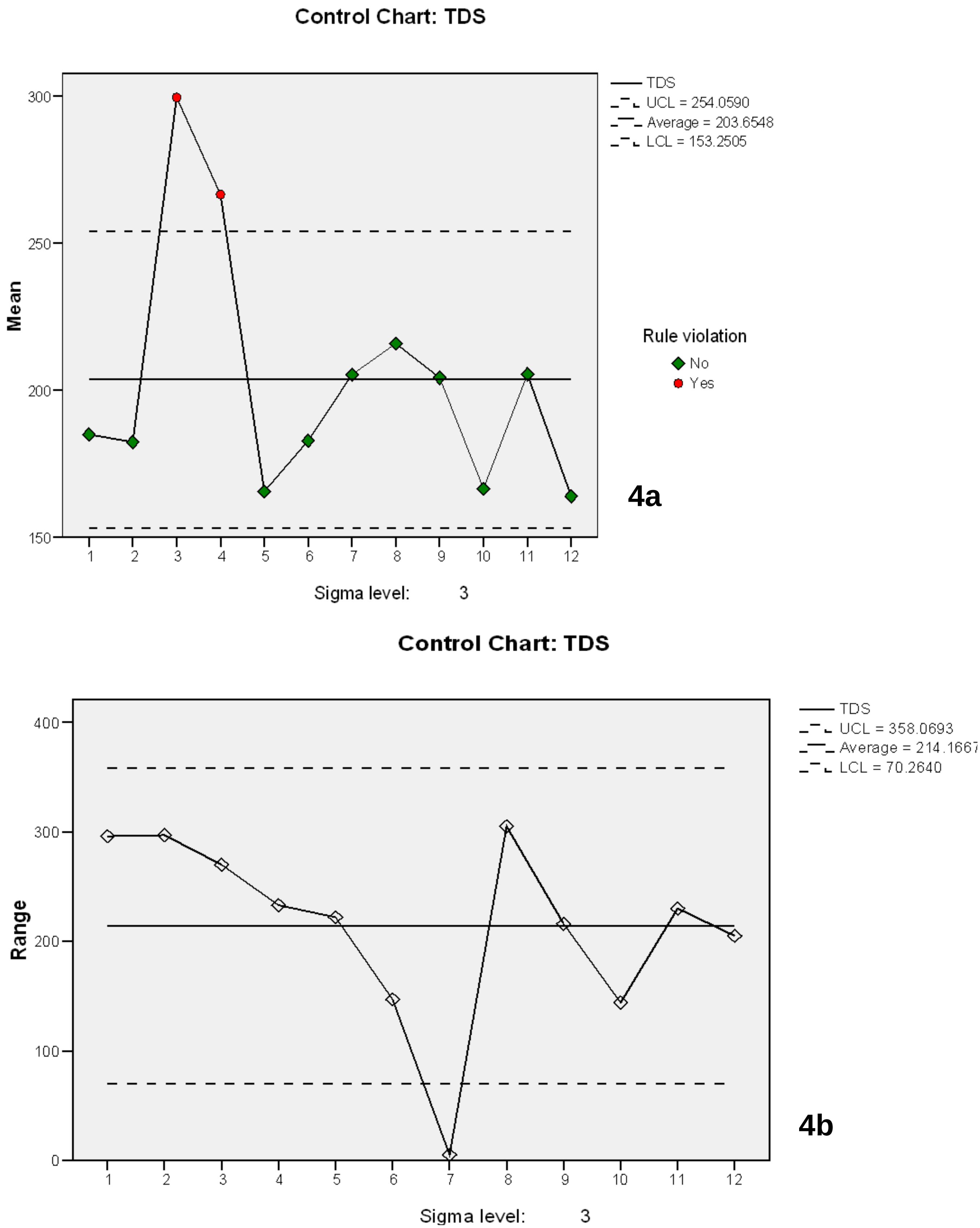



**Figure 4.** Total dissolved solids (TDS) control chart for wells in Obafemi Owode Local Government (4a) using mean and (4b) using range.

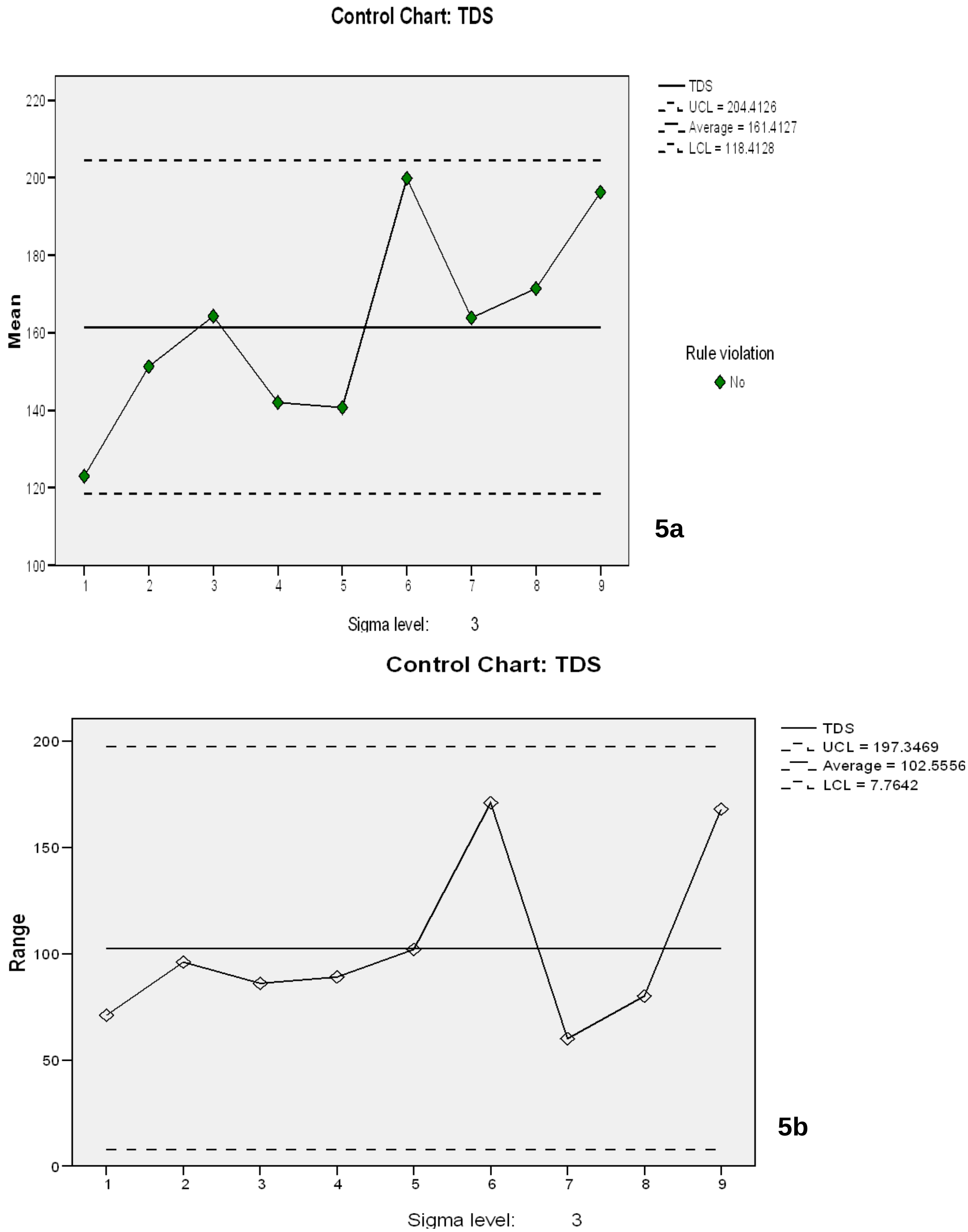



**Figure 5.** Total dissolved solids (TDS) control chart for streams in Obafemi Owode Local Government (5a) using mean and (5b) using range.

value of TDS in water from streams in the Local Government is 99.8778 mg/L while the LCL is 79.3954 mg/L and the UCL is 120.3602 mg/L. Figures 8a to 8b showed that no Area violated the control rule since all TDS values fall within the control limits. This suggests that the water from streams in the Local Government is

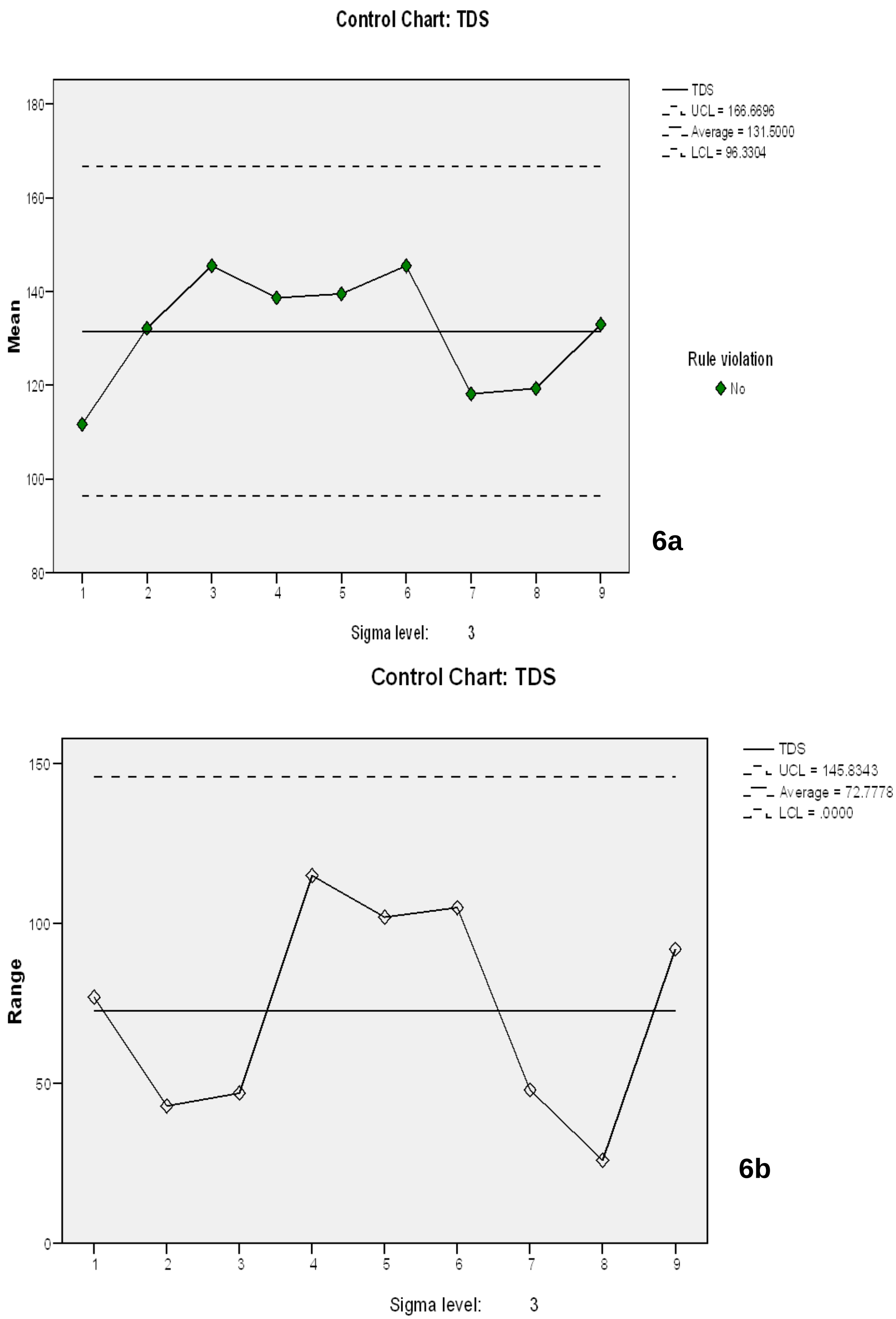



**Figure 6.** Total Dissolved Solids (TDS) control chart for borehole in Obafemi Owode Local Government (6a) using mean and (6b) using range.

