

# **ILEMBE DISTRICT MUNICIPALITY SCHOOLS GROUNDWATER ASSESSMENT**

## **SOMSHOKO SECONDARY SCHOOL HYDROGEOLOGY REPORT**

**REPORT PREPARED ON BEHALF OF: MLOMBOMVU PROJECTS CC**



**REPORT PREPARED FOR: DEPARTMENT OF WORKS – KWAZULU-  
NATAL**

**REPORT NO.: 20200022/1**

**OCTOBER 2021**



**PREPARED BY:**



# **ILEMBE DISTRICT MUNICIPALITY SCHOOLS GROUNDWATER ASSESSMENT – SOMSHOKO SECONDARY SCHOOL HYDROGEOLOGY REPORT**

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**Report Number: 20200022/1**

**October 2021**

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## EXECUTIVE SUMMARY

Mlombomvu Projects was appointed by the KwaZulu-Natal Department of Public Works to develop groundwater sources for Somshoko Secondary School (The School) located in Amatikulu, in the Ilembe District Municipality, in KwaZulu-Natal Province, South Africa.

MMN Groundwater Consulting was appointed by Mlombomvu Projects to conduct hydrogeological assessment for the project. This report summaries the methodologies and findings of groundwater assessment and groundwater quality and further recommend the utilisation and management of the installed boreholes at Somshoko Secondary School

The main objective of the investigation was to develop a groundwater source to be used as a water source for livestock on selected sites. The hydrogeological investigation included the following activities:

- Physical assessment and hydrogeological desk study;
- Geophysical survey;
- Drilling of boreholes;
- Test pumping (aquifer testing),
- Sampling and sample analysis and
- Borehole equipping.

Geophysical surveys was carried out on 01 October 2020 to identify points suitable for the drilling of water supply boreholes, using Wenner resistivity method with a nominal coil separation of 40 m. The following drilling positions were suggested -29.120124°S, 31.574727°E for drilling, based on the lower resistivity indicated. Drilling positions were suggested based on the above mentioned assumptions, as well with a view of obtaining a wide distribution of positions across the site. The final locations/positions of the traverse lines were determined by the site hydrogeologist and were based on accessibility, man-made interferences, field observations and interpreted groundwater flow direction.

Drilling at Somshoko Secondary School was conducted on from 16 November 2020 and was completed 22 November 2020 using the method stipulated in Section 4.3 of this report. The borehole was drilled to a final depth of 102 mbgl. The borehole was drilled from surface to 12 mbgl with an 8-inch (203 mm) diameter drill bit. A solid steel casing of 165 mm was installed from the top of the surface to 12 mbgl. The borehole was then drilled from 12 mbgl to 102 mbgl using 165 mm diameter drill bit. Groundwater was intercepted at 32 mbgl with a blow yield of 0.47 L/s and at 68 mbgl with an accumulative blow yield of 1.56 L/s, which was associated with weathered and fractured rock and contact zones. The total blow yield of 1.56 L/s was measured at the end of drilling. The borehole was subjected to a maximum of 1 hour of development after the final depth.

The pumping tests for the successful borehole was conducted on 20 and 21 August 2021. Borehole depths during the pumping test of the borehole were measured, together with static water level (SWL). The available drawdown for the borehole was calculated from the pump

onset to the SWL. Groundwater samples were collected towards the end of pumping test and were submitted to an accredited laboratory for chemical and bacterial analysis.

The groundwater quality at Somshoko Secondary School meets the minimum requirement for human consumption. The groundwater quality is characterised by elevated Total Coliforms and Standard Plate Count. The presence of these bacterial can indicate a deterioration in cleanliness, possibly stagnation and the potential development of biofilms.

The groundwater from The School shows elevated concentration of microbial. Since the groundwater contains bacterial pathogens, the administration of an effective disinfectant such as chlorine before the groundwater is used, is recommended.

The borehole at The School should be equipped according to the stipulated utilisation recommendations:

- Recommended pump setting to be at 40.00 mbgl.
- Recommended pump rate at 1.00 L/s.
- Recommended pump duration is 12 hours.

To ensure that the aquifer is protected from over abstraction and permanent damage, MMN recommends that a “pump/power cut off switch” be installed at the “aquifer protection water level” depth of 20 metres below ground level.

It is recommended that a groundwater level logger and flow meter should be installed when equipping the borehole and ensure monitoring is done on a monthly basis (water levels and abstraction rate). This will assist in determining the over or under utilisation of the borehole.

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## List of abbreviations

CDT	Constant Discharge Test
DWS	Department of Water and Sanitation
EC	Electric Conductivity
EPWP	Expanded Public Works Programme
KZN	KwaZulu-Natal
RT	Recovery Test
SANS	South African National Standards
SDT	Step Drawdown Test
SWL	Static Water Level

## List of measurements

L	litres
L/s	litres per second
m	metres
mamsl	metres above mean sea level
mbgl	metres below ground level
mm	millimetres

# 1 INTRODUCTION

Mlombomvu Projects was appointed by the KwaZulu-Natal Department of Public Works to develop groundwater sources for Somshoko Secondary School (The School) located in Amatikulu, in the Ilembe District Municipality, in KwaZulu-Natal Province, South Africa.

MMN Groundwater Consulting was appointed by Mlombomvu Projects to conduct hydrogeological assessment for the project. This report summaries the methodologies and findings of groundwater assessment and groundwater quality and further recommend the utilisation and management of the installed boreholes at Somshoko Secondary School.

## 2 PROJECT OBJECTIVES AND WORK PROGRAM

### 2.1 Project objectives

The main objective of the investigation was to develop a groundwater source to be used as a water source for livestock on selected sites.

The stipulated objectives of the program are as follows:

- Assess and describe the geological/hydrogeological characteristics of the rock units underlying the identified site.
- Determine the groundwater yield potential class within and around the identified school.
- Establish the site water supply status quo as well as the condition of the water supply source and related infrastructures.
- Provide reliable water supply to The School by siting, drilling, testing (quality and quantity) and equipping a borehole; and
- to ensure that the work is of a high standard and is completed in the shortest practical time whilst complying with EPWP requirements for using labour intensive construction methods to deliver public infrastructure, and complying with the Occupational Health and Safety Act's requirements for safety.

### 2.2 Work program

The scope of work undertaken to address the objective of the study for the hydrogeological investigation included:

- Project initiation meeting to define the area of investigation and project schedule.
- Desk study – review of existing literature, available maps, and data for the area.
- Site visit and site assessment.
- Geophysical survey to scientifically select suitable drilling positions.
- Drilling of a production borehole, including supervision of the drilling and geological logging of the drilled borehole.
- Aquifer testing of the drilled borehole and water sampling.
- Water quality analyses undertaken by an accredited Laboratory.
- Interpretation of the yield test data and recommendation of abstraction rate, pump duration and pump setting depth of the drilled borehole.

