SOUTH32 SA COAL HOLDINGS (PTY) LTD

VANDYKSDRIFT CENTRAL PROJECT
INTEGRATED WATER USE LICENCE APPLICATION
DRAFT TECHNICAL REPORT

Report No.: JW219/19/G535-012 – Rev 3

November 2019

Jones & Wagener
Engineering & Environmental Consultants

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SYNOPSIS

Background

South32 SA Coal Holdings (Pty) Ltd (South32), is the holder of an amended mining right for coal, under the Department of Mineral Resources (DMR) reference MP30/5/1/2/2/379MR, in respect of its Wolvekrans – Ifalethu Colliery[1].

The Vandyksdrift Central (VDDC) section at Wolvekrans Colliery falls within the footprint of historic underground mining operations at the old Douglas Colliery. In 2007, an amendment of the Environmental Management Programme Report (EMPR) for the Douglas Colliery operations was approved, to allow pillar mining (opencast) of the area previously mined by underground bord and pillar mining. The 2007 approved EMPR Amendment included limited additional infrastructure in support of the opencast mining operations, as it was assumed at that stage that existing infrastructure will be used. A water use licence (licence number 24084535) for the water uses associated with the opencast mining was also issued in 2008.

The historical No. 2 seam underground workings are flooded with water and has to be dewatered to enable the open pit development to proceed and a dewatering strategy has therefore been developed. The applications for authorisation of the activities associated with this dewatering strategy, were limited to the infrastructure to facilitate dewatering (i.e. dewatering boreholes, pumps, pipelines, storage tanks, mechanical evaporators, roads and power lines).

A pre-feasibility investigation has since been conducted, and the need to develop additional infrastructure to support the proposed opencast mining was identified. The additional infrastructure includes the following:

- Storm water management structures (drains and berms);
- Water management measures for the management of mine impacted water, including a modular water treatment plant (WTP) and mechanical evaporators;
- Overburden dumps;
- Run-of-Mine (ROM) coal stockpile areas;
- Mixed ROM coal and slurry stockpile areas;
- Topsoil stockpiles following clearance of vegetation;
- Pipelines for the conveyance of water;
- Hard park area and brake test ramp; and
- Haul roads and service roads.

In addition to the infrastructure development, the proposed VDDC opencast pit boundary, as determined through the pre-feasibility investigation, differs from the mine layout in the 2007 approved EMPR amendment. An area of approximately 196 hectares in the latest mine layout was not included in the previous mine layout and is therefore not approved to be opencast mined. The project is collectively referred to as the VDDC infrastructure and mining development.

These activities must be appropriately authorised before the activities may commence. This includes a water use licence in terms of the National Water Act, 1998 (Act 36 of 1998) (NWA).

[1] Middelburg Mine Services as per mining right

Water uses

The following water uses as defined in the NWA are relevant to the project

S21(c): Impeding or diverting the flow of water in a watercourse and S21(i): Altering the bed, banks, course or characteristics of a watercourse;

Opencast mining of the Vleishaft tributary has been approved in the water use licence issued for the Douglas Middelburg Optimisation project and a section of the tributary has been mined through when the Steenkoolspruit section was mined.

The development of infrastructure and the additional opencast mining areas not approved previously, may further impact on watercourses. The areas where infrastructure development or opencast mining will take place within the regulated area, i.e. the 1:100 year floodline and within 500 m of delineated watercourses, has been categorised as follows:

- *Infrastructure area 1:* Located in the west of the VDDC section, incorporating the footprint of the modular WTP and a portion of the footprint of the overburden dump to be located on the Steenkoolspruit void;
- *Infrastructure area 2:* Located in the west of the VDDC section, incorporating a portion of the footprint of the overburden dump to be located on the Steenkoolspruit void;
- *Infrastructure area 3:* Located in the south of the VDDC section, incorporating infrastructure within the western servitude that will be developed within 500 m of delineated watercourses, as well as a service road;
- *Infrastructure area 4:* The portion of infrastructure that will be developed within the northern and eastern sections of the VDDC section is located within, or close to, the Vleishaft tributary;
- *Opencast mining extension:* Portions of the proposed opencast mining not previously authorised located within 500 m of delineated watercourses. This is to the south of the pit layout;
- *Explosives magazine and discharge point of treated water from modular WTP*, located to the north of the VDDC section. A new section of pipeline (approximately 700 m) will be developed between an existing pipeline and the northern canal, along the haul road. This will be outside of any delineated watercourse, but within 500 m of a wetland and the Olifants River.

S21(f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;

A modular WTP is planned with a treatment capacity of up to 20 Mℓ per day. This will be a scalable plant and the treatment capacity will be adjusted to respond to the operational needs. At maximum capacity of 20 Mℓ per day, an expected 13 200 m^3 of treated water per day will be discharged into the existing northern canal. From the canal, water is discharged via a wetland system into the Olifants River.

S21(g): Disposing of waste in a manner which may detrimentally impact on a water resource;

The following S21(g) water uses are included in the application:

- Overburden dumps: four dragline spoils dumps, extension of the existing overburden dump on the SKS pit and a proposed new Eastern overburden dump;
- Two Mixed ROM coal and slurry stockpiles areas for the storage of blended ROM coal and slurry from the underground workings. The mixed material will be allowed to dewater for a period, before it is removed to the existing Steenkoolspruit tip, from where it will be taken to the South Export Processing Plant;

- ROM coal stockpile areas for the temporary storage of coal form the No. 4 and No. 5 Seam before it is transported to the South Export Processing Plant;
- Dust suppression with mine impacted water.

S21(j): Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

To allow for the safe continuation of mining, the opencast pit will have to be dewatered. Temporary sumps will be developed in the pit floor from where the water will be collected and pumped out of the pit. The average pit water make over the life of mine is 4 760 m^3/day and the peak pit water make (during summer) is 12 950 m^3/day. Water will be pumped to the Vleishaft Dam pollution control dam (PCD) and from there, to one of the evaporator sites, or to the proposed modular WTP.

Potential impact

The main aspect to consider when assessing the impacts associated with the proposed infrastructure and mining development, is that the opencast mining was approved in the 2007 EMPR Amendment. The mining of the Vleishaft tributary was authorised in the water use licence issued in October 2008 as S21(c) and S21(i) water uses.

The bulk of the new infrastructure that will be developed is located within, or close to, this wetland system. Any impact associated with the proposed infrastructure development will therefore be of temporary nature until the infrastructure is decommissioned and the area opencast mined. Irrespective, mitigation measures to be implemented during the different development phases have been proposed to limit the impacts. The total extent of the development within this area was included in the 2007 EMPR opencast mining area and therefore in the wetland offset strategy that has been developed. There is no additional direct impact on wetlands.

Surface water impacts from the proposed development can be effectively mitigated by applying best practice water management principles. All dirty water generated on the site will be directed to the Vleishaft PCD and either re-used for dust suppression, managed through the mechanical evaporation system, or treated in the modular WTP before it is discharged back into the Olifants River system. Surface water quality monitoring has shown that the surface water resources are currently impacted as a result of mining and other land uses in the area. Discharge of water which complies to the Resource Quality Objectives (RQO) for the catchment is expected to result in an improvement in the water quality downstream of the discharge. It is, however, imperative that water quality of the treated water complies with the RQO.

Forced evaporation of mine impacted water and brine from the modular WTP through the proposed mechanical evaporators will require monitoring to ensure that there is no impact on the Olifants River as a result of spray drift. Evaporation should be limited to the SKS. Increased salinisation of the water to be evaporated at these mechanical evaporators and the resultant impact on the efficiency of the evaporators and on the water resources, should be closely monitored. Corrective action should be taken if required.

The main impact on groundwater during the operational phase will be the lowering of the groundwater levels due to the dewatering of the pit to ensure that mining may proceed safely. The dewatering of the VDDC opencast mining area is expected to result in a maximum drawdown of 20 – 60 m, with a cone of depression of 200 – 250 m from the edge of the pit. The tributary of the Olifants River to the south-east of the mining area is likely to be impacted as a result of the drawdown.

Following the cessation of opencast mining and the associated dewatering, it is assumed to lead to groundwater rebound. This estimated rebound time is approximately five (5) years. After rebound has reached equilibrium, decant could potentially occur.

The predicted decant area is to the south-east of the VDDC mining operations. The calculated sub-surface decant elevation is approximately 1 530 mamsl, with a discharge volume of approximately 0.5 ℓ/s. The water level in the pit should therefore be maintained approximately 5 m below the sub-surface discharge elevation as a safe management level. Water levels within the pit will therefore have to be monitored to ensure that the decant levels are not reached. A water management strategy, which includes a decant management plan, should be developed to limit the impact associated with the potential decant. It has also been recommended that the groundwater model be calibrated and updated as mining proceeds to confirm and improve the assumptions in the model. Specifically, the assumption regarding the integrity of the geological barrier between the VDDC opencast pit and the Steenkoolspruit and Glencore backfilled pits to the west, since this will have implications on the potential decant position, level and volume.

With the successful implementation of the mitigation measures contained in this document, it is expected that all potential impacts associated with the proposed infrastructure and mining development will be mitigated to a low, or very low, rating.

INFORMATION SUMMARY SHEET

Report	Integrated Water Use Licence Application Technical Report
Version	Revision 2
Duration	30 years (until 2049)
Applicable legislation	National Water Act, 1998 (Act 36 of 1998) GNR 704
Water uses	<u>S21(c) and (i):</u> • Infrastructure Area 1 • Infrastructure Area 2 • Infrastructure Area 3 • Infrastructure Area 4 • Opencast mining extension • Explosives magazine • Discharge of treated water from modular WTP: new section of pipeline within 500 m of watercourse <u>S21(f):</u> Discharge of water from modular WTP into seepage wetland via existing northern canal. <u>S21(g):</u> • Dust suppression with mine impacted water • Eastern Overburden dump (with silt trap) • Overburden dump on SKS void • Dragline spoils dump 1 • Dragline spoils dump 2 • Dragline spoils dump 3 • Dragline spoils dump 4 • Secondary Mixed ROM coal and slurry stockpile area with silt trap • Primary Mixed ROM coal and slurry stockpile area with silt trap • 4 Seam ROM stockpile • 5 Seam ROM stockpile • 4 Seam ROM stockpile <u>S21(j):</u> Dewatering of opencast pit as mining proceeds
Water use application forms	Please refer to eWULAAS system. Relevant forms include: DW755, DW901, DW902, DW763, DW768, DW766, DW767, DW905, DW805
Applicant	South32 SA Coal Holdings (Pty) Ltd
Postal address	P.O. Box 61820, Marshalltown, 2017
Responsible person	Nandi Ziphethe Operational Manager: Wolvekrans Colliery
Contact person	Thembani Mashamba Manager: Environment

Telephone number	011 376 2705
E-mail address	thembani.mashamba@south32.net
Properties	RE/3, Portion 9 and 10 of Vandyksdrift 19 IS Portion 2 of Steenkoolspruit 18 IS Portion 4 of Kleinkopje 15 IS Portion 6 of Wolvekrans 17 IS
Existing land use	Mining and agriculture
Adjacent land use	Mining and agriculture
Magisterial district	Emalahleni Magisterial District
DMR Regional Office	Mpumalanga (eMalahleni)
Water management authority	Department of Water and Sanitation
Water management area	Olifants River WMA
Quaternary catchments	B11B, B11F and B11G
Surface water resource	Olifants River Vleishaft Tributary Unnamed wetlands
Groundwater resources	Unnamed aquifer
IWULA consultant	Jones & Wagener (Pty) Ltd
Contact person	Tolmay Hopkins
Contact number	011 519 0200 / 082 808 2693
E-mail address	tolmay@jaws.co.za

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Abbreviations used in the report

a	annum
ABA	Acid-Base Accounting
AMD	Acid Mine Drainage
ASPT	Average Score Per Taxon
BBBEE	Broad Based Black Economic Empowerment
°C	Degrees Celsius
CBA	Critical Biodiversity Area
CSR	Consultation Scoping Report
DMO	Douglas Middelburg Optimisation
DMR	Department of Mineral Resources
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EC	Electrical Conductivity
EcoSpecs	Eco specifications
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
ELM	eMalahleni Local Municipality
EME	Earth moving equipment
EMPr	Environmental Management Programme
EMPR	Environmental Management Program Report
ESA	Ecological Support Area
FEFLOW	Finite Element subsurface FLOW system
FEPA	Freshwater Ecosystem Priority Area
FLAC	Fuel, lube, air and coolant
GA	General Authorisation
GDP	Gross Domestic Product
GDT	Groundwater Decision Tool
GN	Government Notice
GNR	Government Notice Regulation
GQM	Groundwater Quality Management
ha	hectares
HGM	Hydrogeomorphic
HMA	Heavily Modified Areas
IRP	Integrated Regulatory Process
IWULA	Integrated Water Use Licence Application

IWWMP	Integrated Water and Waste Management Plan
J&W	Jones & Wagener (Pty) Ltd Engineering and Environmental Consultants
km	kilometre
LAC	Low ash coal
LOM	Life of Mine
m	metre
m^3	cubic metre
mm	millimetre
mS/m	milliSiemens per metre
mamsl	Metres above mean sea level
mbs	metres below surface
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
mbgl	metres below ground level
MBSP	Mpumalanga Biodiversity Sector Plan
MIRAI	Macroinvertebrate Response Assessment Index
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)
Mℓ	Megalitre
Na	Sodium
NAG	Net acid generating
No.	Number
NDM	Nkangala District Municipality
NEMA	National Environmental Management Act 1998 (Act 107 of 1998)
NEM:WA	National Environmental Management: Waste Act, 2008 (Act 59 of 2008)
NFEPA	National Freshwater Ecosystem Priority Area
NP	Neutralising Potential
NNP	Net Neutralising Potential
NWA	National Water Act, 1998 (Act 36 of 1998)
ONA	Other Natural Areas
Ptn	Portion
PCD	Pollution Control Dam
PES	Present Ecological State
PHD	Pulles, Howard & De Lange
PSS	Power station smalls
R	South African Rand
RE	Remaining Extent
ROM	Run-of-Mine
RQO	Resource Quality Objectives

SANS	South African National Standard
SASS5	South African Scoring System, Version 5
SCC	Species of conservation concern
SKS	Steenkoolspruit
SLP	Social and Labour Plan
SO_4	Sulphate
South32	South32 SA Coal Holdings (Pty) Ltd
SWL	Static Water Level
t	tonnes
TBC	The Biodiversity Company
TC	Total concentration
TDS	Total Dissolved Solids
TWQG	Target Water Quality Guidelines
VDDC	Vandyksdrift Central
VDDN	Vandyksdrift North
WMA	Water management area
WQPL	Water quality planning limit
WTP	Water Treatment Plant
WUL	Water Use Licence
XRD	X-ray powder diffraction

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1. INTRODUCTION

1.1 Background

South32 SA Coal Holdings (Pty) Ltd (South32), is the holder of an amended mining right for coal, granted by the Minister of Mineral Resources, in terms of the Mineral and Petroleum Resources Development Act, 2002 (MPRDA, Act 28 of 2002) and notarially executed on 21 May 2015 under the Department of Mineral Resources (DMR) reference MP30/5/1/2/2/379MR, in respect of its Wolvekrans – Ifalethu Colliery[2]. This mining right comprises of the following areas:

- Ifalethu Colliery (previously referred to as Wolvekrans North Section[3]) consisting of the Hartbeestfontein, Bankfontein (mining now ceased), Goedehoop, Klipfontein sections and the North Processing Plant; and
- Wolvekrans Colliery (previously referred to as the Wolvekrans South Section) consisting of the Wolvekrans, Vlaklaagte (mining ceased), Driefontein, Boschmanskrans, Vandyksdrift, Albion and Steenkoolspruit sections, as well as the South Processing Plants (Eskom and Export). Some of these areas were previously known as Douglas Colliery.

The Vandyksdrift Central (VDDC) area falls within the footprint of historic underground mining operations at the old Douglas Colliery. In 2007, an amendment of the Environmental Management Programme Report (EMPR) for the Douglas Colliery operations was approved, to allow pillar mining (opencast) of the area previously mined by underground bord and pillar mining. Authorisation of the VDDC mining project included the following:

- Opencast operation on the farm Kleinkopje 15 IS;
- Opencast operation on the farm Steenkoolspruit 18 IS;
- Pillar extraction operation on the farm Vandyksdrift 19 IS;
- Reclamation of existing slurry ponds; and
- Rewashing of existing discard dumps (PHD, 2006).

[2] Middelburg Mine Services as per mining right
[3] This was previously referred to as Middelburg Colliery

The water uses associated with the opencast mining have been authorised in terms of water use licence (WUL) number 24084535, dated 10 October 2008.

The No. 2 seam workings is flooded with water and has to be dewatered to enable the open pit development to proceed. A dewatering strategy has therefore been developed and an application for Environmental Authorisation (EA) for the dewatering activities has been submitted to the DMR (Jaco-K Consulting, 2016a). The water use activities associated with the dewatering strategy have been authorised by WUL number 06/B11F/GCIJ/7943, dated 19 July 2018.

The 2007 approved EMPR Amendment included limited additional infrastructure in support of the opencast mining operations, as it was assumed at that stage that existing infrastructure will be used. In addition, the applications for authorisation of the activities associated with the dewatering strategy, were limited to the infrastructure to facilitate dewatering (i.e. dewatering boreholes, pumps, pipelines, storage tanks, mechanical evaporators, roads and power lines).

A pre-feasibility investigation has since been conducted, and the need to develop additional infrastructure to support the proposed opencast mining was identified. The additional infrastructure includes the following:

- Storm water management structures (drains and berms);
- Water management measures for the management of mine impacted water, including a modular water treatment plant (WTP) and mechanical evaporators;
- Overburden dumps;
- Run-of-Mine (ROM) coal stockpile areas;
- Mixed ROM coal and slurry stockpile areas;
- Topsoil stockpiles following clearance of vegetation;
- Pipelines for the conveyance of water;
- Hard park area and brake test ramp; and
- Haul roads and service roads.