safe for human consumption. The average value TDS in water from borehole in the Local Government is 127.7778 mg/l while the LCL is 83.3483 mg/L and the UCL is 172.2072 mg/L. Figure 9a showed that only Area 5 violated the control rule having TDS values outside the control limits. However, Figure 9b showed that no area

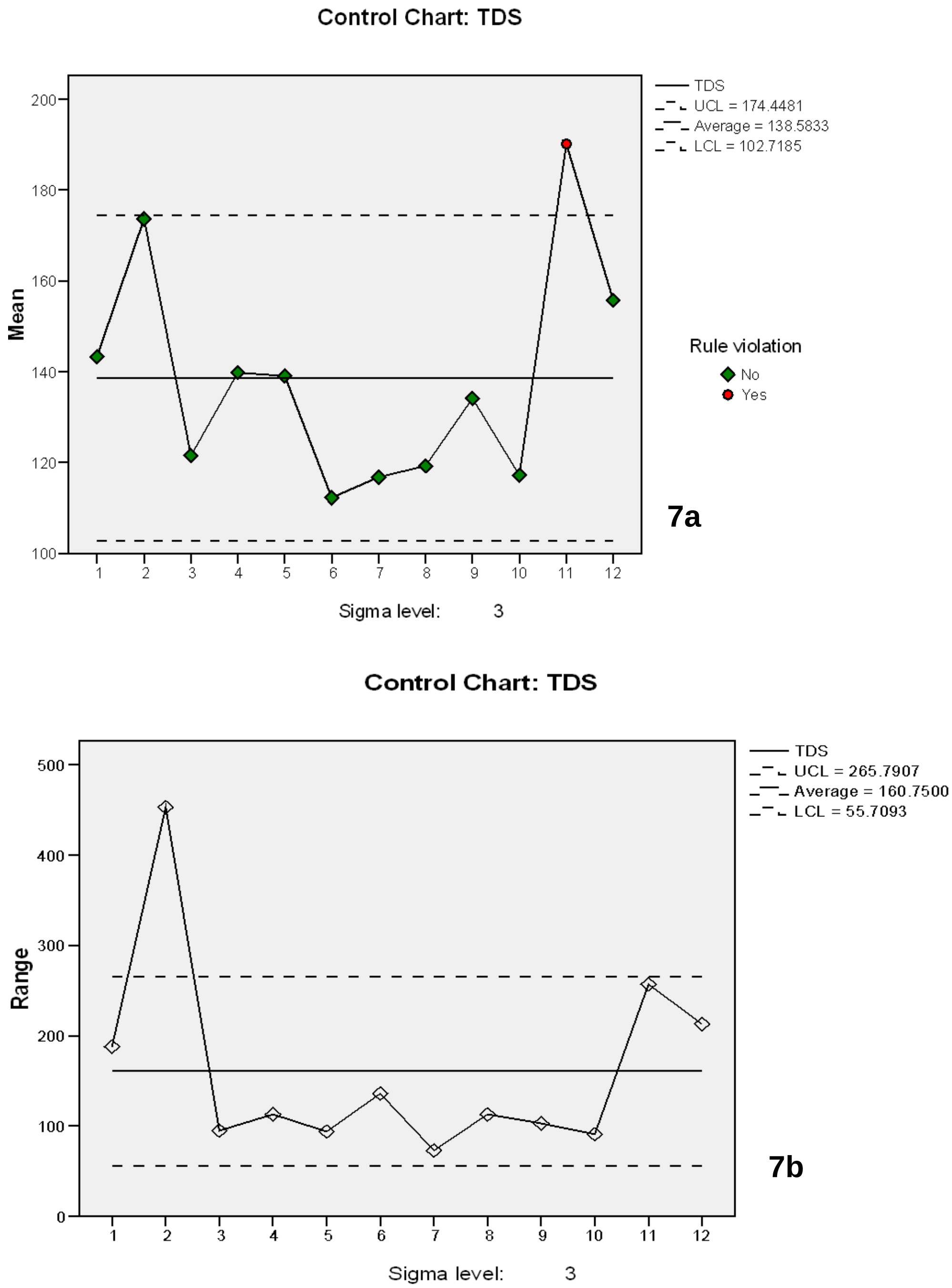



**Figure 7.** Total dissolved solids (TDS) control chart for wells in Abeokuta South Local Government (7a) using mean and (7b) using range.

violated the control rule. This suggests that water from borehole in Area 5 could still be tolerated. It could be seen from Figures 7a to 9b that water from streams in the Local Government has the least TDS values while the TDS values of water from wells and borehole are very close. This suggests that the TDS value in the Local Government is depth dependent.

**Total dissolved solids (TDS) in water from wells, streams and borehole in Abeokuta North Local Government**

The average value of TDS of water from wells in the Local Government is 156.2255 mg/L while the LCL is 135.8905 mg/L and the UCL is 176.5605 mg/L. Figure

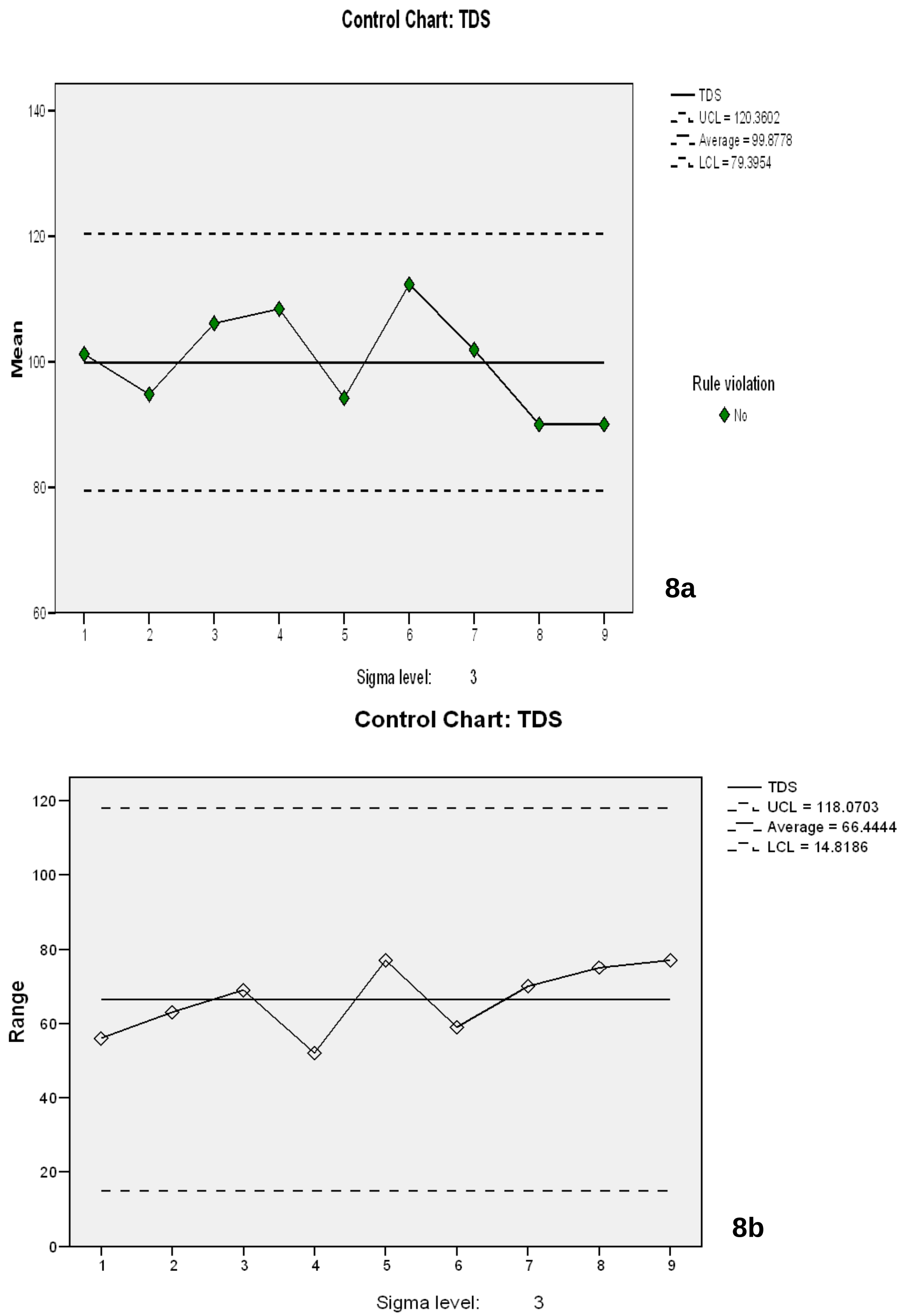



**Figure 8.** Total dissolved solids (TDS) control chart for streams in Abeokuta South Local Government (8a) using mean and (8b) using range.

10a showed that only Area 9 violated the control rule having TDS values outside the control limits. Figure 10b showed that the same Area 9 also violated the control rule, confirming that the TDS values of water from wells in the area are actually outside the control limits. The average value of TDS in water from streams in the Local

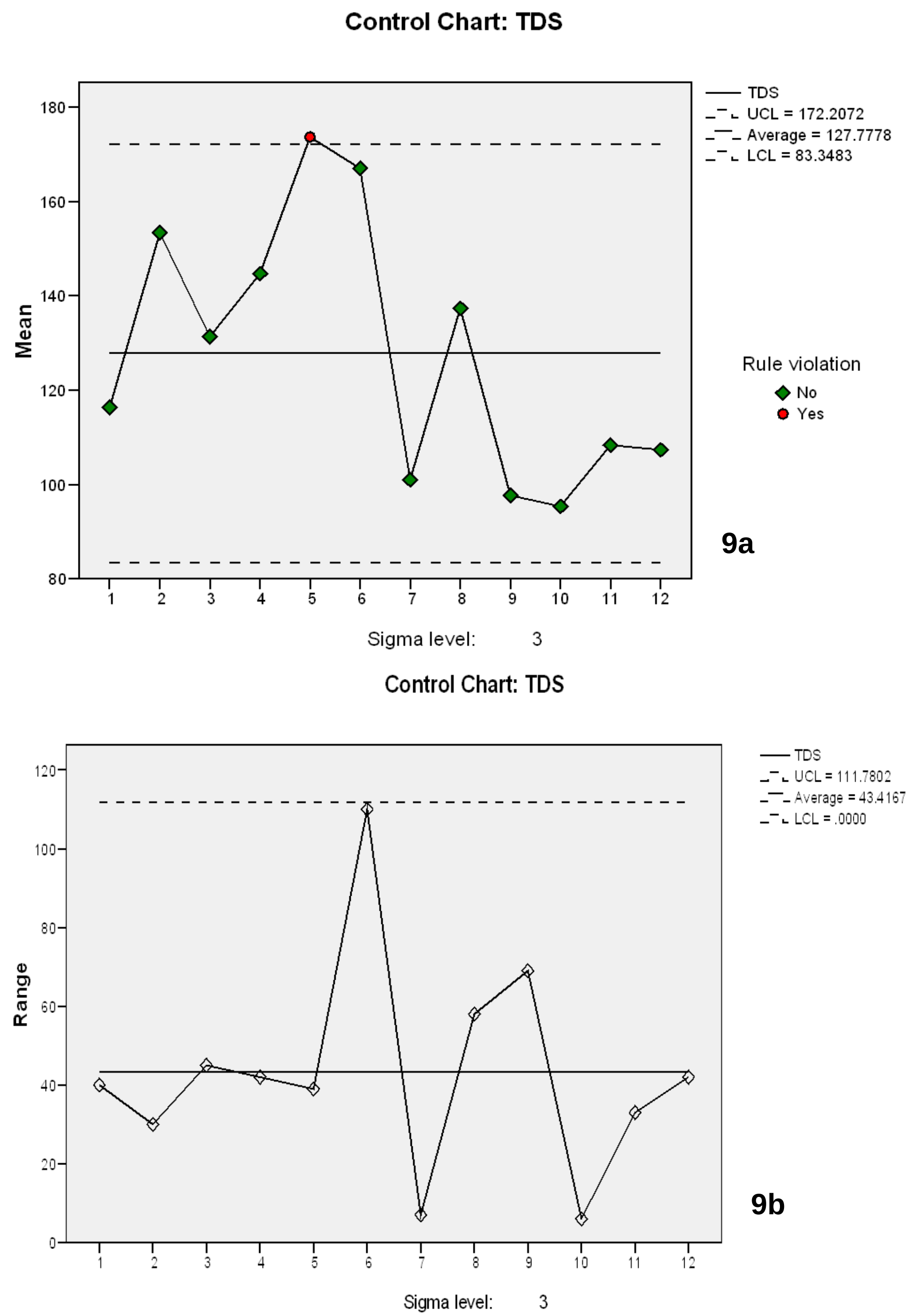



**Figure 9.** Total dissolved solids (TDS) control chart for borehole in Abeokuta South Local Government (9a) using mean (9b) using range.

