



## **QUARTERLY WATER QUALITY REPORT 2019**

01 SEPTEMBER 2019 TO 30 NOVEMBER 2019

**IWUL: Licence No. 04/B20G/CGI/3843**

**File No. 16/2/7/B100/C11**

**Elandsfontein Colliery (Pty) Ltd**

December 2019



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## ABBREVIATIONS

AMD	Acid Mine Drainage
Ag	Silver
Al	Aluminium
As	Arsenic
AWQR	Annual Water Quality Report
BDL	Below detection limit
BH	Borehole
BPG	Best Practice Guideline
Ca	Calcium
Cd	Cadmium
Cl	Chloride
CoC	Chain of Custody
COD	Chemical Oxygen Demand
Co	Cobalt
Cr <sup>6+</sup>	Hexavalent Chrome
CSIR	Council for Scientific and Industrial Research
Cu	Copper
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DRO	Diesel Range Organics
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
F	Fluoride
Fe	Iron
GC-MS	Gas Chromatography Mass Spectrometer
GPS	Global Positioning System



GSW	Geo Soil & Water (Pty) Ltd GSW
GW	Groundwater
HCO <sub>3</sub> <sup>-</sup>	Bicarbonate
ICP-OES	Inductively Coupled Plasma Optical Emission Spectroscopy
IWUL	Integrated Water Use License
K	Potassium
mamsl	metres above mean sea level
mbgl	metres below ground level
Mg	Magnesium
mg/l	milligram per litre
Mn	Manganese
mg/L	Milligrams per Liter
Na	Sodium
NEMA	National Environmental Management Act (Act No. 107 of 1998)
Ni	Nickel
NO <sub>3</sub> <sup>-</sup>	Nitrate
NWA	National Water Act (Act No. 36 of 1998)
ORP	Oxidation Reduction Potential
Pb	Lead
QWQR	Quarterly Water Quality Report
RQO	Resource Quality Objective
SANAS	South African National Accreditation System
SAR	Sodium Absorption Ratio
Se	Selenium
SO <sub>4</sub>	Sulphate
TDS	Total Dissolved Solids
WGS 84	World Geodetic System 1984
Zn	Zinc



## DEFINITIONS

### **Acid Mine Drainage**

Acid Mine Drainage (AMD) refers to the outflow of acidic water from metal or coal mines due to the oxidation of sulphide minerals.

### **Anions**

Ions with a net negative charge. Examples:  $\text{OH}^-$ ,  $\text{O}^{2-}$ ,  $\text{SO}_4^{2-}$ , Alk ( $\text{HCO}_3^-$ ),  $\text{Cl}^-$ , etc. The Bicarbonate ( $\text{HCO}_3^-$ ) ion is the largest component of Alkalinity.

### **Artesian borehole**

Boreholes that penetrate confined aquifers, in which the piezometric surface is above ground level, so that the boreholes spontaneously discharge water without being pumped.

### **Aquifer vulnerability**

Tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer.

### **Borehole**

Includes a well, excavation, or any other artificially constructed or improved underground cavity which can be used for the purpose of intercepting, collecting or storing water in or removing water from an aquifer; observing and collecting data and information on water in an aquifer; or recharging an aquifer. Source: National Water Act (Act No. 36 of 1998).

### **Cations**

Ions with a net positive charge. Examples:  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Fe}^{2+}$ .

### **Compliance monitoring**

Monitoring done in compliance with permit or license conditions.

### **Contamination**

Substances that make it impure and unfit for consumption or an intended use, and can cause harm to human health or the environment. Contaminants can be naturally occurring or caused by humans.

### **Data interpretation**

The analysis of data to obtain information concerning the groundwater system which in turn can be used to manage/remediate the system.



### **Data management**

The effective use of the data while ensuring its integrity and providing a centralized repository for storage.

### **Drawdown**

The distance between the static water level and the surface of the cone of depression.

### **Environment**

The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group. These circumstances include biophysical, social, economic, historical, cultural and political aspects. 'Environment' is described as the surroundings within which humans exist and is made up of:

- the land, water and atmosphere of the earth;
- micro-organisms, plant and animal life;
- any part or combination of (i) and (ii) and the interrelationships among and between them; and
- the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing.

### **Groundwater Flow**

The movement of water through openings in sediment and rock; occurs in the zone of saturation in the direction of the hydraulic gradient.

### **Groundwater modelling**

Numerical representation of a groundwater flow system that attempts to mimic the natural processes in nature. It is a simplified version of a natural system, compiled with geological, hydrogeological, hydrological and meteorological data, which utilises a governing equation to incorporate all this data to simulate the hydraulic properties of the groundwater system.

### **Hydrocensus**

Gathering of hydrogeological information through field measurements.

### **Hydrogeology**

The study of the interrelationships of geologic materials and processes with water, especially groundwater.



### **Impact Assessment**

A formal process used to predict the environmental consequences (positive or negative) of a plan, policy, program, or project prior the implementation decision, it proposes measures to adjust impacts to acceptable levels or to investigate new technological solution.

### **Infiltration**

The downward movement of water from the atmosphere into the ground.

### **Leaching**

The process by which soluble materials in the soil, such as salts, nutrients, pesticide chemicals, or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

### **Monitoring Programme**

A programme for taking regular measurements of the quantity and/or quality of a water resource, waste or wastewater discharge at specified intervals and at specific locations to determine the chemical, physical and biological nature of the water resource, waste or wastewater discharge.

### **Piezometric surface**

An imaginary or hypothetical surface of the piezometric pressure or hydraulic head throughout all or part of a confined or semi-confined aquifer; analogous to the water table of an unconfined aquifer.

### **Plume**

An underground pattern of contaminant concentrations in groundwater created by the movement of groundwater beneath a contaminant source. Contaminants spread mostly laterally in the direction of groundwater movement. The source site has the highest concentration, and the concentration decreases away from the source.

### **Recharge**

Water added to a groundwater aquifer. For example, when rainwater seeps into the ground. Recharge may occur naturally through precipitation or surface water or artificially through injection wells or by spreading water over groundwater reservoirs. See also infiltration.

### **Reserve**

The quantity and quality of water required to supply basic needs of people to be supplied with water from that resource, and to protect aquatic ecosystems in order to secure



ecologically sustainable development and use of water resources. This is a unique water resource management requirement of South African legislation.

### **Resource Quality Objectives**

Used to put a Classification and Reserve into practice by specifying conditions that will ensure that the Class is not compromised and the Reserve can be met. Resource quality may relate to critical flows, groundwater levels and quality that must be maintained.

Sampling and monitoring controls: Control measures to demonstrate the accuracy (how close to the real result you are) and precision (how reproducible your results are) of your monitoring.

### **STIFF Diagram**

A graphical representation or fingerprint of chemical analyses displaying the major ion composition of a water sample. A polygonal shape is created from three parallel horizontal axes extending on either side of a vertical zero axis. Cations are plotted in mill equivalents per litre on the left side of the zero axis, one to each horizontal axis, and anions are plotted on the right side. Stiff patterns are useful in making a rapid visual comparison between water from different sources.

### **Transmissivity**

The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It is expressed as the product of the average hydraulic conductivity and thickness of the saturated portion of an aquifer.

### **Water Quality**

The physical, chemical, toxicological, biological (including microbiological) and aesthetic properties of water that determine sustained (1) healthy functioning of aquatic ecosystems and (2) fitness for use (e.g. domestic, recreational, agricultural, and industrial). Water quality is therefore reflected in (a) concentrations or loads of substances (either dissolved or suspended) or micro-organisms, (b) physic-chemical attributes (e.g. temperature) and (c) certain biological responses to those concentrations, loads or physic-chemical attributes.

### **Water Resource**

A water resource includes any watercourse, surface water, estuary or aquifer. Watercourses include rivers, springs, and natural perennial and non-perennial channels, wetlands, lakes, dams, or any collection identified as such by the Minister in the Government Gazette.





## **Water Use License**

An authorisation from the Department of Water and Sanitation to a designated water user to use water. The authorisation will provide details on the timeframes and conditions for the designated water use.



## EXECUTIVE SUMMARY

Elandsfontein Colliery (Pty) Ltd appointed Geo Soil & Water cc (GSW) to conduct water sampling, water quality analyses and water quality reporting at Elandsfontein Colliery (Elandsfontein), in accordance with the requirements of the Integrated Water Use Licence No: 04/B20G/CGI/3843, File No: 16/2/7/B100/C11 dated 22 October 2015 (IWUL), issued in terms of the National Water Act (Act No. 36 of 1998) (NWA).

The reporting period is from 01 September 2019 to 30 November 2019.

Elandsfontein is located at the headwaters of the B20G quaternary catchment, in the Wilge River Catchment of the Olifants Water Management Area. Therefore, water qualities were compared to the IWUL Limits (compliance) and the Olifants River Resource Quality Objectives (RQO's), as supplementary compliance guidelines.

The following is a summary of the annual results:

The monitoring network provides information for risk based decision making to Elandsfontein management with regard to effectiveness of pollution prevention measures and areas requiring attention.

**Waste water** - Water quality from the mine water/pollution control dams recorded acidic pH levels and elevated concentrations of EC, TDS, SO<sub>4</sub> (dominant) and metals (Al, Fe and Mn), typically associated with coal washing/mining activities. SO<sub>4</sub> is dominant in terms of composition.

**Storm - and surface water runoff** – Upstream and downstream monitoring points recorded elevated concentrations, typically associated with coal washing/mining activities. The upstream monitoring point (**TCM-SW02**) recorded elevated concentrations, with a deterioration of water quality towards the downstream monitoring point (**TCM-SW01**), indicating pollution from Elandsfontein.

**Groundwater** – The following monitoring points recorded elevated concentrations:

**GW-05:** Downstream of the partially rehabilitated discard area in the south eastern corner of Elandsfontein;

**ECBH-02, 03, 04 and 05:** Northern, partially rehabilitated area;

**Eland 11:** Northern boundary with Highveld steel; and

**ELNBH-03:** Downstream of the southern, historical mining and rehabilitated area.



The remainder of the monitoring boreholes (**Eland 1, GW-01, Eland 10, AHBH-01, 02 and 03**) recorded relatively good water quality, despite exceeding a few IWUL limits and Olifants River RQO's. These monitoring boreholes are not concentrated in one area but are located in and around the Elandsfontein mining right area.

**Groundwater levels** - Groundwater levels remained relatively stable, with the exception of **ECBH-05**. During October 2019, **ECHB-05** was connected to a pump and storage tank which possibly influenced the water level.



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## DISCLAIMER

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## 1. INTRODUCTION

### 1.1 Scope of Work

Elandsfontein Colliery (Pty) Ltd appointed Geo Soil & Water cc (GSW) to conduct water sampling, water quality analyses and water quality reporting at Elandsfontein Colliery (Elandsfontein), in accordance with the requirements of the Integrated Water Use Licence No: 04/B20G/CGI/3843, File No: 16/2/7/B100/C11 dated 22 October 2015 (IWUL), issued in terms of the National Water Act (Act No. 36 of 1998) (NWA).

Various activities of an anthropogenic nature take place in South Africa's riverine environments. As custodian of the natural water resources, it is an integral function of the Department of Water and Sanitation (DWS) to manage the effects of these activities on the country's water resources.

Water quality monitoring is a mandatory requirement, stipulated in the National Water Act (1998) (NWA) and forms an integral part of the auditing requirements in terms of the Mineral and Petroleum Resources Development Act (2002) (MPRDA). The MPRDA, Section 39 (1) (2) (3) stipulates that each mine in possession of a mining right must conduct an Environmental Impact Assessment (EIA) and prepare an Environmental Management Program (EMP) of which a monitoring and report auditing process is an integral part of.

The NWA provides for the development of regulations to, amongst others:

- Require that the use of water from a water resource be monitored, measured and recorded;
- Regulate or prohibit any activity in order to protect a water resource or in-stream or riparian habitat; and



- Prescribe the outcome or effect, which must be achieved through management practices for the treatment of waste, or any class of waste before it is discharged into or allowed to enter a water resource.

In order to reach the above-mentioned objectives monitoring systems need to be established, according to Section 137 (2) and implemented to assess, among others:

- Quality of water resources;
- Use and rehabilitation of water resources;
- Compliance to resource water quality objectives; and
- Health of aquatic ecosystems.

## **1.2 Purpose of Monitoring Report**

As part of the commitments made in the Environmental Management Programme Report (EMPR) and conditions set out in the IWUL, surface - and groundwater monitoring were implemented and quarterly reports, reflecting the results, submitted to the DWS.

GSW was commissioned by Elandsfontein to implement and conduct surface - and groundwater monitoring as prescribed in the IWUL, 2015. Surface water monitoring points are sampled monthly and groundwater monitoring points are sampled quarterly. Groundwater levels are recorded on a quarterly basis.

The results of the monitoring report are used to inform Elandsfontein management of the impact from mining activity on water resources, the effectiveness of mitigation measures and the potential need to improve water resource impact prevention measures.

With regular and accurate monitoring of resources a comprehensive management system interprets and assists in pollution prevention, pollution management, the determination, improvement or deterioration of the receiving and surrounding resources.

## **1.3 Approach to Study**

This report investigates and provides summarised information on the monitoring system and various monitoring points at Elandsfontein. Monitoring conducted during the reporting period, includes:



Routine monitoring:

— **September 2019**

IWUL, 2015 Surface - and groundwater monitoring;

— **October 2019**

IWUL, 2015 Surface water monitoring and groundwater level monitoring; and

— **November 2019**

IWUL, 2015 Surface water monitoring and groundwater level monitoring.

## 2. PROJECT BACKGROUND INFORMATION

Elandsfontein operates a wash plant, opencast- and underground (historical) mine, with associated infrastructure on the farm Elandsfontein 309 JS Portions 1, 7, 8 and 14, directly west of the town Clewer in the Mpumalanga Province, South Africa. Highveld Steel and Vanadium is located north of Elandsfontein and Anglo Thermal Coal's Umlalazi operations, directly east. The relevant infrastructure consists of a wash plant, filter press, offices, workshops, weighbridge, diesel bays, topsoil stockpiles, coal stockpiles, overburden stockpiles, etc. Water management structures/pollution control facilities on site consist of a pollution control dams, berms, trenches and in-pit storage.

Elandsfontein received Mining Rights MP 30/5/1/2/2/10162 MR (314) MR and MP 30/5/1/2/2/10162 MR (63) MR in compliance with the Mineral and Petroleum Resources Development Act, 2002 (MPRDA), from the Department of Mineral Resources (DMR) and was granted an Integrated Water Use Licence No: 04/B20G/CGI/3843, File No: 16/2/7/B100/C11 dated 22 October 2015 (IWUL), issued in terms of the National Water Act (Act No. 36 of 1998) (NWA).

### 2.1 Location

Elandsfontein is located in the Emalahleni Local Municipality, within the Nkangala District Municipality in the Mpumalanga Province, on Portions 1, 7, 8 and 14 of the Farm Elandsfontein 309 JS. The colliery is adjacent to the town of Clewer and access is via the R547 regional road. Refer to **Figure 1**.

### 2.2 Catchment, Rainfall Supply and Use and Surrounding Activities

Elandsfontein is located at the headwaters of the B20G quaternary catchment, in the Wilge River Catchment of the Olifants Water Management Area.



The predominant land use in the catchments is residential (formal and informal settlements), agricultural (cattle, pasture and fodder production), current and historical (1930's) mining and industrial activities. Due to historical mining, farming, industrial and residential activities the catchment is relatively modified with existing impacts on the water resource.

## 2.3 Information and Knowledge Gaps

The following are areas of uncertainty:

- Design of several of the monitoring boreholes and drill information (e.g. casing depth, perforated casing depth, drill water strike depth, lithology, and slug test results);
- Geophysical information on preferred flow paths;
- Effect of local farming and associated contaminants;
- Current and historical effect of industrial areas to the north;
- Current and historical extent, interaction and effect of underground workings; and
- Pre-mining / baseline water quality.

## 3. OBJECTIVES OF THE MONITORING PROGRAMME

### 3.1 Objectives

Objectives of Section 9 of the NWA, entailed in this monitoring programme and in correlation with the catchment management strategy, are as follows:

- To establish a continuous database specific to Elandsfontein;
- Assessing the general temporal condition of water quality of resources in the vicinity likely to be impacted upon by the mine;
- Identifying any potential pollution sources and determining their extent, in order to circumvent relevant legal liabilities potentially resulting from recorded impacts on the receiving aquatic environment;
- Quantifying and assessing any impacts in obstruction of legislative stipulations in order to develop mitigation or remedial plans where necessary; and
- To set out strategies, objectives, plans, guidelines and procedures for protection, use, development, conservation, management and control of water resources within the water management area.

## 4. TERMS OF REFERENCE

The terms of reference for the monitoring programme at Elandsfontein are to comply with the requirements of the IWUL and Olifants River Water Quality Objectives.

### 4.1 Changes/Additions in/to Monitoring Network

Six (6) surface water monitoring points and eight (8) groundwater monitoring points are included in the IWUL - Elandsfontein monitors additional points to determine impacts and sources more accurately.

Four (4) additional surface- and seventeen (17) additional groundwater monitoring points are sampled.

The following variables are analysed in addition to the set prescribed in the IWUL, 2015:

- Surface - and waste water: TDS, Total Hardness, Alkalinity, NO<sub>3</sub>.
- Groundwater: TDS, Total Hardness, Alkalinity, NO<sub>3</sub>, NH<sub>3</sub>, Al, Fe, Mn, K.

### 4.2 Surface Water

Surface water monitoring points are sampled on a monthly basis for quality, as prescribed in the IWUL. Refer to **Annexure A** for in-field sampling sheets.

Six (6) IWUL and four (4) additional surface water monitoring points are included in the water monitoring programme.

**Figure 2** indicates the locations of the surface water monitoring points relative to Elandsfontein and water resources.

**Figure 3** displays the photographic evidence of the surface water monitoring points.

**Table 1** presents a summary of the surface water monitoring programme/points including the name, description, coordinates and the frequency of monitoring.