- Comparing of water quality analytic results with the South Africa National Standards (SANS) 241:2015 (1 & 2) Drinking Water Standards to assess the suitability of the water for human consumption.
- Compilation of a technical Hydrogeological Assessment Report.

### **3 REVIEW OF AVAILABLE INFORMATION**

The desktop study included a review of all available hydrocensus, geotechnical, geological and hydrogeological information. This information has been included, where appropriate, in this report.

#### **3.1 Regional and site descriptions**

Somshoko Secondary School (Latitude: -29.120394°; Longitude: 31.574651°) is a public secondary school located in Amatikulu. The Site is located approximately 25 km north east of Mandini town in Ilembe District Municipality in KZN. The Site names and location are shown in Figure 3-1.

#### **3.2 Topography and drainage**

The project area is situated in the Amatikulu River drainage system. The topography is relatively flat, characterised by some gullies. The School lies at approximately 100 mamsl.

#### **3.3 Regional geology**

A 1:250 000 Geological map series has been used to describe the geology for Mandini.

The regional geology comprises of the Karoo Supergroup which is characterised by quaternary alluvium, shale and post Karoo dolerite. Sandstone of the Natal Group is found in some areas.

#### **3.4 Hydrogeology**

The 1:500 000 General Hydrogeological map for the Republic of South Africa published by DWAF (2000) and Aquifer Classification of South Africa by R. Parsons (1999) have been used to describe the hydrogeology for Mandini.

The aquifer in the area is characterised as minor aquifer, which is moderately-yielding aquifer system of variable water quality. The vulnerability<sup>1</sup> of the aquifer is the least in the area and the susceptibility<sup>2</sup> is low. The principal groundwater occurrence in the area is intergranular and fractured aquifers systems that are capable of supporting borehole with yields between 0.5 – 2.0 l/s. The intergranular and fractured aquifer systems which are associated with predominantly meta-arenaceous rocks.

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<sup>1</sup> Aquifer Vulnerability – The tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer.

<sup>2</sup> Aquifer Susceptibility – A quantitative measure of the relative ease at which a groundwater body can be potentially contaminated by anthropogenic activities and includes both aquifer vulnerability and the relative importance of the aquifer in terms of its classification.

It should be noted that groundwater occurrences depict the aquifer types with the highest borehole yield which does not always correlate with surface lithology.

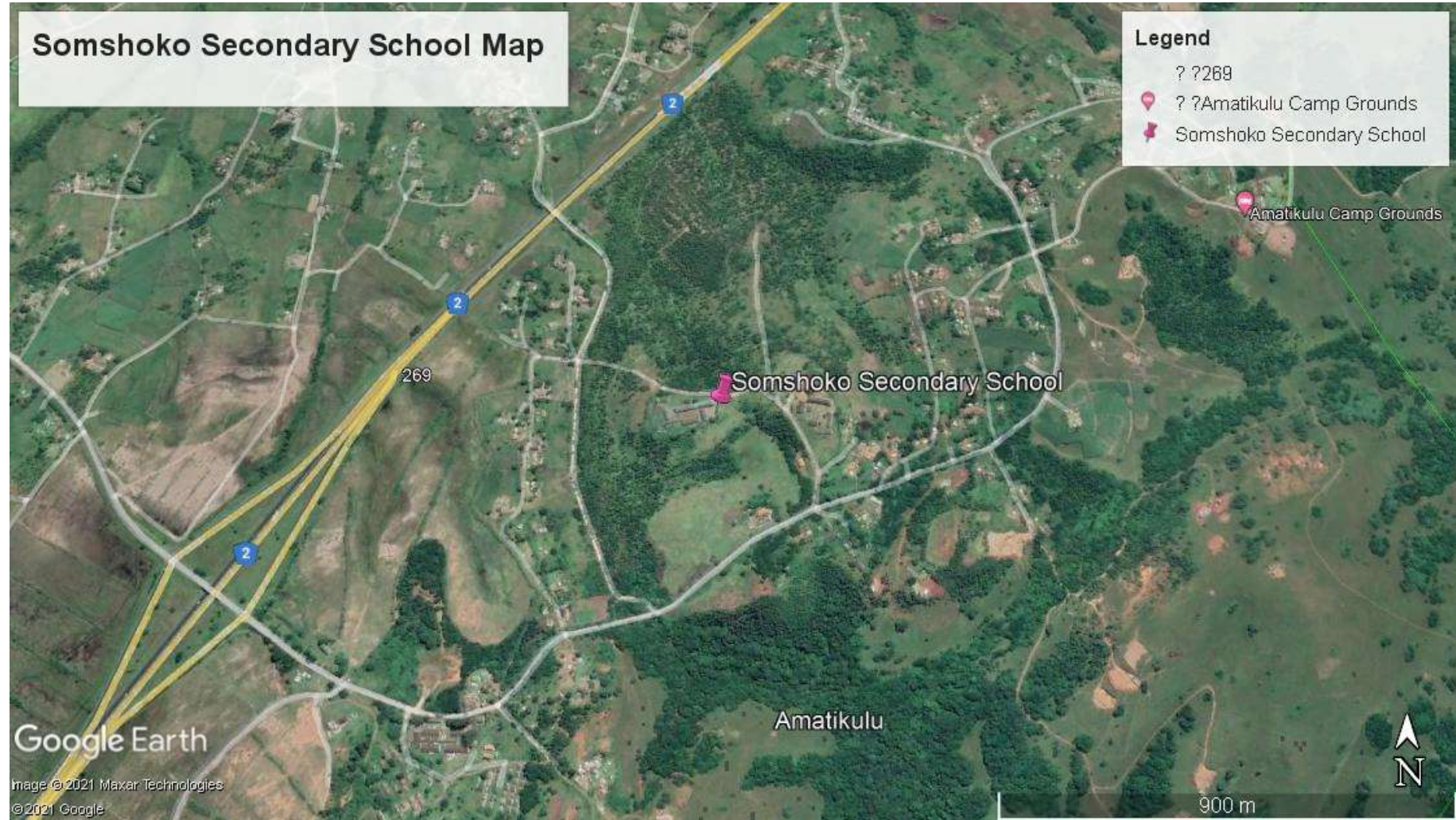


Figure 3-1: Locality map showing Somshoko Secondary School

## **4 INVESTIGATION PROCEDURE**

### **4.1 Desk study**

The desk study was undertaken according to the Department of Water and Sanitation (DWS) guideline for the assessment, planning and management of the groundwater resources in South Africa (2008), which stipulates that the geological and hydrogeological desk study should include:

- Collection of relevant data of the aquifers and the scale of the assessment.
- Collate and review of gathered information.
- Based on the gathered information, groundwater potential areas to be targeted by geophysics were identified.