Government is 196.8500 mg/L while the LCL is 122.2884 mg/L and the UCL is 271.0116 mg/L. Figures 11a and 11b showed that no Area violated the control rule since all the values of TDS in the Local Government fall within the control limits. This shows that the water from streams in the Local Government is safe for human consumption.

The average value of TDS in water from borehole in the Local Government is 143.6111 mg/L while the LCL is 30.8040 mg/L and the UCL is 258.8183 mg/l. Figure 12a showed that no Area violated the control rule as all TDS values fall within the control limits. However, Figure 12b (range control chart) showed that Area 1 violated the

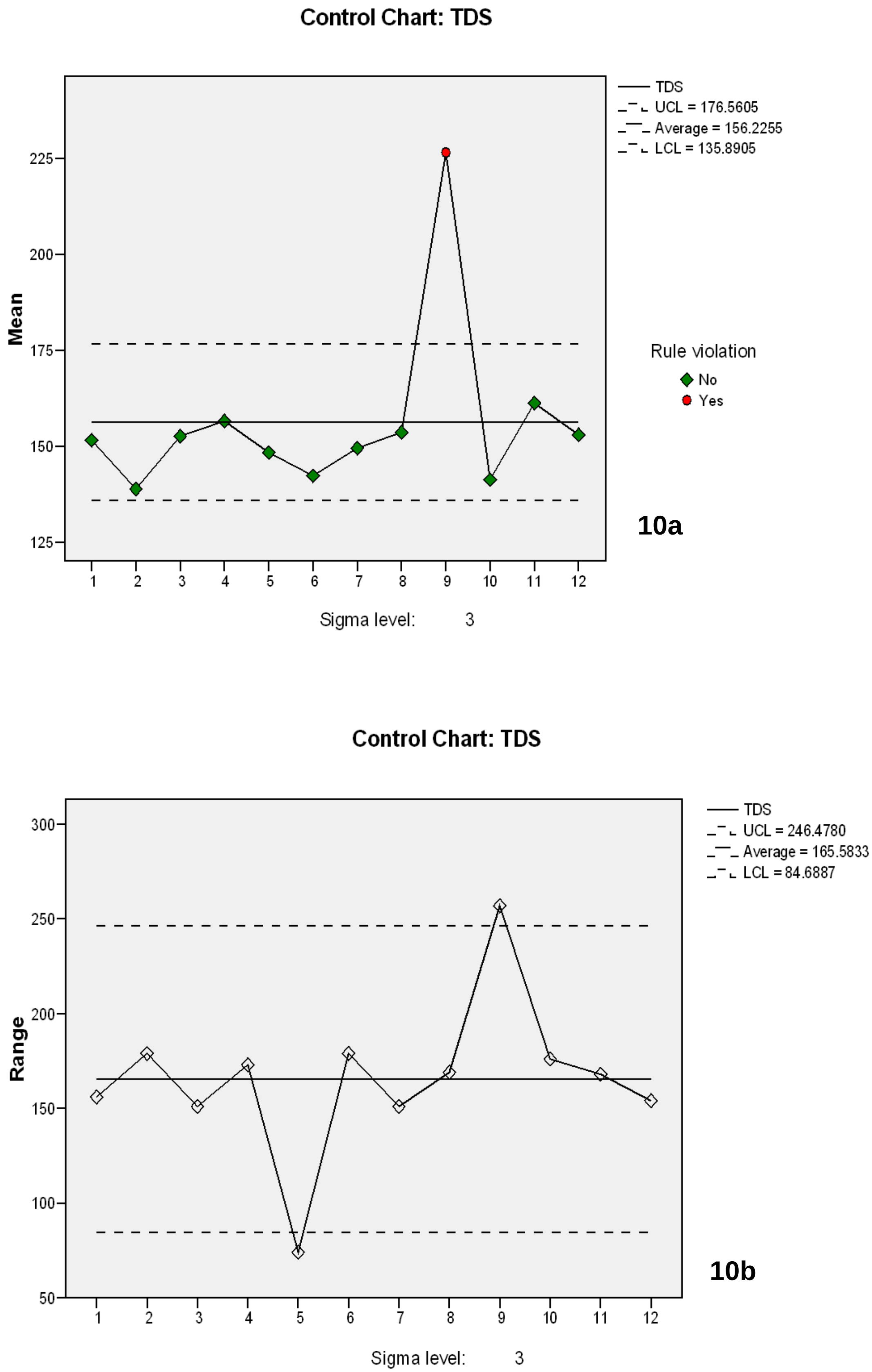
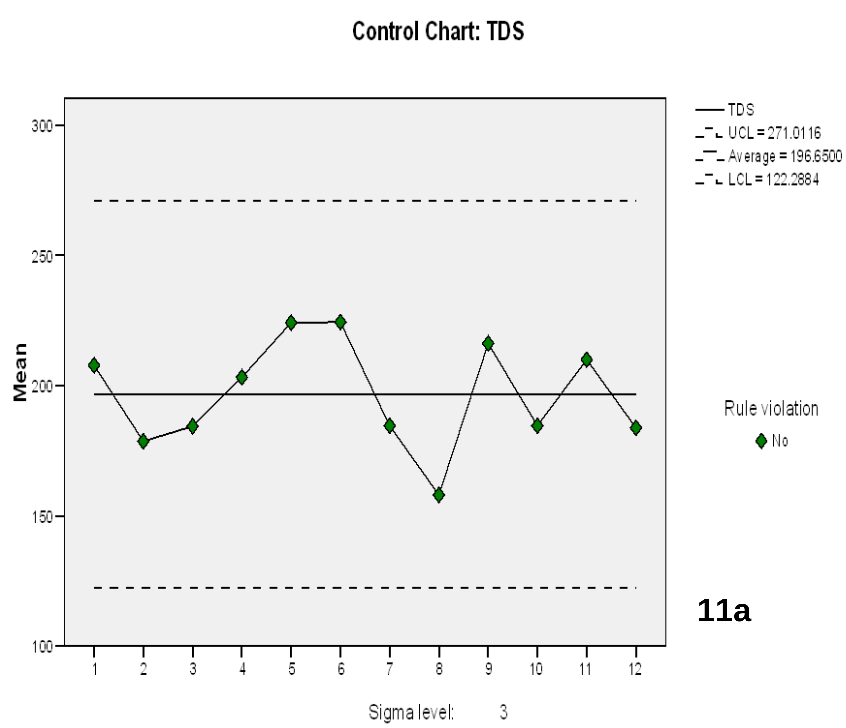



**Figure 10.** Total dissolved solids (TDS) control chart for wells in Abeokuta North Local Government (10a) using mean (10b) using range.



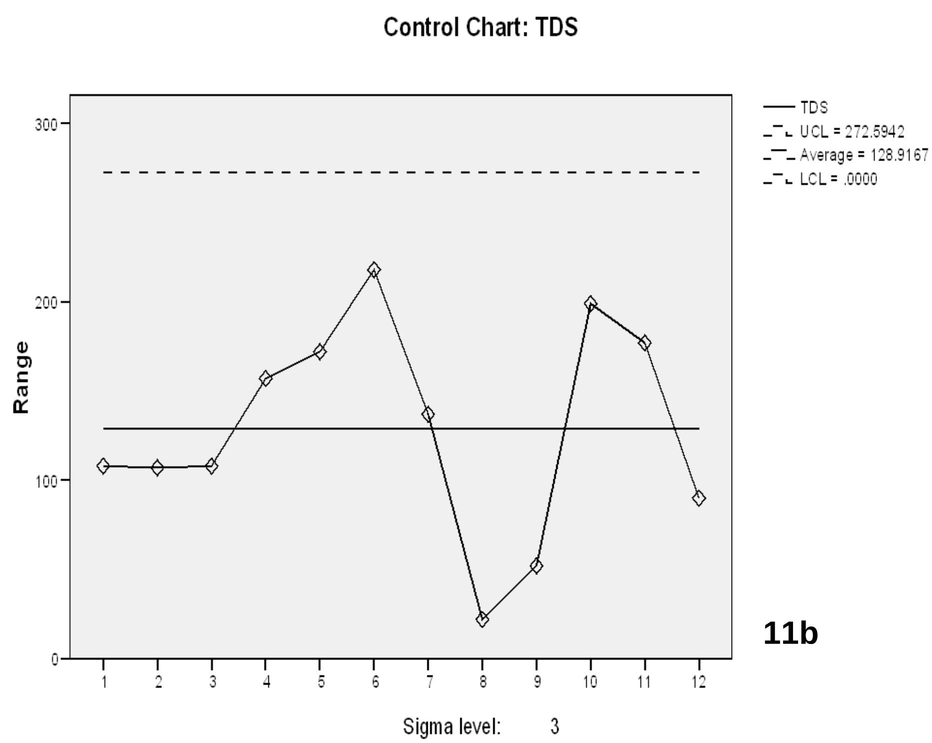




**Figure 11.** Total dissolved solids (TDS) control chart for streams in Abeokuta North Local Government (11a) using mean and (11b) using range.

control rule. This does not necessarily mean that water from the Area is safe for human consumption. Figures 10a to 12a showed that water from borehole has the least TDS values, followed by water from wells with water from streams having the highest values.

**Conductivity of water from wells, streams and borehole in Odeda Local Government**

The average value of conductivity of water from wells in the Local Government is 341. 9309 µS/cm while the LCL