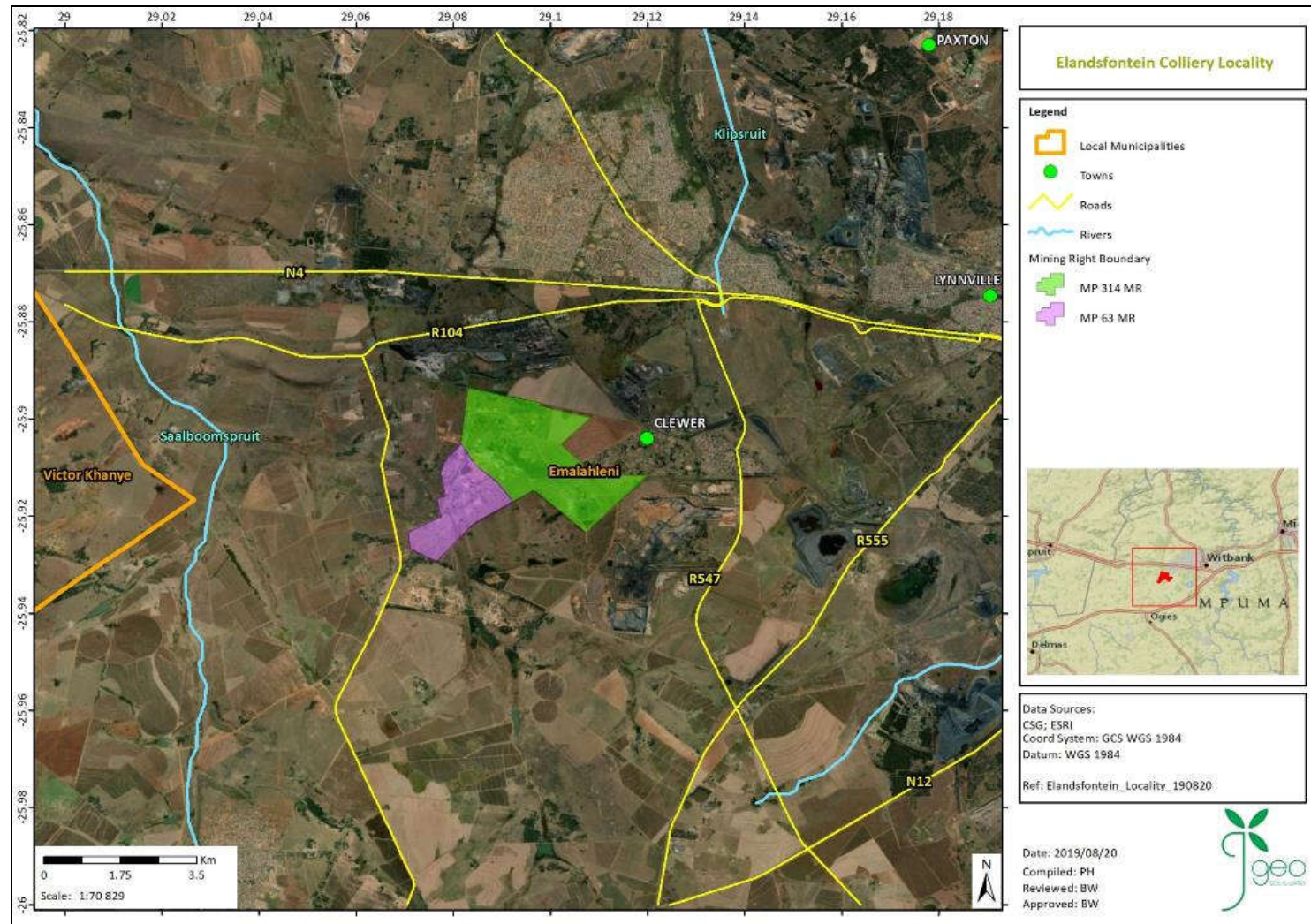
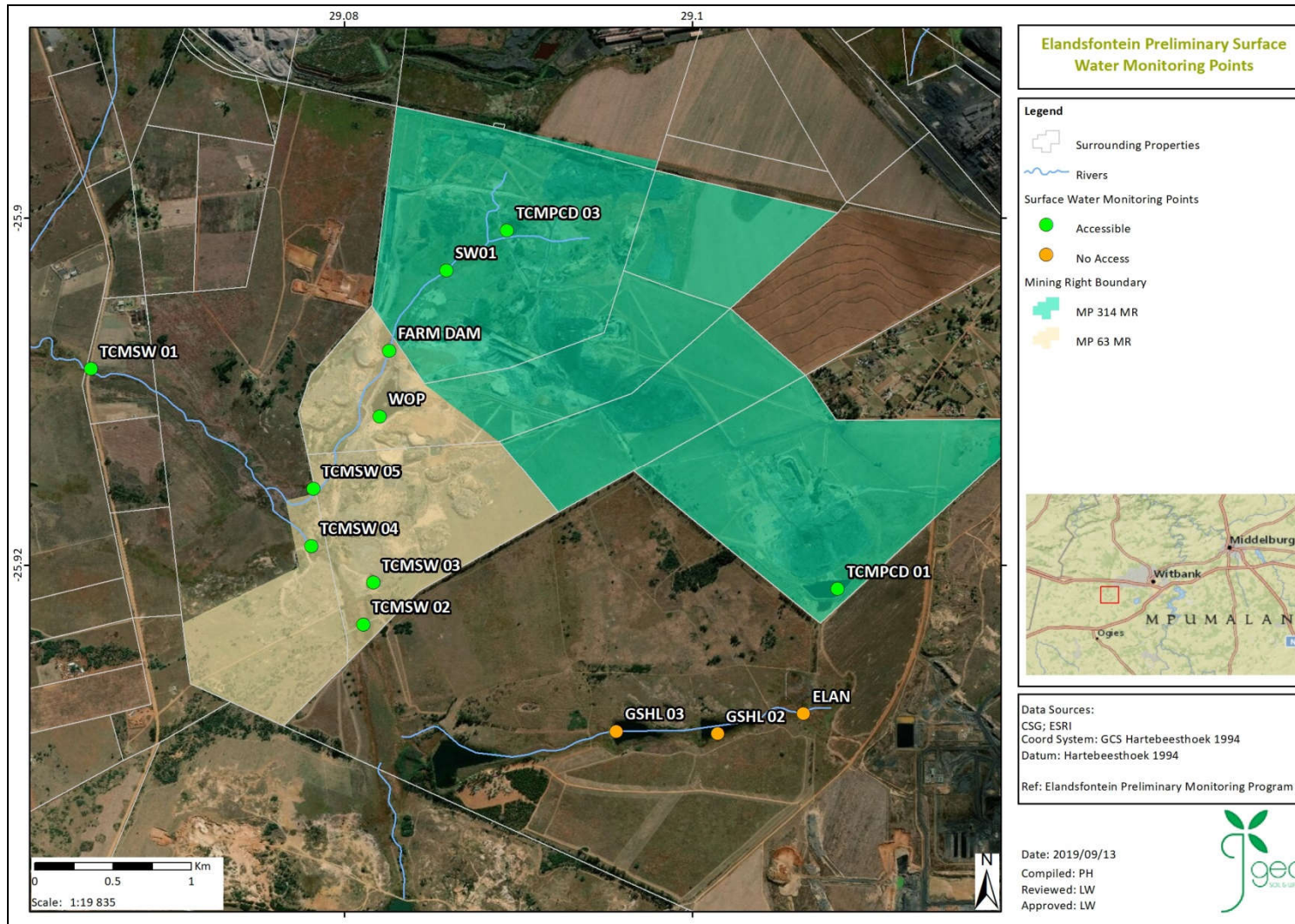


Figure 1 Locality map.









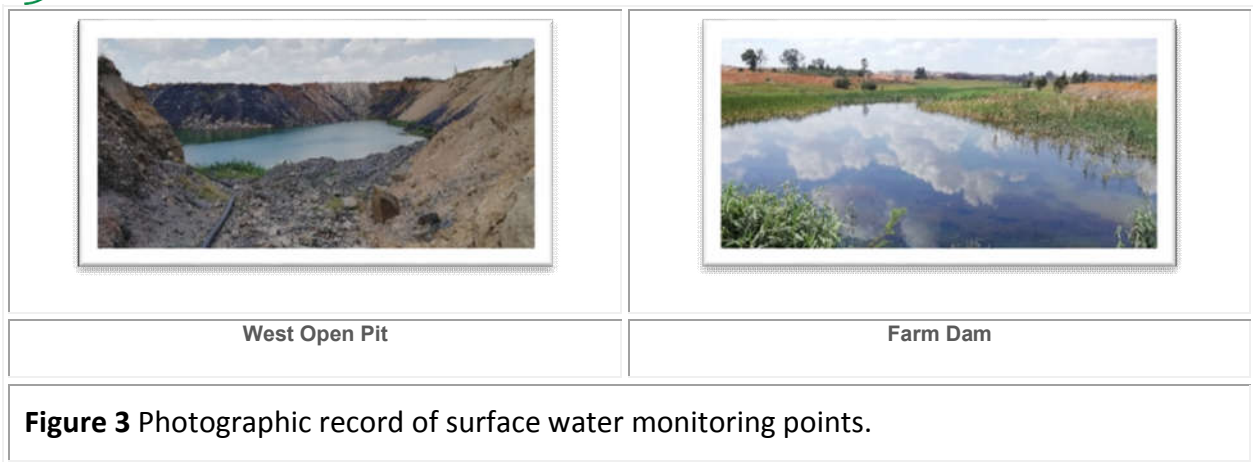
**Figure 2** Location of surface water monitoring points.



**Table 1** Summary of surface water monitoring points.

Elandsfontein Monitoring Programme			
Surface Water Monitoring Points			
Locality	Locality Description	Coordinates WGS 84 ddd.ddddd	Monitoring Frequency
SW1	Most upstream monitoring point in northern tributary	S25.903008° E29.085863°	Monthly
TCM PCD1	Pollution control dam south/adjacent of historical partially rehabilitated discard area	S25.922396° E29.107576°	Monthly
TCM PCD3	Pollution control dam containing decant water, surface water runoff and water from pits	S25.900712° E29.089354°	Monthly
TCM SW1	Most downstream monitoring point after confluence of northern and southern tributaries. Tributary drains northwest towards Olifants River and Loskop Dam	S25.908673° E29.065435°	Monthly
TCM SW2	Most upstream monitoring point of southern tributary	S25.923392° E29.081096°	Monthly
TCM SW3	Open void collecting surface water runoff	S25.920989° E29.081663°	Monthly
TCM SW4	Monitoring point in southern tributary downstream of TCM SW2	S25.918894° E29.078099°	Monthly
TCM SW5	Monitoring point in northern tributary downstream of Farm Dam	S25.915575° E29.078226°	Monthly
WOP	West Open Pit	S25.911403° E29.082017°	Monthly
Farm Dam	Instream Dam downstream of SW1 in northern tributary	S25.907626° E29.082571°	Monthly
	Additional Monitoring Points		
	IWUL Monitoring Points		

	
<p style="text-align: center;"><b>SW1</b></p>	<p style="text-align: center;"><b>TCM PCD1</b></p>
	
<p style="text-align: center;"><b>TCM PCD3</b></p>	<p style="text-align: center;"><b>TCM SW1</b></p>
	
<p style="text-align: center;"><b>TCM SW2</b></p>	<p style="text-align: center;"><b>TCM SW3</b></p>
	
<p style="text-align: center;"><b>TCM SW4</b></p>	<p style="text-align: center;"><b>TCM SW5</b></p>



### 4.3 Groundwater

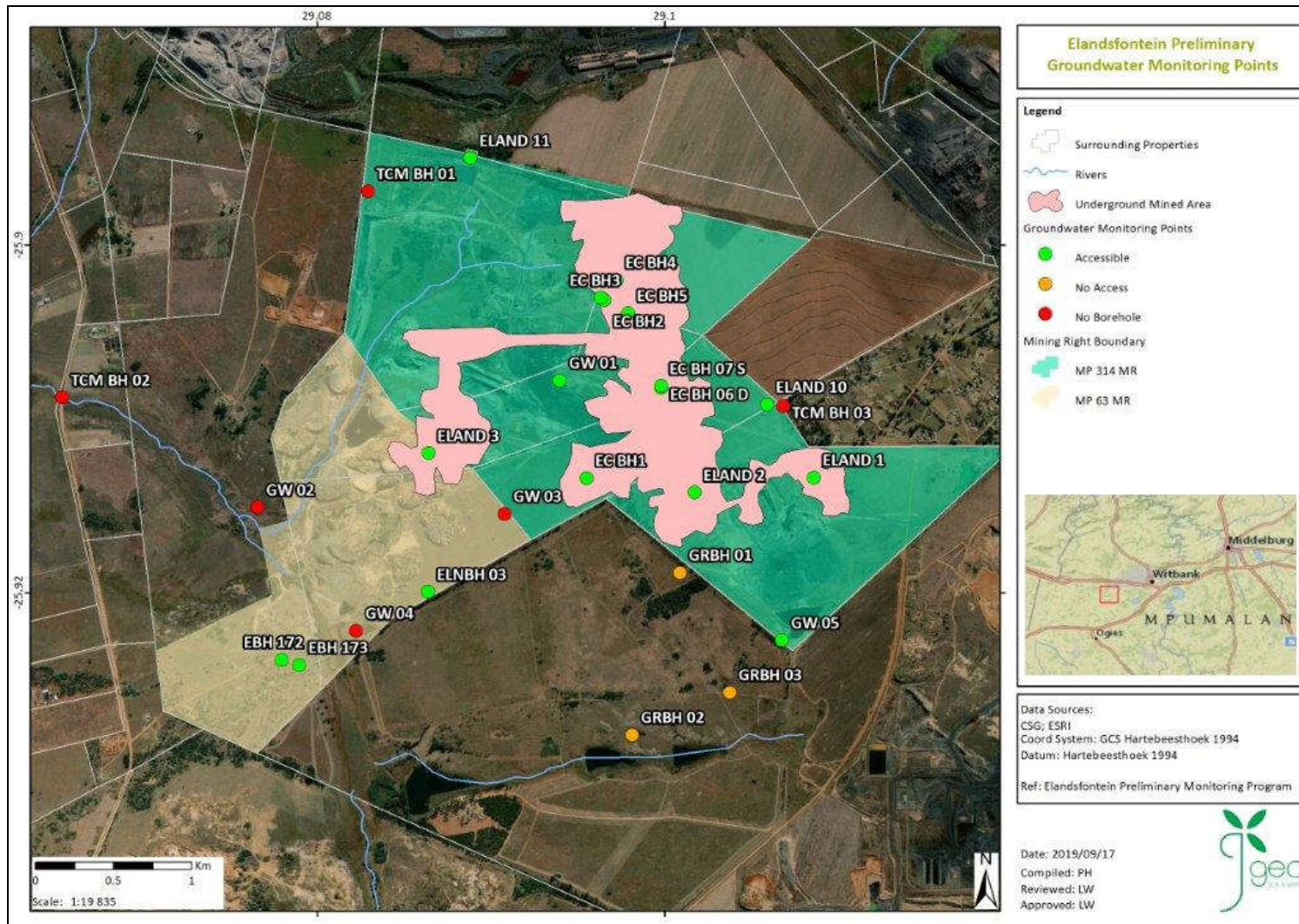
Groundwater monitoring points are sampled on a monthly (level) and quarterly (quality) basis, as prescribed in the IWUL. Three (3) of the additional groundwater monitoring points are sampled biannually. Refer to **Annexure A** for in-field sampling sheets.

Eight (8) IWUL and seventeen (17) additional groundwater monitoring points are included in the monitoring programme.

**Figure 4** indicates the positions of the groundwater monitoring points relative to Elandsfontein and water resources.

**Figure 5** displays the photographic evidence of the groundwater monitoring points.

**Table 2** is a summary of the monitoring points including the name, description, coordinates and the frequency of monitoring.



**Figure 4** Location of groundwater monitoring points.

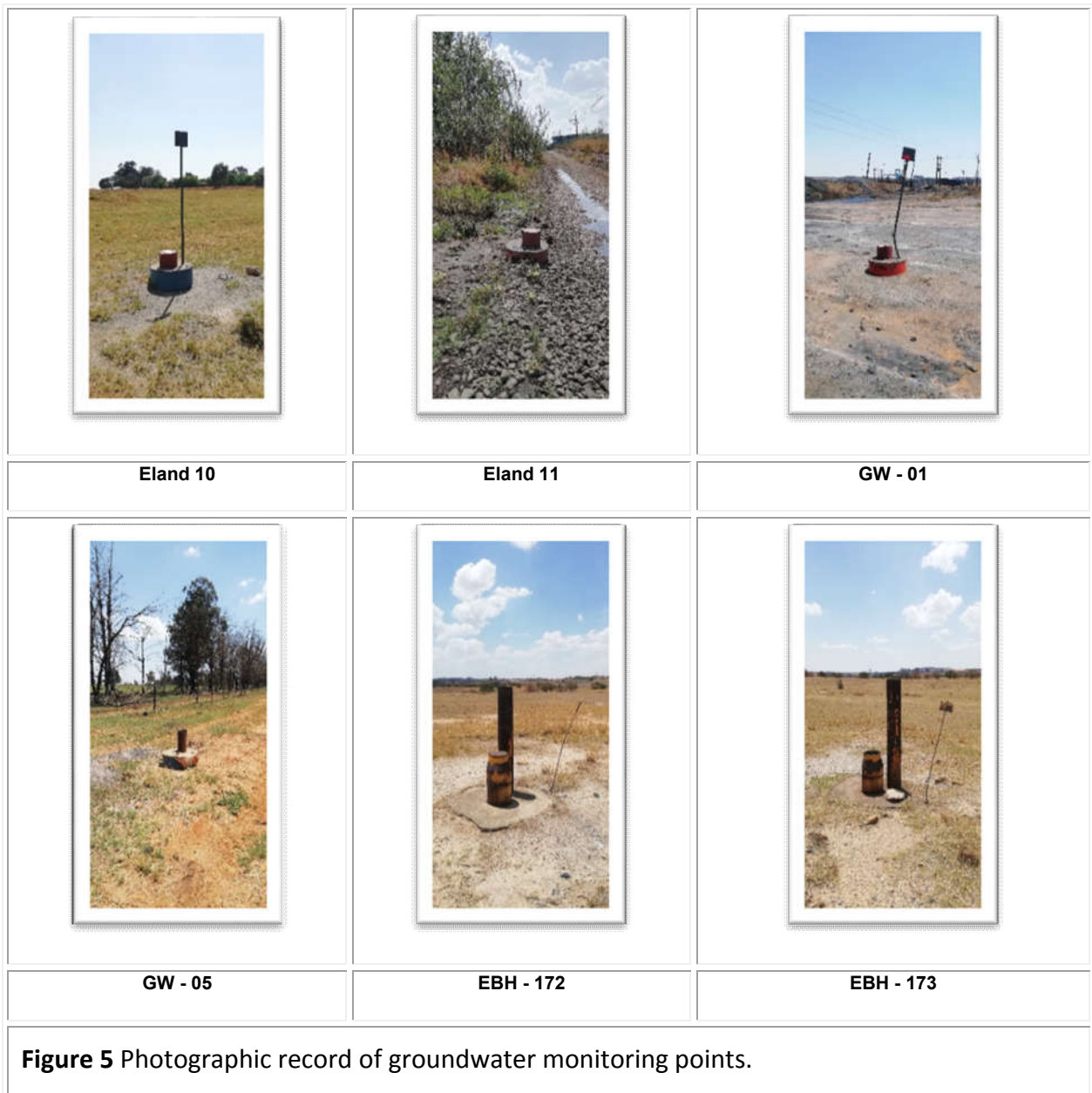


**Table 2** Summary of groundwater monitoring points.

Elandsfontein Groundwater Monitoring Programme			
Groundwater Monitoring Points			
Locality	Locality Description	Coordinates WGS 84 ddd.ddddd	Monitoring Frequency
EC - BH 1	Monitoring borehole	S25.913399° E29.095491°	Monthly levels Quarterly Quality
EC - BH 2	Monitoring borehole	S25.903175° E29.096534°	Monthly levels Quarterly Quality
EC - BH 3	Monitoring borehole	S25.903025° E29.096296°	Monthly levels Quarterly Quality
EC - BH 4	Monitoring borehole	S25.902017° E29.097221°	Monthly levels Quarterly Quality
EC - BH 5	Monitoring borehole	S25.903924° E29.097892°	Monthly levels Quarterly Quality
EC - BH 7s	Monitoring borehole	S25.908105° E29.099771°	Monthly levels Quarterly Quality
Eland 1	Monitoring borehole	S25.913382° E29.108570°	Monthly levels Quarterly Quality
Eland 2	Monitoring borehole	S25.914236° E29.101716°	Monthly levels Quarterly Quality
Eland 3	Monitoring borehole	S25.911966° E29.086386°	Monthly levels Quarterly Quality
Eland 10	Monitoring borehole	S25.909825° E29.105646°	Monthly levels Quarterly Quality
Eland 11	Monitoring borehole	S25.894988° E29.088822°	Monthly levels Quarterly Quality
GW - 01	Monitoring borehole	S25.907794° E29.093953°	Monthly levels Quarterly Quality
GW - 02	Monitoring borehole - Demolished	S25.915078° E29.076539°	Monthly levels Quarterly Quality
GW 03	Monitoring borehole - Demolished	S25.915462° E29.090777°	Monthly levels Quarterly Quality
GW 04	Monitoring borehole - Demolished	S25.922204° E29.082243°	Monthly levels Quarterly Quality
GW - 05	Monitoring borehole	S25.922730° E29.106740°	Monthly levels Quarterly Quality
TCM BH01	Monitoring borehole - Demolished	S25.896915° E29.082912°	Monthly levels Quarterly Quality
TCM BH02	Monitoring borehole - Demolished	S25.908763° E29.065314°	Monthly levels Quarterly Quality
TCM BH03	Monitoring borehole - Demolished	S25.909280° E29.106834°	Monthly levels Quarterly Quality
ELN BH03	Monitoring borehole	S25.919940 E29.086370	Monthly levels Quarterly Quality
EBH - 172	Monitoring borehole	S25.923853° E29.077956°	Monthly levels Quarterly Quality
EBH - 173	Monitoring borehole	S25.924159° E29.078951°	Monthly levels Quarterly Quality

Elandsfontein Groundwater Monitoring Programme			
Groundwater Monitoring Points			
Locality	Locality Description	Coordinates WGS 84 ddd.ddddd	Monitoring Frequency
AHBH-01	Monitoring borehole	S25.916530 E29.062030	Hydrocensus
AHBH-02	Monitoring borehole	S25.918090 E29.045290	Hydrocensus
AHBH-03	Monitoring borehole	S25.928350 E29.071160	Hydrocensus
	<b>Additional Monitoring Points</b>		
	<b>IWUL Monitoring Points</b>		

<p align="center"><b>EC - BH 1</b></p>	<p align="center"><b>EC - BH 2</b></p>	<p align="center"><b>EC - BH 3</b></p>
<p align="center"><b>EC - BH 4</b></p>	<p align="center"><b>EC - BH 5</b></p>	<p align="center"><b>EC - BH 07 S</b></p>
<p align="center"><b>Eland 1</b></p>	<p align="center"><b>Eland 2</b></p>	<p align="center"><b>Eland 3</b></p>



## 5. METHODOLOGY

The following is a description of the sampling protocol, analyses and reporting of the Elandsfontein monitoring programme.

### 5.1 Sampling Protocol

GSW is responsible for the sampling of the monitoring points, the assessment evaluation and report writing. Yanka Laboratories (Pty) Ltd (Yanka) with SANAS Accreditation Number T0647 performs the physical and chemical analyses.



All fieldwork is conducted on the protocols and specifications, and code of practice contained in the SABS ISO 5667-1-15. These international standards address all aspects from the program design, sampling methods, as well as sample preservation and many other aspects.

Boreholes are not purged prior to sampling.

The DWS developed a series of Best Practice Guidelines (BPG's) for water quality management in the South African mining industry. This series of BPG's forms a component of the overall source directed water policy for mining and related activities implemented by the DWAF. The Best Practice Guideline H1: Integrated Mine Water Management, the Best Practice Guideline G2: Water and salt balances and the Best Practice Guideline G3: Water Monitoring Systems make specific references to water monitoring requirements and was used as a guiding tool and subsequent development of a surface - and groundwater monitoring program for Elandsfontein.

## 5.2 Surface water

For chemical analyses, a 1000 mL plastic container was used to collect a grab sample. Bottles are labelled, filled to the brim and sealed before being taken to a South African National Accreditation Systems (SANAS) accredited laboratory, for analyses.

Furthermore, all field data is captured in a custom-made field data sheet, wherein all relevant information regarding each monitoring point is recorded, including date, time, sampler, and immediate environment in terms of potential contributors to recorded qualities.

A geographical coordinate of each monitoring point is collected and a photograph is captured (only at project initiation).

Monitoring occurred at all ten (10) monitoring points, six (6) IWUL water monitoring points and four (4) additional points - depending on environmental conditions and observations.