### **4.2 Geophysical survey**

The identification or siting of drilling targets started with review of existing geological and hydrogeological information of the area to identify geological structures, mapped lineaments and groundwater potential areas within the school. The identified geological structures and groundwater potential areas were then targeted for drilling. To confirm the location of the drilling targets, geophysical surveys was completed.

Geophysical survey involved the use of geophysical techniques which are able to detect the geological structures or well-developed weathering. The targeted geological structures targeted for the development of a borehole was weathered and fractured zones within the school premises. Geohydrological team identified resistivity as the appropriate method of geophysical survey to be used for the area.

The interpretation of the geology and geophysical data was used for final selection of potential drilling targets. These drilling targets were marked in the field and the coordinates recorded, prior to the commencement of drilling.

### **4.3 Borehole drilling**

The borehole was drilled according to the recommended drilling standards and guidelines (SANS 10299 and DWA, 1997 & 2008).

The preferred drilling method for the drilling programme was rotary air percussion using a down-the-hole hammer. This drilling technique is ideally suited for hard rock formations. The was drilled using an 8 inches (203 mm) diameter from the surface, throughout the weathered zone and then completed using the 6.5 inches (165 mm) drilling through solid rock. The drill cuttings were brought to the surface by air return from the borehole and were collected per each meter drilled. The samples of drill chips were collected every 1 meter by the drilling contractor. The drill chips were logged by the site hydrogeologist. The rate at which the drill bit penetrates the rock every meter was measured by the drilling contractor.

The boreholes were constructed with a 6.5 inches (4 mm thick) steel casing and the depth of casing targeted the depth of the weathering zone.

Every water strike was noted, and drilling was temporarily interrupted in order to develop the encountered water strike. During drilling and development, a container of known volume was permanently set up in an approved manner, level and vertical, in the drain line so that continuous monitoring of airlift yields can be obtained.

## **4.4 Pumping testing**

### **4.4.1 Methodology**

The objective of pumping tests is to provide information on the efficiency of the borehole construction and estimate aquifer characteristics in order to determine the optimum pumping rates to ensure sustainability of the groundwater resource.

Pumping test was carried out in accordance with DWS test pumping guidelines. The test pumping programme comprised of the following tests:

#### **Step Drawdown Test (SDT)**

During the SDT the borehole was pumped at a constant yield for a 60-minute interval, thereafter at a higher discharge rate for the same duration. A minimum of three and maximum and five consecutive 60-minute test intervals were carried out per borehole. The drawdown over time was recorded in pumping and observation boreholes. Once the pump was stopped, residual drawdown was measured until 95 % recovery of the water level was reached. The discharge rate for the longer duration constant discharge test (see below) was estimated from the interpretation of the time drawdown data generated during the SDT.

#### **Constant Discharge Test (CDT)**

The CDT follows after the SDT. During a CDT, the borehole was pumped for a predetermined time at a constant rate. The drawdown over time was recorded in the pumping borehole. Discharge measurements were taken at predetermined intervals to ensure that the constant discharge rate is maintained throughout the test period. Any changes in discharge rate were accurately recorded and reported. The CDT was conducted over 24 hours. During CDT the aquifer needed to be stressed sufficiently to identify boundary effects that may impact on long-term aquifer utilisation.

Groundwater samples were collected at the end of the discharge pipe line during the CDT. The samples were sent to SANAS accredited laboratory for chemical analysis.

#### **Recovery test (RT)**

The RT followed directly after pump shut off at the end of the CDT. The residual drawdown over time (water level recovery) was measured in the pumped borehole until 95 % recovery was reached or for a length of time at least equal to the pumping time.

#### 4.4.2 Pumping test data analysis

The pumping test data were interpreted using Flow Characteristics (FC)-Method. FC-Method is an excel based pumping test interpretation software developed by the Institute of Groundwater Studies (IGS) of the University of Free State on behalf of the Water Research Commission (WRC) to analyse the pumping tests in fractured rocks (Van Tonder et al., 2001).

The FC-Method estimates the sustainable yield of the borehole which is considered as the discharge rate that will not cause the water level in the borehole to drop below prescribed limit (critical level), usually the position of a major water strike.

#### 4.5 Water quality analysis

Groundwater samples collected were sent to a SANAS accredited laboratory for chemical analysis. The sample were analysed for the following parameters:

- **Microbiological determinands:** Escherichia coli (E. coli), Total Coliforms and Standard Plate Count;
- **Physical and aesthetic determinands:** pH, Electrical Conductivity, Total dissolved solids, Turbidity;
- **Chemical determinands (Macro):** Calcium as Ca, Chloride as Cl Fluoride as F, Magnesium as Mg, Nitrate as N, Nitrite as N, Sodium as Na, Sulfate as SO<sub>4</sub>.
- **Chemical determinands (Micro):** Copper as Cu, Iron as Fe, Lead as Pb, Manganese as Mn,

The analytical results from the laboratory were compared to SANS 241-1 & 2: 2015 Drinking Water Standards to evaluate the suitability of the water for its intended use.

## 5 FINDINGS

### 5.1 Geophysical survey outcomes

Geophysical surveys was carried out on 01 October 2020 to identify points suitable for the drilling of water supply boreholes. Geophysical survey was conducted using Wenner resistivity method with a nominal coil separation of 40 m. A total of only 50 m of coverage was obtained due to limited space in school perimeter and the location of school buildings. The readings were obtained every 5 m, using both horizontal- and vertical-dipole orientations. The positions of the traverses were recorded with a Garmin GPS.

Traverse lines were planned and located in selected areas. The vertical conductors represent potential drilling targets as they suggest preferential weathering of fracture zones, faults and intrusions, and thus possible aquifers (if not filled with clay). Conductors associated with magnetic anomalies are probably related to intrusions, possibly dykes, whilst those which are not, may indicate fracture zones.

The following drilling positions were suggested -29.120124°S, 31.574727°E for drilling, based on the lower resistivity indicated. Drilling positions were suggested based on the above mentioned assumptions, as well with a view of obtaining a wide distribution of positions across the site. The final locations/positions of the traverse lines were determined by the site hydrogeologist and were based on accessibility, man-made interferences, field observations and interpreted groundwater flow direction.

