QUARTERLY WATER QUALITY REPORT 2-2018

01 JULY 2018 TO 30 SEPTEMBER 2018

IWUL: Licence No. 08/C11B/AGJ/2141,
File No. 16/2/7/C112/C155, 2013

Mooiplaats Colliery (Pty) Ltd

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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
Cr6+	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

GD-VO	Grootdraai Dam Guidelines - Vaal Origin Catchment
GPS	Global Positioning System
GRO	Gasoline Range Organics
GSW	Geo Soil & Water (Pty) Ltd GSW
GW	Groundwater
HCO3-	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
MPN	Mooiplaats Colliery North
MPS	Mooiplaats Colliery South
Na	Sodium
NEMA	National Environmental Management Act (Act No. 107 of 1998)
Ni	Nickel
NO3-	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
SANS	South African National Standard
SAR	Sodium Absorption Ratio
Se	Selenium

SO_4	Sulphate
TDS	Total Dissolved Solids
WGS 84	World Geodetic System 1984
WUL	Water Use License
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: OH-, O2-, SO42-, Alk (HCO3-), Cl-, etc. The Bicarbonate (HCO3-) 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: Ca+, Mg+, Na+, K+, Fe2+.

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 liter 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 time-frames and conditions for the designated water use.

EXECUTIVE SUMMARY

Mooiplaats Colliery (Pty) Ltd (Mooiplaats Colliery) appointed Geo Soil & Water (Pty) Ltd (GSW) to conduct water sampling, water quality analyses and water quality reporting at Mooiplaats Colliery in accordance with the requirements of the Integrated Water Use Licence No: 08/C11B/AGJ/2141, File No: 16/2/7/C112/C155 dated 02 May 2013 (IWUL), issued in terms of the National Water Act (Act No. 36 of 1998) (NWA).

The reporting period is from 01 July 2018 – 30 September 2018.

Water qualities were compared to the IWUL Limits and the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin.

The DWS Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering and the South African National Standard, Drinking Water Standard (Edition 2) (SANS 241:2015) were included as supplementary comparative guidelines and not for compliance purposes.

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

The following is a summary of the results:

Waste water - Water quality from the mine water/pollution control dams monitoring points exceeded limits in terms of EC, TDS, $CaCO_3$, Ca, Mg, F, Cl, SO_4, NH_3, Al, Fe and Mn. These results are typical of water associated with coal washing/mining activities. It should be noted that although these monitoring points recorded elevated variable concentrations, the water is being contained in appropriate waste water storage facilities and circulated in a closed circuit i.e. dirty water circuit and no water are being released into the receiving environment.

Storm and Surface Water Runoff - It is evident that the surface runoff water quality within the boundaries of Mooiplaats Colliery is of general good quality (in comparison with the Witpuntspruit) with the exception of **MPS-S16**. Water quality at **MPS-S16** is the result of a lack of maintenance and management during the care and maintenance phase. Several measures since the commencement of mining activities in 2018 were taken to prevent further pollution. Water quality will be closely monitored for improvement or deterioration.

Water Quality from the **Witpuntspruit** is highly impacted upstream of Mooiplaats Colliery indicating a serious pollution source. Although the water quality improves from the upstream monitoring point towards downstream of Mooiplaats Colliery, the quality of the instream water is not suitable for the aquatic ecosystem. An impact via the **WT-S05** tributary / monitoring point (downstream of **MPS-S16**), on the Witpuntspruit was recorded but the impact from the **WT-S05** tributary is absorbed by the already polluted Witpuntspruit. **WT-S05** recorded no flow into the Witpuntspruit during the reporting period. Known decant from the Usutu mine downstream of **MPS-S08** and upstream of **WT-S06** enters the **Witpuntspruit**, elevating the pH, EC and $CaCO_3$ concentrations. The effect of the decant on the Witpuntspruit and Vaal River will be closely monitored.

Vaal River – Although fewer water quality limits are exceeded in the Vaal river compared to the Witpuntspruit, the change in composition and the deterioration in water quality is evident after the confluence with the Witpuntspruit.

Although water quality remains relative stable downstream it is rather dilution than improvement that will be observed further downstream. The source of the Witpuntspruit pollution should be addressed to prevent constant degradation (build-up of contaminants) of the Vaal River system and a complete collapse in the aquatic functions in the long term.

Groundwater – Groundwater in the Mooiplaats area is of relatively good quality.

Although SO_4 concentrations was observed at the groundwater monitoring point towards the Vaal river, **GKL-2s** was unlikely impacted by Mooiplaats Colliery. The presence of SO_4 and Fe can most probably be ascribed to an exposed coal seam or other geological factors as the borehole is drilled to a depth of 6 meters only. The water quality will be monitored and investigated should an increase in the concentrations be observed.

GKL-4d is a deep borehole drilled to a depth of 80 meters. The $CaCO_3$, Na and Cl concentrations elevate the pH and EC concentrations, leading to IWUL Limit exceedances. Elevated $CaCO_3$, Na and Cl can most likely be ascribed to geological conditions and not mining pollution.

No substantial or uneven increases or decreases in groundwater levels have been observed during the reporting period.

TABLE OF CONTENTS

ANNEXURES

LIST OF FIGURES

LIST OF TABLES

DISCLAIMER

This report has been prepared by Geo Soil and Water cc (GSW), using information provided by the client as well as third parties, which information has been presumed to be correct. While GSW has made every endeavour to supply accurate information, and exercised all care, skill and diligence in the drafting of this report, errors and omissions may occur. Accordingly, GSW does not warrant the accuracy or completeness of the materials in this report. GSW does not accept any liability for any loss or damage which may directly or indirectly result from any advice, opinion, information, representation or omission, whether negligent or otherwise, contained in this report, including the use and interpretation of this report by the client, its officials or their representative agents.

1. INTRODUCTION

1.1 Scope of Work

Mooiplaats Colliery (Pty) Ltd (Mooiplaats) appointed Geo Soil & Water (Pty) Ltd to conduct water sampling, water quality analyses and water quality reporting at Mooiplaats in accordance with the requirements of the Integrated Water Use Licence No: 08/C11B/AGJ/2141, File No: 16/2/7/C112/C155 dated 02 May 2013 (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) 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 will be implemented and quarterly reports, reflecting the results, submitted to the DWS.

GSW was commissioned by Mooiplaats Colliery to implement and conduct surface - and groundwater monitoring as prescribed in the IWUL, 2013. Surface and groundwater water monitoring points are sampled on a monthly and biannual basis.

The results of the monitoring report are used to inform Mooiplaats management of the impact from mining activities 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 of the monitoring system and various monitoring points at Mooiplaats Colliery. The work done during the monitoring period of the contract included:

Routine monitoring:

- July 2018 - Monthly surface and groundwater monitoring,
- August 2018 - Monthly surface and groundwater monitoring,
- September 2018 - Monthly surface and groundwater monitoring.

2. PROJECT BACKGROUND INFORMATION

Mooiplaats operates an Underground mine, wash plant and associated infrastructure on the farm Mooiplaats approximately 20km east of Ermelo in the Mpumalanga Province, South Africa. The relevant infrastructure consists of a wash plant, return water dams, co-disposal dump, offices, workshops, weighbridge, diesel bowsers, coal stockpiles, overburden stockpiles, etc. Water management structures/pollution control facilities on site consist of several return water dams (RWD) at the plant and co-disposal dump areas. All water falling within the plant and co-disposal footprint areas is classed as dirty water and is directed to these various RWD's on site.

Mooiplaats received a Mining Right MP 30/5/1/2/2/68 MP, 2007 (MR) and was granted an Integrated Water Use Licence No. 08/C11B/AGJ/2141, File No: 16/2/7/C112/C155 dated 02 May 2013 (IWUL), from the Department of Water and Sanitation in accordance with the National Water Act, 1998 (NWA).

2.1 Location

Mooiplaats has an approved Mining Right MP 30/5/1/2/2/68 MP, 2007 (MR) and Integrated Water Use Licence No. 08/C11B/AGJ/2141, File No: 16/2/7/C112/C155 dated 02 May 2013, for coal on Portion 1 and 9 of the Farm Mooiplaats 290IT, located east of Ermelo, south of the N2, in the Mpumalanga Province, South Africa.

Mooiplaats is situated in the magisterial district of Ermelo and falls under the Msukaligwa Local Municipality, situated in the Gert Sibande District Municipality.

Several streams, wetlands and springs are located in the area which drains south and east towards the Witpuntspruit and Vaal River in the Grootdraai Dam / Upper Vaal Catchment.

Figures 4.1 and **Annexure A** present the locality map.

2.2 Catchment, Rainfall Supply and Use and Surrounding Activities

Mooiplaats is situated in the Upper Vaal Catchment Management Area (WMA) which includes quaternary catchment C11B.

The Witpuntspruit which passes Mooiplaats and joins the Vaal River which is heavily modified due to previous and current mining activities. Well known decant upstream enters the Humanspruit which enters the Witpuntspruit and eventually the Vaal River which may have a detrimental effect on downstream users.

"*The Upper Vaal water management area lies in the eastern interior of South Africa. From a water resources management perspective it is a pivotal water management area in the country. Large quantities of water are transferred into the area from two neighbouring areas, as well as water sourced from the Upper Orange River via Lesotho. Similarly, large quantities of water are transferred out to three other water management areas, which are dependent on water from the Upper Vaal water management area to meet much of their requirements.*

Extensive urbanisation and mining and industrial activity, which relate to the rich gold and coal deposits in the area, occur in the northern part of the water management area. Economic activity in the remainder of the Upper Vaal water management area mainly relates to livestock farming and rain fed cultivation.

Because of the high level of urbanisation and economic activity in the area and its pivotal role as a water transfer point to other water management areas, water resources in the area are highly developed and regulated, and only marginal potential for further development remains. The total yield transferred into the catchment is in excess of 120 per cent of the yield from local surface resources, while virtually the same quantity of water is again transferred out of the area. Groundwater is mainly used for rural domestic needs and for stock watering, while a substantial quantity of water is also abstracted from dolomitic aquifers for urban use.

The Upper Vaal water management area is highly developed and impacted upon by human activity. The quantities of water transferred into and out of the area are largely dictated by the population needs and economic activity in this as well as similar needs in other recipient water management areas.

Water quality in the Vaal River and in some tributaries downstream of Vaal Dam is seriously affected by urban and industrial and mining return flows and the intensive mining activity. The water resources are therefore carefully managed to maintain acceptable water quality standards. Particular attention is also to be given to the impacts that closure of mines may have on both surface and groundwater." DWS, 2004.

Figures 4.1 and **Annexure A** present the locality map.

2.3 Summary of Previous Studies

Several studies have been and are being conducted as part of impact determination in terms of the water resources. Studies include:

- Surface and Groundwater Monitoring,
- Mooiplaats Monthly Water Quality Report, MON-WQR-13-79. Envass 2018.
- Groundwater Study, 2011.

Abstract from "Mooiplaats North Colliery geology and groundwater study". Fourie, 2011.

Geology baseline

The B Upper seam is well developed throughout the succession and is the only seam which is considered to be economically viable. Because of the depth of this reserve only underground mining methods are proposed.

Within the mine layout the thickness of the seam range between 1.5 - 2.9 m, averaging at 2.1 m. The depth of the coal seam roof within the mine layout ranges between 40 - 165 meters below surface (mbs), averaging at 115 mbs.

Several dolerite dykes and sills have been identified in the area. A major dyke is present between MPN and the old Usutu underground workings. A sill breakthrough also occurs between MPN and MPS. This has resulted in the compartmentalisation of the MPN underground workings as the dolerite will form no-flow boundaries with relation to inter-mine flow. Drilling has been performed in order to target the dolerite between MPN and Usutu. The drilling results were incorporated into the groundwater study.

The geophysical survey confirmed the presence of a dyke between the Usutu and MPN underground mines, as well as the approximate depth of the dyke. The dyke was targeted with 6 boreholes. These boreholes will monitor the groundwater level and quality between the two mines, as well as any potential impact (on the aquifer) caused by pumping of the Usutu mine water by MPN. MBV-2A is the closest to the pumped borehole MS-B7 and shows a slight depletion in groundwater level

Groundwater baseline

Geohydrological drilling and groundwater field work was completed in April 2011. Field work included measurements of the water levels, as well as slug testing of all monitoring boreholes.

A hydro-census within at least 1 km buffer zone around MPN was performed in order to identify the presence and status of existing boreholes and fountains, as well as groundwater use in the area. A total of 10 external users' boreholes were surveyed that are located around MPN, near homesteads, or present in the farming field. Of the 10 boreholes only 2 external user boreholes (WT-B1 and MS-B4) are currently in use for domestic (for a guesthouse) and stock watering purposes respectively. This indicates the low level of groundwater use in the area. A total of 3 fountains were included in the survey. Two of them (WT-F1 and F2) are used for domestic and stock watering purposes respectively.

Hydro-chemical samples were taken from all monitoring boreholes and several external users' boreholes and fountains. Overall, the groundwater in the area is of good quality with only 1) the Usutu monitoring borehole that has non-compliant concentration of Na and F, as well as marginally elevated SO_4, and 2) a slightly elevated SO_4 in one plant monitoring borehole.

The background groundwater could be classified as Na(Ca)-CO_3 dominated water. Groundwater with SO_4 contamination could be distinguished from the background groundwater as SO_4 becomes the dominant anion. Any future mining impact could therefore easily be identified.

The hydraulic conductivity for the shallow weathered aquifer, the deep fractured aquifer and alluvium/soils were determined from slug tests at Mooiplaats North and Mooiplaats South. The chosen hydraulic conductivity used for groundwater modelling is taken as 0.03 m/d, 0.007m/d and 4 m/d respectively.

The Karoo Formation aquifer of the Mooiplaats area can in general be classified as a low yielding aquifer. It does have a viable exploitation potential for domestic and stock-watering application and as such is the main water resource for these applications to the farming communities in the area. The aquifers will however not support formal irrigation application over any extensive area (> 10 ha). The shallow weathered aquifer can therefore be classified as a minor aquifer system in terms of aquifer management.

Groundwater impact assessment

The impact on the geohydrology has been assessed by means of a numerical groundwater model for the MPN area.

The objective of the groundwater flow and transport model was to quantify the impact of mining on the following aspects:

- *Influx of groundwater into mine workings;*
- *Inter-mine flow between adjacent mines;*
- *Impact on external users' boreholes;*
- *Impact on fountains and stream base flow;*
- *Impact of pumping/groundwater use;*
- *Development of pollution plume in aquifer down-gradient of the plant area.*

No significant impact will be presented by the bord-and-pillar mine towards the adjacent mining as the MPN is significantly compartmentalised by sills.

The MPN will also have a negligible impact on external users' boreholes and base flow to streams and fountains. As a worst case the mine may have a small impact on MS-B4 (windpump of Mr Klopper). The depth of this borehole was however not available and the impact is uncertain.

Pumping of Usutu East by MPN will have no adverse effect for Usutu both in terms of the mine water quality and quantity. With respect to both the pumping may actually have a beneficial effect as decanting of Usutu is prolonged and the mine water quality will probably improve.

The most significant impact of MPN relates to the potential plume development down-gradient of the co-disposal facility after closure. The plume will eventually reach the Witpunt Spruit tributary. The following comments relate to the seepage water quality:

- *The co-disposal will show an increase in the total dissolved solids with SO_4 as the dominant anion and will most likely acidify after closure; and*
- *Significant elevation of Al, Fe and Mn will occur. Other metals such as Cd, Sb and Se may also be present in seepage but most probably not at non-compliant concentrations.*

From the model it was calculated that the contamination plume will not develop further than about 100 - 200 m horizontally from the mine boundary within 100 years after closure. The following relates to the mine water quality:

- *The underground mine water will show an increase in the total dissolved solids with SO_4 as the dominant anion but will most likely not acidify; and*

- *No significant elevation of metals will occur in the near-neutral mine water.*

An important management measure during the operational and post-closure phase is the establishment of a groundwater monitoring system in order to detect any impact on the groundwater environment.

Monitoring of the impact on the groundwater relates to the following:

- *Development of cones of depression around the mine.*
- *Influxes of groundwater into the underground mine workings.*
- *Possible impact on the water levels and yields of external users' boreholes and fountains for at least a 1 km buffer zone around any old or active mine working.*
- *Possible depletion of groundwater base flow towards streams.*
- *Mine water levels in the underground mine."*

2.4 Information and Knowledge Gaps

The following are areas of uncertainty:

- The design of some of the monitoring boreholes and drill information (e.g. casing depth, perforated casing depth, drill water strike depth, lithology, and slug test results);
- Complete geophysical information on preferred flow paths; and
- The effect of local farming and associated contaminants.
- All possible pollution sources caused by current and historical mining. The extent / presence of informal historical mining in the catchment.
- Pre-mining / Baseline water quality.
- The impact from current upstream mining activities and industries.

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 Mooiplaats Colliery,
- 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 Mooiplaats Colliery are to comply with the requirements of the IWUL and Grootdraai Dam In-stream Water Quality Guidelines, Vaal Origin. The SANS 241:2015 drinking water standards and DWS Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering will be included as supplementary comparative guidelines and not for compliance purposes.

4.1 Changes/Additions in/to Monitoring Network

Although ten (10) IWUL surface water monitoring points and nine (9) groundwater monitoring points are included in the IWUL, Mooiplaats Colliery monitors additional surface and groundwater monitoring points to determine impacts and sources more accurately.

Several additional surface and groundwater monitoring points are sampled on a monthly and quarterly basis.

Several parameters are analysed in addition to the parameters set in the 2013 IWUL.

4.2 Surface Water

The surface water monitoring points are being sampled on a monthly basis for chemical water quality and levels as prescribed in the IWUL.

Surface water monitoring in this reporting period occurred on a monthly basis as per the conditions set in the IWUL. Refer to **Annexure C** for monthly in-field sampling sheets.

Ten (10) IWUL surface water monitoring points **and** fifteen (15) additional surface water monitoring points are included in the surface water monitoring programme.

Figure 4.1.1 indicates the positions of the surface water monitoring points relative to Mooiplaats and water resources.

Figure 4.1.2 display the photographic evidence of the surface water monitoring points.

Table 4.1 presents a summary of the surface water monitoring programme/points including the name, description, coordinates and the frequency of monitoring.

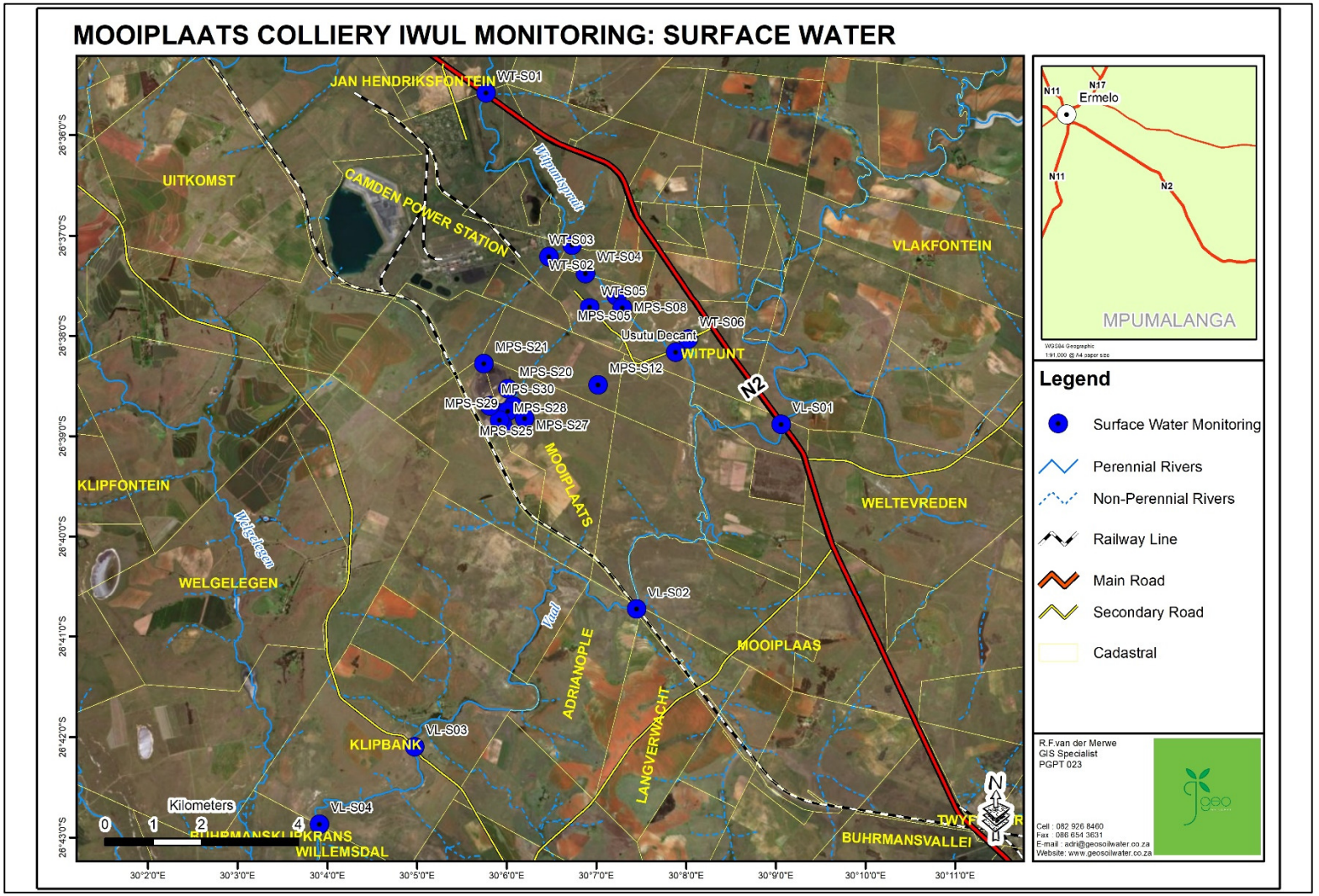


Figure 4.1.1 Location of surface water monitoring points.

Table 4.1 Summary of surface water monitoring points.

Mooiplaats Colliery Monitoring Programme			
Surface Water Monitoring Points			
Locality	**Locality Description**	**Coordinates WGS 84 ddd.ddddd**	**Monitoring Frequency**
VL-S01	Vaal River 1 Upstream	S26.64616° E30.09890°	Monthly
VL-S02	Vaal River 2 Downstream 1	S26.64804° E30.15098°	Monthly
VL-S03	Vaal River 3 Downstream 2	S26.67879° E30.12411°	Monthly
VL-S04	Vaal River 4 Downstream 3	S26.70167° E30.08288°	Monthly
WT-S01	Witpuntspruit 1 Upstream	S26.71447° E30.06519°	Monthly
WT-S02	Witpuntspruit 2 Midstream	S26.59307° E30.09617°	Monthly
WT-S03	Witpuntspruit Tributary North DS 1	S26.61826° E30.11211°	Monthly
WT-S04	Witpuntspruit 3 Midstream	S26.62014° E30.10781°	Monthly
WT-S05	Witpuntspruit Tributary South DS 2	S26.62294° E30.11463°	Monthly
WT-S06	Witpuntspruit 6 Downstream	S26.62863° E30.11539°	Monthly
MPS-S08	Witpuntspruit 5 MS	S26.62873° E30.12149°	Monthly
MPS-S12	Witpuntspruit Tributary @ Access Road	S26.64150° E30.11697°	Monthly
MPS-S13	Runoff from Loading Area	S26.64837° E30.09888°	Monthly
MPS-S14	Gen-sub PCD	S26.64616° E30.09890°	Monthly
MPS-S15	Stormwater trench @ Security	S26.64837° E30.09888°	Monthly
MPS-S16	DS Area of Erikson's + Settling Dams	S26.64505° E30.10121°	Monthly
MPS-S20	Erickson Dams	S26.64505° E30.10121°	Monthly
MPS-S21	Main Holdings Dam	S26.64198° E30.10059°	Monthly
MPS-S25	Workshop Trench DS of Workshop	S26.63826° E30.09506°	Monthly
MPS-S27	Witpuntspruit Tributary entering MP	S26.64716° E30.10336°	Monthly
MPS-S28	Confluence of MPS-S13 and MPS-S15	S26.64808° E30.09925°	Monthly
MPS-S29	Storm water @ Offices	S26.64743° E30.09802	Monthly
MPS-S30	Plant PCD	S26.64508° E30.09674°	Monthly
Usutu Decant Surface	Decant from Old Usutu Workings decanting into the Witpuntspruit Upstream of WT-06 – via surface.	S26.63611°E30.13139°	Monthly
Usutu Decant Sump	Decant from Old Usutu Workings decanting into the Witpuntspruit Upstream of WT-06 – in cement sumps	S26.63611°E30.13139°	Monthly
	Additional Monitoring Points		
	IWUL Monitoring Points		

VL-S01

VL-S02

	
VL-S03	VL-S04
	
WT-S01	WT-S02
	
WT-S03	WT-S04
	
WT-S05	WT-S06
	
MPS-S08	MPS-S13

	
MPS-S14	MPS-S15
	
MPS-S16	MPS-S20
	
MPS-S21	MPS-S25
	
MPS-S27	MPS-S28
	
MPS-S29	MPS-S30

Usutu Decant Surface

Usutu Decant Sump

Figure 4.1.2 Photographic record of surface water monitoring points.

4.3 Groundwater

The IWUL groundwater monitoring points are being sampled on a **monthly** basis for chemical water quality and levels where additional groundwater monitoring points are being sampled on a **biannual** basis.

Nine (9) IWUL (monthly) and twenty (20) additional (biannually) groundwater monitoring points are included in the Groundwater monitoring programme.

Groundwater monitoring in this reporting period occurred on a monthly and biannual basis.

Refer to **Annexure C** for quarterly in-field sampling sheets.

Figure 4.1.3 indicates the positions of the groundwater monitoring points.

Figure 4.1.4 display the photographic evidence of the groundwater monitoring points.

Table 4.2 is a summary of the monitoring points including the name, description, coordinates and the frequency of monitoring.

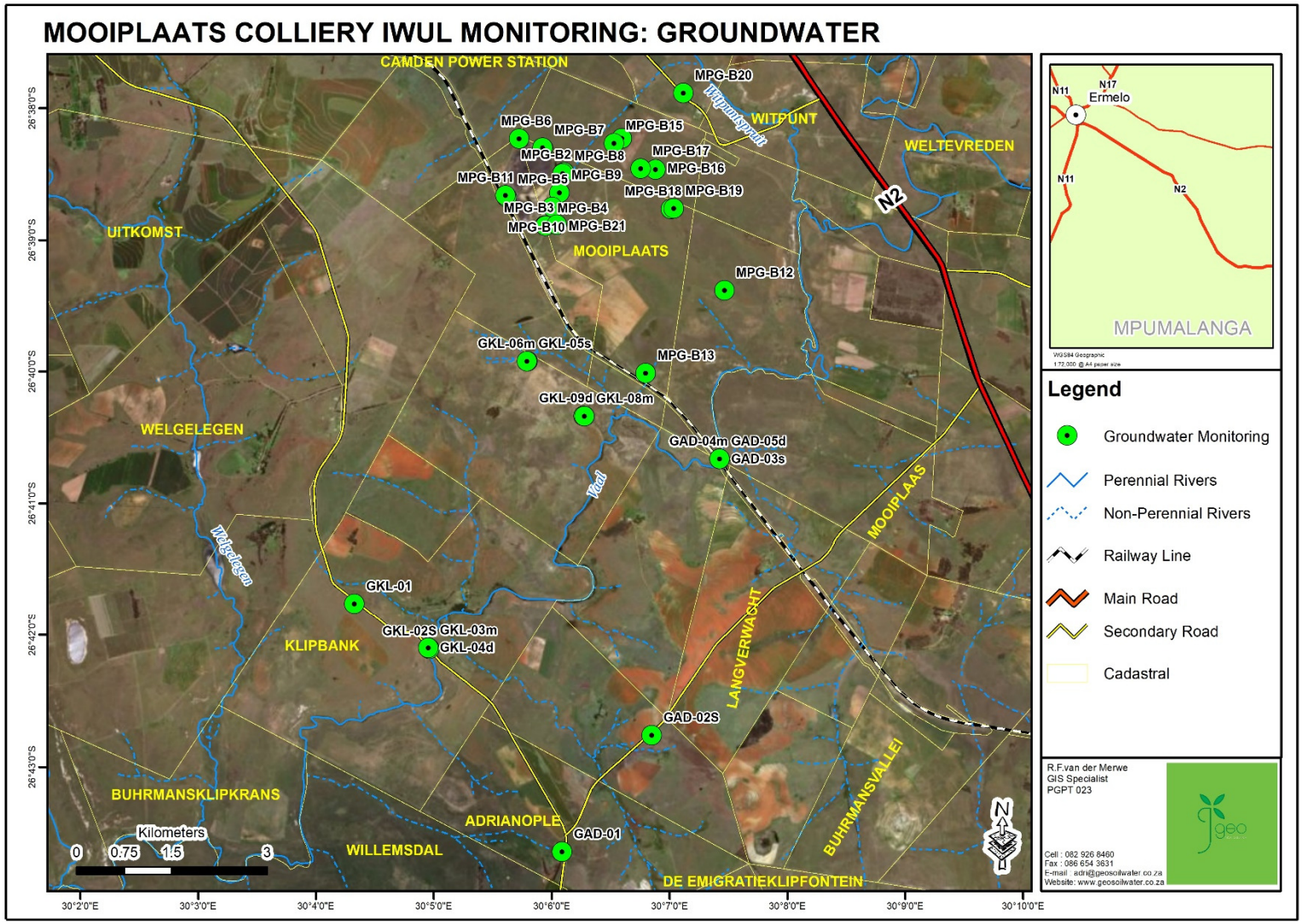


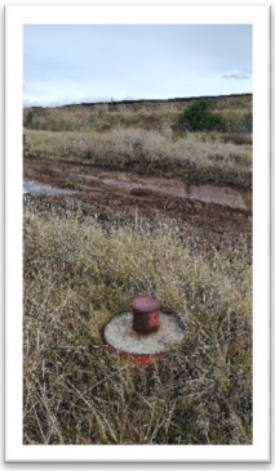
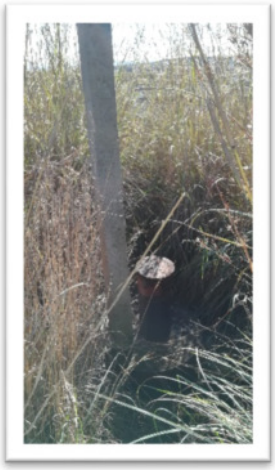
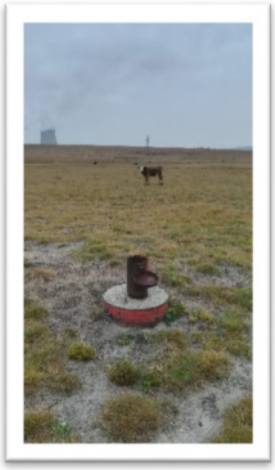
Figure 4.1.3 Location of groundwater monitoring points.

Table 4.2 Summary of groundwater monitoring points.

Mooiplaats Colliery Groundwater Monitoring Programme			
Groundwater Monitoring Points			
Locality	**Locality Description**	**Coordinates WGS 84 ddd.ddddd**	**Monitoring Frequency**
GKL-1	IWUL Borehole	S26.69603° E30.07208°	Monthly
GKL-4d	IWUL Borehole	S26.70167° E30.08253°	Monthly
GKL-3m	Borehole	S26.70178° E30.08269°	Monthly
GKL-2s	IWUL Borehole	S26.70178° E30.08269°	Monthly
GAD-2s	IWUL Borehole	S26.71269° E30.11414°	Monthly
GAD-1	IWUL Borehole	S26.72733° E30.10144°	Monthly
GKL-9D	IWUL Borehole	S26.67231° E30.10450°	Monthly
GKL-8M	IWUL Borehole	S26.67233° E30.10464°	Monthly
GKL-5S	IWUL Borehole	S26.66542° E30.09647°	Monthly
GKL-6M	IWUL Borehole	S26.66542° E30.09658°	Monthly
GAD-3s	Borehole	S26.67772° E30.12374°	Monthly
GAD-4m	Borehole	S26.67772° E30.12374°	Monthly
GAD-5d	Borehole	S26.67772° E30.12374°	Monthly
MPG-B1	Down gradient (north) of the co-disposal facility.	S26.63843° E30.09878°	Biannually
MPG-B2	Down gradient (east) of the lined Settling Dams and co-disposal.	S26.64143° E30.10175°	Biannually
MPG-B3	Near the security gate.	S26.64816° E30.09905°	Biannually
MPG-B4	Near the security gate.	S26.64819° E30.09910°	Biannually
MPG-B5	Up-gradient (south-west) of the plant area next to the railway line.	S26.64457° E30.09363°	Biannually
MPG-B6	Adjacent to the return water dam.	S26.63719° E30.09540°	Biannually
MPG-B7	Down gradient (north) of the co-disposal facility.	S26.63832° E30.09870°	Biannually
MPG-B8	Down gradient (east) of the lined Settling Dams.	S26.64160° E30.10155°	Biannually
MPG-B9	Down gradient (east) of the plant area.	S26.64403° E30.10107°	Biannually
MPG-B10	Down gradient (east) of the plant area.	S26.64581° E30.10007°	Biannually
MPG-B11	Up-gradient (south-west) of the plant area next to the railway line.	S26.64435° E30.09344°	Biannually
MPG-B12	At MPN Vunene extension	S26.65633° E30.12443°	Biannually
MPG-B13	South of the mine next to the railway line.	S26.66689° E30.11329°	Biannually
MPG-B14	Between Usutu/MPN	S26.63716° E30.10992°	Biannually
MPG-B15	Between Usutu/MPN	S26.63778° E30.10881°	Biannually
MPG-B16	Between Usutu/MPN	S26.64106° E30.11469°	Biannually
MPG-B17	Between Usutu/MPN	S26.64095° E30.11259°	Biannually
MPG-B18	Between Usutu/MPN	S26.64608° E30.11685°	Biannually
MPG-B19	Between Usutu/MPN	S26.64600° E30.11725°	Biannually
MPG-B20	Usutu UG. Bh intersecting mine at 90 m	S26.63144° E30.11860°	Biannually
	Additional Monitoring Points		
	IWUL Monitoring Points		

		
GKL-1	GKL-2S	GKL-3M
	No image available No Access to Borehole	No image available No Access to Borehole
GKL-4D	GKL-5S	GKL-6M
No image available No Access to Borehole	No image available No Access to Borehole	
GKL-8M	GKL-9D	GAD-1

		
GAD-2S	GAD-3S	GAD-4M
		
GAD-5D	MPG-B1	MPG-B2
		
MPG-B3	MPG-B4	MPG-B5

		
MPG-B6	MPG-B7	MPG-B8
		
MPG-B9	MPG-B10	MPG-B11
No image available		
MPG-B12	MPG-B13	MPG-B14

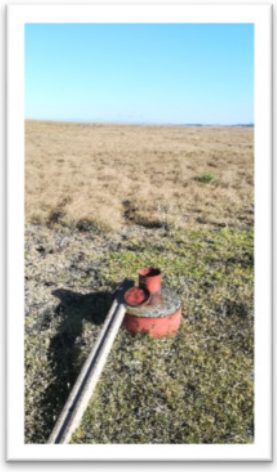
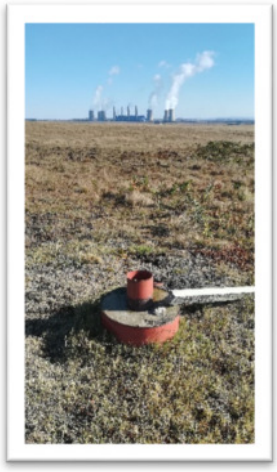
		
MPG-B15	MPG-B16	MPG-B17
		
MPG-B18	MPG-B19	MPG-B20
		
MPG-B21		

Figure 4.1.4 Photographic record of groundwater monitoring points.

5. METHODOLOGY

The following is a description of the sampling protocol, analyses and reporting included in the Mooiplaats Colliery monitoring programme. Please refer to **Section 4** of this report for a complete description of the monitoring points.

5.1 Sampling Protocol

GSW is responsible for the sampling of the monitoring points, the assessment evaluation and report writing.

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 thus used as a guiding tool in this study and the subsequent development of a surface water and groundwater monitoring program for Mooiplaats Colliery.

5.2 Surface water

For chemical analyses, a 200 mL plastic container was used to collect a grab sample. Bottles are properly 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 occurs at twenty five (25) surface water monitoring points on a monthly basis depending on environmental conditions.

Monthly surface water samples are analysed for:

- pH
- EC mS/m
- TDS mg/L
- Total Hardness mg/L
- Alkalinity $CaCO_3$/L
- Ca mg/L
- Mg mg/L
- Na mg/L
- K mg/L
- F mg/L
- Cl mg/L
- SO_4 mg/L
- NO_3 mg/L
- Al mg/L
- Fe mg/L
- Mn mg/L
- NH_3 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.

Geographical coordinates, photos and the date, time and field analyses for each sample are recorded.

Monitoring occurs at thirty three (33) groundwater monitoring points. Thirteen (13) IWUL groundwater points on a monthly basis and the additional twenty (20) groundwater points on a biannual basis depending on environmental conditions and access.

Groundwater samples are analysed for:

- pH
- EC mS/m
- TDS mg/L
- Total Hardness mg/L
- Alkalinity $CaCO_3$/L
- Ca mg/L
- Mg mg/L
- Na mg/L
- K mg/L
- F mg/L
- Cl mg/L
- SO_4 mg/L
- NO_3 mg/L
- Al mg/L
- Fe mg/L
- Mn mg/L
- NH_3 mg/L

5.4 Water levels

Water levels at groundwater monitoring points are recorded on a monthly and biannual basis (as per Section 5.3) using an electronic water level meter with a probe which measures water levels accurately in boreholes and wells (Section 6.9).

5.5 Water sample analyses

Both, surface - and groundwater samples are submitted to UIS Laboratories (UIS), for organic, physical and chemical analyses. Surface - and groundwater samples are analysed for variables as described in **Sections 5.2** and **5.3** or additionally as requested on an ad hoc basis.

5.6 Reporting

The quarterly, biannual and annual surface - and groundwater assessments are evaluated by a registered Pr.Sci.Nat. Environmental Scientist and annual groundwater assessments are evaluated by a registered Pr.Sci.Nat. Geohydrologist.

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

- Quarterly Surface – and Groundwater Monitoring Reports; or
- Bi-annual Surface – and Groundwater Monitoring Reports; and
- Comprehensive Annual Water Quality Report.

Quarterly and Bi-annual 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, 2013 included in this report:

- **July 2018** - IWUL, Monthly surface and IWUL groundwater monitoring,
- **Aug 2018** - IWUL, Monthly surface and IWUL groundwater monitoring,
- **Sep 2018** - IWUL, Monthly surface and IWUL groundwater monitoring,

The following sections are discussions on the surface - and groundwater quality results for Mooiplaats Colliery, for the period 01 July 2018 – 30 September 2018.

Refer to **Annexure C** for:

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

Refer to **Annexure D** 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 6.1**), salinity (**Table 6.2**) and hardness (**Table 6.3**).

Table 6.1 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 6.2 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 6.3 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 water quality discussions on areas associated with current Mooiplaats Colliery mining operations.

Section 6.1 - Contained Waste Water,
Section 6.2 - Storm Water and Surface Water Runoff,
Section 6.3 - Witpuntspruit Surface Water,
Section 6.4 - Vaal River Surface Water,
Section 6.5 - Groundwater,
Section 6.6 - Groundwater Levels

Variable concentration trends and STIFF diagrams are displayed in **Figures 6.1.1** to **6.1.12**.

Surface and groundwater monitoring points will be compared to IWUL Limits and the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin.

The DWS Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering and the South African National Standard, Drinking Water Standard (Edition 2) (SANS 241:2015) were included as supplementary comparative guidelines and not for compliance purposes.

6.1 Waste Water

Table 6.4 indicates the average water quality for the waste water monitoring points compared to the IWUL Limits and the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin.

Contained waste water include:
MPS-S14 - Gensub PCD
MPS-S20 - Erickson Dams
MPS-S21 - North Shaft Return Water Dam (NS RWD)
MPS-S30 - Washplant PCD

Figures 6.1.1 illustrate variable concentration trends for all waste water monitoring points for the duration of the reporting period where **Figure 6.1.2** illustrate the average STIFF diagrams for all waste water monitoring points.

Table 6.4 Average water quality for waste water monitoring points for the reporting period.

Average Waste Water Quality for Mooiplaats July - September 2018									
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**MPS-S14**	**MPS-S20**	**MPS-S21**	**MPS-S30**
pH	-	**3.5 – 8.5**	**6.4 – 8.5**	**5.0 - 9.5**	-	7.51	8.49	8.01	8.34
EC	mS/m	**150**	**25**	**170**	**500**	*183.95	*292.27	*485.33	*374.33
TDS	mg/L	**1288**	-	**1200**	**3000**	1042	*1920	*3642	*2498
Total Hardness	mg/L	-	-	-	-	288	185	1336	409
Alkalinity	$CaCO_3$/L	-	**75**	-	-	386.000	1015.333	334.000	656.333
Ca	mg/L	**87**	-	-	**1000**	64.600	26.933	233.500	77.267
Mg	mg/L	**51.40**	-	-	**500**	30.850	28.633	182.867	52.400
Na	mg/L	**725**	-	**200**	**200**	282.800	660.900	735.500	782.367
K	mg/L	-	-	-	-	10.950	7.333	13.167	9.167
F	mg/L	**3.23**	**0.4**	**1.5**	**2**	0.700	3.133	1.167	2.767
Cl	mg/L	**116.66**	**20**	**300**	**3000**	*131.200	64.100	47.167	68.633
SO_4	mg/L	**740**	**30**	**500**	**1000**	288.950	520.100	*2230.367	*1111.600
NO_3	mg/L	-	**0.5**	**11**	-	0.200	-0.200	-2.000	-0.467
NH_3	mg/L	**0.24**	-	**1.5**	-	20.150	0.020	0.160	0.930
Al	mg/L	**0.09**	-	**0.3**	**5**	-0.050	-0.007	0.100	0.280
Fe	mg/L	**0.001**	-	**0.3**	**10**	0.390	-0.050	0.157	0.013
Mn	mg/L	**0.15**	-	**0.1**	**10**	0.770	0.037	1.493	0.077

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.
- "*" indicate variables exceeding the IWUL limits and GD-VO Guidelines.