Surface water samples are analysed for:

- pH
- EC mS/m
- TDS mg/L



- Total Hardness mg/L
- Alkalinity CaCO<sub>3</sub>/L
- Ca mg/L
- Mg mg/L
- Na mg/L
- K mg/L
- F mg/L
- Cl mg/L
- SO<sub>4</sub> mg/L
- NO<sub>3</sub> mg/L
- DO
- SS
- Turbidity
- Al mg/L
- Fe mg/L
- Mn mg/L
- NH<sub>3</sub> mg/L

### 5.3 Groundwater

For groundwater analyses, a static depth measurement is captured before sampling commences. Disposable, plastic bailers (sealed in separate sleeves) are used to collect the water samples. This way contamination of each sample is prevented to obtain representative samples from each borehole. Bailers are lowered to approximately 5 meters below the static water level where a sample is collected.

A geographical coordinate of each monitoring point is collected and a photograph is captured (only at project initiation).

Monitoring occurred at fourteen (14) of the twenty-five (25) groundwater monitoring points. Six (6) IWUL boreholes were demolished by mining and rehabilitation activities, three (3) were not accessible.

Water levels were monitored.



Groundwater samples are analysed for:

- pH
- EC mS/m
- TDS mg/L
- Total Hardness mg/L
- Alkalinity CaCO<sub>3</sub>/L
- Ca mg/L
- Mg mg/L
- Na mg/L
- K mg/L
- F mg/L
- Cl mg/L
- SO<sub>4</sub> mg/L
- NO<sub>3</sub> mg/L
- Al mg/L
- Fe mg/L
- Mn mg/L
- NH<sub>3</sub> mg/L

## 5.4 Water levels

Groundwater levels at sixteen (16) monitoring points are recorded on a monthly basis, using an electronic water level meter with a probe.

## 5.5 Water sample analyses

Both, surface - and groundwater samples are submitted to Yanka for physical and chemical analyses. Surface - and groundwater samples are analysed for variables as described in **Sections 5.2** and **5.3**.

## 5.6 Reporting

The quarterly and annual surface - and groundwater reports are compiled and evaluated by a registered Pr.Sci.Nat. Environmental Scientist. Annual groundwater reports are evaluated by a registered Pr.Sci.Nat. Geohydrologist.



Various types of reporting are included as required by the enquiry document:

- Three (3) Quarterly Surface – and Groundwater Monitoring Reports; and
- Comprehensive Annual Water Quality Report.

*Quarterly Reports* will include basic representation of data, evaluated against appropriate water quality guidelines with related discussions.

The *Annual Assessment Reports* will be more extensive and include a full evaluation of the results obtained during the year. The report will typically include, but is not limited to, the following functions:

- The Surface Water Report will include a statistical summary (temporal & spatial) of all the chemical variables for all the monitoring points, time-series graphs, linear trend determinations and compliance assessments, water quality thematic maps indicating pollution sources and impacts on the receiving water body as well as a discussion; and
- The Groundwater Report will be similar to the surface water section and will include a statistical summary (temporal & spatial) of all the chemical variables for all the monitoring boreholes, as well as time-series graphs and linear trend determinations.

Temporal trends are subject to a series of sampling frequencies.

## 6. RESULTS

Water monitoring according to IWUL, 2015 included in this report:

- **September 2019**  
IWUL, 2015 Surface - and groundwater monitoring;
- **October 2019**  
IWUL, 2015 Surface water monitoring and groundwater level monitoring; and
- **November 2019**  
IWUL, 2015 Surface water monitoring and groundwater level monitoring.

Refer to **Annexure A** for:

- In-field Sampling Sheets: Tables portraying the name, descriptions and status of the monitoring points.

Refer to **Annexure B** for:

- Test Reports: Laboratory results displaying variable concentrations for all monitoring points during the reporting period.





Water quality results will be described using the DWS Water Quality Guidelines: Domestic Use (Volume 01) 1996 in which summarised descriptions are given for pH (**Table 3**), salinity (**Table 4**) and hardness (**Table 5**).

**Table 3** Summary of pH values.

pH Values used to indicate alkalinity or acidity of water	
pH: > 8.5	Alkaline/Basic
pH: 6.0- 8.5	Neutral
pH: < 6	Acidic

**Table 4** Summary of TDS concentration.

TDS Concentrations to indicate the salinity of water	
TDS < 450 mg/l	Non-saline
TDS 450 - 1 000 mg/l	Saline
TDS 1 000 - 2 400 mg/l	Very saline
TDS 2 400 - 3 400 mg/l	Extremely saline

**Table 5** Summary of Total Hardness concentrations.

Hardness concentrations to indicate softness or hardness of water	
Hardness < 50 mg/l	Soft
Hardness 50 – 100 mg/l	Moderately soft
Hardness 100 – 150 mg/l	Slightly hard
Hardness 150 – 200 mg/l	Moderately hard
Hardness 200 – 300 mg/l	Hard
Hardness 300 – 600 mg/l	Very hard
Hardness > 600mg/l	Extremely hard

**Sections 6.1 to 6.6** are detailed discussions on water qualities associated with Elandsfontein – reporting period September 2019 to November 2019.

**Section 6.1:** Wastewater.

**Section 6.2:** Storm Water, Surface Water Runoff, Natural Streams.

**Section 6.3:** Groundwater.

**Section 6.4:** Groundwater Levels.

Surface - and groundwater monitoring points will be compared to IWUL Limits and the Resource Quality Objectives for the Olifants River System.



## 6.1 Wastewater

**Table 6** indicates the average water quality for the wastewater monitoring points compared to the IWUL Limits and Resource Quality Objectives for the Olifants River System.

Wastewater includes:

**TCM PCD 1:** PCD south/adjacent receiving water form partially rehabilitated discard area.

**TCM PCD 3:** Pollution control dam containing decant water, surface water runoff and water from opencast pits.

**TCM SW 3:** Open void collecting surface water runoff.

**WOP:** West Open Pit, collecting surface water runoff and other water.

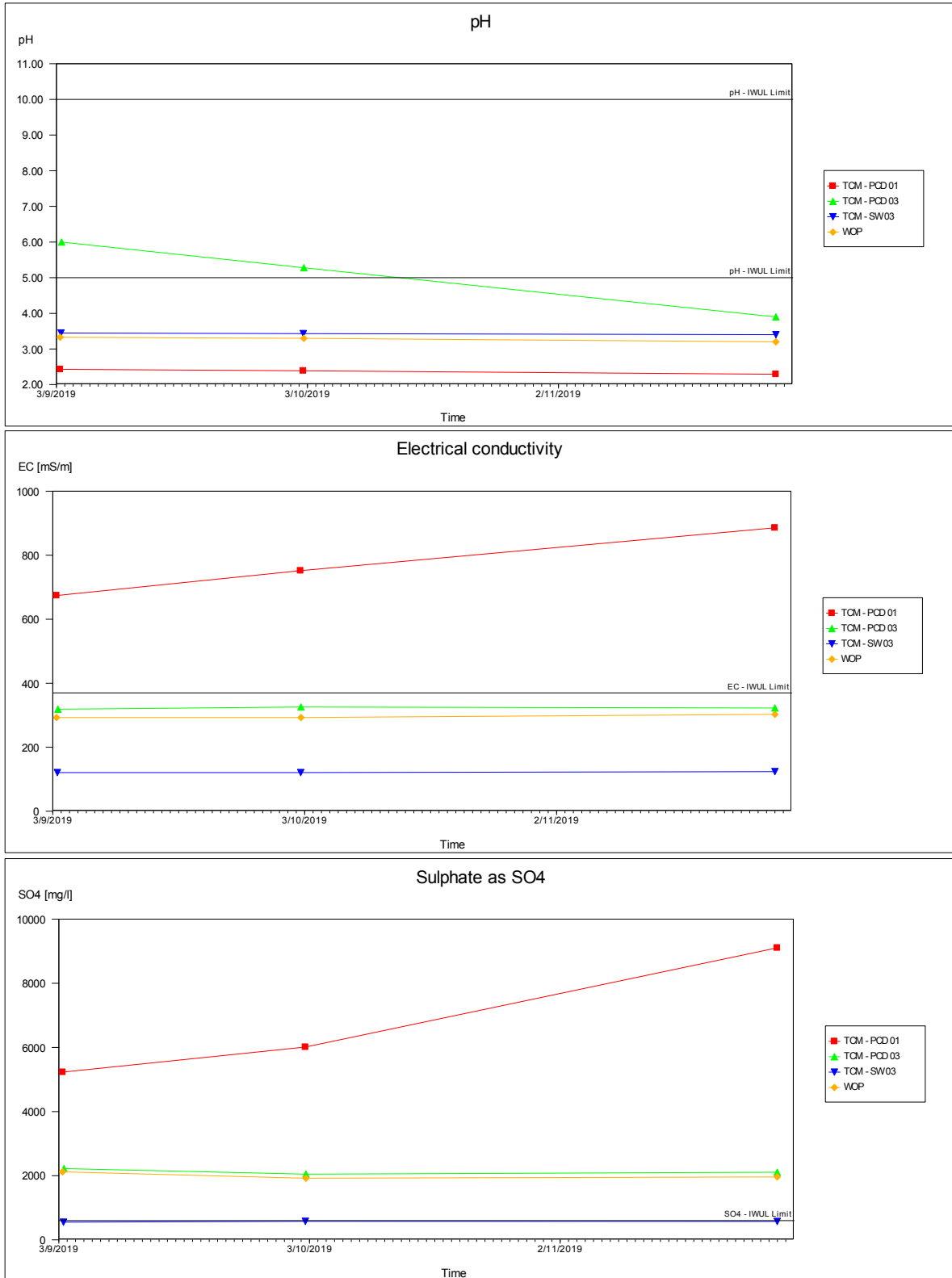
**Figure 6** illustrates variable concentration trends for wastewater monitoring points.

**Figure 7** illustrates the average STIFF diagrams for wastewater monitoring points.

**Table 6** Average water quality for wastewater monitoring points.

Average Wastewater Quality for Elandsfontein September 2019 to November 2019							
Variable	Unit	IWUL Limit Wastewater	Olifants River RQO's	TCM PCD 1	TCM PCD 3	TCM SW 3	WOP
pH	-	5 - 10	6.5 – 8.4	* 2.370	5.060	* 3.427	* 3.277
EC	mS/m	370	111	770.667	322.667	122.000	296.333
TDS	mg/L	-	-	8889.517	3010.103	789.405	2813.916
Total Hardness	mg/L	-	-	2463.467	1969.675	538.418	1945.577
Alkalinity	CaCO <sub>3</sub> /L	-	-	0.000	5.800	0.000	0.000
Ca	mg/L	300	-	604.907	497.407	143.667	543.333
Mg	mg/L	100	-	231.427	176.700	43.633	143.000
Na	mg/L	400	-	17.643	62.970	6.447	40.033
K	mg/L	100	-	2.637	25.190	8.367	18.433
F	mg/L	1.5	3	* 77.303	* 2.087	* 2.073	0.287
Cl	mg/L	600	5	4.423	60.667	4.773	33.533
SO <sub>4</sub>	mg/L	600	500	* 6784.640	* 2129.240	570.333	* 2004.030
NO <sub>3</sub>	mg/L	-	4	-0.350	-0.350	-0.350	-0.083
NH <sub>3</sub>	mg/L	2	-	5.332	5.972	-0.450	1.869
SS	mg/L	25	-	16.600	42.000	1.800	14.000
Turbidity	NTU	3	-	9.605	141.500	2.210	26.450
DO	mg/L	6	-	6.165	6.430	6.780	6.760
Al	mg/L	0.5	-	620.093	2.637	5.283	7.090
Fe	mg/L	2	-	455.545	30.530	1.400	7.510
Mn	mg/L	1	-	80.540	11.243	3.360	13.590

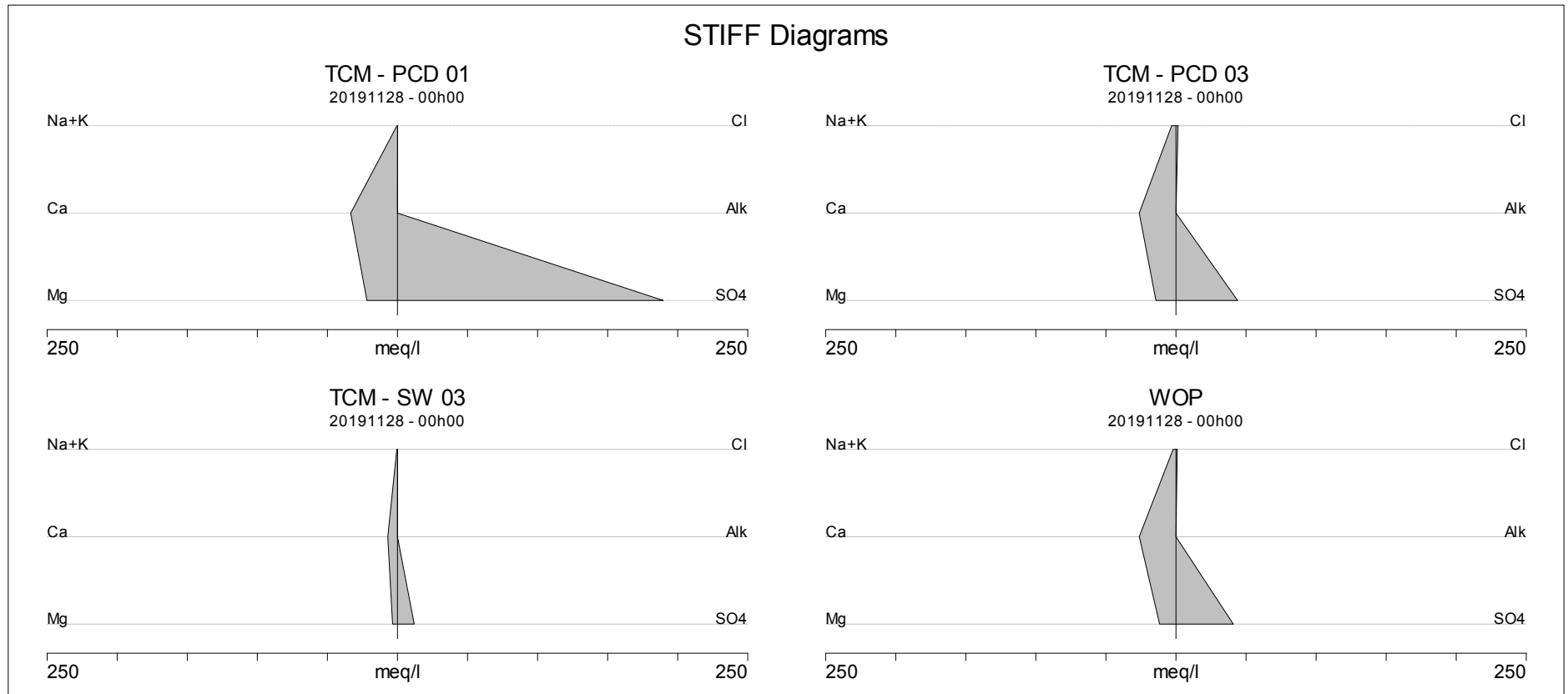
- Variables highlighted in grey are specified by the IWUL where the remainder are additional analyses.
- Values highlighted in red exceeds the limits set in the IWUL where variables highlighted in green exceeds the Olifants River RQO's
- “-“Indicate values below laboratory detection limit. \* Value exceeded both limits.



**Figure 6** Wastewater variable concentration trends.



- STIFF Diagram**
- A dominant Sulphate (SO<sub>4</sub>) anion indicate coal mining pollution.
  - A dominant Alkalinity/Bicarbonate (HCO<sub>3</sub><sup>-</sup>) anion indicates fresh, natural and unimpacted water.
  - Cations are indicators/subjected to/of the local geology and natural conditions.
  - The size/width of the diagram indicates the concentrations in the water.
  - The shape of the diagram indicates the composition of the water.



\* Cations left (Na+K, Ca, Mg)

\* Anions right (Cl, Alk, SO<sub>4</sub>)

**Figure 7** Average wastewater STIFF diagrams.



From **Table 6, Figures 6 and 7** it is evident that the wastewater qualities exceeded several IWUL limits and Olifants River Resource Quality Objectives (RQO's).

Water quality from the mine water/pollution control dams recorded acidic pH levels and elevated concentrations of EC, TDS, SO<sub>4</sub> (dominant) and metals (Al, Fe and Mn), typically associated with coal washing/mining activities. SO<sub>4</sub> is dominant in terms of composition (**Figure 7**).

Below an abstract from **Table 6** indicating acidic pH levels and elevated EC, SO<sub>4</sub>, Al, Fe and Mn.

Variable	TCM PCD 1	TCM PCD 3	TCM SW 3	WOP
pH	* 2.370	5.060	* 3.427	* 3.277
EC	770.667	322.667	122.000	296.333
SO <sub>4</sub>	* 6784.640	* 2129.240	570.333	* 2004.030
Al	620.093	2.637	5.283	7.090
Fe	455.545	30.530	1.400	7.510
Mn	80.540	11.243	3.360	13.590

- Values highlighted in red exceed the limits set in the IWUL where variables highlighted in green exceed the Olifants River RQO's.
- \* Values exceeded both Limits / Guidelines / Objectives.

Trend analysis illustrated in **Figure 6** indicates a slight improvement in water quality during November 2019 – this can be attributed to rainwater entering the water bodies.

Wastewater facilities are not lined and the possibility exists of seepage into the groundwater aquifer. Water quality concentrations and trends will be closely monitored to determine if the concentrations and compositions recorded are seasonal or stable / long term occurrences.

## 6.2 Storm Water, Surface Water Runoff, Natural Streams

**Table 7** indicates the average surface water quality for the surface - and storm water runoff linked to the receiving environment. Water qualities from these monitoring points are compared to the Resource Quality Objectives for the Olifants River System.

Surface - and storm water runoff includes:

**SW – 01:** Most upper reaches of northern tributary (originating in Elandsfontein).

**Farm Dam:** Downstream from **SW – 01**.

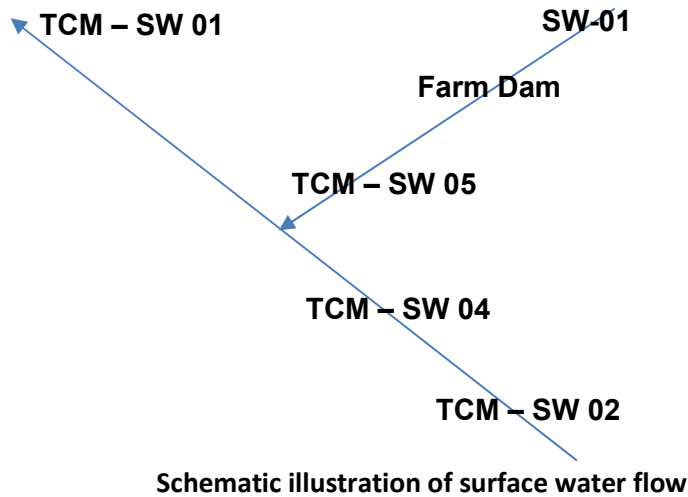
**TCM – SW05:** Downstream of **Farm Dam**.

**TCM – SW02:** Southern tributary entering Elandsfontein.

**TCM – SW04:** Downstream of **TCM – SW 02**.

**TCM – SW 01:** Most downstream monitoring point, after confluence of **TCM – SW 04** and **TCM – SW 05**

Below a schematic illustration of the surface water flow and monitoring points.



The **SW-01** tributary originates within Elandsfontein and flows from north-east to south-west. The **TCM-SW 02** originates outside the boundaries of Elandsfontein and flow through the mining right area, towards monitoring point **TCM–SW 01** (most downstream point), located outside the mining right area, in a north-westerly direction.