Jones & Wagener (Pty) Ltd Engineering and Environmental Consultants (J&W) has been appointed by South32 as an independent Environmental Assessment Practitioner (EAP) to undertake an Integrated Regulatory Process to obtain the required approvals/authorisations for the required infrastructure development to enable South32 to continue with opencast mining at VDDC.

The Consultation Scoping Report (CSR) for the proposed infrastructure development was made available for public review from 8 October to 7 November 2018, which described the proposed infrastructure development. Prior to finalisation of the Scoping Report, several changes to the proposed application were required and therefore a Revised CSR has been compiled and made available for public review from 7 August to 9 September 2019. In addition to the changes in the infrastructure layout, the proposed VDDC opencast pit boundary, as determined through the pre-feasibility investigation, differs from the mine layout in the 2007 approved EMPR amendment. An area of approximately 196 hectares in the latest mine layout was not included in the previous mine layout and is therefore not approved to be opencast mined.

The project is collectively referred to as the VDDC infrastructure and mining development and includes the development of the infrastructure as listed above, as well as the opencast mining areas not previously authorised.

1.2 Regulatory framework

1.2.1 National Water Act, 1998 (Act 36 of 1998)

Water uses are defined in the National Water Act, 1998 (Act 36 of 1998) (NWA) and include the following activities as described in Section 21 of the Act:

(a) taking water from a water resource;

(b) storing water;

(c) impeding or diverting the flow of water in a watercourse;

(d) engaging in a stream flow reduction activity contemplated in section 36;

(e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);

(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;

(g) disposing of waste in a manner which may detrimentally impact on a water resource;

(h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

(i) altering the bed, banks, course or characteristics of a watercourse;

(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

(k) using water for recreational purposes.

In terms of Section 22(1) a person may only undertake the abovementioned water uses if it is appropriately authorised:

22(1) A person may only use water

(a) without a licence

- (i) if that water use is permissible under Schedule 1;
- (ii) if that water use is permissible as a continuation of an existing lawful use; or
- (iii) if that water use is permissible in terms of a general authorisation issued under section 39;

(b) if the water use is authorised by a licence under this Act; or

(c) if the responsible authority has dispensed with a licence requirement under subsection (3).

The authorisations required for the VDDC infrastructure and mining development in terms of the abovementioned sections of NWA, are discussed in detail in section 4.1.

The Regulations on the use of water for mining and related activities, aimed at the protection of water resources as published in terms of the NWA in Government Notice Regulation (GNR) 704 on 4 June 1999 are applicable to the proposed VDDC infrastructure and mining development (this is discussed in detail in section 8.1.3).

1.2.2 Other legislation

An application for an integrated environmental authorisation was lodged with the DMR in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA), Environmental Impact Assessment (EIA) Regulations (GNR 324 to 327 dated 7 April 2017), as well as the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEM:WA) and Regulations.

1.3 Purpose of the document

This document serves as an Integrated Water Use Licence Application (IWULA) for the Section 21 water uses associated with the VDDC infrastructure and mining project, as defined in the NWA. It also provides an application and motivation for exemption from certain provisions of GNR 704.

It therefore:

- Provides details on all the water uses which require registration, licensing and/or exemption in terms of GNR 704;
- Provides a summary description of the proposed activities, the present environmental situation, the potential pollution sources, the expected impacts and the proposed mitigation measures;
- Includes a copy of the Integrated Water and Waste Management Plan (IWWMP) in which the proposed water and waste management at the VDDC section is outlined in detail;
- Provides the engineering designs for the water uses to be undertaken, where relevant; and
- Provides details on the public participation process followed.

2. CONTEXTUALISATION OF ACTIVITY

2.1 Project description

2.1.1 Project location

Wolvekrans Colliery is located approximately 30 km south-east of the town of eMalahleni, within the Nkangala District Municipality (NDM). The proposed infrastructure and mining development will be located within the VDDC area of the mine, which is located in the southern section of the Wolvekrans Colliery.

A locality map is provided in **Figure 2-1**.

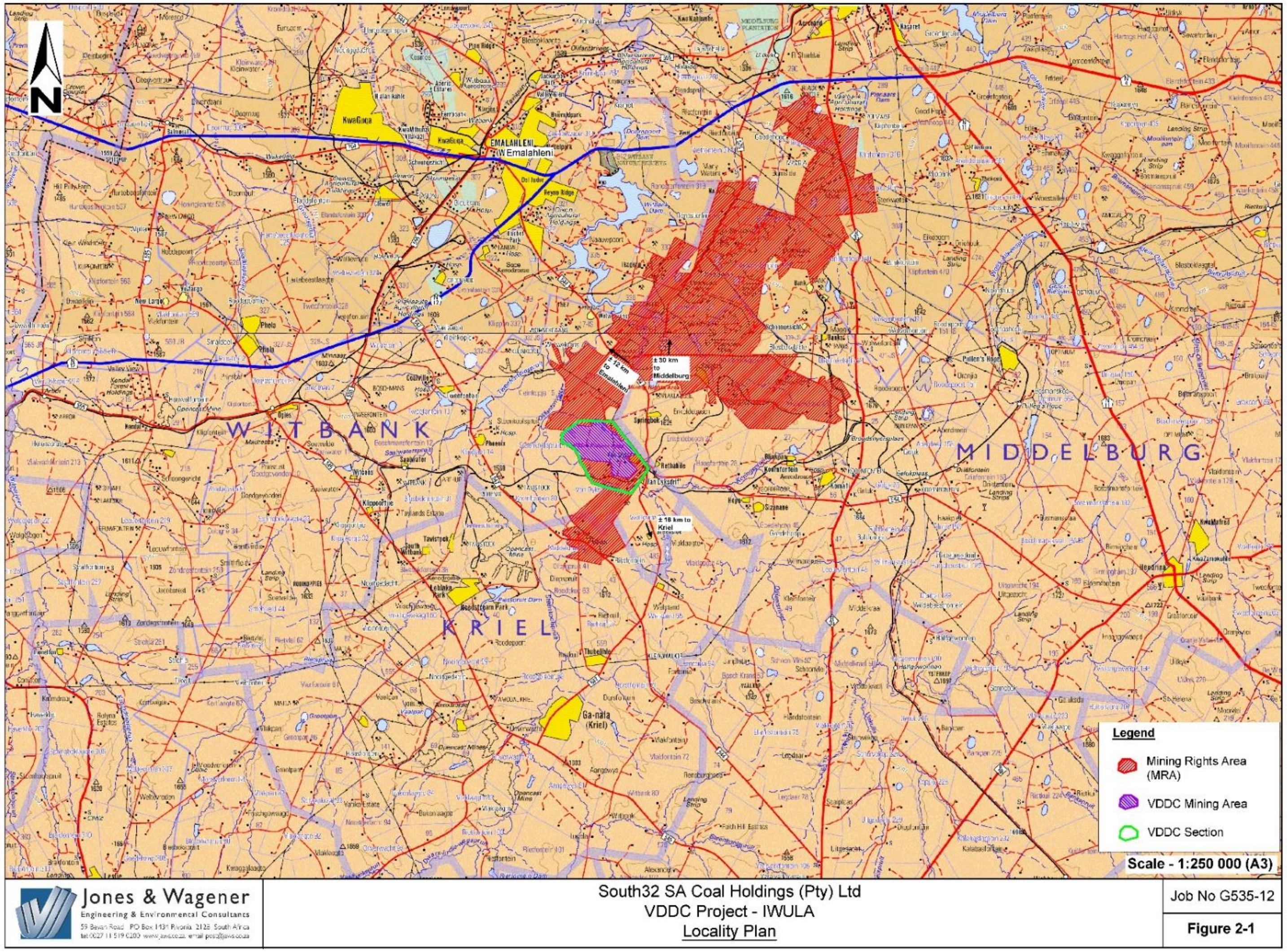

Figure 2-1: Locality map

2.1.2 Historical activities and activities already authorised

The VDDC area falls within the footprint of historic underground mining operations known as Douglas Colliery. Limited opencast mining was done before 1990 in the top shallower No. 5 seam. The No. 4L, No. 2, No. 2A and No. 1 coal seams were exploited in the past by means of underground mining. All underground operations were terminated during October 2008. The No. 2 Seam is the principal seam in the project area and its thickness can exceed 9 m, but only the lower select horizon of higher quality 2.5 m – 4.5 m was previously extracted. The targeted mineable seams are the No. 5, No. S4UA, No. S4L, No. S2RP, No. S2A and No. S1 seams respectively (South32, 2017a).

Mining activities at the Douglas Colliery were described in detail in an EMPR compiled by Jasper Muller and Associates in 2000, and subsequently approved by the (then) Department of Minerals and Energy in 2003. The 2003 EMPR included the past and (at that stage) current mining operations and associated infrastructure, including the Vandyksdrift Plant, Power Station Smalls (PSS) and Low Ash Coal (LAC) discard dumps, slurry dams; coal stockpile, a number of pollution control dams (PCDs), as well as workshops, maintenance and engineering buildings.

In 2007, an amendment of the EMPR for the Douglas Colliery operations was approved, to allow the opencast mining of the remaining No. 5, No. 4, No. 2 and No. 1 seams. Authorisation of the VDDC mining project included the following:

- Opencast operation on the farm Kleinkopje 15 IS;
- Opencast operation on the farm Steenkoolspruit 18 IS;
- Pillar extraction operation on the farm Vandyksdrift 19 IS;
- Reclamation of existing slurry ponds; and
- Rewashing of existing discard dumps (PHD, 2006).

The 2007 approved EMPR included limited infrastructure such as clean and dirty water management systems, haul roads and conveyors.

As a result of the previous mining of the No. 2 seam horizon by bord and pillar means, the following has resulted:

- The majority of the underground No. 2 seam workings are flooded because of water ingress from both surface and underground aquifers. A dewatering programme will be implemented before opencast mining operations commence;
- An area of the No. 2 seam was historically used for placement of slurry from the processing plant. It is believed to be contained in the southeast portion of the deposit by underground seals and barrier pillars (the expected slurry footprint is indicated in **Figure 2-2**).

In order to mine the VDDC reserve, the water contained in the mined out underground workings must be removed prior to mining. This will be achieved by drilling a number of boreholes into the old underground workings and abstracting the water via these boreholes (referred to as the dewatering project).

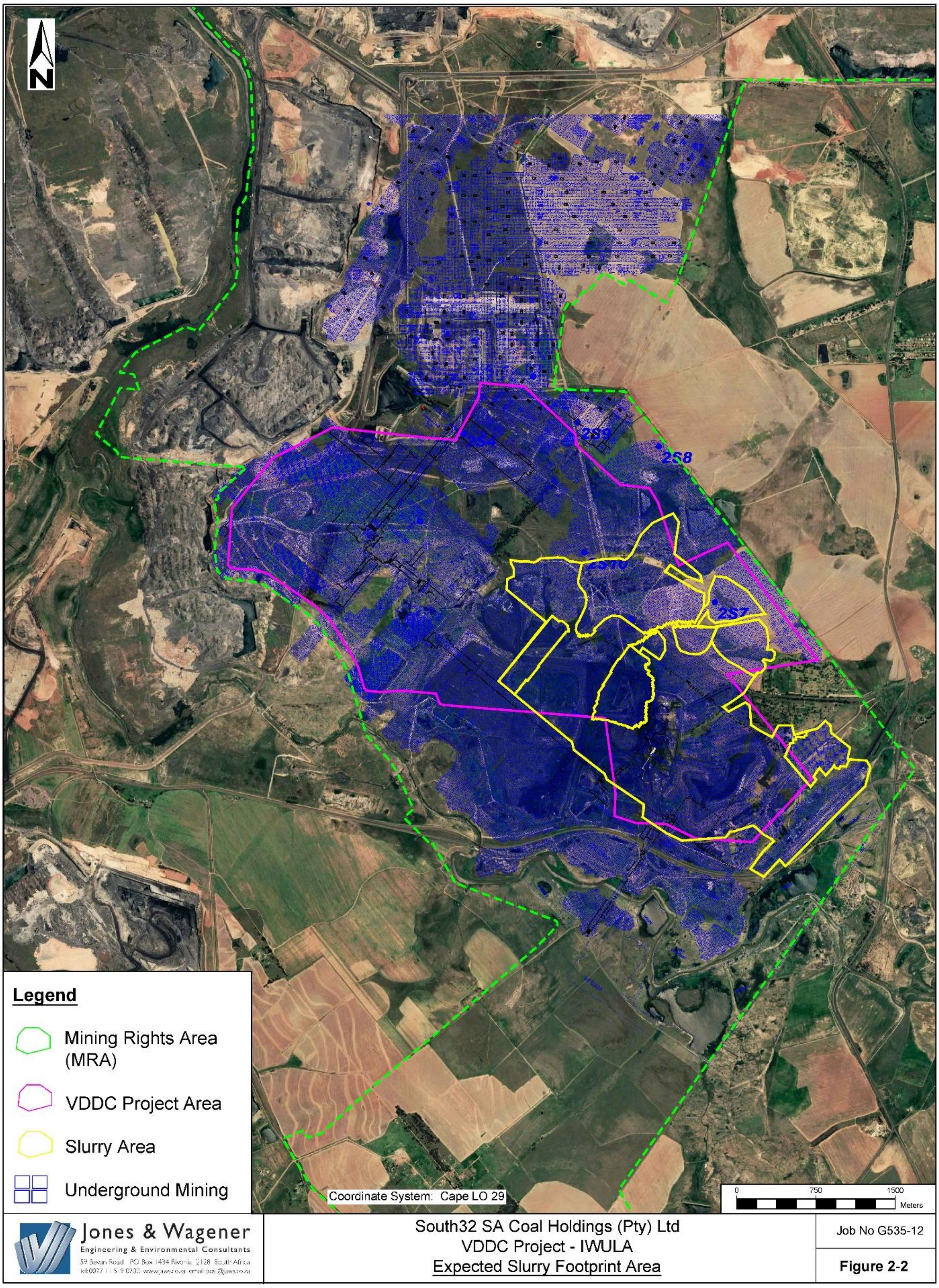

Figure 2-2: Expected slurry footprint

Water will be pumped from the boreholes accessing different underground compartments and will be transferred via borehole connector pipelines to a number of water storage/transfer tanks. From there, the water will be transferred via the main connector pipelines to the Vleishaft PCD and/or directly to the evaporation tanks that will be located at the evaporation sites where water will be evaporated using mechanical evaporators. Three evaporator sites have been identified (5 Seam void, Vleishaft PCD and Vlaklaagte Void). In addition, some water will be pumped and stored in the Steenkoolspruit (SKS) void once the pit is mined out (Jaco-K Consulting, 2016a).

An application for an EA for the dewatering activities has been submitted to the DMR and their final decision is awaited. The WUL for the dewatering project was issued on 19 July 2018 (refer to section 8.1.2 for more detail).

The existing infrastructure in the VDDC area is shown on **Figure 2-3** and described below.

2.1.2.1. Access, transport and logistics

Access to the VDDC project area is via one of three existing approaches, depending on the size of the transport, namely:

- Current SKS main entrance;
- Current Wolvekrans main entrance (via the Boschmanskrans workshops); or
- Current Vandyksdrift main entrance (opposite Springbok village).

All personnel transport and light delivery vehicles will enter the site via the current SKS main entrance. Personal vehicles will park in the existing personnel vehicle parking, whilst busses will drop personnel off at the existing bus turnaround.

Light delivery vehicles and heavy delivery vehicles, up to 10 t single body trucks, will also enter via the existing SKS main entrance and deliver to the required location, or to the existing store facilities.

The heavy delivery vehicles and lowbeds will access the site via either the Wolvekrans main entrance or the Vandyksdrift main entrance, depending on the destination within the VDDC Project area (South32, 2017b).

A number of existing haul roads have been developed within the mining area.

2.1.2.2. Steenkoolspruit facilities

Existing facilities at the SKS operations include the ROM tip and the overland conveyor system to the South Export Plant, the SKS complex offices, warehouse, change houses, workshops, wash bays, laydown areas, a sewage treatment plant and fuelling facilities.

The southern SKS facilities currently in use by the Vandyksdrift North (VDDN) operation include contractors' offices, laydown areas, as well as a fuel, lube, air and coolant (FLAC) station.

2.1.2.3. Topsoil dump

An existing topsoil dump is located on the north-eastern boundary of the VDDC section.