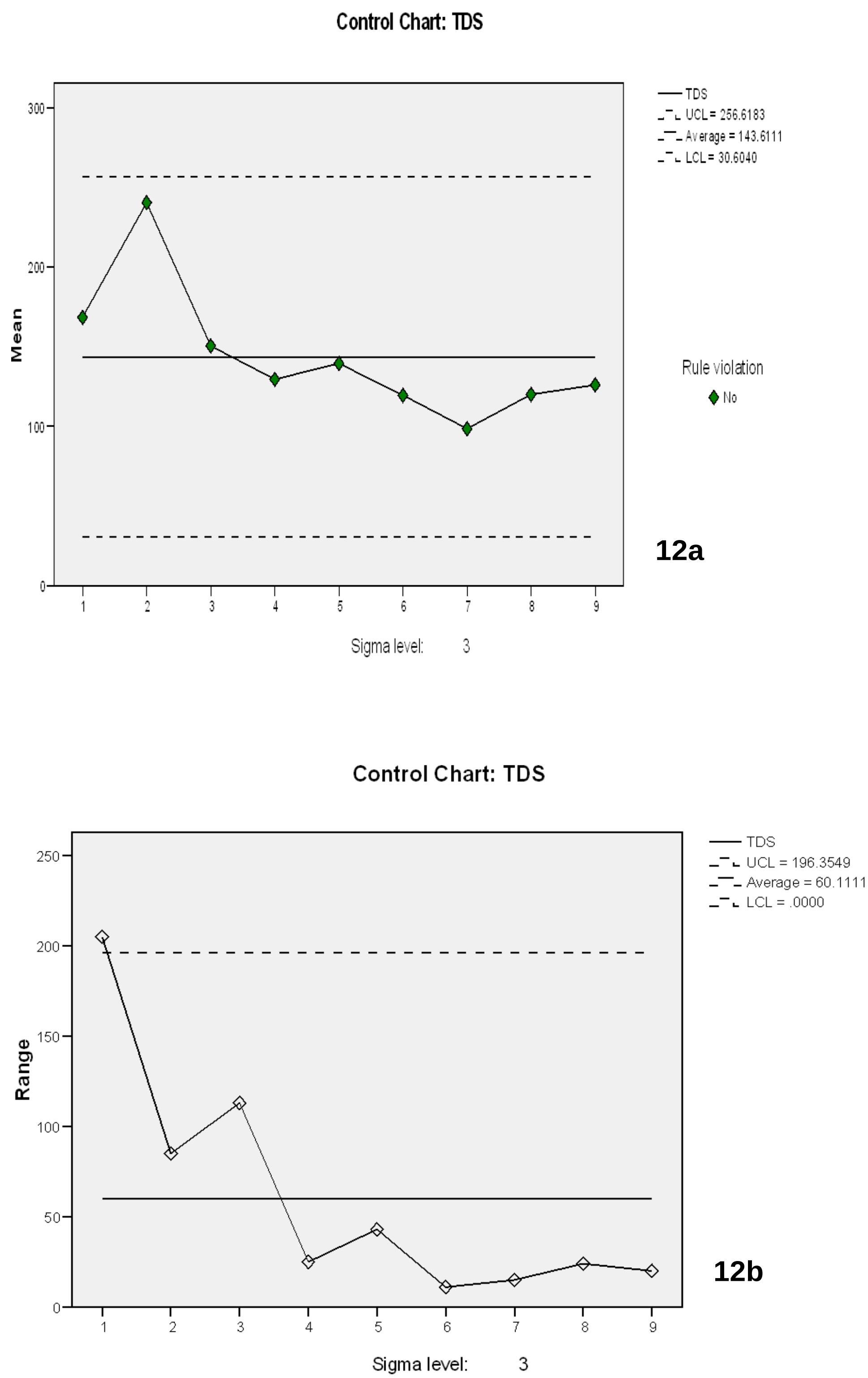



**Figure 12.** Total dissolved solids (TDS) control chart for borehole in Abeokuta North Local Government (12a) using mean and (12b) using range

is 214.0115 µS/cm and the UCL is 469.8485 µS/cm. Figure 13a showed that conductivity of water from wells in Areas 7, 9 and 11 violated the control rule having values outside the control limits. This shows that water from these Areas may not be safe for human consumption. Figure 13b showed that Area 7 also

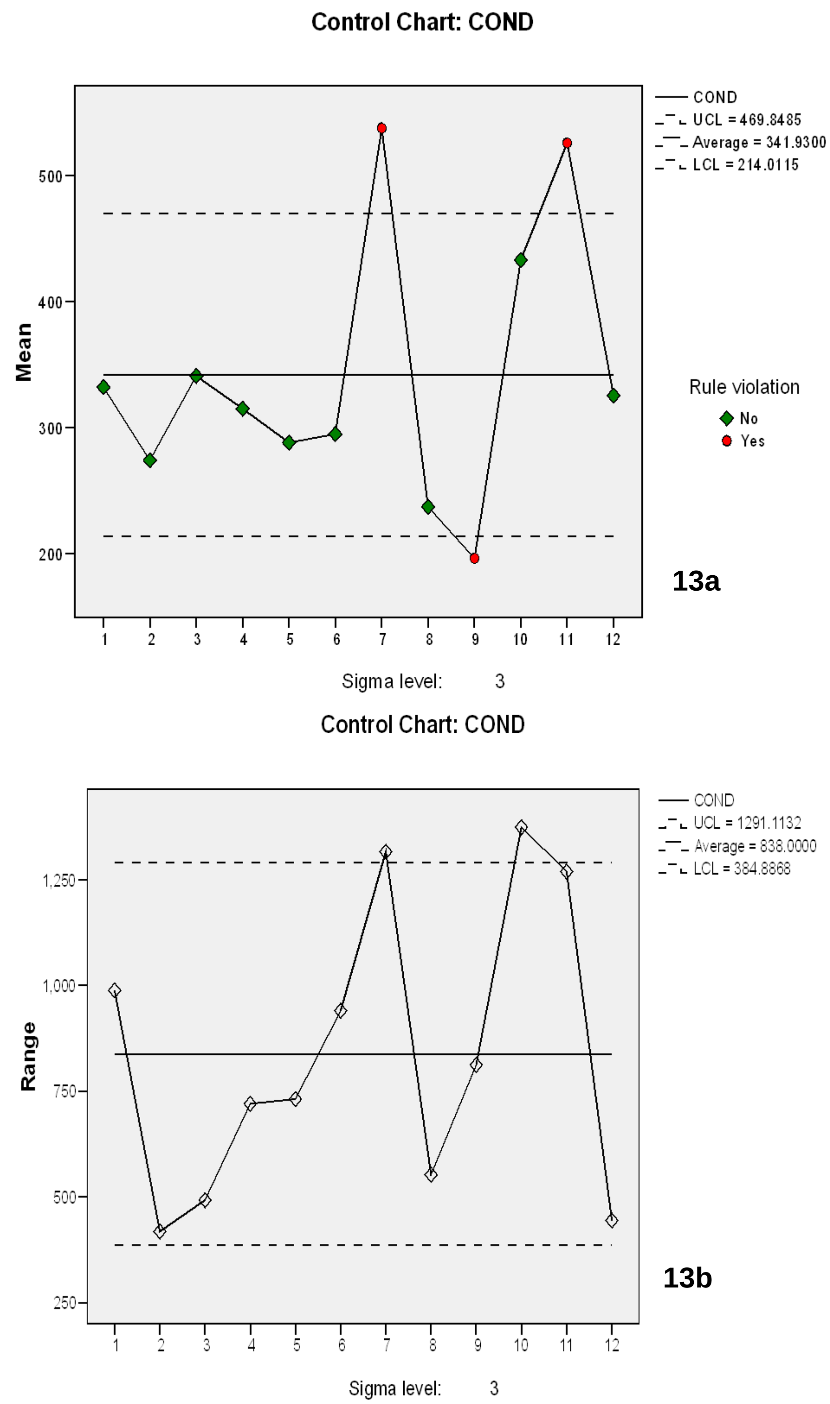



**Figure 13.** Electrical conductivity control chart for wells in Odeda Local Government (13a) using mean and (13b) using range.

violated the control rule alongside Area 10. This confirms that water from Area 7 may not be suitable for human consumption. The average conductivity of water from streams in the Local Government is 198.8642 µS/cm while the LCL is 131.2629 µS/cm and the UCL is 266.4655 µS/cm. Figure 14a showed that Areas 2, 3, 6, 7 and 9 violated the control rule having values outside the control limits. This suggests that water fro streams in these Areas may not be safe for human consumption. However, the range control chart in Figure 14b showed that only Area 7 violated the control rule. The average conductivity of water from borehole in the Local Government is 357.4296 µS/cm while the LCL is 39.5139 µS/cm and the UCL is 754.3711 µS/cm. Figures 15a and

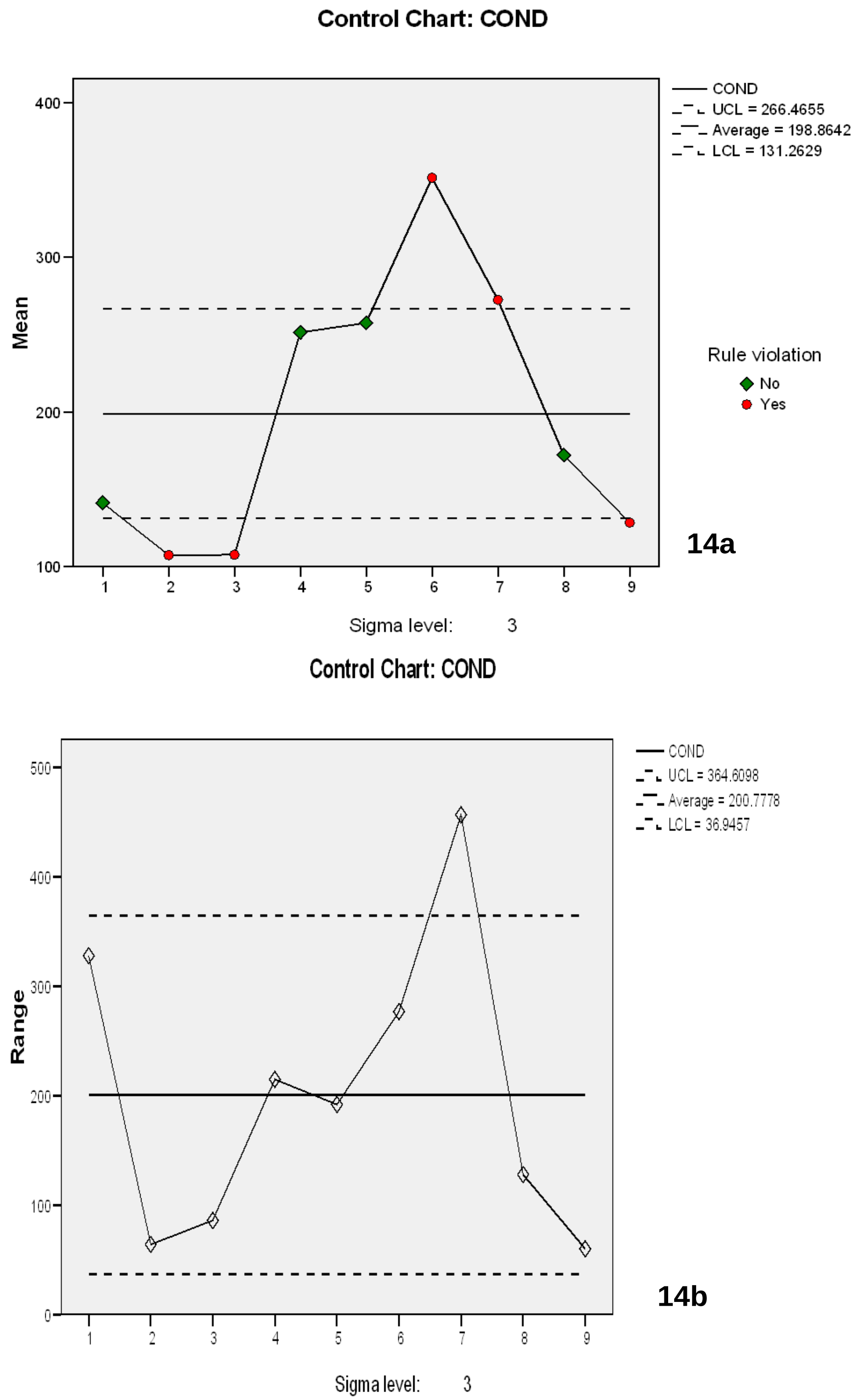
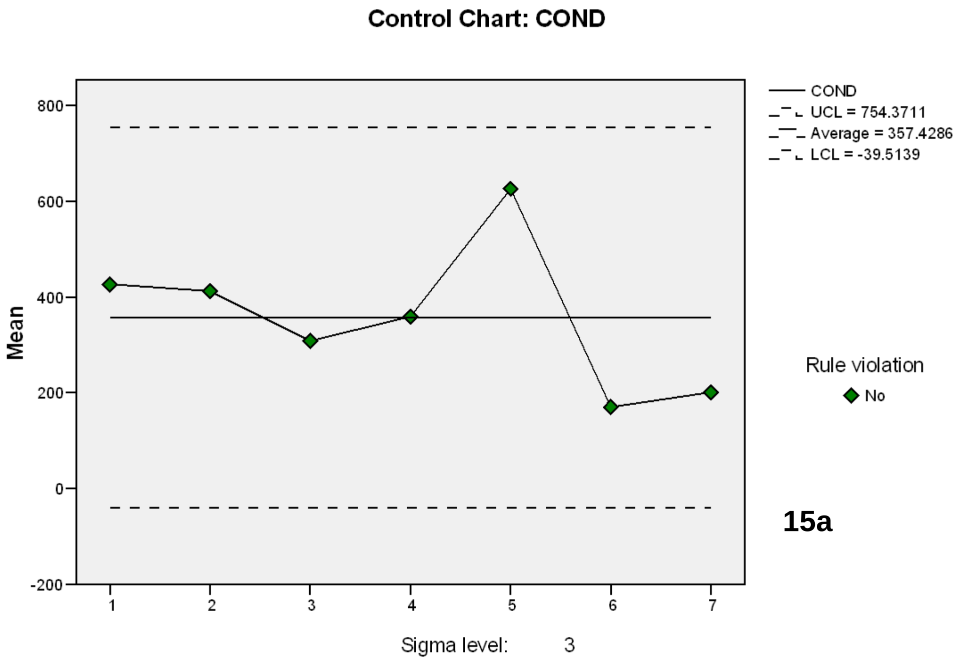



**Figure 14.** Electrical conductivity control chart for streams in Odeda Local Government (14a) using mean and (14b) using range.