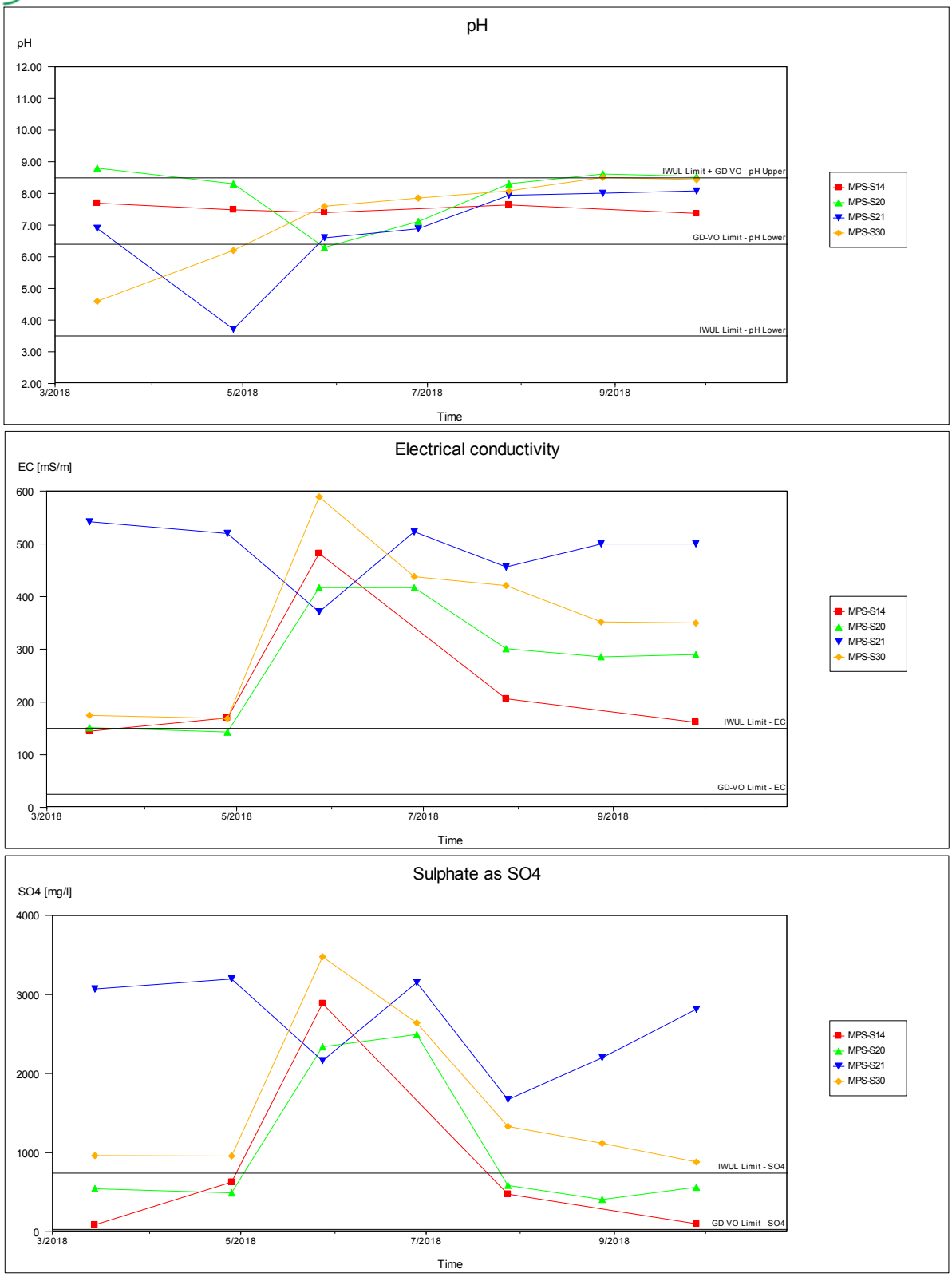
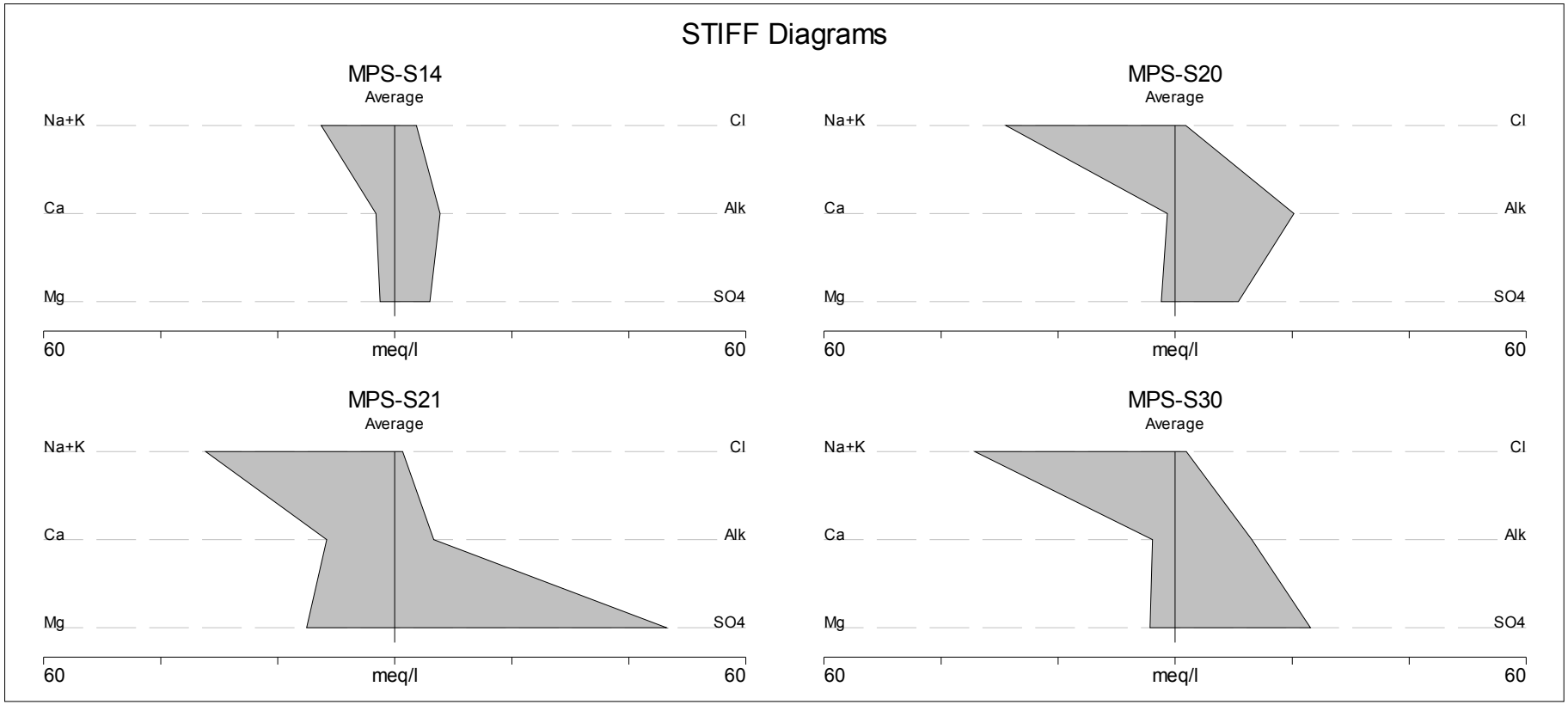


Figure 6.1.1 Waste water variable concentration trends

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.2 Average waste water STIFF diagrams.

From **Table 6.4** it is evident that the waste water quality exceeded several IWUL limits and the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin.

Although the pH of the waste water remained neutral during the reporting period, variable elevations in other variable concentrations were noted at the NS RWD (**MPS-S21**), where water quality at the Washplant PCD (**MPS-S30**), Underground Erickson dams (**MPS-S20**) and Gensub PCD (**MPS-S14**) improved.

The stabilisation/lowering in the majority of variable concentrations, as indicated with the EC and SO_4 concentrations as per **Figure 6.1.1** can be ascribed to the stabilisation in the producing/washing activities/processes since June/July 2018.

Although metal concentrations exceeded the IWUL, it must be noted that the limits are very low for contained process water.

From **Figure 6.1.2** it is evident that SO_4 is the dominating anion in the water composition, typical of coal waste water (except at the Gensub PCD which is a catchment PCD at the workshop area.

All waste water facilities are constructed and lined appropriately and operated in a closed circuit.

6.2 Storm Water and Surface Water Runoff

Table 6.5 indicates the average surface water quality for the surface and storm water runoff linked to the receiving environment from Mooiplaats Colliery. Water quality from these monitoring points is compared to the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin and IWUL Waste Water Limits.

The DWS Livestock watering upper limit, 1996 and the SANS 241:2015 drinking water standards are included for comparative purposes.

Variables exceeding the limits, standards are highlighted respectively.

Storm water and surface water runoff include:

MPS-S13 - Runoff from Loading Area
MPS-S15 - Clean stormwater trench entering Mooiplaats at Security Gate
MPS-S16 - DS area from Erickson dams and Settling Dams
MPS-S25 - Stormwater Trench Downstream of Workshop
MPS-S27 - Witpuntspruit entering Mooiplaats
MPS-S28 - After confluence of MPS-S13 and MPS-S15

MPS-S29 - Stormwater trench at Offices, Upstream of MPS-S25

Figure 6.1.3 illustrate variable concentration trends for surface and runoff water where **Figure 6.1.4** illustrate the water composition in STIFF diagrams

Table 6.5 Average water quality for surface and storm water runoff monitoring points for the reporting period.

Average Storm and Surface Water Quality for Mooiplaats Colliery July - September 2018										
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241: 2011**	**DWS Livestock Watering**	**MPS-S13**	**MPS-S15**	**MPS-S16**	**MPS-S25**	**MPS-S28**
pH	-	3.5 – 8.5	6.4 – 8.5	5.0 - 9.5	-	7.84	*8.59	5.48	8.22	*8.52
EC	mS/m	150	25	170	500	119.47	61.90	*578.00	26.25	63.40
TDS	mg/L	1288	-	1200	3000	779	354	4433	147	365
Total Hardness	mg/L	-	-	-	-	443	238	2246	109	248
Alkalinity	$CaCO_3$/L	-	75	-	-	194.667	144.000	342.833	142.000	148.000
Ca	mg/L	87	-	-	1000	90.633	46.300	213.433	27.500	48.200
Mg	mg/L	51.40	-	-	500	52.600	29.600	415.967	9.833	31.100
Na	mg/L	725	-	200	200	104.100	40.400	632.200	17.500	38.700
K	mg/L	-	-	-	-	2.933	1.100	17.000	2.467	1.200
F	mg/L	3.23	0.4	1.5	2	-0.400	-0.400	1.133	-0.400	-0.400
Cl	mg/L	116.66	20	300	3000	29.600	21.800	47.100	2.700	20.800
SO_4	mg/L	740	30	500	1000	384.533	131.200	*2900.333	3.700	138.600
NO_3	mg/L	-	0.5	11	-	-2.000	-2.000	-0.100	-2.000	-2.000
NH_3	mg/L	0.24	-	1.5	-	0.590	-0.020	1.870	-0.020	-0.020
Al	mg/L	0.09	-	0.3	5	0.067	0.070	45.427	0.043	0.100
Fe	mg/L	0.001	-	0.3	10	0.063	-0.050	2.793	0.123	0.060
Mn	mg/L	0.15	-	0.1	10	0.000	-0.050	116.370	-0.007	-0.050

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit. "*" indicate variables exceeding the IWUL limits and GD-VO Guidelines.
- "*" indicate variables exceeding the IWUL limits and GD-VO Guidelines.

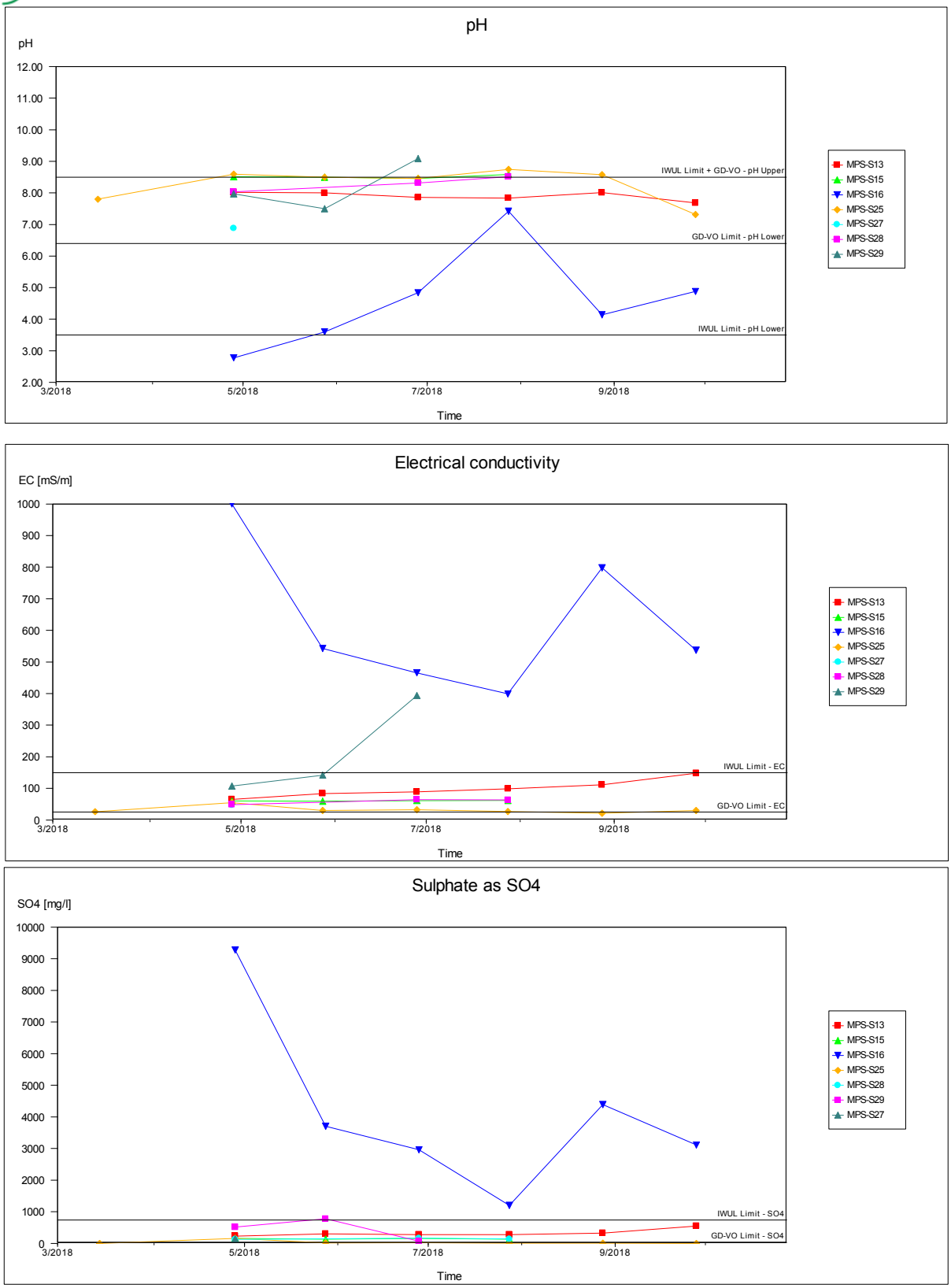
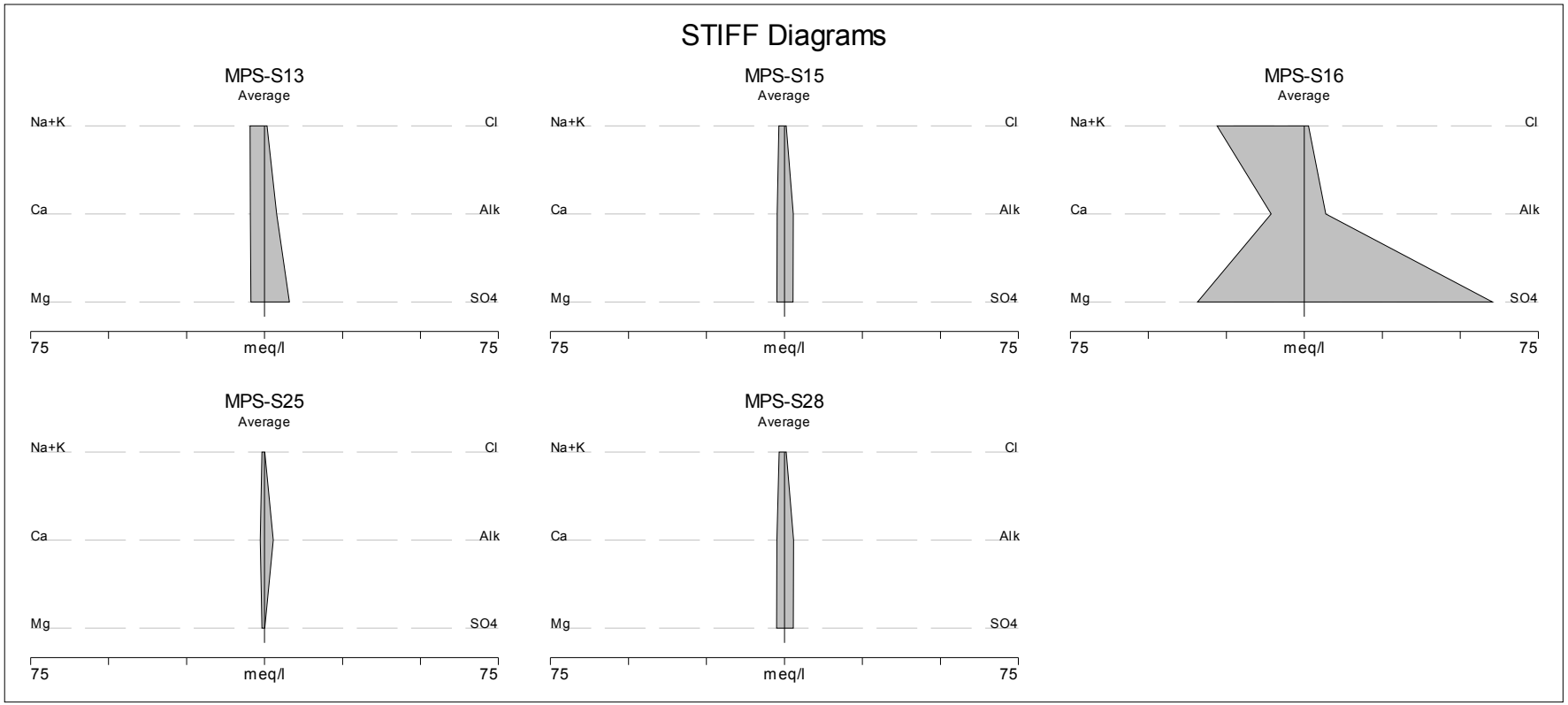


Figure 6.1.3 Variable concentration trends for surface and runoff water monitoring points.

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.4 STIFF Diagrams for surface and storm water runoff monitoring points.

From **Table 6.5** and **Figures 6.1.3** and **6.1.4** it is evident that water quality at all runoff monitoring points recorded signs of coal mine pollution as indicators such as pH, EC and SO_4 recorded elevated concentrations.

Although the IWUL Waste Water Limits was mostly not exceeded, the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin was exceeded in terms of EC, Alkalinity and SO_4.

The water quality at **MPS-S16** can be associated with Acid Mine Drainage (AMD) with a very low pH, elevated salts and metals. **MPS-S16** is located directly down gradient of the coal disposal facility, and several other water related infrastructure. Water from this area should be prevented from entering the receiving environment.

All stormwater and surface water runoff reports to the Witpuntspruit tributary, **WT-S05** where a definite coal mine impact is observed.

The high to elevated $CaCO_3$ (in Alkalinity) concentrations can be ascribed to geological conditions as it originate from the sedimentary rocks (limestone) containing calcite and aragonite. $CaCO_3$ is also the active ingredient in agricultural lime.

Although **MPS-S15** is located upstream of mining activities, the pH, EC, SO_4, Alkalinity and Cl exceeded GD-VO Guidelines. **MPS-S13** (runoff from loading area) reports to **MPS-S15** upstream of **MPS-S28** where a slight deterioration in water quality was noted. Although **MPS-S13** was mostly stagnant during the reporting period, the possibility exists that water from **MPS-S13** overflowed into **MPS-S15** during a rain event.

MPS-S25 drain the offices area and a small clean area of the workshop. Although the EC and Alkalinity ($CaCO_3$) exceeded the GD-VO Guidelines, the variable concentrations cannot be ascribed to coal mine pollution but rather to geological and environmental conditions.

6.3 Witpuntspruit Surface Water

Table 6.6 indicates the average surface water quality for the Witpuntspruit and associated tributaries draining Mooiplaats Colliery and other possible pollution sources. Water quality from these monitoring points are compared to the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin and IWUL Waste Water Limits.

The DWS Livestock watering upper limit, 1996 and the SANS 241:2015 drinking water standards are included for comparative purposes.

Variables exceeding the limits, standards are highlighted respectively.

Figure 6.1.5 depicts the Witpuntspruit surface monitoring point variable concentration trends, **Figure 6.1.6** represent the water quality stream profile for the Witpuntspruit and **Figure 6.1.7** illustrates the composition of the Witpuntspruit water quality in STIFF Diagrams.

Table 6.6 Average water quality for the Witpuntspruit and its Tributaries surface water monitoring points for the reporting period.

Average Witpuntspruit Water Quality for Mooiplaats Colliery July - September 2018										
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**WT-S01**	**WT-S03**	**WT-S02**	**WT-S04**	**WT-S05**
pH	-	3.5 – 8.5	6.4 – 8.5	5.0 - 9.5	-	*3.07	7.53	7.24	7.08	*3.17
EC	mS/m	150	25	170	500	*237.70	55.17	79.97	99.67	*590.00
TDS	mg/L	1288	-	1200	3000	1559	325	491	639	5009
Total Hardness	mg/L	-	-	-	-	936	180	270	342	2605
Alkalinity	$CaCO_3$/L	-	75	-	-	-3.500	79.667	66.333	67.000	-3.500
Ca	mg/L	87	-	-	1000	180.533	41.233	57.767	70.167	409.933
Mg	mg/L	51.40	-	-	500	117.833	18.700	30.600	40.600	383.933
Na	mg/L	725	-	200	200	74.067	42.833	55.967	72.167	584.200
K	mg/L	-	-	-	-	8.600	3.333	7.133	10.667	17.567
F	mg/L	3.23	0.4	1.5	2	-0.400	-0.400	-0.400	-0.100	-0.400
Cl	mg/L	116.66	20	300	3000	22.900	17.533	25.267	32.000	27.967
SO_4	mg/L	740	30	500	1000	*1159.367	155.600	277.000	375.100	*3590.300
NO_3	mg/L	-	0.5	11	-	0.000	0.000	0.000	0.000	0.000
NH_3	mg/L	0.24	-	1.5	-	1.010	-0.020	0.510	0.110	0.940
Al	mg/L	0.09	-	0.3	5	31.073	0.023	0.033	0.067	39.297
Fe	mg/L	0.001	-	0.3	10	19.530	0.340	0.073	0.157	17.423
Mn	mg/L	0.15	-	0.1	10	12.333	-0.050	0.460	0.180	28.573

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.
- "*" indicate variables exceeding the IWUL limits and GD-VO Guidelines.

Table 6.6 (cont.) Average water quality for the Witpuntspruit and its Tributaries surface water monitoring points for the reporting period.

Average Witpuntspruit Water Quality for Mooiplaats Colliery July - September 2018									
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**MPS-S08**	**Usutu Decant Surface**	**Usutu Decant Sump**	**WT-S06**
pH	-	**3.5 – 8.5**	**6.4 – 8.5**	**5.0 - 9.5**	**-**	7.38	*8.74	7.40	8.08
EC	mS/m	**150**	**25**	**170**	**500**	106.37	*452.00	*173.55	*174.57
TDS	mg/L	**1288**	**-**	**1200**	**3000**	704	3408	1199	1118
Total Hardness	mg/L	**-**	**-**	**-**	**-**	373	120	352	251
Alkalinity	$CaCO_3$/L	**-**	**75**	**-**	**-**	58.000	1338.000	508.500	478.000
Ca	mg/L	**87**	**-**	**-**	**1000**	74.267	26.000	85.700	51.633
Mg	mg/L	**51.40**	**-**	**-**	**500**	45.500	13.300	33.400	29.667
Na	mg/L	**725**	**-**	**200**	**200**	87.633	1377.000	336.250	322.233
K	mg/L	**-**	**-**	**-**	**-**	11.400	8.100	9.850	7.133
F	mg/L	**3.23**	**0.4**	**1.5**	**2**	-0.100	2.900	0.450	1.467
Cl	mg/L	**116.66**	**20**	**300**	**3000**	33.167	86.800	42.250	52.433
SO_4	mg/L	**740**	**30**	**500**	**1000**	419.767	*1092.700	385.700	369.000
NO_3	mg/L	**-**	**0.5**	**11**	**-**	0.000	0.000	0.100	0.000
NH_3	mg/L	**0.24**	**-**	**1.5**	**-**	0.210	-0.020	-0.020	0.620
Al	mg/L	**0.09**	**-**	**0.3**	**5**	0.077	0.590	-0.050	-0.013
Fe	mg/L	**0.001**	**-**	**0.3**	**10**	0.103	0.640	-0.050	-0.050
Mn	mg/L	**0.15**	**-**	**0.1**	**10**	0.047	-0.050	-0.050	-0.050

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.
- "*" indicate variables exceeding the IWUL limits and GD-VO Guidelines.

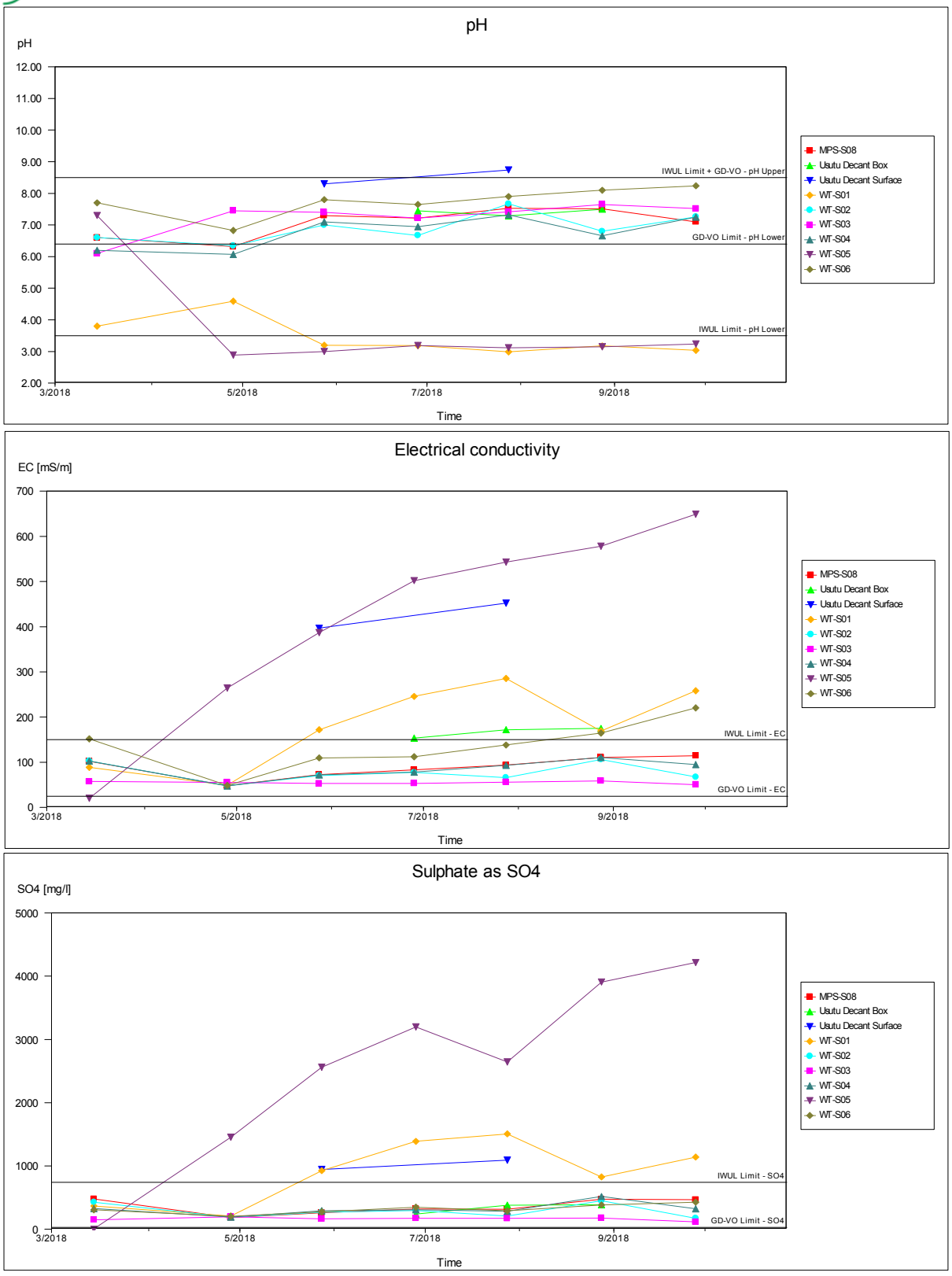
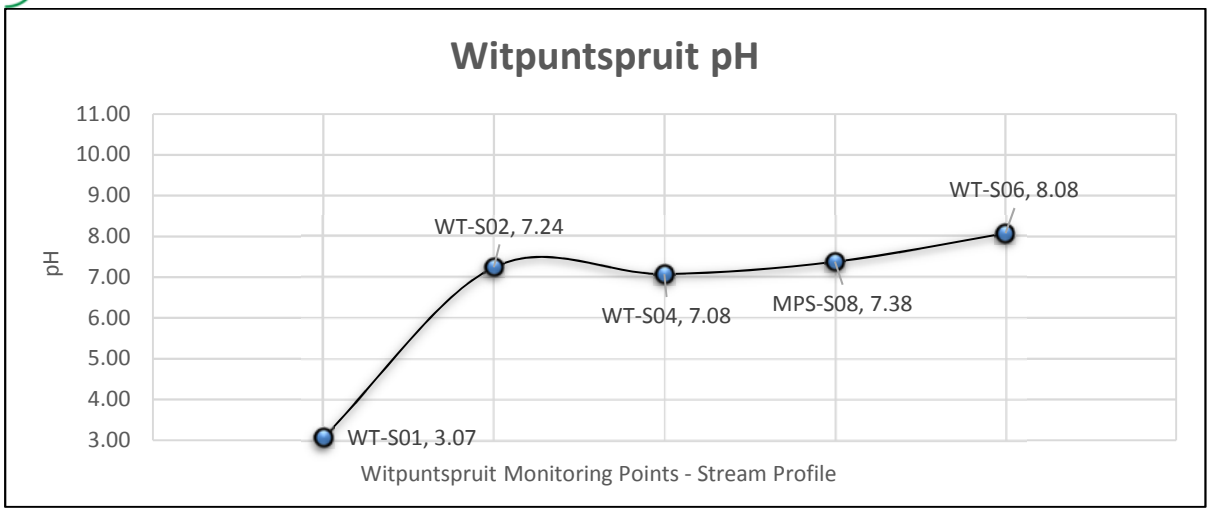
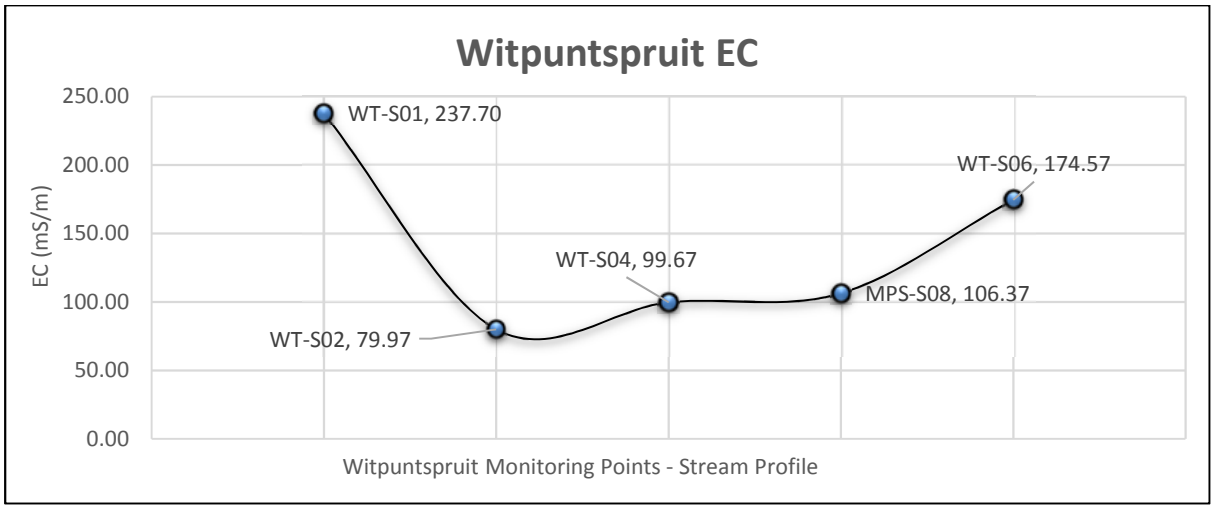


Figure 6.1.5 Witpuntspruit and Tributaries water monitoring points variable concentration trends.





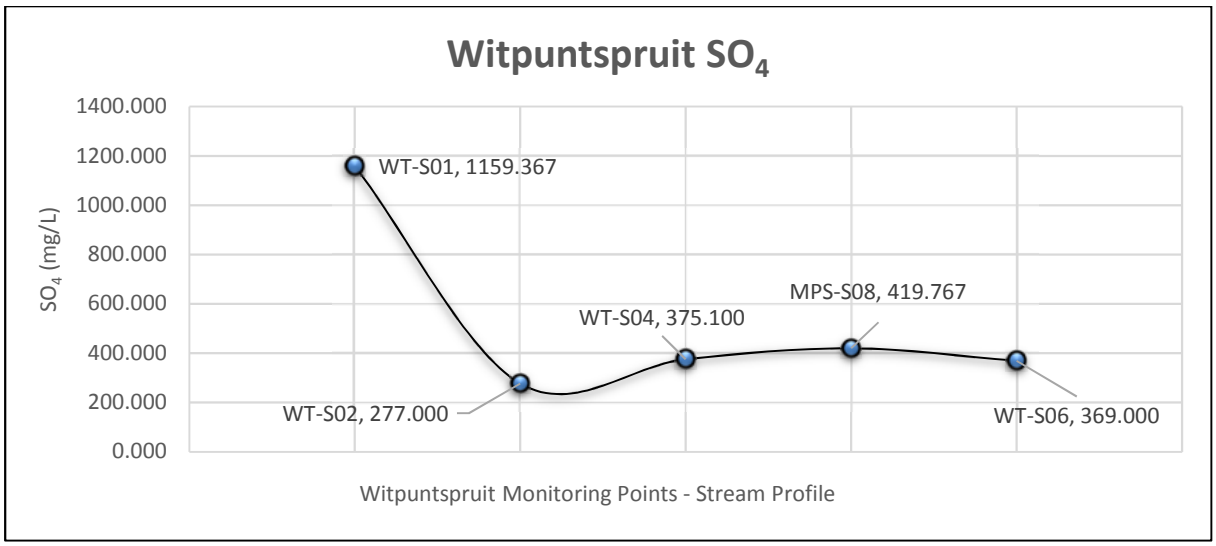
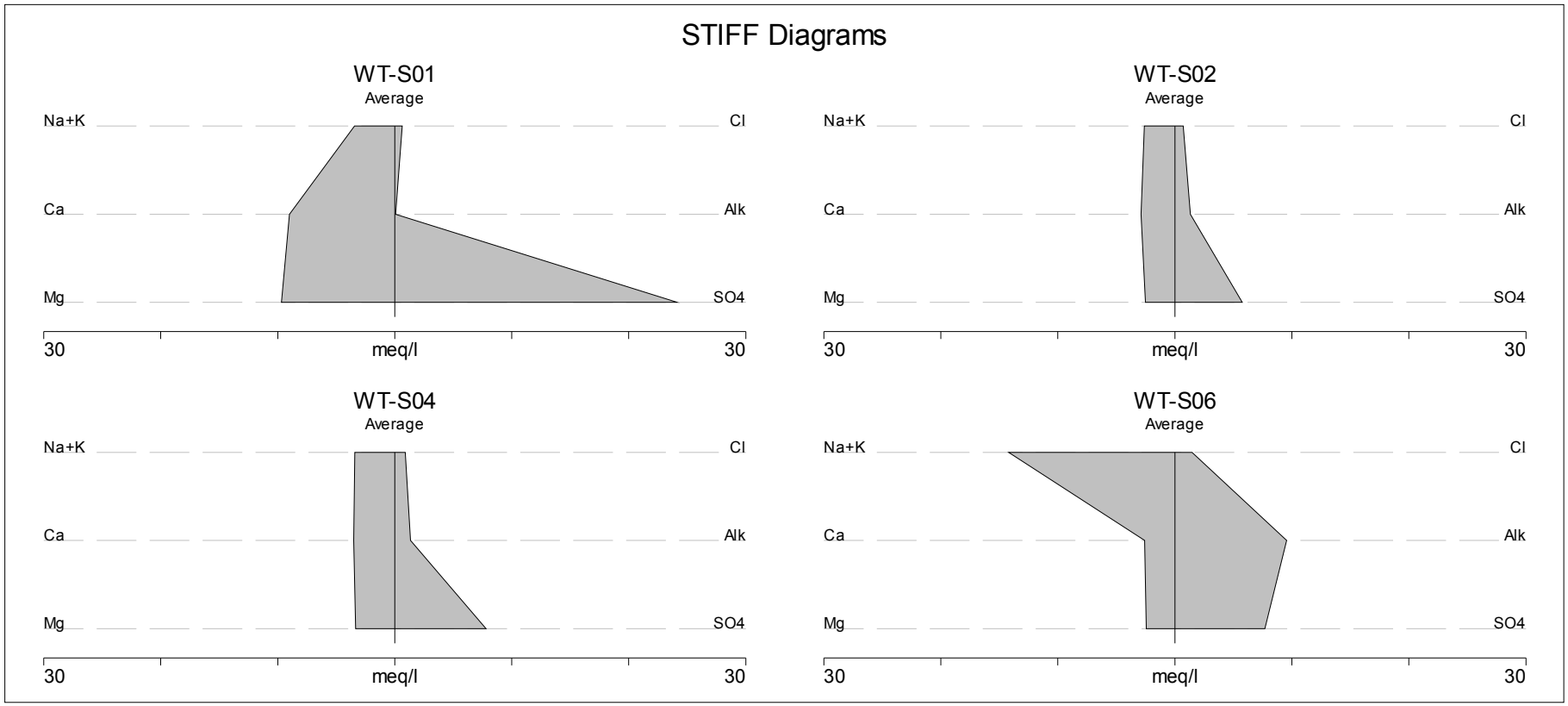


Figure 6.1.6 Witpuntspruit stream profile. *Upstream left, to downstream right.*

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible coal mining pollution.

- A dominant Alkalinity/Bicarbonate (HCO_3^-) anion indicates fresh, natural and unimpacted water.
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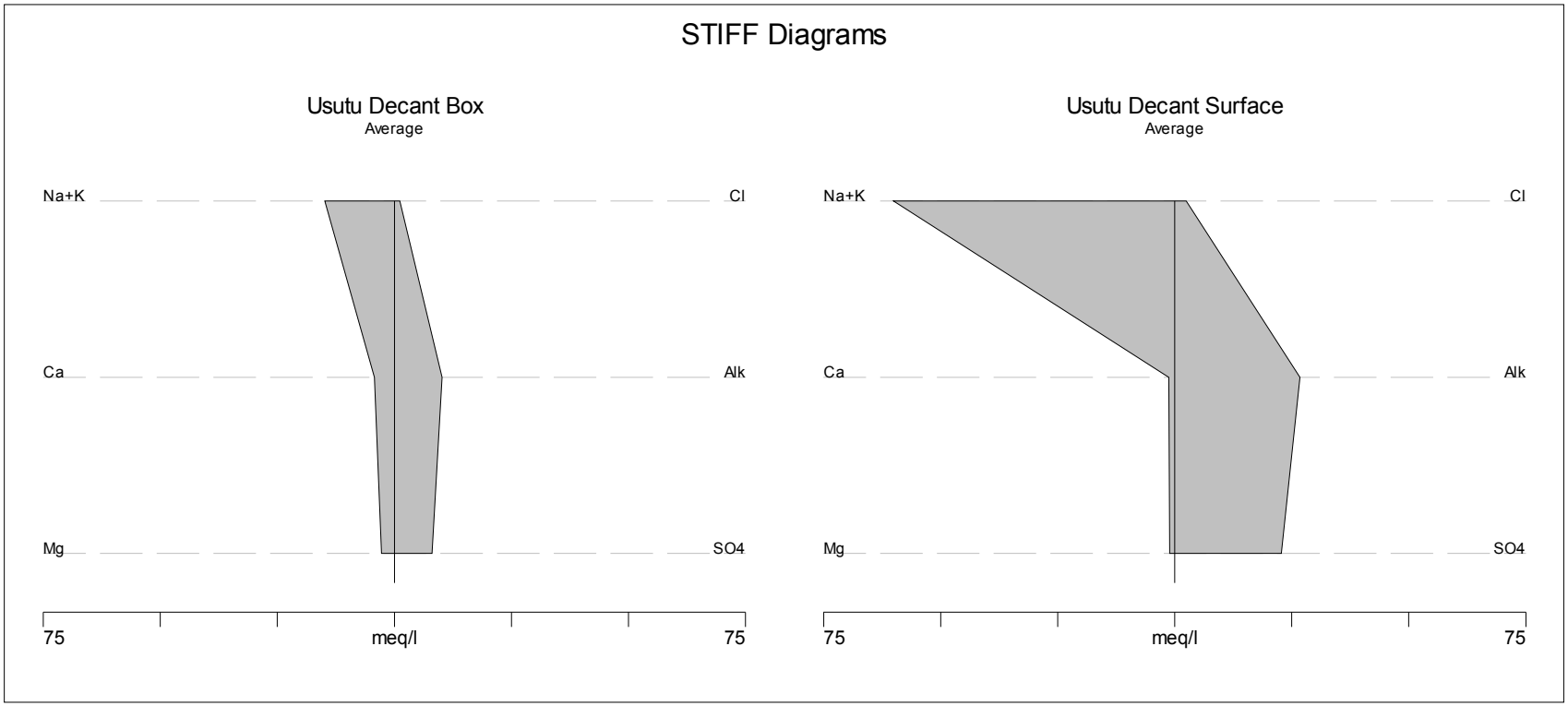

* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.7 STIFF Diagrams for the Witpuntspruit surface water monitoring points.

From **Table 6.6** and **Figures 6.1.5** and **6.1.6** it is evident that water quality from the Witpuntspruit are highly impacted on, from upstream (**WT-S01**) of Mooiplaats Colliery to downstream (**WT-S06**) of Mooiplaats Colliery before the confluence with the Vaal River. Irrespective of the tributaries draining Mooiplaats Colliery entering the Witpuntspruit, the water quality already exceeds Unacceptable water quality in terms of the Grootdraai Dam Guidelines.