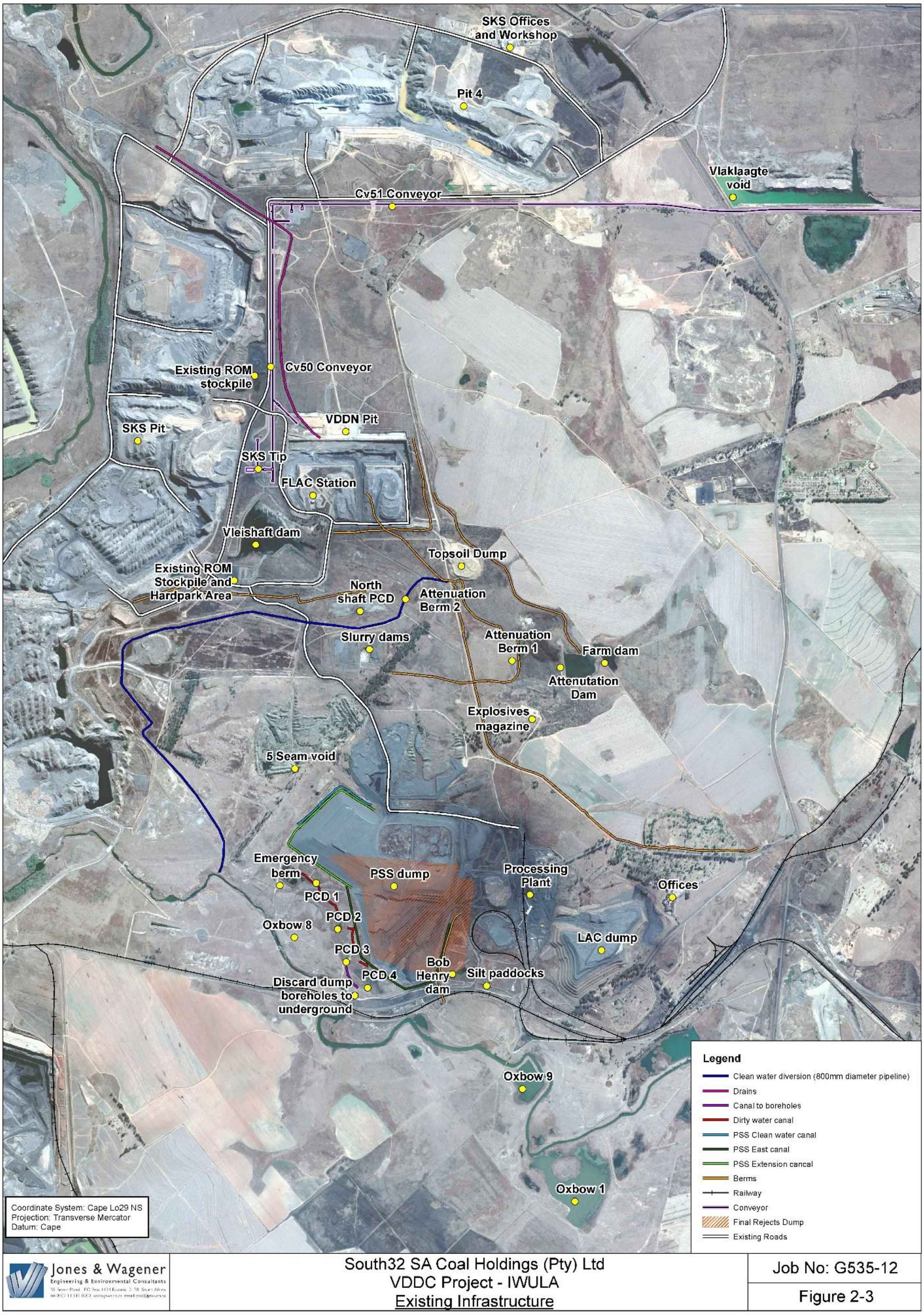

Figure 2-3: Existing infrastructure

2.1.2.4. *Surface dumps*

Surface discard dumps exist on the southern portion of the VDDC resource area, namely the PSS and LAC dumps. These dumps are in the process of being reclaimed and processed at an existing facility located to the east of the PSS dump. It is expected that approximately 40% of the material will be reclaimed. Final rejects from the reclamation process is disposed of on the southern portion of the PSS dump. This Final Rejects Dump will remain in future and the VDDC mining area has been changed to exclude this footprint from the mine plan.

2.1.2.5. *Storm water management measures*

A number of clean and dirty water management berms and canals have been constructed to ensure that runoff is managed. This includes a clean water diversion dam (Attenuation Dam 1) which contains clean runoff from the undisturbed areas to the north-east.

A number of dirty water canals drain dirty runoff to dirty water facilities. The Vleishaft Dam is an existing PCD with a capacity of 600 000 m^3, that has been authorised for the disposal of mine impacted water in terms of WULs issued to the mine.

Dirty runoff from the discard reclamation and processing plant drains to the Bob Henry dam and silt paddocks.

Existing water management measures at the PSS dump comprises of a clean water canal, which collects clean water west of the PSS Dump Extension, as well as a system of unlined canals which collect dirty runoff from the PSS Dump and conveys the water to four PCD's. Excess water from the PCD's is pumped to the underground workings via a borehole. Water is abstracted from the workings via boreholes for re-use in the processing plant.

2.1.2.6. *ROM coal stockpiles*

Two ROM coal stockpiles have been developed:

- A ROM coal pad located between the SKS void and the haul road, from where it is taken to the South Export Processing Plant via conveyors from the SKS crushing plant; and
- A ROM stockpile area to the south of the Vleishaft PCD, of which a portion is currently used as a hard park area.

2.1.2.7. *Power supply*

The VDDC section is supplied from Eskom's Klein 132 kV Substation, which feeds the Klein Olifant 132 kV Substation. The voltage is stepped down to 22 kV via two 20 MVA power transformers feeding the 22 kV switchgear located in the Klein Olifant Substation (South32, 2017b).

A section of the Klein-Kromfontein 132 kV powerline traverses the proposed opencast pit and must be relocated to allow opencast mining to proceed.

2.1.2.8. Upfront dewatering infrastructure

In order to mine the VDDC reserve, the water contained in the underground workings must be removed prior to mining. This will be achieved by drilling a number of boreholes into the old underground workings and abstracting the water via these boreholes.

Water will be pumped from the boreholes accessing different underground compartments and will be transferred via borehole connector pipelines to the Vleishaft PCD and/or directly to the evaporation tanks that will be located at the evaporation sites where water will be evaporated using mechanical evaporators. Three evaporator sites have been identified, namely No. 5 Seam void, Vleishaft PCD and Vlaklaagte Void.

In addition, some water will be pumped and stored in the SKS Pit void (Jaco-K Consulting, 2016(b)).

The following evaporator systems have been installed:

- Eight evaporators at Vleishaft PCD (2 Mℓ/day per evaporator);
- Twenty evaporators at Vlaklaagte void (2 Mℓ/day per evaporator); and
- An additional 12 new evaporators (3 Mℓ/day per evaporator) will be installed at the No. 5 Seam void by the end of 2019.

Refer to **Table 8-1** for a summary of the water uses authorised in terms of the WUL for the dewatering project.

2.1.3 Description of proposed activities

2.1.3.1. Proposed new infrastructure

A description of the infrastructure required in support of the VDDC opencast mining is provided below and shown on **Figure 2-4**.

Topsoil dumps

The topsoil stripped from the boxcut areas and areas cleared for the development of infrastructure will be relocated to a new topsoil stockpile area to be located adjacent to the existing topsoil stockpile in the east of the project area. In addition, provision has been made for a new topsoil stockpile area in between the ramps.

The boxcut topsoil will be stockpiled due to the lack of the direct placement option at the start of the opencast mining operations.

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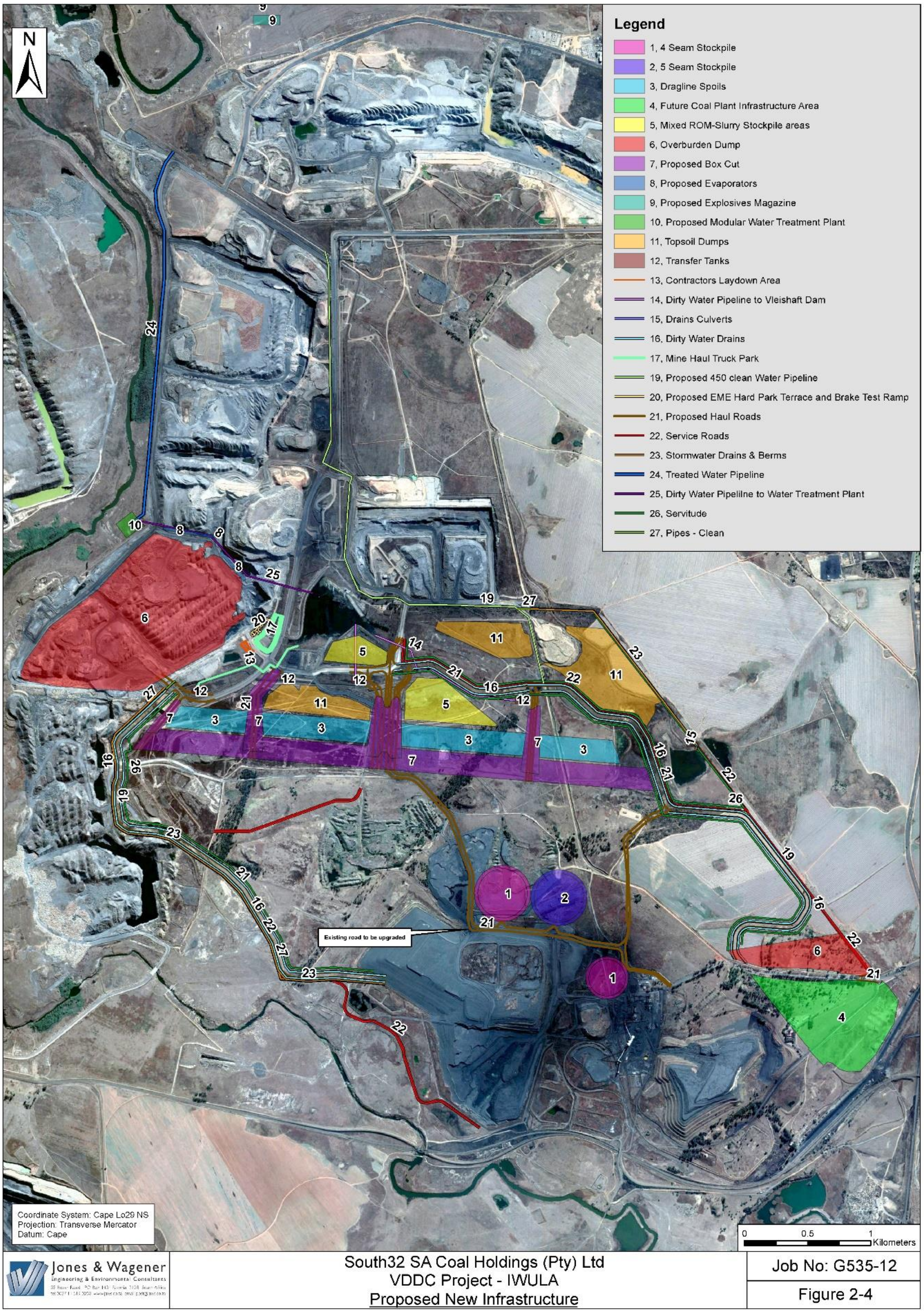

Figure 2-4: Proposed new infrastructure

Overburden dumps

The boxcut will be constructed using a combination of dragline and truck and shovel. Overburden from the boxcut will be placed on four overburden dumps located in between the proposed ramps.

In addition, provision has been made for two overburden dumps. A new overburden dump will be developed in the south-east of the project area (referred to as the Eastern Overburden Dump) and the existing overburden dump at the SKS pit will also be used.

Upon steady state mining being achieved, rehabilitation activities can commence safely behind the active dynamic window of operations and the in-pit backfilling of overburden can advance. As the mine pit expands, there will be more opportunity to strip overburden and apply it directly to re-contoured areas, thus avoiding stockpiling. It has been assumed that overburden stockpiling will be during the initial stages of mining and that direct placement will commence when sufficient placement areas are available (South32, 2017a).

ROM stockpiles and Mixed ROM coal and slurry stockpile areas

A portion of the underground No. 2 seam was historically used for placement of slurry from the processing plant. It is believed to be contained in the southeast portion of the deposit by underground seals and barrier pillars. The expected slurry footprint is indicated in **Figure 2-2**.

Slurry will be mined with the ROM coal and the blended coal and slurry will be transferred to the two mixed ROM coal and slurry stockpile areas:

- Primary Mixed ROM coal and slurry stockpile area located between the ramps; and
- Secondary Mixed ROM coal and slurry stockpile area located directly south of the Vleishaft PCD.

The mixed material will be allowed to dewater before the mixed dried slurry and ROM coal is removed to the existing SKS tip, from where it will be taken to the South Export Processing Plant[4]. Water will be collected and conveyed via a silt trap to the Vleishaft PCD.

ROM coal from the No. 4 and No. 5 seams will be placed on transfer stockpiles. These stockpiles will be located on a partially reclaimed area of the PSS dump footprint. The stockpile positions will be moved as mining progresses but will remain within the footprint of the existing PSS dump or other previously mined out, or disturbed areas.

Water consumption requirements

Potable water and wash water for vehicles and workshops will be supplied from the existing water supply at the SKS complex.

Water for dust suppression will be sourced from mine impacted water

[4] Processing of the slurry at the existing South Plant may require changes to the processing plant. This, however, falls outside of this application process. Slurry from the Plant will be managed in terms of the existing slurry management practices, i.e. disposal in slurry cells.

Management of mine impacted water

The proposed mining operations require the management of mine impacted water. Dirty areas that have been identified:

- Opencast pit;
- Mixed ROM coal and slurry stockpile areas;
- Overburden dumps;
- ROM stockpiles; and
- Hard park area.

Opencast pit

In order to manage the inflow of water into the mining operations, sumps will be constructed in the pit floor where the water will be collected at the bottom of the pit (at lowest points) and pumped out of the pit. These temporary sumps will be situated at the bottom of each access ramp and the piping routed in a berm servitude on the side of the access ramp, up to transfer tanks situated at the top of the ramp. Once the water reaches the transfer tanks, it will join the polluted water management system. Water will be pumped from the pit with self-priming diesel driven pumps mounted on trailers or skids to allow for easy movement (South32, 2017a). Water will be pumped from the tanks to the Vleishaft PCD and from there, to one of the evaporator sites, or to the proposed modular (WTP or to Vlaklaagte void.

Mechanical evaporator sites were described in section 2.1.2.8. Three sites will be established as part of the upfront dewatering strategy and as part of the VDDC infrastructure development, eight (8) new evaporators will be established at the SKS void. As mining progresses at VDDC, the 12 evaporators at the No. 5 seam void will move to the SKS void, bringing the number of evaporators at the SKS void to a total of 20.

Surplus water which cannot be handled through the evaporation system, will be conveyed to a mobile WTP, which will be a scalable plant and the treatment capacity will be adjusted to respond to the operational needs, with a maximum treatment capacity of 20 Mℓ/day. Brine from the WTP will be conveyed to the evaporators on the SKS void. The WTP will be implemented if the evaporator system becomes not economically viable (e.g. excessive electricity cost) or unreliable.

Effluent from the WTP (i.e. treated mine water) will be conveyed via a pipeline to the existing northern clean water canal, from where it will discharge via a wetland area into the Olifants River. Water will be treated to comply with Resource Quality Objectives (RQOs) for the Olifants River catchment as published in GN 466 in April 2016.

Mixed ROM coal and slurry stockpile areas

Mine impacted water from the Mixed ROM coal and slurry stockpile areas will be collected and conveyed to the Vleishaft PCD via silt traps.

Overburden dumps

The overburden dump located at the SKS void will drain to the void and no additional measures are foreseen.

Pollution control measures will be required at the Eastern overburden dump to collect dirty runoff and seepage. Mine impacted water will be conveyed via suitable diversion structures to the dirty water management infrastructure and pumped into the underground via an existing borehole.

Dust Suppression

Dust on haul roads will be controlled using water bowsers. Bowsers will fill up at filling stations that will be located in close proximity to VDDC pit. The use of chemical dust suppressants will also be considered.

Clean water management

Clean run-off water from the area to the east of the VDDC mining area will be diverted away from the mining areas so that it will not become contaminated by the mining operations.

The existing VDDN clean water diversion canal will be diverted around the proposed new topsoil dumps on the eastern boundary of the mining right area.

High wall drains will be constructed to divert clean water away from the mining area where practical. These drains will move as mining progresses.

Two 450 mm diameter clean water diversion pipelines will be installed from the existing clean water diversion dam, to the existing northern canal from where water will be discharged via a wetland area into the Olifants River.

Explosives magazine

The existing explosives magazine will be relocated to the north of Pit 4.

New roads

New roads required for the VDDC project include:

- Temporary high wall roads and dragline walkways which will be re-established as mining progresses;
- Earth Moving Equipment (EME) haul roads (40 m width) from the bottom of box cut ramps to the existing haul roads;
- Additional maintenance/service and access roads within the VDDC project area from the existing infrastructure to the box-cut;
- New haul road to the No. 4 seam and No. 5 seam stockpiles.

EME Hard park and Brake Test Ramp

A hard park will be developed between the Vleishaft PCD and the SKS pit. The hard park will include perimeter drains that convey dirty water runoff (primarily as a result of silt) to the SKS void.

A brake test ramp will be provided for EME traffic at the hard park area. The brake test ramp is positioned such that all vehicles will need to traverse the ramp before entering the pit areas. The ramp has been designed to enable the longest expected vehicle entering the mining areas to stop on the inclined sections, with both axles or all wheels. The incline sections are to the steepest recommended grade for these vehicles or to the incline of the ramps to the pits.

In-pit vehicle ramps are of similar construction to the remainder of the haul roads including safety berms.

Access control and security fencing

Access control will be through the existing control measures.

Triple security fencing will be provided at the explosives magazine. Triple fencing includes a triple barrier of 2.4 m high clear mesh, electric and normal security fencing. Electric fencing is connected to the local security system (South32, 2017b).

Other supporting infrastructure

The remainder of the supporting infrastructure is mostly catered for by the existing SKS complex facilities. Existing change houses, stores facilities, office facilities, tracked vehicle workshops, light delivery vehicle workshops will be used.

No additional fuel or lube storage area, servicing bays or tyre bays are required.

Future coal plant infrastructure area

As indicated earlier, the PSS and LAC dumps are currently reclaimed and processed within the existing VDD processing plant. As mining progresses, this plant will need to be relocated. An area has been allocated for this purpose and is situated to the south of the proposed Eastern overburden dump.

2.1.3.2. Changes to opencast mining

The VDDC mine layout as determined through the pre-feasibility investigation, as well as the mine layout included in the approved 2007 EMPR Amendment is shown on **Figure 2-5**. The area where the existing LAC dump is located, as well as a small area further north-east, were not included in the approved 2007 EMPR Amendment, and therefore require authorisation for opencast mining.