15b showed that no Area violated the control rule indicating that water from borehole in the Local Government is safe for human consumption. Figures 13a to 13b showed that water from streams have the least conductivity values followed by water from wells with water from borehole having the highest values. This shows that conductivity of water in the Local Government is depth dependent.



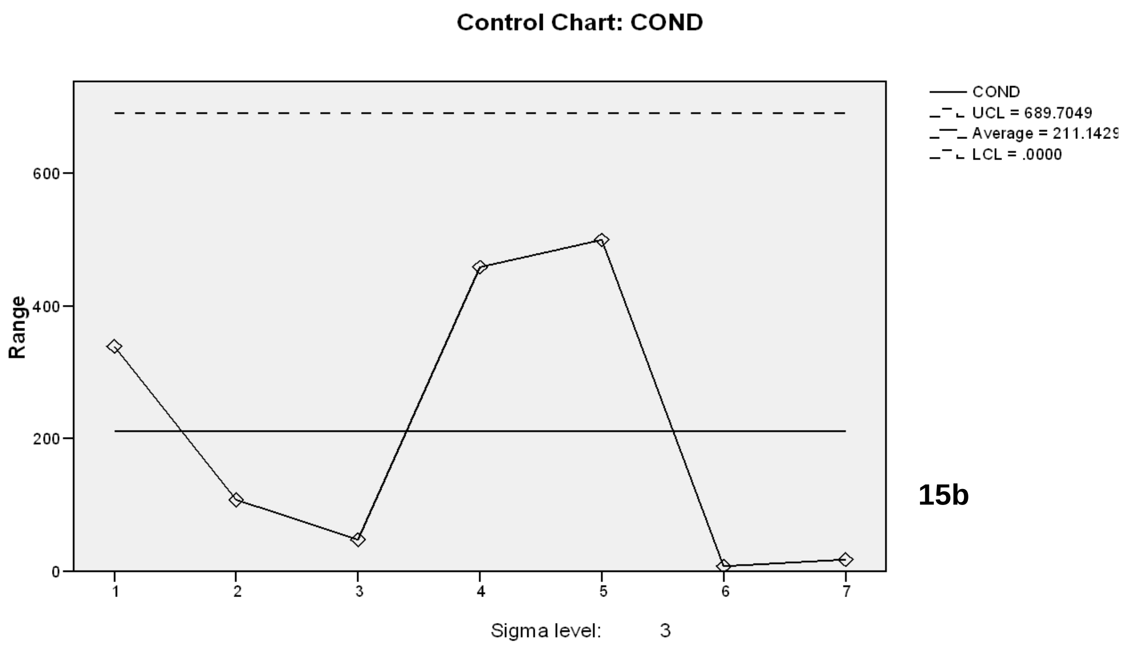




**Figure 15.** Electrical conductivity control chart for borehole in Odeda Local Government (15a) using mean and (15b) using range.

## Conductivity of water from wells, streams and borehole in Obafemi Owode Local Government

The average value of conductivity of water from wells in the Local Government is 409.0476 µS/cm while the LCL is 307.2391 µS/cm and the UCL is 508.8561 µS/cm. Figure 16a showed that Areas 3 and 4 violated the control rule having conductivity values outside the control limits. This shows that water in the two Areas may not be suitable for human consumption. However, these two Areas did not violate the control rule in the range control chart (16a) indicating that the water in the two Areas could still be tolerated for human consumption. The average value of conductivity of water from streams in the Local Government is 324.4127 µS/cm while the LCL is 239.9037 µS/cm and the UCL is 408.9217 µS/cm. Figures 17a and 17b showed that no Area in the Local Government violated the control rule since the values of

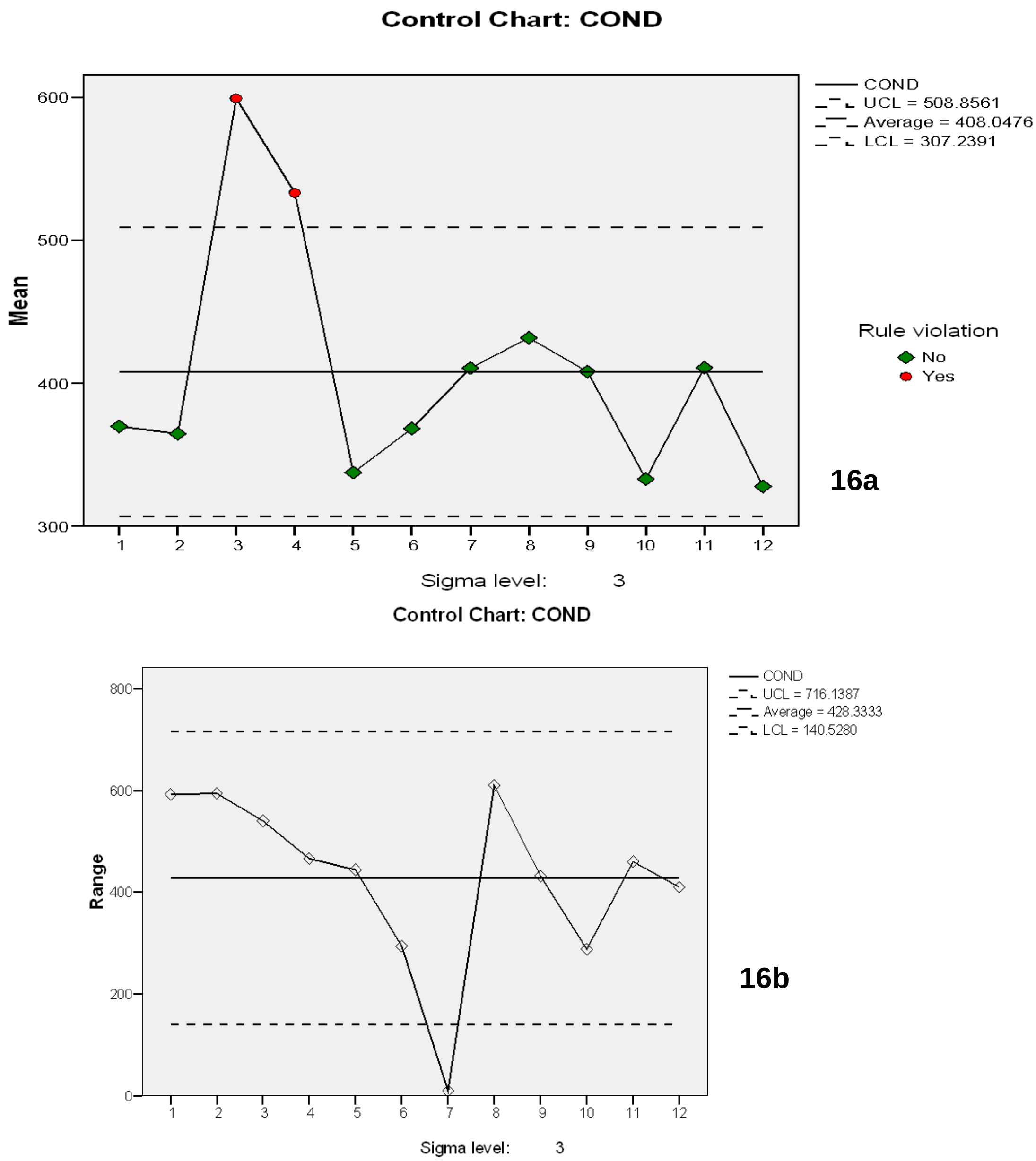



**Figure 16.** Electrical conductivity control chart for wells in Obafemi Owode Local Government (16a) using mean (16b) using range.

conductivity of water in the Local Government fall within the control limits. This shows that the water from streams in the Local Government is safe for human consumption. The average value of conductivity of water from borehole in the Local Government is 263.0000 µS/cm while the LCL is 192.6609 µS/cm and the UCL is 333.3391 µS/cm. Figures 18a and 18b showed that no Area in the Local Government violated the control rule since the values of conductivity of water from borehole in the Local Government fall within the control limits. This shows that the water from borehole in the Local Government is safe for human consumption. Figures 16a to 18b showed that water from streams in the Local Government has the least average conductivity value followed by that from borehole with water from wells having the highest.

**Conductivity of water from wells, streams and borehole in Abeokuta South Local Government**

The average value of conductivity of water from wells in the Local Government is 271.1778 µS/cm while the LCL is 205.4482 µS/cm and the UCL is 348.9074 µS/cm. Figure 19a showed that only Area 11 violated the control

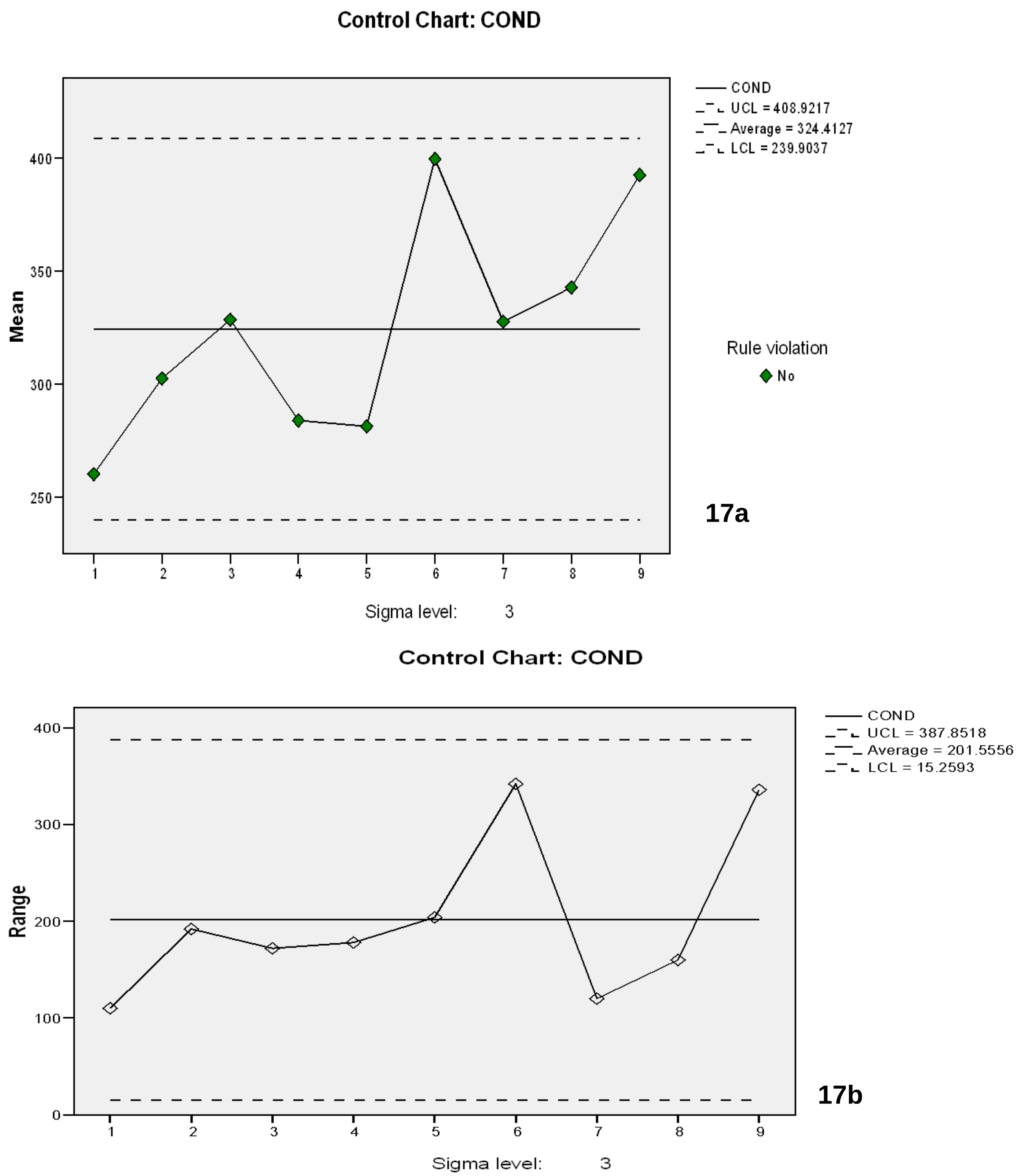



**Figure 17.** Electrical conductivity control chart for streams in Obafemi Owode Local Government (17a) using mean and (17b) using range.