**Figure 8** illustrates variable concentration trends for surface - and storm water runoff.

**Figure 9** illustrates the average STIFF diagrams for surface - and storm water runoff monitoring points.

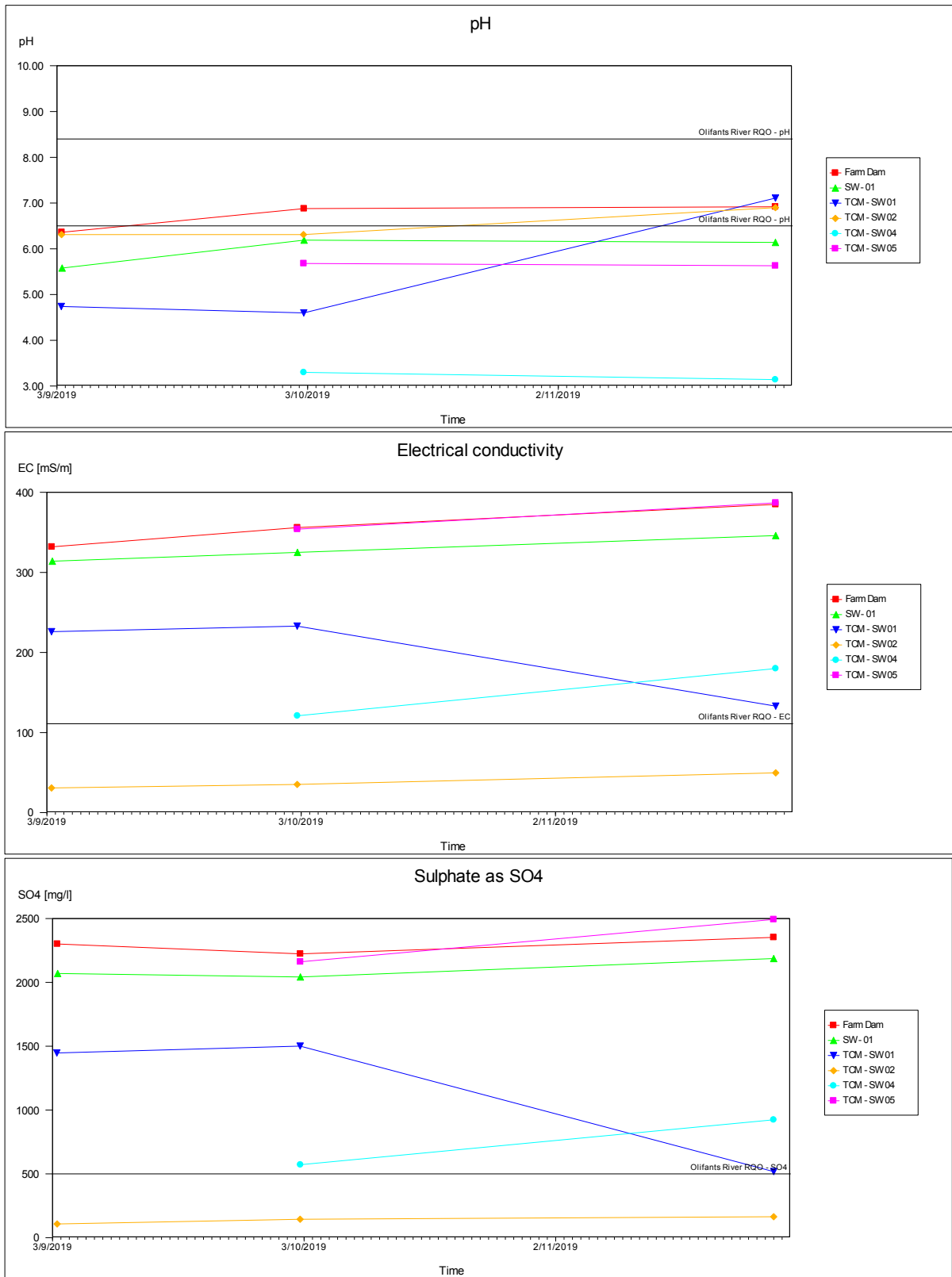


**Table 7** Average water quality for surface and storm water runoff monitoring points for the reporting period.

Average Surface Water Quality for Elandsfontein September 2019 to November 2019									
Variable	Unit	IWUL Limit Wastewater	Olifants River RQO's	SW - 01	Farm Dam	TCM - SW 05	TCM - SW 02	TCM - SW 04	TCM - SW 01
pH	-	5 - 10	6.5 – 8.4	5.970	6.720	5.655	6.507	* 3.220	5.483
EC	mS/m	370	111	328.333	357.667	* 370.500	38.633	150.500	197.333
TDS	mg/L	-	-	3075.832	3464.713	3380.061	233.269	1036.155	1714.760
Total Hardness	mg/L	-	-	2059.546	2347.311	2251.944	154.704	644.001	1201.397
Alkalinity	CaCO <sub>3</sub> /L	-	-	7.000	21.467	5.200	36.333	0.000	26.333
Ca	mg/L	300	-	558.900	615.543	565.067	33.212	172.443	326.333
Mg	mg/L	100	-	161.237	196.770	204.219	17.429	51.824	93.867
Na	mg/L	400	-	108.667	135.377	138.500	9.078	11.401	40.567
K	mg/L	100	-	28.667	36.993	38.100	2.300	17.450	11.887
F	mg/L	1.5	3	-0.090	-0.090	-0.090	0.173	1.455	0.717
Cl	mg/L	600	5	90.767	167.497	99.600	6.180	9.470	54.773
SO <sub>4</sub>	mg/L	600	500	* 2100.000	* 2292.667	* 2328.000	139.217	* 748.000	* 1156.057
NO <sub>3</sub>	mg/L	-	4	1.943	-0.020	0.485	-0.350	-0.350	-0.100
NH <sub>3</sub>	mg/L	2	-	0.453	-0.450	-0.450	-0.450	-0.450	-0.450
SS	mg/L	25	-	3.600	2.000	-0.400	2.200	9.600	11.200
Turbidity	NTU	3	-	1.460	2.005	1.330	3.135	1.920	9.600
DO	mg/L	6	-	6.465	6.415	6.630	6.665	6.540	6.700
Al	mg/L	0.5	-	-0.010	0.000	0.006	0.017	5.810	3.837
Fe	mg/L	2	-	0.260	0.093	0.040	0.157	4.775	0.320
Mn	mg/L	1	-	13.483	5.573	1.257	3.703	13.527	9.720

- Variables highlighted in grey are specified by the IWUL where the remainder are additional analyses.
- Values highlighted in red exceeds the Wastewater limits set in the IWUL where variables highlighted in green exceeds the Olifants River RQO's
- "- "Indicate values below laboratory detection limit. \* Value exceeded both limits.

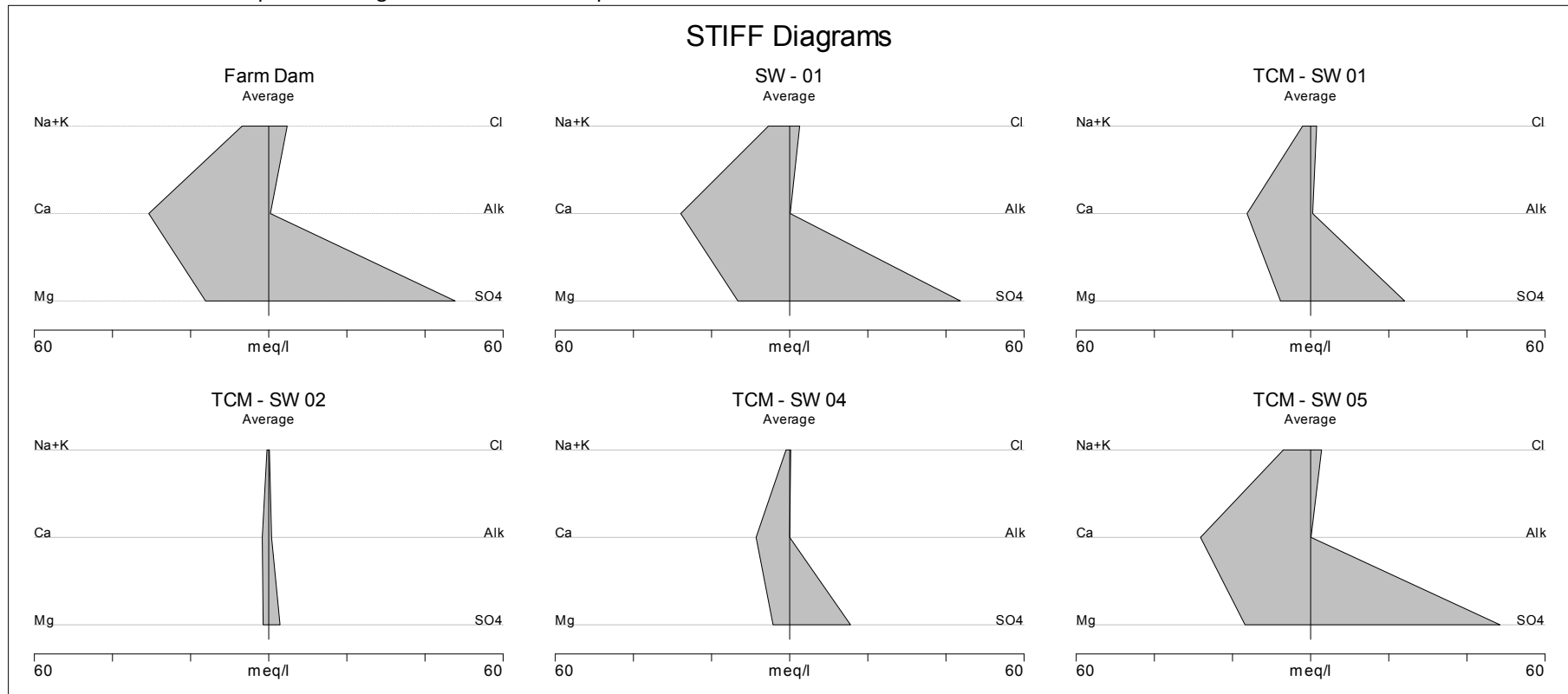




**Figure 8** Variable concentration trends for surface - and runoff water monitoring points.



- STIFF Diagram**
- A dominant Sulphate ( $SO_4$ ) anion indicate coal mining pollution.
  - A dominant Alkalinity/Bicarbonate ( $HCO_3^-$ ) anion indicates fresh, natural and unimpacted water.
  - Cations are indicators/subjected to/of the local geology and natural conditions.
  - The size/width of the diagram indicates the concentrations in the water.
  - The shape of the diagram indicates the composition of the water.

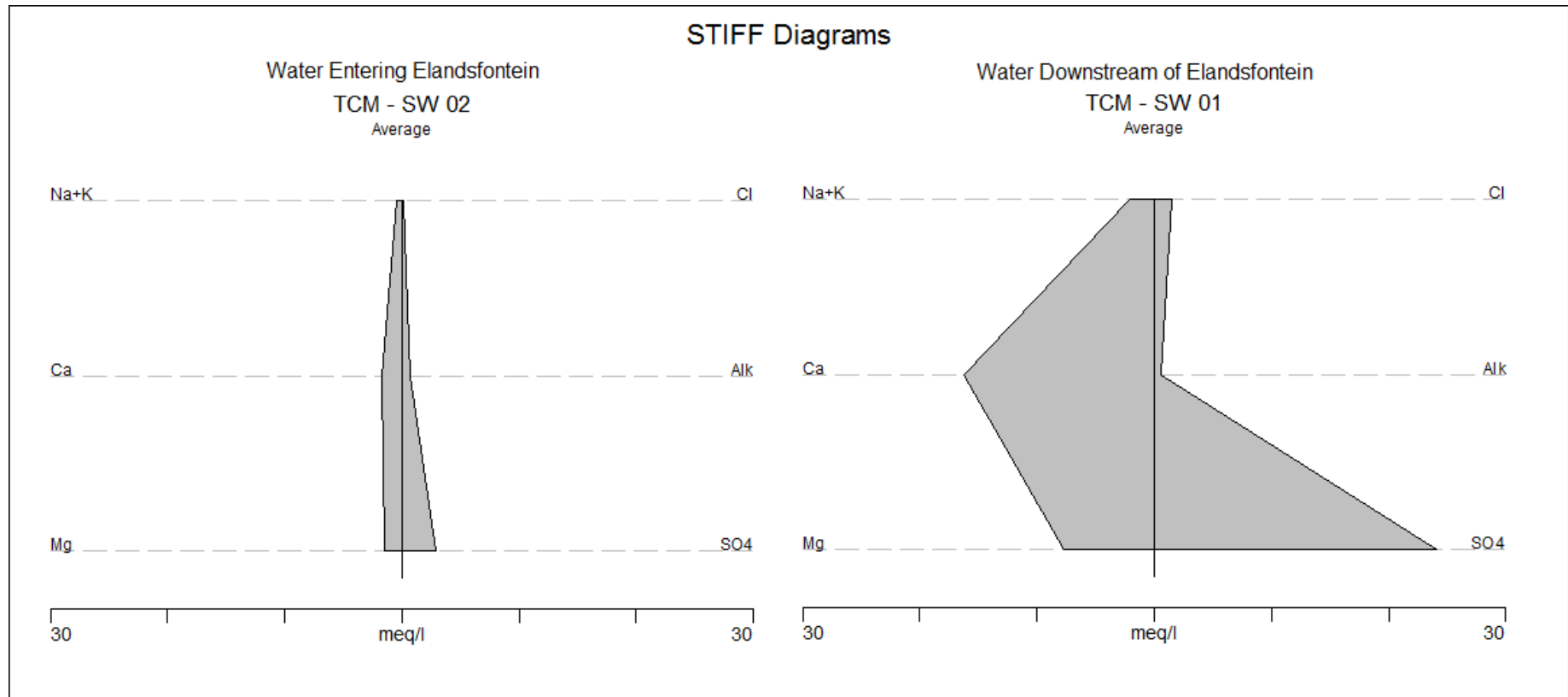


\* Cations left (Na+K, Ca, Mg)

\* Anions right (Cl, Alk,  $SO_4$ )



- STIFF Diagram
- A dominant Sulphate ( $\text{SO}_4$ ) anion indicate coal mining pollution.
  - A dominant Alkalinity/Bicarbonate ( $\text{HCO}_3^-$ ) anion indicates fresh, natural and unimpacted water.
  - Cations are indicators/subjected to/of the local geology and natural conditions.
  - The size/width of the diagram indicates the concentrations in the water.
  - The shape of the diagram indicates the composition of the water.



\* Cations left (Na+K, Ca, Mg)

\* Anions right (Cl, Alk,  $\text{SO}_4$ )

**Figure 9** STIFF Diagrams for surface - and storm water runoff monitoring points.



From **Table 7, Figure 8 and 9** it is evident that the **southern tributary** at monitoring point **TCM-SW 02**, recorded elevated concentrations of EC, SO<sub>4</sub> and Mn. Downstream of **TCM-SW 02** towards **TCM-SW 04**, a substantial lowering in pH and elevation in several variable concentrations (EC, TDS, Ca, Mg, SO<sub>4</sub>, Al, Fe and Mn) is observed, which indicate a pollution source located/originating between **TCM-SW 02** and **TCM-SW 04**. Rehabilitated mining areas to the east of the tributary should be investigated as the pollution source.

From **Table 7** it is evident that the **northern tributary** at monitoring point **SW-01**, recorded elevated concentrations of EC, TDS, Ca, Mg, Na, SO<sub>4</sub> and Mn, indicating coal mining pollution. **SW-01** is a natural spring which receives decant water from **TCM-PCD03**, an unlined facility. The decant water originates from groundwater flow from mining areas and industrial facilities located to the north of Elandsfontein.

From **Table 7, Figure 8 and 9** it is evident that neither quality nor composition of the water (from **SW-01** to **Farm Dam** to **TCM-SW05**) indicates significant change - no deterioration nor improvement was recorded.

After the confluence of **TCM-SW04** (southern tributary) and **TCM-SW05** (northern tributary) a combination of the two tributaries can be observed at **TCM-SW01** (most downstream monitoring point). Although, the composition of the two tributaries is similar, the concentration of the waters differs. The combination of the composition of the concentration is evident in **Figure 9**. At **TCM-SW01**, the water quality from **TCM-SW05** is slightly diluted to a lower concentration; the water quality at **TCM-SW01** indicates a definite coal impact in comparison with the upstream monitoring point, **TCM-SW02** in **Table 7, Figure 8 and 9**.

### 6.3 Groundwater

**Table 8** indicates the average groundwater quality for Elandsfontein monitoring points compared to the IWUL limits and Olifants River Resource Quality Objectives.

**Figure 10** illustrates the composition of the groundwater water quality in STIFF Diagrams.

**Please note:** As only one set of groundwater quality analysis exist for the reporting period (September 2019), trend analyses will be included in the next (December 2019 to February 2020) quarterly water quality report. Several Hydrocensus boreholes (September 2019) were included in this report to establish a baseline water quality and determine impacts more accurately. The groundwater monitoring network / program is subjected to change during the following monitoring occasions.

**Table 8** Average water quality for Elandsfontein groundwater monitoring points.

Average Groundwater Quality for Elandsfontein September 2019 to November 2019								
Variable	Unit	IWUL RQO	Olifants River RQO's	GW - 01	GW - 05	Eland 10	Eland 11	AHBH - 01
pH	-	8.79	6.5 – 8.4	8.370	4.310	6.940	6.960	7.160
EC	mS/m	75.52	111	54.100	* 401.000	6.000	* 138.000	12.760
TDS	mg/L	-	-	257.660	4559.270	27.360	862.605	63.007
Total Hardness	mg/L	-	-	76.855	1310.338	16.763	294.391	36.711
Alkalinity	CaCO <sub>3</sub> /L	-	-	168.000	0.000	21.000	32.800	55.600
Ca	mg/L	32.56	-	7.740	403.880	3.250	95.479	7.134
Mg	mg/L	34.71	-	13.970	73.300	2.100	13.594	4.589
Na	mg/L	44.00	-	69.060	10.520	2.130	138.307	10.406
K	mg/L	-	-	5.060	7.550	3.290	52.536	1.081
F	mg/L	0.14	3	-0.090	0.830	0.240	-0.090	0.210
Cl	mg/L	36.34	5	3.900	3.390	3.130	86.000	3.600
SO <sub>4</sub>	mg/L	10.36	500	57.070	* 3314.050	0.490	455.000	2.490
NO <sub>3</sub>	mg/L	0.11	4	-0.350	-0.350	-0.350	-0.350	-0.350
NH <sub>3</sub>	mg/L	-	-	-0.450	-0.450	-0.450	0.777	-0.450
Al	mg/L	-	-	-0.010	97.290	-0.01	-0.010	0.010
Fe	mg/L	-	-	0.040	589.740	0.02	0.070	0.127
Mn	mg/L	-	-	0.020	58.720	0.11	0.937	-0.010

- Variables highlighted in grey are specified by the IWUL where the remainder are additional analyses.
- Values highlighted in red exceeds the limits set in the IWUL where variables highlighted in green exceeds the Olifants River RQO's
- "-"Indicate values below laboratory detection limit. \* Value exceeded both limits.

**Table 8 (cont.)** Average water quality for Elandsfontein groundwater monitoring points.

Average Groundwater Quality for Elandsfontein September 2019 to November 2019								
Variable	Unit	IWUL RQO	Olifants River RQO's	AHBH - 02	AHBH - 03	Eland 01	ELN - BH 03	ELN - BH 07
pH	-	8.79	6.5 – 8.4	7.570	7.440	6.490	2.900	5.170
EC	mS/m	75.52	111	47.800	21.400	12.100	* 254.000	5.560
TDS	mg/L	-	-	248.460	108.692	59.729	1832.707	33.958
Total Hardness	mg/L	-	-	119.433	73.951	36.994	899.004	17.562
Alkalinity	CaCO <sub>3</sub> /L	-	-	141.000	91.800	38.000	0.000	3.200
Ca	mg/L	32.56	-	28.700	20.100	8.730	243.778	5.120
Mg	mg/L	34.71	-	11.600	5.770	3.690	70.493	1.160
Na	mg/L	44.00	-	51.600	10.600	3.170	17.072	1.580
K	mg/L	-	-	2.520	4.630	5.520	9.740	1.360
F	mg/L	0.14	3	1.910	1.030	0.180	32.184	0.110
Cl	mg/L	36.34	5	* 59.900	* 6.900	2.970	4.490	2.240

Average Groundwater Quality for Elandsfontein September 2019 to November 2019								
Variable	Unit	IWUL RQO	Olifants River RQO's	AHBH - 02	AHBH - 03	Eland 01	ELN - BH 03	ELN - BH 07
SO <sub>4</sub>	mg/L	10.36	500	7.630	2.780	5.950	* 1306.710	3.050
NO <sub>3</sub>	mg/L	0.11	4	-0.350	0.400	1.510	-0.350	3.925
NH <sub>3</sub>	mg/L	-	-	-0.450	-0.450	-0.450	3.050	-0.450
Al	mg/L	-	-	-0.010	-0.010	0.010	31.200	0.010
Fe	mg/L	-	-	-0.010	0.030	0.020	105.000	-0.010
Mn	mg/L	-	-	-0.010	-0.010	-0.010	8.105	0.020

- Variables highlighted in grey are specified by the IWUL where the remainder are additional analyses.
- Values highlighted in red exceeds the limits set in the IWUL where variables highlighted in green exceeds the Olifants River RQO's
- "-"Indicate values below laboratory detection limit. \* Value exceeded both limits.

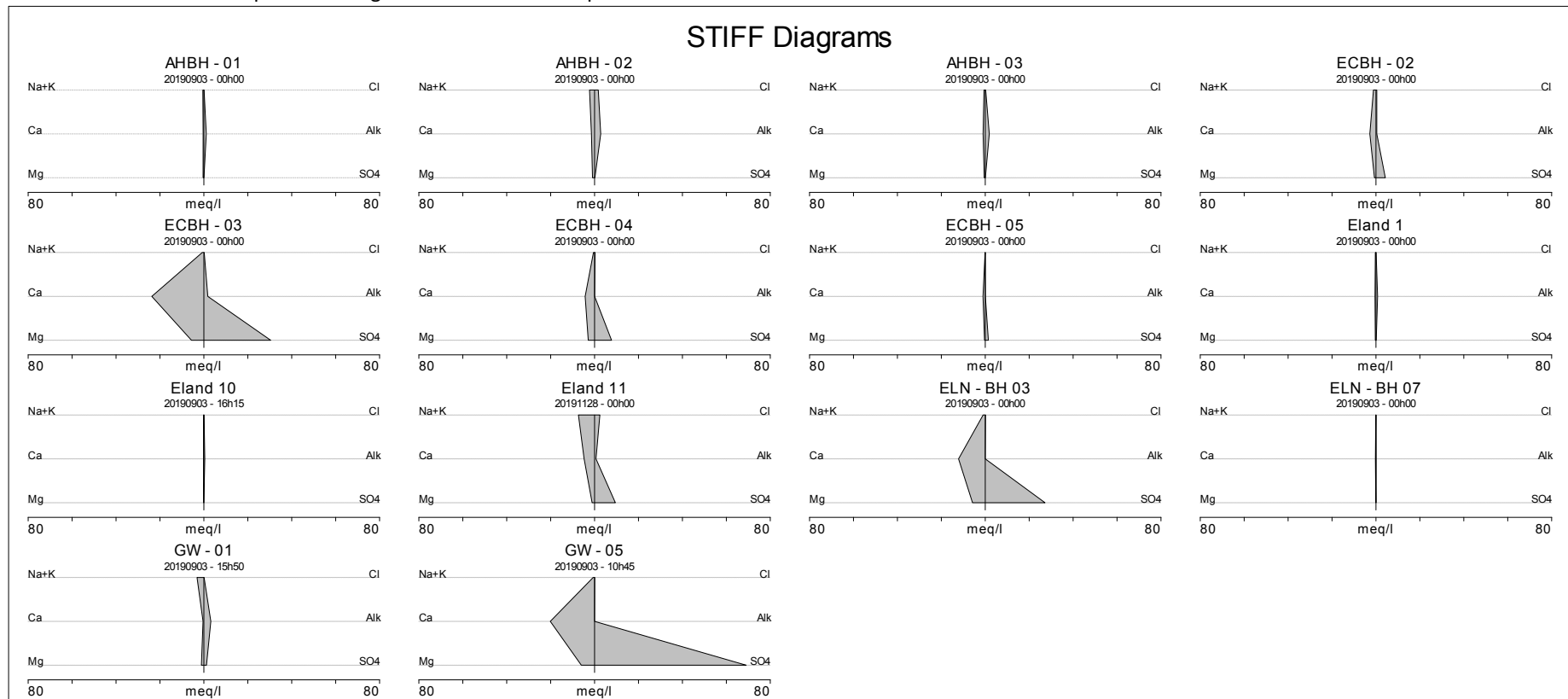
**Table 8** Average water quality for Elandsfontein groundwater monitoring points.