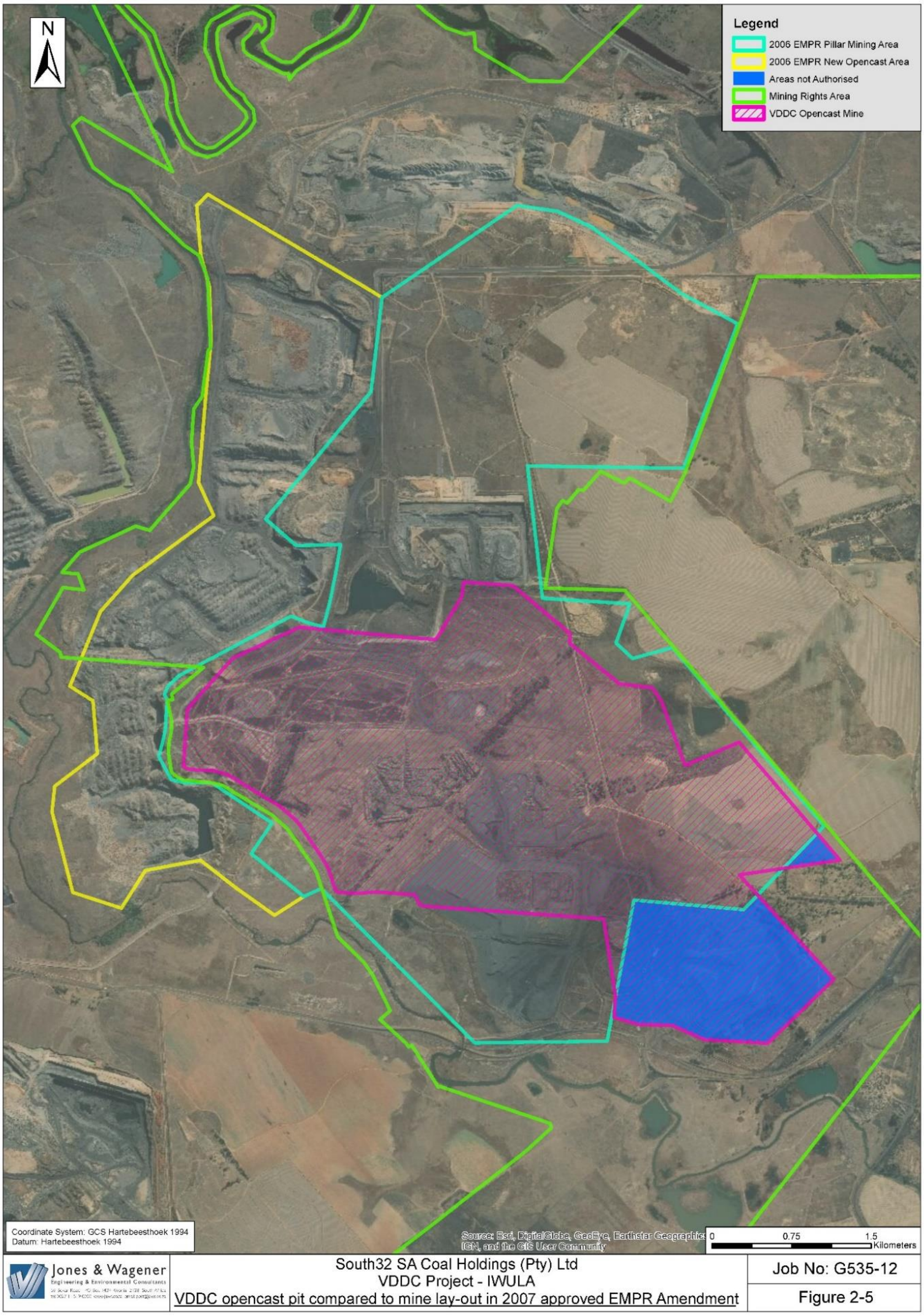

Figure 2-5: VDDC opencast pit compared to mine layout in 2007 approved EMPR Amendment

2.1.4 Extent of activity

The total VDDC mining area is approximately 1 400 ha in extent. The opencast mining area not previously authorised, is approximately 196 ha.

The aerial extent of the proposed infrastructure components is summarised in **Table 2-1**.

Table 2-1: Aerial extent of proposed infrastructure

Infrastructure	Aerial Extent of Activity
Modular WTP (20 Mℓ/day treatment capacity)	~2 ha
4 Seam stockpile	~ 16 ha
5 Seam stockpile	~ 16 ha
4 Seam stockpile	~ 8.5 ha
Four Boxcut spoils dumps	~ 55 ha
Eastern overburden dump	~ 23 ha
Overburden Dump at SKS Void	~ 134 ha
Primary Mixed ROM coal and slurry stockpile area (next to the ramps)	~ 8.5 ha
Secondary Mixed ROM coal and slurry stockpile area (directly south of Vleishaft PCD)	~ 17.5 ha
Construction of new haul roads (40 m wide) and service roads	~ 55 ha
Upgrade of existing roads	~ 10 ha
Development of topsoil stockpiles	~ 62 ha
Development of mechanical evaporators at Steenkoolspruit Pit	~ 2.5 ha

2.1.5 Key processes and products

Wolvekrans Colliery is a multi-product mine supplying the export market. The average coal quality is summarised in **Table 2-2** (AGES, 2013).

Table 2-2: Average export coal quality at Wolvekrans Colliery (AGES, 2013)

Calorific Value:	27.7 MJ/kg
Ash:	14.4%
Volatile Matter:	24.5%
Sulphur:	0.55%
Inherent Moisture:	2.5%

The VDDC pit will be opencast mined. A boxcut will be established by means of the truck and shovel mining method, after which mining using draglines will continue. Topsoil will be stripped and placed separately on topsoil stockpiles for use during rehabilitation. Following blasting, the overburden will be stripped and stockpiled on the overburden dumps described in **section 2.1.3.1**, exposing the coal seams. Coal drilling and blasting will follow, and the coal will be extracted and hauled to ROM stockpiles. When mining takes place in areas where slurry has been stored in the old underground workings, the mixed ROM coal and slurry will be stored temporarily on the Mixed ROM coal and slurry stockpile areas where it will be allowed to dewater. Coal from the ROM stockpiles, and from the Mixed ROM coal and slurry stockpile areas, will be hauled to the existing South Export Processing Plant for processing.

The "roll-over" mining method will be used for the opencast operations, whereby mining and rehabilitation will be undertaken concurrently. As part of the ongoing mining operations, the rehabilitation process will already start with topsoil stripping ahead of the mining operation. After the removal of the coal, the spoil will be levelled, and the topsoil replaced and re-vegetated. In terms of pre-strip, spoils and levelled spoils and rehab areas, the total length behind the active face will be 522 m J&W, 2019b):

2.1.6 Activity life description

The proposed infrastructure development is in support of the 2007 approved EMPR Amendment for opencast mining. As the infrastructure would be used in conjunction with the approved mining, the infrastructure would be required for the life of operation until 2046. Construction will commence during 2020, once all required authorisations have been obtained.

2.2 Details of applicant

Applicant:	South32 SA Coal Holdings Proprietary Limited: Wolvekrans Colliery
Company Registration:	1963/000537/07
Contact person:	Thembani Mashamba
Designation:	Manager: Environment
Telephone number:	011 376 2705
Fax number:	011 376 2160
E-mail:	thembani.mashamba@south32.net
Postal address:	P.O. Box 61820, Marshalltown, 2017

2.3 Mining right owner

Name:	South32 SA Coal Holdings Proprietary Limited
Company Registration:	1963/000537/07
Contact person:	Sibongile Booi
Designation:	Lead Tenement Management
Telephone number:	071 607 0326
E-mail:	Sibongile.Booi@south32.net
Postal address:	P.O. Box 61820, Marshalltown, 2017

2.4 Responsible person

Contact person: Nandi Ziphethe
Designation: Operational Manager: Wolvekrans Colliery
Telephone number: 013 689 4450
E-mail: Nandipha.Ziphethe@south32.net
Postal address: P.O. Box 1, Witbank, 1035

2.5 Details of landowner

Details of the properties on which water uses will take place are summarised in **Table 2-3**.

A map showing property ownership in the area is shown in **Figure 2-6**.

Table 2-3: Property details

Farm name	Portion(s)	Property owner	Title Deed	Property size (ha)
Vandyksdrift 19 IS	RE/3	Ingwe Surface Holdings (Pty) Ltd	T76548/1999	1 494.0760
	Ptn 9		T76547/1999	23.7749
	Ptn 10		T76547/1999	44.5858
Steenkoolspruit 18 IS	Ptn 2	Ingwe Surface Holdings (Pty) Ltd	T76581/1999	917.0541
Kleinkopje 15 IS	Ptn 4	Ingwe Surface Holdings (Pty) Ltd	T76581/1999	360.9797
Wolvekrans 17 IS	Ptn 6	Ingwe Surface Holdings (Pty) Ltd	T76586/1999	325.8345

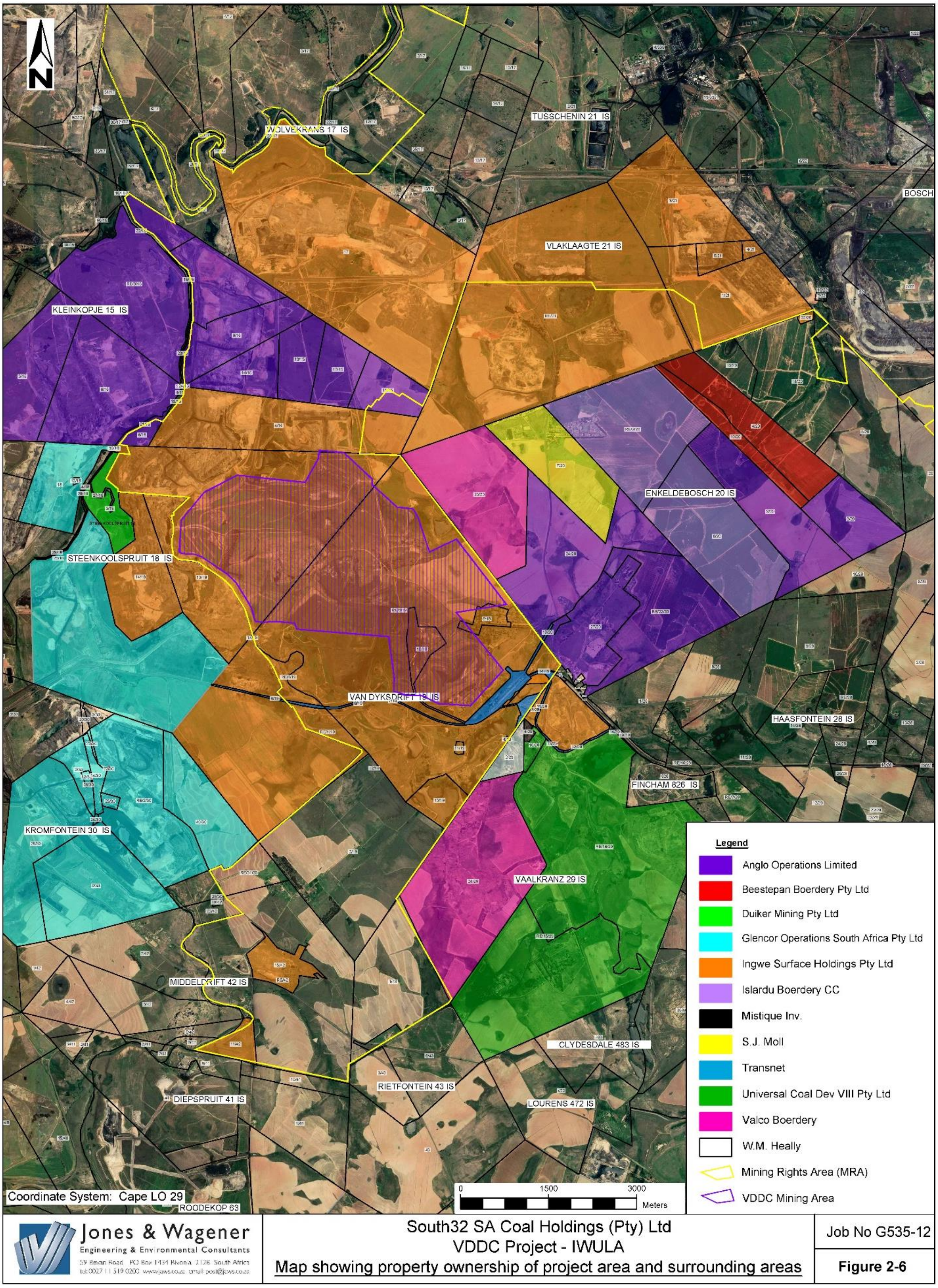

Figure 2-6: Map showing property ownership of project area and surrounding areas

3. PRESENT ENVIRONMENTAL SITUATION

3.1 Topography and drainage

The VDDC section is largely a brownfields area where the natural topography has been dramatically disturbed by mining related activities. The greater study area is characterised by a flat, slightly undulating topography at an elevation of between 1 625 and 1 505 metre above mean sea level (mamsl). The study area tends to slope from east to west at an angle of between 1% and 2%.

The proposed infrastructure and mining development project is situated within quaternary sub-catchment B11F, B11G and B11B of the Limpopo-Olifants primary drainage region.

The main river systems are indicated on **Figure 3-1**. The Olifants River is located to the south of the VDDC project area and further to the east, adjacent to the SKS section. Drainage is in the direction of the river systems. Prior to mining, the northern portion drained via the Vleishaft tributary to the Olifants River. This tributary has been partially mined through and the Vleishaft Dam that has been developed within the watercourse, currently serves as a PCD. Authorisation was granted in 2007 to mine the remainder of this tributary.

Downstream of the mine, the river flows to the Witbank Dam, then to the Loskop Dam and through the central part of the Kruger National Park to Mozambique. It joins the Limpopo River and discharges into the Indian Ocean on the east African coastline.

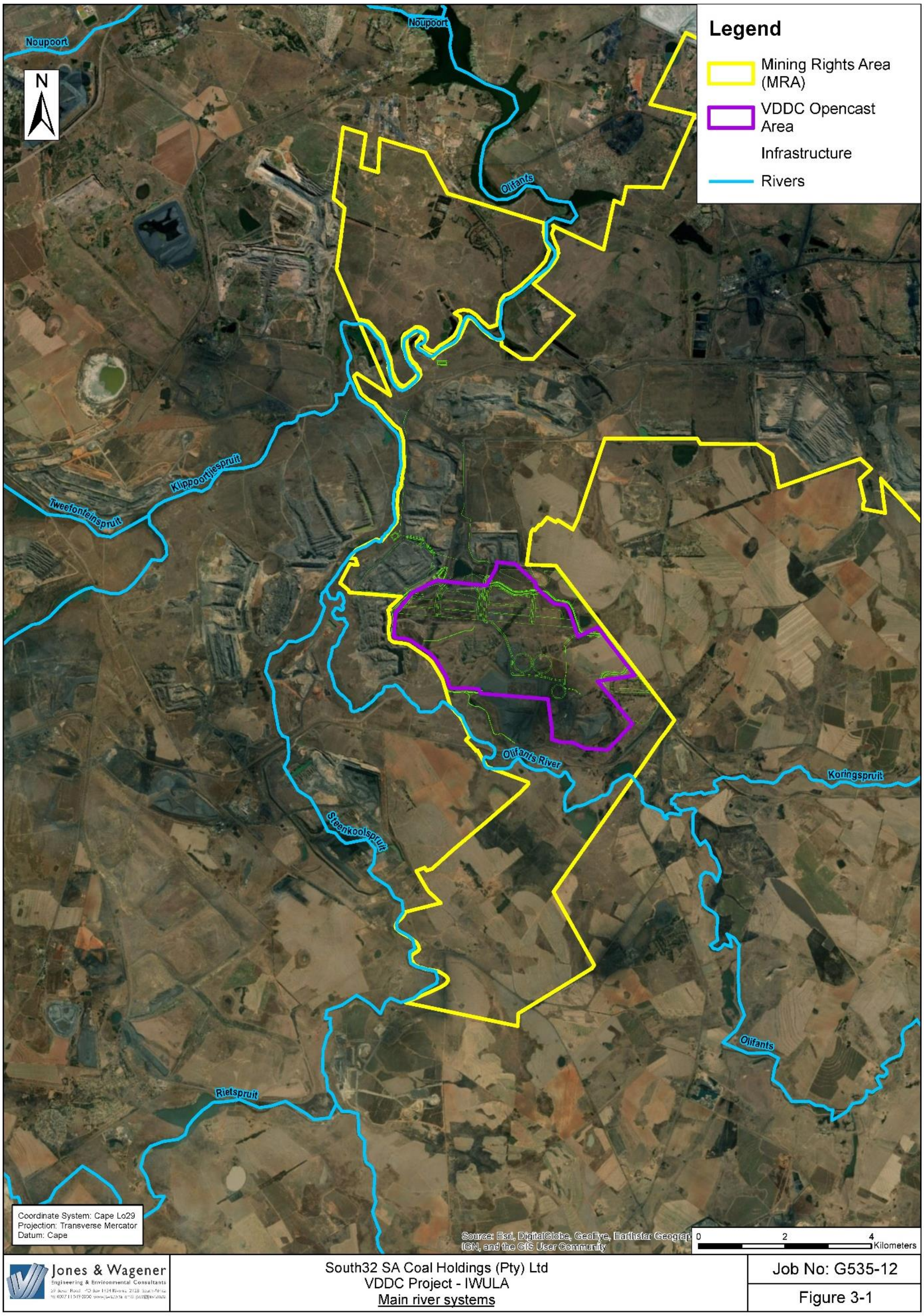

Figure 3-1: Main river systems within the area

3.2 Land use

The land use of the VDDC project area and surrounds is shown in **Figure 3-2** and is listed in **Table 3-1**. The dominant land uses on site are mining and open grasslands. These are followed by wetlands, cultivation, bush and urban development. The minor land uses include water, shrubland, plantations, bare ground and mine buildings.