rule having conductivity values outside the control limits. This shows that water from Area 11 may not be suitable for human consumption. However, this Area did not violate the control rule in the range control chart (figure 19b) indicating that the water may not be too dangerous for human consumption. The average value of conductivity of water from streams in the Local Government is 199.7556 µS/cm while the LCL is 158.7907 µS/cm and the UCL is 240.7204 µS/cm. Figures 20a and 20b showed that no Area in the Local Government violated the control rule having all values of conductivity within the control limits. This shows that water from streams in the Local Government is safe for human consumption. The average value of conductivity

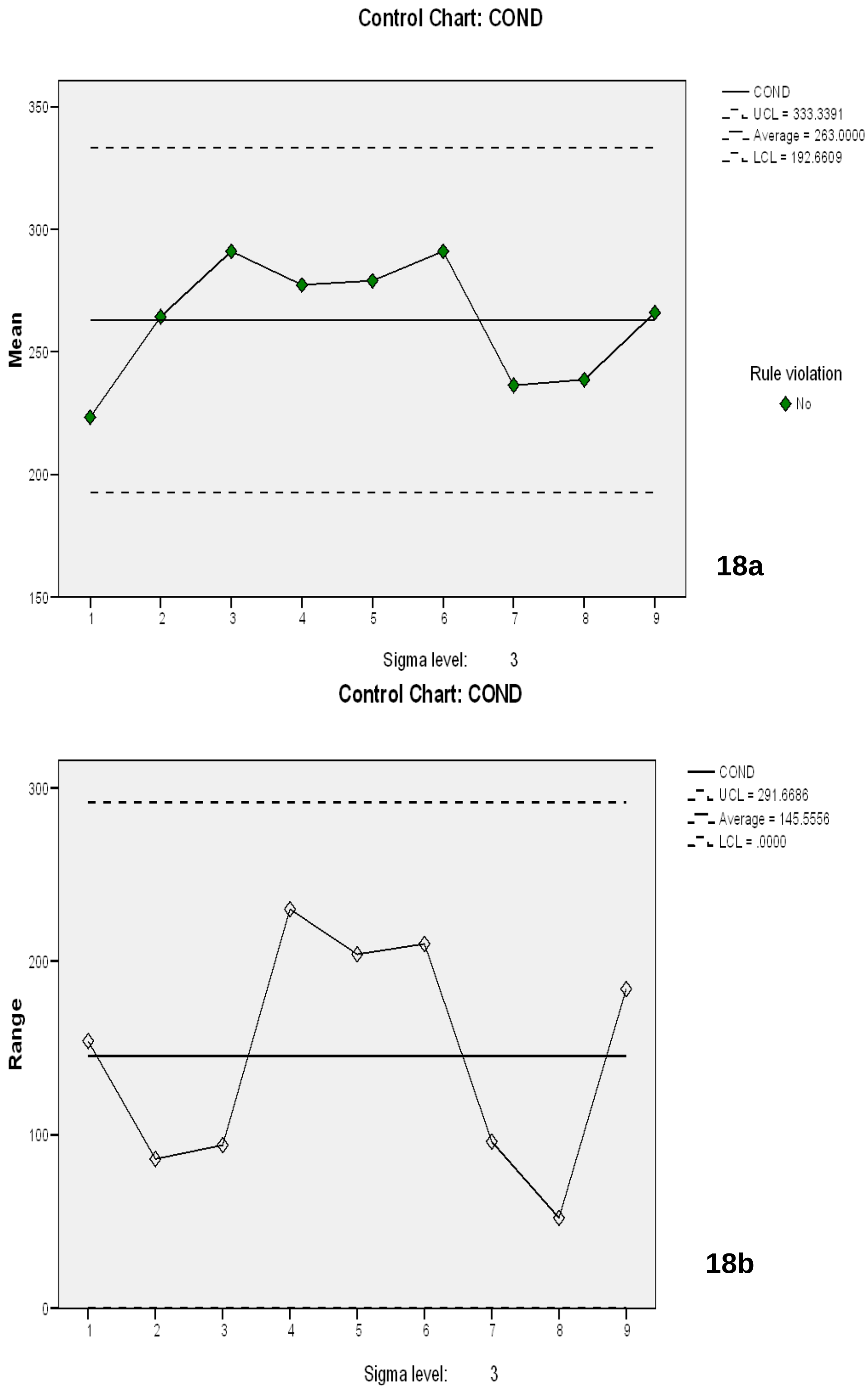



**Figure 18.** Electrical conductivity control chart for borehole in Obafemi Owode Local Government (18a) using mean and (18b) using range.

of water from borehole in the Local Government is 255.5556 µS/cm while the LCL is 166.6967 µS/cm and the UCL is 344.4144 µS/cm. Figure 21a showed that only Area 5 violated the control rule having conductivity values

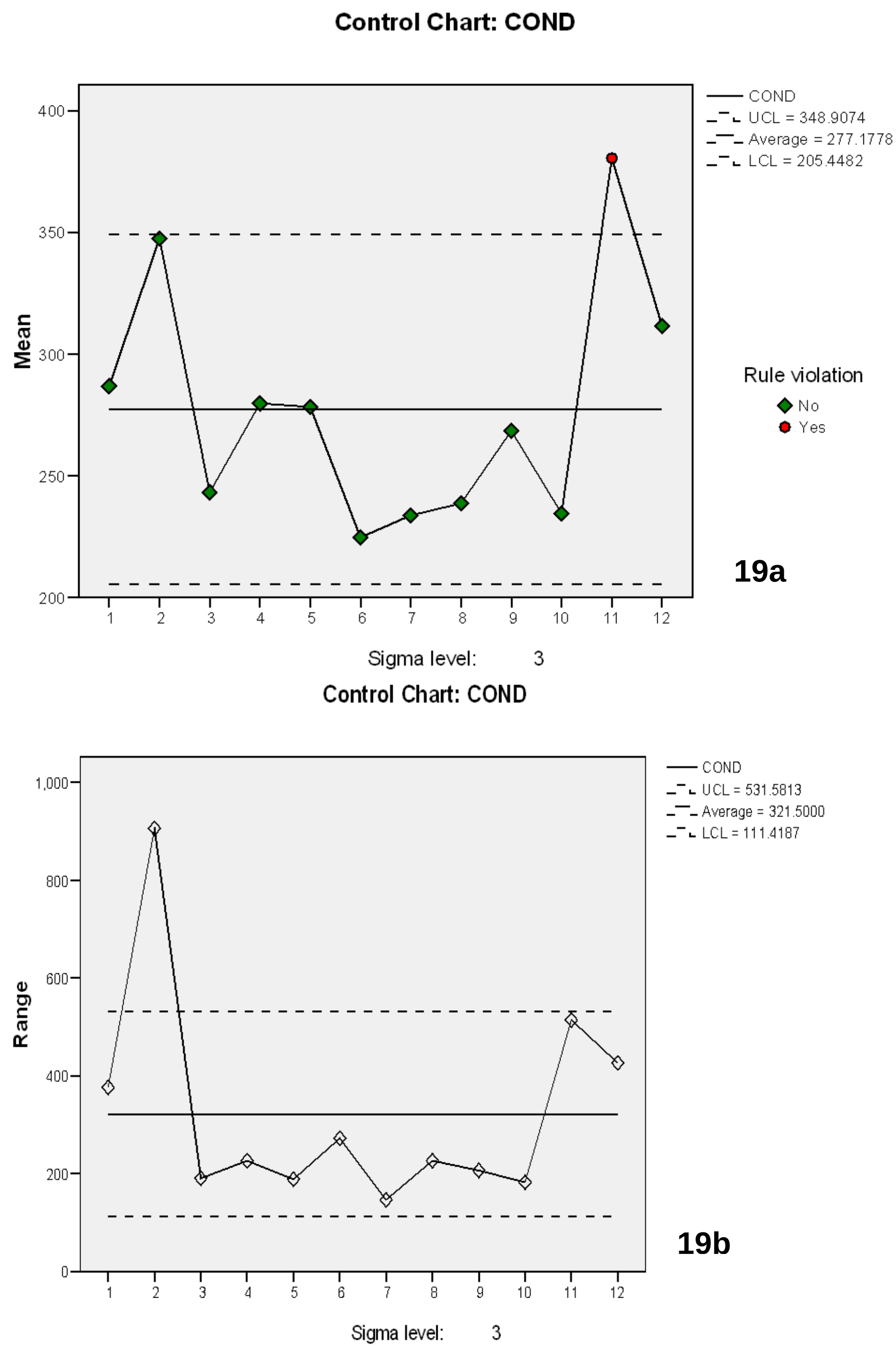



**Figure 19**. Electrical conductivity control chart for wells in Abeokuta South Local Government (19a) using mean and (19b) using range.

falling outside the control limits, indicating its non suitability for human consumption. However, Figure 21b showed that this Area 5 did not violate the control rule in the range control chart. Figure 19a to 21a showed that water from streams in the Local Government has the least conductivity values followed by water from wells with water from borehole having the highest values.