Average Groundwater Quality for Elandsfontein September 2019 to November 2019							
Variable	Unit	IWUL RQO	Olifants River RQO's	ECBH - 02	ECBH - 03	ECBH - 04	ECBH - 05
pH	-	8.79	6.5 – 8.4	6.500	5.980	4.830	5.060
EC	mS/m	75.52	111	52.200	* 218.000	80.000	18.000
TDS	mg/L	-	-	333.371	2091.536	524.924	105.619
Total Hardness	mg/L	-	-	174.801	1469.393	359.122	70.389
Alkalinity	CaCO <sub>3</sub> /L	-	-	19.800	90.200	2.600	2.800
Ca	mg/L	32.56	-	56.100	475.000	86.100	20.900
Mg	mg/L	34.71	-	8.431	68.800	35.000	4.420
Na	mg/L	44.00	-	20.043	11.300	8.920	1.500
K	mg/L	-	-	10.499	9.960	5.070	1.340
F	mg/L	0.14	3	1.470	0.520	0.510	0.090
Cl	mg/L	36.34	5	14.130	5.830	8.850	1.100
SO <sub>4</sub>	mg/L	10.36	500	205.000	* 1461.000	371.740	68.100
NO <sub>3</sub>	mg/L	0.11	4	-0.350	0.460	0.660	1.440
NH <sub>3</sub>	mg/L	-	-	4.440	0.820	-0.450	-0.450
Al	mg/L	-	-	0.020	-0.010	1.070	0.050
Fe	mg/L	-	-	-0.010	1.540	1.160	-0.010
Mn	mg/L	-	-	0.070	0.370	2.020	0.060

- Variables highlighted in grey are specified by the IWUL where the remainder are additional analyses.
- Values highlighted in red exceeds the limits set in the IWUL where variables highlighted in green exceeds the Olifants River RQO's
- "-"Indicate values below laboratory detection limit. \* Value exceeded both limits.



- STIFF Diagram**
- A dominant Sulphate (SO<sub>4</sub>) anion indicate coal mining pollution.
  - A dominant Alkalinity/Bicarbonate (HCO<sub>3</sub><sup>-</sup>) anion indicates fresh, natural and unimpacted water.
  - Cations are indicators/subjected to/of the local geology and natural conditions.
  - The size/width of the diagram indicates the concentrations in the water.
  - The shape of the diagram indicates the composition of the water.



\* Cations left (Na+K, Ca, Mg)

\* Anions right (Cl, Alk, SO<sub>4</sub>)

**Figure 10** STIFF Diagrams for Elandsfontein groundwater monitoring points.



From **Table 8** and **Figure 10** it is evident that groundwater qualities in the Elandsfontein area occasionally recorded acidic pH and elevated concentrations of EC, Ca, Mg, Na, Cl, SO<sub>4</sub> and NO<sub>3</sub>. Elevated concentration in coal mining pollutant indicators i.e. low pH, high EC, SO<sub>4</sub> and metal concentrations, as well as dominant SO<sub>4</sub> anions, indicates groundwater contamination in certain areas.

**ECBH-02, ECBH-03, ECBH-04** (west) and **ECBH-05** (south) are located directly west and south of the partially rehabilitated pit and discard facility - groundwater impacts recorded more severe in the western monitoring boreholes. Acidic pH levels (<6) were recorded at **ECBH-03, ECBH-04** and **ECBH-05** with elevated EC concentrations recorded at **ECBH-02, ECBH-03, ECBH-04**. **ECBH-03** recorded the most impacted water quality in the area.

**ELNBH-03** recorded an acidic pH and elevated concentrations of EC, TDS, Ca, SO<sub>4</sub>, Al, Fe and Mn. **ELNBH-03** is located on the southern boundary of the mining right and south of a previously rehabilitated area.

**GW-05** which is located south of the partially rehabilitated discard facility recorded an acidic pH and elevated concentrations of EC, Ca, SO<sub>4</sub>, Al, Fe and Mn - indicating pollution from the upgradient historical mining activities (discard facility).

**Eland 11** is located directly north of the mining right area, on the boundary with Highveld steel. The water quality and composition indicates contamination - elevated concentrations of EC, Na, Cl and SO<sub>4</sub>. The contamination can possibly be ascribed to both mining and industrial activities, as the borehole is located in very close proximity to both. A Geohydrological Model will indicate the groundwater flow path as to determine the source of the contamination plume.

The remainder of the monitoring boreholes (**Eland 1, GW-01, Eland 10, AHBH-01, 02** and **03**) recorded relatively good water quality, despite exceeding a few IWUL limits and Olifants River RQO's. These monitoring boreholes are not concentrated to one area but are located in and around the Elandsfontein mining right area.

The groundwater monitoring program is not final and will be closely monitored, supplemented and adjusted during the following monitoring occasions.

## 6.4 Groundwater Levels

Groundwater levels are monitored on a monthly basis to determine the possible impact of mining activities on the groundwater aquifer.





**Table 9** indicates groundwater levels below ground level (MBGL).

**Figure 11** illustrates groundwater level trends.

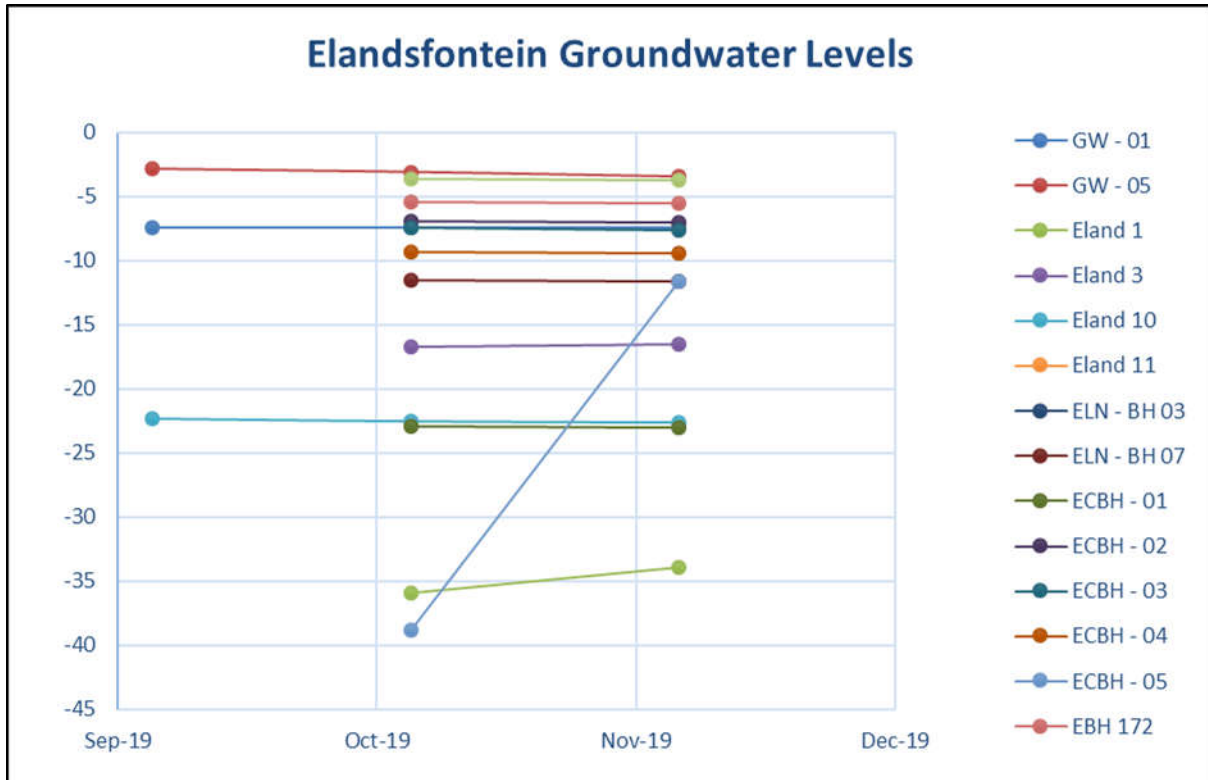
**Please note:** The first groundwater monitoring was conducted in September 2019, concurrent with a Hydrocensus, hence the incomplete data. Complete data will be included in the Hydrocensus report.

**Table 9** Elandsfontein groundwater levels for IWUL monitoring boreholes.

Elandsfontein Groundwater Levels			
Date	Sep-19	Oct-19	Nov-19
GW - 01	-7.43	-7.41	-7.47
GW - 05	-2.85	-3.1	-3.46
Eland 1	-	-35.9	-33.94
Eland 3	-	-16.74	-16.5
Eland 10	-22.33	-22.52	-22.61
Eland 11	-	-	-7.13
ELN - BH 03	-	-	-
ELN - BH 07	-	-11.51	-11.66
ECBH - 01	-	-22.89	-23.01
ECBH - 02	-	-6.9	-7.07
ECBH - 03	-	-7.41	-7.58
ECBH - 04	-	-9.33	-9.45
ECBH - 05	-	-38.83	-11.66
EBH 172	-	-5.41	-5.5
EBH 173	-	-3.65	-3.74

“-” Indicate level below ground level

From **Table 9** and **Figure 11** it is evident that groundwater levels remained relatively stable, with the exception of **ECBH-05**. During October 2019, **ECBH-05** was connected to a pump and storage tank which possibly influenced the water level.



**Figure 11** Elandsfontein groundwater level trends.



## 7. DISCUSSION AND CONCLUSION

The monitoring network provides information for risk-based decision making to Elandsfontein management with regard to effectiveness of pollution prevention measures and areas requiring management attention.

### 7.1 Surface water

**Wastewater** - Water quality from the mine water/pollution control dams recorded acidic pH levels and elevated concentrations of EC, TDS, SO<sub>4</sub> (dominant) and metals (Al, Fe and Mn), typically associated with coal washing/mining activities. SO<sub>4</sub> is dominant in terms of composition.

**Storm and Surface Water Runoff** – Upstream and downstream monitoring points recorded elevated concentrations, typically associated with coal washing/mining activities. The upstream monitoring point (**TCM-SW02**) recorded elevated concentrations, with a deterioration of water quality towards the downstream monitoring point (**TCM-SW01**), indicating pollution from Elandsfontein.

### 7.2 Groundwater

The following monitoring points recorded elevated concentrations:

**GW-05:** Downstream of the partially rehabilitated discard area in the south eastern corner of Elandsfontein;

**ECBH-02, 03, 04 and 05:** Northern, partially rehabilitated area;

**Eland 11:** Northern boundary with Highveld steel; and

**ELNBH-03:** Downstream of the southern, historical mining and rehabilitated area.

The remainder of the monitoring boreholes (**Eland 1, GW-01, Eland 10, AHBH-01, 02 and 03**) recorded relatively good water quality, despite exceeding a few IWUL limits and Olifants River RQO's. These monitoring boreholes are not concentrated to one area but are located in and around the Elandsfontein mining right area.

Groundwater, especially close to pollution sources should be monitored and mitigation measures investigated/recommended.

**Groundwater levels** - Groundwater levels remained relatively stable, with the exception of **ECBH-05**. During October 2019, **ECHB-05** was connected to a pump and storage tank which possibly influenced the water level.



## 8. REFERENCES

- General Authorisations in terms of section 39 of the NWA, 1998 (Act No.36 of 1998), GG 36206 (4 March 2013), GNR 169, Section 21 (f) & (h).
- ISO 5667-1: 2006 Part 1: Guidance on the design of sampling programs and sampling techniques.
- ISO 5667-3: 2003 Part 3: Guidance on preservation and handling of samples.
- ISO 5667-6: 2005 Part 6: Guidance on sampling of rivers and streams.
- ISO 5667-11: 1993 Part 11: Guidance on sampling of groundwater.
- Mineral and Petroleum Resources Development Act (Act No.28 of 2002).
- National Water Act (Act No. 36 of 1998).
- South African Water Quality Guidelines (1996). Volume 1. Domestic Use. Department of Water Affairs and Forestry.
- South African Water Quality Guidelines (1996). Volume 7. Aquatic Ecosystems. Department of Water Affairs and Forestry.
- South African Water Quality Guidelines (1996). Volume 5. Agricultural Use: Livestock Watering. Department of Water Affairs and Forestry.
- Department of Water and Sanitation, National Water Resource Strategy, 2004.

## 9. ANNEXURES

Refer to **Annexure A** for:

- In-field Sampling Sheets: Tables portraying the name, descriptions and status of the monitoring points.

Refer to **Annexure B** for:

- Test Reports: Laboratory results displaying variable concentrations for all monitoring points during the reporting period.



## **ANNEXURE A**

### **In-field Sampling Sheets**

Tables portraying the name, descriptions and status of the monitoring points.

				Geo-Soil and Water CC Tel: 012 648 4795 Fax: 012 654 3531 E-mail: <a href="mailto:info@geosolwater.co.za">info@geosolwater.co.za</a> Web: <a href="http://www.geosolwater.co.za">www.geosolwater.co.za</a> VAT No: 4430244586 Pretorius Struik 3219 Private Bag 432 Lynwood 6040 15A Midas Ave, Olympia, Pretoria		
		Elandsfontein Colliery Project: Elandsfontein Colliery Monitoring Month: Sep-19 Monitoring Duration: IWUL Quarterly Surface and Groundwater Monitoring Date of Sampling: 02/09/2019 to 03/09/2019		Locality ID:		
Analyses Required	Time / Date	Sampled	Level	Medium	Comments/Observations	
Surface and Groundwater  pH, EC, Ammonia, Ca, Mg, Ni, K, S, Cl, SO <sub>4</sub> , NO <sub>3</sub> , Ni, Mn, Al, Fe, Mn + SS, DO, Turbidity  Issued by: Received by: YANKA LABS 20/9/2019 Date:	TCM SW01	Yes	High	Water	Clear	
	TCM SW02	Yes	Mid	Water	Clear	
	TCM SW03	Yes	Low	Water	Clear	
	<del>TCM SW04</del>					
	ELAN	No	N/A	Water	No Access to game farm	
	TCM PCD01	Yes	Yes	Mid	Water	Clear
	TCM PCD03	No	No	Low	Water	No Access to game farm
	SW01	Yes	Yes	N/A	Water	Clear
	GSHL02	No	No	N/A	Water	No Access to game farm
	GSHL03	No	No	N/A	Water	No Access to game farm
Decant	Yes	Yes	Mid	Water	Clear	
Farm Dam	Yes	Yes	Mid	Water	Clear	
Groundwater pH, EC, CaCO <sub>3</sub> , Ca, Mg, Na, K, F, Cl, SO <sub>4</sub> , NO <sub>3</sub> , Al, Fe, Mn	GW01	Yes	7.45	Water	Clear	
	GW02	No			No BTL at coords.	
	GW03	No			No BTL at coords.	
	GW04	No			No BTL at coords.	
	GW05	Yes	Yes	2.55	Water	Clear
	TCM BH01	No	No			No Access - In game farm
	TCM BH02	No	No			No BTL at coords.
	TCM BH03	No	No			No BTL at coords.
	GR BH01	No	No			No Access - In game farm
	GR BH02	No	No			No Access to game farm
GR BH03	No	No			No Access to game farm.	



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 Tel: 082 548 4765  
 Fax: 086 654 3531  
 E-mail: louh@geosoilwater.co.za  
 Web: www.geosoilwater.co.za  
 VAT No: 4420244596  
 Postnet Suite C319 Private Bag X18 Lynnwood Ridge 0040  
 15A Midas Ave, Olympos, Pretoria



T0547

Analysis Required  
 Surface Water

pH, EC, Alkalinity, Ca, Mg, Na, K, F, Cl, SO<sub>4</sub>,  
 NO<sub>3</sub>-N, NH<sub>3</sub>/A, Al, Fe, Mn

Sent by:

L. Waniis

Received by:

YANICA LINDS

Date:

2019/10/08

Project: Elandsfontein Colliery

Monitoring Month: Oct-19

Monitoring Occasion: IWUL Quarterly Surface and Groundwater Monitoring

Date of Sampling: 02/10/2019 to 03/10/2019

Locality ID	Time / Date	Sampled	Level	Medium	Comments/Observations
SURFACE WATER					
FARM DAM	13:55	Yes	Med	Water	Clear
SW01	14:00	Yes	Med	Water	Clear
TCMPCD 01	12:15	Yes	Med	Water	Clear - AMD
TCMPCD 03	14:10	Yes	Low	Water	Clear
TCMSW 01	13:15	Yes	Low	Water	Clear
TCMSW 02	12:55	Yes	Low	Water	Clear
TCMSW 03	12:50	Yes	Med	Water	Clear
TCMSW 04	13:30	Yes	Low	Water	Clear
TCMSW 05	13:35	Yes	Low	Water	Clear
WOP	13:50	Yes	Med	Water	Clear
GROUNDWATER LEVELS ONLY					
Locality ID	Level	Locality ID	Level		
EC BH1	22.89	ELAND 2	760.66	11:50	
EC BH2	6.90	ELAND 3	16.74	14:40	
EC BH3	7.41	ELAND 10	22.52	10:05	
EC BH4	9.33	GW 01	7.41	14:25	
EC BH5	38.83	GW 05	3.10	12:10	
EC BH 07 S	11.51	EBH 172	5.41	13:00	
ELNBH 03	Dear	EBH 173	3.65	13:05	
ELAND 1	35.90	EC BH 14	> 60.66	11:10	



10647

Analyses Required

Surface Water

pH, EC, Alkalinity, Ca, Mg, Na, K, F, Cl, SO<sub>4</sub>,  
 NO<sub>3</sub>-N, NH<sub>4</sub>-N, Al, Fe, Mn

Sent by:

L. Morris

Received by:

East

Date:

8/11/19

Project	Elandsfontein Colliery	
Monitoring Month	Nov-19	
Monitoring Occasion	IWUL Monthly Surface and Groundwater Monitoring	
Date of Sampling	04/11/2019	to 04/11/2019

Locality ID	Time	Sampled	Level	Medium	Comment/Observations
SURFACE WATER					
✓ FARM DAM	13:40	Yes	W/d	Water	Clear
✓ SW01	13:50	Yes	W/d	Water	Clear
✓ TCMPGD 01	11:15	Yes	Low	Water	Clear - Orange. AWD
✓ TCMPGD 03	13:20	Yes	W/d	Water	Clear
✓ TCMSW 01	12:40	Yes	W/d	Water	Clear - Skyward
✓ TCMSW 02	12:20	Yes	W/d	Water	Clear
✓ TCMSW 03	12:10	Yes	W/d	Water	Clear
✓ TCMSW 04	12:55	Yes	Low	Water	Clear
✓ TCMSW 05	13:00	Yes	W/d	Water	Clear
✓ WQP	13:10	Yes	W/d	Water	Clear
✓ ELAND 11	14:05	Yes	7.13	Water	Clear

GROUNDWATER LEVELS ONLY					
Locality ID	Time	Level	Locality ID	Time	Level
EC BH1	11:00	23.01	ELAND 2	11:55	Day / Night @ 48m
EC BH2	10:15	7.07	ELAND 3	ELNBH3	Night existing
EC BH3	10:20	7.58	ELAND 10	09:55	22.61
EC BH 5	10:05	38.81	GW 01	10:40	7.47
EC BH 4	10:20	9.45	GW 05	11:20	3.46
EC BH 07 S	10:00	11.66	EBH 172	12:25	5.50
<del>ELAND 3</del>	10:50	16.50	EBH 173	12:20	3.74
ELAND 1	11:45	35.94	ELAND 11	14:05	7.13





## **ANNEXURE B**

### **Test Reports**

Laboratory results displaying variable concentrations for all monitoring points during the reporting period

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 Private Bag X18  
**LYNNWOOD RIDGE**  
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Job No: **E41632 - W19\_2927**  
 Report Reference: **ER\_GEO\_2019-09-11\_07923\_001**  
 Enquiries: **Rita Botha**  
 Date: **2019-09-11**  
**RitaB@yanka.co.za**  
 Job Reference: **W19/2927 - Advice Note 1909W127**  
 Job Description: **3 x Routine Analysis**

Project: **ELANDSFONTEIN GW SAMPLES**

## TEST RESULTS FOR

## Geo Soil Elandsfontein Groundwater - 10 September 2019

This report contains results pertaining only to the water/dust samples analysed.

For Standards referenced, and methods base, please see

<http://www.yanka.co.za/TestsAndStandards.htm>

Please contact us if you have any queries concerning the information contained herein. Thank you for your support.