The final locations/positions of the traverse lines were determined by the site hydrogeologist and were based on accessibility, man-made interferences, field observations and interpreted groundwater flow direction.

The geophysical data is presented on the Appendix A of this report.

## **5.2 Borehole drilling outcomes**

Drilling at Somshoko Secondary School was conducted on from 16 November 2020 and was completed 22 November 2020 using the method stipulated in Section 4.3 of this report. The borehole was drilled to a final depth of 102 mbgl. The borehole was drilled from surface to 12 mbgl with an 8-inch (203 mm) diameter drill bit. A solid steel casing of 165 mm was installed from the top of the surface to 12 mbgl. The borehole was then drilled from 12 mbgl to 102 mbgl using 165 mm diameter drill bit.

Groundwater was intercepted at 32 mbgl with a blow yield of 0.47 L/s and at 68 mbgl with an accumulative blow yield of 1.56 L/s, which was associated with weathered and fractured rock and contact zones. The total blow yield of 1.56 L/s was measured at the end of drilling.

The borehole was subjected to a maximum of 1 hour of development after the final depth.

All drilling data was supplied to the hydrogeologist by the driller on site, including drilling chips, water strike depths, strike yields and borehole construction information. MMN Groundwater Consulting is not to be held accountable for any inaccuracy in the drilling information provided.

Borehole ID	Somshoko Secondary School
GPS Coordinates - Latitude	-29.120124°S
GPS Coordinates - Longitude	31.574727°E
Date Drilling starts	16 November 2020
Date Drilling completed	22 November 2020
Borehole depth (mbgl)	102.00
Drilling Diameter – 203 mm (mbgl)	12.00
Drilling Diameter – 165 mm (mbgl)	90.00
Construction Solid casing (mbgl)	12.00
Construction Perforated casing (mbgl)	0.00
Summary of intercepted strata (mbgl)	32; 68
Final Blow Yield in L/s	1.56
Comment	Borehole recommended for pumping test.

Table 5-1: Table summarising drilling at Somshoko Secondary School

Summary of the drilling programme is presented in Table 5-1. Borehole drilling logs are attached on Appendix B of this report.

## 5.3 Borehole sustainable yield testing

### 5.3.1 Pumping test outcomes

The pumping tests for the successful borehole was conducted on 20 and 21 August 2021. The pumping test was conducted according to the stipulated methodologies as presented in Section 4.4.1 above. Borehole depths during the pumping test of the borehole were measured, together with static water level (SWL). The available drawdown for the borehole was calculated from the pump onset to the SWL.

Summary of the pumping test programme at The School is summarised in Table 5-2.

Borehole ID	Somshoko Secondary School
GPS Coordinates - Latitude	-29.120124°S
GPS Coordinates - Longitude	31.574727°E
Date tested	20 - 21 August 2021
Depth during testing (mbgl)	102.00
Static water level (mbgl)	17.21
Pump setting (mbgl)	95.00
Estimated available drawdown for pump test (m)	77.66
CRDT duration (min)	480.00
CRDT pumping rate (l/s)	1.00
Sample collected	Yes