Although the water quality show improvement in **Figures 6.1.6** and **6.1.7** from **WT-S01** to **WT-S06**, a slight deterioration from **WT-S04** to **MPS-S08** can be seen as the EC and SO_4 concentrations increase after the confluence of the **WT-S05** (downstream of **MPS-S16**) tributary from Mooiplaats Colliery entering the Witpuntspruit. Although the **WT-S05** tributary has been stagnant for the duration of the reporting period and did not enter the Witpuntspruit it is assumed that due to the prolonged contamination (especially during the care and maintenance phase of Mooiplaats) of this tributary, an effect can still be seen on the Witpuntspruit.

As per the STIFF Diagrams in **Figure 6.1.7** the improvement in water quality and composition from **WT-S01** to **WT-S02**, to **WT-S04** are clearly visible where the composition of the water changes at **WT-S06** due to **decant** from the **Old Usutu mine** entering the Witpuntspruit between **MPS-S08** and **WT-S06**. Two areas of Usutu decant are monitored, one decant flowing via surface (elevated pH, EC, $CaCO_3$, Na, Cl, F and SO_4) and one flowing below surface (monitored in flooded sump structures) with lower variable concentrations of the above mentioned variables. Nevertheless, the addition of the Usutu decants into the Witpuntspruit elevate the pH, EC, $CaCO_3$, Na, Cl, F and SO_4 concentrations in the Witpuntspruit.

The Usutu decant is not the responsibility or legacy of Mooiplaats Colliery.

Irrespective of the unacceptable water quality and composition of the Witpuntspruit, any possible pollution from Mooiplaats Colliery entering the Witpuntspruit should be prevented.

From **WT-S01** to **WT-S02** a dramatic improvement in water quality were recorded due to a large wetland situated between the monitoring points. Should this wetland be enhanced or extended to the lower reaches of the Witpuntspruit (towards **WT-S06** or lower) the water quality will possibly improve further, improving the water quality entering the Vaal River.

6.4 Vaal River Surface Water

Table 6.7 indicates the average surface water quality for the Vaal River and associated tributaries draining Mooiplaats Colliery and other possible pollution sources. Water quality

from these monitoring points are compared to the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin and IWUL Waste Water Limits.

The DWS Livestock watering upper limit, 1996 and the SANS 241:2015 drinking water standards are included for comparative purposes.

Variables exceeding the limits, standards are highlighted respectively.

Figure 6.1.8 depicts the Vaal River surface monitoring point variable concentration trends, **Figure 6.1.9** represent the Vaal River water quality stream profile,
Figure 6.1.10 illustrates the composition of the Vaal River water quality in STIFF Diagrams, and **Figure 6.1.11** illustrate the impact of pollution sources on the Vaal River.

Table 6.7 Average water quality for the Vaal River surface water monitoring points for the reporting period.

Average Vaal River Water Quality for Mooiplaats July - September 2018									
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**VL-S01**	**VL-S02**	**VL-S03**	**VL-S04**
pH	-	**3.5 – 8.5**	**6.4 – 8.5**	**5.0 - 9.5**	-	7.37	7.67	8.33	8.20
EC	mS/m	**150**	**25**	**170**	**500**	20.29	33.76	33.71	33.86
TDS	mg/L	**1288**	-	**1200**	**3000**	114	189	193	194
Total Hardness	mg/L	-	-	-	-	77	92	95	95
Alkalinity	$CaCO_3$/L	-	**75**	-	-	76.000	95.000	92.000	94.667
Ca	mg/L	**87**	-	-	**1000**	13.633	17.300	17.800	17.967
Mg	mg/L	**51.40**	-	-	**500**	10.367	11.967	12.167	12.267
Na	mg/L	**725**	-	**200**	**200**	13.033	35.867	35.867	35.600
K	mg/L	-	-	-	-	2.400	3.133	2.933	2.967
F	mg/L	**3.23**	**0.4**	**1.5**	**2**	-0.400	-0.400	-0.400	-0.400
Cl	mg/L	**116.66**	**20**	**300**	**3000**	12.767	16.500	16.733	16.767
SO_4	mg/L	**740**	**30**	**500**	**1000**	18.333	50.067	53.333	54.100
NO_3	mg/L	-	**0.5**	**11**	-	-2.000	-2.000	-0.367	-2.000
NH_3	mg/L	**0.24**	-	**1.5**	-	-0.020	0.220	-0.020	-0.020
Al	mg/L	**0.09**	-	**0.3**	**5**	-0.010	-0.013	-0.003	-0.007
Fe	mg/L	**0.001**	-	**0.3**	**10**	0.133	0.063	0.120	0.100
Mn	mg/L	**0.15**	-	**0.1**	**10**	-0.050	-0.050	-0.050	-0.050

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.
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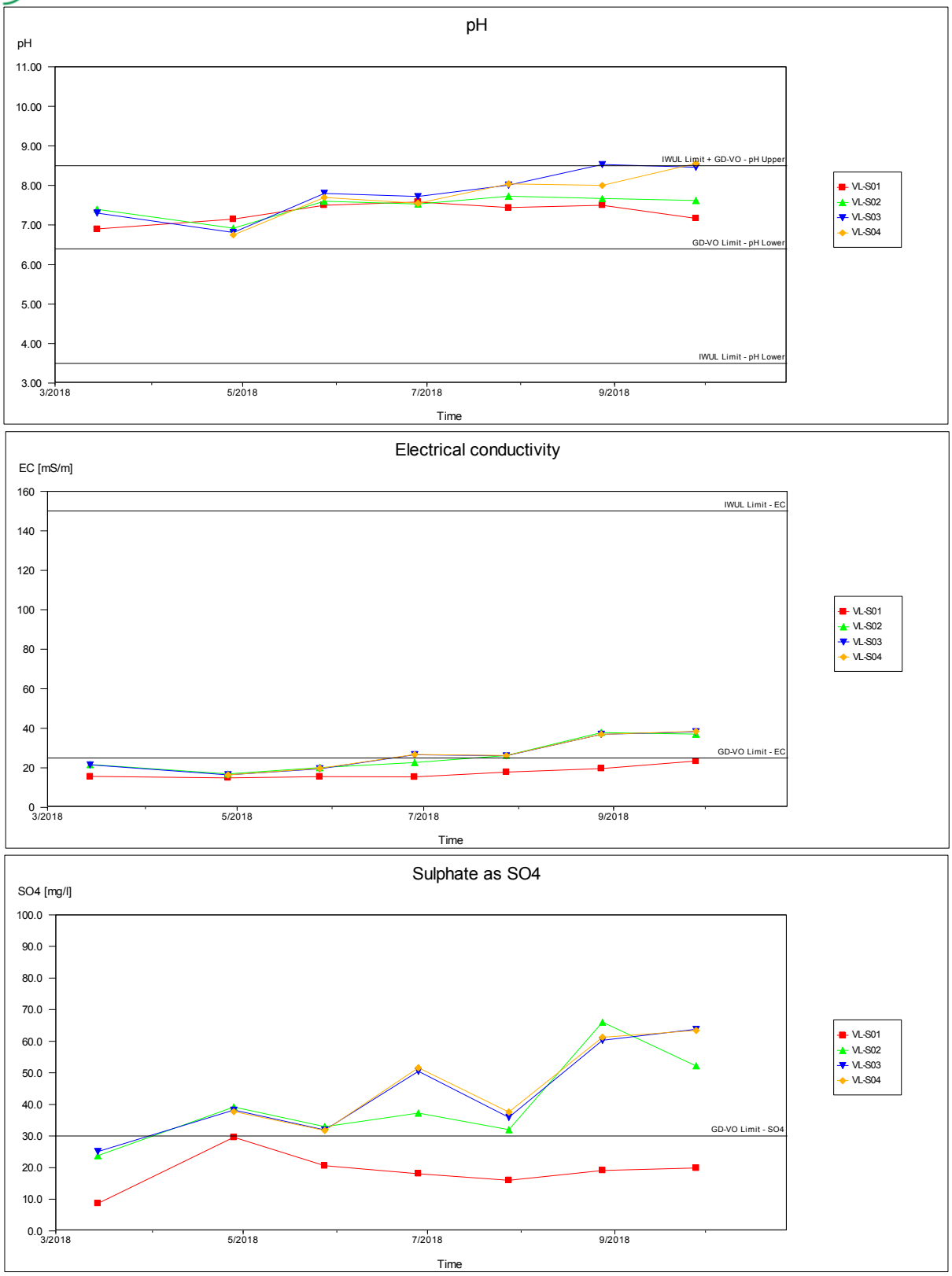


Figure 6.1.8 Vaal River water monitoring points variable concentration trends.

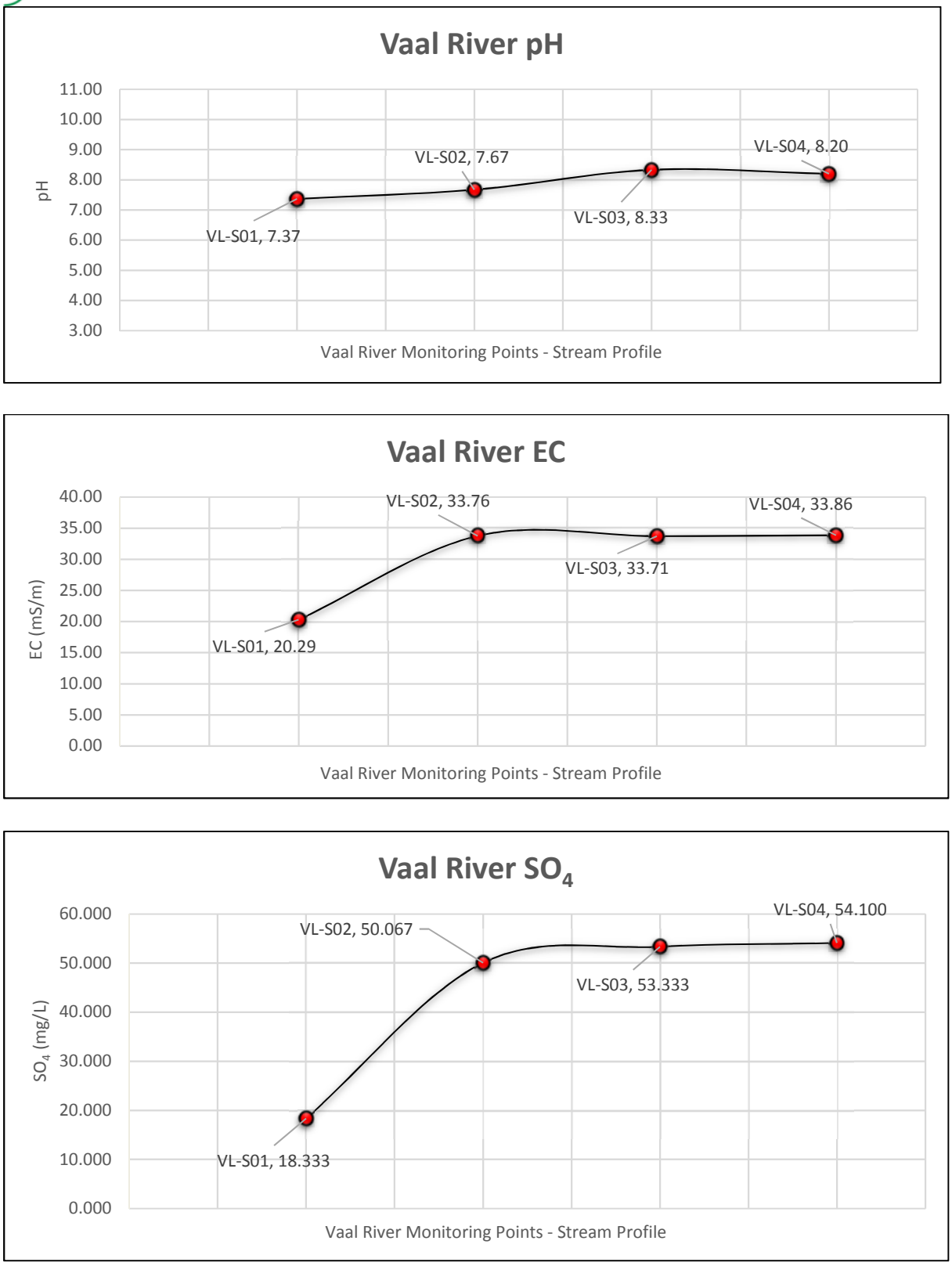
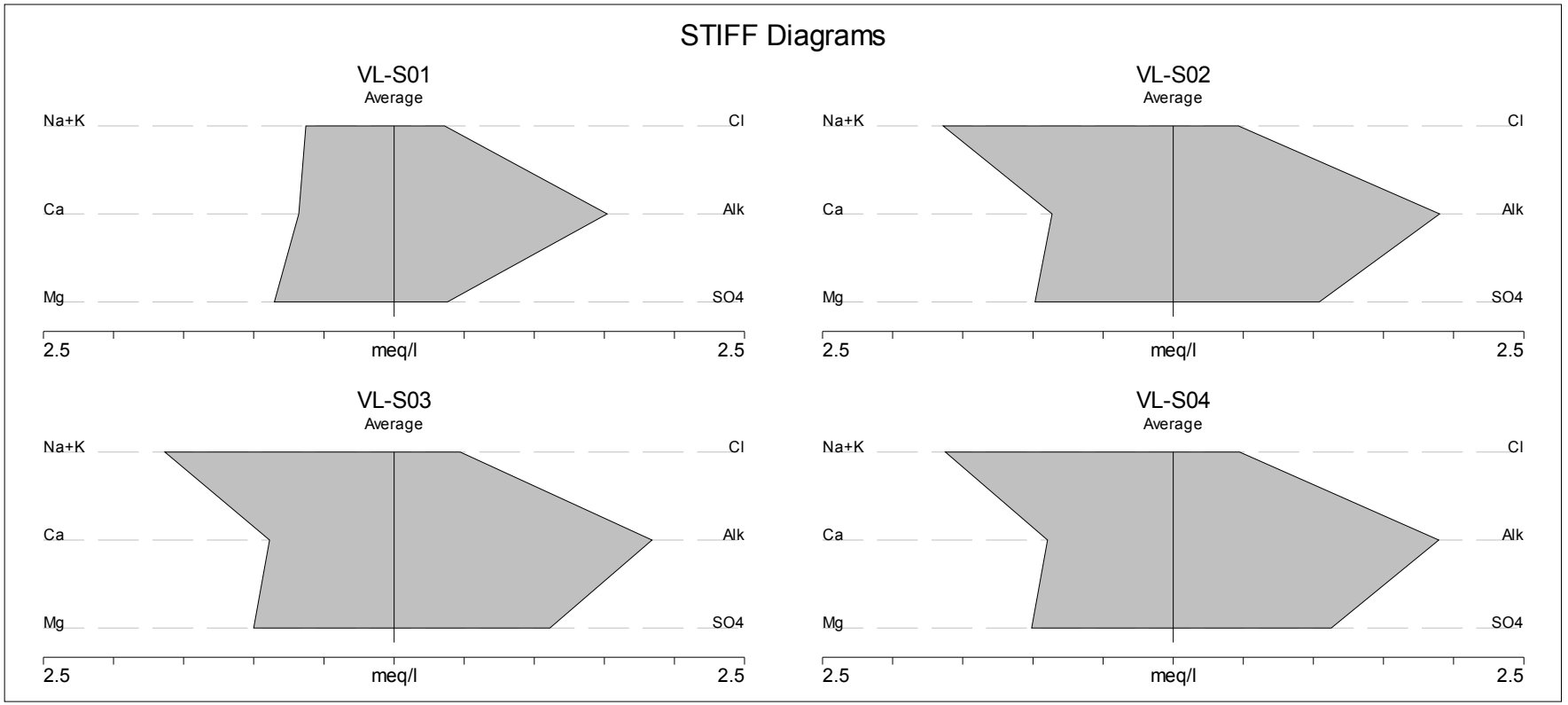


Figure 6.1.9 Vaal River stream profile. *Upstream left, to downstream right.*

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.10 STIFF Diagrams for the Vaal River surface water monitoring points.

From **Table 6.7** and **Figures 6.1.8** to **6.1.11** it is evident that the water quality and composition from the Vaal River deteriorate / change after the confluence with the Witpuntspruit between monitoring points **VL-S01** and **VL-S02**.

Although the EC, $CaCO_3$ (Alkalinity) and SO_4 concentrations exceeded the Grootdraai Dam Guidelines downstream of the Witpuntspruit confluence in the Vaal River(**VL-S02**, **VL-S03** and **VL-S04**), the water quality can be described as Unacceptable (in terms of SO_4) after the confluence with the Witpuntspruit.

The deterioration in water quality in the Vaal River downstream of the Witpuntspruit confluence, can probably be ascribed to the lower Vaal River flow and constant Witpuntspruit flow into the Vaal River – increasing the percentage of Witpuntspruit water in the Vaal River system. From **VL-S02** to **VL-SO4** the water quality of the Vaal River remains relative stable.

Low Fe concentrations at all Vaal River monitoring points (upstream and downstream of the Witpuntspruit confluence) exceeded the IWUL limits which is very low. Low Fe concentrations can possibly be ascribed to geological conditions as Fe and Al concentrations in the water environment are very often the result of weathered rock entering the water resource.

The pollution source of the Witpuntspruit, upstream of Mooiplaats Colliery (upstream of **WT-S01**) should be addressed (by the relevant authority and contributors) to reduce the pressure on the Vaal River system and downstream users.

Mooiplaats Colliery has been in care and maintenance for approximately five years before the commencement of activities in 2018. Neglected and abandoned water infrastructure on Mooiplaats Colliery during the care and maintenance phase possibly contributed / impacted on the immediate surrounding area and therefore the water quality observed at **WT-S05**.

With the commencement of activities (under new ownership and management) in 2018 slight improvements have been noted due to several maintenance operations. Maintenance and management efforts should be continued to further improve the environmental conditions surrounding Mooiplaats Colliery.

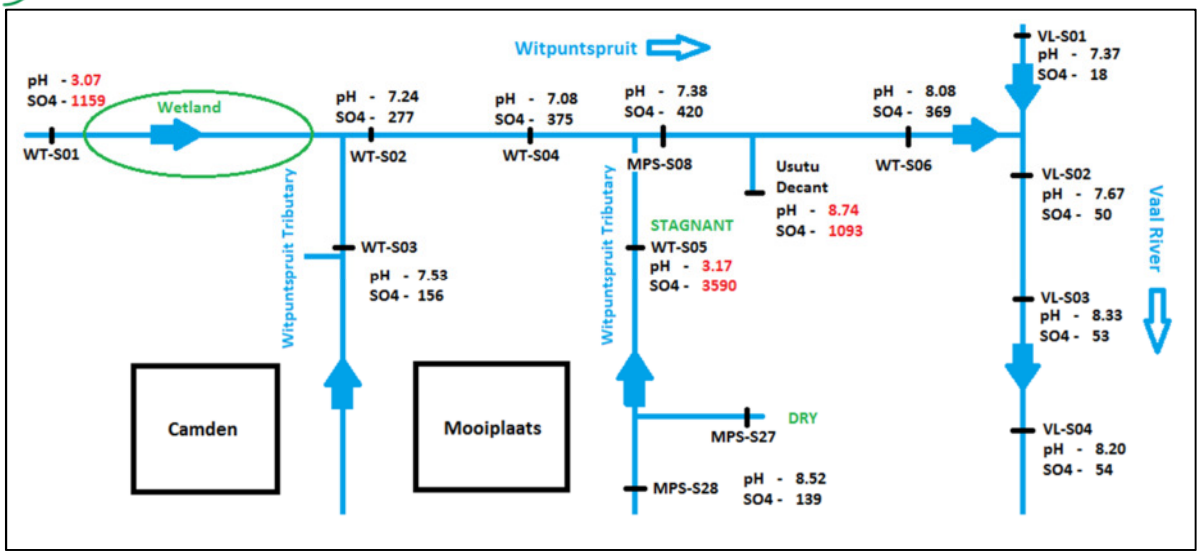


Figure 6.1.11 Schematic flow diagram of the Witpuntspruit and Vaal River relative to Mooiplaats and surrounding activities.

6.5 Groundwater

Table 6.8 and indicates the average groundwater quality for the Mooiplaats Colliery monitoring points compared to the IWUL limits, Grootdraai Dam Guidelines - Vaal Origin, DWS Livestock watering upper limit, 1996 and the SANS 241:2015 drinking water standards. Variables exceeding the limits, standards are highlighted respectively.

Figure 6.1.12 illustrates the composition of the groundwater water quality in STIFF Diagrams.

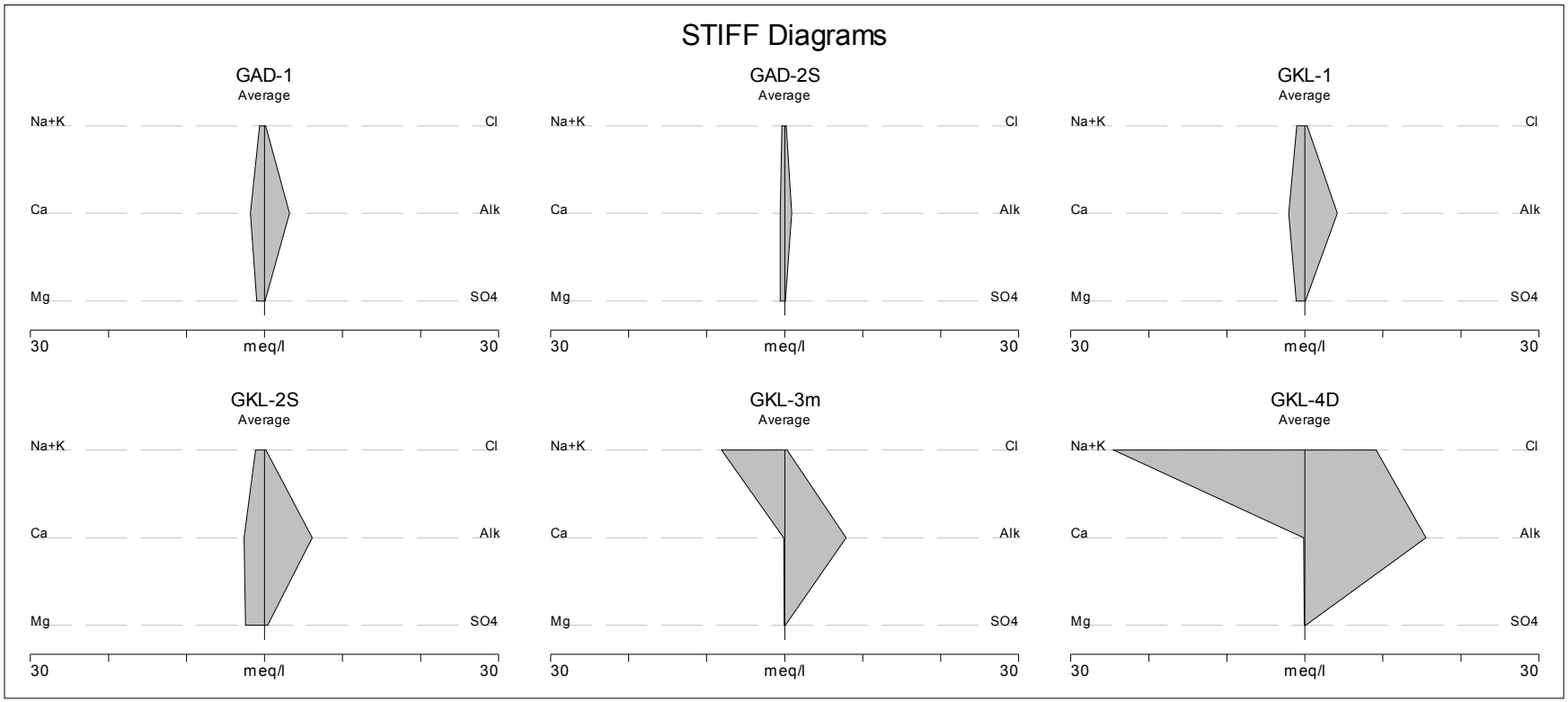
Table 6.8 Average water quality for Mooiplaats groundwater monitoring points for the reporting period.

Average Groundwater Quality for Mooiplaats July - September 2018											
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**GAD-1**	**GAD-2S**	**GKL-1**	**GKL-2S**	**GKL-3m**	**GKL-4D**
pH	-	8.78	6.4 – 8.5	5.0 - 9.5	-	7.14	7.30	7.24	7.60	*9.12	8.63
EC	mS/m	150	25	170	500	29.70	13.11	36.90	58.27	72.60	*238.10
TDS	mg/L	-	-	1200	3000	159	59	212	316	434	1364
Total Hardness	mg/L	-	-	-	-	140	57	160	255	10	11
Alkalinity	$CaCO_3$/L	-	75	-	-	160.000	45.333	209.000	305.667	393.667	776.333
Ca	mg/L	15.18	-	-	1000	36.133	11.367	41.567	52.800	2.733	2.800
Mg	mg/L	6.96	-	-	500	12.000	7.000	13.700	29.800	0.833	0.900
Na	mg/L	61.55	-	200	200	13.733	7.400	18.300	25.633	185.400	562.467
K	mg/L	-	-	-	-	2.033	0.733	9.733	1.700	1.100	2.900
F	mg/L	0.30	0.4	1.5	2	-0.400	*0.567	-0.400	-0.400	*1.300	*2.967
Cl	mg/L	19.97	20	300	3000	5.400	7.333	10.133	6.067	10.733	*323.933
SO_4	mg/L	0.25	30	500	1000	-4.000	-4.000	-4.000	19.400	-4.000	-0.333
NO_3	mg/L	0.07	0.5	11	-	-2.000	*1.367	-2.000	-2.000	-0.567	*2.600
NH_3	mg/L	-	-	1.5	-	0.080	-0.020	-0.020	-0.020	0.610	1.290
Al	mg/L	-	-	0.3	5	-0.050	0.047	-0.013	0.080	-0.013	0.023
Fe	mg/L	-	-	0.3	10	0.573	0.443	0.123	0.217	0.183	0.197
Mn	mg/L	-	-	0.1	10	0.333	-0.050	0.040	-0.050	-0.050	-0.050

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.
- "*"Indicate variables exceeding the IWUL limits and GD-VO Guidelines.

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.12 STIFF Diagrams for Mooiplaats Colliery groundwater monitoring points.

From **Table 6.8** and **Figure 6.1.12** it is evident that groundwater in the greater Mooiplaats Colliery area are of relatively good quality with high pH values and Alkalinity ($CaCO_3$) concentrations.

Due to very low IWUL limits (SO_4 of 0.25mg/L, Ca of 15.18mg/L and Mg of 6.96 mg/L), several IWUL limits were exceeded. Naturally high $CaCO_3$ concentrations elevate EC concentrations and pH values which exceeded the Grootdraai Dam Guidelines - Vaal Origin for pH, EC and $CaCO_3$.

Although SO_4 concentrations was observed at the groundwater monitoring point towards the Vaal river, **GKL-2s** was unlikely impacted by Mooiplaats Colliery. The presence of SO_4 and Fe can most probably be ascribed to an exposed coal seam or other geological factors as the borehole is drilled to a depth of 6 meters only. The water quality will be monitored and investigated should an increase in the concentrations be observed.

GKL-4d is a deep borehole drilled to a depth of 80 meters. The $CaCO_3$, Na and Cl concentrations elevate the pH and EC concentrations, leading to IWUL Limit exceedances. Elevated $CaCO_3$, Na and Cl can most likely be ascribed to geological conditions and not mining pollution.

The presence (some areas elevated) of $CaCO_3$, Na, Ca, Mg, Cl and Fe concentrations can most probably be ascribed to the geology of the area as illustrated in the STIFF Diagrams in almost all surface and groundwater monitoring points.

6.6 Groundwater Levels

Groundwater levels are monitored on a monthly (IWUL boreholes) and biannual (additional boreholes) basis to determine whether Mooiplaats Colliery has an effect on the groundwater resource and levels.

Table 6.9 contain groundwater levels below ground level (MBGL) for the IWUL monitoring boreholes and **Figure 6.2** illustrate the groundwater level trends.

Table 6.9 Mooiplaats groundwater levels for IWUL monitoring boreholes.

Mooiplaats Groundwater Levels						
Date	**GAD-1**	**GAD-2S**	**GKL-1**	**GKL-2S**	**GKL-3m**	**GKL-4D**
May-18	-4.82	-8.99	No Access	-4.21	-4.72	-4.65
Jun-18	-4.95	-9.23	-26.44	-4.24	-4.72	-4.68
Jul-18	-5.07	-9.50	-26.46	-4.29	-4.80	-4.75
Aug-18	-5.145	-9.66	-26.40	-4.31	-4.83	-4.71

Mooiplaats Groundwater Levels						
Date	**GAD-1**	**GAD-2S**	**GKL-1**	**GKL-2S**	**GKL-3m**	**GKL-4D**
Sep-18	-5.33	-9.88	-26.48	-4.37	-4.87	-4.74

Evident from **Table 6.9** and **Figure 6.2**, all groundwater levels showed a slight but continuous lowering in level. The slight lowering in water levels can be ascribed to the dry season as no to very little rain water recharges the groundwater aquifer during this time. It is expected that the groundwater aquifer will start to recharge after the commencement of the wet season (December/January/February depending on the amount of rains received).

No substantial or uneven increases or decreases in groundwater levels have been observed during the reporting period.

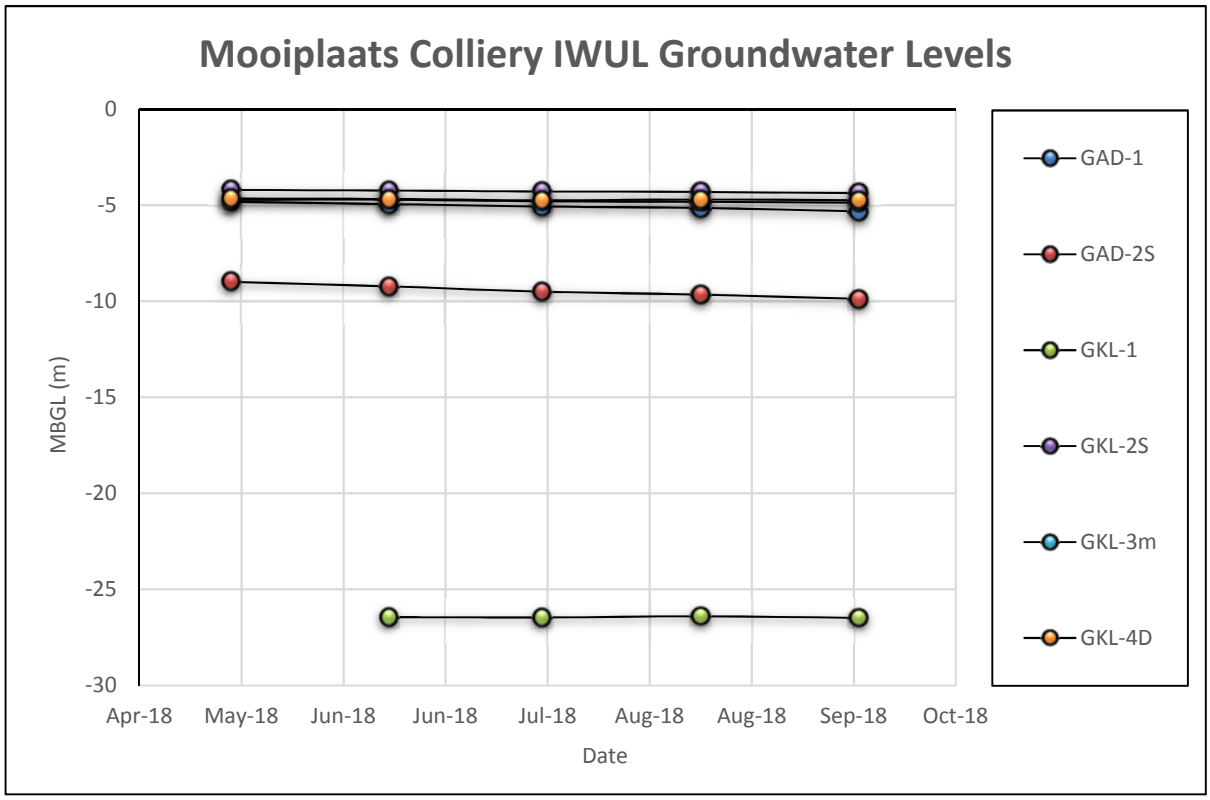


Figure 6.2 Mooiplaats Colliery IWUL groundwater level trends.

7. DISCUSSION AND CONCLUSION

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

7.1 Surface water

Waste water - Water quality from the mine water/pollution control dams monitoring points exceeded limits in terms of EC, TDS, $CaCO_3$, Ca, Mg, F, Cl, SO_4, NH_3, Al, Fe and Mn. These results are typical of water associated with coal washing/mining activities. It should be noted that although these monitoring points recorded elevated variable concentrations, the water is being contained in appropriate waste water storage facilities and circulated in a closed circuit i.e. dirty water circuit and no water are being released into the receiving environment.

Storm and Surface Water Runoff - It is evident that the surface runoff water quality within the boundaries of Mooiplaats Colliery is of general good quality (in comparison with the Witpuntspruit) with the exception of **MPS-S16**. Water quality at **MPS-S16** is the result of a lack of maintenance and management during the care and maintenance phase. Several measures since the commencement of mining activities in 2018 were taken to prevent further pollution. Water quality will be closely monitored for improvement or deterioration.

Water Quality from the **Witpuntspruit** is highly impacted upstream of Mooiplaats Colliery indicating a serious pollution source. Although the water quality improves from the upstream monitoring point towards downstream of Mooiplaats Colliery, the quality of the instream water is not suitable for the aquatic ecosystem. An impact via the **WT-S05** tributary / monitoring point (downstream of **MPS-S16**), on the Witpuntspruit was recorded but the impact from the **WT-S05** tributary is absorbed by the already polluted Witpuntspruit. **WT-S05** recorded no flow into the Witpuntspruit during the reporting period. Known decant from the Usutu mine downstream of **MPS-S08** and upstream of **WT-S06** enters the **Witpuntspruit**, elevating the pH, EC and $CaCO_3$ concentrations. The effect of the decant on the Witpuntspruit and Vaal River will be closely monitored.

Vaal River – Although fewer water quality limits are exceeded in the Vaal river compared to the Witpuntspruit, the change in composition and the deterioration in water quality is evident after the confluence with the Witpuntspruit.

Although water quality remains relative stable downstream it is rather dilution than improvement that will be observed further downstream. The source of the Witpuntspruit

pollution should be addressed to prevent constant degradation (build-up of contaminants) of the Vaal River system and a complete collapse in the aquatic functions in the long term.

7.2 Groundwater

Groundwater in the Mooiplaats area is of relatively good quality.

Although SO_4 concentrations was observed at the groundwater monitoring point towards the Vaal river, **GKL-2s** was unlikely impacted by Mooiplaats Colliery. The presence of SO_4 and Fe can most probably be ascribed to an exposed coal seam or other geological factors as the borehole is drilled to a depth of 6 meters only. The water quality will be monitored and investigated should an increase in the concentrations be observed.

GKL-4d is a deep borehole drilled to a depth of 80 meters. The $CaCO_3$, Na and Cl concentrations elevate the pH and EC concentrations, leading to IWUL Limit exceedances. Elevated $CaCO_3$, Na and Cl can most likely be ascribed to geological conditions and not mining pollution.

The water quality will be monitored and investigated to determine the source.

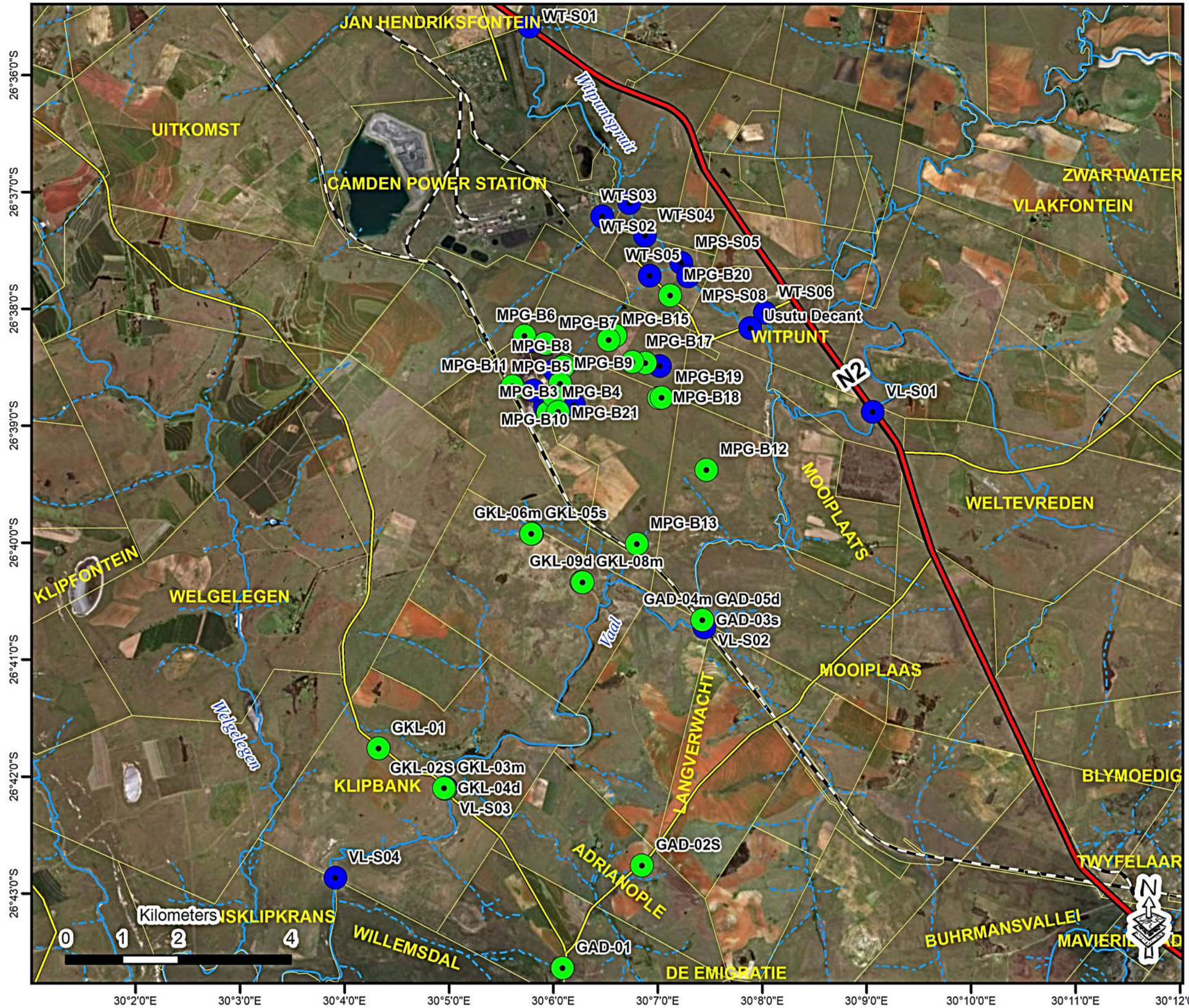
No substantial or uneven increases or decreases in groundwater levels have been observed during the reporting period.

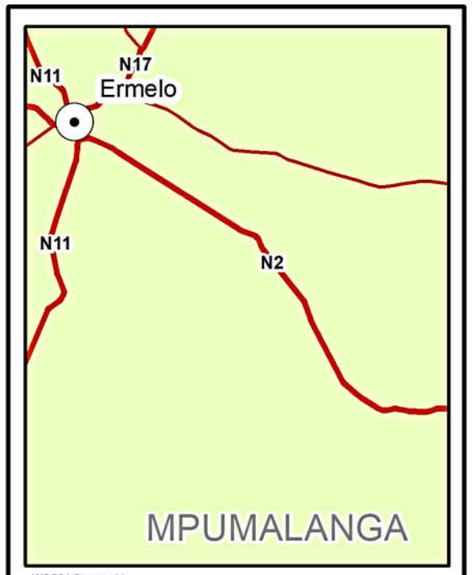
8. REFERENCES

- 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 groundwaters.
- 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.
- Standards South Africa. SANS 241 – 1: 2011. South African National Standard. Drinking Water. (Edition 1).
- Standards South Africa. SANS 241 – 1: 2015. South African National Standard. Drinking Water. (Edition 2).
- Department of Water and Sanitation, National Water Resource Strategy, 2004.
- Mooiplaats North Colliery geology and groundwater study, Coal of Africa Limited. Report No. V1110001. J. Fourie, 2011.