*Electronically approved*

**RITA BOTHA (Technical Signatory)**  
**ENVIRONMENTAL SERVICES**

SANAS Certificate obtainable from the address below

<http://www.sanas.co.za/schedules/testing/T0647-10-2015.pdf>

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### **ANALYSTS**

Marné, Magda, Venna, Drieka, Sue, Rosemary, Vida, Elize, Charnelle, Petricia

 <b>YANKA LABORATORIES</b> <b>CHEMISTRY TEST RESULTS</b>			Domestic Water. Class II is for information only			SANS 241:2015 / 2011 / 2006				
			LABORATORY NUMBER	SpGeo 1	SpGeo 2	SpGeo 3	SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT
SAMPLE DESCRIPTION			GW - 01	GW - 05	Eland - BH 10					
SAMPLE NUMBER			E41632-001	E41632-002	E41632-003					
SAMPLED	Test Method **		2019/09/03 15:50	2019/09/03 10:45	2019/09/03 16:15					
Remarks			Clear	Clear	Clear					
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	168	0.00	21.0					
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	150	0.00	21.0					
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	18.0	0.00	0.00					
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	159	0.00	21.0					
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	9.00	0.00	0.00					
Conductivity (Laboratory)	mS/m	YE020CON	54.1	401	6.00	< 170	150 - 370	7 years	* < 70	* < 50
pH ( Laboratory)		YE030pH	8.37	4.31	6.94	5.0 - 9.7	4.0 - 10.0	No limit	5.5-9.5	5.5-7.5
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	76.9	1310	16.8					
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	19.3	1008	8.12					
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	57.5	302	8.65					
Total Dissolved Solids (TDS)	mg/L	Calculation	258	4559	27.4	< 1200	1000-2400	7 years		
Temperature	°C	Thermometer	21.0	21.0	21.0					
Calcium	mg Ca/L	YE060ICP	7.74	404	3.25	< 150	150 - 300	7 years		
Chloride	mg Cl/L	YE070AK	3.90	3.39	3.13	< 300	200 - 600	7 years		
Magnesium	mg Mg/L	YE060ICP	14.0	73.3	2.10	< 70	70 - 100	7 years		
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35	<0.35	<0.35	< 12	10 - 20	7 years	< 15	<1.5
Potassium	mg K/L	YE060ICP	5.06	7.55	3.29	< 50	50 - 100	7 years		
Sodium	mg Na/L	YE060ICP	69.1	10.5	2.13	< 200	200 - 400	7 years		
Silicon	mg Si/L	YE060ICP	0.33	3.91	0.34					
Sulphate	mg SO <sub>4</sub> /L	YE070AK	57.1	3314	0.49	< 500	400 - 600	7 years		
Aluminium	mg Al/L	YE060ICP	<0.01	97.3	<0.01	< 0.3	0.3 - 0.5	1 year		
Fluoride	mg F/L	YE070AK	<0.09	0.83	0.24	< 1.5	1.0 - 1.5	1 year	<1.0	<1.0
Iron	mg Fe/L	YE060ICP	0.04	590	0.02	< 2	0.2 - 2.0	7 years	<0.3	<0.3
Manganese	mg Mn/L	YE060ICP	0.02	58.7	0.11	< 0.4	0.1 - 1.0	7 years	< 0.1	< 0.1
Langelier Index (indicative, not SANS)	Calculation		-0.03	-17.49	-2.63	-0.5 - 0.5	negative: water may corrode surfaces; positive: water may form scale on			
pHs (indicative, not SANS)	Calculation		8.40	21.80	9.57		Saturation pH (used in calculations)			
Sodium Absorption Ratio (indicative)	Calculation		3.41	0.13	0.23	< 1.5	Relevant in irrigation and water/plant/soil			
TDS to EC Ratio (indicative, not SANS)	Calculation		4.76	11.37	4.56		Analytical indicator			
Corrosion Ratio (indicative, not SANS)	Calculation		0.24	173598871578	0.43	0 - 0.3	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due < 6: water may form scale on surfaces; > 7: water may corrode surfaces			
Ryznar Index (indicative, not SANS)	Calculation		8.43	39.29	12.19	6 - 7				
Anion Sum			4.66	69.18	0.53					
Cation Sum			4.69	71.59	0.52					
Difference			0.03	2.41	-0.01					
% Difference			0.28%	1.71%	-1.21%					

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.

Ion balance is not used as QC check where pH<3.5.

\*\* Methods Starting with YE are accredited, and based on ISO, SANS, and/or other national or international standards, please see <http://www.yanka.co.za/TestsAndStandards.htm> . For ranges, uncertainties, etc., please contact us.



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Job No: **E41647 - W19\_2941**  
 Report Reference: **ER\_GRA\_2019-09-11\_07940\_001**  
 Enquiries: **Rita Botha**  
 Date: **2019-09-11**  
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 Job Reference: **W19/2941 - Advice Note 1909W141**

Job Description: **8 x Routine Analysis**Project: **HG-L-2019-021 SAMPLES**

## TEST RESULTS FOR

## Gradient Consulting HG-L-2019-021 - 11 September 2019

This report contains results pertaining only to the water/dust samples analysed.

For Standards referenced, and methods base, please see

<http://www.yanka.co.za/TestsAndStandards.htm>

Please contact us if you have any queries concerning the information contained herein. Thank you for your support.

*Electronically approved*

**RITA BOTHA (Technical Signatory)**  
**ENVIRONMENTAL SERVICES**

SANAS Certificate obtainable from the address below

<http://www.sanas.co.za/schedules/testing/T0647-10-2015.pdf>

*Results not marked with a Test Method YE####\*, as well as results marked "Subcontracted" or "Outsourced", in this report, are not included in the SANAS Schedule of Accreditation for this laboratory. However, outsourced results may be within the Schedule of Accreditation of the source laboratory.*

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### **ANALYSTS**

Marné, Magda, Venna, Drieka, Sue, Rosemary, Vida, Elize, Charnelle, Petricia



## YANKA LABORATORIES

### CHEMISTRY TEST RESULTS

Domestic Water  
Class II is for information  
SANS 241:2015 / 20

LABORATORY NUMBER	SpGrad 1	SpGrad 2	SpGrad 3	SpGrad 4	SpGrad 5	SpGrad 6	SpGrad 7	SpGrad 8	SANS 241:2015 STANDARD LIMIT [Comparison] [Threshold] [2011/other]		
SAMPLE DESCRIPTION	ASW - 01	AHBH - 01	AHBH - 02	AHBH - 03	AHBH - 04	AHBH - 05	AHBH - 06	AHBH - 07			
SAMPLE NUMBER	E41647-001	E41647-002	E41647-003	E41647-004	E41647-005	E41647-006	E41647-007	E41647-008			
SAMPLED	Test Method **	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00	2019/09/04 00:00	2019/09/04 00:00	2019/09/04 00:00		
Remarks	Clear	Clear	Clear	Clear	Brownish	Clear	Clear	Rusty			
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	55.6	141	91.8	18.0	7.60	5.80	20.6	
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	55.6	141	91.8	18.0	7.60	5.80	20.6	
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	55.6	141	91.8	18.0	7.60	5.80	20.6	
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Conductivity (Laboratory)	mS/m	YE020CON	239	12.8	47.8	21.4	22.1	10.9	6.46	10.4	< 170
pH ( Laboratory)		YE030pH	3.90	7.16	7.57	7.44	5.71	5.68	5.45	5.90	5.0 - 9.7
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	1500	36.7	119	74.0	48.8	24.8	14.7	17.9	
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	1039	17.8	71.7	50.2	31.0	14.4	9.26	8.96	
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	461	18.9	47.8	23.8	17.8	10.4	5.39	8.98	
Total Dissolved Solids (TDS)	mg/L	Calculation	2151	63.0	248	109	138	58.9	34.6	48.9	< 1200
Temperature	°C	Thermometer	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	
Ammonia and Ammonium	mg N/L	YE070AK	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	< 1.5
Calcium	mg Ca/L	YE060ICP	416	7.13	28.7	20.1	12.4	5.77	3.71	3.59	< 150
Chloride	mg Cl/L	YE070AK	38.7	3.60	59.9	6.90	20.9	8.09	3.09	10.6	< 300
Magnesium	mg Mg/L	YE060ICP	112	4.59	11.6	5.77	4.33	2.53	1.31	2.18	< 70
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35	<0.35	<0.35	0.40	13.9	5.65	3.80	1.59	< 12
Ortho Phosphate	mg P/L	YE070AK	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.05	< 5
Potassium	mg K/L	YE060ICP	12.1	1.08	2.52	4.63	5.81	6.61	2.49	1.76	< 50
Sodium	mg Na/L	YE060ICP	28.0	10.4	51.6	10.6	19.9	3.83	2.92	9.93	< 200
Silicon	mg Si/L	YE060ICP	8.22	10.7	5.27	5.98	5.36	5.85	4.47	2.82	
Sulphate	mg SO <sub>4</sub> /L	YE070AK	1529	2.49	7.63	2.78	1.85	2.43	0.68	1.16	< 500
Aluminium	mg Al/L	YE060ICP	6.60	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.3
Fluoride	mg F/L	YE070AK	<0.09	0.21	1.91	1.03	0.09	<0.09	0.10	<0.09	< 1.5
Iron	mg Fe/L	YE060ICP	0.09	0.13	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	< 2
Manganese	mg Mn/L	YE060ICP	8.14	<0.01	<0.01	<0.01	0.09	0.01	0.01	0.14	< 0.4
Langelier Index (indicative, not SANS)	Calculation		-17.85	-1.69	-0.34	-0.77	-3.41	-4.11	-4.62	-3.66	-0.5 - 0.5
pHs (indicative, not SANS)	Calculation		21.75	8.85	7.91	8.21	9.12	9.79	10.07	9.56	
Sodium Absorption Ratio (indicative)	Calculation		0.31	0.74	2.05	0.53	1.24	0.33	0.33	1.02	< 1.5
TDS to EC Ratio (indicative, not SANS)	Calculation		9.00	4.94	5.20	5.08	6.24	5.40	5.36	4.71	
Corrosion Ratio (indicative, not SANS)	Calculation		90571696164	0.21	1.23	0.23	3.33	3.17	1.56	1.48	0 - 0.3
Ryznar Index (indicative, not SANS)	Calculation		39.60	10.53	8.24	8.97	12.54	13.89	14.69	13.22	6 - 7
Anion Sum			32.96	1.28	4.79	2.17	2.00	0.84	0.50	0.86	
Cation Sum			32.70	1.23	4.71	2.07	2.00	0.84	0.49	0.84	
Difference			-0.27	-0.05	-0.08	-0.11	0.00	0.00	-0.01	-0.02	
% Difference			-0.40%	-2.02%	-0.85%	-2.52%	0.09%	-0.11%	-0.96%	-0.89%	

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.

Ion balance is not used as QC check where pH<3.5.

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 <b>YANKA LABORATORIES</b> Domestic Water. <b>CHEMISTRY TEST RESULTS</b> for information only SANS 241:2015 / 2011 / 2006			Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT
LABORATORY NUMBER	SAMPLE DESCRIPTION					
SAMPLE NUMBER						
SAMPLED		Test Method **				
Remarks						
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk				
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk				
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk				
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk				
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk				
Conductivity (Laboratory)	mS/m	YE020CON	150 - 370	7 years	* < 70	* < 50
pH ( Laboratory)		YE030pH	4.0 - 10.0	No limit	5.5-9.5	5.5-7.5
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H				
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H				
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H				
Total Dissolved Solids (TDS)	mg/L	Calculation	1000-2400	7 years		
Temperature	°C	Thermometer				
Ammonia and Ammonium	mg N/L	YE070AK			< 6	< 2
Calcium	mg Ca/L	YE060ICP	150 - 300	7 years		
Chloride	mg Cl/L	YE070AK	200 - 600	7 years		
Magnesium	mg Mg/L	YE060ICP	70 - 100	7 years		
Nitrate and Nitrite (TON)	mg N/L	YE070AK	10 - 20	7 years	< 15	< 1.5
Ortho Phosphate	mg P/L	YE070AK			< 10	< 1
Potassium	mg K/L	YE060ICP	50 - 100	7 years		
Sodium	mg Na/L	YE060ICP	200 - 400	7 years		
Silicon	mg Si/L	YE060ICP				
Sulphate	mg SO <sub>4</sub> /L	YE070AK	400 - 600	7 years		
Aluminium	mg Al/L	YE060ICP	0.3 - 0.5	1 year		
Fluoride	mg F/L	YE070AK	1.0 - 1.5	1 year	<1.0	<1.0
Iron	mg Fe/L	YE060ICP	0.2 - 2.0	7 years	<0.3	<0.3
Manganese	mg Mn/L	YE060ICP	0.1 - 1.0	7 years	< 0.1	< 0.1
Langelier Index (indicative, not SANS)		Calculation	negative: water may corrode surfaces; positive: water may form scale on			
pHs (indicative, not SANS)		Calculation	Saturation pH (used in calculations)			
Sodium Absorption Ratio (indicative)		Calculation	Relevant in irrigation and water/plant/soil			
TDS to EC Ratio (indicative, not SANS)		Calculation	Analytical indicator			
Corrosion Ratio (indicative, not SANS)		Calculation	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due			
Ryznar Index (indicative, not SANS)		Calculation	< 6: water may form scale on surfaces; > 7: water may corrode surfaces			
Anion Sum						
Cation Sum						
Difference						
% Difference						

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# YANKA LABORATORIES

## CHEMISTRY TEST RESULTS


LABORATORY NUMBER			SpGrad 1	SpGrad 2	SpGrad 3	SpGrad 4	SpGrad 5	SpGrad 6	SpGrad 7	SpGrad 8	SpGrad 9
SAMPLE DESCRIPTION			ELN - BH 01	ELN - BH 03	ELN - BH 07	ECBH - 02	ECBH - 03	ECBH - 04	ECBH - 05	New - BH 01	New - BH 02
SAMPLE NUMBER			E41648-001	E41648-002	E41648-003	E41648-004	E41648-005	E41648-006	E41648-007	E41648-008	E41648-009
SAMPLED		Test Method **	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00	2019/09/03 00:00
Remarks			Clear	Clear	Clear	Rusty	Brownish	Clear	Clear	Rusty	Clear
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	38.0	0.00	3.20	19.8	90.2	2.60	2.80	0.00	11.2
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	38.0	0.00	3.20	19.8	90.2	2.60	2.80	0.00	11.2
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	38.0	0.00	3.20	19.8	90.2	2.60	2.80	0.00	11.2
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conductivity (Laboratory)	mS/m	YE020CON	12.1	254	5.56	52.2	218	80.0	18.0	169	14.7
pH ( Laboratory)		YE030pH	6.49	2.90	5.17	6.50	5.98	4.83	5.06	3.07	6.39
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	37.0	899	17.6	175	1469	359	70.4	529	48.5
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	21.8	609	12.8	140	1186	215	52.2	383	41.8
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	15.2	290	4.78	34.7	283	144	18.2	146	6.70
Total Dissolved Solids (TDS)	mg/L	Calculation	59.7	1833	34.0	333	2092	525	106	1024	76.5
Temperature	°C	Thermometer	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
Ammonia and Ammonium	mg N/L	YE070AK	<0.45	3.05	<0.45	4.44	0.82	<0.45	<0.45	0.63	<0.45
Calcium	mg Ca/L	YE060ICP	8.73	244	5.12	56.1	475	86.1	20.9	154	16.8
Chloride	mg Cl/L	YE070AK	2.97	4.49	2.24	14.1	5.83	8.85	1.10	1.16	1.55
Magnesium	mg Mg/L	YE060ICP	3.69	70.5	1.16	8.43	68.8	35.0	4.42	35.5	1.63
Nitrate and Nitrite (TON)	mg N/L	YE070AK	1.51	<0.35	3.93	<0.35	0.46	0.66	1.44	<0.35	<0.35
Ortho Phosphate	mg P/L	YE070AK	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Potassium	mg K/L	YE060ICP	5.52	9.74	1.36	10.5	9.96	5.07	1.34	4.18	2.45
Sodium	mg Na/L	YE060ICP	3.17	17.1	1.58	20.0	11.3	8.92	1.50	6.06	5.30
Silicon	mg Si/L	YE060ICP	5.48	19.9	3.11	<0.1	3.20	7.57	4.12	13.6	0.40
Sulphate	mg SO <sub>4</sub> /L	YE070AK	5.95	1307	3.05	205	1461	372	68.1	734	38.9
Aluminium	mg Al/L	YE060ICP	0.01	31.2	0.01	0.02	<0.01	1.07	0.05	20.1	0.14
Fluoride	mg F/L	YE070AK	0.18	32.2	0.11	1.47	0.52	0.51	0.09	12.3	2.91
Iron	mg Fe/L	YE060ICP	0.02	105	<0.01	<0.01	1.54	1.16	<0.01	43.4	0.06
Manganese	mg Mn/L	YE060ICP	<0.01	8.11	0.02	0.07	0.37	2.02	0.06	13.0	0.09
Langelier Index (indicative, not SANS)	Calculation		-2.43	-19.08	-5.01	-1.97	-0.99	-4.34	-4.62	-19.08	-2.78
pHs (indicative, not SANS)	Calculation		8.92	21.98	10.18	8.47	6.97	9.17	9.68	22.15	9.17
Sodium Absorption Ratio (indicative)	Calculation		0.23	0.25	0.16	0.66	0.13	0.20	0.08	0.11	0.33
TDS to EC Ratio (indicative, not SANS)	Calculation		4.94	7.22	6.11	6.39	9.59	6.56	5.87	6.06	5.20
Corrosion Ratio (indicative, not SANS)	Calculation		0.30	69339208989	2.47	7.40	8.61	84.02	13.77	38557120012	2.20
Ryznar Index (indicative, not SANS)	Calculation		11.35	41.05	15.20	10.43	7.96	13.51	14.30	41.23	11.95
Anion Sum			1.09	29.05	0.48	5.15	32.47	8.12	1.61	15.97	1.23
Cation Sum			1.03	28.68	0.46	4.97	30.38	7.99	1.52	16.09	1.29
Difference			-0.06	-0.37	-0.02	-0.18	-2.08	-0.13	-0.09	0.12	0.06
% Difference			-2.87%	-0.64%	-2.11%	-1.75%	-3.31%	-0.80%	-2.97%	0.36%	2.23%

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 <b>YANKA LABORATORIES</b> <b>CHEMISTRY TEST RESULTS</b>			Domestic Water. Class II is for information only		SANS 241:2015 / 2011 / 2006			
			SpGrad 10	SpGrad 11	SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT
LABORATORY NUMBER			SpGrad 10	SpGrad 11				
SAMPLE DESCRIPTION			ASW - 02	FFBH - 11				
SAMPLE NUMBER			E41648-010	E41648-011				
SAMPLED		Test Method **	2019/09/03 00:00	2019/09/04 00:00				
Remarks			Brownish	Brown				
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010AIK	0.00	38.2				
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010AIK	0.00	38.2				
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010AIK	0.00	0.00				
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010AIK	0.00	38.2				
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010AIK	0.00	0.00				
Conductivity (Laboratory)	mS/m	YE020CON	91.4	119	< 170	150 - 370	7 years	* < 70 * < 50
pH ( Laboratory)		YE030pH	3.25	7.09	5.0 - 9.7	4.0 - 10.0	No limit	5.5-9.5 5.5-7.5
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	328	152				
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	223	116				
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	105	35.8				
Total Dissolved Solids (TDS)	mg/L	Calculation	488	742	< 1200	1000-2400	7 years	
Temperature	°C	Thermometer	21.0	21.0				
Ammonia and Ammonium	mg N/L	YE070AK	<0.45	0.62	< 1.5			< 6 < 2
Calcium	mg Ca/L	YE060ICP	89.2	46.6	< 150	150 - 300	7 years	
Chloride	mg Cl/L	YE070AK	5.42	96.3	< 300	200 - 600	7 years	
Magnesium	mg Mg/L	YE060ICP	25.5	8.70	< 70	70 - 100	7 years	
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35	<0.35	< 12	10 - 20	7 years	< 15 <1.5
Ortho Phosphate	mg P/L	YE070AK	<0.03	<0.03	< 5			< 10 < 1
Potassium	mg K/L	YE060ICP	3.21	54.1	< 50	50 - 100	7 years	
Sodium	mg Na/L	YE060ICP	8.13	150	< 200	200 - 400	7 years	
Silicon	mg Si/L	YE060ICP	3.83	<0.1				
Sulphate	mg SO <sub>4</sub> /L	YE070AK	349	362	< 500	400 - 600	7 years	
Aluminium	mg Al/L	YE060ICP	1.52	<0.01	< 0.3	0.3 - 0.5	1 year	
Fluoride	mg F/L	YE070AK	0.58	<0.09	< 1.5	1.0 - 1.5	1 year	<1.0 <1.0
Iron	mg Fe/L	YE060ICP	0.80	<0.01	< 2	0.2 - 2.0	7 years	<0.3 <0.3
Manganese	mg Mn/L	YE060ICP	4.52	0.15	< 0.4	0.1 - 1.0	7 years	< 0.1 < 0.1
Langelier Index (indicative, not SANS)	Calculation		-19.11	-1.21	-0.5 - 0.5	negative: water may corrode surfaces; positive: water may form scale on		
pHs (indicative, not SANS)	Calculation		22.36	8.30		Saturation pH (used in calculations)		
Sodium Absorption Ratio (indicative)	Calculation		0.19	5.28	< 1.5	Relevant in irrigation and water/plant/soil		
TDS to EC Ratio (indicative, not SANS)	Calculation		5.34	6.23		Analytical indicator		
Corrosion Ratio (indicative, not SANS)	Calculation		19710891509	12.04	0 - 0.3	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due < 6: water may form scale on surfaces; > 7: water may corrode surfaces		
Ryznar Index (indicative, not SANS)	Calculation		41.46	9.51	6 - 7			
Anion Sum			7.46	11.06				
Cation Sum			7.40	11.01				
Difference			-0.06	-0.04				
% Difference			-0.40%	-0.20%				