Table 5-2: Table summarising pumping test at Somshoko Secondary School

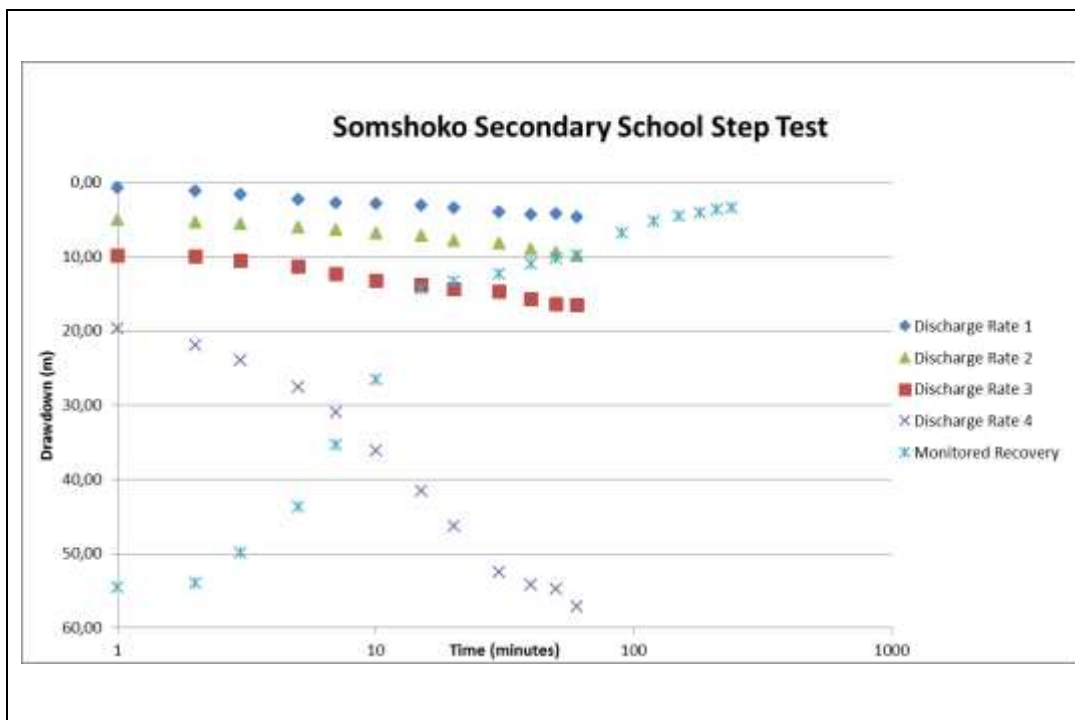


Figure 5-3: Step test graphs from data at Somshoko Secondary School

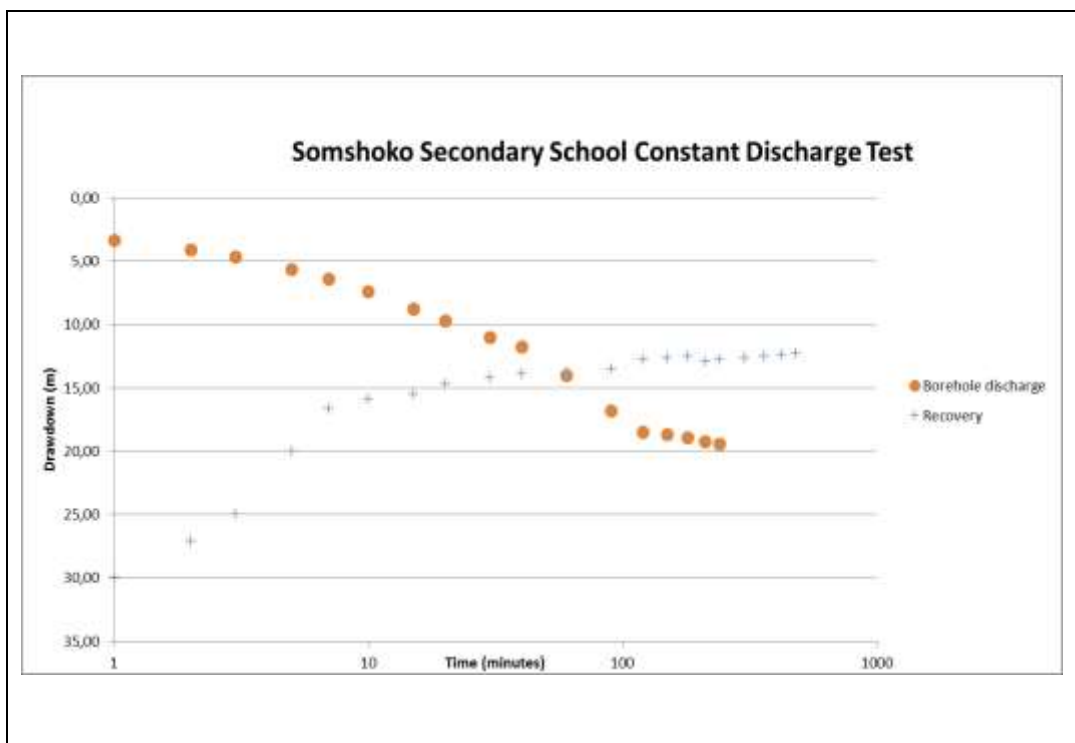


Figure 5-4: CDT graphs from data at Somshoko Secondary School

### 5.3.2 Recommended borehole utilisation

The pumping test data were interpreted to determine a maximum pumping rate. Cognisance of the surrounding groundwater use i.e., abstraction from other nearby production boreholes and potential for periodic recharge of the aquifer were taken into account when calculating the maximum yield of the tested boreholes. Based on the interpretations, the pumping rate, installation depth and the pumping duration were recommended.

The recommended abstraction rate, duty cycle, aquifer protection level, etc., are presented in Table 5-5. The recommended abstraction rate was calculated on a 12-hour pump cycle per day, allowing the aquifer to recover for 12 hours per day. However, there is a risk in that the borehole could be left operating for a longer period and dewatering can take place. In the medium to long term this will destroy the borehole.

The depth of the main water strike has been marked as the critical water level, i.e., aquifer protection level. During abstraction from the borehole, the water level should not drop below the recommended critical water level as this poses a risk of dewatering the aquifer, in turn damaging the aquifer permanently reducing the sustainable yield of the borehole.

Borehole ID	Somshoko Secondary School
<b>Borehole depth (mbgl)</b>	102.00
<b>Static water level (mbgl)</b>	17.21
<b>Recommended pumping rate (L/s)</b>	0.74
<b>Pumping Duration (Duty cycle) in hrs</b>	12 Hours
<b>Pump setting (mbgl)</b>	95.00
<b>Critical water level (mbgl)</b>	37.00
<b>Daily abstraction volumes (m<sup>3</sup>)</b>	31.97

Table 5-5: Recommended installation and utilisation details

To ensure that the aquifer is protected from over abstraction and permanent damage, MMN recommends that a “pump/power cut off switch” be installed at the “aquifer protection water level” depth, where electrical pumps are used.

## 5.4 Water quality compliance with drinking standards

The water from the newly drilled boreholes is going to be used mainly for consumption and some domestic purposes. For this reason, SANS 241-1 & 2: 2015 Drinking Water Standards were used to evaluate the suitability of the water for its intended use.

The summary of water quality results in comparison to the SANS 241-1 & 2: 2015 are presented in Table 5-6 and the laboratory analytical certificate are included as Appendix D.

The groundwater quality at Somshoko Secondary School meets the minimum requirement for human consumption. The groundwater quality is characterised by elevated Total Coliforms and Standard Plate Count. The presence of these bacterial can indicate a deterioration in cleanliness, possibly stagnation and the potential development of biofilms.

Chemical	Units	SANS 241-1:2015 Limits		Somshoko Secondary School
		Chronic	Aesthetic	
Calcium (Ca)	mg/L			7.45
Magnesium (Mg)	mg/L			7.62
Sodium (Na)	mg/L	≤200		53.00
Copper (Cu)	µg/L	≤2000		4.50
Iron (Fe)	µg/L	≤2000	≤300	70.00
Manganese (Mn)	µg/L	≤400	≤100	14.80
Lead (Pb)	µg/L	≤10		2.60
Total Alkalinity (CaCO <sub>3</sub> )	Mg/L			24.00
Chloride (Cl)	mg/L	≤300		75.00
Electrical Conductivity @ 25°	mS/m		170	30.00
Fluoride (F)	mg/L	≤1.5		0.09
Nitrate (N)	mg/L	≤11		2.02
Nitrite (N)	mg/L	≤0.9		<0.05
Turbidity	NTU		≤5	0.59
pH @25°	pH units	≥5 to 9,7		6.40
Sulphate (SO <sub>4</sub> )	mg/L	≤500	≤250	3.78
Total Hardness (CaCO <sub>3</sub> )	mg/L			50.00
<i>E.coli</i>	MPN/100 mL	0		Not detected
Total Coliforms	MPN/100 mL	≤10 count/100 mL		19.00
Standard Plate Count	colonies/mL		≤1000 count/1 mL	>1000

Table 5-6: Water quality analytical results in comparison to SANS 241:2015

## **6 HEALTH, SAFETY, ENVIRONMENT AND RISK ASSESSMENT**

### **6.1 Health and safety plan**

In order to establish and maintain safe working conditions, conditions of Occupational Health and Safety Act 85 of 1993 were adopted and maintained for the duration of the project. A Health & Safety Plan (HASP) which established personnel protection standards and mandatory safety practices and procedures for the field activities for the environmental site assessment was drafted. The HASP assigned responsibilities, established standard operating procedures, and provided for contingencies that may have arisen during site activities. The objective of this plan was to establish procedures that ensured a safe and incident free operation during field activities.

The Site Supervisor conducted a pre-mobilisation briefing on the contents of the HASP for all site personnel involved in the covered activities. All such personnel signed the Project Health and Safety Plan Briefing Acknowledgment form, acknowledging that they have attended the pre mobilisation briefing, and have understood this HASP and will abide by its contents.