Table 3-1: Land use (J&W, 2019d)

Land Use	ha	%
Water Seasonal	2.34	0.05%
Water permanent	6.93	0.14%
Wetlands	272.61	5.56%
Bush	150.12	3.06%
Grassland	1 341.09	27.37%
Shrubland	20.97	0.43%
Cultivation	338.49	6.91%
Plantations	27.09	0.55%
Mining	2 520.18	51.43%
Mine Water	61.74	1.26%
Mine Buildings	17.46	0.36%
Bare Ground	33.12	0.68%
Urban	108.09	2.21%
Total	**4 900.23***	**100%**

*** Note: The soils, land use and land capability study area extend beyond the VDDC project area**

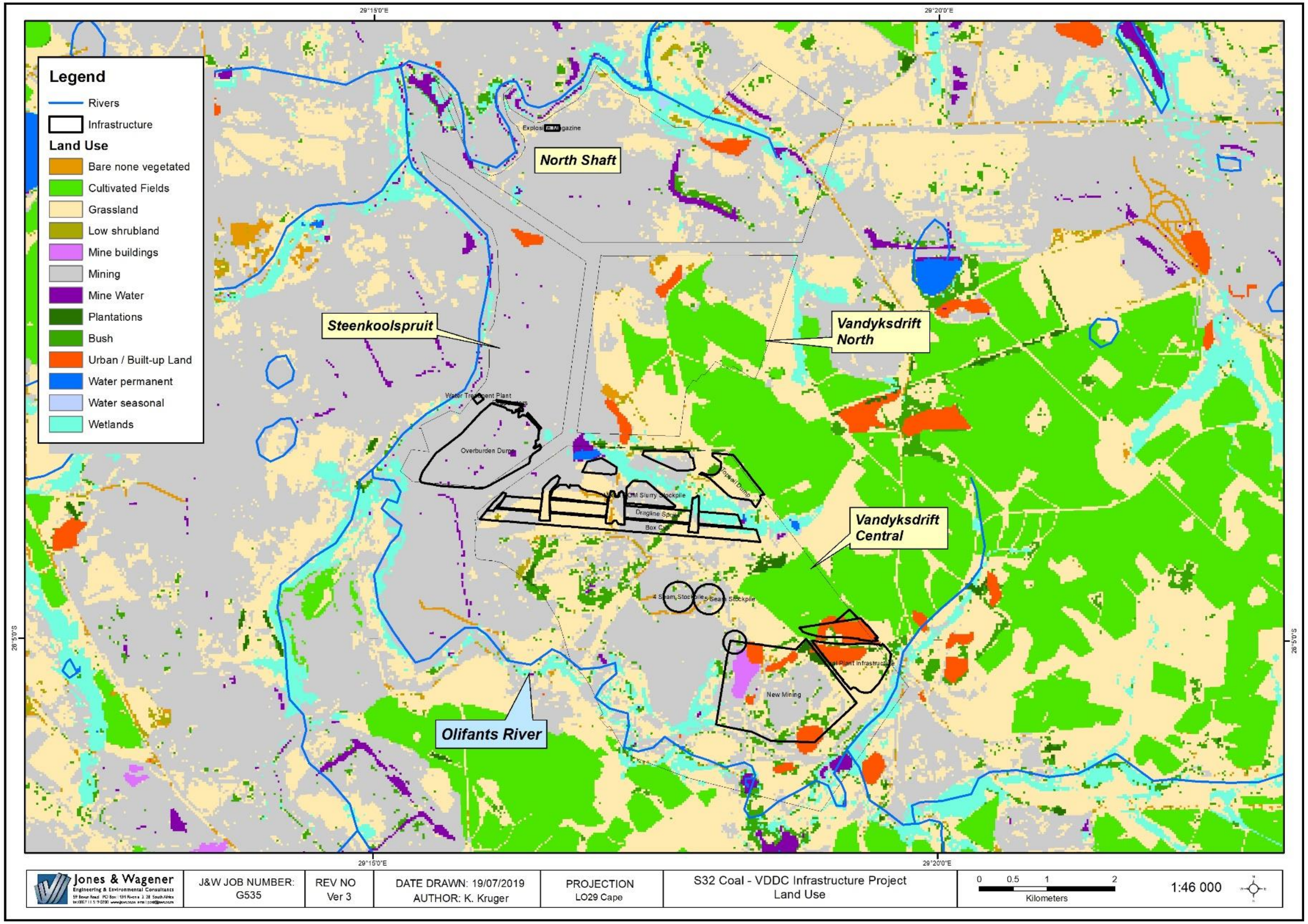

Figure 3-2: Land use within the VDDC study area (J&W, 2019d)

3.3 Social setting

The Mpumalanga Province is divided into three district municipalities, which are comprises of 20 local municipalities. The VDDC area falls within the eMalahleni Local Municipality (ELM) which falls within the NDM.

The ELM has a mining and industrial history and is thus the most industrialised municipal area in the NDM. Mining also remains the most prominent sector in terms of its employment contribution with 23%, followed by the trade sector which provides 18% of the employment in the ELM area.

According to the draft Integrated Development Plan (2017), the eMalahleni municipal population is expected to increase to 516 399 individuals in 2020 and to 646 708 individuals in 2030. The age structure of the ELM indicates a young population, with 25.2% of the local population under the age of 14. Those within the working age (15-64) form 71.2% of the local population.

The average annual economic growth rate for eMalahleni was at 2.4% over the period 1996 to 2015. The forecasted average annual gross domestic product (GDP) growth for eMalahleni for 2015-2020 is anticipated to be approximately 2% per annum, in line with national and provincial growth expectations. ELM experienced population growth rates higher than their economic growth rates, which has significant negative implications from a GDP per capita and an infrastructure-, service delivery-, and job creation point of view (Batho Earth, 2019).

3.4 Climate

3.4.1 Regional climate

The VDDC infrastructure and mining development project is in the Mpumalanga Highveld region where the climate is characterised as generally dry. Frost and mist are frequently experienced during the winter months on the Mpumalanga Highveld.

3.4.2 Temperature

Summers are warm to hot with an average daily high temperature of approximately 27°C (with occasional extremes up to 35°C). Winters range from mild to cold with an average daily high of approximately 15°C (with occasional extreme minima as low as -10°C).

3.4.3 Rainfall

The average rainfall per year at the Vandyksdrift rainfall station (0478546 W) varies between a 988 mm and 368 mm, with the mean annual precipitation (MAP) being 705 mm. The higher rainfall months occur from October to March during spring/summer (J&W, 2019b).

3.4.4 Evaporation

The annual evaporation rates range between 1 211 mm to 1 879 mm, with a mean annual evaporation (MAE) of 1 476 mm. Average monthly evaporation rates range between 65 mm (June) to 164 mm (January and December) (J&W, 2019b).

3.5 Geology and soils

3.5.1 Geology

The VDDC project area is situated in the Great Karoo Basin in South Africa, consisting of the Karoo Supergroup. Geologically, the Karoo Supergroup is the largest stratigraphic unit in southern Africa covering almost two thirds of the land surface. The basin hosts all the South African coal deposits and was formed in the great Gondwana basin which comprised parts of Southern Africa, India, Antarctica, Australia and South America.

The Karoo Supergroup comprises a sedimentary succession of sandstones, siltstones, shales and coal stratigraphic units. These stratigraphic units (from oldest to youngest) consist of the following:

- Dwyka Group – glacial marine deposit (comprising of diamictites and tillites) in the Carboniferous period;
- Ecca Group – fluvial deposition in the Permian period;
- Beaufort Group (terrestrial); and
- Stormberg Group (including basalts).

The majority of the coal deposits in South Africa are contained in the Vryheid Formation (part of the Ecca Group) of the main basin and are restricted to the north eastern area of terrestrial deposition on a gently subsiding shelf platform. The strata, mostly shale, sandstone and coal seams, formed in fluvial environments (J&W, 2019a). A 1:250 000 regional geological map indicating the location of the project area is shown in **Figure 3-3**.

Figure 3-3: **Regional geology of the VDDC project area (J&W, 2019a)**

3.5.2 Soils

The soil forms in the study area are shown on **Figure 3-4**.

The deeper and more sandy loam soils are considered High Potential materials and are distinguished by the better than average depth of relatively free draining soil to a greater depth (> 1 200 mm). The resultant land capability is rated as moderate intensity grazing and/or arable depending on their production potential. These soils are generally much lower in clay than the associated wet based soils and more structured colluvial derived materials, have a distinctly weaker structure and are deeper and better drained. The ability for water to move through these profiles is significantly better. The sandier texture of this soil group renders them more easily worked and of a lower sensitivity (depth > 750 mm).

In contrast, the shallower and more structured materials are more sensitive and will require greater management if disturbed. This group of shallower and more sensitive soils (< 500 mm) are associated almost exclusively with the sub outcropping of the parent materials (Karoo Sediments) at surface or with a ferricrete (ouklip) layer, constituting a relatively large percentage of the overall study area. These materials play an important function in the sustainability of the overall biodiversity of the area.

The third group of soils comprises those that are associated with the hard pan ferricrete layer and perched soil water. This group of soils has a set of distinctive characteristics and nature that is separated out due to its inherently much more difficult management characteristics. These soils are characterised by relatively much higher clay contents (often of a swelling nature), poor intake rates, poor drainage, generally poor liberation of soil water and a restricted depth. No perched aquifers are reported, albeit a significant area of well-developed ferricrete was mapped within the vadose zone (J&W, 2019d).

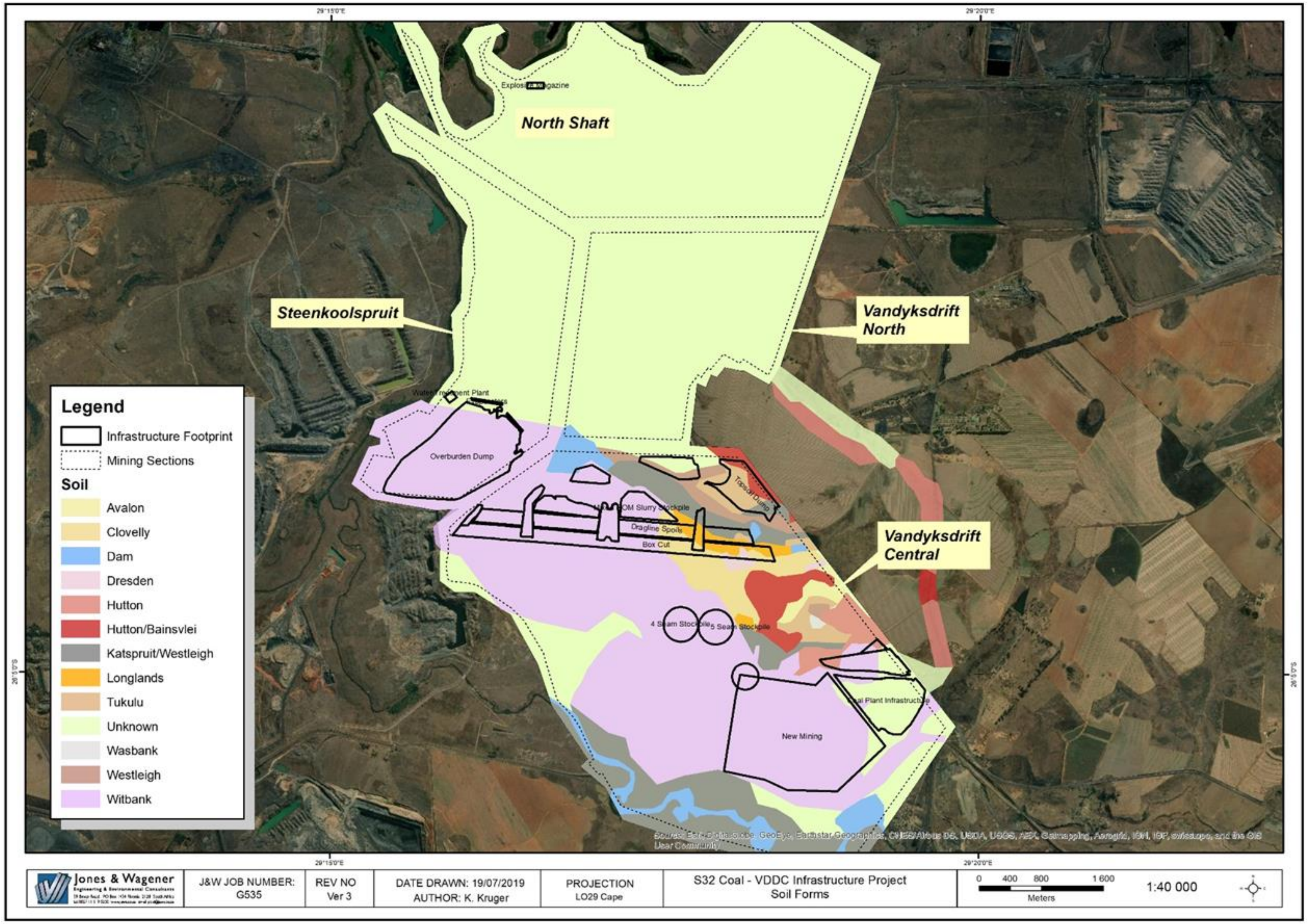

Figure 3-4: Soil groups identified in the VDDC study area (J&W, 2019d)

3.6 Surface water

3.6.1 Water management area

The VDDC infrastructure development project is situated within the catchment area of the Olifants River. This catchment makes up part of the Witbank and Loskop Dam catchment. The proposed VDDC infrastructure and mining development project is largely situated within quaternary sub-catchment B11F and B11B, with some infrastructure components located within B11G. The VDDC project in relation to the quaternary catchments is shown in **Figure 3-5.**

3.6.2 Mean Annual Runoff

The Witbank Dam has been selected as the receiving water body for the VDDC project as it is located downstream of the proposed development within the Olifants River catchment area. Beyond the Witbank Dam, the potential impact of the mine becomes extremely small due to the water volumes in the catchment and dilution effects. By the time the water reaches Witbank Dam, it is required to be suitable for use by all of the expected uses (drinking water, agricultural, industrial and aquatic ecosystems). Thus, by achieving compliance in terms of these, no additional impacts are expected downstream of the Witbank Dam. The receiving water body is relevant only in so far as it defines the aerial extent of the catchment to be considered in the impact assessment and described in the baseline study.

The catchment area for the Witbank Dam is 579 km^2. The proposed VDDC development area covers approximately 14.5 km^2. The mine area thus totals approximately 2.5% of the Witbank Dam catchment (J&W, 2019b).

The mean annual runoff (MAR) for Witbank Dam is 190 x 10^6 m^3, while the MAR for the proposed mining area is estimated at 0.40 x 10^6 m^3.

Simulated monthly flow records were generated, for which the MAR is shown in **Table 3-2**.

Table 3-2: Computed Mean Annual Runoff (J&W, 2019b)

River	Measured at	MAR ($x10^6m^3$)	Percentage of MAR at Witbank Dam
Olifants River	Entrance to mine	59.5	46
Steenkoolspruit	Immediately before confluence with Olifants River	52.0	40
Olifants River	Exit from mine property	188.1	99
Witbank Dam	At dam	190	100

Note: Varying values on the MAR for Witbank Dam were found in the literature. This value of 190 x 10^6 m^3 is derived from the runoff values given for various measuring points in the Surface Water Resources of South Africa – 1990

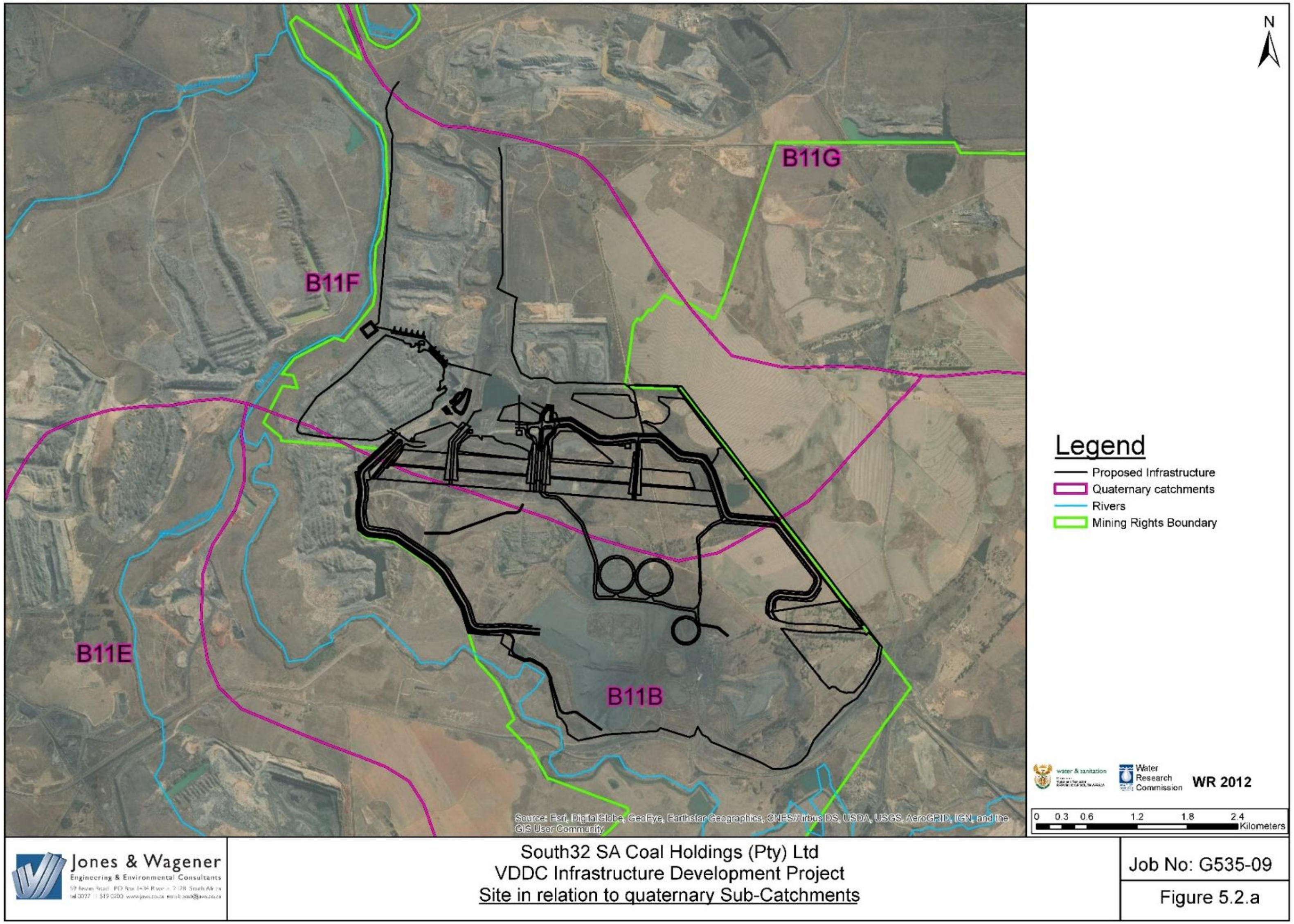

Figure 3-5: Proposed infrastructure in relation to quarternary catchments (J&W, 2019b)

3.6.3 Floodlines

The 1:100 year recurrence interval floodlines, as taken from a 2004 surface water report compiled by J&W, are shown in **Figure 3-6**.