ANNEXURE A

MOOIPLAATS COLLIERY IWUL MONITORING: GROUNDWATER AND SURFACE WATER





WGS84 Geographic
1:95,000 @ A4 paper size

Legend

- Groundwater Monitoring
- Surface Water Monitoring
- Perennial Rivers
- Non-Perennial Rivers
- Railway Line
- Main Road
- Secondary Road
- Cadastral

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ANNEXURE B

CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

UIS SEDIBA LABORATORY (PTY) LTD
Co. Reg. No.: 2011/06070/07

Facility Accreditation Number: **T0584**

is a South African National Accreditation System accredited Testing laboratory provided that all SANAS conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation Annexure "A", bearing the above accreditation number for

WATER ANALYSIS

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17025:2005

The accreditation demonstrates technical competency for a defined scope and the operation of a laboratory quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant SANAS accreditation symbol to issue facility reports and/or certificates

_____

Mr R Josias
Chief Executive Officer

Effective Date: 09 April 2013
Certificate Expires: 08 April 2018

ANNEXURE A

SCHEDULE OF ACCREDITATION

Facility Number: T0584

Permanent Address of Laboratory: UIS- Sediba Laboratory (Pty) Ltd Unit 6 Carresa House 15 Sovereign Street Route 21 Corporate Park Irene	**Technical Signatories:** Dr WJ Havenga Mr JH Oosthuizen
Postal Address: P O Box 9025 Centurion 0046	**Nominated Representative:** Dr WJ Havenga
Tel: (012) 345-1004 Fax: (012) 345-4004 E-mail: willieh@uisol.co.za	Issue No.: 01 Date of Issue: 10 April 2013 Expiry Date: 08 April 2018

Materials / Products Tested	Type of Tests / Properties Measured, Range of Measurement	Standard Specifications, Equipment / Technique Used
WATER:	Anions By Ion Chromagraphy (IC)	UISSL-WL-005
Drinking	Chloride (Cl)	
Industrial	Nitrate (N03)	
Effluent	Phosphate (P04)	
Borehole	Sulphate (S04)	
Environmental		
Toxic characteristics Leach procedure(TCLP) extract	Total dissolved solid at 110℃ (TDS)	UISSL-WL-004
Acid Rain Extract	pH	UISSL-WL-003
Borax extract	P & M Alkalinity	UISSL-WL-002
Reverse Osmosis	Electrical Conductivity	UISSL-WL-001
Water extract	Formaldehyde by HPLC	UISSL-HPLC-001
Green Building Materials	Total Volatile	ASTM-D 3960-05
	Organic content	UISSL-GB-001
		ASTM-D 2369-10
		ASTM- D 4017-02

Issued by the South African National Accreditation System

Field Manager

ANNEXURE C

UIS sediba laboratory

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15A Midas Ave, Olympys, Pretoria

Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Jul-18
Monitoring Occasion	Monthly Surface and Groundwater Monitoring
Date of Sampling	12-Jul-18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Description	Comment/Observations
Quote 749	✓	MPS-S08	S26.62873° E30.12149°	13:00	Yes	Medium	Witpuntspruit 5 MS	Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	MPS-S13	S26.64837° E30.09888°	11:20	Yes	V Low	Runoff from Loading Area	Stagnant - Clear
	✓	MPS-S14	S26.64616° E30.09890°	12:30	Yes	Med	Gen-sub PCD	Clear - Oil
	✓	MPS-S15	S26.64837° E30.09888°	11:10	Yes	V Low	Stormwater trench @ Security	Flowing - Clear
	✓	MPS-S16	S26.64505° E30.10121°	12:00	Yes	Low	DS Area of Ericsons + Settl Dams	AMD
	✓	MPS-S20	S26.64505° E30.10121°	12:05	Yes	Full	Erickson Dams	Clear
	✓	MPS-S21	S26.64198° E30.10059°	11:50	Yes	Med	Main Holdings Dam	Clear
Sent by:	✓	MPS-S25	S26.63826° E30.09506°	12:20	Yes	Low	Workshop Trench @ ~~Security~~ Workshop	Clear - Oil
	✗	MPS-S26 *	S26.63727° E30.08963°	10:30	No	Dry	Witpunt Tributary North US 1	Dry
	✗	MPS-S27	S26.64716° E30.10336°	11:05	No	Dry	Witpuntspruit Tributary entering MP	Dry
Received by:	✓	MPS-S28	S26.64808° E30.09925°	11:00	Yes	V Low	Confluence of MPS-S13 and MPS-S15	Clear - Stagnant
	✗	MPS-S29	S26.64743° E30.09802	11:30	No	Dry	Storm water @ Offices	Dry
	✓	MPS-S30	S26.64508° E30.09674°	11:35	Yes	Med	Plant PCD	Clear - Turbid
Date:	✓	Usutu Decant 1 ✓		10:40	Yes	Low	Decant @ cement pit	- Clear
	✓	Usutu Decant 2 ✓		10:45	Yes	Low	Decant in Field	- Clear - Salt deposits

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Jul-18
Monitoring Occasion	Monthly Surface and Groundwater Monitoring
Date of Sampling	12-Jul-18

Analyses Required: Quote 749

pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3

	Monitoring Point	Coordinates	Time	Sampled	Level	Medium	Comment/Observations
✓	VL-S01	S26.64616° E30.09890°	07:55	Yes	Med	Vaal River 1 US	Clear
✓	VL-S02	S26.64804° E30.15098°	10:05	Yes	Med	Vaal River 2 DS	Clear
✓	VL-S03	S26.67879° E30.12411°	09:00	Yes	Med	Vaal River 3 DS	Clear
✓	VL-S04	S26.70167° E30.08288°	09:30	Yes	Med	Vaal River 4 DS	Clear
✓	WT-S01	S26.71447° E30.06519°	07:40	Yes	Med	Witpuntspruit 1 US	Clear
✓	WT-S02	S26.59307° E30.09617°	13:40	Yes	Med	Witpuntspruit 2 MS	Clear
✓	WT-S03	S26.61826° E30.11211°	13:50	Yes	Med	Witpunt Tributary North DS 1	Clear - Flowing
✓	WT-S04	S26.62014° E30.10781°	13:20	Yes	Med	Witpuntspruit 3 MS	Clear
✓	WT-S05	S26.62294° E30.11463°	13:10	Yes	Low	Witpunt Tributary South DS 2	Clear - Stagnant
✓	WT-S06	S26.62863° E30.11539°	10:35	Yes	Med	Witpuntspruit 6 MS	Clear
✓	GKL-1	S26.69603° E30.07208°	08:50	Yes	26.46	IWUL Borehole	Clear
✓	GKL-4d	S26.70167° E30.08253°	09:05	Yes	4.78	IWUL Borehole	Clear
✓	GKL-3m	S26.70178° E30.08269°	09:10	Yes	4.80	IWUL Borehole	Clear
✓	GKL-2s	S26.70178° E30.08269°	09:15	Yes	4.29	IWUL Borehole	Turbid - Clear
✓	GAD-2s	S26.71269° E30.11414°	09:50	Yes	9.50	IWUL Borehole	Clear
✓	GAD-1	S26.72733° E30.10144°	08:20	Yes	5.07	IWUL Borehole	Clear
X	GKL-9D	S26.67231° E30.10450°	10:10	No	—	IWUL Borehole	No Access
X	GKL-8M	S26.67233° E30.10464°			—	IWUL Borehole	No Access
X	GKL-5S	S26.66542° E30.09647°	10:20	No	—	IWUL Borehole	Not Found
X	GKL-6M	S26.66542° E30.09658°			—	IWUL Borehole	Not Found
X	GAD-3s	S26.67772° E30.12374°	/	/	/	IWUL Borehole	Not IWUL Monthly sampling points
X	GAD-4m	S26.67772° E30.12374°				IWUL Borehole	
X	GAD-5d	S26.67772° E30.12374°				IWUL Borehole	

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Aug-18
Monitoring Occasion	Monthly Surface and Groundwater Monitoring
Date of Sampling	08-Aug-18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Description	Comment/Observations
Quote 749	✓	MPS-S08	S26.62873° E30.12149°	13:10	Yes	Med	Witpuntspruit 5 MS	Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	MPS-S13	S26.64837° E30.09888°	11:25	Yes	Low	Runoff from Loading Area	Stagnant
	X	MPS-S14	S26.64616° E30.09890°	12:50	No	N/A	Gen-sub PCD	Locked.
	X	MPS-S15	S26.64837° E30.09888°	11:10	No	Low	Stormwater trench @ Security	Low
	✓	MPS-S16	S26.64505° E30.10121°	12:30	Yes	Low	DS Area of Ericsons + Settl Dams	Clear — White salt dry
	✓	MPS-S20	S26.64505° E30.10121°	12:40	Yes	Low	Erickson Dams	Clear
	✓	MPS-S21	S26.64198° E30.10059°	12:25	Yes	High	Main Holdings Dam	Clear
Sent by:	✓	MPS-S25	S26.63826° E30.09506°	11:35	Yes	Low	Workshop Trench @ Security	Clear
	X	MPS-S27	S26.64716° E30.10336°	11:07	No	Low	Witpuntspruit Tributary entering MP	Low
	X	MPS-S28	S26.64808° E30.09925°	11:15	No	Low	Confluence of MPS-S13 and MPS-S15	Low
Received by:	X	MPS-S29	S26.64743° E30.09802	11:30	No	Low	Storm water @ Offices	Low
	✓	MPS-S30	S26.64508° E30.09674°	12:05	Yes	Med	Plant PCD	Turbid.
	✓	Usuku Decant	✓	10:50	Yes	Med	Decant Foam box	clear
Date:								

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Aug-18
Monitoring Occasion	Monthly Surface and Groundwater Monitoring
Date of Sampling	08-Aug-18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Medium	Comment/Observations
Quote 749	✓	VL-S01	S26.64616° E30.09890°	08:15	Yes	Wet	Vaal River 1 US	Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	VL-S02	S26.64804° E30.15098°	10:25	Yes	Wet	Vaal River 2 DS	Clear
	✓	VL-S03	S26.67879° E30.12411°	09:05	Yes	Wet	Vaal River 3 DS	Clear
	✓	VL-S04	S26.70167° E30.08288°	09:45	Yes	Wet	Vaal River 4 DS	Clear
	✓	WT-S01	S26.71447° E30.06519°	07:50	Yes	Wet	Witpuntspruit 1 US	Clear
	✓	WT-S02	S26.59307° E30.09617°	14:20	Yes	Wet	Witpuntspruit 2 MS	Clear
	✓	WT-S03	S26.61826° E30.11211°	14:15	Yes	Wet	Witpunt Tributary North DS 1	Clear
	✓	WT-S04	S26.62014° E30.10781°	13:35	Yes	Wet	Witpuntspruit 3 MS	Clear
	✓	WT-S05	S26.62294° E30.11463°	13:25	Yes	Low	Witpunt Tributary South DS 2	Clear - Stagnant
	✓	WT-S06	S26.62863° E30.11539°	10:45	Yes	Med	Witpuntspruit 6 MS	Clear
	✓	GKL-1	S26.69603° E30.07208°	08:55	Yes	26.40	IWUL Borehole	Clear
	✓	GKL-4d	S26.70167° E30.08253°	09:25	Yes	4.71	IWUL Borehole	Clear
	✓	GKL-3m	S26.70178° E30.08269°	09:20	Yes	4.83	IWUL Borehole	Clear
	✓	GKL-2s	S26.70178° E30.08269°	09:15	Yes	4.31	IWUL Borehole	Turbid
	✓	GAD-2s	S26.71269° E30.11414°	10:10	Yes	2.66	IWUL Borehole	Clear
	✓	GAD-1	S26.72733° E30.10144°	08:40	Yes	5.145	IWUL Borehole	Clear - SS
	✗	GKL-9D	S26.67231° E30.10450°	10:30	No	NA	IWUL Borehole	No Access
	✗	GKL-8M	S26.67233° E30.10464°	10:30	No	NA	IWUL Borehole	No Access
	✗	GKL-5S	S26.66542° E30.09647°	10:30	No	NA	IWUL Borehole	No Access
	✗	GKL-6M	S26.66542° E30.09658°	10:30	No	NA	IWUL Borehole	No Access

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Sep-18
Monitoring Occasion	Monthly Surface and Groundwater Monitoring
Date of Sampling	11-Sep-18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Description	Comment/Observations
Quote 749	✓	MPS-S08	S26.62873° E30.12149°	13:40	Yes	Med	Witpuntspruit 5 MS	Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	MPS-S13	S26.64837° E30.09888°	11:20	Yes	Low	Runoff from Loading Area	Stagnant
	✓	MPS-S14	S26.64616° E30.09890°	13:15	Yes	Med	Gen-sub PCD	Clear
	X	MPS-S15	S26.64837° E30.09888°	11:15	No	Dry	Stormwater trench @ Security Clean	Dry
	✓	MPS-S16	S26.64505° E30.10121°	12:35	Yes	Med	DS Area of Ericsons + Settl Dams	Murky
	✓	MPS-S20	S26.64505° E30.10121°	12:25	Yes	Low	Erickson Dams	Clear
	✓	MPS-S21	S26.64198° E30.10059°	12:10	Yes	High	Main Holdings Dam	Clear
Sent by:	✓	MPS-S25	S26.63826° E30.09506°	12:40	Yes	Low	Workshop Trench @ Security	Clear - Stagnant.
	X	MPS-S27	S26.64716° E30.10336°	11:10	No	Dry	Witpuntspruit Tributary entering MP	Dry
	X	MPS-S28	S26.64808° E30.09925°	11:15	No	Dry	Confluence of MPS-S13 and MPS-S15	Dry
Received by:	X	MPS-S29	S26.64743° E30.09802	11:30	No	Dry	Storm water @ Offices	Dry
	✓	MPS-S30	S26.64508° E30.09674°	11:50	Yes	Med	Plant PCD	Turbid.
Date:								

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Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Medium	Comment/Observations
Quote 749	✓	VL-S01	S26.64616° E30.09890°	08:15	Yes	Med/L	Vaal River 1 US	Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	VL-S02	S26.64804° E30.15098°	10:30	Yes	Med/L	Vaal River 2 DS	Clear
	✓	VL-S03	S26.67879° E30.12411°	09:35	Yes	Med/L	Vaal River 3 DS	Clear
	✓	VL-S04	S26.70167° E30.08288°	09:45	Yes	Med/L	Vaal River 4 DS	Clear
	✓	WT-S01	S26.71447° E30.06519°	08:00	Yes	Med/L	Witpuntspruit 1 US	Clear
	✓	WT-S02	S26.59307° E30.09617°	14:20	Yes	Med/L	Witpuntspruit 2 MS	Clear
	✓	WT-S03	S26.61826° E30.11211°	14:30	Yes	Med/Lo	Witpunt Tributary North DS 1	Clear
	✓	WT-S04	S26.62014° E30.10781°	14:05	Yes	Med	Witpuntspruit 3 MS	Clear
	✓	WT-S05	S26.62294° E30.11463°	13:50	Yes	Low	Witpunt Tributary South DS 2	Clear - Stagnant
	✓	WT-S06	S26.62863° E30.11539°	10:55	Yes	Med	Witpuntspruit 6 MS	Clear
	✓	GKL-1	S26.69603° E30.07208°	09:10	Yes	26.48	IWUL Borehole	Clear
	✓	GKL-4d	S26.70167° E30.08253°	09:20	Yes	4.74	IWUL Borehole	Clear
	✓	GKL-3m	S26.70178° E30.08269°	09:25	Yes	4.87	IWUL Borehole	Clear
	✓	GKL-2s	S26.70178° E30.08269°	09:30	Yes	4.37	IWUL Borehole	Clear
	✓	GAD-2s	S26.71269° E30.11414°	10:05	Yes	9.88	IWUL Borehole	Clear
	✓	GAD-1	S26.72733° E30.10144°	08:40	Yes	5.33	IWUL Borehole	Clear
	X	GKL-9D	S26.67231° E30.10450°				IWUL Borehole	
	X	GKL-8M	S26.67233° E30.10464°				IWUL Borehole	
	X	GKL-5S	S26.66542° E30.09647°				IWUL Borehole	No Access
	X	GKL-6M	S26.66542° E30.09658°				IWUL Borehole	

ANNEXURE D

Monitoring Point	DateTimeMeas	MALK CaCO3/L	EC mS/m	pH	TotHardness mg/l	CaHardness mg/l	MgHardness mg/l	TDS mg/l	Ca mg/l	Cl mg/l	Mg mg/l	F mg/l	NO3 mg/l	K mg/l	Na mg/l	SO4 mg/l	Al mg/l	Fe mg/l	Mn mg/l
GAD1	2018/07/12 00:00	153.000	29.250	7.100	143.452	92.389	51.063	156.200	37.000	5.700	12.400	-0.400	-2.000	2.300	13.400	-4.000	-0.050	0.930	0.340
GAD2S	2018/07/12 00:00	44.000	12.780	7.390	57.542	28.716	28.826	52.300	11.500	5.700	7.000	-0.400	-2.000	0.900	7.200	-4.000	-0.050	0.710	-0.050
GKL 1	2018/07/12 00:00	195.000	36.500	7.110	146.773	94.886	51.887	230.300	38.000	26.700	12.600	-0.400	-2.000	27.000	15.400	-4.000	0.060	0.060	-0.050
GKL 3M	2018/07/12 00:00	382.000	72.700	9.160	12.108	7.990	4.118	433.200	3.200	11.500	1.000	1.000	2.300	1.200	187.800	-4.000	-0.050	0.150	-0.050
GKL-2S	2018/07/12 00:00	304.000	58.600	7.500	263.731	134.838	128.893	316.800	54.000	7.100	31.300	-0.400	-2.000	2.400	26.600	15.400	0.060	-0.050	-0.050
GKL-4d	2018/07/12 00:00	752.000	240.500	8.710	11.784	8.490	3.294	1355.100	3.400	335.800	0.800	2.800	11.800	3.100	550.200	-4.000	-0.050	-0.050	-0.050
MPS S15	2018/07/12 00:00	144.000	61.900	8.590	237.504	115.611	121.893	354.400	46.300	21.800	29.600	-0.400	-2.000	1.100	40.400	131.200	0.070	-0.050	-0.050
MPS16	2018/07/12 00:00	1021.000	399.000	7.420	708.018	193.268	514.750	2727.700	77.400	63.400	125.000	4.200	3.700	11.500	628.900	1201.000	4.830	0.640	33.910
MPS-S08	2018/07/12 00:00	63.000	93.600	7.530	315.718	160.058	155.660	583.300	64.100	31.900	37.800	-0.400	-2.000	10.900	85.700	317.500	0.060	0.120	0.070
MPS-S13	2018/07/12 00:00	170.000	99.000	7.840	365.869	183.030	182.839	618.600	73.300	27.400	44.400	-0.400	-2.000	2.700	90.800	280.400	0.130	0.140	-0.050
MPS-S14	2018/07/12 00:00	333.000	206.200	7.640	427.042	235.967	191.075	1242.800	94.500	117.400	46.400	0.500	2.400	10.700	294.200	476.900	-0.050	0.570	1.210
MPS-S20	2018/07/12 00:00	903.000	301.000	8.310	294.459	119.856	174.603	1885.800	48.000	61.300	42.400	3.300	3.400	7.400	590.300	587.900	0.080	-0.050	0.080
MPS-S21	2018/07/12 00:00	610.000	456.000	7.950	1020.854	455.453	565.401	3101.300	182.400	46.100	137.300	1.500	-2.000	11.900	685.100	1673.000	0.090	-0.050	1.160
MPS-S25	2018/07/12 00:00	143.000	27.040	8.750	118.749	77.157	41.592	157.600	30.900	3.700	10.100	-0.400	-2.000	2.800	15.900	10.800	-0.050	-0.050	-0.050
MPS-S28	2018/07/12 00:00	148.000	63.400	8.520	248.425	120.355	128.070	365.000	48.200	20.800	31.100	-0.400	-2.000	1.200	38.700	138.600	0.100	0.060	-0.050
MPS-S30	2018/07/12 00:00	409.000	421.000	8.080	859.200	472.932	386.268	2721.000	189.400	54.700	93.800	1.300	-2.000	9.100	796.300	1333.000	0.080	-0.050	0.330
USUTU DECANT Sump	2018/07/12 00:00	502.000	172.100	7.290	376.610	225.479	151.131	1224.900	90.300	42.700	36.700	0.400	2.200	14.200	354.400	382.800	-0.050	-0.050	-0.050
USUTU DECANT Surface	2018/07/12 00:00	1338.000	452.000	8.740	119.691	64.922	54.769	3407.600	26.000	86.800	13.300	2.900	-2.000	8.100	1377.000	1092.700	0.590	0.640	-0.050
VLS01	2018/07/12 00:00	57.000	17.840	7.440	68.349	30.463	37.886	97.800	12.200	13.600	9.200	-0.400	-2.000	2.600	12.400	16.000	0.070	0.170	-0.050
VLS02	2018/07/12 00:00	70.000	26.280	7.730	73.242	33.710	39.533	140.200	13.500	15.100	9.600	-0.400	-2.000	2.700	27.700	32.000	0.060	0.100	-0.050
VLS03	2018/07/12 00:00	69.000	26.030	8.010	75.814	35.457	40.356	144.100	14.200	15.800	9.800	-0.400	-2.000	2.800	26.600	35.900	0.090	0.300	-0.050
VLS04	2018/07/12 00:00	72.000	26.170	8.040	76.725	35.957	40.768	147.300	14.400	15.600	9.900	-0.400	-2.000	2.900	26.100	37.600	-0.050	0.080	-0.050
WT-S01	2018/07/12 00:00	-3.500	285.600	2.990	1301.022	618.257	682.764	2027.800	247.600	18.300	165.800	-0.400	-2.000	9.700	81.900	1509.000	47.490	39.330	17.180
WT-S02	2018/07/12 00:00	46.000	66.200	7.670	188.794	104.375	84.419	364.500	41.800	21.900	20.500	-0.400	-2.000	4.900	42.400	207.800	-0.050	-0.050	-0.050
WT-S03	2018/07/12 00:00	62.000	56.000	7.420	175.975	99.381	76.595	330.300	39.800	17.800	18.600	-0.400	-2.000	3.600	42.200	173.500	-0.050	0.270	-0.050
WT-S04	2018/07/12 00:00	65.000	93.400	7.320	299.930	154.564	145.365	527.500	61.900	30.900	35.300	-0.400	-2.000	9.500	69.500	283.800	0.080	0.360	-0.050
WT-S05	2018/07/12 00:00	-3.500	543.000	3.120	2315.206	885.436	1429.770	3895.600	354.600	25.100	347.200	-0.400	-2.000	11.900	516.400	2644.900	41.930	26.930	28.390
WT-S06	2018/07/12 00:00	308.000	138.400	7.900	233.587	119.107	114.480	815.900	47.700	45.200	27.800	0.900	-2.000	6.600	213.900	291.000	-0.050	-0.050	-0.050

Monitoring Point	Date	MALK CaCO3/L	EC mS/m	pH	TotHardness mg/l	CaHardness mg/l	MgHardness mg/l	TDS mg/l	Ca mg/l	Cl mg/l	Mg mg/l	F mg/l	NO3 mg/l	K mg/l	Na mg/l	SO4 mg/l	Al mg/l	Fe mg/l	Mn mg/l
GAD-1	2018/08/08 00:00	165.000	29.460	7.250	145.862	94.387	51.475	165.700	37.800	6.000	12.500	-0.400	-2.000	2.200	14.600	-4.000	-0.050	0.380	0.350
GAD-2S	2018/08/08 00:00	49.000	12.960	7.350	61.760	30.463	31.297	68.700	12.200	9.200	7.600	2.500	3.200	0.800	7.800	-4.000	-0.050	0.430	-0.050
GKL 2S	2018/08/08 00:00	319.000	58.000	7.670	249.253	128.596	120.657	323.800	51.500	7.600	29.300	-0.400	-2.000	1.500	25.700	19.200	0.120	0.620	-0.050
GKL 3M	2018/08/08 00:00	388.000	72.400	9.080	9.537	6.243	3.294	425.600	2.500	10.700	0.800	1.600	-2.000	1.200	182.000	-4.000	-0.050	0.180	-0.050
GKL-1	2018/08/08 00:00	218.000	36.800	7.350	180.689	116.860	63.829	210.600	46.800	1.800	15.500	-0.400	-2.000	1.300	20.800	-4.000	-0.050	0.150	-0.050
GKL-4d	2018/08/08 00:00	786.000	238.900	8.580	11.771	7.241	4.530	1380.100	2.900	338.800	1.100	3.200	-2.000	3.400	565.100	-4.000	0.170	0.500	-0.050
MPS-S08	2018/08/08 00:00	38.000	110.700	7.510	450.024	228.476	221.548	757.900	91.500	30.400	53.800	-0.400	-2.000	12.500	74.500	474.800	0.090	0.080	0.120
MPS-S13	2018/08/08 00:00	204.000	111.400	8.010	429.566	217.489	212.077	711.400	87.100	28.500	51.500	-0.400	-2.000	3.100	98.900	322.300	0.120	0.100	-0.050
MPS-S16	2018/08/08 00:00	-3.500	798.000	4.140	4020.283	961.844	3058.439	6142.100	385.200	13.300	742.700	-0.400	-2.000	24.100	591.300	4390.000	126.300	2.180	236.300
MPS-S20	2018/08/08 00:00	1083.000	285.900	8.620	144.676	44.197	100.479	1858.600	17.700	69.000	24.400	2.100	-2.000	8.200	679.700	409.700	-0.050	-0.050	0.080
MPS-S21	2018/08/08 00:00	43.000	500.000	8.010	1482.782	656.711	826.071	3470.900	263.000	50.100	200.600	0.800	-2.000	14.600	714.900	2203.100	0.100	0.290	2.540
MPS-S25	2018/08/08 00:00	120.000	21.320	8.580	94.791	54.435	40.356	128.500	21.800	2.900	9.800	-0.400	-2.000	2.300	17.800	4.300	0.120	0.110	-0.050
MPS-S30	2018/08/08 00:00	770.000	352.000	8.510	168.639	51.688	116.951	2529.000	20.700	79.200	28.400	3.600	2.600	9.400	804.300	1118.800	0.810	0.140	-0.050
USUTU DECANT Sump	2018/08/08 00:00	515.000	175.000	7.500	326.459	202.507	123.952	1172.700	81.100	41.800	30.100	0.500	-2.000	5.500	318.100	388.600	-0.050	-0.050	-0.050
VL-S01	2018/08/08 00:00	91.000	19.640	7.500	77.036	34.209	42.827	124.400	13.700	13.200	10.400	-0.400	-2.000	2.500	13.300	19.100	-0.050	0.120	-0.050
VL-S02	2018/08/08 00:00	103.000	37.900	7.670	106.606	50.190	56.417	221.900	20.100	17.500	13.700	-0.400	-2.000	3.700	41.500	66.000	-0.050	-0.050	-0.050
VL-S03	2018/08/08 00:00	105.000	36.900	8.530	100.228	46.694	53.534	217.200	18.700	17.100	13.000	-0.400	-2.000	3.100	44.400	60.300	-0.050	-0.050	-0.050
VL-S04	2018/08/08 00:00	109.000	37.000	8.000	102.962	48.192	54.769	220.900	19.300	17.100	13.300	-0.400	-2.000	3.100	43.800	61.300	0.080	0.100	-0.050
WT-S01	2018/08/08 00:00	-3.500	169.200	3.180	621.269	300.889	320.380	1105.500	120.500	18.500	77.800	-0.400	-2.000	6.000	59.800	827.400	16.130	4.930	7.840
WT-S02	2018/08/08 00:00	38.000	106.300	6.800	423.288	215.741	207.547	715.200	86.400	28.800	50.400	-0.400	-2.000	10.900	67.500	450.800	0.080	0.100	1.480
WT-S03	2018/08/08 00:00	85.000	59.000	7.650	211.701	121.105	90.596	361.700	48.500	16.700	22.000	-0.400	-2.000	3.500	44.500	177.900	-0.050	0.260	-0.050
WT-S04	2018/08/08 00:00	17.000	110.600	6.660	451.671	228.476	223.196	778.800	91.500	31.300	54.200	-0.400	-2.000	12.200	64.800	517.000	-0.050	-0.050	0.330
WT-S05	2018/08/08 00:00	-3.500	578.000	3.150	2434.512	952.855	1481.656	5221.900	381.600	22.600	359.800	-0.400	-2.000	18.300	534.800	3909.300	38.190	15.600	27.710
WTS06	2018/08/08 00:00	398.000	164.800	8.100	342.695	180.034	162.661	1039.100	72.100	48.100	39.500	1.100	-2.000	7.600	247.900	386.000	-0.050	-0.050	-0.050

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Sample number	Date	MALK CaCO3/L	EC mS/m	pH	TotHardness mg/l	CaHardness mg/l	MgHardness mg/l	TDS mg/l	Ca mg/l	Cl mg/l	Mg mg/l	F mg/l	NO3 mg/l	K mg/l	Na mg/l	SO4 mg/l	Al mg/l	Fe mg/l	Mn mg/l	NH3 mg/l
GAD-1	2018/09/28 00:00	162.000	30.400	7.070	129.609	83.899	45.710	154.800	33.600	4.500	11.100	-0.400	-2.000	1.600	13.200	-4.000	-0.050	0.410	0.310	0.080
GAD-2S	2018/09/28 00:00	43.000	13.600	7.150	52.324	25.969	26.355	55.900	10.400	7.100	6.400	-0.400	2.900	0.500	7.200	-4.000	0.240	0.190	-0.050	-0.020
GKL-1	2018/09/28 00:00	214.000	37.400	7.270	153.164	99.630	53.534	196.400	39.900	1.900	13.000	-0.400	-2.000	0.900	18.700	-4.000	-0.050	0.160	0.220	-0.020
GKL-2S	2018/09/28 00:00	294.000	58.200	7.620	250.690	132.091	118.598	308.600	52.900	3.500	28.800	-0.400	-2.000	1.200	24.600	23.600	0.060	0.080	-0.050	-0.020
GKL-3M	2018/09/28 00:00	411.000	72.700	9.110	9.125	6.243	2.883	442.400	2.500	10.000	0.700	1.300	-2.000	0.900	186.400	-4.000	0.060	0.220	-0.050	0.610
GKL-4D	2018/09/28 00:00	791.000	234.900	8.590	8.538	5.244	3.294	1356.900	2.100	297.200	0.800	2.900	-2.000	2.200	572.100	7.000	-0.050	0.140	-0.050	1.290
MPS-S08	2018/09/28 00:00	73.000	114.800	7.100	352.697	167.798	184.898	772.100	67.200	37.200	44.900	0.500	-2.000	10.800	102.700	467.000	0.080	0.110	-0.050	0.210
MPS-S13	2018/09/28 00:00	210.000	148.000	7.680	533.320	278.416	254.904	1006.400	111.500	32.900	61.900	-0.400	-2.000	3.000	122.600	550.900	-0.050	-0.050	0.100	0.590
MPS-S14	2018/09/28 00:00	439.000	161.700	7.370	149.651	86.646	63.005	840.900	34.700	145.000	15.300	0.900	-2.000	11.200	271.400	101.000	-0.050	0.210	0.330	20.150
MPS-S16	2018/09/28 00:00	11.000	537.000	4.880	2009.381	443.717	1565.664	4428.500	177.700	64.600	380.200	-0.400	-2.000	15.400	676.400	3110.000	5.150	5.560	78.900	1.870
MPS-S20	2018/09/28 00:00	1060.000	289.900	8.540	116.359	37.705	78.654	2016.000	15.100	62.000	19.100	4.000	-2.000	6.400	712.700	562.700	-0.050	-0.050	-0.050	0.020
MPS-S21	2018/09/28 00:00	349.000	500.000	8.080	1504.647	636.985	867.663	4354.200	255.100	45.300	210.700	1.200	-2.000	13.000	806.500	2815.000	0.110	0.230	0.780	0.160
MPS-S25	2018/09/28 00:00	163.000	30.400	7.320	113.943	74.411	39.533	153.400	29.800	1.500	9.600	-0.400	-2.000	2.300	18.800	-4.000	0.060	0.310	0.080	-0.020
MPS-S30	2018/09/28 00:00	790.000	350.000	8.440	198.315	54.185	144.130	2242.600	21.700	72.000	35.000	3.400	-2.000	9.000	746.500	883.000	-0.050	-0.050	-0.050	0.930
VL-S01	2018/09/28 00:00	80.000	23.400	7.170	84.812	37.455	47.357	119.000	15.000	11.500	11.500	-0.400	-2.000	2.100	13.400	19.900	-0.050	0.110	-0.050	-0.020
VL-S02	2018/09/28 00:00	112.000	37.100	7.620	97.582	45.695	51.887	206.200	18.300	16.900	12.600	-0.400	-2.000	3.000	38.400	52.200	-0.050	0.140	-0.050	0.220
VL-S03	2018/09/28 00:00	102.000	38.200	8.460	107.605	51.189	56.417	218.500	20.500	17.300	13.700	-0.400	2.900	2.900	36.600	63.800	-0.050	0.110	-0.050	-0.020
VL-S04	2018/09/28 00:00	103.000	38.400	8.560	106.444	50.439	56.005	214.000	20.200	17.600	13.600	-0.400	-2.000	2.900	36.900	63.400	-0.050	0.120	-0.050	-0.020
WT-S01	2018/09/28 00:00	-3.500	258.300	3.040	885.798	433.230	452.568	1543.100	173.500	31.900	109.900	-0.400	-2.000	10.100	80.500	1141.700	29.600	14.330	11.980	1.010
WT-S02	2018/09/28 00:00	115.000	67.400	7.260	198.681	112.615	86.066	393.700	45.100	25.100	20.900	-0.400	-2.000	5.600	58.000	172.400	0.070	0.170	-0.050	0.510
WT-S03	2018/09/28 00:00	92.000	50.500	7.520	152.223	88.394	63.829	281.900	35.400	18.100	15.500	-0.400	-2.000	2.900	41.800	115.400	0.170	0.490	-0.050	-0.020
WT-S04	2018/09/28 00:00	119.000	95.000	7.250	275.590	142.579	133.011	610.100	57.100	33.800	32.300	0.500	-2.000	10.300	82.200	324.500	0.170	0.160	0.260	0.110
WT-S05	2018/09/28 00:00	-3.500	649.000	3.240	3064.206	1232.519	1831.686	5910.700	493.600	36.200	444.800	-0.400	-2.000	22.500	701.400	4216.700	37.770	9.740	29.620	0.940
WT-S06	2018/09/28 00:00	728.000	220.500	8.240	177.005	87.645	89.361	1500.100	35.100	64.000	21.700	2.400	-2.000	7.200	504.900	430.000	0.060	-0.050	-0.050	0.620

WATER QUALITY REPORT 1-2018

01 MARCH 2018 TO 30 JUNE 2018

IWUL: Licence No. 08/C11B/AGJ/2141,
File No. 16/2/7/C112/C155, 2013

Mooiplaats Colliery (Pty) Ltd

July 2018

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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
Cr6+	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
GRO	Gasoline Range Organics
GSW	Geo Soil & Water (Pty) Ltd GSW
GW	Groundwater
HCO3-	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
MPN	Mooiplaats Colliery North
MPS	Mooiplaats Colliery South
Na	Sodium
NEMA	National Environmental Management Act (Act No. 107 of 1998)
Ni	Nickel
NO3-	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
SANS	South African National Standard
SAR	Sodium Absorption Ratio
Se	Selenium
SO_4	Sulphate

TDS	Total Dissolved Solids
WGS 84	World Geodetic System 1984
WUL	Water Use License
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: OH-, O2-, SO42-, Alk (HCO3-), Cl-, etc. The Bicarbonate (HCO3-) 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: Ca+, Mg+, Na+, K+, Fe2+.

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 liter 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 time-frames and conditions for the designated water use.

EXECUTIVE SUMMARY

Mooiplaats Colliery (Pty) Ltd (Mooiplaats Colliery) appointed Geo Soil & Water (Pty) Ltd (GSW) to conduct water sampling, water quality analyses and water quality reporting at Mooiplaats Colliery in accordance with the requirements of the Integrated Water Use Licence No: 08/C11B/AGJ/2141, File No: 16/2/7/C112/C155 dated 02 May 2013 (IWUL), issued in terms of the National Water Act (Act No. 36 of 1998) (NWA).

The reporting period is from 01 March 2018 – 30 June 2018.

Water qualities were compared to the IWUL Limits and the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin.

The DWS Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering and the South African National Standard, Drinking Water Standard (Edition 2) (SANS 241:2015) were included as supplementary comparative guidelines and not for compliance purposes.

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

The following is a summary of the results:

Waste water - Water quality from the mine water/pollution control dams monitoring points exceeded the limits in terms of EC, TDS, Ca, Mg, F, Cl, SO_4, NH_3, Al, Fe and Mn. These results are typical of water associated with coal washing/mining activities. It should be noted that although these monitoring points recorded elevated variable concentrations, the water is being contained in appropriate waste water storage facilities and circulated in a closed circuit i.e. dirty water circuit and no water are being released into the receiving environment.

Storm and Surface Water Runoff - It is evident that the surface runoff water quality within the boundaries of Mooiplaats Colliery is of general good quality (in comparison with the Witpuntspruit) with the expectance of **MPS-S16**. Water quality at **MPS-S16** is the result of a lack of maintenance and management during the care and maintenance phase. Several measures since the commencement of mining activities in 2018 were taken to prevent further pollution. Water quality will be closely monitored for improvement or deterioration.

Water Quality from the **Witpuntspruit** is highly impacted upstream of Mooiplaats Colliery indicating a serious pollution source. Although the water quality improves from the upstream monitoring point towards downstream of Mooiplaats Colliery, the quality of the instream water is not suitable for the aquatic ecosystem. An impact via the **WT-S05** tributary / monitoring point (downstream of **MPS-S16**), on the Witpuntspruit was recorded but the impact from the **WT-S05** tributary is absorbed by the already polluted Witpuntspruit. **WT-S05** recorded a very low flow into the Witpuntspruit during March 2018 where after it was stagnant through June 2018. Known decant from the Usutu mine downstream of **MPS-S08** and upstream of **WT-S06** enters the **Witpuntspruit**, elevating the pH and EC concentrations. The effect of the decant will be closely monitored.

Vaal River – Although fewer water quality limits are exceeded in the Vaal river compared to the Witpuntspruit, the change in composition and the deterioration in water quality is evident after the confluence with the Witpuntspruit.

Although water quality will improve slightly naturally downstream, it is rather dilution than improvement that will be observed further downstream. The source of the Witpuntspruit pollution should be addressed to prevent constant degradation (build-up of contaminants) of the Vaal River system and a complete collapse in the aquatic functions in the long term.

Groundwater - Although several IWUL limits were exceeded, the groundwater quality of Mooiplaats Colliery is good with the exception of two small areas where the shallow aquifer has been slightly affected potentially due to historical contaminated surface water runoff. The groundwater quality should be closely monitored with trends analysed accordingly.

Should groundwater be used/considered for domestic purposes or drinking water, the SANS 241-2015 drinking water standards should be taken into consideration as several variables, especially metals exceed the threshold criteria.

TABLE OF CONTENTS

ANNEXURES

LIST OF FIGURES

LIST OF TABLES

Table 6.5 Average water quality for surface and storm water runoff monitoring points for the reporting period.

Table 6.6 Average water quality for the Witpuntspruit and its Tributaries surface water monitoring points for the reporting period.

Table 6.7 Average water quality for the Vaal River surface water monitoring points for the reporting period.

Table 6.8 Average water quality for Mooiplaats groundwater monitoring points for the reporting period.

DISCLAIMER

This report has been prepared by Geo Soil and Water cc (GSW), using information provided by the client as well as third parties, which information has been presumed to be correct. While GSW has made every endeavour to supply accurate information, and exercised all care, skill and diligence in the drafting of this report, errors and omissions may occur. Accordingly, GSW does not warrant the accuracy or completeness of the materials in this report. GSW does not accept any liability for any loss or damage which may directly or indirectly result from any advice, opinion, information, representation or omission, whether negligent or otherwise, contained in this report, including the use and interpretation of this report by the client, its officials or their representative agents.

1. INTRODUCTION

1.1 Scope of Work

Mooiplaats Colliery (Pty) Ltd (Mooiplaats) appointed Geo Soil & Water (Pty) Ltd to conduct water sampling, water quality analyses and water quality reporting at Mooiplaats in accordance with the requirements of the Integrated Water Use Licence No: 08/C11B/AGJ/2141, File No: 16/2/7/C112/C155 dated 02 May 2013 (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) 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 will be implemented and quarterly reports, reflecting the results, submitted to the DWS.

GSW was commissioned by Mooiplaats Colliery to implement and conduct surface - and groundwater monitoring as prescribed in the IWUL, 2013. Surface and groundwater water monitoring points are sampled on a monthly and biannual basis.

The results of the monitoring report are used to inform Mooiplaats management of the impact from mining activities 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 of the monitoring system and various monitoring points at Mooiplaats Colliery. The work done during the monitoring period of the contract included:

Routine monitoring:

- Mar 2018 - Monthly surface water monitoring,
- Apr 2018 - Biannual surface and groundwater monitoring,
- May 2018 - Monthly surface and groundwater monitoring,
- Jun 2018 - Monthly surface and groundwater monitoring.

2. PROJECT BACKGROUND INFORMATION

Mooiplaats operates an Underground mine, wash plant and associated infrastructure on the farm Mooiplaats approximately 20km east of Ermelo in the Mpumalanga Province, South Africa. The relevant infrastructure consists of a wash plant, return water dams, co-disposal dump, offices, workshops, weighbridge, diesel bowsers, coal stockpiles, overburden stockpiles, etc. Water management structures/pollution control facilities on site consist of several return water dams (RWD) at the plant and co-disposal dump areas. All water falling within the plant and co-disposal footprint areas is classed as dirty water and is directed to these various RWD's on site.

Mooiplaats received a Mining Right MP 30/5/1/2/2/68 MP, 2007 (MR) and was granted an Integrated Water Use Licence No. 08/C11B/AGJ/2141, File No: 16/2/7/C112/C155 dated 02 May 2013 (IWUL), from the Department of Water and Sanitation in accordance with the National Water Act, 1998 (NWA).

2.1 Location

Mooiplaats has an approved Mining Right MP 30/5/1/2/2/68 MP, 2007 (MR) and Integrated Water Use Licence No. 08/C11B/AGJ/2141, File No: 16/2/7/C112/C155 dated 02 May 2013, for coal on Portion 1 and 9 of the Farm Mooiplaats 290IT, located east of Ermelo, south of the N2, in the Mpumalanga Province, South Africa.

Mooiplaats is situated in the magisterial district of Ermelo and falls under the Msukaligwa Local Municipality, situated in the Gert Sibande District Municipality.

Several streams, wetlands and springs are located in the area which drains south and east towards the Witpuntspruit and Vaal River in the Grootdraai Dam / Upper Vaal Catchment.

Figures 4.1 and **Annexure A** present the locality map.

2.2 Catchment, Rainfall Supply and Use and Surrounding Activities

Mooiplaats is situated in the Upper Vaal Catchment Management Area (WMA) which includes quaternary catchment C11B.

The Witpuntspruit which passes Mooiplaats and joins the Vaal River which is heavily modified due to previous and current mining activities. Well known decant upstream enters the Humanspruit which enters the Witpuntspruit and eventually the Vaal River which may have a detrimental effect on downstream users.

"*The Upper Vaal water management area lies in the eastern interior of South Africa. From a water resources management perspective it is a pivotal water management area in the country. Large quantities of water are transferred into the area from two neighbouring areas, as well as water sourced from the Upper Orange River via Lesotho. Similarly, large quantities of water are transferred out to three other water management areas, which are dependent on water from the Upper Vaal water management area to meet much of their requirements.*

Extensive urbanisation and mining and industrial activity, which relate to the rich gold and coal deposits in the area, occur in the northern part of the water management area. Economic activity in the remainder of the Upper Vaal water management area mainly relates to livestock farming and rain fed cultivation.

Because of the high level of urbanisation and economic activity in the area and its pivotal role as a water transfer point to other water management areas, water resources in the area are highly developed and regulated, and only marginal potential for further development remains. The total yield transferred into the catchment is in excess of 120 per cent of the yield from local surface resources, while virtually the same quantity of water is again transferred out of the area. Groundwater is mainly used for rural domestic needs and for stock watering, while a substantial quantity of water is also abstracted from dolomitic aquifers for urban use.

The Upper Vaal water management area is highly developed and impacted upon by human activity. The quantities of water transferred into and out of the area are largely dictated by the population needs and economic activity in this as well as similar needs in other recipient water management areas.

Water quality in the Vaal River and in some tributaries downstream of Vaal Dam is seriously affected by urban and industrial and mining return flows and the intensive mining activity. The water resources are therefore carefully managed to maintain acceptable water quality standards. Particular attention is also to be given to the impacts that closure of mines may have on both surface and groundwater." DWS, 2004.

Figures 4.1 and **Annexure A** present the locality map.

2.3 Summary of Previous Studies

Several studies have been and are being conducted as part of impact determination in terms of the water resources. Studies include:

- Surface and Groundwater Monitoring,
- Mooiplaats Monthly Water Quality Report, MON-WQR-13-79. Envass 2018.
- Groundwater Study, 2011.

Abstract from "Mooiplaats North Colliery geology and groundwater study". Fourie, 2011.