### **6.2 Stop work authority**

All site personnel are empowered, expected, and have the responsibility to stop their own work and the work of other site personnel if any person's safety or the environment are at risk. No repercussions will result from this action. Should a Stop Work Authority be used at the site then the details must be recorded in the Stop Work Register which will be included in the H&S File. Work can continue once the unsafe conditions have been eliminated or removed and the site is deemed safe by the Site Safety Officer (SSO).

### **6.3 Hazard analysis and risk mitigation by task**

Some of the potential hazards/risks that were likely to be encountered during the course of the construction component of the hydrogeological project may include the following:

- Vehicle traffic and driving conditions;
- Slip, trip, falls;
- Fatigue;
- Lifting and improper ergonomics;
- Mechanical failure of equipment;
- Dropping heavy equipment;
- Underground services;
- Extreme weather conditions;
- Pinch and shear points/sharp objects;
- Fires; and
- Biological hazards.

Minimum Protective Clothing/Equipment Requirements are as follows:

- Long sleeved shirts and long pants;
- Safety glasses with side shields or “wrap-around” protection;
- Steel-toed work boots;
- Ear plugs;
- High visibility safety vest;
- Protective gloves

Safety, physical, and biological hazards can be mitigated by the use of proper work procedures and controls, safety equipment (e.g. hard hat, safety glasses, steel-toed shoes, protective gloves), good communication among all on-site personnel and being alert to potential hazards.

## 7 CONCLUSIONS AND RECOMMENDATIONS

### 7.1 Conclusions

Groundwater resource development at Somshoko Secondary School encompassed a data review, site visit, geophysical investigation and drilling. The following conclusions may be drawn from the investigation:

- The borehole was drilled in The School to the final depth of 102 mbgl.
- Test pumping was conducted at The School and lasted for 480 minutes after being pumped constantly at the rate of 1.00 L/s.
- The groundwater chemistry at the school meets the minimum requirements for drinking water standards (SANS 241, 2015). The groundwater quality is characterised by elevated Total Coliforms and Standard Plate Count. The presence of these bacterial can indicate a deterioration in cleanliness, possibly stagnation and the potential development of biofilms.
- Groundwater sources were successfully developed at The School. The developed borehole will be able to meet the water demand.

### 7.2 Recommendations

MMN recommends the following:

- The groundwater from The School shows elevated concentration of microbial. Since the groundwater contains bacterial pathogens, the administration of an effective disinfectant such as chlorine before the groundwater is used, is recommended.
- The borehole at The School should be equipped according to the stipulated utilisation recommendations (Table 5-5):
  - Recommended pump setting to be at 40.00 mbgl.
  - Recommended pump rate at 1.00 L/s.
  - Recommended pump duration is 12 hours.
- To ensure that the aquifer is protected from over abstraction and permanent damage, MMN recommends that a “pump/power cut off switch” be installed at the “aquifer protection water level” depth of 20 mbgl.
- It is recommended that a groundwater level logger and flow meter should be installed when equipping the borehole and ensure monitoring is done on a monthly basis (water levels and abstraction rate). This will assist in determining the over or under utilisation of the borehole.

## 8 References

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# Appendices

## **Appendix A: Geophysical Survey Data**

Distance	Resistivity ( $\Omega$ ) (40m spacing)	Standard Deviation	Latitude	Longitude
<b>Traverse 1</b>				
0	367.19	0.1	-29.120314°	31.574571°
10	343.86	1.3		
20	333.16	0.2		
30	156.97	0.1		
40	129.62	0.1		
50	122.03	0.2		
60	158.36	0.1		
70	137.65	0.1		
80	156.66	0.2		
90	155.52	0.2	-29.119930°	31.575313°

## **Appendix B: Drilling Logs**

BOREHOLE ID: SOMSHOKO SECONDARY SCHOOL												
<b>School Name</b>	Somshoko Secondary School	<b>Borehole Depth:</b>	102 mbgl	<b>Latitude:</b>	-29.120118°							
<b>Client Name:</b>		<b>Collar elevation:</b>	0,13	<b>Longitude:</b>	31.574728°							
<b>Site Location:</b>	Amatikulu, KZN	<b>RWL:</b>	17,21	<b>Datum:</b>	WGS84							
<b>Drilling Company:</b>	Mzansi Drilling	<b>Drilling Method:</b>	Air Percussion	<b>Date Drilled:</b>	22 November 2020							
<b>Logged by:</b>	Mfundo Nyembe	<b>Project Name</b>	Ilembe DM Schools Groundwater Assessment									
Depth (mbgl)	Lithology	Hole diameter (mm)	Casing	Annulus	Water Level (mbgl)	Water Strikes (L/s)						
2	SAND. Brown, loose, medium grained, moist.	203	Steel									
4												
6												
8												
10												
12	DOLERITE. Light grey, fine grained, moderately weathered, sub-rounded grains	165			17,21							
14												
16												
18												
20												
22												
24												
26												
28												
30												
32												
34												
36	DOLERITE. Grey, medium grained, slightly weathered, sub-angular grains	165				0,47						
38												
40												
42												
44												
46												
48												
50												
52												
54												
56												
58												
60	DOLERITE. Grey, medium grained, slightly weathered, angular grains	165				1,56						
62												
64												
66												
68												
70												
72												
74												
76												
78												
80												
82												
84												
86												
88												
90												
92												
94												
96												
98												
100												
102												
Notes:							Final blow yield: 1,56 L/s.					