## Conductivity of water from wells, streams and borehole in Abeokuta North Local Government

The average value of conductivity of water from wells in the Local Government is 313.3652 µS/cm while the LCL is 272.6952 µS/cm and the UCL is 354.0352 µS/cm. Figure 22a showed that only Area 9 violated the control

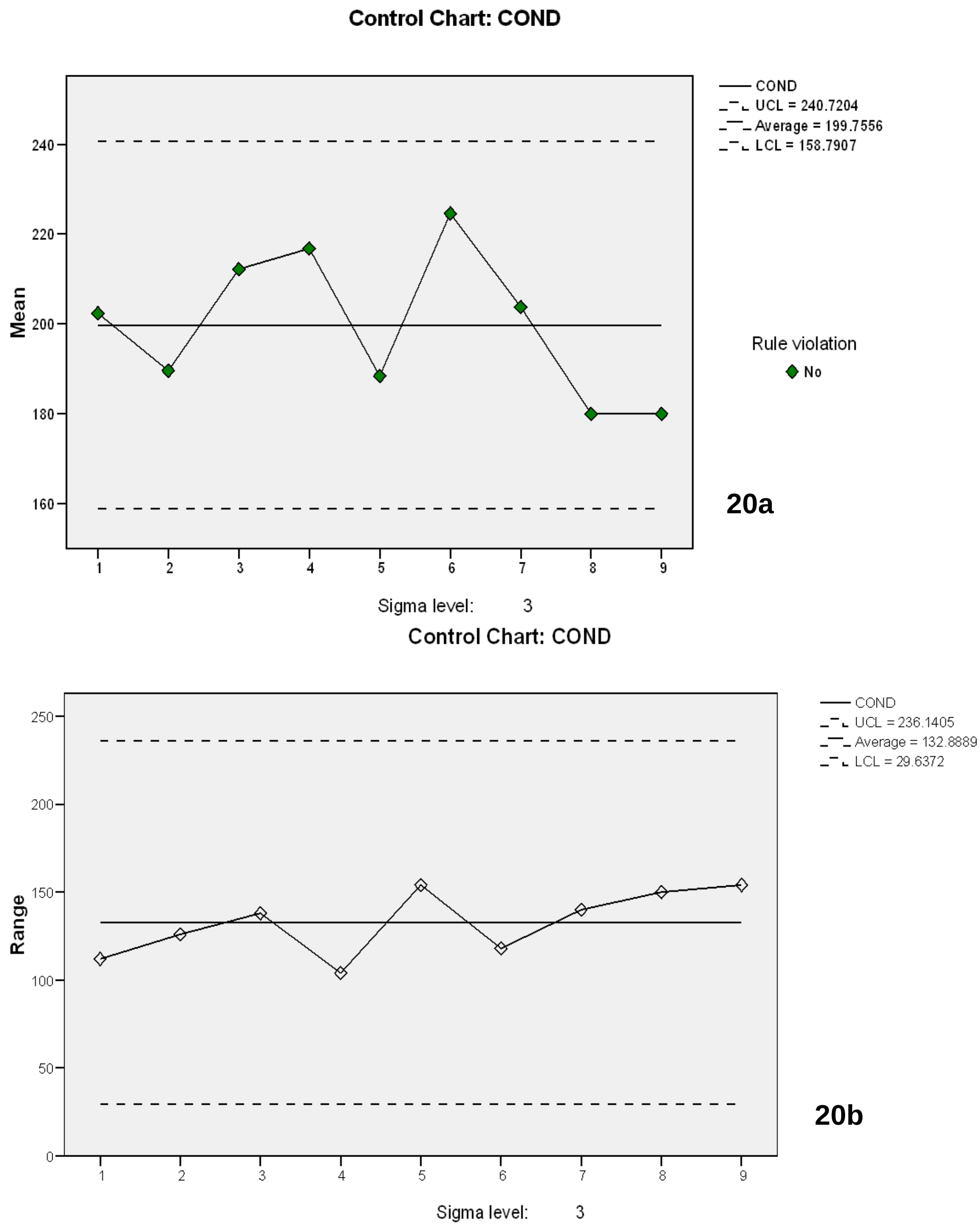



**Figure 20.** Electrical conductivity control chart for streams in Abeokuta South Local Government (20a) using mean and (20b) using range.

rule having conductivity value falling outside the control limits. The range control chart showed that the same Area 9 violated the control rule (Figure 22b). The average value of conductivity of water from streams in the Local Government is 393.5000 µS/cm while the LCL is 244.8248 µS/cm and the UCL is 542.1752 µS/cm. Figures 23a and 23b showed that no Area violated the control rule in the Local Government since all values of conductivity fall within the control limits. This shows that the water from streams in the Local Government is safe for human consumption. The average value of conductivity of water from borehole in the Local Government is 230.6111 µS/cm while the LCL is 61.0457 µS/cm and the UCL is 520.1785 µS/cm. Figure 24a

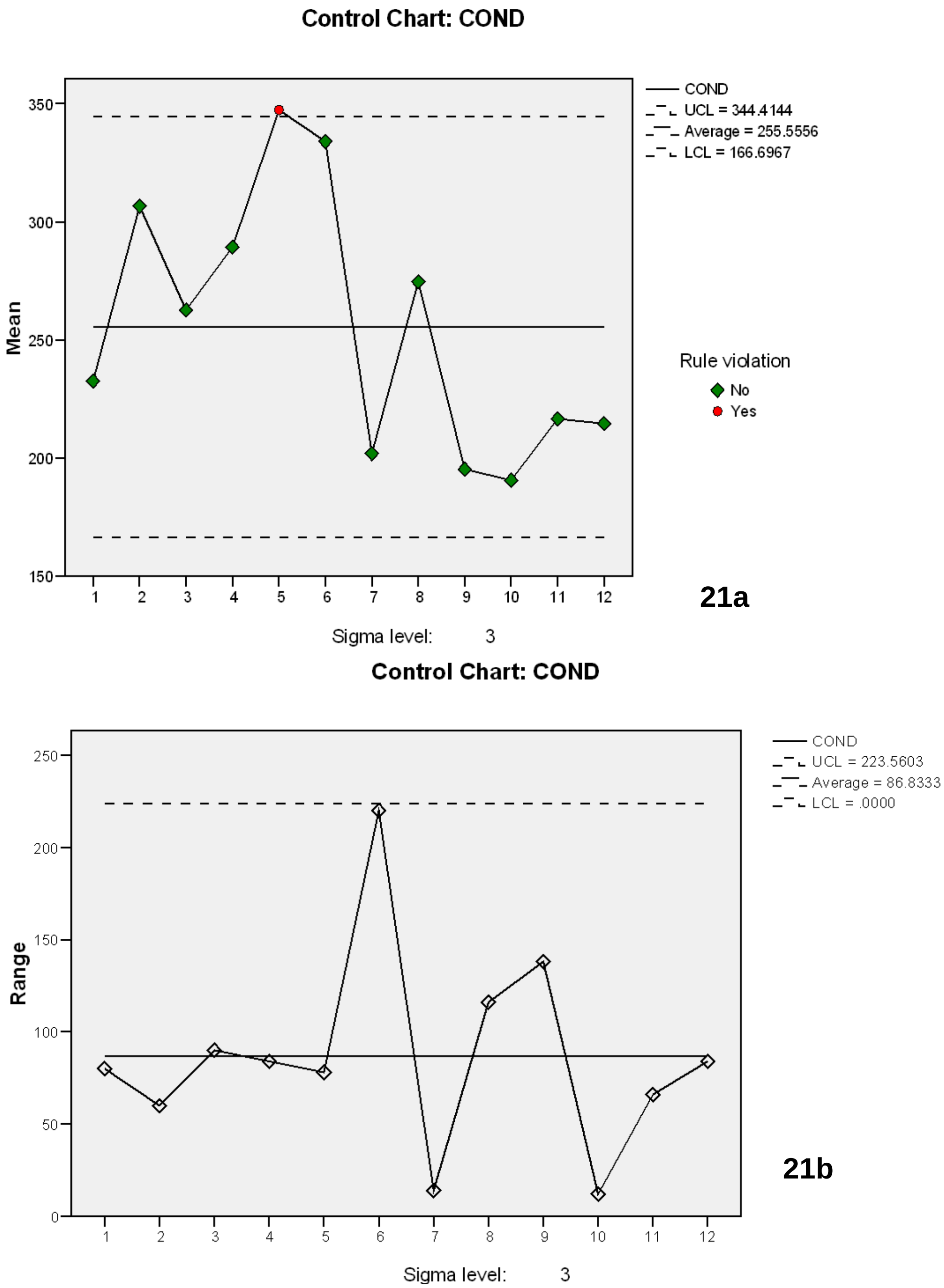



**Figure 21.** Electrical Conductivity control chart for borehole in Abeokuta South Local Government (21a) using mean and (21b) using range.

showed that no Area violated the control rule since all values of conductivity of water from borehole in the Local Government fall within the control limits. However, Figure 24b showed that Area 1 violated the control rule in the range control chart. Figure 22a to 24b showed that water from borehole has the least average conductivity value followed by water from wells with water from streams having the highest average conductivity value.

## DISCUSSION

While TDS is not considered a primary pollutant, high TDS level typically indicate hard water and may lead to scale build up in pipes, reduction in efficiency of water filters, hot water heaters etc, and aesthetic problems such as a bitter or salty taste. (Wellcare, 2011). No recent data on health effects associated with the

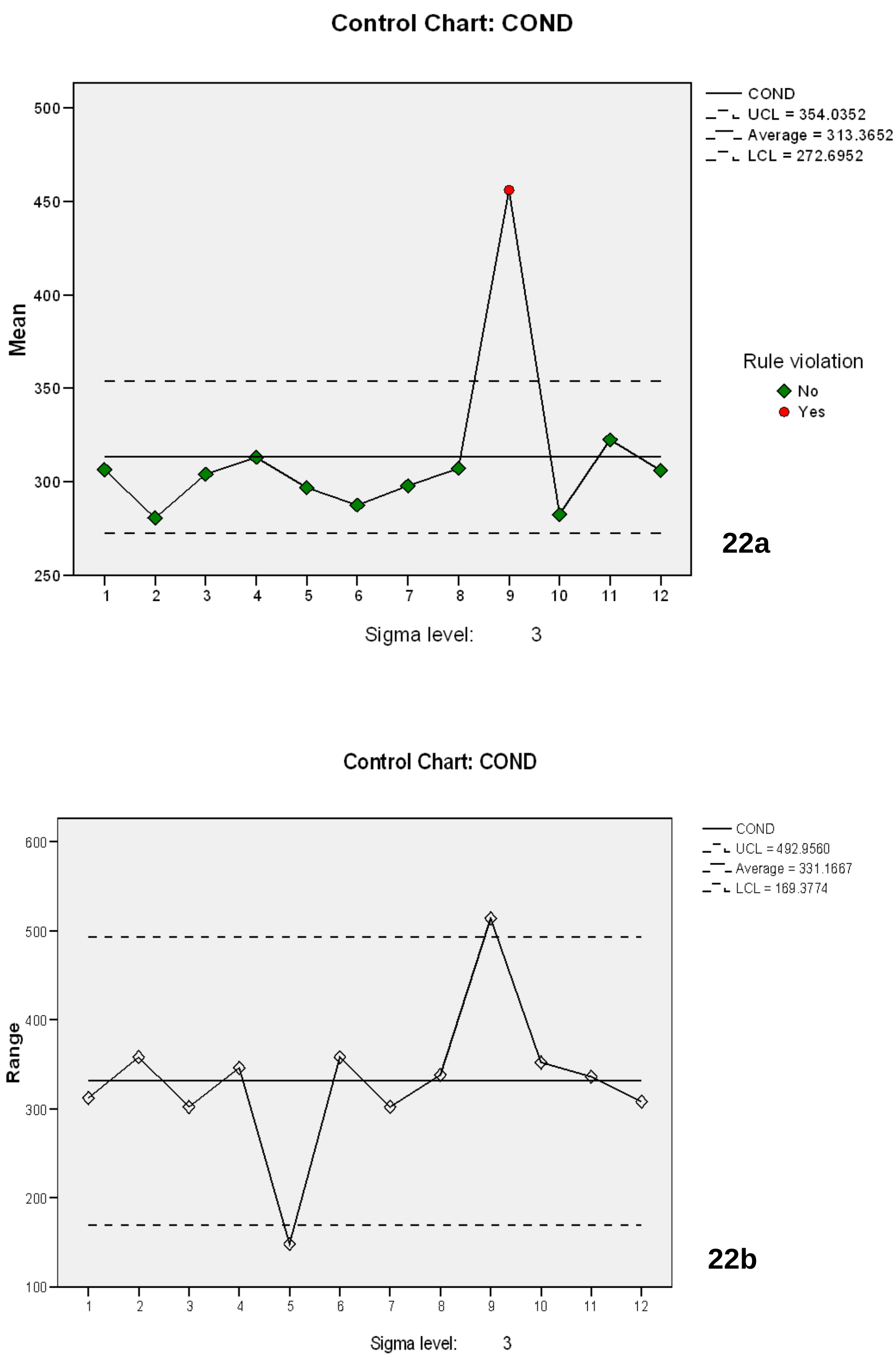



**Figure 22.** Electrical conductivity control chart for wells in Abeokuta North Local Government (22a) using mean and (22b) using range.

ingestion of TDS in drinking water appears to exist, however, associations between various health effects and hardness, rather that TDS contents have been investigated in many studies (WHO, 1996). The result of early epidemiological studies suggests that even low concentration of TDS in drinking water may have