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# YANKA LABORATORIES

## CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpGeo 1	SpGeo 2	SpGeo 3	SpGeo 4	SpGeo 5	SpGeo 6	SpGeo 7	SpGeo 8	SpGeo 9
SAMPLE DESCRIPTION			TCM - SW 01	TCM - SW 02	TCM - SW 03	TCM - PCD 01	WOP	ELAN	SW - 01	Decant	Farm Dam
SAMPLE NUMBER			E41631-001	E41631-002	E41631-003	E41631-004	E41631-005	E41631-006	E41631-007	E41631-008	E41631-009
SAMPLED		Test Method **	2019/09/03 13:05	2019/09/03 13:40	2019/09/03 13:30	2019/09/03 11:00	2019/09/03 11:00	2019/09/03 10:50	2019/09/03 15:30	2019/09/03 15:20	2019/09/03 14:15
Remarks			Clear	Clear	Clear	Clear	Clear	No Acces	Clear	Clear	Clear
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	2.60	15.2	0.00	0.00	0.00		5.20	13.8	12.2
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	2.60	15.2	0.00	0.00	0.00		5.20	13.8	12.2
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	2.60	15.2	0.00	0.00	0.00		5.20	13.8	12.2
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Conductivity (Laboratory)	mS/m	YE020CON	226	30.8	121	674	293		314	319	332
pH ( Laboratory)		YE030pH	4.74	6.31	3.45	2.43	3.33		5.58	6.00	6.36
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	1437	120	549	2145	1953		2064	2008	2285
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	996	64.9	365	1320	1343		1365	1311	1517
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	441	54.8	184	825	609		699	696	768
Total Dissolved Solids (TDS)	mg/L	Calculation	2073	172	774	7026	2953		3047	3135	3379
Suspended Solids (TSS)	mg/L	YE081TSS	10.0	2.40	1.20	20.4	14.0		7.60	44.0	2.80
Temperature	°C	Thermometer	21.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Turbidity	NTU	YE082TB	6.20	2.09	2.08	8.11	33.4		1.88	124	1.54
Oxygen Dissolved (DO)	mg O <sub>2</sub> /L	YE051OD	6.58	6.39	6.81	6.11	6.91		6.35	6.55	6.12
Ammonia and Ammonium	mg N/L	YE070AK	<0.45	<0.45	<0.45	4.09	1.74		1.33	5.50	<0.45
Calcium	mg Ca/L	YE060ICP	399	26.0	146	529	538		547	525	608
Chloride	mg Cl/L	YE070AK	44.7	6.43	5.04	3.17	34.4		85.6	62.4	95.2
Magnesium	mg Mg/L	YE060ICP	107	13.3	44.7	200	148		170	169	187
Nitrate and Nitrite (TON)	mg N/L	YE070AK	0.40	<0.35	<0.35	<0.35	0.45		2.12	<0.35	0.64
Potassium	mg K/L	YE060ICP	13.3	1.21	8.23	3.72	18.5		32.7	25.3	36.7
Sodium	mg Na/L	YE060ICP	43.4	6.78	7.11	28.7	41.9		115	70.8	137
Silicon	mg Si/L	YE060ICP	6.70	2.06	5.93	67.1	6.04		3.42	6.07	0.72
Sulphate	mg SO <sub>4</sub> /L	YE070AK	1448	108	554	5231	2122		2070	2223	2301
Aluminium	mg Al/L	YE060ICP	3.02	0.01	4.40	403	17.1		<0.01	<0.01	0.02
Fluoride	mg F/L	YE070AK	1.05	0.15	2.75	117	0.12		<0.09	2.93	<0.09
Iron	mg Fe/L	YE060ICP	0.13	0.15	1.69	437	13.7		0.52	29.8	0.10
Manganese	mg Mn/L	YE060ICP	9.75	0.87	<0.01	68.3	14.5		12.6	11.2	5.13
Langelier Index (indicative, not SANS)	Calculation		-3.82	-2.57	-18.71	-19.27	-18.32		-2.57	-1.75	-1.38
pHs (indicative, not SANS)	Calculation		8.56	8.88	22.16	21.70	21.65		8.15	7.75	7.74
Sodium Absorption Ratio (indicative)	Calculation		0.50	0.27	0.13	0.27	0.41		1.10	0.69	1.24
TDS to EC Ratio (indicative, not SANS)	Calculation		9.17	5.59	6.40	10.42	10.08		9.70	9.83	10.18
Corrosion Ratio (indicative, not SANS)	Calculation		338.36	4.89	30282866993	273394029432	120257845218		253.63	96.60	120.18
Ryznar Index (indicative, not SANS)	Calculation		12.39	11.46	40.87	40.97	39.98		10.72	9.50	9.12
Anion Sum			31.58	2.75	11.83	115.23	45.23		45.83	48.53	50.95
Cation Sum			31.79	2.77	12.13	115.56	44.82		47.90	46.48	53.01
Difference			0.21	0.03	0.29	0.33	-0.41		2.07	-2.05	2.07
% Difference			0.34%	0.53%	1.23%	0.15%	-0.45%		2.21%	-2.16%	1.99%

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.

Ion balance is not used as QC check where pH<3.5.

\*\* Methods Starting with YE are accredited, and based on ISO, SANS, and/or other national or international standards, please see <http://www.yanka.co.za/TestsAndStandards.htm> . For ranges, uncertainties, etc., please contact us.

 <b>YANKA LABORATORIES</b> <b>CHEMISTRY TEST RESULTS</b>			Domestic Water. Class II is for information only		SANS 241:2015 / 2011 / 2006			
			SpGeo 10	SpGeo 11	SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT
LABORATORY NUMBER			SpGeo 10	SpGeo 11				
SAMPLE DESCRIPTION			GSH - L 02	GSH - L 03				
SAMPLE NUMBER			E41631-010	E41631-011				
SAMPLED		Test Method **	2019/09/03 11:15	2019/09/03 11:15				
Remarks			No Access to Game Farm	No Access to Game Farm				
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Aik						
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Aik						
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Aik						
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Aik						
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Aik						
Conductivity (Laboratory)	mS/m	YE020CON			< 170	150 - 370	7 years	* < 70 * < 50
pH ( Laboratory)		YE030pH			5.0 - 9.7	4.0 - 10.0	No limit	5.5-9.5 5.5-7.5
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H						
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H						
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H						
Total Dissolved Solids (TDS)	mg/L	Calculation			< 1200	1000-2400	7 years	
Suspended Solids (TSS)	mg/L	YE081TSS						< 25 < 10
Temperature	°C	Thermometer						
Turbidity	NTU	YE082TB			< 1	1 - 5	No limit	
Oxygen Dissolved (DO)	mg O <sub>2</sub> /L	YE051OD						
Ammonia and Ammonium	mg NL	YE070AK			< 1.5			< 6 < 2
Calcium	mg Ca/L	YE060ICP			< 150	150 - 300	7 years	
Chloride	mg Cl/L	YE070AK			< 300	200 - 600	7 years	
Magnesium	mg Mg/L	YE060ICP			< 70	70 - 100	7 years	
Nitrate and Nitrite (TON)	mg NL	YE070AK			< 12	10 - 20	7 years	< 15 < 1.5
Potassium	mg KL	YE060ICP			< 50	50 - 100	7 years	
Sodium	mg Na/L	YE060ICP			< 200	200 - 400	7 years	
Silicon	mg Si/L	YE060ICP						
Sulphate	mg SO <sub>4</sub> /L	YE070AK			< 500	400 - 600	7 years	
Aluminium	mg Al/L	YE060ICP			< 0.3	0.3 - 0.5	1 year	
Fluoride	mg F/L	YE070AK			< 1.5	1.0 - 1.5	1 year	<1.0 <1.0
Iron	mg Fe/L	YE060ICP			< 2	0.2 - 2.0	7 years	<0.3 <0.3
Manganese	mg Mn/L	YE060ICP			< 0.4	0.1 - 1.0	7 years	< 0.1 < 0.1
Langelier Index (indicative, not SANS)	Calculation				-0.5 - 0.5	negative: water may corrode surfaces; positive: water may form scale on		
pHs (indicative, not SANS)	Calculation					Saturation pH (used in calculations)		
Sodium Absorption Ratio (indicative)	Calculation				< 1.5	Relevant in irrigation and water/plant/soil		
TDS to EC Ratio (indicative, not SANS)	Calculation					Analytical indicator		
Corrosion Ratio (indicative, not SANS)	Calculation				0 - 0.3	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due < 6: water may form scale on surfaces; > 7: water may corrode surfaces		
Ryznar Index (indicative, not SANS)	Calculation				6 - 7			
Anion Sum								
Cation Sum								
Difference								
% Difference								

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Job No: **E41631 - W19\_2926**  
 Report Reference: **ER\_GEO\_2019-09-11\_07922\_001**

Enquiries: **Rita Botha**Date: **2019-09-11****RitaB@yanka.co.za**Job Reference: **W19/2926 - Advice Note 1909W126**Job Description: **8 x Routine Analysis**Project: **ELANDSFONTEIN SURFACE SAMPLES**

## TEST RESULTS FOR

## Geo Soil Elandsfontein Surface - 10 September 2019

This report contains results pertaining only to the water/dust samples analysed.

For Standards referenced, and methods base, please see

<http://www.yanka.co.za/TestsAndStandards.htm>

Please contact us if you have any queries concerning the information contained herein. Thank you for your support.

*Electronically approved*

**RITA BOTHA (Technical Signatory)**  
**ENVIRONMENTAL SERVICES**

SANAS Certificate obtainable from the address below

<http://www.sanas.co.za/schedules/testing/T0647-10-2015.pdf>

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# YANKA LABORATORIES

## CHEMISTRY TEST RESULTS


LABORATORY NUMBER			SpGeo 1	SpGeo 2	SpGeo 3	SpGeo 4	SpGeo 5	SpGeo 6	SpGeo 7	SpGeo 8	SpGeo 9
SAMPLE DESCRIPTION			TCM - SW 01	TCM - SW 02	TCM - SW 03	TCM - PCD 01	WOP	ELAN	SW - 01	Decant	Farm Dam
SAMPLE NUMBER			E41631-001	E41631-002	E41631-003	E41631-004	E41631-005	E41631-006	E41631-007	E41631-008	E41631-009
SAMPLED		Test Method **	2019/09/03 13:05	2019/09/03 13:40	2019/09/03 13:30	2019/09/03 11:00	2019/09/03 11:00	2019/09/03 10:50	2019/09/03 15:30	2019/09/03 15:20	2019/09/03 14:15
Remarks			Clear	Clear	Clear	Clear	Clear	No Acces	Clear	Clear	Clear
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	2.60	15.2	0.00	0.00	0.00		5.20	13.8	12.2
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	2.60	15.2	0.00	0.00	0.00		5.20	13.8	12.2
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	2.60	15.2	0.00	0.00	0.00		5.20	13.8	12.2
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
Conductivity (Laboratory)	mS/m	YE020CON	226	30.8	121	674	293		314	319	332
pH ( Laboratory)		YE030pH	4.74	6.31	3.45	2.43	3.33		5.58	6.00	6.36
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	1437	120	549	2145	1953		2064	2008	2285
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	996	64.9	365	1320	1343		1365	1311	1517
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	441	54.8	184	825	609		699	696	768
Total Dissolved Solids (TDS)	mg/L	Calculation	2073	172	774	7026	2953		3047	3135	3379
Suspended Solids (TSS)	mg/L	YE081TSS	10.0	2.40	1.20	20.4	14.0		7.60	44.0	2.80
Temperature	°C	Thermometer	21.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Turbidity	NTU	YE082TB	6.20	2.09	2.08	8.11	33.4		1.88	124	1.54
Oxygen Dissolved (DO)	mg O <sub>2</sub> /L	YE051OD	6.58	6.39	6.81	6.11	6.91		6.35	6.55	6.12
Ammonia and Ammonium	mg N/L	YE070AK	<0.45	<0.45	<0.45	4.09	1.74		1.33	5.50	<0.45
Calcium	mg Ca/L	YE060ICP	399	26.0	146	529	538		547	525	608
Chloride	mg Cl/L	YE070AK	44.7	6.43	5.04	3.17	34.4		85.6	62.4	95.2
Magnesium	mg Mg/L	YE060ICP	107	13.3	44.7	200	148		170	169	187
Nitrate and Nitrite (TON)	mg N/L	YE070AK	0.40	<0.35	<0.35	<0.35	0.45		2.12	<0.35	0.64
Potassium	mg K/L	YE060ICP	13.3	1.21	8.23	3.72	18.5		32.7	25.3	36.7
Sodium	mg Na/L	YE060ICP	43.4	6.78	7.11	28.7	41.9		115	70.8	137
Silicon	mg Si/L	YE060ICP	6.70	2.06	5.93	67.1	6.04		3.42	6.07	0.72
Sulphate	mg SO <sub>4</sub> /L	YE070AK	1448	108	554	5231	2122		2070	2223	2301
Aluminium	mg Al/L	YE060ICP	3.02	0.01	4.40	403	17.1		<0.01	<0.01	0.02
Fluoride	mg F/L	YE070AK	1.05	0.15	2.75	117	0.12		<0.09	2.93	<0.09
Iron	mg Fe/L	YE060ICP	0.13	0.15	1.69	437	13.7		0.52	29.8	0.10
Manganese	mg Mn/L	YE060ICP	9.75	0.87	<0.01	68.3	14.5		12.6	11.2	5.13
Langelier Index (indicative, not SANS)	Calculation		-3.82	-2.57	-18.71	-19.27	-18.32		-2.57	-1.75	-1.38
pHs (indicative, not SANS)	Calculation		8.56	8.88	22.16	21.70	21.65		8.15	7.75	7.74
Sodium Absorption Ratio (indicative)	Calculation		0.50	0.27	0.13	0.27	0.41		1.10	0.69	1.24
TDS to EC Ratio (indicative, not SANS)	Calculation		9.17	5.59	6.40	10.42	10.08		9.70	9.83	10.18
Corrosion Ratio (indicative, not SANS)	Calculation		338.36	4.89	30282866993	273394029432	120257845218		253.63	96.60	120.18
Ryznar Index (indicative, not SANS)	Calculation		12.39	11.46	40.87	40.97	39.98		10.72	9.50	9.12
Anion Sum			31.58	2.75	11.83	115.23	45.23		45.83	48.53	50.95
Cation Sum			31.79	2.77	12.13	115.56	44.82		47.90	46.48	53.01
Difference			0.21	0.03	0.29	0.33	-0.41		2.07	-2.05	2.07
% Difference			0.34%	0.53%	1.23%	0.15%	-0.45%		2.21%	-2.16%	1.99%

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 <b>YANKA LABORATORIES</b> <b>CHEMISTRY TEST RESULTS</b>			Domestic Water. Class II is for information only		SANS 241:2015 / 2011 / 2006			
			SpGeo 10	SpGeo 11	SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT
LABORATORY NUMBER			SpGeo 10	SpGeo 11				
SAMPLE DESCRIPTION			GSH - L 02	GSH - L 03				
SAMPLE NUMBER			E41631-010	E41631-011				
SAMPLED		Test Method **	2019/09/03 11:15	2019/09/03 11:15				
Remarks			No Access to Game Farm	No Access to Game Farm				
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Aik						
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Aik						
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Aik						
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Aik						
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Aik						
Conductivity (Laboratory)	mS/m	YE020CON			< 170	150 - 370	7 years	* < 70 * < 50
pH ( Laboratory)		YE030pH			5.0 - 9.7	4.0 - 10.0	No limit	5.5-9.5 5.5-7.5
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H						
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H						
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H						
Total Dissolved Solids (TDS)	mg/L	Calculation			< 1200	1000-2400	7 years	
Suspended Solids (TSS)	mg/L	YE081TSS						< 25 < 10
Temperature	°C	Thermometer						
Turbidity	NTU	YE082TB			< 1	1 - 5	No limit	
Oxygen Dissolved (DO)	mg O <sub>2</sub> /L	YE051OD						
Ammonia and Ammonium	mg NL	YE070AK			< 1.5			< 6 < 2
Calcium	mg Ca/L	YE060ICP			< 150	150 - 300	7 years	
Chloride	mg Cl/L	YE070AK			< 300	200 - 600	7 years	
Magnesium	mg Mg/L	YE060ICP			< 70	70 - 100	7 years	
Nitrate and Nitrite (TON)	mg NL	YE070AK			< 12	10 - 20	7 years	< 15 < 1.5
Potassium	mg KL	YE060ICP			< 50	50 - 100	7 years	
Sodium	mg Na/L	YE060ICP			< 200	200 - 400	7 years	
Silicon	mg Si/L	YE060ICP						
Sulphate	mg SO <sub>4</sub> /L	YE070AK			< 500	400 - 600	7 years	
Aluminium	mg Al/L	YE060ICP			< 0.3	0.3 - 0.5	1 year	
Fluoride	mg F/L	YE070AK			< 1.5	1.0 - 1.5	1 year	<1.0 <1.0
Iron	mg Fe/L	YE060ICP			< 2	0.2 - 2.0	7 years	<0.3 <0.3
Manganese	mg Mn/L	YE060ICP			< 0.4	0.1 - 1.0	7 years	< 0.1 < 0.1
Langelier Index (indicative, not SANS)	Calculation				-0.5 - 0.5	negative: water may corrode surfaces; positive: water may form scale on		
pHs (indicative, not SANS)	Calculation					Saturation pH (used in calculations)		
Sodium Absorption Ratio (indicative)	Calculation				< 1.5	Relevant in irrigation and water/plant/soil		
TDS to EC Ratio (indicative, not SANS)	Calculation					Analytical indicator		
Corrosion Ratio (indicative, not SANS)	Calculation				0 - 0.3	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due < 6: water may form scale on surfaces; > 7: water may corrode surfaces		
Ryznar Index (indicative, not SANS)	Calculation				6 - 7			
Anion Sum								
Cation Sum								
Difference								
% Difference								

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Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.

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 <b>YANKA LABORATORIES</b> <b>CHEMISTRY TEST RESULTS</b>			Domestic Water. Class II is for information only			SANS 241:2015 / 2011 / 2006				
			LABORATORY NUMBER	SpGeo 1	SpGeo 2	SpGeo 3	SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT
SAMPLE DESCRIPTION	GW - 01	GW - 05	Eland - BH 10							
SAMPLE NUMBER		E41632-001	E41632-002	E41632-003						
SAMPLED	Test Method **	2019/09/03 15:50	2019/09/03 10:45	2019/09/03 16:15						
REMARKS		Clear	Clear	Clear						
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	168	0.00	21.0					
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	150	0.00	21.0					
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	18.0	0.00	0.00					
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	159	0.00	21.0					
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	9.00	0.00	0.00					
Conductivity (Laboratory)	mS/m	YE020CON	54.1	401	6.00	< 170	150 - 370	7 years	* < 70	* < 50
pH ( Laboratory)		YE030pH	8.37	4.31	6.94	5.0 - 9.7	4.0 - 10.0	No limit	5.5-9.5	5.5-7.5
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	76.9	1310	16.8					
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	19.3	1008	8.12					
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	57.5	302	8.65					
Total Dissolved Solids (TDS)	mg/L	Calculation	258	4559	27.4	< 1200	1000-2400	7 years		
Temperature	°C	Thermometer	21.0	21.0	21.0					
Calcium	mg Ca/L	YE060ICP	7.74	404	3.25	< 150	150 - 300	7 years		
Chloride	mg Cl/L	YE070AK	3.90	3.39	3.13	< 300	200 - 600	7 years		
Magnesium	mg Mg/L	YE060ICP	14.0	73.3	2.10	< 70	70 - 100	7 years		
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35	<0.35	<0.35	< 12	10 - 20	7 years	< 15	<1.5
Potassium	mg K/L	YE060ICP	5.06	7.55	3.29	< 50	50 - 100	7 years		
Sodium	mg Na/L	YE060ICP	69.1	10.5	2.13	< 200	200 - 400	7 years		
Silicon	mg Si/L	YE060ICP	0.33	3.91	0.34					
Sulphate	mg SO <sub>4</sub> /L	YE070AK	57.1	3314	0.49	< 500	400 - 600	7 years		
Aluminium	mg Al/L	YE060ICP	<0.01	97.3	<0.01	< 0.3	0.3 - 0.5	1 year		
Fluoride	mg F/L	YE070AK	<0.09	0.83	0.24	< 1.5	1.0 - 1.5	1 year	<1.0	<1.0
Iron	mg Fe/L	YE060ICP	0.04	590	0.02	< 2	0.2 - 2.0	7 years	<0.3	<0.3
Manganese	mg Mn/L	YE060ICP	0.02	58.7	0.11	< 0.4	0.1 - 1.0	7 years	< 0.1	< 0.1
Langelier Index (indicative, not SANS)	Calculation		-0.03	-17.49	-2.63	-0.5 - 0.5	negative: water may corrode surfaces; positive: water may form scale on			
pHs (indicative, not SANS)	Calculation		8.40	21.80	9.57		Saturation pH (used in calculations)			
Sodium Absorption Ratio (indicative)	Calculation		3.41	0.13	0.23	< 1.5	Relevant in irrigation and water/plant/soil			
TDS to EC Ratio (indicative, not SANS)	Calculation		4.76	11.37	4.56		Analytical indicator			
Corrosion Ratio (indicative, not SANS)	Calculation		0.24	173598871578	0.43	0 - 0.3	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due < 6: water may form scale on surfaces; > 7: water may corrode surfaces			
Ryznar Index (indicative, not SANS)	Calculation		8.43	39.29	12.19	6 - 7				
Anion Sum			4.66	69.18	0.53					
Cation Sum			4.69	71.59	0.52					
Difference			0.03	2.41	-0.01					
% Difference			0.28%	1.71%	-1.21%					

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.