## **Appendix C: Pumping test data**

<b>Borehole Yield Test- (Step test and recovery)</b>														
<b>Borehole number:</b>		Somshoko Secondary School		<b>Co-ordinates:</b>				<b>Region:</b>		Kw aZulu-Natal				
				<b>Latitude (S)</b>		-29.120118°		<b>District:</b>		llembe District Municipality				
<b>Date Tested:</b>		20 August 2021		<b>Longitude (E)</b>		31.574728°		<b>Community Name:</b>		Amatikulu				
<b>Borehole depth (meters):</b>		98,00		<b>Casing Height (magl):</b>		0,13		<b>Existing Pump make:</b>		New borehole				
<b>Water Level (mbgl):</b>		17,21		<b>Borehole diameter (mm):</b>		165,00		<b>Test Pump Type:</b>		2,2 kW submersible				
<b>Depth of pump (meters):</b>		95,00												
<b>Discharge Rate 1</b>				<b>Discharge Rate 2</b>				<b>Discharge Rate 3</b>				<b>Monitored Recovery</b>		
Time (minutes)	Water Level (mbgl)	Draw down (mbgl)	Yield (m <sup>3</sup> /hr)	Time (minutes)	Water Level (mbgl)	Draw down (mbgl)	Yield (m <sup>3</sup> /hr)	Time (minutes)	Water Level (mbgl)	Draw down (mbgl)	Yield (m <sup>3</sup> /hr)	Time (minutes)	Recovery (W/L) (mbgl)	Recovery (mbgl)
1	18,06	0,72	1000	1	22,37	5,03	2000	1	27,21	9,87	3600	1	71,72	54,51
2	18,43	1,09		2	22,61	5,27		2	27,30	9,96		2	71,12	53,91
3	18,97	1,63		3	22,89	5,55		3	27,83	10,49		3	67,06	49,85
5	19,62	2,28		5	23,33	5,99		5	28,60	11,26		5	60,91	43,70
7	20,10	2,76		7	23,72	6,38		7	29,64	12,30		7	52,58	35,37
10	20,19	2,85		10	24,14	6,80		10	30,55	13,21		10	43,74	26,53
15	20,45	3,11		15	24,49	7,15		15	31,08	13,74		15	31,60	14,39
20	20,75	3,41		20	25,10	7,76		20	31,72	14,38		20	30,59	13,38
30	21,34	4,00		30	25,51	8,17		30	32,03	14,69		30	29,47	12,26
40	21,63	4,29		40	26,22	8,88		40	32,98	15,64		40	28,17	10,96
50	21,55	4,21		50	26,67	9,33		50	33,68	16,34		50	27,41	10,20
60	22,00	4,66		60	27,13	9,79		60	33,87	16,53		60	27,07	9,86
												90	24,03	6,82
<b>Discharge Rate 4</b>				<b>Discharge Rate 5</b>				<b>Discharge Rate 6</b>				120	22,40	5,19
Time (minutes)	Water Level (mbgl)	Draw down (mbgl)	Yield (m <sup>3</sup> /hr)	Time (minutes)	Draw down (mbgl)	Yield (m <sup>3</sup> /hr)	Time (minutes)	Draw down (mbgl)	Yield (m <sup>3</sup> /hr)	150	21,76	4,55		
1	36,96	19,62	6700	1			1			180	21,23	4,02		
2	39,21	21,87		2			2			210	20,89	3,68		
3	41,30	23,96		3			3			240	20,57	3,36		
5	44,88	27,54		5			5			300				
7	48,27	30,93		7			7			360				
10	53,40	36,06		10			10			420				
15	58,90	41,56		15			15			480				
20	63,65	46,31		20			20			540				
30	69,81	52,47		30			30			600				
40	71,46	54,12		40			40			660				
50	72,07	54,73		50			50			720				
60	74,46	57,12		60			60							
<b>Comments</b>														

Borehole Yield Test- (Constant discharge and recovery)									
Borehole Number:	Somshoko Secondary School			Co-ordinates (DD-MM-SS):					
				Latitude (S):			-29.120118°		
Region:	KwaZulu-Natal			Longitude (E):			31.574728°		
District:	Ilembe						Test Duration		
Farm/ Community Name	Amatikulu			Date:	21 August 2021	Time:	06:00:00		(mins)
Existing Pump make:	New borehole			Test Completed:			480		
Test pump type:	1.5 Kw submersible			Date:	21 August 2021	Time:	22:00:00		8
Borehole depth (meters):	98.00			Casing Height (magl):			0.13		Tested by:-
Water Level (mbgl):	17.21			Borehole diameter (mm):			165		Eddy
Depth of pump (meters):	95.00								Philani
Borehole discharge				Borehole recovery			Observation borehole		
Time (minutes)	Yield (m <sup>3</sup> /hr)	Drawdown (mbgl)	Water Level (mbgl)	Time (minutes)	Recovery (WL) (mbgl)	Recovery (mbgl)	Time (minutes)	Drawdown (mbgl)	Recovery (mbgl)
1	3600.00	3.35	20.69	1	47.28	29.94	1		
2		4.09	21.43	2	44.41	27.07	2		
3		4.66	22.00	3	42.30	24.96	3		
5		5.60	22.94	5	37.32	19.98	5		
7		6.40	23.74	7	33.91	16.57	7		
10		7.38	24.72	10	33.16	15.82	10		
15		8.76	26.10	15	32.79	15.45	15		
20		9.66	27.00	20	31.98	14.64	20		
30		10.99	28.33	30	31.53	14.19	30		
40		11.74	29.08	40	31.17	13.83	40		
60	3600.00	14.00	31.34	60	31.09	13.75	60		
90		16.79	34.13	90	30.79	13.45	90		
120		18.44	35.78	120	30.06	12.72	120		
150		18.63	35.97	150	29.94	12.60	150		
180		18.91	36.25	180	29.82	12.48	180		
210		19.23	36.57	210	30.19	12.85	210		
240	3600.00	19.38	36.72	240	30.06	12.72	240		
300		21.16	38.50	300	29.94	12.60	300		
360		24.20	41.54	360	29.82	12.48	360		
420		30.18	47.52	420	29.69	12.35	420		
480		35.41	52.75	480	29.56	12.22	480		
540				540			540		
600				600			600		
660				660			660		
720				720			720		
900				900			900		
1000				1000			1000		
1100				1100			1100		
1200				1200			1200		
1300				1300			1300		
1400				1400			1400		
1440				1440			1440		

## **Appendix D: Laboratory Certificates**



A Level 2 B-BBEE company

[007398/21], [2021/10/25]

## Certificate of Analysis

### Project details

#### Customer Details

Company name:	MZANSI DRILLING
Contact address:	PLOT 77 HARDINGS DALE FARM, 1 CLARIDGE EXTENSION OTTO'S BLUFF ROAD, 3201
Contact person:	DONALD

#### Sampling Details

Sampled by:	CUSTOMER
Sampled date:	2021/10/14

#### Sample Details

Sample type(s):	GROUNDWATER SAMPLES
Date received:	2021-10-15
Delivered by:	CUSTOMER
Temperature at sample receipt (°C):	11.6

#### Report Details

Testing commenced:	2021-10-15
Testing completed:	2021-10-20
Report date:	2021-10-25
Our reference:	007398/21