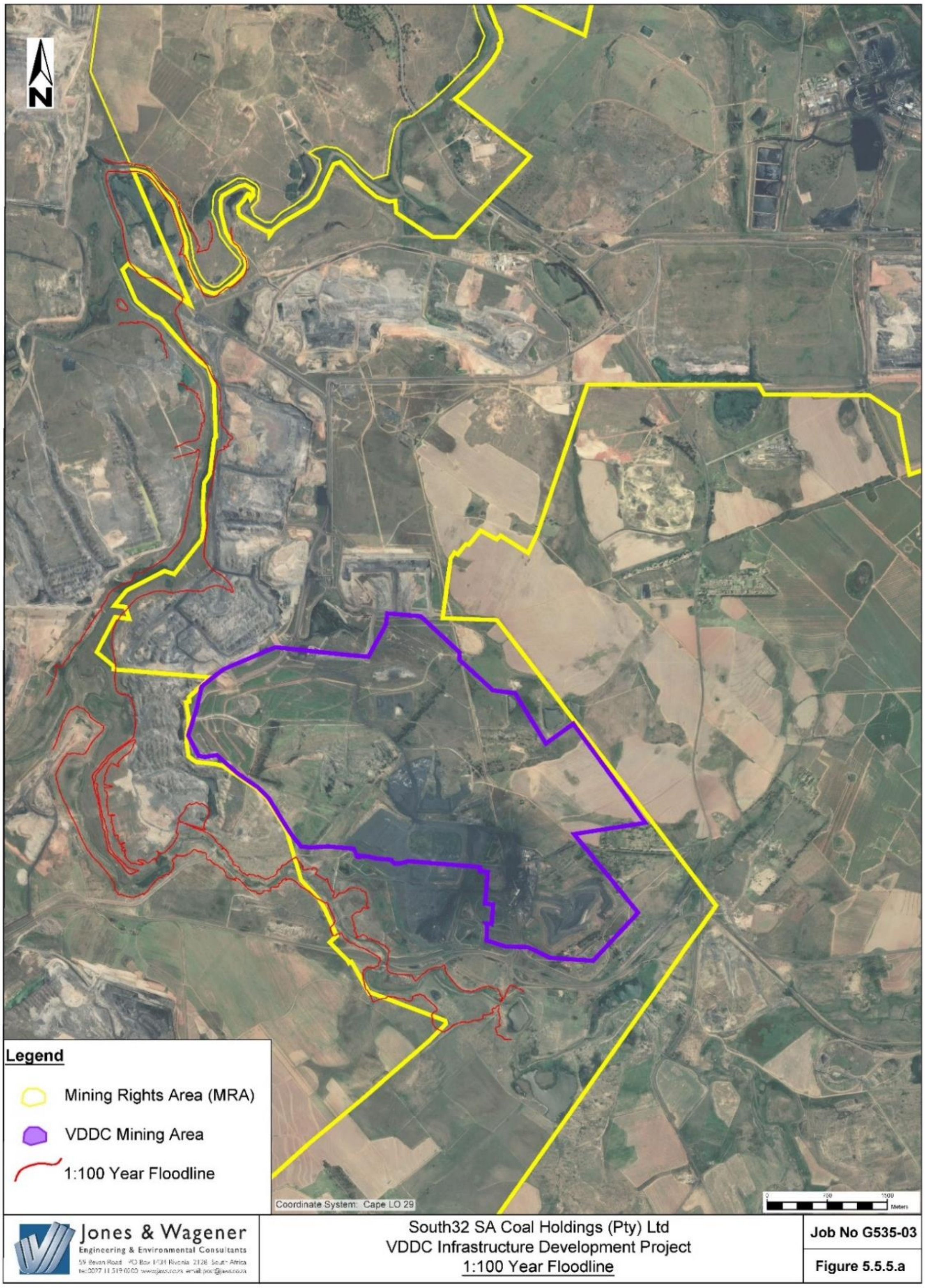

Figure 3-6: Delineated 1:100 year floodlines of the VDDC infrastructure development project (J&W, 2019b)

3.6.4 Resource Class, Resource Quality Objectives and Reserve

Resource Class

The Minister of Water and Sanitation published the Classes and Resource Quality Objective of water resources for the catchments of the Olifants River catchment in GN 466 on 22 April 2016in terms of S13(4) of the NWA. The purpose is to ensure ecological sustainability by taking into consideration the social and economic needs of competing interests of all who rely on the water resources. Water resources are classified in terms of their permissible utilisation and protection. The proposed classification of the Upper Olifants River catchment is Class III, requiring sustainable minimal protection and indicating high utilisation.

In terms of the GN 466, quaternary drainage region B11B is to be maintained at Ecological Category C, and quaternary drainage regions B11F and B11G are to be maintained at Ecological Category D.

Resource Quality Objectives

The Resource Quality Objectives (RQO) for the Olifants River was also published in GN 466 on 22 April 2016. VDDC is located within Resource Unit 11 of Integrated Unit of Analysis 1, the Upper Olifants River catchment.

Reserve

The Reserve is the quantity and quality of the water required to satisfy the basic human needs by securing a basic water supply and to protect the aquatic ecosystem in order to secure ecologically sustainable development and use of the relevant water resource. The Reserve determination of water resources for the catchments of the Olifants and Letaba Rivers was published in GN 932 on 7 September 2018 and is relevant to this IWULA.

3.6.5 Surface water quality

VDDC is part of an existing mine and has a monitoring programme in place and therefore, the available surface water quality data was used. Water quality data for several locations around the site, extending from September to October 2012, July 2015 to November 2017 and January to February 2018, was received from South32.

The surface water monitoring locations are summarised in **Table 3-3** and shown on **Figure 3-7.** The water quality monitoring results are summarised in **Table 3-4** as the average, maximum and minimum concentrations, together with the coefficient of variation.

The water quality results are compared to the RQO for the Olifants River as published in GN 466 on 22 April 2016. VDDC is located within Resource Unit 11 of Integrated Unit of Analysis 1, the Upper Olifants River catchment. It is important to note that the 2016 RQO do not provide limits for all constituents and therefore the SANS 241 Drinking Water Standards were used in such cases. However, there are certain constituents for which no limitations are specified.

For **Table 3-4**, values highlighted in **red** indicate where the RQO for the Olifants River catchments is exceeded, **or** for constituents for which there is not an RQO, where the SANS 241 Standards are exceeded.

Table 3-3: Surface water quality monitoring points used in baseline assessment (J&W, 2019b)

Monitoring point name	Monitoring point name and description according to South32 records	Coordinates
VDD 1	V01 Springbokspruit @ entrance to mine property	S26°06.043' E29°19.148'
VDD 2	Upstream of vlei shaft & V7 con. belt	S26°03.599' E29°17.218'
VDD 5	V09 Oxbow 9 ponded water	S26°06.146' E29°18.214'
VDD 6	V16 Olifants D/S of PSS discard dump	S26°05.135' E29°16.416'
VDD 7	V22 Douglas Upstream Betal Bridge	S26°06.383' E29°19.371'
VDD 8	V30 Olifants D/S of confluence with Steenkoolspruit	S26°03.40.7 E29°15.03.8'
VDD 9	V31 Olifants U/S Steenkoolspruit confluence D/S pit	S26°03.791' E29°15.177'
VDD 10	V32 Olifants D/S tributary near defunct pit U/S pit	S26°05.108' E29°16.116'
VDD 11	V40 Plant water u/g railway boreholes @ small bridge	S26°05.844' E29°17.308'
VDD 12	V11 Olifants @ DWAF Weir U/S PSS discard dump	S26°05.502" E29°16.967'
VDD 18	VW Olifants tributary from PSS dump pollution control dam	S26°05.838 E29°17.544
VDD 20	Attenuation dam1	S26°04.081' E29°18.287'
VDD 21	Outlet of the Southern Canal	S26°05.109' E29°16.629'
VDD22	Exit of the Northern canal	S26°01.119' E29°16.877'
VDD 23	Attenuation Berm 2	S26°03.599' E29°17.653'
Douglas 1	W02 Olifants River at Wolwekrans Weir.	S26°00.413' E29°15.240'

Figure 3-7: Surface water monitoring locations (J&W, 2019b)

Table 3-4: Surface water quality results for measurements taken in September to October 2012, July 2015 to November 2017, and January to February 2018 (J&W, 2019b)

Mine	Sample Location	RQO and SANS Guidelines	pH	EC mS/m	TDS mg/ℓ	SS mg/ℓ	Fe mg/ℓ	TALK	Ca mg/ℓ	Cl mg/ℓ	Mg mg/ℓ	NO_3 mg/ℓ	PO_4 mg/ℓ	K mg/ℓ	Na mg/ℓ	SO_4 mg/ℓ	Al mg/ℓ	F mg/ℓ	Mn mg/ℓ
		SANS 241 2015	5-9.7	170	1200	-	2	-	-	300	-	11	-	-	200	500	-	1.5	0.4
		Olifants IUA 1		111	-	-	-	-	-	-	-	4	0.125	-	-	500			
Mine	Sample Location																		
	VDD1	Average	7.71	121.59	999.33	24.61	0.08	87.50	108.02	23.11	85.78	0.16	0.00	9.43	49.27	581.80	0.08	0.91	0.25
		Maximum	8.80	268.00	2444.00	252.00	0.37	142.00	269.00	61.00	210.00	0.42	0.00	14.40	176.00	1481.00	0.20	1.37	1.43
		Minimum	6.05	42.40	326.00	3.60	0.01	17.00	39.00	8.13	25.50	0.00	0.00	6.15	15.90	187.00	0.02	0.60	0.01
		Coeff of Variation %	8.66	34.96	39.74	188.37	102.87	47.86	38.61	41.59	42.05	64.26		17.00	57.94	40.12	63.94	27.60	160.89
	VDD2	Average	7.71	325.45	3069.52	380.10	0.20	172.14	302.41	27.61	194.93	0.85		10.76	299.55	1900.83	0.09	0.61	1.17
		Maximum	8.23	523.00	5088.00	7900.00	1.86	316.00	516.00	53.50	340.00	5.68	0.00	31.00	542.00	3172.00	0.19	0.94	9.54
		Minimum	7.02	189.00	1548.00	4.00	0.02	57.00	150.00	3.50	87.10	0.10	0.00	1.85	112.00	895.00	0.01	0.34	0.01
		Coeff of Variation%	4.41	24.64	29.24	382.37	189.14	36.70	29.16	37.60	29.38	214.94		47.50	31.26	32.11	58.54	26.14	174.18
	VDD5	Average	8.05	90.21	674.87	26.84	0.08	115.53	72.38	24.51	50.39	0.15	0.10	9.12	54.92	342.48	0.13	0.69	0.04
		Maximum	8.74	175.00	1524.00	91.20	0.21	155.00	149.00	50.50	139.00	0.24	0.10	13.00	110.00	863.00	0.50	1.10	0.20
		Minimum	6.99	39.60	280.00	0.40	0.01	60.00	28.90	12.50	16.80	0.10	0.10	6.11	24.50	95.90	0.01	0.49	0.01
		Coeff of Variation%	4.61	39.71	46.26	74.25	71.79	22.35	44.61	37.26	59.82	40.77		18.88	39.15	57.17	96.43	22.63	112.14
	VDD6	Average	7.47	132.66	1097.11	754.44	0.31	137.33	122.56	42.48	82.91	0.25	0.32	23.29	65.15	581.52	0.19	0.63	1.84
		Maximum	8.31	295.00	2506.00	10450.00	1.31	297.00	266.00	136.00	221.00	0.88	0.38	186.00	147.00	1439.00	1.13	1.36	11.80
		Minimum	6.48	26.60	182.00	1.60	0.01	32.00	18.20	9.66	9.30	0.10	0.23	4.88	10.60	63.80	0.01	0.47	0.01
		Coeff of Variation%	6.45	59.85	65.54	330.16	107.64	49.81	57.81	79.31	74.48	94.59	25.19	187.13	65.47	70.80	141.59	30.74	161.30
	VDD7	Average	7.90	209.01	2070.13	22.67	0.23	120.07	215.58	25.53	177.13	1.93		14.47	97.61	1288.03	0.52	0.66	2.63
		Maximum	8.44	478.00	5406.00	64.40	1.04	163.00	569.00	38.80	504.00	5.24	0.00	43.70	241.00	3480.00	9.08	0.96	14.10
		Minimum	7.43	32.60	230.00	2.80	0.01	69.00	23.40	11.80	13.40	0.17	0.00	5.35	21.40	60.00	0.01	0.43	0.01
		Coeff of Variation%	3.31	80.55	93.56	76.77	104.45	23.41	89.12	32.85	100.94	78.60		67.06	68.30	100.98	319.32	25.45	154.23
	VDD8	Average	7.85	51.76	373.10	43.78	0.29	99.00	39.27	20.07	25.63	0.93	0.14	6.88	33.97	152.21	0.41	0.41	0.10
		Maximum	8.90	113.40	842.00	82.00	1.42	149.00	99.20	37.60	64.50	3.18	0.21	10.30	62.10	436.00	2.32	0.63	0.51
		Minimum	7.32	31.10	208.00	14.40	0.02	68.00	20.40	14.10	13.10	0.10	0.10	5.06	22.80	59.10	0.02	0.25	0.01
VDDC		Coeff of Variation%	3.85	41.54	46.72	45.78	101.19	19.80	51.00	28.04	59.79	85.19	43.45	21.61	32.44	70.37	118.22	24.37	131.86
	VDD9	Average	7.96	74.41	565.20	24.97	0.25	110.90	60.62	22.75	40.87	0.46		8.06	45.95	269.03	0.29	0.51	0.05
		Maximum	8.53	158.00	1410.00	54.40	0.93	158.00	150.00	46.20	115.00	1.06	0.00	13.60	98.70	780.00	1.63	0.74	0.26
		Minimum	7.35	30.30	240.00	1.60	0.02	61.00	25.30	12.40	14.50	0.20	0.00	5.74	21.60	90.00	0.01	0.32	0.01
		Coeff of Variation%	3.49	41.88	49.35	67.18	100.47	21.24	51.81	32.04	59.89	48.01		21.80	39.03	62.06	121.21	17.12	140.19
	VDD10	Average	7.87	96.47	761.40	33.74	0.23	115.20	81.99	24.31	59.98	0.25		9.80	52.21	400.72	0.21	0.67	0.14
		Maximum	8.58	248.00	2232.00	537.00	0.73	179.00	217.00	72.00	206.00	0.41	0.00	17.00	165.00	1284.00	0.77	1.12	0.98
		Minimum	6.53	31.30	248.00	0.80	0.01	60.00	25.40	9.76	14.80	0.10	0.00	5.71	12.00	80.10	0.01	0.39	0.01
		Coeff of Variation%	6.53	56.70	65.31	285.22	100.97	31.65	59.11	50.76	77.87	49.49		28.55	61.04	75.02	117.26	29.94	180.85
	VDD11	Average	7.87	107.67	873.72	13.30	0.23	121.69	92.54	26.92	64.28	1.05		9.63	66.07	457.89	0.24	0.59	0.33
		Maximum	8.50	231.00	2058.00	41.20	0.92	175.00	223.00	61.70	167.00	8.50	0.00	15.90	146.00	1210.00	1.31	0.83	3.88
		Minimum	6.78	31.20	244.00	0.80	0.01	63.00	24.50	12.80	14.20	0.00	0.00	5.68	22.40	76.10	0.01	0.42	0.01
		Coeff of Variation%	4.78	51.73	59.03	86.29	110.38	25.88	57.87	46.23	64.31	250.95		26.62	54.28	67.34	135.13	18.36	266.42
	VDD12	Average	8.14	101.19	797.33	25.55	0.33	112.04	78.44	26.67	60.93	0.24	8.96	10.85	71.85	412.65	0.18	0.65	0.10
		Maximum	9.04	195.40	1590.00	246.00	3.00	182.00	132.00	44.50	143.00	0.57	8.96	34.30	246.00	939.00	0.64	0.92	0.36
		Minimum	7.12	31.10	248.00	1.20	0.01	63.00	25.10	13.20	14.40	0.10	8.96	5.76	21.60	0.05	0.01	0.41	0.01
		Coeff of Variation%	5.97	47.80	52.78	186.92	186.54	25.13	46.74	39.02	61.42	68.01		50.28	65.81	65.37	107.70	23.34	109.48
	VDD18	Average	6.51	29.78	217.43	69.78	1.23	35.44	22.25	7.44	12.10	1.48		6.10	17.55	110.98	0.15	0.44	0.66
		Maximum	7.72	74.50	614.00	320.00	4.90	187.00	70.80	28.10	31.90	4.28	0.00	20.60	41.70	347.00	1.16	0.65	3.83
		Minimum	4.69	5.57	36.00	1.60	0.02	5.00	2.57	1.90	1.17	0.10	0.00	1.17	1.11	14.50	0.02	0.23	0.01
		Coeff of Variation%	13.26	62.85	67.07	144.92	131.63	157.31	79.54	79.58	74.08	128.16		74.87	54.46	81.19	166.20	28.45	171.58