Geology baseline

The B Upper seam is well developed throughout the succession and is the only seam which is considered to be economically viable. Because of the depth of this reserve only underground mining methods are proposed.

Within the mine layout the thickness of the seam range between 1.5 - 2.9 m, averaging at 2.1 m. The depth of the coal seam roof within the mine layout ranges between 40 - 165 meters below surface (mbs), averaging at 115 mbs.

Several dolerite dykes and sills have been identified in the area. A major dyke is present between MPN and the old Usutu underground workings. A sill breakthrough also occurs between MPN and MPS. This has resulted in the compartmentalisation of the MPN underground workings as the dolerite will form no-flow boundaries with relation to inter-mine flow. Drilling has been performed in order to target the dolerite between MPN and Usutu. The drilling results were incorporated into the groundwater study.

The geophysical survey confirmed the presence of a dyke between the Usutu and MPN underground mines, as well as the approximate depth of the dyke. The dyke was targeted with 6 boreholes. These boreholes will monitor the groundwater level and quality between the two mines, as well as any potential impact (on the aquifer) caused by pumping of the Usutu mine water by MPN. MBV-2A is the closest to the pumped borehole MS-B7 and shows a slight depletion in groundwater level

Groundwater baseline

Geohydrological drilling and groundwater field work was completed in April 2011. Field work included measurements of the water levels, as well as slug testing of all monitoring boreholes.

A hydro-census within at least 1 km buffer zone around MPN was performed in order to identify the presence and status of existing boreholes and fountains, as well as groundwater use in the area. A total of 10 external users' boreholes were surveyed that are located around MPN, near homesteads, or present in the farming field. Of the 10 boreholes only 2 external user boreholes (WT-B1 and MS-B4) are currently in use for domestic (for a guesthouse) and stock watering purposes respectively. This indicates the low level of groundwater use in the area. A total of 3 fountains were included in the survey. Two of them (WT-F1 and F2) are used for domestic and stock watering purposes respectively.

Hydro-chemical samples were taken from all monitoring boreholes and several external users' boreholes and fountains. Overall, the groundwater in the area is of good quality with only 1) the Usutu monitoring borehole that has non-compliant concentration of Na and F, as well as marginally elevated SO_4, and 2) a slightly elevated SO_4 in one plant monitoring borehole.

The background groundwater could be classified as Na(Ca)-CO_3 dominated water. Groundwater with SO_4 contamination could be distinguished from the background groundwater as SO_4 becomes the dominant anion. Any future mining impact could therefore easily be identified.

The hydraulic conductivity for the shallow weathered aquifer, the deep fractured aquifer and alluvium/soils were determined from slug tests at Mooiplaats North and Mooiplaats South. The chosen hydraulic conductivity used for groundwater modelling is taken as 0.03 m/d, 0.007m/d and 4 m/d respectively.

The Karoo Formation aquifer of the Mooiplaats area can in general be classified as a low yielding aquifer. It does have a viable exploitation potential for domestic and stock-watering application and as such is the main water resource for these applications to the farming communities in the area. The aquifers will however not support formal irrigation application over any extensive area (> 10 ha). The shallow weathered aquifer can therefore be classified as a minor aquifer system in terms of aquifer management.

Groundwater impact assessment

The impact on the geohydrology has been assessed by means of a numerical groundwater model for the MPN area.

The objective of the groundwater flow and transport model was to quantify the impact of mining on the following aspects:

- *Influx of groundwater into mine workings;*
- *Inter-mine flow between adjacent mines;*
- *Impact on external users' boreholes;*
- *Impact on fountains and stream base flow;*
- *Impact of pumping/groundwater use;*
- *Development of pollution plume in aquifer down-gradient of the plant area.*

No significant impact will be presented by the bord-and-pillar mine towards the adjacent mining as the MPN is significantly compartmentalised by sills.

The MPN will also have a negligible impact on external users' boreholes and base flow to streams and fountains. As a worst case the mine may have a small impact on MS-B4 (windpump of Mr Klopper). The depth of this borehole was however not available and the impact is uncertain.

Pumping of Usutu East by MPN will have no adverse effect for Usutu both in terms of the mine water quality and quantity. With respect to both the pumping may actually have a beneficial effect as decanting of Usutu is prolonged and the mine water quality will probably improve.

The most significant impact of MPN relates to the potential plume development down-gradient of the co-disposal facility after closure. The plume will eventually reach the Witpunt Spruit tributary. The following comments relate to the seepage water quality:

- *The co-disposal will show an increase in the total dissolved solids with SO_4 as the dominant anion and will most likely acidify after closure; and*
- *Significant elevation of Al, Fe and Mn will occur. Other metals such as Cd, Sb and Se may also be present in seepage but most probably not at non-compliant concentrations.*

From the model it was calculated that the contamination plume will not develop further than about 100 - 200 m horizontally from the mine boundary within 100 years after closure. The following relates to the mine water quality:

- *The underground mine water will show an increase in the total dissolved solids with SO_4 as the dominant anion but will most likely not acidify; and*

- *No significant elevation of metals will occur in the near-neutral mine water.*

An important management measure during the operational and post-closure phase is the establishment of a groundwater monitoring system in order to detect any impact on the groundwater environment.

Monitoring of the impact on the groundwater relates to the following:

- *Development of cones of depression around the mine.*
- *Influxes of groundwater into the underground mine workings.*
- *Possible impact on the water levels and yields of external users' boreholes and fountains for at least a 1 km buffer zone around any old or active mine working.*
- *Possible depletion of groundwater base flow towards streams.*
- *Mine water levels in the underground mine."*

2.4 Information and Knowledge Gaps

The following are areas of uncertainty:

- The design of some of the monitoring boreholes and drill information (e.g. casing depth, perforated casing depth, drill water strike depth, lithology, and slug test results);
- Complete geophysical information on preferred flow paths; and
- The effect of local farming and associated contaminants.
- All possible pollution sources caused by current and historical mining. The extent / presence of informal historical mining in the catchment.
- 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 Mooiplaats Colliery,
- 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 Mooiplaats Colliery are to comply with the requirements of the IWUL and Grootdraai Dam In-stream Water Quality Guidelines, Vaal Origin. The SANS 241:2015 drinking water standards and DWS Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering will be included as supplementary comparative guidelines and not for compliance purposes.

4.1 Changes/Additions in/to Monitoring Network

Although ten (10) IWUL surface water monitoring points and nine (9) groundwater monitoring points are included in the IWUL, Mooiplaats Colliery monitors additional surface and groundwater monitoring points to determine impacts and sources more accurately.

Several additional surface and groundwater monitoring points are sampled on a monthly and quarterly basis.

Several parameters are analysed in addition to the parameters set in the 2013 IWUL.

4.2 Surface Water

The surface water monitoring points are being sampled on a monthly basis for chemical water quality and levels as prescribed in the IWUL.

Surface water monitoring in this reporting period occurred on a monthly basis as per the conditions set in the IWUL. Refer to **Annexure C** for monthly in-field sampling sheets.

Ten (10) IWUL surface water monitoring points **and** fifteen (15) additional surface water monitoring points are included in the surface water monitoring programme.

Figure 4.1.1 indicates the positions of the surface water monitoring points relative to Mooiplaats and water resources.

Figure 4.1.2 display the photographic evidence of the surface water monitoring points.

Table 4.1 presents a summary of the surface water monitoring programme/points including the name, description, coordinates and the frequency of monitoring.

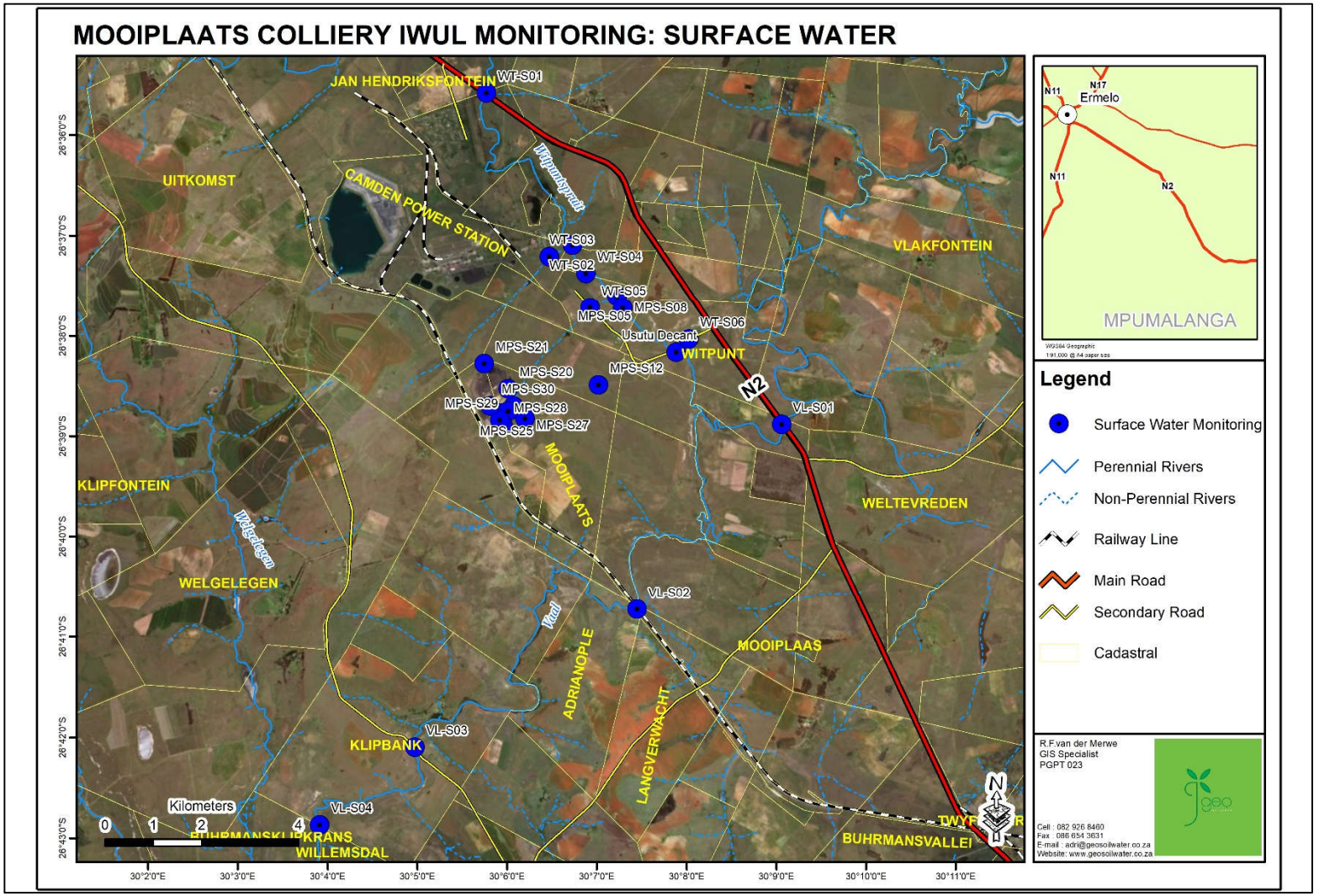


Figure 4.1.1 Location of surface water monitoring points.

Table 4.1 Summary of surface water monitoring points.

Mooiplaats Colliery Monitoring Programme			
Surface Water Monitoring Points			
Locality	**Locality Description**	**Coordinates WGS 84 ddd.ddddd**	**Monitoring Frequency**
VL-S01	Vaal River 1 Upstream	S26.64616° E30.09890°	Monthly
VL-S02	Vaal River 2 Downstream 1	S26.64804° E30.15098°	Monthly
VL-S03	Vaal River 3 Downstream 2	S26.67879° E30.12411°	Monthly
VL-S04	Vaal River 4 Downstream 3	S26.70167° E30.08288°	Monthly
WT-S01	Witpuntspruit 1 Upstream	S26.71447° E30.06519°	Monthly
WT-S02	Witpuntspruit 2 Midstream	S26.59307° E30.09617°	Monthly
WT-S03	Witpuntspruit Tributary North DS 1	S26.61826° E30.11211°	Monthly
WT-S04	Witpuntspruit 3 Midstream	S26.62014° E30.10781°	Monthly
WT-S05	Witpuntspruit Tributary South DS 2	S26.62294° E30.11463°	Monthly
WT-S06	Witpuntspruit 6 Downstream	S26.62863° E30.11539°	Monthly
MPS-S08	Witpuntspruit 5 MS	S26.62873° E30.12149°	Monthly
MPS-S12	Witpuntspruit Tributary @ Access Road	S26.64150° E30.11697°	Monthly
MPS-S13	Runoff from Loading Area	S26.64837° E30.09888°	Monthly
MPS-S14	Gen-sub PCD	S26.64616° E30.09890°	Monthly
MPS-S15	Stormwater trench @ Security	S26.64837° E30.09888°	Monthly
MPS-S16	DS Area of Erikson's + Settling Dams	S26.64505° E30.10121°	Monthly
MPS-S20	Erickson Dams	S26.64505° E30.10121°	Monthly
MPS-S21	Main Holdings Dam	S26.64198° E30.10059°	Monthly
MPS-S25	Workshop Trench DS of Workshop	S26.63826° E30.09506°	Monthly
MPS-S27	Witpuntspruit Tributary entering MP	S26.64716° E30.10336°	Monthly
MPS-S28	Confluence of MPS-S13 and MPS-S15	S26.64808° E30.09925°	Monthly
MPS-S29	Storm water @ Offices	S26.64743° E30.09802	Monthly
MPS-S30	Plant PCD	S26.64508° E30.09674°	Monthly
Usutu Decant	Decant from Old Usutu Workings Decanting into the Witpuntspruit Upstream of WT-06	S26.63611°E30.13139°	Monthly
	Additional Monitoring Points		
	IWUL Monitoring Points		

VL-S01

VL-S02

	
VL-S03	VL-S04
	
WT-S01	WT-S02
	
WT-S03	WT-S04
	
WT-S05	WT-S06
	
MPS-S08	MPS-S13

	
MPS-S14	MPS-S15
	
MPS-S16	MPS-S20
	
MPS-S21	MPS-S25
	
MPS-S27	MPS-S28
	
MPS-S29	MPS-S30

Usutu Decant

Figure 4.1.2 Photographic record of surface water monitoring points.

4.3 Groundwater

The IWUL groundwater monitoring points are being sampled on a **monthly** basis for chemical water quality and levels where additional groundwater monitoring points are being sampled on a **biannual** basis.

Nine (9) IWUL and twenty (20) additional groundwater monitoring points are included in the Groundwater monitoring programme.

Groundwater monitoring in this reporting period occurred on a monthly and biannual basis.

Refer to **Annexure C** for quarterly in-field sampling sheets.

Figure 4.1.3 indicates the positions of the groundwater monitoring points.

Figure 4.1.4 display the photographic evidence of the groundwater monitoring points.

Table 4.2 is a summary of the monitoring points including the name, description, coordinates and the frequency of monitoring.

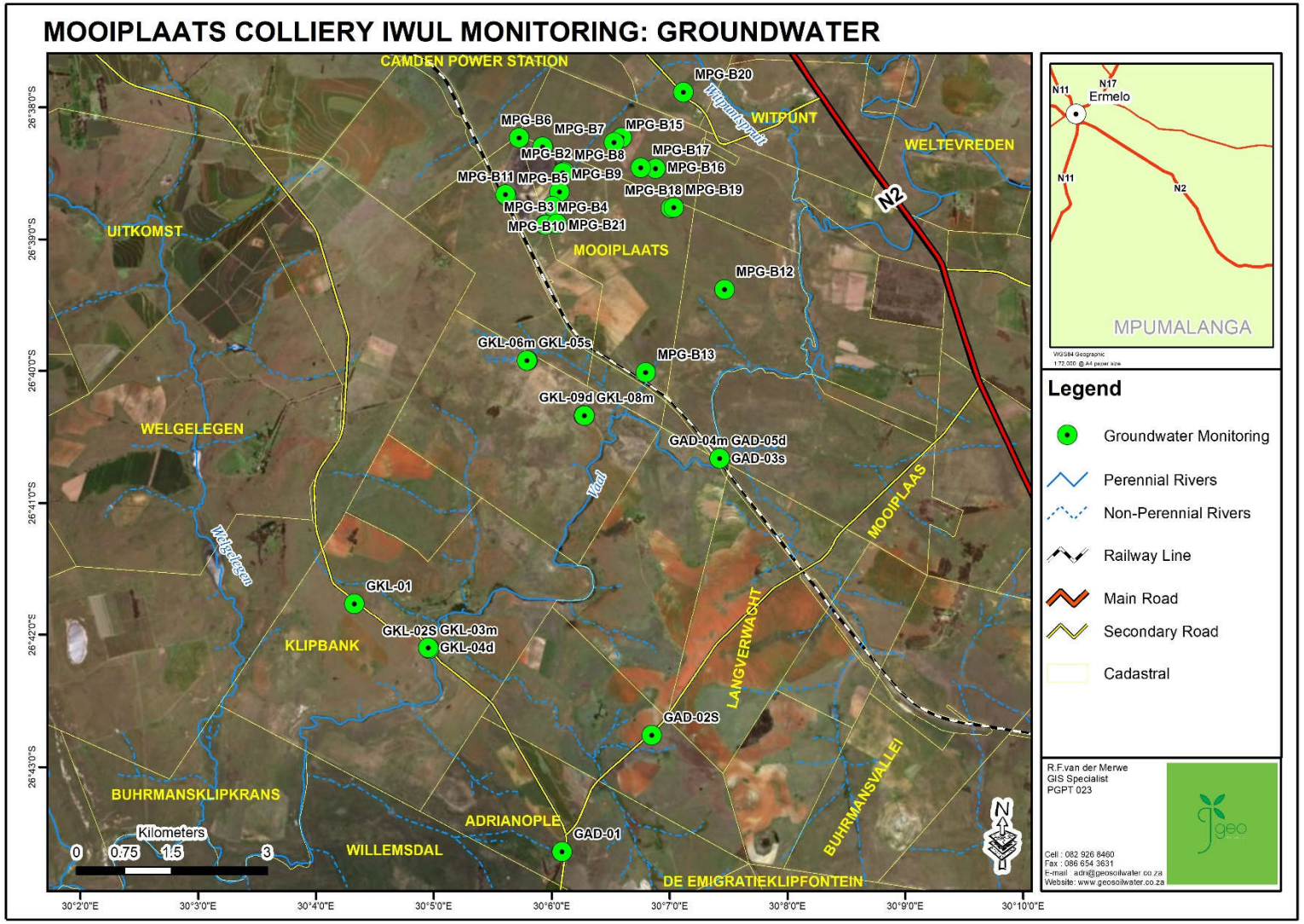


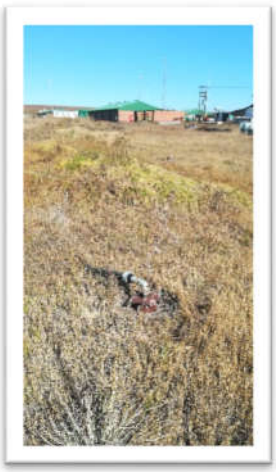
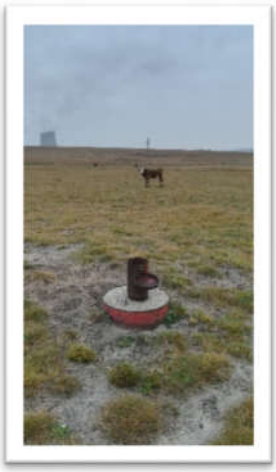
Figure 4.1.3 Location of groundwater monitoring points.

Table 4.2 Summary of groundwater monitoring points.

Mooiplaats Colliery Groundwater Monitoring Programme			
Groundwater Monitoring Points			
Locality	**Locality Description**	**Coordinates WGS 84 ddd.ddddd**	**Monitoring Frequency**
GKL-1	IWUL Borehole	S26.69603° E30.07208°	Monthly
GKL-4d	IWUL Borehole	S26.70167° E30.08253°	Monthly
GKL-3m	Borehole	S26.70178° E30.08269°	Monthly
GKL-2s	IWUL Borehole	S26.70178° E30.08269°	Monthly
GAD-2s	IWUL Borehole	S26.71269° E30.11414°	Monthly
GAD-1	IWUL Borehole	S26.72733° E30.10144°	Monthly
GKL-9D	IWUL Borehole	S26.67231° E30.10450°	Monthly
GKL-8M	IWUL Borehole	S26.67233° E30.10464°	Monthly
GKL-5S	IWUL Borehole	S26.66542° E30.09647°	Monthly
GKL-6M	IWUL Borehole	S26.66542° E30.09658°	Monthly
GAD-3s	Borehole	S26.67772° E30.12374°	Monthly
GAD-4m	Borehole	S26.67772° E30.12374°	Monthly
GAD-5d	Borehole	S26.67772° E30.12374°	Monthly
MPG-B1	Down gradient (north) of the co-disposal facility.	S26.63843° E30.09878°	Biannually
MPG-B2	Down gradient (east) of the lined Settling Dams and co-disposal.	S26.64143° E30.10175°	Biannually
MPG-B3	Near the security gate.	S26.64816° E30.09905°	Biannually
MPG-B4	Near the security gate.	S26.64819° E30.09910°	Biannually
MPG-B5	Up-gradient (south-west) of the plant area next to the railway line.	S26.64457° E30.09363°	Biannually
MPG-B6	Adjacent to the return water dam.	S26.63719° E30.09540°	Biannually
MPG-B7	Down gradient (north) of the co-disposal facility.	S26.63832° E30.09870°	Biannually
MPG-B8	Down gradient (east) of the lined Settling Dams.	S26.64160° E30.10155°	Biannually
MPG-B9	Down gradient (east) of the plant area.	S26.64403° E30.10107°	Biannually
MPG-B10	Down gradient (east) of the plant area.	S26.64581° E30.10007°	Biannually
MPG-B11	Up-gradient (south-west) of the plant area next to the railway line.	S26.64435° E30.09344°	Biannually
MPG-B12	At MPN Vunene extension	S26.65633° E30.12443°	Biannually
MPG-B13	South of the mine next to the railway line.	S26.66689° E30.11329°	Biannually
MPG-B14	Between Usutu/MPN	S26.63716° E30.10992°	Biannually
MPG-B15	Between Usutu/MPN	S26.63778° E30.10881°	Biannually
MPG-B16	Between Usutu/MPN	S26.64106° E30.11469°	Biannually
MPG-B17	Between Usutu/MPN	S26.64095° E30.11259°	Biannually
MPG-B18	Between Usutu/MPN	S26.64608° E30.11685°	Biannually
MPG-B19	Between Usutu/MPN	S26.64600° E30.11725°	Biannually
MPG-B20	Usutu UG. Bh intersecting mine at 90 m	S26.63144° E30.11860°	Biannually
	Additional Monitoring Points		
	IWUL Monitoring Points		

		
GKL-1	GKL-2S	GKL-3M
	No image available	No image available
GKL-4D	GKL-5S	GKL-6M
No image available	No image available	
GKL-8M	GKL-9D	GAD-1

		
GAD-2S	GAD-3S	GAD-4M
		
GAD-5D	MPG-B1	MPG-B2
		
MPG-B3	MPG-B4	MPG-B5

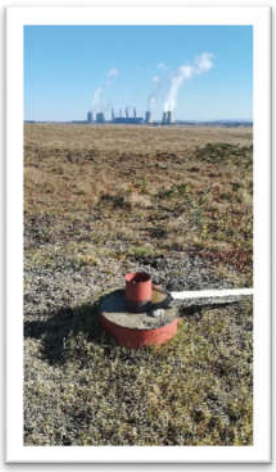
		
MPG-B6	MPG-B7	MPG-B8
		
MPG-B9	MPG-B10	MPG-B11
No image available	No image available	
MPG-B12	MPG-B13	MPG-B14

MPG-B15

MPG-B16

MPG-B17

MPG-B18



MPG-B19

MPG-B20

MPG-B21

Figure 4.1.4 Photographic record of groundwater monitoring points.

5. METHODOLOGY

The following is a description of the sampling protocol, analyses and reporting included in the Mooiplaats Colliery monitoring programme. Please refer to **Section 4** of this report for a complete description of the monitoring points.

5.1 Sampling Protocol

GSW is responsible for the sampling of the monitoring points, the assessment evaluation and report writing.

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 thus used as a guiding tool in this study and the subsequent development of a surface water and groundwater monitoring program for Mooiplaats Colliery.

5.2 Surface water

For chemical analyses, a 200 mL plastic container was used to collect a grab sample. Bottles are properly 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 occurs at twenty five (25) surface water monitoring points on a monthly basis.

Monthly surface water samples are analysed for:

- pH
- EC mS/m
- TDS mg/L
- Total Hardness mg/L
- Alkalinity $CaCO_3$/L
- Ca mg/L
- Mg mg/L
- Na mg/L
- K mg/L
- F mg/L
- Cl mg/L
- SO_4 mg/L
- NO_3 mg/L
- Al mg/L
- Fe mg/L
- Mn mg/L
- NH_3 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.

Geographical coordinates, photos and the date, time and field analyses for each sample are recorded.

Monitoring occurs at thirty three (33) groundwater monitoring points. Thirteen (13) IWUL groundwater points on a monthly basis and the additional twenty (20) groundwater points on a biannual basis.

Groundwater samples are analysed for:

- pH
- EC mS/m
- TDS mg/L
- Total Hardness mg/L
- Alkalinity $CaCO_3$/L
- Ca mg/L
- Mg mg/L
- Na mg/L
- K mg/L
- F mg/L
- Cl mg/L
- SO_4 mg/L
- NO_3 mg/L
- Al mg/L
- Fe mg/L
- Mn mg/L
- NH_3 mg/L

5.4 Water levels

Water levels at groundwater monitoring points are recorded on a monthly and biannual basis (as per Section 5.3) using an electronic water level meter with a probe which measures water levels accurately in boreholes and wells (Section 6.9).

5.5 Water sample analyses

Both, surface - and groundwater samples are submitted to UIS Laboratories (UIS), for organic, physical and chemical analyses. Surface - and groundwater samples are analysed for variables as described in **Sections 5.2** and **5.3** or additionally as requested on an ad hoc basis.

5.6 Reporting

The quarterly, biannual and annual surface - and groundwater assessments are evaluated by a registered Pr.Sci.Nat. Environmental Scientist and annual groundwater assessments are evaluated by a registered Pr.Sci.Nat. Geohydrologist.

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

- Quarterly Surface – and Groundwater Monitoring Reports; or
- Bi-annual Surface – and Groundwater Monitoring Reports; and
- Comprehensive Annual Water Quality Report.

Quarterly and Bi-annual 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, 2013 included in this report:

- **Mar 2018-** IWUL, Monthly surface water monitoring.
- **Apr 2018-** IWUL, Monthly surface water monitoring.
- **May 2018-**IWUL, Monthly surface and decant and biannual groundwater monitoring,
- **June 2018-**IWUL, Monthly surface and IWUL groundwater monitoring,

The following sections are discussions on the surface - and groundwater quality results for Mooiplaats Colliery, for the period 01 March 2018 – 30 June 2018.

Refer to **Annexure C** for:

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

Refer to **Annexure D** 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 6.1**), salinity (**Table 6.2**) and hardness (**Table 6.3**).

Table 6.1 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 6.2 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 6.3 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 water quality discussions on areas associated with current Mooiplaats Colliery mining operations.

Section 6.1 - Contained Waste Water,
Section 6.2 - Storm Water and Surface Water Runoff,
Section 6.3 - Witpuntspruit Surface Water,
Section 6.4 - Vaal River Surface Water,
Section 6.5 - Groundwater,
Section 6.6 - Groundwater Levels

Variable concentration trends and STIFF diagrams are displayed in **Figures 6.1.1** to **6.1.12**.

Surface and groundwater monitoring points will be compared to IWUL Limits and the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin.

The DWS Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering and the South African National Standard, Drinking Water Standard (Edition 2) (SANS 241:2015) were included as supplementary comparative guidelines and not for compliance purposes.

6.1 Waste Water

Table 6.4 indicates the average water quality for the waste water monitoring points compared to the IWUL Limits and the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin.

Contained waste water include:
MPS-S14 - Gensub PCD
MPS-S20 - Erickson Dams
MPS-S21 - Main Holdings Dam
MPS-S30 - Plant PCD

Figures 6.1.1 illustrate variable concentration trends for all waste water monitoring points for the duration of the reporting period where **Figure 6.1.2** illustrate the average STIFF diagrams for all waste water monitoring points.

Table 6.4 Average water quality for waste water monitoring points for the reporting period.

Average Waste Water Quality for Mooiplaats March – June 2018									
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**MPS-S14**	**MPS-S20**	**MPS-S21**	**MPS-S30**
pH	-	**3.5 – 8.5**	**6.4 – 8.5**	**5.0 - 9.5**	-	7.53	7.63	6.03	6.57
EC	mS/m	**150**	**25**	**170**	**500**	265.63	282.08	489.00	342.70
TDS	mg/L	**1288**	-	**1200**	**3000**	2038	2271	4291	2892
Total Hardness	mg/L	-	-	-	-	823	928	2057	1332
Alkalinity	$CaCO_3$/L	-	**75**	-	-	201.067	119.675	134.050	37.875
Ca	mg/L	**87**	-	-	**1000**	174.000	173.075	376.375	290.375
Mg	mg/L	**51.40**	-	-	**500**	94.233	120.425	271.350	147.400
Na	mg/L	**725**	-	**200**	**200**	346.500	404.575	629.350	390.600
K	mg/L	-	-	-	-	10.667	8.325	11.025	8.825
F	mg/L	**3.23**	**0.4**	**1.5**	**2**	0.820	1.223	0.283	0.498
Cl	mg/L	**116.66**	**20**	**300**	**3000**	90.033	24.200	26.475	21.650
SO_4	mg/L	**740**	**30**	**500**	**1000**	1201.667	1468.350	2896.450	2010.750
NO_3	mg/L	-	**0.5**	**11**	-	-0.000	-0.000	-0.000	-0.000
NH_3	mg/L	**0.24**	-	**1.5**	-	-0.000	0.730	1.055	1.680
Al	mg/L	**0.09**	-	**0.3**	**5**	0.283	0.103	2.643	0.845
Fe	mg/L	**0.001**	-	**0.3**	**10**	0.803	0.830	0.798	0.263
Mn	mg/L	**0.15**	-	**0.1**	**10**	4.260	3.998	8.590	3.140

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.

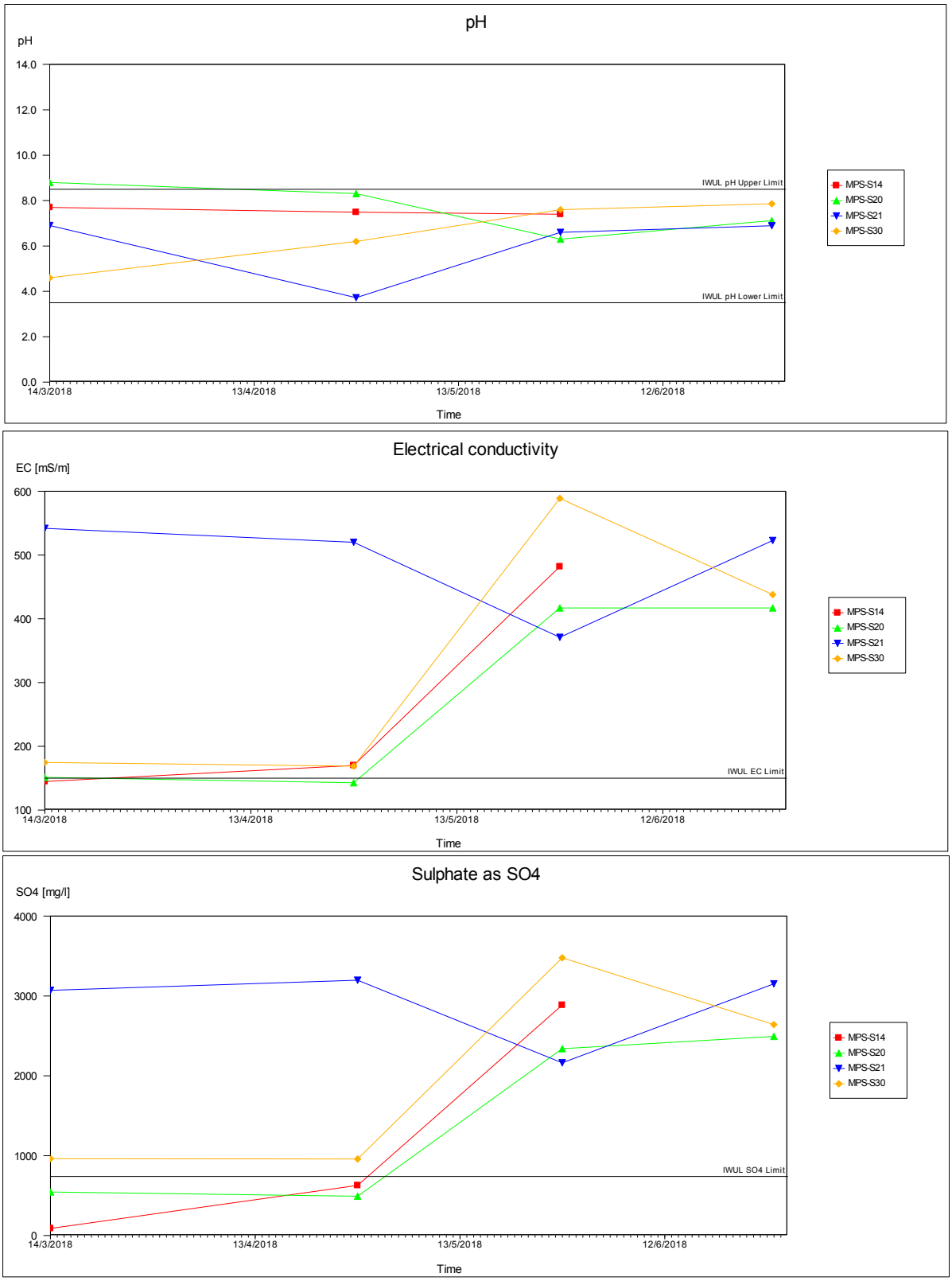
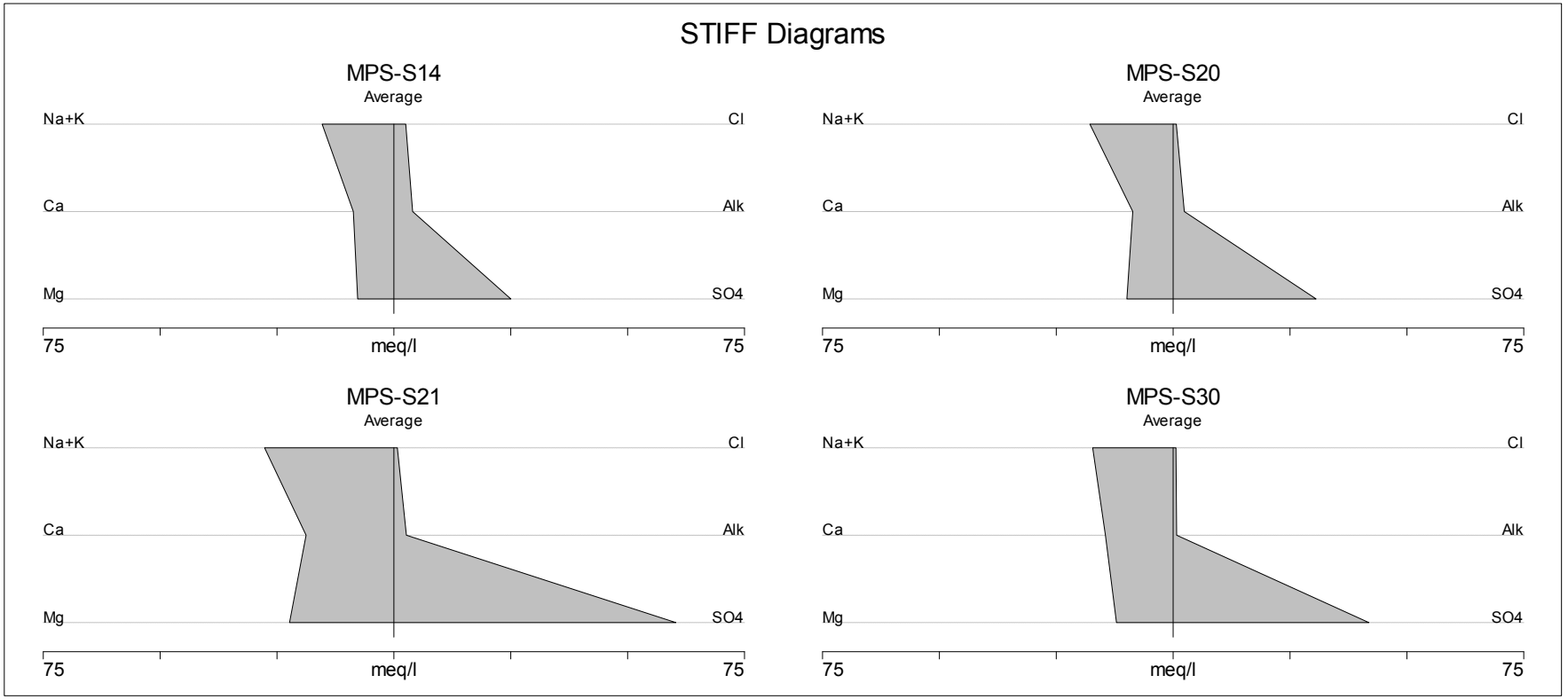


Figure 6.1.1 Waste water variable concentration trends

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.2 Average waste water STIFF diagrams.

From **Table 6.4** it is evident that the waste water quality exceeded several IWUL limits and the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin.

Although the pH of the waste water remained neutral during the reporting period, clear elevations in other variable concentrations were noted.

The elevation in the majority of variable concentrations, as indicated with the EC and SO_4 concentrations as per **Figure 6.1.1** can be ascribed to the commencement of coal producing / washing activities in April 2018, where the concentrations increased from May 2018 to stabilise in June 2018. Elevated metal concentrations, especially Al and Mn were recorded during the reporting period.

From **Figure 6.1.2** it is evident that SO_4 is the dominating anion in the water composition, typical of coal waste water.

All waste water facilities are constructed and lined appropriately, and operated in a closed circuit.

6.2 Storm Water and Surface Water Runoff

Table 6.5 indicates the average surface water quality for the surface and storm water runoff linked to the receiving environment from Mooiplaats Colliery. Water quality from these monitoring points is compared to the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin and IWUL Waste Water Limits.

The DWS Livestock watering upper limit, 1996 and the SANS 241:2015 drinking water standards are included for comparative purposes.

Variables exceeding the limits, standards are highlighted respectively.

Storm water and surface water runoff include:

MPS-S13 - Runoff from Loading Area
MPS-S15 - Clean stormwater trench entering Mooiplaats at Security Gate
MPS-S16 - DS area from Erickson dams and Settling Dams
MPS-S25 - Stormwater Trench Downstream of Workshop
MPS-S27 - Witpuntspruit entering Mooiplaats
MPS-S28 - After confluence of MPS-S13 and MPS-S15
MPS-S29 - Stormwater trench at Offices, Upstream of MPS-S25

Figure 6.1.3 illustrate variable concentration trends for surface and runoff water where **Figure 6.1.4** illustrate the water composition in STIFF diagrams

Table 6.5 Average water quality for surface and storm water runoff monitoring points for the reporting period.

Average Storm and Surface Water Quality for Mooiplaats Colliery March – June 2018												
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241: 2011**	**DWS Livestock Watering**	**MPS-S13**	**MPS-S15**	**MPS-S16**	**MPS-S25**	**MPS-S27**	**MPS-S28**	**MPS-S29**
pH	-	3.5 – 8.5	6.4 – 8.5	5.0 - 9.5	-	7.96	8.49	3.74	8.34	6.88	8.18	8.19
EC	mS/m	150	25	170	500	79.40	60.50	669.67	36.15	47.70	56.65	214.37
TDS	mg/L	1288	-	1200	3000	506	353	6517	211	294	323	1281
Total Hardness	mg/L	-	-	-	-	257	229	2712	148	194	190	393
Alkalinity	$CaCO_3$/L	-	75	-	-	111.833	123.167	1.167	140.950	86.000	117.500	132.833
Ca	mg/L	87	-	-	1000	52.167	44.667	302.733	37.850	46.700	38.250	92.533
Mg	mg/L	51.40	-	-	500	30.767	28.433	474.900	12.875	18.800	23.000	39.433
Na	mg/L	725	-	200	200	65.367	36.733	401.133	20.925	18.900	29.900	313.667
K	mg/L	-	-	-	-	2.333	1.533	13.033	2.675	6.000	1.950	3.900
F	mg/L	3.23	0.4	1.5	2	-0.267	-0.267	-0.267	-0.200	-0.400	-0.400	-0.267
Cl	mg/L	116.66	20	300	3000	18.133	18.533	11.900	3.275	8.600	16.500	298.067
SO_4	mg/L	740	30	500	1000	272.167	150.433	5314.000	49.975	145.900	144.900	455.000
NO_3	mg/L	-	0.5	11	-	0.000	0.000	0.533	0.000	0.000	0.000	0.000
NH_3	mg/L	0.24	-	1.5	-	0.030	0.000	1.405	0.080	0.000	0.000	0.000
Al	mg/L	0.09	-	0.3	5	0.157	0.103	63.723	0.028	0.050	0.070	0.017
Fe	mg/L	0.001	-	0.3	10	0.137	0.123	778.507	0.088	0.200	0.090	0.773
Mn	mg/L	0.15	-	0.1	10	-0.033	-0.033	65.103	-0.025	-0.050	-0.050	-0.033

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.