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Job No: **E41979 - W19\_3272**  
 Report Reference: **ER\_GEO\_2019-10-08\_08271\_001**

Enquiries: **Rita Botha**Date: **2019/10/08****RitaB@yanka.co.za**Job Reference: **W19/3272 - Advice Note 1910W092**Job Description: **10 x Routine Analysis**Project: **ELANDSFONTEIN SURFACE SAMPLES**

## TEST RESULTS FOR

## Geo Soil and Water Elandsfontein Surface - 8 October 2019

This report contains results pertaining only to the water/dust samples analysed.

For Standards referenced, and methods base, please see

<http://www.yanka.co.za/TestsAndStandards.htm>

Please contact us if you have any queries concerning the information contained herein. Thank you for your support.

*Electronically approved*

**RITA BOTHA (Technical Signatory)**  
**ENVIRONMENTAL SERVICES**

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<http://www.sanas.co.za/schedules/testing/T0647-10-2015.pdf>

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### **ANALYSTS**

Marné, Magda, Venna, Drieka, Sue, Rosemary, Vida, Elize, Charnelle, Petricia



# YANKA LABORATORIES

## CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpGeo 1	SpGeo 2	SpGeo 3	SpGeo 4	SpGeo 5	SpGeo 6	SpGeo 7	SpGeo 8	SpGeo 9
SAMPLE DESCRIPTION			Farm Dam	SW - 01	TCM - PCD 01	TCM - PCD 03	TCM - SW 01	TCM - SW 02	TCM - SW 03	TCM - SW 04	TCM - SW 05
SAMPLE NUMBER			E41979-001	E41979-002	E41979-003	E41979-004	E41979-005	E41979-006	E41979-007	E41979-008	E41979-009
SAMPLED		Test Method **	2019/10/02 13:55	2019/10/02 14:00	2019/10/02 12:15	2019/10/02 14:10	2019/10/02 13:15	2019/10/02 12:55	2019/10/02 12:50	2019/10/02 13:30	2019/10/02 13:35
Remarks			Clear	Clear	Rusty	Rusty	Clear	Clear	Clear	Clear	Clear
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	16.6	7.60	0.00	3.60	2.20	17.6	0.00	0.00	5.40
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	16.6	7.60	0.00	3.60	2.20	17.6	0.00	0.00	5.40
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	16.6	7.60	0.00	3.60	2.20	17.6	0.00	0.00	5.40
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conductivity (Laboratory)	mS/m	YE020CON	356	325	752	326	233	35.3	121	121	354
pH ( Laboratory)		YE030pH	6.88	6.19	2.39	5.28	4.60	6.31	3.43	3.30	5.68
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	2330	2063	2484	1874	1507	145	545	519	2074
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	1541	1466	1541	1104	1021	79.9	365	360	1277
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	790	597	943	770	486	65.5	180	159	797
Total Dissolved Solids (TDS)	mg/L	Calculation	3534	3020	8001	2880	2176	219	798	802	3143
Suspended Solids (TSS)	mg/L	YE081TSS	1.20	<0.4	12.8	40.0	12.4	2.00	2.40	9.60	<0.4
Temperature	°C	Thermometer	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
Turbidity	NTU	YE082TB	2.47	1.04	11.1	159	13.0	4.18	2.34	1.92	1.33
Oxygen Dissolved (DO)	mg O <sub>2</sub> /L	YE051OD	6.71	6.58	6.22	6.31	6.82	6.94	6.75	6.54	6.63
Ammonia and Ammonium	mg N/L	YE070AK	<0.45	0.48	5.47	6.35	<0.45	<0.45	<0.45	<0.45	<0.45
Calcium	mg Ca/L	YE060ICP	617	587	617	442	409	32.0	146	144	511
Chloride	mg Cl/L	YE070AK	312	96.7	5.22	66.3	51.4	5.00	4.27	7.44	102
Magnesium	mg Mg/L	YE060ICP	192	145	229	187	118	15.9	43.8	38.7	194
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35	1.85	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	0.44
Ortho Phosphate	mg P/L	YE070AK	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.06	<0.03	<0.03
Potassium	mg K/L	YE060ICP	42.8	25.4	2.85	26.2	18.1	1.40	8.54	10.1	39.6
Sodium	mg Na/L	YE060ICP	129	96.0	17.4	61.3	48.9	7.11	6.09	9.06	128
Silicon	mg Si/L	YE060ICP	1.30	4.48	132	8.67	9.96	3.00	11.0	6.27	0.67
Sulphate	mg SO <sub>4</sub> /L	YE070AK	2224	2043	6014	2053	1501	145	581	572	2162
Aluminium	mg Al/L	YE060ICP	<0.01	<0.01	408	0.55	8.50	0.05	5.65	4.35	<0.01
Fluoride	mg F/L	YE070AK	<0.09	<0.09	115	0.80	0.73	0.12	1.49	1.38	<0.09
Iron	mg Fe/L	YE060ICP	0.10	0.20	500	19.8	0.84	0.25	1.07	3.78	0.05
Manganese	mg Mn/L	YE060ICP	5.97	13.0	75.1	12.2	16.7	1.59	<0.01	11.0	0.98
Langelier Index (indicative, not SANS)	Calculation		-0.73	-1.76	-19.25	-3.11	-4.03	-2.43	-18.73	-18.87	-2.48
pHs (indicative, not SANS)	Calculation		7.61	7.95	21.64	8.39	8.63	8.74	22.16	22.17	8.16
Sodium Absorption Ratio (indicative)	Calculation		1.16	0.92	0.15	0.61	0.55	0.26	0.11	0.17	1.22
TDS to EC Ratio (indicative, not SANS)	Calculation		9.93	9.29	10.64	8.83	9.34	6.20	6.60	6.63	8.88
Corrosion Ratio (indicative, not SANS)	Calculation		122.75	175.80	314766467002	348.73	421.13	5.09	31472024831	31898099025	261.67
Ryznar Index (indicative, not SANS)	Calculation		8.33	9.72	40.89	11.51	12.65	11.17	40.90	41.04	10.64
Anion Sum			55.60	45.62	131.67	44.78	32.84	3.52	12.31	12.20	48.10
Cation Sum			53.80	46.80	126.23	43.08	34.50	3.35	12.12	12.17	48.31
Difference			-1.80	1.17	-5.44	-1.71	1.66	-0.18	-0.19	-0.04	0.22
% Difference			-1.64%	1.27%	-2.11%	-1.94%	2.47%	-2.55%	-0.78%	-0.15%	0.23%


Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.

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 <b>YANKA LABORATORIES</b> <b>CHEMISTRY TEST RESULTS</b>				Domestic Water. Class II is for information only				
				SANS 241:2015 / 2011 / 2006				
LABORATORY NUMBER		SpGeo 10		SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT
SAMPLE DESCRIPTION		WOP						
SAMPLE NUMBER		E41979-010						
SAMPLED		Test Method **		2019/10/02 13:50				
Remarks		Clear						
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00					
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00					
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00					
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00					
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00					
Conductivity (Laboratory)	mS/m	YE020CON	293	< 170	150 - 370	7 years	* < 70	* < 50
pH ( Laboratory)		YE030pH	3.30	5.0 - 9.7	4.0 - 10.0	No limit	5.5-9.5	5.5-7.5
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	1988					
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	1416					
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	572					
Total Dissolved Solids (TDS)	mg/L	Calculation	2745	< 1200	1000-2400	7 years		
Suspended Solids (TSS)	mg/L	YE081TSS	14.0				< 25	< 10
Temperature	°C	Thermometer	21.0					
Turbidity	NTU	YE082TB	19.5	< 1	1 - 5	No limit		
Oxygen Dissolved (DO)	mg O <sub>2</sub> /L	YE051OD	6.61					
Ammonia and Ammonium	mg N/L	YE070AK	1.97	< 1.5			< 6	< 2
Calcium	mg Ca/L	YE060ICP	567	< 150	150 - 300	7 years		
Chloride	mg Cl/L	YE070AK	33.2	< 300	200 - 600	7 years		
Magnesium	mg Mg/L	YE060ICP	139	< 70	70 - 100	7 years		
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35	< 12	10 - 20	7 years	< 15	<1.5
Ortho Phosphate	mg P/L	YE070AK	<0.03	< 5			< 10	< 1
Potassium	mg K/L	YE060ICP	19.3	< 50	50 - 100	7 years		
Sodium	mg Na/L	YE060ICP	41.4	< 200	200 - 400	7 years		
Silicon	mg Si/L	YE060ICP	9.84					
Sulphate	mg SO <sub>4</sub> /L	YE070AK	1924	< 500	400 - 600	7 years		
Aluminium	mg Al/L	YE060ICP	2.07	< 0.3	0.3 - 0.5	1 year		
Fluoride	mg F/L	YE070AK	0.31	< 1.5	1.0 - 1.5	1 year	<1.0	<1.0
Iron	mg Fe/L	YE060ICP	2.41	< 2	0.2 - 2.0	7 years	<0.3	<0.3
Manganese	mg Mn/L	YE060ICP	14.2	< 0.4	0.1 - 1.0	7 years	< 0.1	< 0.1
Langelier Index (indicative, not SANS)	Calculation		-18.33	-0.5 - 0.5	negative: water may corrode surfaces; positive: water may form scale on			
pHs (indicative, not SANS)	Calculation		21.63		Saturation pH (used in calculations)			
Sodium Absorption Ratio (indicative)	Calculation		0.40	< 1.5	Relevant in irrigation and water/plant/soil			
TDS to EC Ratio (indicative, not SANS)	Calculation		9.37		Analytical indicator			
Corrosion Ratio (indicative, not SANS)	Calculation		109602916156	0 - 0.3	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due < 6: water may form scale on surfaces; > 7: water may corrode surfaces			
Ryznar Index (indicative, not SANS)	Calculation		39.96	6 - 7				
Anion Sum			41.05					
Cation Sum			43.25					
Difference			2.20					
% Difference			2.61%					

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

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Job No: **E42397 - W19\_3688**  
 Report Reference: **ER\_GEO\_2019-11-12\_08697\_001**  
 Enquiries: **Rita Botha**  
 Date: **2019/11/12**  
**RitaB@yanka.co.za**  
 Job Reference: **W19/3688 - Advice Note 1911W111**  
 Job Description: **11 x Routine Analysis**

Project: **ELANDSFONTEIN SURFACE & GW**

## TEST RESULTS FOR

## Geo Soil Elandsfontein Surface and GW - 08 November 2019

This report contains results pertaining only to the water/dust samples analysed.

For Standards referenced, and methods base, please see

<http://www.yanka.co.za/TestsAndStandards.htm>

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*Electronically approved*

**RITA BOTHA (Technical Signatory)**  
**ENVIRONMENTAL SERVICES**

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<http://www.sanas.co.za/schedules/testing/T0647-10-2015.pdf>

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### **ANALYSTS**

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# YANKA LABORATORIES

## CHEMISTRY TEST RESULTS

LABORATORY NUMBER		SpGeo 1	SpGeo 2	SpGeo 3	SpGeo 4	SpGeo 5	SpGeo 6	SpGeo 7	SpGeo 8	SpGeo 9	
SAMPLE DESCRIPTION		Farm Dam	SW - 01	TCM - PCD 01	TCM - PCD 03	TCM - SW 01	TCM - SW 02	TCM - SW 03	TCM - SW 04	TCM - SW 05	
SAMPLE NUMBER		E42397-001	E42397-002	E42397-003	E42397-004	E42397-005	E42397-006	E42397-007	E42397-008	E42397-009	
SAMPLED		Test Method **	2019/11/04 13:40	2019/11/04 13:30	2019/11/04 11:15	2019/11/04 13:20	2019/11/04 12:40	2019/11/04 12:20	2019/11/04 12:10	2019/11/04 12:55	2019/11/04 13:00
Remarks		Clear	Clear	Orange	Clear	Clear	Clear	Clear	Clear	Clear	
Flow/Level		Steady, Turbulent, Flood, Stagnant, Low, Dry									
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	35.6	8.20	0.00	0.00	74.2	76.2	0.00	0.00	5.00
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	35.6	8.20	0.00	0.00	74.2	76.2	0.00	0.00	5.00
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	35.6	8.20	0.00	0.00	74.2	76.2	0.00	0.00	5.00
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conductivity (Laboratory)	mS/m	YE020CON	385	346	886	323	133	49.8	124	180	387
pH ( Laboratory)		YE030pH	6.92	6.14	2.29	3.90	7.11	6.90	3.40	3.14	5.63
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	2426	2052	2762	2027	660	199	522	769	2430
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	1553	1356	1670	1311	427	104	347	502	1545
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	873	696	1091	717	233	95.1	175	267	885
Total Dissolved Solids (TDS)	mg/L	Calculation	3481	3160	11642	3015	896	309	796	1270	3617
Temperature	°C	Thermometer	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
Ammonia and Ammonium	mg N/L	YE070AK	<0.45	<0.45	6.44	6.07	<0.45	<0.45	<0.45	<0.45	<0.45
Calcium	mg Ca/L	YE060ICP	622	543	669	525	171	41.6	139	201	619
Chloride	mg Cl/L	YE070AK	95.3	90.0	4.88	53.3	68.2	7.11	5.01	11.5	97.2
Magnesium	mg Mg/L	YE060ICP	212	169	265	174	56.6	23.1	42.4	64.9	215
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35	1.86	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	0.53
Potassium	mg K/L	YE060ICP	31.4	27.9	1.34	24.1	4.26	4.29	8.33	24.8	36.6
Sodium	mg Na/L	YE060ICP	140	115	6.83	56.8	29.4	13.3	6.14	13.7	149
Sulphate	mg SO <sub>4</sub> /L	YE070AK	2353	2187	9109	2112	519	165	576	924	2494
Aluminium	mg Al/L	YE060ICP	<0.01	<0.01	1050	7.37	<0.01	<0.01	5.80	7.27	0.02
Fluoride	mg F/L	YE070AK	<0.09	<0.09	<0.09	2.53	0.37	0.25	1.98	1.53	<0.09
Iron	mg Fe/L	YE060ICP	0.08	0.06	429	42.0	<0.01	0.07	1.44	5.77	0.03
Manganese	mg Mn/L	YE060ICP	5.62	14.9	98.3	10.4	2.71	8.65	10.1	16.1	1.53
Langelier Index (indicative, not SANS)	Calculation		-0.36	-1.82	-19.33	-17.77	-0.35	-1.12	-18.78	-18.91	-2.49
pHs (Indicative, not SANS)	Calculation		7.28	7.96	21.62	21.67	7.46	8.02	22.18	22.05	8.12
Sodium Absorption Ratio (Indicative)	Calculation		1.23	1.10	0.06	0.55	0.50	0.41	0.12	0.21	1.31
TDS to EC Ratio (indicative, not SANS)	Calculation		9.04	9.13	13.14	9.34	6.74	6.20	6.42	7.06	9.35
Corrosion Ratio (indicative, not SANS)	Calculation		41.95	169.78	475901153691	125069419997	6.23	1.39	31420463888	51381332080	314.45
Ryznar Index (indicative, not SANS)	Calculation		7.63	9.78	40.95	39.43	7.81	9.13	40.97	40.95	10.61
Anion Sum			52.46	48.43	189.91	45.66	14.26	5.17	12.25	19.66	54.87
Cation Sum			55.87	47.49	199.68	47.73	14.75	5.01	12.05	18.39	56.32
Difference			3.41	-0.94	9.77	2.07	0.49	-0.16	-0.19	-1.27	1.45
% Difference			3.15%	-0.98%	2.51%	2.22%	1.70%	-1.53%	-0.80%	-3.33%	1.30%

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# YANKA LABORATORIES

## CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpGeo 10	SpGeo 11	SpGeo 12	SpGeo 13	SpGeo 14	SpGeo 15	SpGeo 16	SpGeo 17	SpGeo 18
SAMPLE DESCRIPTION			WOP	Eland 11	EC - BH 1	EC - BH 2	EC - BH 3	EC - BH 4	EC - BH 5	EC - BH 07 S	Eland 1
SAMPLE NUMBER			E42397-010	E42397-011	E42397-012	E42397-013	E42397-014	E42397-015	E42397-016	E42397-017	E42397-018
SAMPLED		Test Method **	2019/11/04 13:10	2019/11/04 14:05	2019/11/04 11:00	2019/11/04 10:15	2019/11/04 10:20	2019/11/04 10:20	2019/11/04 10:05	2019/11/04 10:00	2019/11/04 11:45
Remarks			Clear	Clear	Level Only	Level Only	Level Only	Level Only	Level Only	Level Only	Level Only
Flow/Level		Steady, Turbulent, Flood, Slagnant, Low, Dry		7.13	23.01	7.07	7.58	9.45	38.81	11.66	35.94
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	32.8							
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	32.8							
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00							
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	32.8							
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk	0.00	0.00							
Conductivity (Laboratory)	mS/m	YE020CON	303	138							
pH ( Laboratory)		YE030pH	3.20	6.96							
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H	1896	294							
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H	1311	238							
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H	585	56.0							
Total Dissolved Solids (TDS)	mg/L	Calculation	2744	863							
Temperature	°C	Thermometer	21.0	21.0							
Ammonia and Ammonium	mg N/L	YE070AK	1.90	0.78							
Calcium	mg Ca/L	YE060ICP	525	95.5							
Chloride	mg Cl/L	YE070AK	33.0	86.0							
Magnesium	mg Mg/L	YE060ICP	142	13.6							
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35	<0.35							
Potassium	mg K/L	YE060ICP	17.5	52.5							
Sodium	mg Na/L	YE060ICP	36.8	138							
Sulphate	mg SO <sub>4</sub> /L	YE070AK	1966	455							
Aluminium	mg Al/L	YE060ICP	2.07	<0.01							
Fluoride	mg F/L	YE070AK	0.43	<0.09							
Iron	mg Fe/L	YE060ICP	6.39	0.07							
Manganese	mg Mn/L	YE060ICP	12.1	0.94							
Langelier Index (indicative, not SANS)	Calculation		-18.46	-1.10							
pHs (indicative, not SANS)	Calculation		21.66	8.06							
Sodium Absorption Ratio (indicative)	Calculation		0.37	3.50							
TDS to EC Ratio (indicative, not SANS)	Calculation		9.06	6.25							
Corrosion Ratio (indicative, not SANS)	Calculation		111732836039	14.62							
Ryznar Index (indicative, not SANS)	Calculation		40.12	9.16							
Anion Sum			41.92	12.59							
Cation Sum			41.28	13.36							
Difference			-0.64	0.77							
% Difference			-0.77%	2.96%							

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# YANKA LABORATORIES

## CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpGeo 19	SpGeo 20	SpGeo 21	SpGeo 22	SpGeo 23	SpGeo 24	SpGeo 25	SpGeo 26
SAMPLE DESCRIPTION			Eland 2	Eland 3	Eland 10	Eland 11	GW - 01	GW - 05	EBH - 172	EBH - 173
SAMPLE NUMBER			E42397-019	E42397-020	E42397-021	E42397-022	E42397-023	E42397-024	E42397-025	E42397-026
SAMPLED		Test Method **	2019/11/04 11:55	2019/11/04 10:50	2019/11/04 09:55	2019/11/04 14:05	2019/11/04 10:40	2019/11/04 11:20	2019/11/04 12:25	2019/11/04 12:20
Remarks			Dry / Mud @ 48m	Level Only	Level Only	Level Only	Level Only	Level Only	Level Only	Level Only
Flow/Level		Steady, Turbulent, Flood, Stagnant, Low, Dry		16.5	22.61	7.13	7.47	3.46	5.5	3.74
Total Alkalinity (pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk								
Bicarbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk								
Carbonate Alkalinity	mg CaCO <sub>3</sub> /L	YE010Alk								
M Alkalinity (8.3>pH>4.5)	mg CaCO <sub>3</sub> /L	YE010Alk								
P Alkalinity (pH>8.3)	mg CaCO <sub>3</sub> /L	YE010Alk								
Conductivity (Laboratory)	mS/m	YE020CON								
pH ( Laboratory)		YE030pH								
Total Hardness	mg CaCO <sub>3</sub> /L	YE061H								
Calcium Hardness	mg CaCO <sub>3</sub> /L	YE061H								
Magnesium Hardness	mg CaCO <sub>3</sub> /L	YE061H								
Total Dissolved Solids (TDS)	mg/L	Calculation								
Temperature	°C	Thermometer								
Ammonia and Ammonium	mg N/L	YE070AK								
Calcium	mg Ca/L	YE060ICP								
Chloride	mg Cl/L	YE070AK								
Magnesium	mg Mg/L	YE060ICP								
Nitrate and Nitrite (TON)	mg N/L	YE070AK								
Potassium	mg K/L	YE060ICP								
Sodium	mg Na/L	YE060ICP								
Sulphate	mg SO <sub>4</sub> /L	YE070AK								
Aluminium	mg Al/L	YE060ICP								
Fluoride	mg F/L	YE070AK								
Iron	mg Fe/L	YE060ICP								
Manganese	mg Mn/L	YE060ICP								
Langelier Index (indicative, not SANS)		Calculation								
pHs (indicative, not SANS)		Calculation								
Sodium Absorption Ratio (indicative)		Calculation								
TDS to EC Ratio (indicative, not SANS)		Calculation								
Corrosion Ratio (indicative, not SANS)		Calculation								
Ryznar Index (indicative, not SANS)		Calculation								
Anion Sum										
Cation Sum										
Difference										
% Difference										

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