Mine	Sample Location	RQO and SANS Guidelines	pH	EC mS/m	TDS mg/ℓ	SS	Fe mg/ℓ	TALK	Ca mg/ℓ	Cl mg/ℓ	Mg mg/ℓ	NO_3 mg/ℓ	PO_4 mg/ℓ	K mg/ℓ	Na mg/ℓ	SO_4 mg/ℓ	Al mg/ℓ	F mg/ℓ	Mn mg/ℓ
		SANS 241 2015	**5-9.7**	**170**	**1200**	**-**	**2**	**-**	**-**	**300**	**-**	**11**	**-**	**-**	**200**	**500**	**-**	**1.5**	**0.4**
		Olifants IUA 1		**111**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4**	**0.125**	**-**	**-**	**500**			
VDDC	**VDD20**	**Average**	7.82	48.66	339.19	814.15	0.63	101.07	27.74	24.83	15.86	0.41	0.31	11.49	52.22	114.71	0.37	1.42	0.66
		Maximum	9.75	131.00	856.00	8264.00	1.91	424.00	125.00	130.00	42.40	1.55	0.76	28.50	251.00	412.00	3.24	6.54	3.21
		Minimum	6.36	6.09	52.00	0.40	0.06	6.00	3.31	2.92	1.02	0.12	0.00	3.40	3.20	4.39	0.01	0.43	0.01
		Coeff of Variation%	10.43	79.84	83.74	214.13	76.37	84.40	98.74	105.14	74.61	98.62	130.65	68.85	111.83	140.07	169.67	82.04	157.00
	VDD21	**Average**	8.05	261.64	2370.00	74.46	0.15	112.57	248.21	93.71	204.29	0.17		14.39	173.10	1500.71	0.08	0.56	0.17
		Maximum	8.59	552.00	4840.00	590.00	0.55	202.00	503.00	338.00	559.00	0.31	0.00	53.80	644.00	4118.00	0.54	1.36	1.28
		Minimum	7.06	168.00	1322.00	3.20	0.01	16.00	145.00	31.50	101.00	0.00	0.00	7.85	72.60	762.00	0.02	0.31	0.01
		Coeff of Variation%	5.14	36.89	38.16	205.82	118.56	46.71	38.49	79.70	56.89	76.39		81.74	82.26	54.47	165.44	47.92	230.24
	VDD22	**Average**	7.26	59.70	496.50	976.90	0.21	46.75	48.53	16.57	39.80			4.57	31.60	286.45	0.12	0.73	0.65
		Maximum	8.31	168.00	1456.00	3685.00	0.39	119.00	145.00	31.50	126.00	0.00	0.00	11.50	72.60	881.00	0.27	1.36	2.21
		Minimum	6.57	20.40	150.00	4.80	0.07	11.00	15.60	9.20	9.89	0.00	0.00	1.30	11.60	60.00	0.05	0.39	0.01
		Coeff of Variation%	10.24	121.00	128.89	185.07	77.96	104.62	132.55	62.95	144.42			105.09	87.95	138.55	87.73	59.94	162.41
	VDD23	**Average**	7.44	182.67	1654.56	126.02	0.20	155.56	167.32	23.87	94.80	0.33	0.26	12.17	166.74	942.44	0.09	0.89	1.03
		Maximum	8.34	433.00	4482.00	1245.00	1.07	381.00	516.00	48.90	293.00	0.98	0.35	53.40	418.00	2839.00	0.33	1.94	8.00
		Minimum	6.20	35.40	256.00	10.80	0.02	10.00	30.60	5.56	17.50	0.11	0.12	0.30	23.60	70.20	0.01	0.33	0.01
		Coeff of Variation%	6.28	80.06	89.35	209.30	129.45	56.12	87.60	53.72	87.50	77.42	38.22	92.64	89.02	101.80	84.58	37.63	228.71
	Douglas 1	**Average**	7.80	47.01	340.13	42.19	0.36	85.63	34.04	18.13	21.77	0.64	0.00	6.62	31.74	140.74	0.31	0.45	0.06
		Maximum	8.23	69.80	526.00	178.00	1.35	113.00	45.60	23.80	32.70	1.22	0.00	8.83	61.90	229.00	1.65	0.60	0.43
		Minimum	7.49	28.30	224.00	4.80	0.02	65.00	22.90	13.20	13.70	0.21	0.00	5.24	22.10	75.90	0.03	0.29	0.01
		Coeff of Variation%	2.70	22.01	23.55	107.37	131.92	13.72	21.72	14.71	26.72	45.93		14.93	30.33	32.94	137.12	18.52	223.21

Interpretations of the surface water quality monitoring results that are summarised in **Table 3-4,** are discussed below:

pH

On average, all the monitoring points are within the required pH range of 5 to 9.7, as illustrated in **Figure 3-8**.

Minimum recorded levels of pH which fell out of the required pH range, and lower than the required 5.0 was at monitoring point VDD18. A decrease in the pH level may be due to mining activities.

Maximum recorded levels of pH which fell out of the required pH range, and higher than the required 9.7 was at monitoring point VDD20, which may be due to agricultural activities.

Sulphate (SO_4)

Sulphate is a key indicator of water affected by coal mining and the average SO_4 concentrations exceed the acceptable limit at a number of monitoring points as indicated in **Table 3-4** and **Figure 3-9**.

All of the monitoring points exceed the SO_4 concentration limit of 500 mg/ℓ with the exception of VDD8, VDD20, VDD18 and Douglas1.

On average, the majority of the monitoring points exceed the required SO_4 concentration limit, with the exception of VDD5, VDD9, VDD10, VDD11, VDD12 and VDD22.

The monitoring data indicates that the water upstream of the VDDC mining section shows an impact as a result of the land use activities. The elevated sulphate concentrations at these locations may be attributed to mining activities in the area.

Electrical Conductivity (EC)

Electrical conductivity is a measure of salinity or total salt content of water. Accumulation of salts can influence the potential to use the water downstream by water users, such as irrigation for agriculture, as well as livestock watering. In **Table 3-4** and **Figure 3-10**, elevated EC levels were noted for monitoring points VDD1, VDD2, VDD6, VDD7, VDD21 and VDD23.

Elevated EC is attributed to the existing mining activities, as well as the farming activities in the area. The monitoring data shows an impact on the water resources upstream of the VDDC mining area as a result of the land use activities.

Aluminium (Al)

Iron (Fe) is the fourth most abundant element, constitutes 5% of the earth's crust and is found in many minerals. An important mineral in the context of this investigation is pyrite (FeS), which is often associated with coal formations. Iron can be present in water as dissolved ferric iron (Fe III), as ferrous iron (Fe II) or as suspended iron hydroxides. The concentration of dissolved iron in unpolluted surface water is typically in the range of 0.001 - 0.5 mg/ℓ (DWAF, 1996). There are no limits provided in the RQO for iron and the SANS 241 guidelines is set as 2 mg/ℓ.

The results indicate on average, iron concentrations for all monitoring locations are within the guideline limits. Maximum recorded iron concentrations which were marginally elevated were noted at VDD12 and VDD18. Elevated iron concentrations may be due to mining and/or agricultural activities in the surrounding area.

Aluminium (Al)

Aluminium occurs in water either as suspended aluminium minerals or as dissolved aluminium species. The concentration of dissolved aluminium in unpolluted water at neutral pH is typically 0.005 mg/ℓ or less. In water with a low pH, or where soluble aluminium complexes are present, the dissolved aluminium concentration can rise to high values (DWAF, 1996).

There are no limits set for Al in the SANS 241 guidelines or the RQO for the catchment. Therefore, the TWQO for irrigation and aquatic ecosystems was used to assess the current status. The TWQO for irrigation for Al is 5 mg/ℓ or less, and the TWQO for aquatic ecosystems are as follows:

- For pH <6.5 the Al concentration limit is 0.005 mg/ℓ or less;
- For pH >6.5 the Al concentration limit is 0.01 mg/ℓ or less.

On average, all monitoring locations are within the TWQO for irrigation, with a maximum recorded Al concentration of 9 mg/ℓ noted at VDD7. On average all monitoring locations have a pH > 6.5, and all monitoring locations exceed the TWQO for aquatic ecosystems of 0.01 mg/ℓ or less.

On average, elevated aluminium concentrations were noted at the following monitoring locations: VDD1, VDD2, VDD5, VDD21, VDD22 and VDD23.

Elevated aluminium concentrations may be due to agricultural activities and mining activities in the surrounding area.

Manganese (Mn)

On average, elevated manganese concentrations were noted at the following monitoring locations: VDD2, VDD6, VDD7, VDD18, VDD20, VDD22 and VDD23.

Elevated manganese concentrations may be due to agricultural activities and mining activities in the surrounding area.

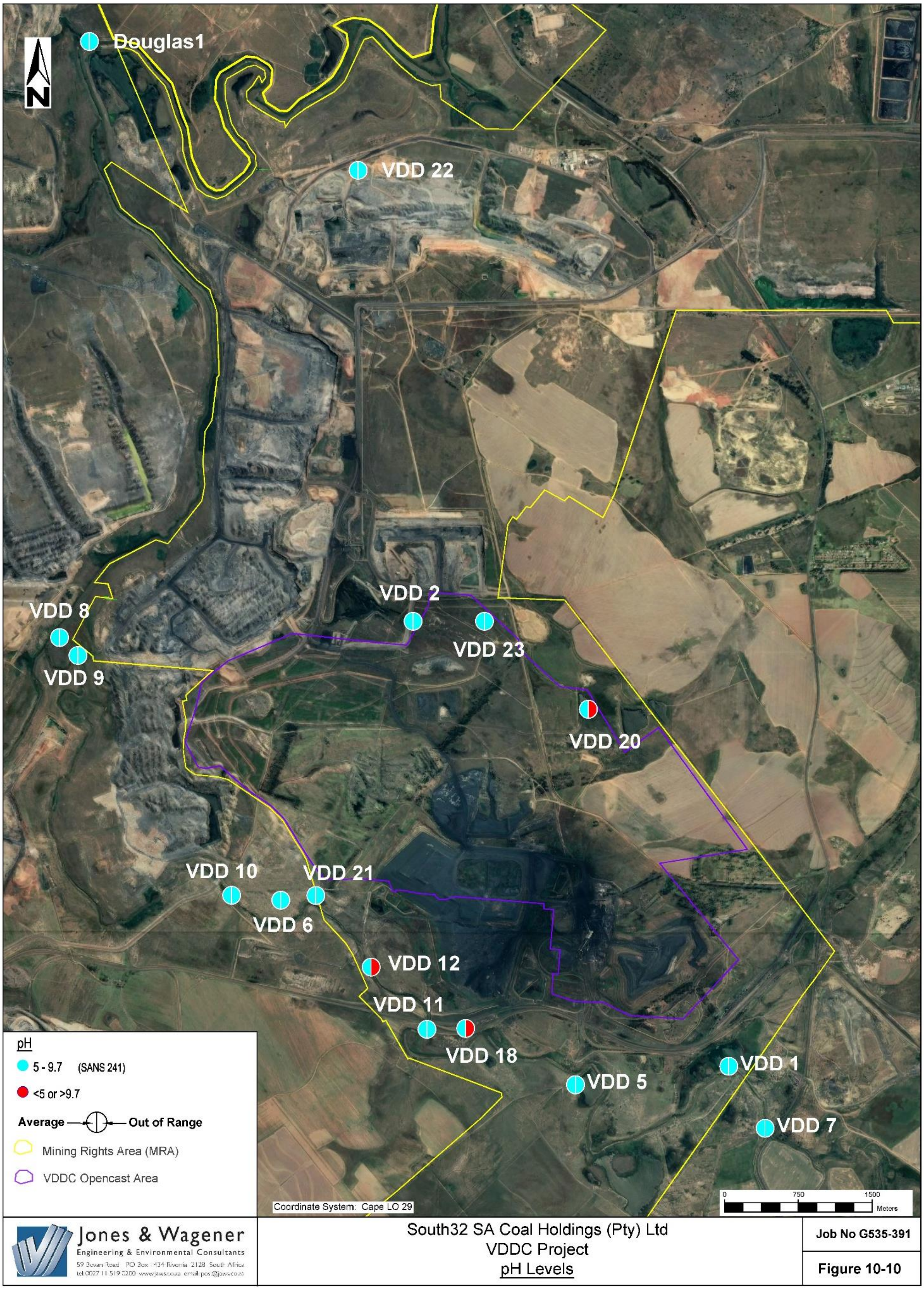

Figure 3-8: pH levels measured at surface water monitoring locations (J&W, 2019b)

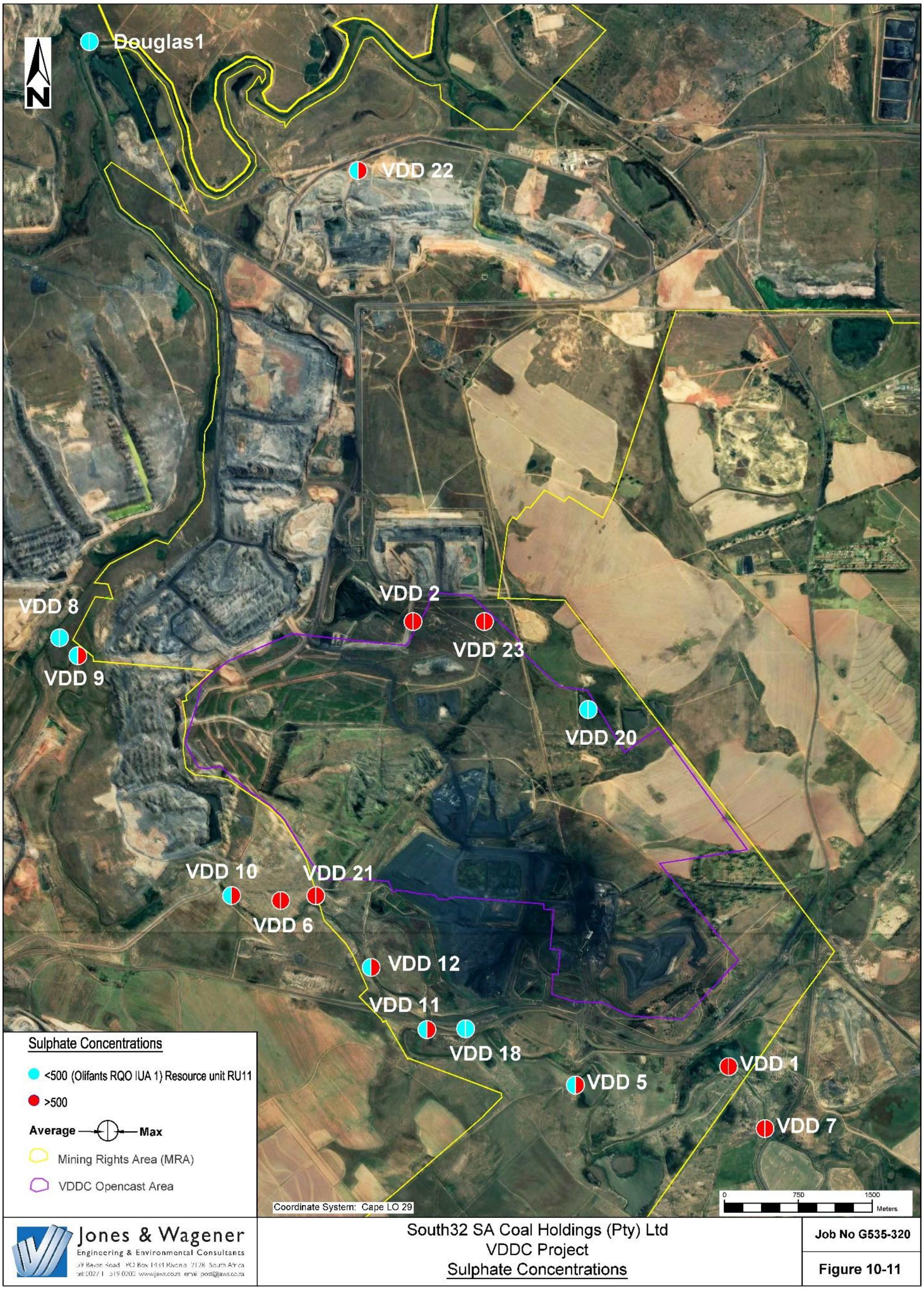

Figure 3-9: Sulphate (SO_4) concentrations measured at surface water monitoring locations (J&W, 2019b)

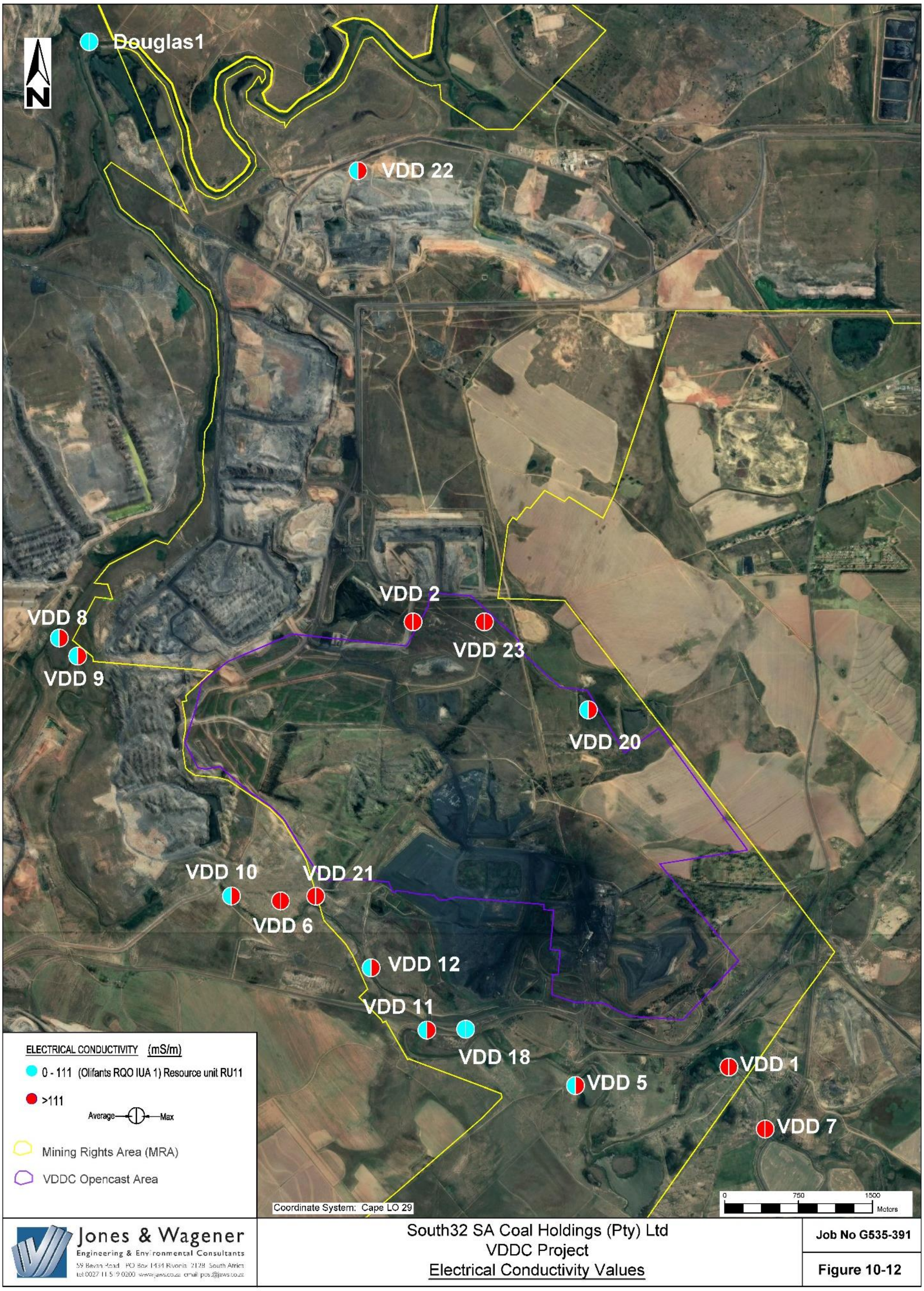

Figure 3-10: Electrical conductivity (EC) levels measured at surface water monitoring locations (J&W, 2019b)

Other constituents

Analysis of other constituents in **Table 3-4** indicates the following:

- On average, the total dissolved solids (TDS) levels at the majority of the monitoring points was highly elevated when compared to the SANS 241 standard, which can be attributed to mining in the area;
- On average, Sodium (Na) concentrations at the majority of the locations was within range when compared to the SANS 241 guidelines, except for VDD2 which can be attributed to mining in the area;
- The maximum recorded Nitrate (NO_3) concentrations were elevated at monitoring points VDD2, VDD7, and VDD11, when compared to the RQOs, which may be attributed mining activities in the area;
- Phosphate (PO_4) concentrations on average, as well as maximum recorded, at monitoring points VDD6, VDD8, VDD12, VDD20 and VDD23 were elevated when compared to the RQOs, which may be attributed to farming and mining activities in the area;
- Although there are no guideline limitations provided for suspended solids, several points show on average elevated suspended solids and highly elevated suspended solids for the maximum recorded at the monitoring points VDD2, VDD6, VDD22 and VDD23. These are all within the mining area and therefore may be attributed to mining (J&W, 2019b).