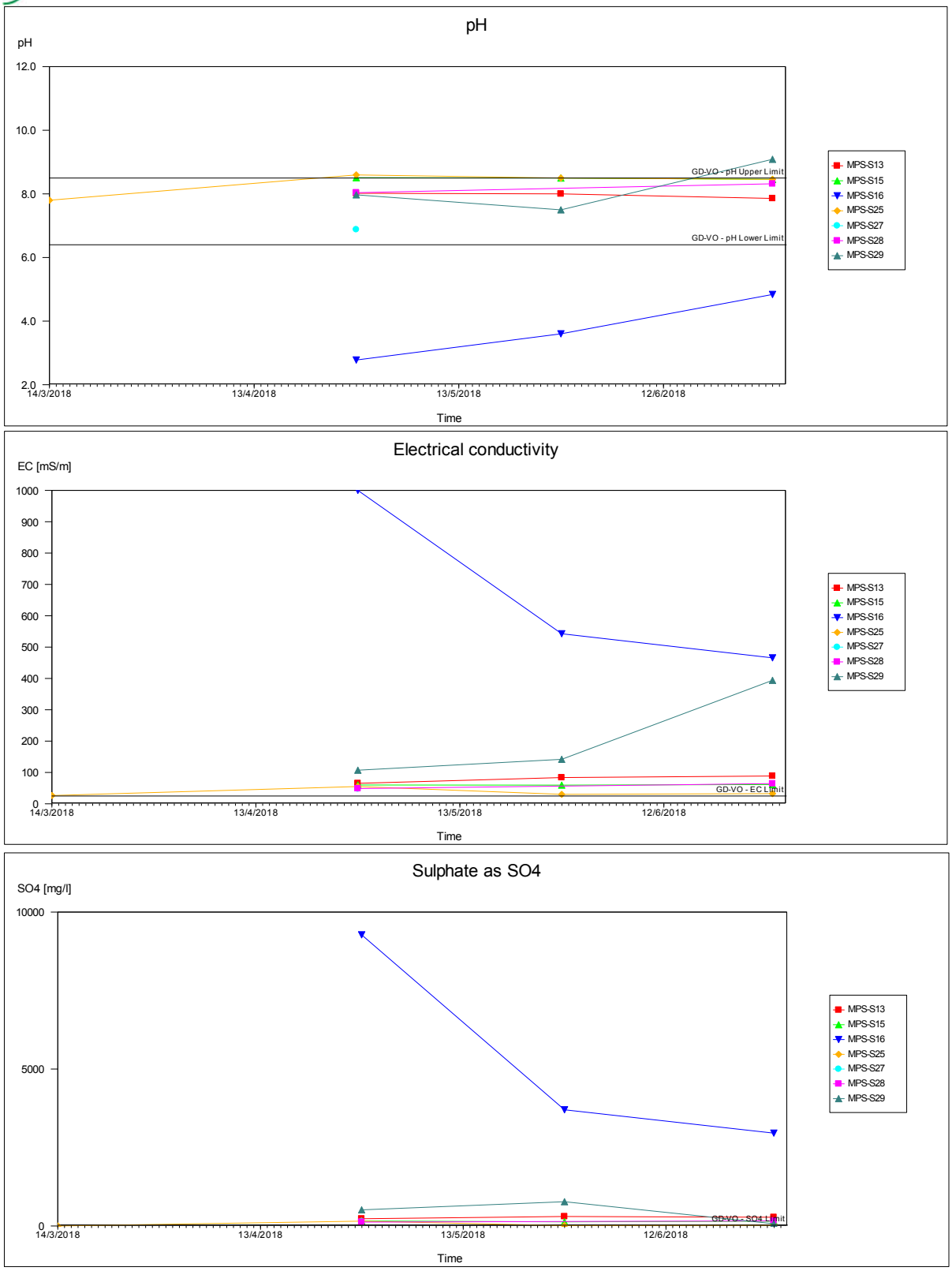
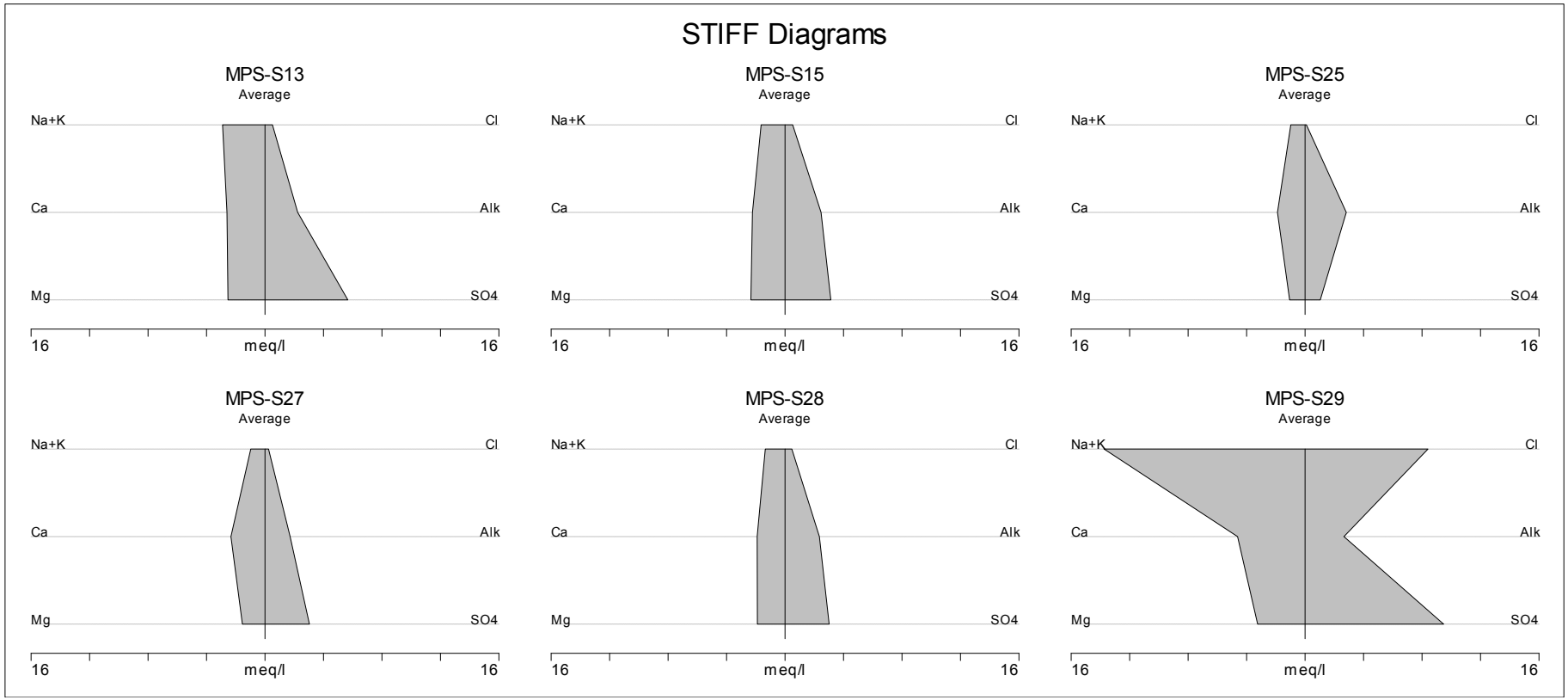


Figure 6.1.3 Variable concentration trends for surface and runoff water monitoring points.

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.4 STIFF Diagrams for surface and storm water runoff monitoring points.

From **Table 6.5** and **Figures 6.1.3** and **6.1.4** it is evident that water quality at all runoff monitoring points recorded signs of coal mine pollution as indicators such as pH, EC and SO_4 recorded elevated concentrations.

Although the IWUL Waste Water Limits was mostly not exceeded, the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin was exceeded in terms of EC, Alkalinity and SO_4.

The water quality at **MPS-S16** can be associated with Acid Mine Drainage (AMD) with a very low pH, elevated salts and metals. **MPS-S16** is located directly down gradient of the coal disposal facility, and several other water related infrastructure. Water from this area should be prevented from entering the receiving environment.

All stormwater and surface water runoff reports to the Witpuntspruit tributary, **WT-S05** where a definite coal mine impact are observed.

6.3 Witpuntspruit Surface Water

Table 6.6 indicates the average surface water quality for the Witpuntspruit and associated tributaries draining Mooiplaats Colliery and other possible pollution sources. Water quality from these monitoring points are compared to the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin and IWUL Waste Water Limits.

The DWS Livestock watering upper limit, 1996 and the SANS 241:2015 drinking water standards are included for comparative purposes.

Variables exceeding the limits, standards are highlighted respectively.

Figure 6.1.5 depicts the Witpuntspruit surface monitoring point variable concentration trends, **Figure 6.1.6** represent the water quality stream profile for the Witpuntspruit and **Figure 6.1.7** illustrates the composition of the Witpuntspruit water quality in STIFF Diagrams.

Table 6.6 Average water quality for the Witpuntspruit and its Tributaries surface water monitoring points for the reporting period.

Average Witpuntspruit Water Quality for Mooiplaats Colliery March – June 2018										
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**WT-S01**	**WT-S03**	**WT-S02**	**WT-S04**	**WT-S05**
pH	-	3.5 – 8.5	6.4 – 8.5	5.0 - 9.5	-	3.70	7.04	6.65	6.58	4.10
EC	mS/m	150	25	170	500	139.13	54.70	74.68	75.23	293.42
TDS	mg/L	1288	-	1200	3000	952	321	480	448	2394
Total Hardness	mg/L	-	-	-	-	512	180	258	225	1099
Alkalinity	$CaCO_3$/L	-	75	-	-	-1.750	56.500	35.300	26.250	21.175
Ca	mg/L	87	-	-	1000	102.475	41.975	52.900	46.050	164.550
Mg	mg/L	51.40	-	-	500	62.275	18.275	30.650	26.750	167.075
Na	mg/L	725	-	200	200	41.950	36.800	51.300	50.175	225.250
K	mg/L	-	-	-	-	5.675	3.750	7.000	7.125	7.550
F	mg/L	3.23	0.4	1.5	2	-0.200	-0.200	-0.200	-0.200	-0.085
Cl	mg/L	116.66	20	300	3000	15.950	15.775	22.175	21.950	13.500
SO_4	mg/L	740	30	500	1000	724.300	171.575	296.125	280.825	1804.950
NO_3	mg/L	-	0.5	11	-	0.900	-0.000	-0.000	0.550	-0.000
NH_3	mg/L	0.24	-	1.5	-	0.930	-0.000	-0.000	-0.000	0.215
Al	mg/L	0.09	-	0.3	5	14.540	0.035	0.163	0.108	26.660
Fe	mg/L	0.001	-	0.3	10	9.008	0.523	0.168	0.025	29.018
Mn	mg/L	0.15	-	0.1	10	6.180	0.333	1.253	0.535	12.345

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.

Table 6.6 (cont.) Average water quality for the Witpuntspruit and its Tributaries surface water monitoring points for the reporting period.

Average Witpuntspruit Water Quality for Mooiplaats Colliery March – June 2018									
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**MPS-S05**	**MPS-S08**	**Usutu Decant**	**WT-S06**
pH	-	**3.5 – 8.5**	**6.4 – 8.5**	**5.0 - 9.5**	-	6.50	6.86	7.88	7.50
EC	mS/m	**150**	**25**	**170**	**500**	75.50	76.48	275.25	105.73
TDS	mg/L	**1288**	-	**1200**	**3000**	444	495	1791	644
Total Hardness	mg/L	-	-	-	-	251	246	161	240
Alkalinity	$CaCO_3$/L	-	**75**	-	-	23.625	39.425	806.500	191.175
Ca	mg/L	**87**	-	-	**1000**	50.900	49.575	37.700	49.100
Mg	mg/L	**51.40**	-	-	**500**	29.975	29.775	16.150	28.575
Na	mg/L	**725**	-	**200**	**200**	46.450	54.175	598.250	130.075
K	mg/L	-	-	-	-	6.650	6.550	8.000	6.150
F	mg/L	**3.23**	**0.4**	**1.5**	**2**	-0.200	-0.200	1.475	0.640
Cl	mg/L	**116.66**	**20**	**300**	**3000**	21.450	21.700	54.000	30.550
SO_4	mg/L	**740**	**30**	**500**	**1000**	275.575	311.025	592.500	284.725
NO_3	mg/L	-	**0.5**	**11**	-	0.275	-0.000	-0.000	0.250
NH_3	mg/L	**0.24**	-	**1.5**	-	-0.000	-0.000	0.130	-0.000
Al	mg/L	**0.09**	-	**0.3**	**5**	0.198	0.180	0.205	0.443
Fe	mg/L	**0.001**	-	**0.3**	**10**	0.098	0.105	0.245	0.428
Mn	mg/L	**0.15**	-	**0.1**	**10**	0.408	0.550	0.025	0.345

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.

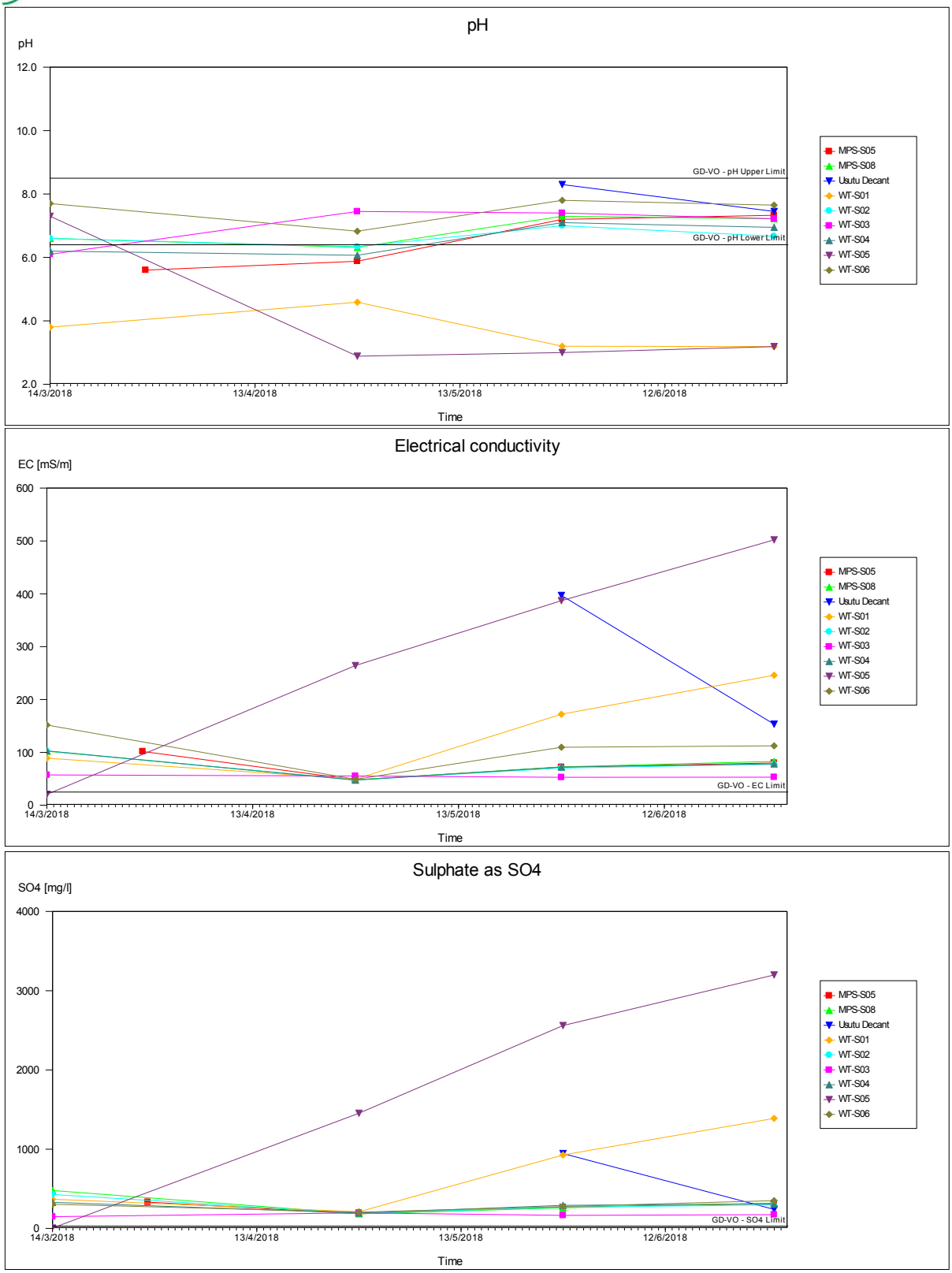


Figure 6.1.5 Witpuntspruit and Tributaries water monitoring points variable concentration trends.

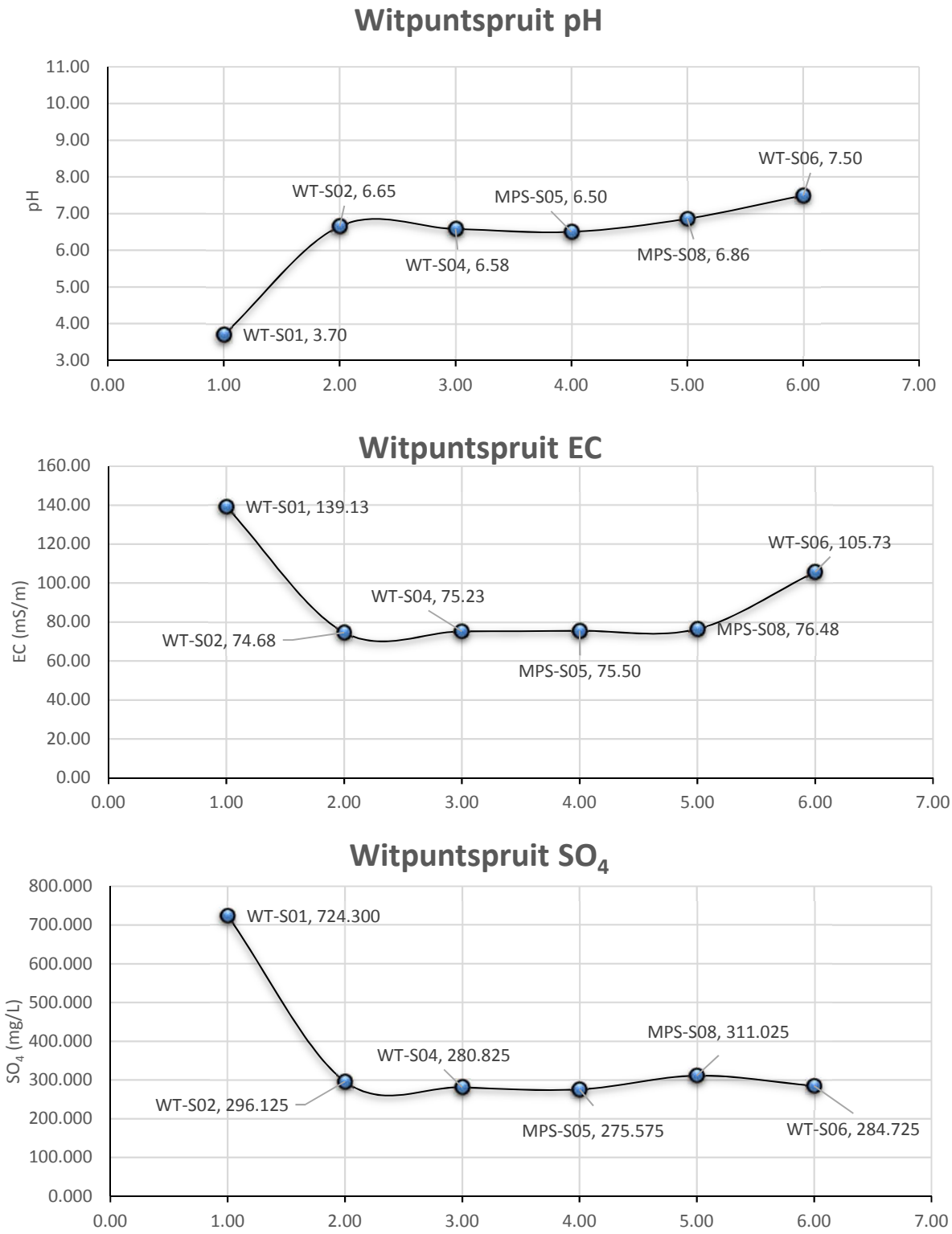
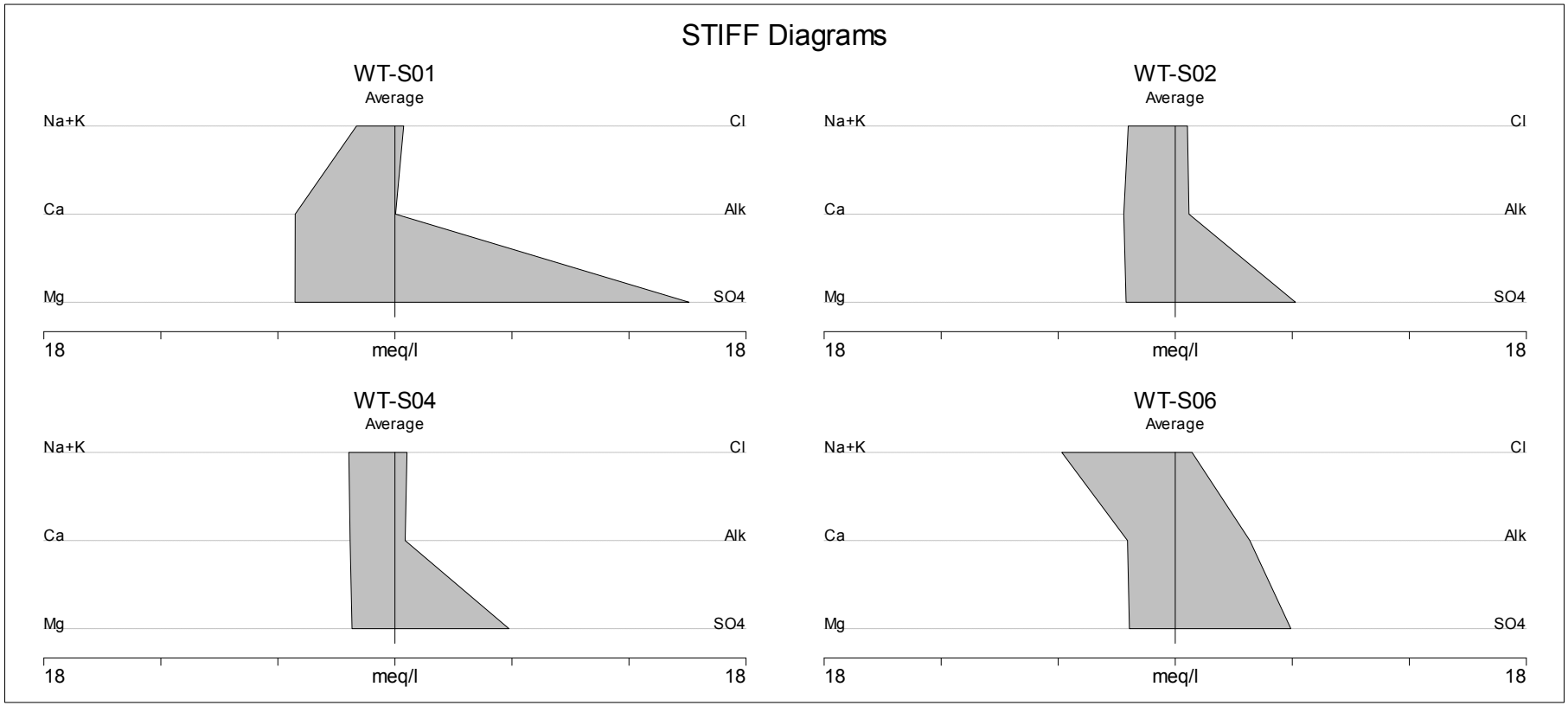


Figure 6.1.6 Witpuntspruit stream profile.

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible coal mining pollution.

- A dominant Alkalinity/Bicarbonate (HCO_3^-) anion indicates fresh, natural and unimpacted water.

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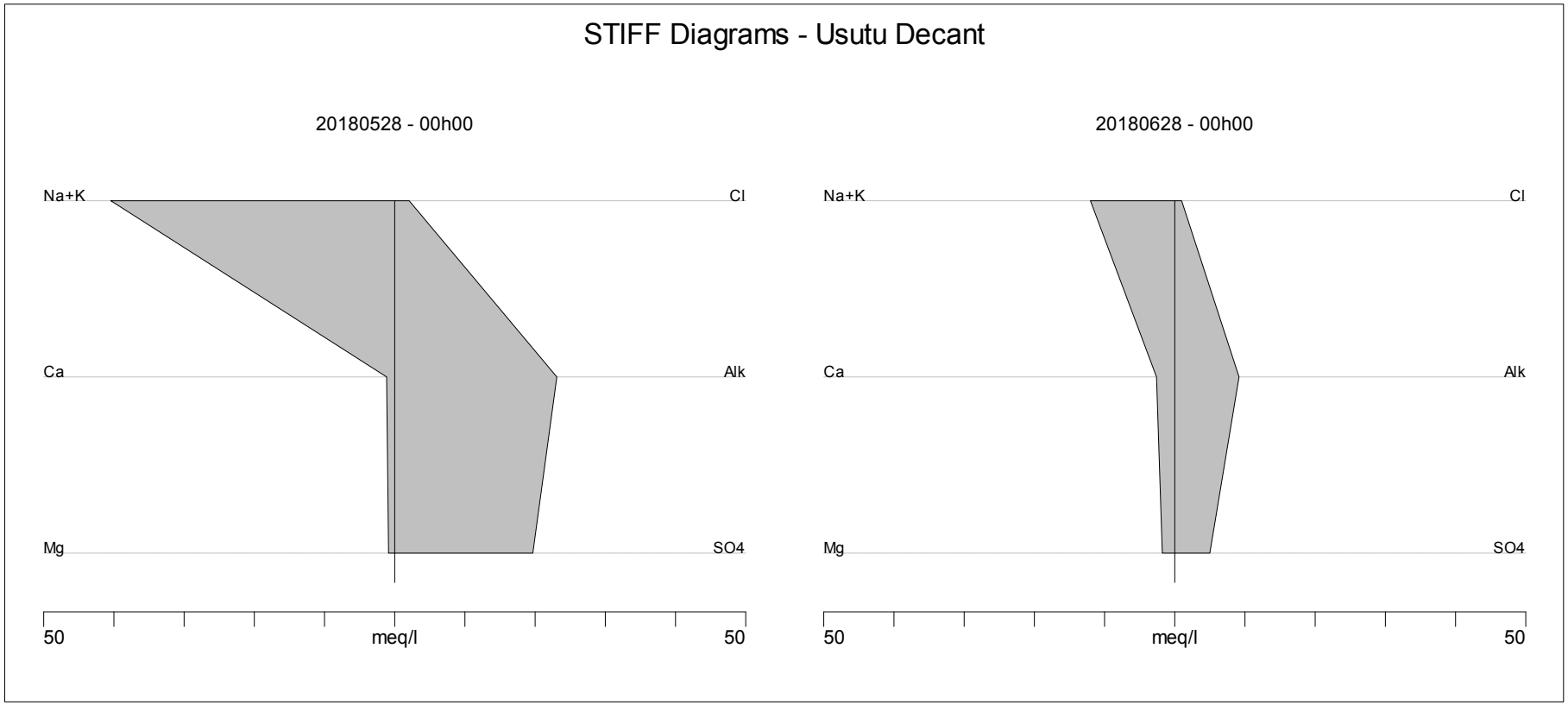


* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.7 STIFF Diagrams for the Witpuntspruit surface water monitoring points.

From **Table 6.6** and **Figures 6.1.5** and **6.1.6** it is evident that water quality from the Witpuntspruit are highly impacted on, from upstream (**WT-S01**) of Mooiplaats Colliery to downstream (**WT-S06**) of Mooiplaats Colliery before the confluence with the Vaal River. Irrespective of the tributaries draining Mooiplaats Colliery entering the Witpuntspruit, the water quality already exceeds Unacceptable water quality in terms of the Grootdraai Dam Guidelines.

Although the water quality show improvement in **Figures 6.1.6** and **6.1.7** from **WT-S01** to **WT-S06**, a slight deterioration from the **WT-S05** tributary from Mooiplaats Colliery can be seen between **WT-S04** and **MPS-S08** where the EC and SO_4 concentrations increase.

As per the STIFF Diagrams in **Figure 6.1.7** the improvement in water quality and composition from **WT-S01** to **WT-S02**, to **WT-S04** are clearly visible where the composition of the water changes at **WT-S06** due to **decant** from the **Old Usutu mine** entering the Witpuntspruit between **MPS-S08** and **WT-S06**.

Irrespective of the unacceptable water quality and composition of the Witpuntspruit, any possible pollution from Mooiplaats Colliery entering the Witpuntspruit should be prevented.

6.4 Vaal River Surface Water

Table 6.7 indicates the average surface water quality for the Witpuntspruit and associated tributaries draining Mooiplaats Colliery and other possible pollution sources. Water quality from these monitoring points are compared to the In-stream Water Quality Guidelines for the Grootdraai Dam Catchment - Vaal origin and IWUL Waste Water Limits.

The DWS Livestock watering upper limit, 1996 and the SANS 241:2015 drinking water standards are included for comparative purposes.

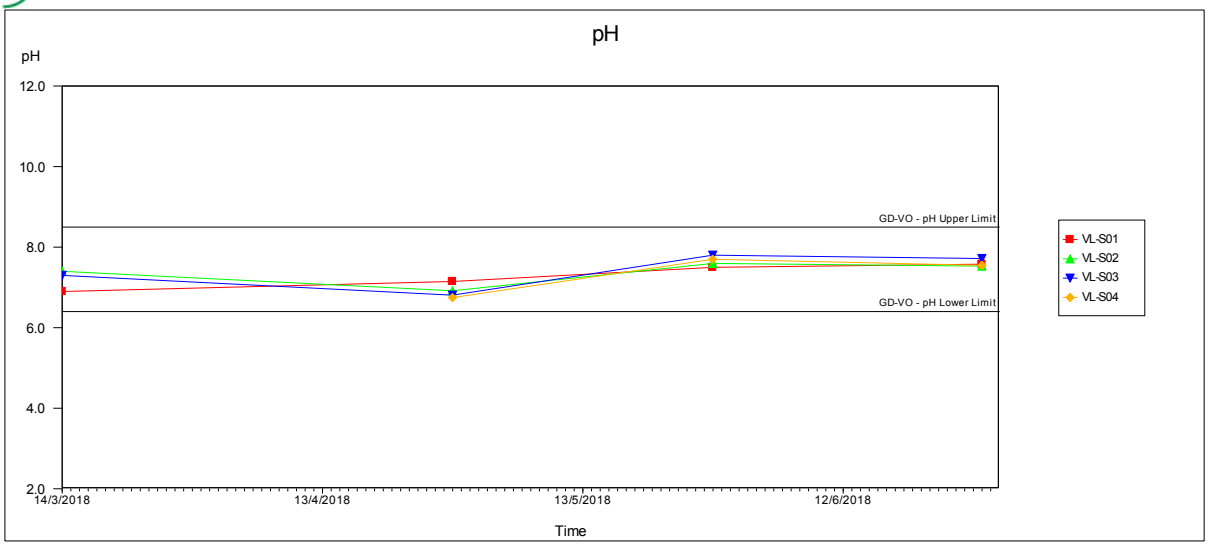
Variables exceeding the limits, standards are highlighted respectively.

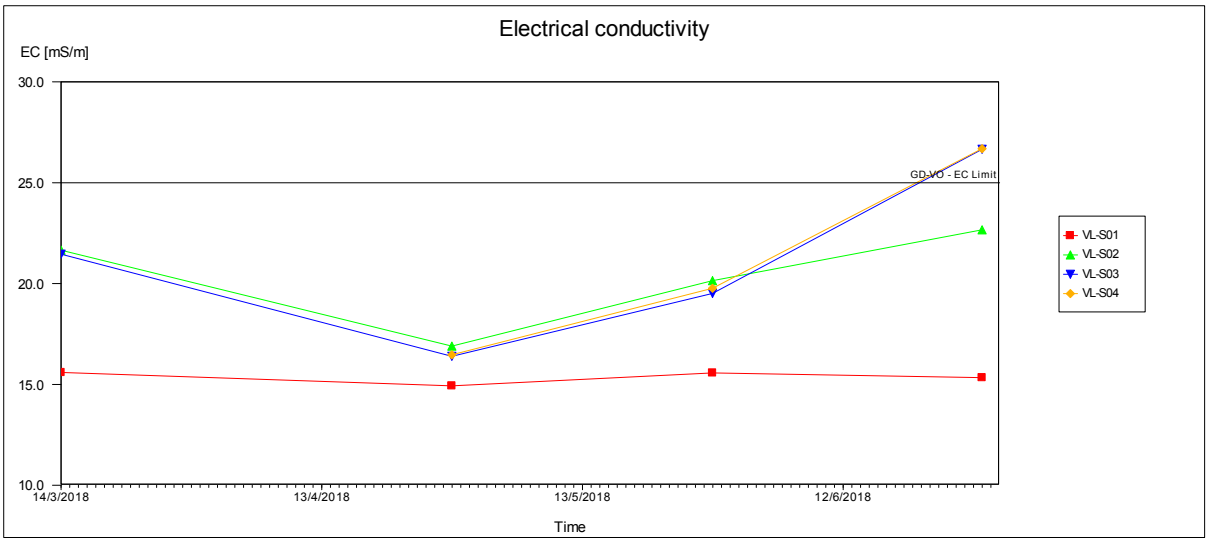
Figure 6.1.8 depicts the Vaal River surface monitoring point variable concentration trends,
Figure 6.1.9 represent the water quality stream profile,
Figure 6.1.10 illustrates the composition of the Vaal River water quality in STIFF Diagrams, and **Figure 6.1.11** illustrate the impact of pollution sources on the Vaal River.

Table 6.7 Average water quality for the Vaal River surface water monitoring points for the reporting period.

Average Vaal River Water Quality for Mooiplaats March – June 2018									
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**VL-S01**	**VL-S02**	**VL-S03**	**VL-S04**
pH	-	**3.5 – 8.5**	**6.4 – 8.5**	**5.0 - 9.5**	-	7.28	7.36	7.41	7.33
EC	mS/m	**150**	**25**	**170**	**500**	15.36	20.35	21.01	20.98
TDS	mg/L	**1288**	-	**1200**	**3000**	86	108	114	118
Total Hardness	mg/L	-	-	-	-	53	63	67	64
Alkalinity	$CaCO_3$/L	-	**75**	-	-	47.500	45.200	44.500	46.000
Ca	mg/L	**87**	-	-	**1000**	9.875	11.975	12.775	12.133
Mg	mg/L	**51.40**	-	-	**500**	6.900	7.950	8.525	8.100
Na	mg/L	**725**	-	**200**	**200**	9.425	15.425	16.300	16.033
K	mg/L	-	-	-	-	2.625	2.925	3.075	3.067
F	mg/L	**3.23**	**0.4**	**1.5**	**2**	-0.200	-0.200	-0.200	-0.267
Cl	mg/L	**116.66**	**20**	**300**	**3000**	10.275	10.850	10.800	11.933
SO_4	mg/L	**740**	**30**	**500**	**1000**	19.250	33.325	36.425	40.367
NO_3	mg/L	-	**0.5**	**11**	-	0.325	0.000	0.550	0.333
NH_3	mg/L	**0.24**	-	**1.5**	-	0.000	0.000	0.000	0.000
Al	mg/L	**0.09**	-	**0.3**	**5**	0.160	0.203	0.170	0.203
Fe	mg/L	**0.001**	-	**0.3**	**10**	0.460	0.448	0.418	0.450
Mn	mg/L	**0.15**	-	**0.1**	**10**	-0.025	0.008	-0.025	-0.033

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.





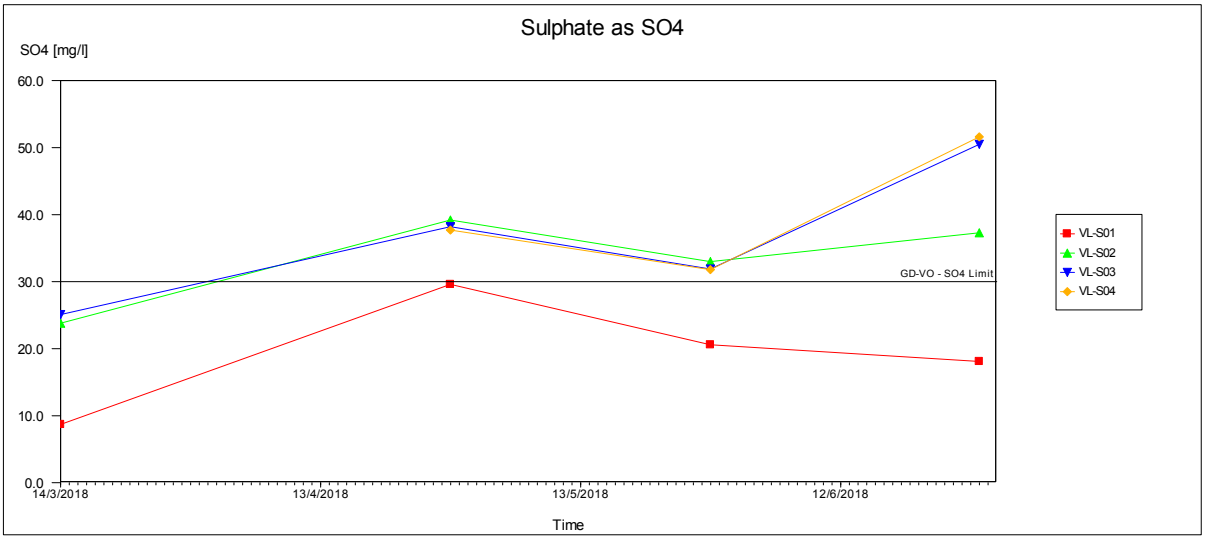
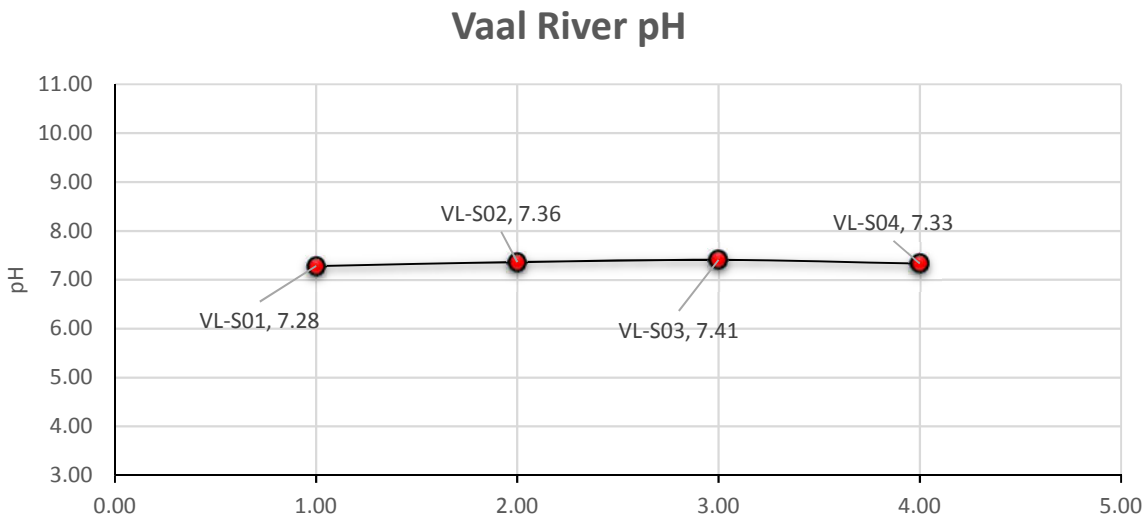
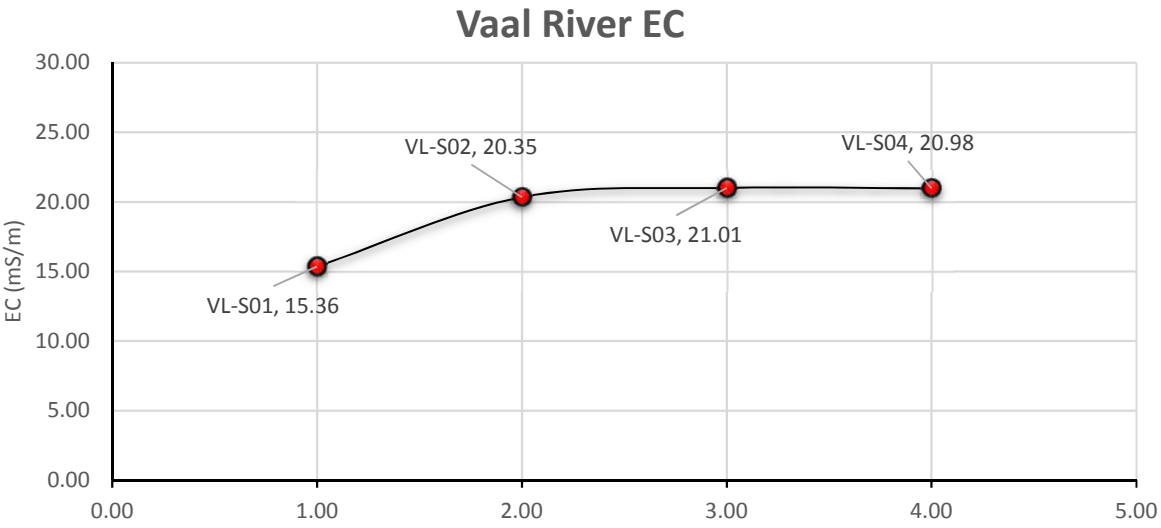


Figure 6.1.8 Vaal River water monitoring points variable concentration trends.