## Analytical Results

Methods	Determinands	Units	024255/21
			SOMSHOKO HIGH SCHOOL 14.10.2021
<b>Chemical</b>			
85	Dissolved Calcium	mg Ca/l	7.45
85	Potassium	mg K/l	4.06
85	Dissolved Magnesium	mg Mg/l	7.62
84	Sodium	mg Na/l	53
83A	Copper	µg Cu/l	4.5
83A	Iron	µg Fe/l	70
83A	Manganese	µg Mn/l	14.8
83A	Lead	µg Pb/l	2.6
10G	Total Alkalinity	mg CaCO <sub>3</sub> /l	24
16G	Chloride	mg Cl/l	75
123	Free Chlorine*	mg Cl <sub>2</sub> /l	<0.1
122	Monochloramine*	mg/l	<3
40A	Colour (True)*	mg Pt-Co/l	<10
2A	Electrical Conductivity at 25°C	mS/m	30.0
18G	Fluoride	mg F/l	0.09
65Gc	Nitrate	mg N/l	2.02
65Gb	Nitrite	mg N/l	<0.05
Calc.	Combined Nitrate + Nitrite (sum of	-	0.24
4	Turbidity	NTU	0.59
1	pH at 25°C	pH units	6.4
67G	Sulphate	mg SO <sub>4</sub> /l	3.78
Calc.	Total Hardness*	mg CaCO <sub>3</sub> /l	50
<b>Microbiological</b>			
32	<i>E.coli</i>	MPN/100m <sup>l</sup>	<1 (Not detected)
32	Total Coliforms	MPN/100m <sup>l</sup>	<b>19</b>
31	Standard Plate Count	colonies/m <sup>l</sup>	<b>&gt;1000</b>

Refer to the "Notes" section at the end of this report for further explanations.

Where the laboratory reporting limit for a test is higher than the required specification limit, the raw data is reviewed and the detection limit highlighted in bold font if outside of specification.

### Specific Observations

Results that appear in bold do not meet the specification limits in Appendix 1 of this report.

## Quality Assurance

### Technical signatories

### Notes to this report

#### Limitations

This report shall not be reproduced except in full without prior written approval of the laboratory. Results in this report relate only to the samples as taken, and the condition received by the laboratory. Any opinions and interpretations expressed herein are outside the scope of SANAS accreditation. The decision rule applicable to this laboratory is available on request. Sample preparation may require filtration, dilution, digestion or similar. Final results are reported accordingly. Where the laboratory has undertaken the sampling, the location of sampling and sampling plan are available on request. Talbot Laboratories is guided by the National Standards SANS 5667-3:2006 Part 3 Guidance on the Preservation and Handling of Water Samples; SANS 5667-1:2008 Part 1 Guidance on the Design of Sampling Programmes and Sampling Techniques and SANS 5667-2:1991 Part 2: Guidance on Sampling Techniques. Customers to contact Talbot Laboratories for further information.

#### Uncertainty of measurement

Talbot Laboratories' Uncertainty of Measurement (UoM) values are:

- Identified for relevant tests.
- Calculated as a percentage of the respective results.
- Applicable to total, dissolved and acid soluble metals for ICP element analyses.
- Available upon request.

#### Analysis explanatory notes

Tests may be marked as follows:

^	Tests conducted at our Port Elizabeth satellite laboratory.
*	Tests not included in our Schedule of Accreditation and therefore that are not SANAS accredited.
#	Tests that have been sub-contracted to a peer laboratory.
NR	Not required -shown, for example, where the schedule of analysis varied between samples.
σ	Field sampling point on-site results.
<sup>a</sup>	Testing has deviated from Method.

## Appendix 1: Specifications - SANS 241-1:2015 RECOMMENDED LIMITS

Reported Determinands	Limits	Reported Determinands	Limits
E.coli	0 Count/100m <sup>l</sup> (0 MPN/100m <sup>l</sup> )	Zinc	≤5000 µg/l (≤5 mg/l)
Faecal Coliforms	0 Count/100m <sup>l</sup> (0 MPN/100m <sup>l</sup> )	Antimony	≤20 µg/l (≤0.02 mg/l)
Cryptosporidium species	Not Detected	Arsenic	≤10 µg/l (≤0.01 mg/l)
Giardia species	Not Detected	Barium	≤700 µg/l (≤0.7 mg/l)
Total Coliforms	≤10 Count/100m <sup>l</sup> (10 MPN/100m <sup>l</sup> )	Boron	≤2400 µg/l (≤2.4 mg/l)
Standard Plate Count	≤1000 Count/1m <sup>l</sup>	Cadmium	≤3 µg/l (≤0.003 mg/l)
Somatic Coliphages	Not Detected	Total Chromium	≤50 µg/l (≤0.05 mg/l)
Cytopathogenic viruses	Not detected	Copper	≤2000 µg/l (≤2 mg/l)
Enteric Virus (Sub#)	Not Detected	Cyanide	≤200 µg/l (≤0.2 mg/l)
Colour	≤15 mg/l Pt-Co	Iron	Chronic: ≤ 2000 µg/l (≤2 mg/l)
Electrical Conductivity	≤170 mS/m	Iron	Aesthetic: ≤ 300 µg/l (≤0.3 mg/l)
Total Dissolved Solids at 180°C	≤1200 mg/l	Lead	≤10 µg/l (≤0.01 mg/l)
Turbidity	Operational ≤1 NTU	Manganese	Chronic: ≤ 400 µg/l (≤0.4 mg/l)
Turbidity	Aesthetic ≤5 NTU	Manganese	Aesthetic: ≤100 µg/l (≤0.1 mg/l)
pH	≥ 5 to ≤ 9.7	Mercury	≤6 µg/l (≤0.006 mg/l)
Odour	Inoffensive	Nickel	≤70 µg/l (≤0.07 mg/l)
Free Chlorine	≤5 mg/l	Selenium	≤40 µg/l (≤0.04 mg/l)
Monochloramine	≤3000 µg/l (≤3 mg/l)	Uranium	≤30 µg/l (≤0.03 mg/l)
Nitrate	≤11 mg/l	Aluminium	≤300 µg/l (≤0.3 mg/l)
Nitrite	≤0.9 mg/l	Total Organic Carbon	≤10 mg/l
Combined Nitrate plus Nitrite (sum of	≤1	Chloroform	≤300 µg/l (≤0.3 mg/l)
Sulphate	Acute: ≤ 500 mg/l	Bromoform	≤100 µg/l (≤0.1 mg/l)
Sulphate	Aesthetic: ≤ 250 mg/l	Dibromochloromethane	≤100 µg/l (≤0.1 mg/l)
Fluoride	≤1500 µg/l (≤1.5 mg/l)	Bromodichloromethane	≤60 µg/l (≤0.06 mg/l)
Ammonia	≤1.5 mg/l	Trihalomethanes Ratio	≤1
Chloride	≤ 300 mg/l	Microcystins	≤1 µg/l
Sodium	≤200 mg/l	Phenols	≤10 µg/l (≤0.01 mg/l)

\*\*\*\*\*End of Report\*\*\*\*\*