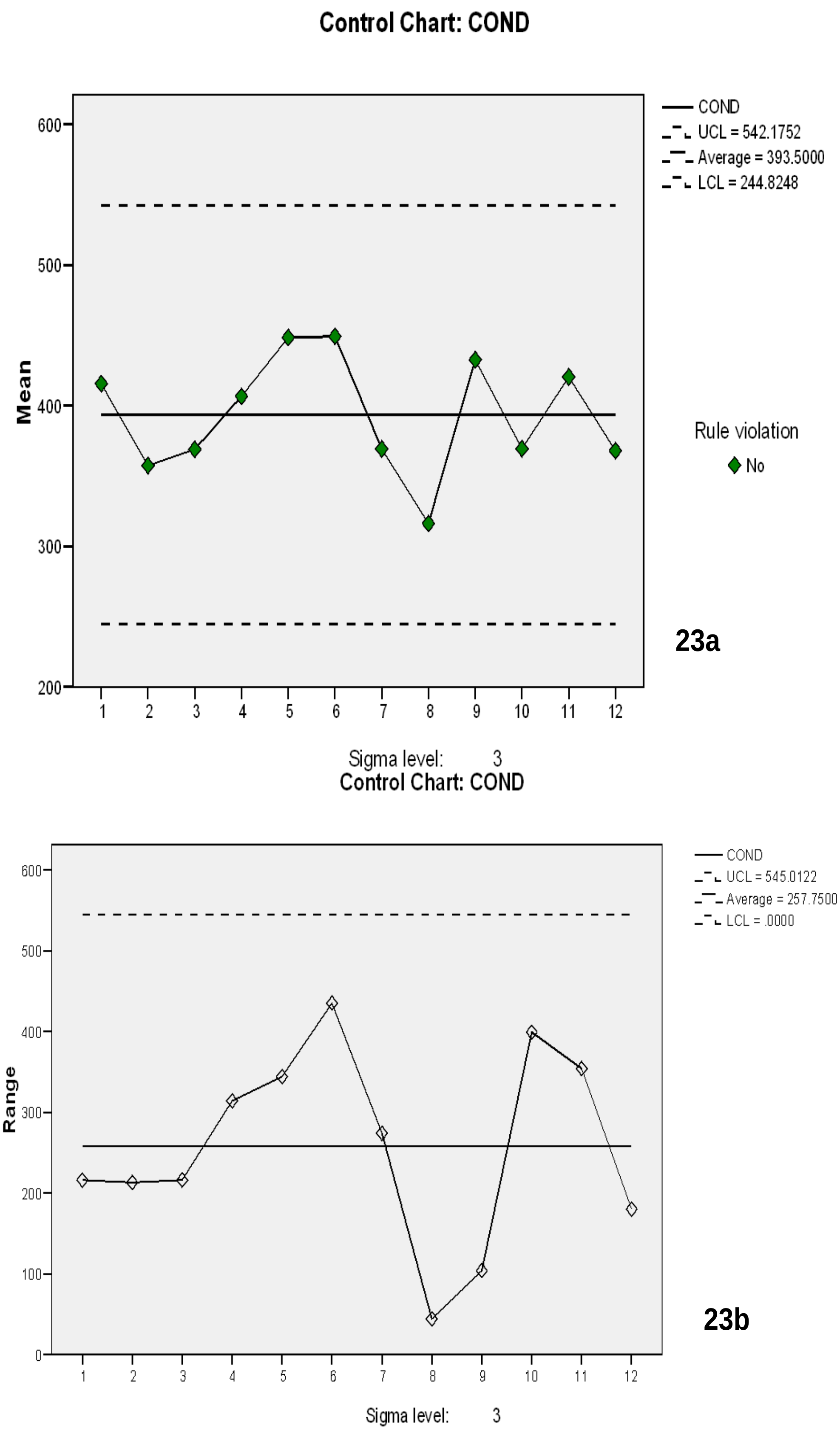
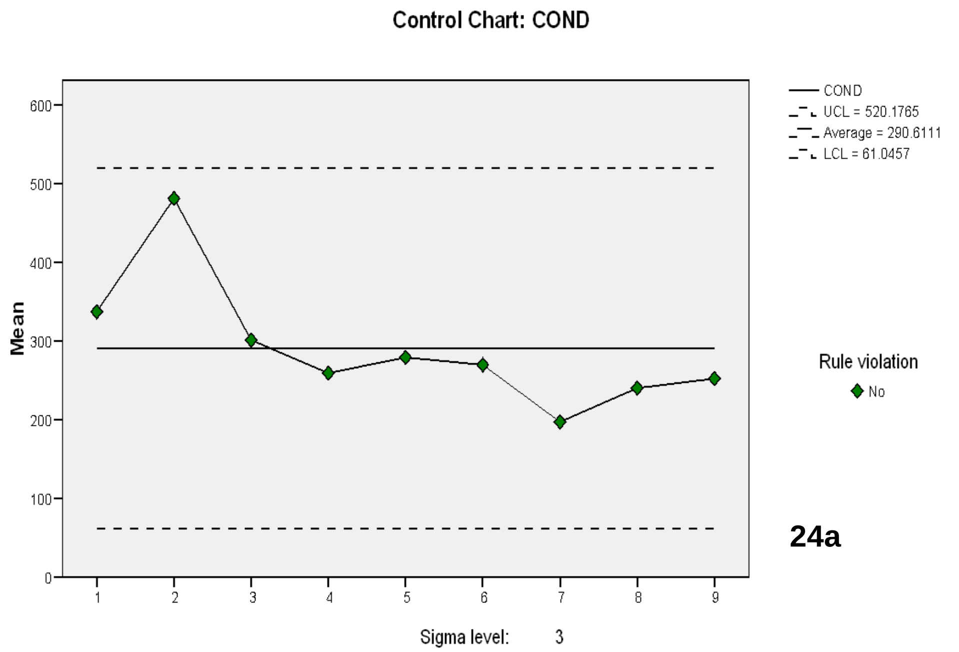



**Figure 23.** Electrical conductivity control chart for streams in Abeokuta North Local Government (23a) using mean and (23b) using range.



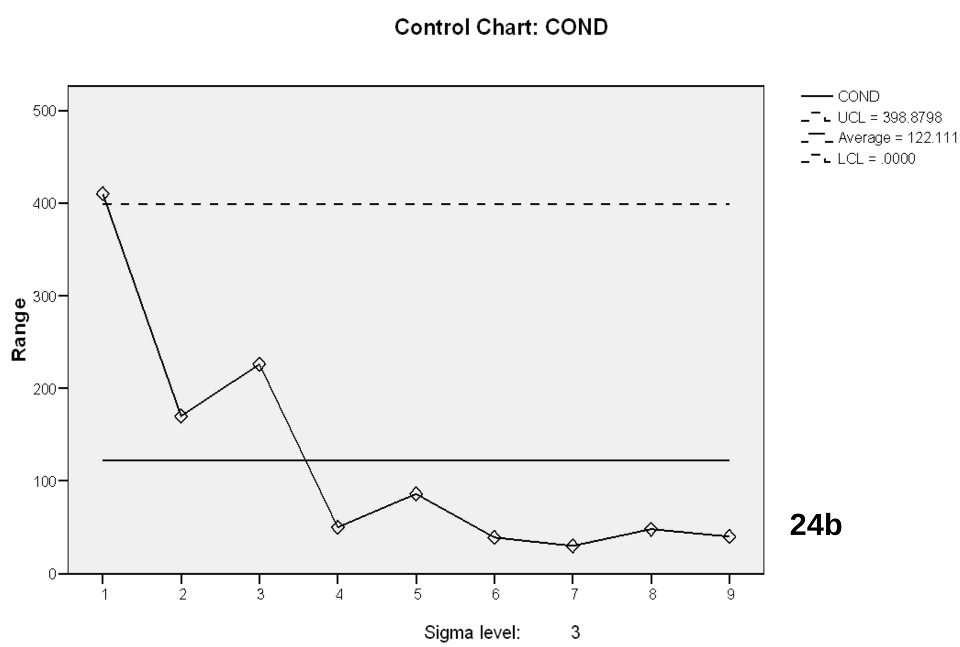




**Figure 24.** Electrical conductivity control chart for borehole in Abeokuta North Local Government (24a) using mean and (24b) using range.

beneficial effects, although adverse effects have been reported in some cases. Water containing TDS concentrations below 1000 mg/L is usually acceptable to consumers, although acceptability may vary according to circumstances. TDS is used to estimate the quality of potable water because it represents the amount of ions in the total coliform and faecal coliform. The TDS in water sampled in this work range from 99.8778 mg/L to 203.6548 mg/l and may be considered appropriate since falling within the allowable limits of 1000 mg/L. Electrical conductivity of water may have some significant implications on total coliform concentration (Adejuwon and Adeniyi, 2011). The values of Electrical conductivity of water in this work which ranges from 198.8642 μS/cm to 409.0476 μS/cm are within the EU permissible limit of 2500 μS/cm for portable water.

**Table 1.** Summary table for measured quantities.

| Local Government | Water Source | Quantity Measured | Average Value |
|---|---|---|---|
| Odeda | Well | Total dissolved solids | 170.8133 mg/l |
| Odeda | Stream | Total dissolved solids | 100.5432 mg/l |
| Odeda | Borehole | Total dissolved solids | 178.5714 mg/l |
| Obafemi Owode | Well | Total dissolved solids | 203.6548 mg/l |
| Obafemi Owode | Stream | Total dissolved solids | 161.4127 mg/l |
| Obafemi Owode | Borehole | Total dissolved solids | 131.5000 mg/l |
| Abeokuta South | Well | Total dissolved solids | 138.5833 mg/l |
| Abeokuta South | Stream | Total dissolved solids | 99.8778 mg/l |
| Abeokuta South | Borehole | Total dissolved solids | 127.7778 mg/l |
| Abeokuta North | Well | Total dissolved solids | 156.2255 mg/l |
| Abeokuta North | Stream | Total dissolved solids | 196.8500 mg/l |
| Abeokuta North | Borehole | Total dissolved solids | 143.6111 mg/l |
| Odeda | Well | Electrical conductivity | 341.9309 µS/cm |
| Odeda | Stream | Electrical conductivity | 198.8642 µS/cm |
| Odeda | Borehole | Electrical conductivity | 357.4296 µS/cm |
| Obafemi Owode | Well | Electrical conductivity | 409.0476 µS/cm |
| Obafemi Owode | Stream | Electrical conductivity | 324.4127 µS/cm |
| Obafemi Owode | Borehole | Electrical conductivity | 263.0000 µS/cm |
| Abeokuta South | Well | Electrical conductivity | 271.1778 µS/cm |
| Abeokuta South | Stream | Electrical conductivity | 199.7556 µS/cm |
| Abeokuta South | Borehole | Electrical conductivity | 255.5556 µS/cm |
| Abeokuta North | Well | Electrical conductivity | 313.3652 µS/cm |
| Abeokuta North | Stream | Electrical conductivity | 393.5000 µS/cm |
| Abeokuta North | Borehole | Electrical conductivity | 230.6111 µS/cm |

## Conclusion

Results indicate low values of TDS and EC (Table 1). There are several factors which may contribute to the degradation in the quality of ground water in Abeokuta. Human activities as well as municipal waste disposal may be principally responsible for the quality of ground water within the metropolis. According to Oram et al. (2011), there is no primary drinking water standard for TDS, but the secondary standard for TDS is 500 mg/L. In the present study, about 99% of the wells, streams and borehole sampled had TDS below 500 mg/L. Water with a very low TDS value may be corrosive and may leak toxic metals such as copper and lead from household plumbing. This also means that trace metals could be present at levels that may pose a health risk. An elevated TDS in water indicate aesthetic problems such as staining, taste or colour. Rain water typically has a TDS of 20 mg/L or less, fresh water from lakes, rivers and ground water is more variable with TDS ranging from 20 mg/L to approximately 1000 mg/L. Brackish water is by definition, water with TDS exceeding 1000 mg/L. Waters under consideration fall in the category of fresh water. Electrical conductivity values of water shows that the water sampled may have some level of impurity but may not pose serious health risk to human health.

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