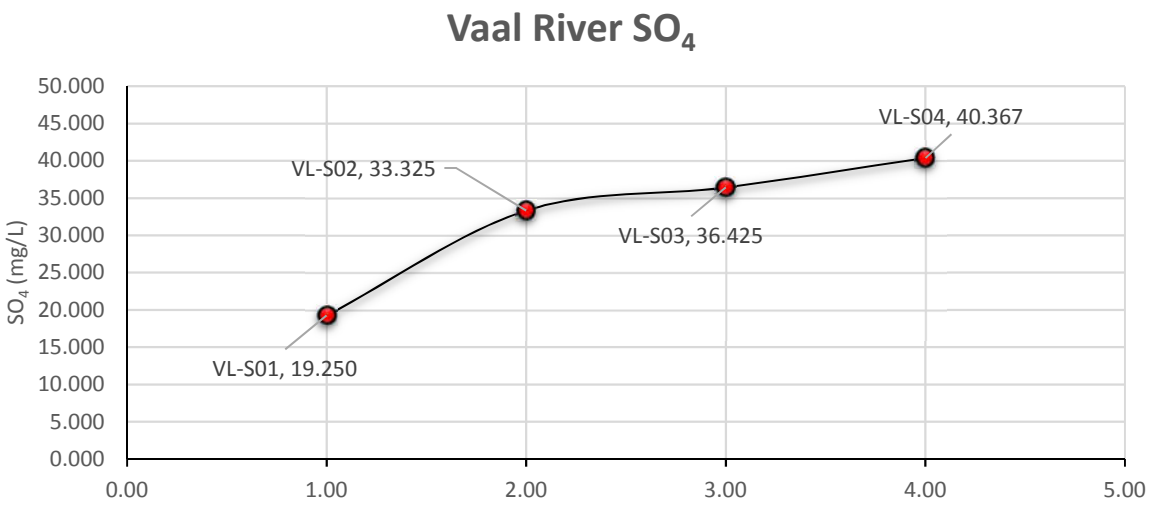
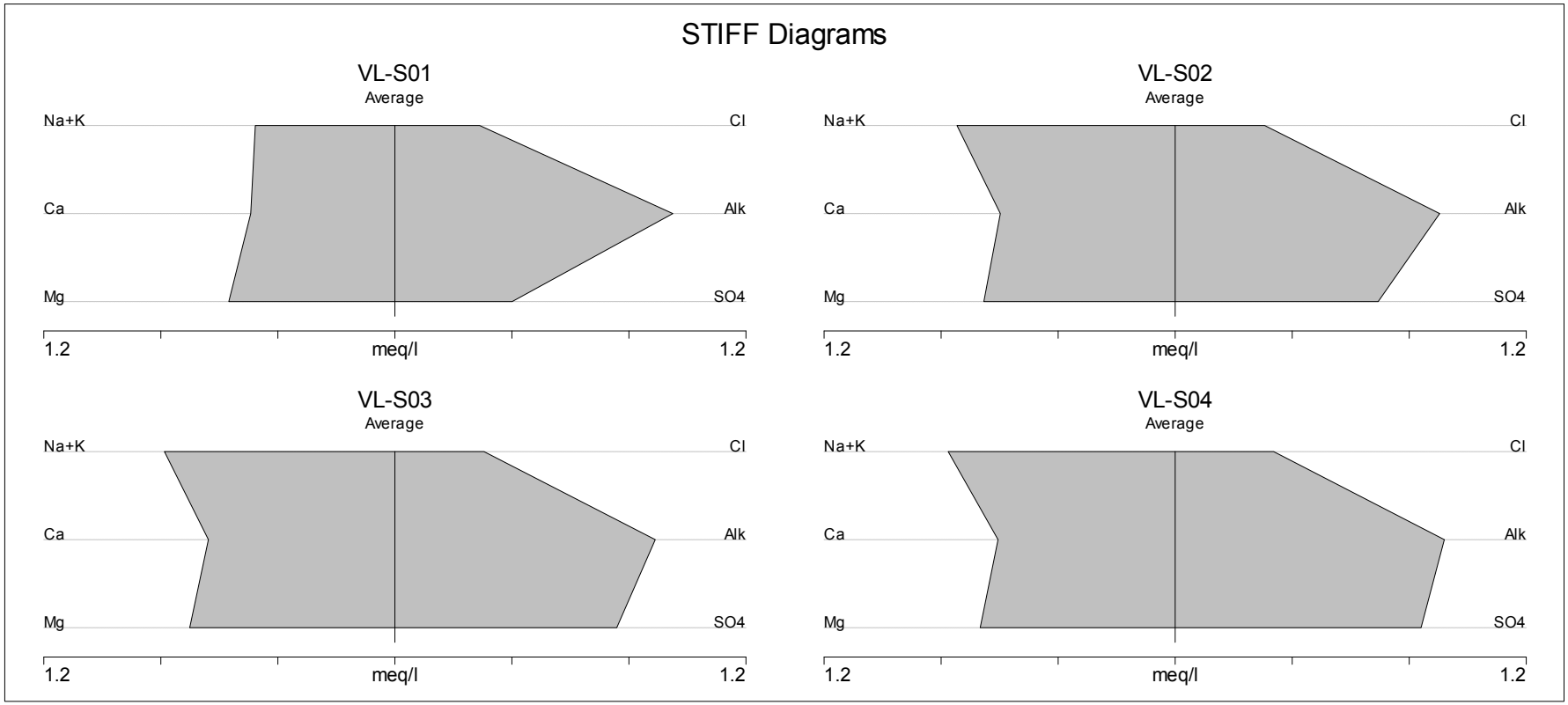


Figure 6.1.9 Vaal River stream profile.

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.10 STIFF Diagrams for the Vaal River surface water monitoring points.

From **Table 6.7** and **Figures 6.1.8** to **6.1.11** it is evident that the water quality and composition from the Vaal River deteriorate / change after the confluence with the Witpuntspruit between monitoring points **VL-S01** and **VL-S02**.

Although mostly the SO_4 concentrations exceeded the Grootdraai Dam Guidelines downstream of the Witpuntspruit confluence (**VL-S02**, **VL-S03** and **VL-S04**), the water quality can be described as Unacceptable (in terms of SO_4) after the confluence with the Witpuntspruit.

The deterioration in water quality in the Vaal River downstream of the Witpuntspruit confluence, can probably be ascribed to the lower Vaal River flow and constant Witpuntspruit flow into the Vaal River – increasing the percentage of Witpuntspruit water in the Vaal River system.

The pollution source of the Witpuntspruit, upstream of Mooiplaats Colliery should be addressed to reduce the pressure on the Vaal River system and downstream users.

Mooiplaats Colliery has been in care and maintenance for approximately five years before the commencement of activities in 2018. Neglected and abandoned water infrastructure on Mooiplaats Colliery during the care and maintenance phase possibly contributed / impacted on the immediate surrounding area and therefore the water quality observed at **WT-S05**.

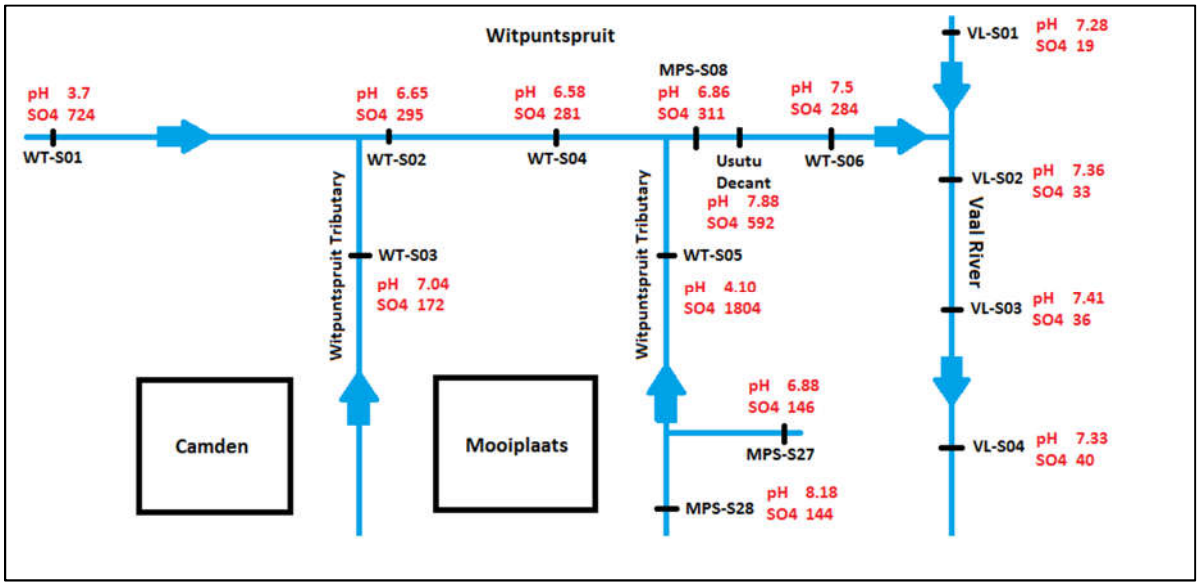


Figure 6.1.11 Schematic flow diagram of the Witpuntspruit and Vaal River relative to Mooiplaats and surrounding activities.

6.5 Groundwater

Table 6.8 and indicates the average groundwater quality for the Mooiplaats Colliery monitoring points compared to the IWUL limits, Grootdraai Dam Guidelines - Vaal Origin, DWS Livestock watering upper limit, 1996 and the SANS 241:2015 drinking water standards. Variables exceeding the limits, standards are highlighted respectively.

Figure 6.1.12 illustrates the composition of the groundwater water quality in STIFF Diagrams.

Table 6.8 Average water quality for Mooiplaats groundwater monitoring points for the reporting period.

Average Groundwater Quality for Mooiplaats March – June 2018										
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**GAD-3S**	**GAD-4M**	**GAD-5D**	**GKL-1**	**GKL-2S**
pH	-	8.78	6.4 – 8.5	5.0 - 9.5	-	7.18	7.36	9.08	8.84	8.75
EC	mS/m	150	25	170	500	28.99	12.89	78.90	27.54	309.00
TDS	mg/L	-	-	1200	3000	161	63	498	150	1877
Total Hardness	mg/L	-	-	-	-	143	58	191	107	15
Alkalinity	$CaCO_3$/L	-	75	-	-	153.750	43.000	163.000	119.000	1552.000
Ca	mg/L	15.18	-	-	1000	37.000	11.500	8.200	17.100	2.700
Mg	mg/L	6.96	-	-	500	12.250	7.200	41.300	15.700	2.100
Na	mg/L	61.55	-	200	200	14.600	6.600	114.400	20.800	805.900
K	mg/L	-	-	-	-	2.150	0.750	0.700	0.900	5.100
F	mg/L	0.30	0.4	1.5	2	-0.200	-0.200	-0.400	-0.400	8.100
Cl	mg/L	19.97	20	300	3000	4.200	10.700	22.300	7.600	127.800
SO_4	mg/L	0.25	30	500	1000	-0.300	-0.550	215.500	18.900	-4.000
NO_3	mg/L	0.07	0.5	11	-	-1.000	1.650	-2.000	-2.000	-2.000
NH_3	mg/L	-	-	1.5	-	-0.020	0.125	-0.020	-0.020	2.280
Al	mg/L	-	-	0.3	5	-0.025	-0.025	-0.050	-0.050	-0.050
Fe	mg/L	-	-	0.3	10	0.590	0.460	0.260	0.170	0.100
Mn	mg/L	-	-	0.1	10	0.320	0.025	-0.050	-0.050	-0.050

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.

Table 6.8 (cont.) Average water quality for Mooiplaats groundwater monitoring points for the reporting period.

Average Groundwater Quality for Mooiplaats March – June 2018										
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**GKL-1**	**GKL-2S**	**GKL-3m**	**GKL-4D**	**MPG-B1**
pH	-	8.78	6.4 – 8.5	5.0 - 9.5	-	7.18	7.45	9.27	8.86	7.00
EC	mS/m	150	25	170	500	36.60	61.85	71.95	240.85	13.38
TDS	mg/L	-	-	1200	3000	199	338	409	1329	79
Total Hardness	mg/L	-	-	-	-	173	268	10	12	40
Alkalinity	$CaCO_3$/L	-	75	-	-	206.000	329.500	382.000	758.750	78.500
Ca	mg/L	15.18	-	-	1000	45.200	52.600	2.700	3.300	9.900
Mg	mg/L	6.96	-	-	500	14.700	33.200	0.850	0.950	3.800
Na	mg/L	61.55	-	200	200	19.000	27.250	166.500	559.700	14.800
K	mg/L	-	-	-	-	1.100	1.550	1.050	2.850	3.700
F	mg/L	0.30	0.4	1.5	2	-0.400	-0.200	1.015	2.495	0.000
Cl	mg/L	19.97	20	300	3000	1.700	8.200	10.100	306.750	0.000
SO_4	mg/L	0.25	30	500	1000	-4.000	18.400	-1.450	-1.400	0.000
NO_3	mg/L	0.07	0.5	11	-	-2.000	-1.000	-1.000	-1.000	0.000
NH_3	mg/L	-	-	1.5	-	-0.020	-0.020	0.170	0.725	-0.020
Al	mg/L	-	-	0.3	5	-0.050	0.140	-0.025	0.100	0.000
Fe	mg/L	-	-	0.3	10	-0.050	0.640	0.140	0.270	1.300
Mn	mg/L	-	-	0.1	10	-0.050	0.125	-0.025	-0.025	0.100

- Variables highlighted in grey are specified by the IWUL where the remainder are additional analyses.
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- "-"Indicate values below laboratory detection limit.

Table 6.8 (cont.) Average water quality for Mooiplaats groundwater monitoring points for the reporting period.

Average Groundwater Quality for Mooiplaats March – June 2018										
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**MPG-B2**	**MPG-B3**	**MPG-B4**	**MPG-B5**	**MPG-B6**
pH	-	8.78	6.4 – 8.5	5.0 - 9.5	-	9.30	8.70	8.00	7.70	7.10
EC	mS/m	150	25	170	500	19.20	23.21	30.30	24.80	9.54
TDS	mg/L	-	-	1200	3000	113	137	160	151	57
Total Hardness	mg/L	-	-	-	-	40	47	76	98	21
Alkalinity	$CaCO_3$/L	-	75	-	-	73.000	136.000	144.000	158.000	51.000
Ca	mg/L	15.18	-	-	1000	8.300	7.100	18.500	25.000	4.700
Mg	mg/L	6.96	-	-	500	4.600	7.200	7.200	8.600	2.200
Na	mg/L	61.55	-	200	200	23.800	35.400	38.100	13.600	14.600
K	mg/L	-	-	-	-	4.100	1.100	1.200	3.000	1.600
F	mg/L	0.30	0.4	1.5	2	0.000	0.000	0.000	0.000	0.000
Cl	mg/L	19.97	20	300	3000	3.400	3.100	4.000	2.200	3.700
SO_4	mg/L	0.25	30	500	1000	24.600	1.300	4.500	3.700	0.000
NO_3	mg/L	0.07	0.5	11	-	0.000	0.000	0.000	0.000	0.000
NH_3	mg/L	-	-	1.5	-	-0.020	-0.020	0.230	-0.020	-0.020
Al	mg/L	-	-	0.3	5	0.000	0.000	0.000	0.000	0.000
Fe	mg/L	-	-	0.3	10	0.000	0.000	0.800	0.400	3.400
Mn	mg/L	-	-	0.1	10	0.000	0.100	0.100	0.100	0.100

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.

Table 6.8 (cont.) Average water quality for Mooiplaats groundwater monitoring points for the reporting period.

Average Groundwater Quality for Mooiplaats March – June 2018											
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**MPG-B7**	**MPG-B8**	**MPG-B9**	**MPG-B11**	**MPG-B14**	**MPG-B15**
pH	-	**8.78**	**6.4 – 8.5**	**5.0 - 9.5**	-	8.20	9.90	8.40	7.20	9.50	7.10
EC	mS/m	**150**	**25**	**170**	**500**	14.12	108.90	35.60	16.82	36.60	25.59
TDS	mg/L	-	-	**1200**	**3000**	91	706	204	96	211	144
Total Hardness	mg/L	-	-	-	-	16	42	62	65	8	82
Alkalinity	$CaCO_3$/L	-	**75**	-	-	47.000	110.000	170.000	86.000	196.500	80.500
Ca	mg/L	**15.18**	-	-	**1000**	3.700	3.800	13.300	15.200	2.000	16.900
Mg	mg/L	**6.96**	-	-	**500**	1.600	8.000	6.900	6.500	0.700	9.700
Na	mg/L	**61.55**	-	**200**	**200**	23.900	218.300	55.600	12.800	81.500	20.300
K	mg/L	-	-	-	-	2.400	5.000	1.600	3.500	1.800	1.100
F	mg/L	**0.30**	**0.4**	**1.5**	**2**	0.000	0.000	0.000	0.000	0.400	0.000
Cl	mg/L	**19.97**	**20**	**300**	**3000**	8.400	11.900	6.800	3.200	4.200	11.300
SO_4	mg/L	**0.25**	**30**	**500**	**1000**	21.600	393.200	17.600	3.000	2.800	36.300
NO_3	mg/L	**0.07**	**0.5**	**11**	-	1.100	0.000	0.000	0.000	0.000	0.000
NH_3	mg/L	-	-	**1.5**	-	-0.020	-0.020	-0.020	0.980	-0.020	-0.020
Al	mg/L	-	-	**0.3**	**5**	0.000	0.000	0.000	0.000	4.420	0.000
Fe	mg/L	-	-	**0.3**	**10**	0.800	0.000	0.100	2.400	2.600	0.100
Mn	mg/L	-	-	**0.1**	**10**	0.000	0.000	0.000	0.100	0.000	0.000

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.

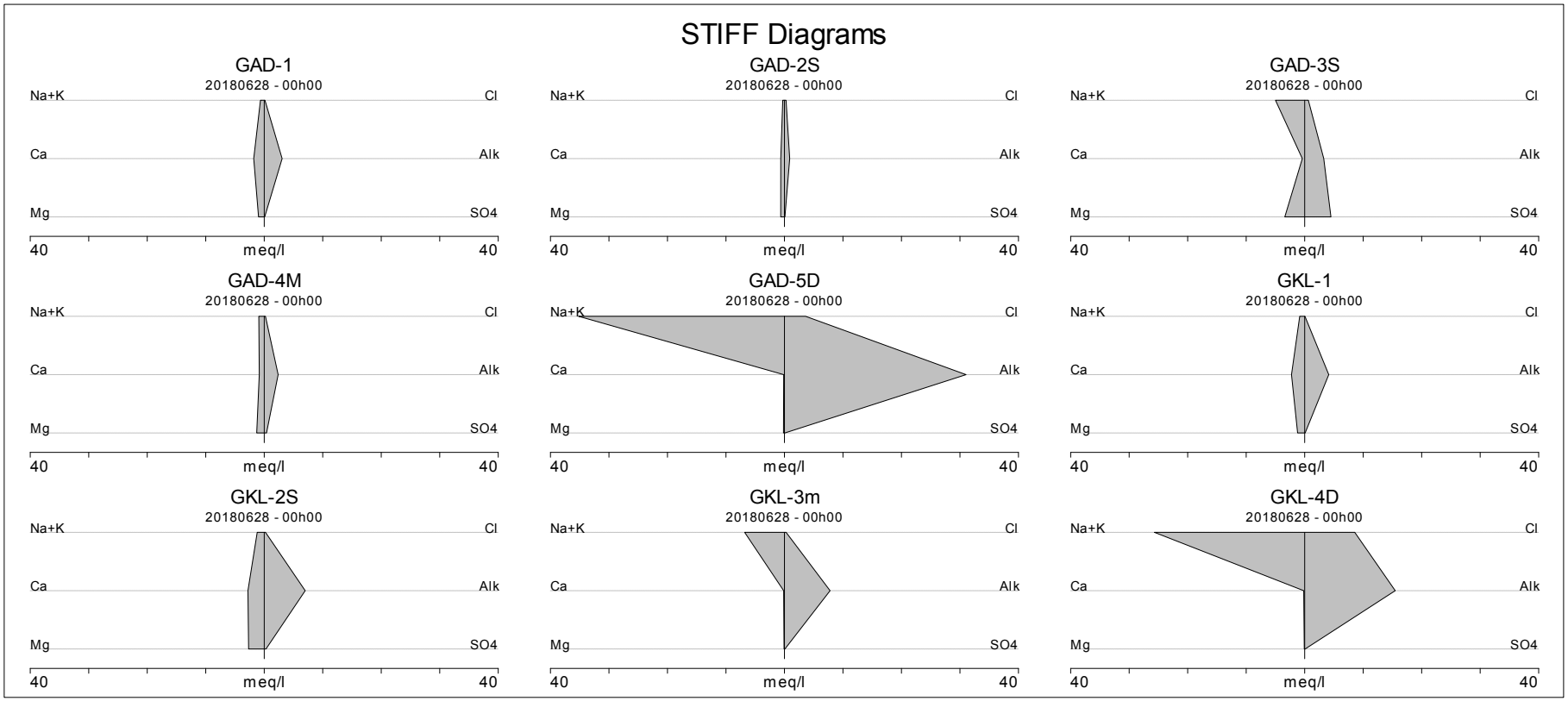
Table 6.8 (cont.) Average water quality for Mooiplaats groundwater monitoring points for the reporting period.

Average Groundwater Quality for Mooiplaats March – June 2018											
Variable	**Unit**	**IWUL Limit**	**Grootdraai Dam Guidelines Vaal Origin**	**SANS 241:2011**	**DWS Livestock Watering**	**MPG-B16**	**MPG-B17**	**MPG-B18**	**MPG-B19**	**MPG-B20**	**MPG-B21**
pH	-	8.78	6.4 – 8.5	5.0 - 9.5	-	8.20	7.40	8.00	7.10	9.00	7.70
EC	mS/m	150	25	170	500	21.00	18.81	18.08	15.71	242.90	24.57
TDS	mg/L	-	-	1200	3000	120	101	102	81	1500	136
Total Hardness	mg/L	-	-	-	-	44	90	72	65	31	69
Alkalinity	$CaCO_3$/L	-	75	-	-	114.500	95.500	100.000	72.500	1048.000	131.500
Ca	mg/L	15.18	-	-	1000	8.400	19.700	18.600	14.800	5.700	18.500
Mg	mg/L	6.96	-	-	500	5.500	9.800	6.100	6.700	4.100	5.500
Na	mg/L	61.55	-	200	200	31.500	8.000	11.100	8.600	579.500	27.600
K	mg/L	-	-	-	-	1.900	0.900	2.400	1.900	3.200	1.700
F	mg/L	0.30	0.4	1.5	2	0.000	0.000	0.000	0.000	5.830	0.000
Cl	mg/L	19.97	20	300	3000	3.000	5.500	2.400	3.600	56.900	2.200
SO_4	mg/L	0.25	30	500	1000	1.200	0.000	1.800	1.700	216.000	1.600
NO_3	mg/L	0.07	0.5	11	-	0.000	0.000	0.000	0.000	0.000	0.000
NH_3	mg/L	-	-	1.5	-	0.090	-0.020	-0.020	-0.020	-0.020	-0.020
Al	mg/L	-	-	0.3	5	0.000	0.000	0.000	0.100	0.000	0.060
Fe	mg/L	-	-	0.3	10	0.200	1.100	0.100	0.100	0.000	0.200
Mn	mg/L	-	-	0.1	10	0.100	0.100	0.000	0.000	0.100	0.000

- 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 Grootdraai Dam Catchment Guidelines of the Vaal Origin
- "-"Indicate values below laboratory detection limit.

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



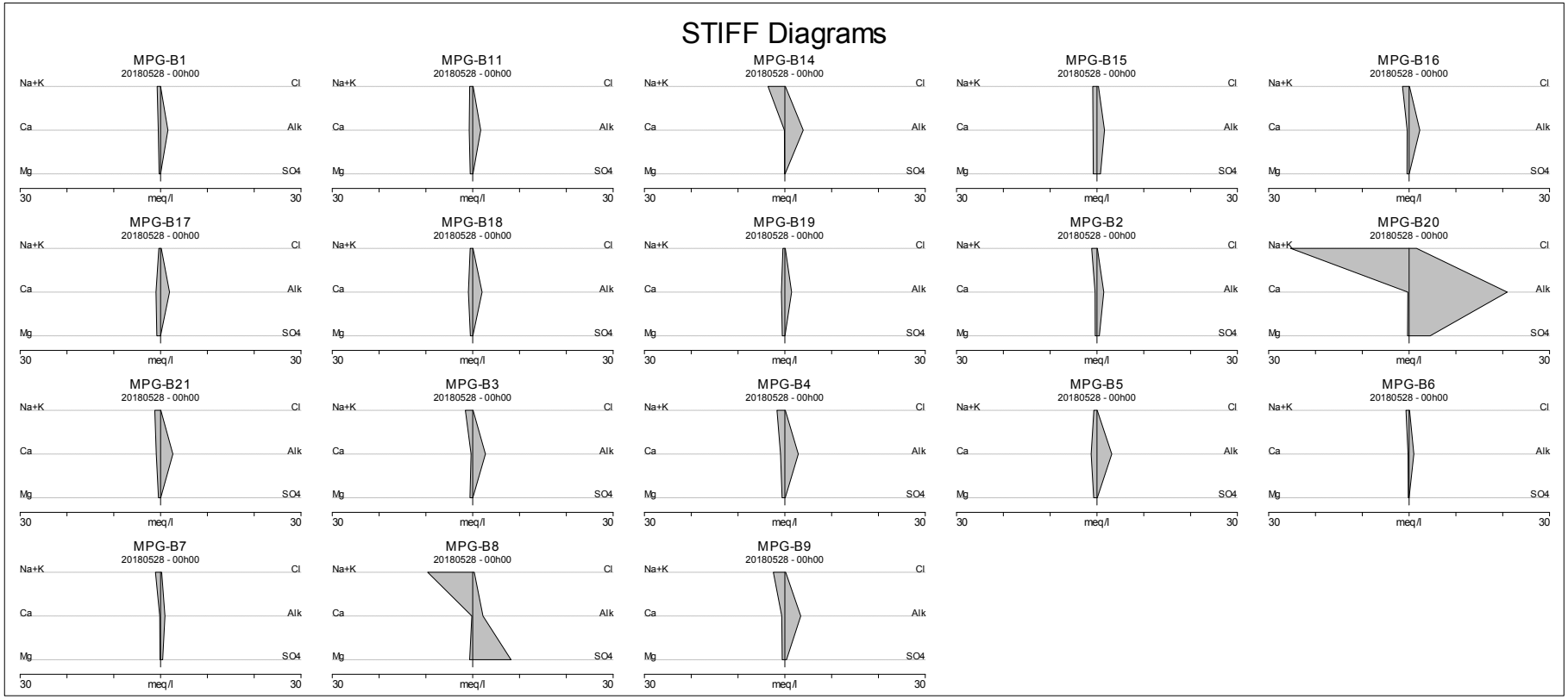
* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

STIFF Diagram - A dominant Sulphate (SO_4) anion indicate possible 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 where the shape indicates the composition of the water.



* Cations left (Na+K, Ca, Mg)
* Anions right (Cl, Alk, SO_4)

Figure 6.1.12 STIFF Diagrams for Mooiplaats Colliery groundwater monitoring points.

From **Table 6.8** and **Figure 6.1.12** it is evident that groundwater in the greater Mooiplaats Colliery area are of relative good quality with high pH values and Alkalinity ($CaCO_3$) concentrations.

Due to very low IWUL limits (SO_4 of 0.25mg/L, Ca of 15.18mg/L and Mg of 6.96 mg/L), several IWUL limits were exceeded. Naturally high $CaCO_3$ concentrations elevate EC concentrations and pH values which exceeded the Grootdraai Dam Guidelines - Vaal Origin for pH, EC and $CaCO_3$.

Despite the relative good groundwater quality two areas of concern exist. **1**) From the co-disposal area to, and between Mooiplaats and Usutu Mine towards the Witpuntspruit in a north easterly direction (**MPG-B8**, **B15** and **B20**), and **2**) in a south westerly direction at the Vaal river (**GAD-3s**).

The **MPG-B8**, **B15** and **B20** boreholes are drilled in the shallow aquifer, indicating that probable surface pollution / runoff from the co-disposal area affected the water qualities.

The groundwater monitoring point towards the Vaal river, **GAD-3s** was unlikely impacted by Mooiplaats Colliery. The water quality will be monitored and investigated to determine the source.

6.6 Groundwater Levels

Groundwater levels are monitored on a monthly and biannual basis to determine whether Mooiplaats Colliery has an effect on the groundwater resource and levels.

As this report is the first report since the commencement of activities in 2018, groundwater level trends will be included in the following reports.

7. DISCUSSION AND CONCLUSION

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

7.1 Surface water

Waste water - Water quality from the mine water/pollution control dams monitoring points exceeded the limits in terms of EC, TDS, Ca, Mg, F, Cl, SO_4, NH_3, Al, Fe and Mn. These results are typical of water associated with coal washing/mining activities. It should be noted that although these monitoring points recorded elevated variable concentrations, the water is being contained in appropriate waste water storage facilities and circulated in a closed circuit i.e. dirty water circuit and no water are being released into the receiving environment.

Storm and Surface Water Runoff - It is evident that the surface runoff water quality within the boundaries of Mooiplaats Colliery is of general good quality (in comparison with the Witpuntspruit) with the expectance of **MPS-S16**. Water quality at **MPS-S16** is the result of a lack of maintenance and management during the care and maintenance phase. Several measures since the commencement of mining activities in 2018 were taken to prevent further pollution. Water quality will be closely monitored for improvement or deterioration.

Water Quality from the **Witpuntspruit** is highly impacted upstream of Mooiplaats Colliery indicating a serious pollution source. Although the water quality improves from the upstream monitoring point towards downstream of Mooiplaats Colliery, the quality of the instream water is not suitable for the aquatic ecosystem. An impact via the **WT-S05** tributary / monitoring point (downstream of **MPS-S16**), on the Witpuntspruit was recorded but the impact from the **WT-S05** tributary is absorbed by the already polluted Witpuntspruit. **WT-S05** recorded a very low flow into the Witpuntspruit during March 2018 where after it was stagnant through June 2018. Known decant from the Usutu mine downstream of **MPS-S08** and upstream of **WT-S06** enters the **Witpuntspruit**, elevating the pH and EC concentrations. The effect of the decant will be closely monitored.

Vaal River – Although fewer water quality limits are exceeded in the Vaal river compared to the Witpuntspruit, the change in composition and the deterioration in water quality is evident after the confluence with the Witpuntspruit.

Although water quality will improve slightly naturally downstream, it is rather dilution than improvement that will be observed further downstream. The source of the Witpuntspruit

pollution should be addressed to prevent constant degradation (build-up of contaminants) of the Vaal River system and a complete collapse in the aquatic functions in the long term.

7.2 Groundwater

Although several IWUL limits were exceeded, the groundwater quality of Mooiplaats Colliery is good with the exception of two small areas where the shallow aquifer has been slightly affected potentially due to historical contaminated surface water runoff. The groundwater quality should be closely monitored with trends analysed accordingly.

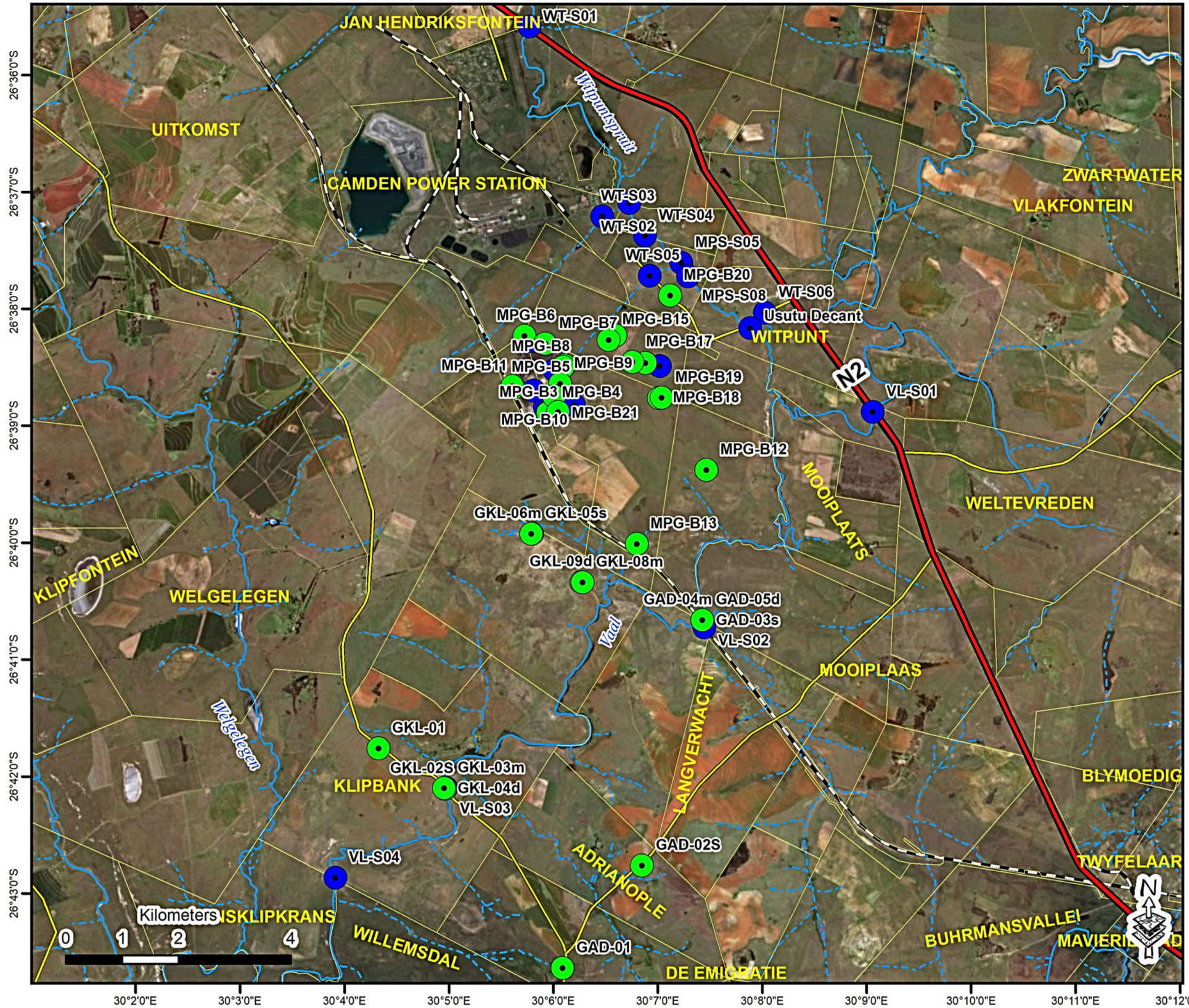
Should groundwater be used/considered for domestic purposes or drinking water, the SANS 241-2015 drinking water standards should be taken into consideration as several variables, especially metals exceed the threshold criteria.

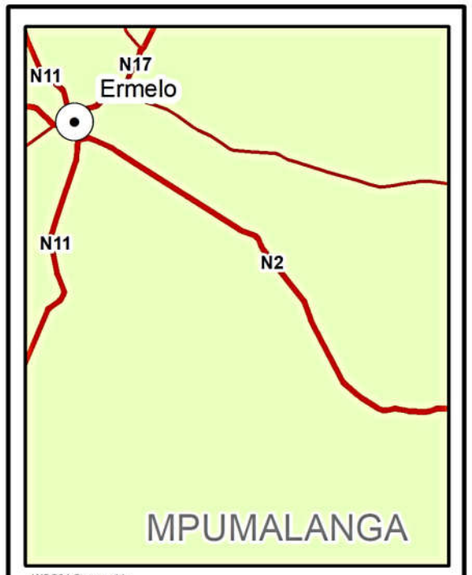
8. REFERENCES

- 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 groundwaters.
- 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.
- Standards South Africa. SANS 241 – 1: 2011. South African National Standard. Drinking Water. (Edition 1).
- Standards South Africa. SANS 241 – 1: 2015. South African National Standard. Drinking Water. (Edition 2).
- Department of Water and Sanitation, National Water Resource Strategy, 2004.
- Mooiplaats North Colliery geology and groundwater study, Coal of Africa Limited. Report No. V1110001. J. Fourie, 2011.

ANNEXURE A

MOOIPLAATS COLLIERY IWUL MONITORING: GROUNDWATER AND SURFACE WATER





WGS84 Geographic
1:95,000 @ A4 paper size

Legend

- Groundwater Monitoring
- Surface Water Monitoring
- Perennial Rivers
- Non-Perennial Rivers
- Railway Line
- Main Road
- Secondary Road
- Cadastral

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PGPT 023

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ANNEXURE B

CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

UIS SEDIBA LABORATORY (PTY) LTD
Co. Reg. No.: 2011/06070/07

Facility Accreditation Number: **T0584**

is a South African National Accreditation System accredited Testing laboratory provided that all SANAS conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation Annexure "A", bearing the above accreditation number for

WATER ANALYSIS

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17025:2005

The accreditation demonstrates technical competency for a defined scope and the operation of a laboratory quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant SANAS accreditation symbol to issue facility reports and/or certificates

_____

Mr R Josias
Chief Executive Officer

Effective Date: 09 April 2013
Certificate Expires: 08 April 2018

ANNEXURE A

SCHEDULE OF ACCREDITATION

Facility Number: T0584

Permanent Address of Laboratory: UIS- Sediba Laboratory (Pty) Ltd Unit 6 Carresa House 15 Sovereign Street Route 21 Corporate Park Irene	**Technical Signatories:** Dr WJ Havenga Mr JH Oosthuizen
Postal Address: P O Box 9025 Centurion 0046	**Nominated Representative:** Dr WJ Havenga
Tel: (012) 345-1004 Fax: (012) 345-4004 E-mail: willieh@uisol.co.za	Issue No.: 01 Date of Issue: 10 April 2013 Expiry Date: 08 April 2018

Materials / Products Tested	Type of Tests / Properties Measured, Range of Measurement	Standard Specifications, Equipment / Technique Used
WATER:	Anions By Ion Chromagraphy (IC)	UISSL-WL-005
Drinking	Chloride (Cl)	
Industrial	Nitrate (N03)	
Effluent	Phosphate (P04)	
Borehole	Sulphate (S04)	
Environmental		
Toxic characteristics Leach procedure(TCLP) extract	Total dissolved solid at 110℃ (TDS)	UISSL-WL-004
Acid Rain Extract	pH	UISSL-WL-003
Borax extract	P & M Alkalinity	UISSL-WL-002
Reverse Osmosis	Electrical Conductivity	UISSL-WL-001
Water extract	Formaldehyde by HPLC	UISSL-HPLC-001
Green Building Materials	Total Volatile	ASTM-D 3960-05
	Organic content	UISSL-GB-001
		ASTM-D 2369-10
		ASTM- D 4017-02

Issued by the South African National Accreditation System

Field Manager

ANNEXURE C

~~S26° 37' 57.6~~
~~E30 06 41.5~~

MPS7

MPS4 S 26.6278958
E 30.0994602

S 26.6528575
E 30.1118091

UIS sediba laboratory

sanas South African National Accreditation System

T0584

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15A Midas Ave, Olympys, Pretoria

Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Mar-18
Monitoring Occasion	Monthly Surface Water Monitoring
Date of Sampling	12-Mar-18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Medium	Comment/Observations
Quote 749	X	~~MPS-S04~~	S26.62432° E30.10409°				Water	
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	MPS-S05	S26.62678° E30.12041°	13:30	Yes	Med	Water	Clear
	✓	MPS-S06	S26.62760° E30.11823°	13:35	Yes	V Low	Water	Clear
	✓	MPS-S07	S26.63313° E30.11158°	13:15	Yes	Med	Water	Clear
	✓	MPS-S08	S26.62873° E30.12149°	13:40	Yes	Med/H	Water	Clear
		~~MPS-S12~~	S26.64150° E30.11697°				Water	
	X	MPS-S13	S26.64837° E30.09888°	12:30	No	Dry	Water	Dry
Sent by:	✓	MPS-S14	S26.64616° E30.09890°	10:55	Yes	Med	Water	Turbid. Gensub - Run-off Workshop
	X	MPS-S15	S26.64837° E30.09888°	12:43	No	Dry	Water	Dry
	X	~~MPS-S16~~	S26.64505° E30.10121°				Water	
Received by:	X	~~MPS-S17~~	S26.64078° E30.10052°				Water	
	X	~~MPS-S18~~	S26.64078° E30.10052°				Water	
	X	~~MPS-S19~~	S26.64139° E30.10057°				Water	
Date:	✓	MPS-S20	S26.64198° E30.10059°	11:40	Yes	High	Water	@ Erickson Dams - Clear
	✓	MPS-S21	S26.63826° E30.09506°	12:05	Yes	Med	Water	Clear
		~~MPS-S22~~	S26.64701° E30.09819°				Water	
		~~MPS-S23~~					Water	
		~~MPS-S24~~					Water	

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Mar-18
Monitoring Occasion	Monthly Surface Water Monitoring
Date of Sampling	12-Mar-18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Medium	Comment/Observations
Quote 749	✓	~~MPS-S25~~	S26.64616° E30.09890°	11:25	Yes	Low	Water	Trench DS of Workshop
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	VL-S01 ~~MPS-S10~~	S26.64804° E30.15098°	10:05	Yes	Med	Water	Clear
	✓	VL-S02 ~~MPS-S11~~	S26.67879° E30.12411°	09:40	Yes	Med	Water	Clear
	✓	VL-S03	S26.70167° E30.08288°	09:00	Yes	Med	Water	Clear
	✗	VL-S04	S26.71447° E30.06519°	09:20	No	N/A	Water	No Access
	✓	WT-S01 ~~MPS-S01~~	S26.59307° E30.09617°	14:50	Yes	Med	Water	Clear
	✓	WT-S02 ~~MPS-S02~~	S26.61826° E30.11211°	14:20	Yes	High	Water	Clear
	✓	WT-S03 ~~MPS-S03~~	S26.62014° E30.10781°	14:30	Yes	Low	Water	Clear
	✓	WT-S04	S26.62294° E30.11463°	14:00	Yes	Med H	Water	Clear
	✓	WT-S05	S26.62863° E30.11539°	13:50	Yes	Low	Water	Clear - Stagnant.
	✓	WT-S06 ~~MPS-S09~~	S26.63393° E30.13373°	10:15	Yes	Med L	Water	Clear
Ad Hoc Sampling	-	~~MPPD~~						Plant Dam.
	✓	MPPPCD		12:25	Yes	Med		Clear
	✗	MP OSW	S26:64743 E30:09802	12:30	No	Dog		Office Storm water

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Apr-18
Monitoring Occasion	Monthly Surface Water Monitoring
Date of Sampling	09-Apr-18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Description	Comment/Observations
Quote 749	✓	MPS-S05	S26.62678° E30.12041°	13:40	Yes	Medium	Witpuntspruit 4 MS	Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	MPS-S06 •	S26.62760° E30.11823°	13:45	Yes	Low	Witpunt Tributary South DS 3	Clear
	✓	MPS-S07 •	S26.63313° E30.11158°	13:30	Yes	Medium	Witpunt Tributary South DS 1	Clear
	✓	MPS-S08	S26.62873° E30.12149°	13:15	Yes	Med	Witpuntspruit 5 MS	Clear
	✗	MPS-S12	S26.64150° E30.11697°	12:45	No	Low	Witpunt Tributary @ Access Road	Low
	✓	MPS-S13	S26.64837° E30.09888°	10:05	Yes	Low	Runoff from Loading Area	Clear / Flowing.
	✓	MPS-S14	S26.64616° E30.09890°	10:20	Yes	Med	Gen-sub PCD	Turbid - Oil
Sent by:	✓	MPS-S15	S26.64837° E30.09888°	10:05	Yes	Low	Stormwater trench @ Security	Clear Stagnant
	✓	MPS-S16	S26.64505° E30.10121°	10:55	Yes	Med	DS Area of Ericsons + Settl Dams	Yellow - Orange sediment
	✓	MPS-S20	S26.64505° E30.10121°	10:50	Yes	Med	Erickson Dams	Clear
Received by:	✓	MPS-S21	S26.64198° E30.10059°	11:10	Yes	Ultigh	Main Holdings Dam	Clear - OF
	✓	MPS-S25	S26.63826° E30.09506°	10:40	Yes	Low	Workshop Trench @ Security	Clear
	✓	VL-S01	S26.64616° E30.09890°	08:00	Yes	High	Vaal River 1 US	Clear
Date:	✓	VL-S02	S26.64804° E30.15098°	08:55	Yes	High	Vaal River 2 DS	Clear
	✓	VL-S03	S26.67879° E30.12411°	08:20	Yes	High	Vaal River 3 DS	Clear
	✓	VL-S04	S26.70167° E30.08288°	08:40	Yes	High	Vaal River 4 DS	Clear
	✓	WT-S01	S26.71447° E30.06519°	07:40	Yes	Ultigh	Witpuntspruit 1 US	Clear
	✓	WT-S02	S26.59307° E30.09617°	14:15	Yes	Medium	Witpuntspruit 2 MS	Clear

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Apr-18
Monitoring Occasion	Monthly Surface Water Monitoring
Date of Sampling	09-Apr-18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Medium	Comment/Observations
Quote 749		~~VL-S04~~	~~S26.70167° E30.08288~~				~~Vaal River 4 DS~~	
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3		~~WT-S01~~	~~S26.71447° E30.06519°~~				~~Witpuntspruit 1 US~~	
		~~WT-S02~~	~~S26.59307° E30.09617°~~				~~Witpuntspruit 2 MS~~	
	✓	WT-S03	S26.61826° E30.11211°	14:30	Yes	Med/H	Witpunt Tributary North DS 1	Clear
	✓	WT-S04	S26.62014° E30.10781°	14:00	Yes	Med/H	Witpuntspruit 3 MS	Clear
	✓	WT-S05	S26.62294° E30.11463°	13:50	Yes	Med/Low	Witpunt Tributary South DS 2	Clear
	✓	WT-S06	S26.62863° E30.11539°	09:25	Yes	Med	Witpuntspruit 6 MS	Clear
	✓	~~MP PCD~~ MPS530	S26.64508° E30.09674°	10:45	Yes	High	Plant PCD	Clear OF
	✓	~~MP OSW~~ MPS529	S26.64743° E30.09802	10:15	Yes	Low	Storm water @ Offices turn gate	Clear
	X	MPS-S26	S26.63727° E30.08963°	11:20	No	NA	Witpunt Tributary North US 1	No Access
Ad Hoc Sampling	✓	MPS 527	S26.64716 E30.10336	09:55	Yes	Low Stag	Witpunt Trib bottom gate into Mooiplaats	Clear
	✓	MPS528	cont/ @13+15	10:00	Yes	Low	cont/ of 13+15	Clear

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	May-18
Monitoring Occasion	Monthly Surface Water Monitoring
Date of Sampling	14-May-18 + 17 May 18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Description	Comment/Observations
Quote 749	✓	MPS-S05	S26.62678° E30.12041°	11:15	Yes	Medium	Witpuntspruit 4 MS	Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	MPS-S08	S26.62873° E30.12149°	11:05	Yes	Medium	Witpuntspruit 5 MS	Clear
	X	MPS-S12	S26.64150° E30.11697°	11:00	No	Dry	Witpunt Tributary @ Access Road	Dry
	✓	MPS-S13	S26.64837° E30.09888°	13:25	Yes	Flood	Runoff from Loading Area	Stagnant
	✓	MPS-S14	S26.64616° E30.09890°	14:00	Yes	Mixed	Gen-sub PCD	Oil
	✓	MPS-S15	S26.64837° E30.09888°	13:10	Yes	Low	Stormwater trench @ Security	Clear
	✓	MPS-S16	S26.64505° E30.10121°	14:25	Yes	Mixed	DS Area of Ericsons + Settl Dams	AMD ?
Sent by:	✓	MPS-S20	S26.64505° E30.10121°	14:35	Yes	High	Erickson Dams	Turbid.
	✓	MPS-S21	S26.64198° E30.10059°	15:20	Yes	Low	Main Holdings Dam	Clear
	✓	MPS-S25	S26.63826° E30.09506°	13:55	Yes	Low	Workshop Trench @ Security 25 of 15	Oil
Received by:		~~MPS-S26~~	~~S26.63727° E30.08963°~~				~~Witpunt Tributary North UC 1~~	
	X	MPS-S27	S26.64716° E30.10336°	12:40	No	Dry	Witpuntspruit Tributary entering MP	Clear
	X	MPS-S28	S26.64808° E30.09925°	13:05	No	Dry	Confluence of MPS-S13 and MPS-S15	Dry
	✓	MPS-S29	S26.64743° E30.09802	13:40	Yes	Flow	Storm water @ Offices	Clear
	✓	MPS-S30	S26.64508° E30.09674°	15:50	Yes	Flow	Plant PCD	Silt. Clear
Date:								

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	May-18
Monitoring Occasion	Monthly Surface Water Monitoring
Date of Sampling	14-May-18 + 17 May 18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Medium	Comment/Observations
Quote 749	✓	VL-S01	S26.64616° E30.09890°	8:10	Yes	Mod	Vaal River 1 US	Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	VL-S02	S26.64804° E30.15098°	10:20	Yes	Mod	Vaal River 2 DS	Clear
	✓	VL-S03	S26.67879° E30.12411°	09:35	Yes	Mod	Vaal River 3 DS	Clear
	✓	VL-S04	S26.70167° E30.08288°	10:00	Yes	Mod	Vaal River 4 DS	Clear
	✓	WT-S01	S26.71447° E30.06519°	7:50	Yes	Mod	Witpuntspruit 1 US	Clear
	✓	WT-S02	S26.59307° E30.09617°	11:50	Yes	Mod H	Witpuntspruit 2 MS	Clear
	✓	WT-S03	S26.61826° E30.11211°	12:00	Yes	Mod L	Witpunt Tributary North DS 1	Clear
	✓	WT-S04	S26.62014° E30.10781°	11:35	Yes	Mod H	Witpuntspruit 3 MS	Clear
	✓	WT-S05	S26.62294° E30.11463°	11:25	Yes	Low	Witpunt Tributary South DS 2	Clear - Stagnant.
	✓	WT-S06	S26.62863° E30.11539°	10:50	Yes	Mod	Witpuntspruit 6 MS	Clear
Ad Hoc Sampling	✓	Usutu Decant	S26.63623 E30.13001	10:55	Yes	Mod L	Possible Usutu Decant	Clear

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	May-18
Monitoring Occasion	Quarterly Groundwater Monitoring
Date of Sampling	14-May-18 + 17 May

Analyses Required

Quote 749

pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3

Sent by:

Received by:

Date:

	Monitoring Point	Coordinates	Time	Sampled	Level	Description	Comment/Observations
✓	MPG-B1	S26.63843° E30.09878°	15:15	Yes	1.36	Down gradient (north) of the co-disposal facility.	Clear
✓	MPG-B2	S26.64143° E30.10175°	14:50	Yes	1.90	Down gradient (east) of the lined Settling Damsand co-disposal.	Clear
✓	MPG-B3	S26.64816° E30.09905°	13:15	Yes	12.15	Near the security gate. Closest to sec gate	Clear
✓	MPG-B4	S26.64819° E30.09910°	13:20	Yes	12.79	Near the security gate.	Clear
✓	MPG-B5	S26.64457° E30.09363°	09:40	Yes	6.18	Up-gradient (south-west) of the plant area nextto the railway line.	Clear
✓	MPG-B6	S26.63719° E30.09540°	15:30	Yes	4.67	Adjacent to the return water dam. 30	Clear
✓	MPG-B7	S26.63832° E30.09870°	15:10	Yes	1.48	Down gradient (north) of the co-disposal facility.	
✓	MPG-B8	S26.64160° E30.10155°	14:55	Yes	3.08	Down gradient (east) of the lined Settling Dams.	Clear
✓	MPG-B9	S26.64403° E30.10107°	10:05	Yes	11.53	Down gradient (east) of the plant area.	Clear.
✗	MPG-B10	S26.64581° E30.10007°	10:15	No	Eq	Down gradient (east) of the plant area.	Equipped.
✓	MPG-B11	S26.64435° E30.09344°	09:30	Yes	5.08	Up-gradient (south-west) of the plant area nextto the railway line.	Clear
✗	MPG-B12	S26.65633° E30.12443°	09:10	No	NA	At MPN Vunene extension	No Access
✗	MPG-B13	S26.66689° E30.11329°	15:00	No	NA	South of the mine next to the railway line.	No Access
✓	MPG-B14	S26.63716° E30.10992°	12:00	Yes	16.61	Between Usutu/MPN	Clear
✓	MPG-B15	S26.63778° E30.10881°	11:55	Yes	4.66	Between Usutu/MPN	Clear
✓	MPG-B16	S26.64106° E30.11469°	11:20	Yes	29.34	Between Usutu/MPN	Clear
✓	MPG-B17	S26.64095° E30.11259°	11:35	Yes	5.28	Between Usutu/MPN	Clear
✓	MPG-B18	S26.64608° E30.11685°	08:40	Yes	24.72	Between Usutu/MPN	Clear

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	May-18
Monitoring Occasion	Quarterly Groundwater Monitoring
Date of Sampling	14-May-18 + 17 May 18

Analyses Required

Quote 749

pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3

Ad Hoc Sampling

	Monitoring Point	Coordinates	Time	Sampled	Level	Medium	Comment/Observations
✓	MPG-B19	S26.64600° E30.11725°	08:50	Yes	21.27	Between Usutu/MPN	Clear
✓	MPG-B20	S26.63144° E30.11860°	10:55	Yes	2.70	Usutu UG. Bh intersecting mine at 90 m	Clear
X	GKL-1	S26.69603° E30.07208°	14:00	No	NA	Borehole	Not Found NA
✓	GKL-4D	S26.70167° E30.08253°	09:20	Yes	6.65	Borehole Deep @ Vaal VLS3 80	Clear
✓	GKL-2S	S26.70178° E30.08269°	09:25	Yes	4.21	Borehole Shallow @ Vaal 6	Clear
✓	GAD-2S	S26.71269° E30.11414°	08:30	Yes	8.99	Borehole on OVS Road. 40	Clear
✓	GAD-1	S26.72733° E30.10144°	08:45	Yes	4.82	Borehole 30	Clear
X	GKL-9D	S26.67231° E30.10450°	13:20	No	NA	Borehole	Not Found NA
X	GKL-8M	S26.67233° E30.10464°	16:15	No	NA	Borehole	Not Found NA
X	GKL-5S	S26.66542° E30.09647°	16:05	No	NA	Borehole	Not Found NA
X	GKL-6M	S26.66542° E30.09658°	15:40	No	NA	Borehole	Not found NA
✓	GKL-3m @ GKL 214		08:35	Yes	4.72	BH Medium @ Vaal 30	Clear
✓	MPG-B21	S26.64805 E30.10074	12:55	Yes	13.50	BH @ Entrance 300m	Clear

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Jun-18
Monitoring Occasion	Monthly Surface and Groundwater Monitoring
Date of Sampling	08-Jun-18 – 11 Jun 18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Description	Comment/Observations
Quote 749	✓	MPS-S05	S26.62678° E30.12041°	13:05	Yes	Med	Witpuntspruit 4 MS	Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	MPS-S08	S26.62873° E30.12149°	12:50	Yes	Med	Witpuntspruit 5 MS	Clear
	✗	MPS-S12 *	S26.64150° E30.11697°	12:05	No	Dry	Witpunt Tributary @ Access Road	Dry
	✓	MPS-S13	S26.64837° E30.09888°	08:55	Yes	Low	Runoff from Loading Area	Turbid – Stagnant
	✗	MPS-S14	S26.64616° E30.09890°	11:30	No	Med	Gen-sub PCD	Too oily to sample
	✓	MPS-S15	S26.64837° E30.09888°	12:15	Yes	V Low	Stormwater trench @ Security Clean	Clear / Flowing AMD
	✓	MPS-S16	S26.64505° E30.10121°	10:50	Yes	Low	DS Area of Ericsons + Settl Dams	Clear
Sent by:	✓	MPS-S20	S26.64505° E30.10121°	10:40	Yes	Low	Erickson Dams	Clear
	✓	MPS-S21	S26.64198° E30.10059°	10:15	Yes	V Low	Main Holdings Dam	Clear
	✓	MPS-S25	S26.63826° E30.09506°	11:20	Yes	Low	Workshop Trench @ Security	Dirty @ turnstiles Oily
Received by:	✗	MPS-S26 *	S26.63727° E30.08963°	12:30	No	N/A	Witpunt Tributary North US 1	No Access
	✗	MPS-S27	S26.64716° E30.10336°	12:25	No	Dry	Witpuntspruit Tributary entering MP	Dry
	✓	MPS-S28	S26.64808° E30.09925°	12:20	Yes	Low	Confluence of MPS-S13 and MPS-S15	Clear – Stagnant
Date:	✓	MPS-S29	S26.64743° E30.09802	09:05	Yes	Low	Storm water @ Offices	Turbid.
	✓	MPS-S30	S26.64508° E30.09674°	11:00	Yes	Low	Plant PCD	Turbid.
	✓	Usutu Decant	S26.63646 E30.12945	12:00	Yes	High	Decant 1638m	Clear @ Cement Box

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Project	Mooiplaats IWUL Water Monitoring
Monitoring Month	Jun-18
Monitoring Occasion	Monthly Surface and Groundwater Monitoring
Date of Sampling	08-Jun-18

Analyses Required		Monitoring Point	Coordinates	Time	Sampled	Level	Medium		Comment/Observations
Quote 749	✓	VL-S01	S26.64616° E30.09890°	08:55	Yes	Mod	Vaal River 1 US		Clear
pH, EC, P and M Alkalinity, Ca, Mg, Na, K, F, Cl, SO4, NO3-N, Al, Fe, Mn, NH3	✓	VL-S02	S26.64804° E30.15098°	10:55	Yes	Mod	Vaal River 2 DS		Clear
	✓	VL-S03	S26.67879° E30.12411°	10:00	Yes	Mod	Vaal River 3 DS		Clear
	✓	VL-S04	S26.70167° E30.08288°	10:45	Yes	Mod	Vaal River 4 DS		Clear
	✓	WT-S01	S26.71447° E30.06519°	08:44	Yes	Mod	Witpuntspruit 1 US		Clear
	✓	WT-S02	S26.59307° E30.09617°	13:40	Yes	Mod	Witpuntspruit 2 MS		Clear
	✓	WT-S03	S26.61826° E30.11211°	13:50	Yes	Mod	Witpunt Tributary North DS 1		Clear
	✓	WT-S04	S26.62014° E30.10781°	13:25	Yes	Mod	Witpuntspruit 3 MS		Clear
	✓	WT-S05	S26.62294° E30.11463°	13:20	Yes	Low	Witpunt Tributary South DS 2		Clear – very slow Flow
	✓	WT-S06	S26.62863° E30.11539°	11:50	Yes	Mod	Witpuntspruit 6 MS		Clear
	✓	GKL-1	S26.69603° E30.07208°	09:55	Yes	26.44	Borehole	40	Clear
	✓	GKL-4D	S26.70167° E30.08253°	10:20	Yes	4.68	Borehole	80	Clear
	✓	GKL-2S	S26.70178° E30.08269°	10:15	Yes	4.24	Borehole	30	Clear
	✓	GAD-2S	S26.71269° E30.11414°	09:25	Yes	9.23	Borehole	40	Clear
	✓	GAD-1	S26.72733° E30.10144°	09:40	Yes	4.95	Borehole		Clear
	X	GKL-9D	S26.67231° E30.10450°	11:30	No	–	Borehole		Not Found
	X	GKL-8M	S26.67233° E30.10464°	11:30	No	–	Borehole		Not Found
*	X	GKL-5S	S26.66542° E30.09647°	11:30	No	–	Borehole		Not Found
*	X	GKL-6M	S26.66542° E30.09658°	11:30	No	–	Borehole		Not Found.
	✓	GKL-3M		10:10	Yes	4.72		30	Clear
	✓	GAD-3S	S26.67772	11:05	Yes	2.52		6	Clear
	✓	GAD-4M	E30.12374	11:10	Yes	2.62		30	Clear
	✓	GAD-5D	Z 1622 m	11:15	Yes	0		80	Salt + bubbles

ANNEXURE D

Date	Lab_ no	Sample number	Units	pH	Conductivi ty	m- Alkalinity	Fluorine	Chloride	Suphate	Al	Ca	Fe	K	Mg	Mn	Na	Nitrate as N
14-Mar-18	6587	MPP-PCD	mg/l [ppm]	4.60	1749.00	2.00	0.47	6.50	963.50	1.81	191.40	0.00	4.40	75.50	2.50	114.40	1.00
14-Mar-18	6587	MPS-S05	mg/l [ppm]	5.60	1018.00	6.00	0.00	18.90	333.40	0.26	69.90	0.10	5.00	42.30	0.30	55.40	1.10
14-Mar-18	6587	MPS-S06	mg/l [ppm]	7.50	1439.00	155.30	0.00	17.60	395.60	0.06	93.60	0.00	3.20	45.30	0.00	132.20	0.00
14-Mar-18	6587	MPS-S07	mg/l [ppm]	6.70	162.80	68.70	0.00	6.10	3.80	0.00	11.40	0.50	3.30	7.20	0.00	20.50	0.00
14-Mar-18	6587	MPS-S08	mg/l [ppm]	6.60	1023.00	13.70	0.00	19.20	478.90	0.00	66.10	0.00	4.70	40.70	0.60	78.30	0.00
14-Mar-18	6587	MPS-S14	mg/l [ppm]	7.70	1449.00	279.70	0.50	204.70	89.90	0.00	66.00	1.70	10.60	19.60	0.70	180.10	0.00
14-Mar-18	6587	MPS-S20	mg/l [ppm]	8.80	1514.00	199.70	1.82	16.80	545.90	0.00	34.50	0.10	5.30	27.00	0.00	358.10	0.00
14-Mar-18	6587	MPS-S21	mg/l [ppm]	6.90	5420.00	128.70	0.60	39.90	3071.40	0.66	443.00	0.60	16.50	345.90	12.80	907.50	0.00
14-Mar-18	6587	MPS-S25	mg/l [ppm]	7.80	265.80	143.30	0.00	2.50	2.60	0.00	31.30	0.20	2.80	10.30	0.00	15.30	0.00
14-Mar-18	6587	VL-S01	mg/l [ppm]	6.90	156.00	52.00	0.00	8.10	8.70	0.00	11.50	0.10	2.40	8.20	0.00	10.50	0.00
14-Mar-18	6587	VL-S02	mg/l [ppm]	7.40	216.60	51.30	0.00	8.30	23.80	0.21	13.80	0.40	2.80	9.10	0.00	17.90	0.00
14-Mar-18	6587	VL-S03	mg/l [ppm]	7.30	214.60	51.00	0.00	7.70	25.10	0.00	13.80	0.10	2.80	9.20	0.00	15.70	0.00
14-Mar-18	6587	WT-S01	mg/l [ppm]	3.80	890.00	0.00	0.00	18.20	369.60	5.08	68.30	1.60	4.70	42.40	4.20	53.40	1.20
14-Mar-18	6587	WT-S02	mg/l [ppm]	6.60	1029.00	32.70	0.00	20.00	430.00	0.07	79.70	0.10	6.30	48.50	1.90	84.80	0.00
14-Mar-18	6587	WT-S03	mg/l [ppm]	6.10	574.00	47.30	0.00	13.20	149.10	0.05	54.00	1.30	3.40	20.90	1.10	35.70	0.00
14-Mar-18	6587	WT-S04	mg/l [ppm]	6.20	1029.00	11.00	0.00	19.70	329.30	0.00	53.50	0.00	6.20	33.20	1.10	77.50	0.00
14-Mar-18	6587	WT-S05	mg/l [ppm]	7.30	203.90	91.70	0.46	7.00	5.20	0.00	10.80	0.40	3.10	7.50	0.00	22.40	0.00
14-Mar-18	6587	WT-S06	mg/l [ppm]	7.70	1518.00	315.70	1.55	33.80	305.70	1.44	77.30	1.60	4.80	42.70	0.00	190.80	1.00

SiteName	DateTimeMeas	MALK CaCO3/L	EC mS/m	pH	TotHardness mg/l	CaHardness mg/l	MgHardness mg/l	TDS mg/l	Ca mg/l	Cl mg/l	Mg mg/l	NO3 mg/l	K mg/l	Na mg/l	SO4 mg/l	Al mg/l	F mg/l	Fe mg/l	Mn mg/l
MPS-S05	2018/04/28 00:00	9.000	48.100	5.880	157.322	79.904	77.418	289.500	32.000	18.200	18.800	-2.000	6.700	26.000	184.800	0.340	-0.400	0.100	1.140
MPS-S06	2018/04/28 00:00	-3.500	266.000	2.930	820.299	313.374	506.926	1742.500	125.500	12.400	123.100	-2.000	6.000	158.700	1321.300	24.640	-0.400	26.460	8.410
MPS-S07	2018/04/28 00:00	-3.500	278.800	2.930	906.444	320.865	585.580	1986.300	128.500	11.700	142.200	-2.000	4.600	160.400	1543.400	26.120	-0.400	68.480	9.150
MPS-S08	2018/04/28 00:00	9.000	48.100	6.320	155.487	77.657	77.830	288.400	31.100	18.200	18.900	-2.000	6.900	25.700	184.600	0.390	-0.400	0.300	1.130
MPS-S13	2018/04/28 00:00	71.000	65.400	8.020	192.198	99.131	93.067	404.100	39.700	13.500	22.600	-2.000	2.500	53.600	232.000	0.270	-0.400	0.170	-0.050
MPS-S14	2018/04/28 00:00	235.000	170.000	7.490	263.459	163.803	99.656	1198.000	65.600	29.600	24.200	-2.000	7.100	303.100	628.100	0.470	1.300	0.310	0.780
MPS-S15	2018/04/28 00:00	112.000	60.000	8.510	218.706	105.873	112.833	352.200	42.400	18.700	27.400	-2.000	1.900	36.400	160.600	-0.050	-0.400	0.050	-0.050
MPS-S16	2018/04/28 00:00	-3.500	1000.000	2.780	3583.144	721.134	2862.010	10579.800	288.800	3.800	695.000	-2.000	8.100	310.800	9277.800	143.700	-0.400	2334.000	53.750
MPS-S20	2018/04/28 00:00	192.000	142.900	8.310	182.245	84.648	97.597	958.400	33.900	17.700	23.700	-2.000	4.100	271.000	493.000	0.220	1.800	2.490	0.150
MPS-S21	2018/04/28 00:00	225.000	520.000	3.720	2273.147	974.329	1298.817	4682.300	390.200	23.600	315.400	-2.000	12.100	610.000	3198.400	9.730	-0.400	1.930	15.710
MPS-S25	2018/04/28 00:00	126.000	55.200	8.600	215.349	131.342	84.007	347.500	52.600	4.200	20.400	-2.000	2.600	36.600	157.900	0.160	-0.400	0.200	-0.050
MPS-S27	2018/04/28 00:00	86.000	47.700	6.880	194.028	116.610	77.418	294.100	46.700	8.600	18.800	-2.000	6.000	18.900	145.900	0.050	-0.400	0.200	-0.050
MPS-S28	2018/04/28 00:00	99.000	48.700	8.040	186.481	95.885	90.596	286.600	38.400	12.800	22.000	-2.000	2.600	27.100	126.700	0.070	-0.400	0.230	-0.050
MPS-S29	2018/04/28 00:00	59.000	107.200	7.970	401.988	218.737	183.251	755.400	87.600	4.500	44.500	-2.000	1.900	70.300	513.600	0.050	-0.400	2.270	-0.050
MPS-S30	2018/04/28 00:00	7.000	168.900	6.200	773.098	500.898	272.200	1358.000	200.600	7.500	66.100	-2.000	3.600	118.700	958.800	0.140	0.500	0.160	1.980
VL-S01	2018/04/28 00:00	50.000	14.930	7.150	44.123	21.474	22.649	93.400	8.600	10.500	5.500	-2.000	3.600	8.000	29.600	0.290	-0.400	0.500	-0.050
VL-S02	2018/04/28 00:00	28.000	16.900	6.920	53.235	26.468	26.767	95.700	10.600	10.800	6.500	-2.000	4.000	10.200	39.200	0.350	-0.400	0.490	0.080
VL-S03	2018/04/28 00:00	22.000	16.400	6.810	52.823	26.468	26.355	90.800	10.600	10.700	6.400	-2.000	4.100	10.000	38.200	0.380	-0.400	0.490	-0.050
VL-S04	2018/04/28 00:00	29.000	16.470	6.750	51.251	25.719	25.532	93.700	10.300	10.700	6.200	-2.000	4.000	9.800	37.700	0.360	-0.400	0.440	-0.050
WT-S01	2018/04/28 00:00	-3.500	49.500	4.590	143.304	70.415	72.889	293.300	28.200	16.600	17.700	-2.000	5.100	20.100	210.100	1.900	-0.400	0.390	-0.050
WT-S02	2018/04/28 00:00	8.000	47.900	6.340	155.426	79.654	75.771	292.800	31.900	19.000	18.400	-2.000	6.700	24.900	189.500	0.350	-0.400	0.270	1.030
WT-S03	2018/04/28 00:00	59.000	55.300	7.450	180.220	103.626	76.595	341.900	41.500	12.800	18.600	-2.000	4.000	35.400	196.600	0.090	-0.400	0.370	0.280
WT-S04	2018/04/28 00:00	10.000	47.400	6.070	152.280	78.156	74.124	296.100	31.300	18.400	18.000	-2.000	6.400	24.700	193.700	0.260	-0.400	-0.050	1.090
WT-S05	2018/04/28 00:00	-3.500	264.300	2.890	808.489	302.387	506.102	1866.500	121.100	11.900	122.900	-2.000	5.200	155.800	1454.100	23.270	-0.400	36.400	8.170
WT-S06	2018/04/28 00:00	19.000	49.000	6.830	149.871	76.159	73.712	318.700	30.500	19.000	17.900	-2.000	6.500	29.500	206.300	0.260	-0.400	0.160	1.130

SiteName	DateTimeMeas	MALK CaCO3/L	EC mS/m	pH	TotHardness mg/l	CaHardness mg/l	MgHardness mg/l	TDS mg/l	Ca mg/l	Cl mg/l	Mg mg/l	NO3 mg/l	K mg/l	Na mg/l	SO4 mg/l	Al mg/l	F mg/l	Fe mg/l	Mn mg/l	NH3 mg/l
GAD-1	2018/05/28 00:00	154.500	28.850	7.200	146.773	94.886	51.887	168.200	38.000	3.800	12.600	0.000	2.300	15.400	3.400	0.000	0.000	0.500	0.300	-0.020
GAD-2S	2018/05/28 00:00	41.000	11.560	7.500	52.898	25.719	27.179	63.600	10.300	11.600	6.600	0.000	0.800	6.800	2.900	0.000	0.000	0.600	0.100	0.270
GKL-2S	2018/05/28 00:00	309.000	62.700	7.500	262.702	123.102	139.600	328.500	49.300	8.700	33.900	0.000	1.300	27.800	22.100	0.220	0.000	1.200	0.000	-0.020
GKL-3m	2018/05/28 00:00	374.000	71.700	9.300	9.787	6.492	3.294	418.130	2.600	10.100	0.800	0.000	0.800	177.300	1.100	0.000	1.030	0.100	0.000	0.260
GKL-4D	2018/05/28 00:00	743.500	240.900	8.900	12.358	8.240	4.118	1296.790	3.300	309.900	1.000	0.000	2.400	530.900	1.200	0.000	1.990	0.100	0.000	0.400
MPG-B1	2018/05/28 00:00	78.500	13.380	7.000	40.369	24.720	15.648	79.300	9.900	0.000	3.800	0.000	3.700	14.800	0.000	0.000	0.000	1.300	0.100	-0.020
MPG-B11	2018/05/28 00:00	86.000	16.820	7.200	64.721	37.954	26.767	95.800	15.200	3.200	6.500	0.000	3.500	12.800	3.000	0.000	0.000	2.400	0.100	0.980
MPG-B14	2018/05/28 00:00	196.500	36.600	9.500	7.877	4.994	2.883	211.300	2.000	4.200	0.700	0.000	1.800	81.500	2.800	4.420	0.400	2.600	0.000	-0.020
MPG-B15	2018/05/28 00:00	80.500	25.590	7.100	82.144	42.199	39.945	143.900	16.900	11.300	9.700	0.000	1.100	20.300	36.300	0.000	0.000	0.100	0.000	-0.020
MPG-B16	2018/05/28 00:00	114.500	21.000	8.200	43.624	20.975	22.649	120.200	8.400	3.000	5.500	0.000	1.900	31.500	1.200	0.000	0.000	0.200	0.100	0.090
MPG-B17	2018/05/28 00:00	95.500	18.810	7.400	89.547	49.191	40.356	101.200	19.700	5.500	9.800	0.000	0.900	8.000	0.000	0.000	0.000	1.100	0.100	-0.020
MPG-B18	2018/05/28 00:00	100.000	18.080	8.000	71.564	46.444	25.120	102.400	18.600	2.400	6.100	0.000	2.400	11.100	1.800	0.000	0.000	0.100	0.000	-0.020
MPG-B19	2018/05/28 00:00	72.500	15.710	7.100	64.546	36.956	27.591	80.800	14.800	3.600	6.700	0.000	1.900	8.600	1.700	0.100	0.000	0.100	0.000	-0.020
MPG-B2	2018/05/28 00:00	73.000	19.200	9.300	39.668	20.725	18.943	112.600	8.300	3.400	4.600	0.000	4.100	23.800	24.600	0.000	0.000	0.000	0.000	-0.020
MPG-B20	2018/05/28 00:00	1048.000	242.900	9.000	31.117	14.233	16.884	1500.030	5.700	56.900	4.100	0.000	3.200	579.500	216.000	0.000	5.830	0.000	0.100	-0.020
MPG-B21	2018/05/28 00:00	131.500	24.570	7.700	68.844	46.195	22.649	136.000	18.500	2.200	5.500	0.000	1.700	27.600	1.600	0.060	0.000	0.200	0.000	-0.020
MPG-B3	2018/05/28 00:00	136.000	23.210	8.700	47.378	17.729	29.650	136.800	7.100	3.100	7.200	0.000	1.100	35.400	1.300	0.000	0.000	0.000	0.100	-0.020
MPG-B4	2018/05/28 00:00	144.000	30.300	8.000	75.844	46.195	29.650	159.900	18.500	4.000	7.200	0.000	1.200	38.100	4.500	0.000	0.000	0.800	0.100	0.230
MPG-B5	2018/05/28 00:00	158.000	24.800	7.700	97.840	62.425	35.415	150.900	25.000	2.200	8.600	0.000	3.000	13.600	3.700	0.000	0.000	0.400	0.100	-0.020
MPG-B6	2018/05/28 00:00	51.000	9.540	7.100	20.796	11.736	9.060	57.400	4.700	3.700	2.200	0.000	1.600	14.600	0.000	0.000	0.000	3.400	0.100	-0.020
MPG-B7	2018/05/28 00:00	47.000	14.120	8.200	15.828	9.239	6.589	90.900	3.700	8.400	1.600	1.100	2.400	23.900	21.600	0.000	0.000	0.800	0.000	-0.020
MPG-B8	2018/05/28 00:00	110.000	108.900	9.900	42.433	9.489	32.944	706.200	3.800	11.900	8.000	0.000	5.000	218.300	393.200	0.000	0.000	0.000	0.000	-0.020
MPG-B9	2018/05/28 00:00	170.000	35.600	8.400	61.624	33.210	28.414	203.800	13.300	6.800	6.900	0.000	1.600	55.600	17.600	0.000	0.000	0.100	0.000	-0.020
MPS-S05	2018/05/28 00:00	41.500	72.100	7.200	220.108	113.863	106.244	445.300	45.600	24.200	25.800	0.000	6.400	50.200	268.200	0.000	0.000	0.100	0.000	-0.020
MPS-S08	2018/05/28 00:00	75.000	72.500	7.300	213.567	110.617	102.950	459.700	44.300	25.100	25.000	0.000	6.300	53.400	260.600	0.050	0.000	0.000	0.000	-0.020
MPS-S13	2018/05/28 00:00	120.500	84.000	8.000	265.366	133.590	131.776	551.900	53.500	19.800	32.000	0.000	2.100	69.300	302.900	0.060	0.000	0.100	0.000	-0.020
MPS-S14	2018/05/28 00:00	88.500	482.000	7.400	1958.619	974.829	983.790	4176.460	390.400	35.800	238.900	0.000	14.300	556.300	2887.000	0.380	0.660	0.400	11.300	-0.020
MPS-S15	2018/05/28 00:00	134.500	59.800	8.500	221.203	108.370	112.833	341.600	43.400	18.100	27.400	0.000	1.400	37.500	133.100	0.050	0.000	0.100	0.000	-0.020
MPS-S16	2018/05/28 00:00	0.000	543.000	3.600	2494.267	690.171	1804.096	4869.500	276.400	11.800	438.100	1.600	14.900	421.700	3705.000	38.730	0.000	1.300	101.400	1.650
MPS-S20	2018/05/28 00:00	27.000	417.000	6.300	1583.733	701.657	882.076	3374.270	281.000	30.600	214.200	1.400	10.100	480.200	2340.000	0.080	0.570	0.400	9.500	0.980

MPS-S21	2018/05/28 00:00	71.500	371.000	6.600	1442.931	744.106	698.825	3102.630	298.000	19.800	169.700	0.000	7.900	399.900	2164.000	0.110	0.430	0.600	5.900	0.730
MPS-S25	2018/05/28 00:00	148.500	30.200	8.500	128.225	85.397	42.827	167.000	34.200	3.000	10.400	0.000	2.500	14.300	13.500	0.000	0.000	0.000	0.000	0.160
MPS-S29	2018/05/28 00:00	61.500	141.900	7.500	537.958	320.115	217.842	1125.000	128.200	8.800	52.900	0.000	1.900	120.300	776.000	0.050	0.000	0.100	0.000	-0.020
MPS-S30	2018/05/28 00:00	84.500	589.000	7.600	2001.772	1052.985	948.787	5060.020	421.700	42.000	230.400	0.000	13.500	822.200	3479.000	0.090	0.520	0.100	2.700	2.470
Usutu Decant	2018/05/28 00:00	1155.000	397.000	8.300	101.993	57.930	44.063	2680.850	23.200	73.200	10.700	0.000	8.800	924.500	945.000	0.360	2.450	0.400	0.100	0.150
VL-S01	2018/05/28 00:00	43.000	15.570	7.500	54.046	25.220	28.826	88.000	10.100	10.900	7.000	1.300	2.200	10.100	20.600	0.170	0.000	0.700	0.000	-0.020
VL-S02	2018/05/28 00:00	49.500	20.150	7.600	60.012	28.716	31.297	112.600	11.500	11.900	7.600	0.000	2.400	16.500	33.000	0.160	0.000	0.600	0.000	-0.020
VL-S03	2018/05/28 00:00	51.000	19.510	7.800	61.997	29.465	32.532	112.500	11.800	11.600	7.900	0.000	2.500	16.200	31.900	0.150	0.000	0.600	0.000	-0.020
VL-S04	2018/05/28 00:00	50.000	19.770	7.700	59.763	28.466	31.297	111.500	11.400	12.100	7.600	1.000	2.500	15.100	31.800	0.140	0.000	0.500	0.000	-0.020
WT-S01	2018/05/28 00:00	0.000	172.100	3.200	625.877	331.851	294.025	1188.100	132.900	12.100	71.400	0.000	4.100	39.400	928.200	17.530	0.000	9.200	8.000	0.540
WT-S02	2018/05/28 00:00	51.500	70.400	7.000	213.918	112.615	101.303	450.300	45.100	25.500	24.600	0.000	6.600	48.600	269.000	0.130	0.000	0.200	0.700	-0.020
WT-S03	2018/05/28 00:00	44.700	52.900	7.400	160.573	91.390	69.182	310.020	36.600	21.300	16.800	0.000	3.800	39.100	165.600	0.050	0.000	0.300	0.000	-0.020
WT-S04	2018/05/28 00:00	46.000	72.300	7.100	229.894	120.355	109.539	476.100	48.200	24.200	26.600	0.000	6.800	51.100	291.600	0.220	0.000	0.200	0.000	-0.020
WT-S05	2018/05/28 00:00	0.000	387.000	3.000	1499.788	550.589	949.199	3285.900	220.500	15.200	230.500	0.000	8.000	250.700	2561.000	42.040	0.000	49.900	17.300	0.070
WT-S06	2018/05/28 00:00	253.000	109.700	7.800	196.254	101.129	95.126	700.410	40.500	38.000	23.100	0.000	5.300	164.200	276.700	0.000	0.810	0.000	0.000	-0.020

SiteName	DateTimeMeas	MALK CaCO3/L	EC mS/m	pH	TotHardness mg/l	CaHardness mg/l	MgHardness mg/l	TDS mg/l	Ca mg/l	Cl mg/l	Mg mg/l	NO3 mg/l	K mg/l	Na mg/l	SO4 mg/l	Al mg/l	F mg/l	Fe mg/l	Mn mg/l
GAD-1	2018/06/28 00:00	153.000	29.130	7.150	138.896	89.892	49.004	153.700	36.000	4.600	11.900	-2.000	2.000	13.800	-4.000	-0.050	-0.400	0.680	0.340
GAD-2S	2018/06/28 00:00	45.000	14.220	7.210	63.832	31.712	32.120	63.300	12.700	9.800	7.800	3.300	0.700	6.400	-4.000	-0.050	-0.400	0.320	-0.050
GAD-3S	2018/06/28 00:00	163.000	78.900	9.080	190.549	20.475	170.073	497.800	8.200	22.300	41.300	-2.000	0.700	114.400	215.500	-0.050	-0.400	0.260	-0.050
GAD-4M	2018/06/28 00:00	119.000	27.540	8.840	107.351	42.699	64.653	150.000	17.100	7.600	15.700	-2.000	0.900	20.800	18.900	-0.050	-0.400	0.170	-0.050
GAD-5D	2018/06/28 00:00	1552.000	309.000	8.750	15.390	6.742	8.648	1876.900	2.700	127.800	2.100	-2.000	5.100	805.900	-4.000	-0.050	8.100	0.100	-0.050
GKL-1	2018/06/28 00:00	206.000	36.600	7.180	173.399	112.864	60.535	198.900	45.200	1.700	14.700	-2.000	1.100	19.000	-4.000	-0.050	-0.400	-0.050	-0.050
GKL-2S	2018/06/28 00:00	350.000	61.000	7.400	273.417	139.582	133.835	346.900	55.900	7.700	32.500	-2.000	1.800	26.700	14.700	0.060	-0.400	0.080	0.250
GKL-3M	2018/06/28 00:00	390.000	72.200	9.230	10.698	6.992	3.706	399.800	2.800	10.100	0.900	-2.000	1.300	155.700	-4.000	-0.050	1.000	0.180	-0.050
GKL-4D	2018/06/28 00:00	774.000	240.800	8.810	11.946	8.240	3.706	1361.000	3.300	303.600	0.900	-2.000	3.300	588.500	-4.000	0.200	3.000	0.440	-0.050
MPS-S05	2018/06/28 00:00	38.000	80.000	7.330	275.976	140.082	135.894	512.600	56.100	24.500	33.000	-2.000	8.500	54.200	315.900	0.190	-0.400	0.090	0.190
MPS-S08	2018/06/28 00:00	60.000	83.000	7.220	283.901	141.830	142.071	536.800	56.800	24.300	34.500	-2.000	8.300	59.300	320.000	0.280	-0.400	0.120	0.470
MPS-S13	2018/06/28 00:00	144.000	88.800	7.860	313.309	158.060	155.249	563.300	63.300	21.100	37.700	-2.000	2.400	73.200	281.600	0.140	-0.400	0.140	-0.050
MPS-S15	2018/06/28 00:00	123.000	61.700	8.460	245.954	120.355	125.599	364.100	48.200	18.800	30.500	-2.000	1.300	36.300	157.600	0.310	-0.400	0.220	-0.050
MPS-S16	2018/06/28 00:00	7.000	466.000	4.840	2057.280	856.471	1200.809	4102.700	343.000	20.100	291.600	-2.000	16.100	470.900	2959.200	8.740	-0.400	0.220	40.160
MPS-S20	2018/06/28 00:00	60.000	417.000	7.120	1749.004	856.221	892.782	3643.400	342.900	31.700	216.800	-2.000	13.800	509.000	2494.500	0.110	0.700	0.330	6.340
MPS-S21	2018/06/28 00:00	111.000	523.000	6.890	1982.246	934.627	1047.619	4476.000	374.300	22.600	254.400	-2.000	7.600	600.000	3152.000	0.070	0.500	0.060	-0.050
MPS-S25	2018/06/28 00:00	146.000	32.600	8.460	125.977	83.150	42.827	178.500	33.300	3.400	10.400	-2.000	2.800	17.500	25.900	-0.050	-0.400	-0.050	-0.050
MPS-S28	2018/06/28 00:00	136.000	64.600	8.320	193.968	95.136	98.832	358.600	38.100	20.200	24.000	-2.000	1.300	32.700	163.100	0.070	-0.400	-0.050	-0.050
MPS-S29	2018/06/28 00:00	278.000	394.000	9.090	240.381	154.315	86.066	1961.700	61.800	880.900	20.900	-2.000	7.900	750.400	75.400	-0.050	-0.400	-0.050	-0.050
MPS-S30	2018/06/28 00:00	58.000	438.000	7.860	1764.533	868.457	896.077	3791.900	347.800	30.600	217.600	-2.000	13.800	507.100	2641.700	1.340	0.500	0.790	5.380
Usutu Decant	2018/06/28 00:00	458.000	153.500	7.450	219.292	130.343	88.949	901.100	52.200	34.800	21.600	-2.000	7.200	272.000	240.000	0.050	0.500	0.090	-0.050
VL-S01	2018/06/28 00:00	45.000	15.340	7.580	51.636	23.222	28.414	81.900	9.300	11.600	6.900	-2.000	2.300	9.100	18.100	0.180	-0.400	0.540	-0.050
VL-S02	2018/06/28 00:00	52.000	22.670	7.530	65.379	29.964	35.415	118.700	12.000	12.400	8.600	-2.000	2.500	17.100	37.300	0.090	-0.400	0.300	-0.050
VL-S03	2018/06/28 00:00	54.000	26.660	7.720	80.856	37.205	43.651	149.600	14.900	13.200	10.600	2.200	2.900	23.300	50.500	0.150	-0.400	0.480	-0.050
VL-S04	2018/06/28 00:00	59.000	26.690	7.550	79.945	36.706	43.239	148.700	14.700	13.000	10.500	-2.000	2.700	23.200	51.600	0.110	-0.400	0.410	-0.050
WT-S01	2018/06/28 00:00	-3.500	245.900	3.190	934.985	450.709	484.277	1767.900	180.500	16.900	117.600	2.400	8.800	54.900	1389.300	33.650	-0.400	24.840	12.570
WT-S02	2018/06/28 00:00	49.000	77.500	6.670	265.155	137.085	128.070	488.500	54.900	24.200	31.100	-2.000	8.400	46.900	296.000	0.100	-0.400	0.100	1.380
WT-S03	2018/06/28 00:00	75.000	53.200	7.220	158.575	89.393	69.182	326.800	35.800	15.800	16.800	-2.000	3.800	37.000	175.000	-0.050	-0.400	0.120	-0.050
WT-S04	2018/06/28 00:00	38.000	78.300	6.950	248.092	127.846	120.246	495.700	51.200	25.500	29.200	2.200	9.100	47.400	308.700	-0.050	-0.400	-0.050	-0.050
WT-S05	2018/06/28 00:00	-3.500	502.000	3.190	2029.456	763.583	1265.873	4314.100	305.800	19.900	307.400	-2.000	13.900	472.100	3199.500	41.330	-0.400	29.370	23.910
WT-S06	2018/06/28 00:00	177.000	112.400	7.650	246.117	120.106	126.011	708.900	48.100	31.400	30.600	-2.000	8.000	135.800	350.200	0.070	0.600	-0.050	0.250