Therefore, in terms of surface water quality within the study area there are existing impacts associated with mining activities. Surface water quality upstream of the VDDC mining area shows an existing impact.

3.6.6 Surface water use

The VDDC Project area is situated in a farming district, where water from the Olifants River and the Steenkoolspruit upstream of the mining area is used for irrigation, formal and informal domestic usage, as well as livestock watering. Other uses include domestic supply to villages and other amenities in the area.

The Witbank Dam is located downstream of the mining area and is used for municipal and industrial water supply, as well as recreational activities such as fishing and boating.

The aquatic ecosystem is also present as a downstream user.

3.6.7 Wetlands

An assessment of the wetlands was done by The Biodiversity Company (TBC) and a copy of the report is attached to the IWWMP in Appendix B.

3.6.7.1. Delineated wetlands

The following wetland hydrogeomorphic (HGM) units have been identified on site:

- Riparian area[5];
- Channelled Valley Bottom (along the Olifants River);

[5] The riparian area has been delineated for the project, and an ecological assessment of the Olifants River included in the aquatic assessment component of the project.

- Unchannelled Valley Bottom;
- Hillslope Seep; and
- Depression (the area where treated water from the modular water treatment plant will be discharged).

In addition to the abovementioned delineations and classifications, the following systems were identified, delineated and have been defined according to the following:

- *Artificial systems:* These systems are artificial systems, man-made and are associated with pollution control dams or stormwater ponds. These systems are often characterised by hydrophytes but are not natural wetland systems;
- *Dams:* These are man-made structures within channelled systems which have contributed to the modified status and functioning of these systems. Dams are considered as a driver of change for the respective system;
- *Previously mined:* These areas have been mined in the past. These areas are now waterlogged, and are also not considered to be natural wetland systems;
- *Remnant wetland:* This system is no longer considered to be a wetland and has been directly impacted on by mining and lost as a result. This remnant system was associated with the flooding features of the Olifants River, but owing to the diversion channel that was constructed the remnant system was isolated from the river with wetland drivers being removed as a result.

The extent of potential wetland areas is indicated on **Figure 3-11**. The ecological assessment for this project only considered the natural wetland systems that would be directly impact on by the proposed project and the associated features (i.e. excluding the artificial system, remnant wetlands, dams and previously mined watercourses), which comprise of the following wetland systems:

- HGM 1: Channelled valley bottom wetland along Olifants River;
- HGM 2: Unchannelled valley bottom wetland representing the system previously known as the Vleishaft tributary, which now forms part of the dirty water management system at the mine;
- HGM 3: Hillslope seepage wetland to the east, feeding into HGM2
- HGM 4: Seepage wetland to the southeast
- HGM 5: Small depression to the west of HGM4;
- HGM 6: Depression to the north of the VDDC area into which treated water from the modular WTP will be discharged.

3.6.7.2. *Wetland Present Ecological State (PES)*

The wetlands have all been impacted on by the historical and current (predominantly) mining operations in the area, with local agricultural activities also impacting on the systems, specifically the systems associated with the Olifants River. The mining operations have altered the topography of the landscape, resulting in altered flow dynamics of the catchment areas. To manage water in these areas, watercourses have been diverted, trenches dug to intercept flows, and dams constructed to attenuate flows, all having an impact on the hydrology of these systems. The development of the catchment area and the altered hydrology have modified the geomorphology of these systems. These modifications include encroachment of wetland, reducing the system extent, and increased wetland area extent due to storm water inputs. Vegetation has also been altered, largely due to vegetation being cleared and the establishment of alien vegetation in the area.

A summary of key aspects that have contributed to the impacted state of the wetlands includes the following:

- The operation, decommissioning and rehabilitation of mining areas within the project area;
- Agricultural cultivation on the periphery of the project area, and south of the Olifants River;
- Infrastructure development within the catchment area, including roads, dams and crossings;
- The water management measures within the project area, including diversions, storm water management and control dams; and
- The establishment of alien vegetation (TBC, 2019).

The PES ratings are indicated in **Table 3-5** and shown on **Figure 3-12**. The PES of wetlands that may be impacted as a result of the proposed infrastructure development are rated as category C (moderately modified) to category D (largely modified).

Table 3-5: Wetland PES for the assessed systems (TBC, 2019)

Wetland	Hydrology		Geomorphology		Vegetation	
	Rating	Score	Rating	Score	Rating	Score
Channelled Valley Bottom (HGM 1)	C: Moderately Modified	3.5	C: Moderately Modified	3.0	C: Moderately Modified	3.8
Overall PES Score:	**3.4**		**Overall PES Class:**		**C – Moderately modified**	
Unchannelled Valley Bottom (HGM 2)	D: Largely Modified	4.7	D: Largely Modified	5.2	C: Moderately Modified	3.5
Overall PES Score:	**4.5**		**Overall PES Class:**		**D – Largely modified**	
Hillslope Seep (HGM 3)	C: Moderately Modified	3.5	C: Moderately Modified	2.2	C: Moderately Modified	2.6
Overall PES Score:	**2.9**		**Overall PES Class:**		**C – Moderately modified**	
Hillslope Seep (HGM 4)	E: Seriously Modified	6.5	C: Moderately Modified	2.8	E: Seriously Modified	7.2
Overall PES Score:	**5.6**		**Overall PES Class:**		**D – Largely modified**	
Depression (Pan) (HGM 5)	C: Moderately Modified	3.5	C: Moderately Modified	2.5	C: Moderately Modified	3.5
Overall PES Score:	**3.2**		**Overall PES Class:**		**C – Moderately modified**	
Depression (Pan) (HGM 6)	D: Largely Modified	4.7	C: Moderately Modified	2.8	C: Moderately Modified	2.5
Overall PES Score:	**3.5**		**Overall PES Class:**		**C – Moderately modified**	

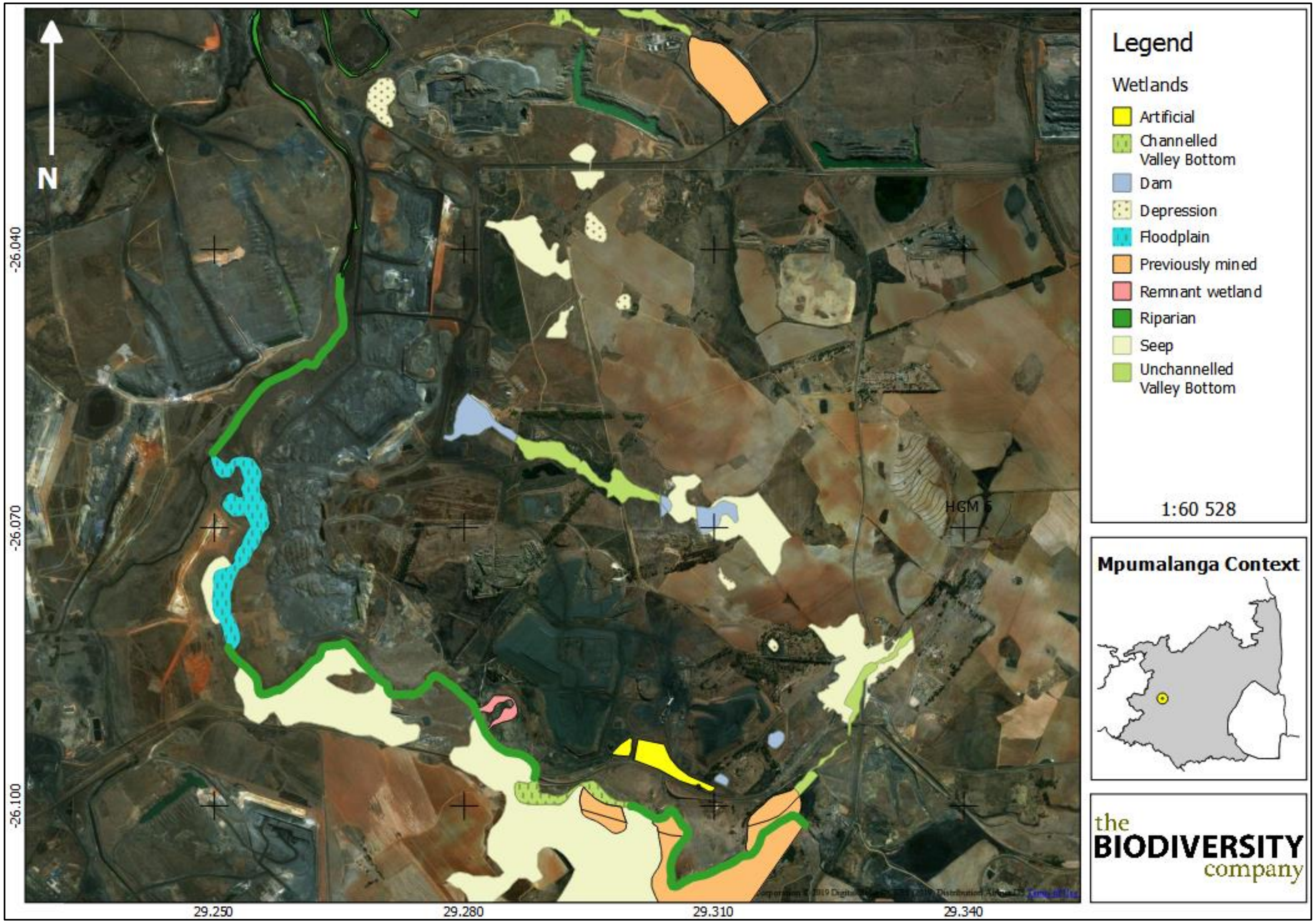

Figure 3-11: All identified water features (TBC, 2019)

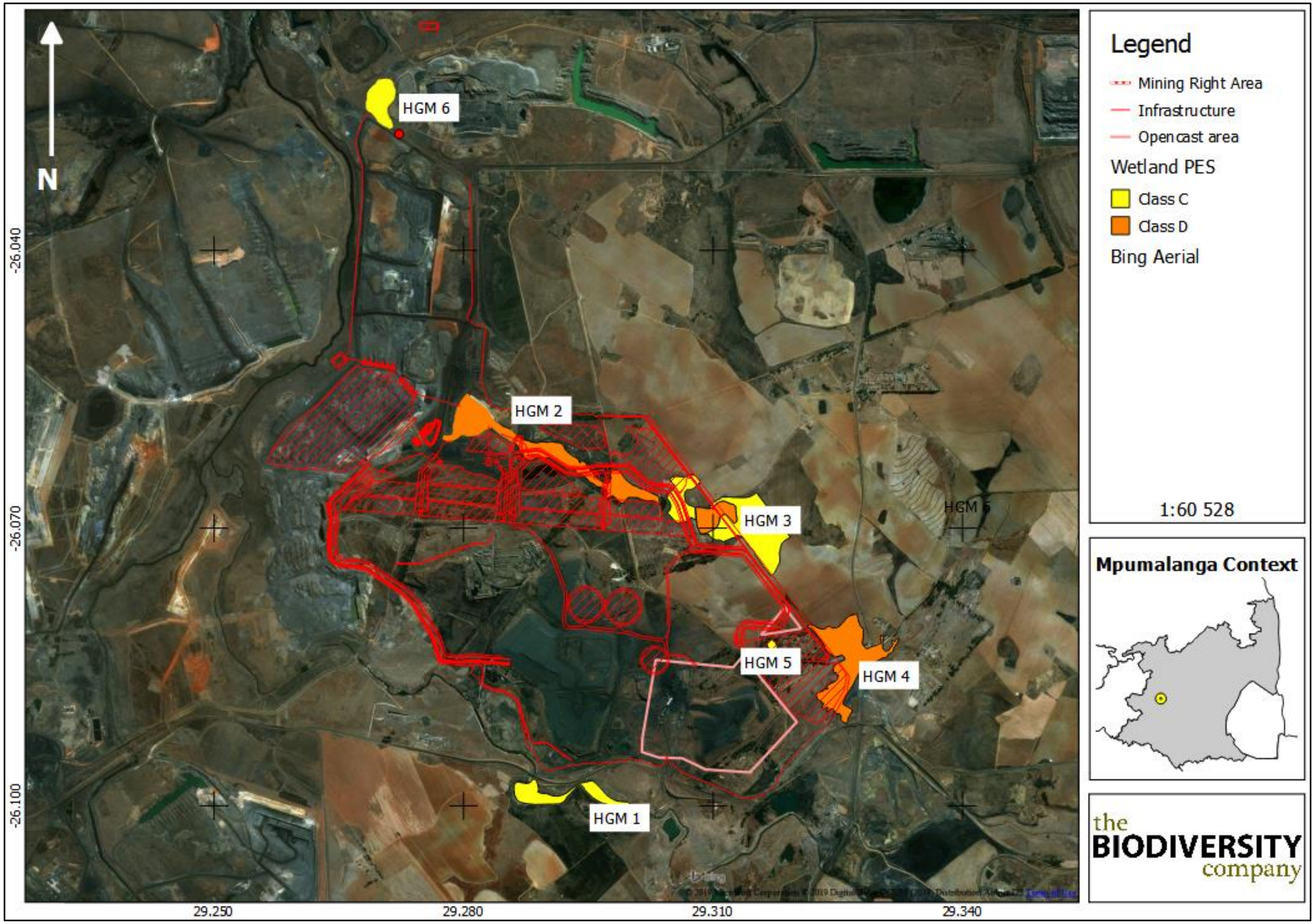

Figure 3-12: Present Ecological State (PES) of wetlands (TBC, 2019)

3.6.7.3. *Wetland Ecosystem Services*

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices. An assessment was undertaken that examines and rates the services according to their degree of importance and the degree to which the services are provided in **Table 3-6**.

Table 3-6: Classes for determining the likely extent to which a benefit is being supplied (TBC, 2019)

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

All of the wetland units scored an overall intermediate service rating, with the unchanneled valley bottom (HGM 2) and northernmost depression (HGM 6) system having an overall moderately low service rating. The highest ratings (moderately high) for all the HGM units is associated with the indirect benefits, specifically for the enhancement of water quality, streamflow regulation and the enhancement of biodiversity. No services provided by the wetlands provide a high level of benefit, as can be seen in **Table 3-7**.

Table 3-7: Level of ecosystem benefits provided by the assessed wetland units (TBC, 2019)

Wetland Unit					HGM1	HGM 2	HGM 3	HGM 4	HGM 5	HGM 6
Ecosystem Services Supplied by Wetlands	Indirect Benefits	Regulating and supporting benefits	Flood attenuation		1.7	2.1	1.1	1.4	1.3	1.6
			Streamflow regulation		2.1	2.2	2.8	1.3	2.7	1.4
			Water Quality enhancement benefits	Sediment trapping	1.5	1.8	2.4	1.4	2.5	1.5
				Phosphate assimilation	1.3	1.7	2.5	1.8	2.4	1.6
				Nitrate assimilation	1.3	1.7	2.8	1.7	2.7	1.6
				Toxicant assimilation	1.4	1.6	2.6	1.8	2.6	1.7
				Erosion control	1.1	1.6	2.2	1.4	1.5	1.5
			Carbon storage		1.5	1.3	1.7	1.6	0.7	1.4
	Direct Benefits	Biodiversity maintenance			1.2	1.1	3.0	2.0	1.8	2.0
		Provisioning benefits	Provisioning of water for human use		1.8	0.6	1.8	0.8	1.6	0.6
			Provisioning of harvestable resources		1.1	0.2	0.8	1.0	0.8	0.8
			Provisioning of cultivated foods		1.5	0.0	1.8	0.2	1.8	0.0
		Cultural benefits	Cultural heritage		1.1	0.0	0.0	0.0	0.0	0.0
			Tourism and recreation		1.6	0.0	0.9	0.8	1.0	0.6
			Education and research		1.7	0.0	0.8	1.1	0.8	0.5
Overall					21.9	15.9	27.1	20.2	23.9	16.8
Average					1.5	1.1	1.8	1.3	1.6	1.1

3.6.7.4. Ecological Importance and Sensitivity

The method used for the Ecological Importance and Sensitivity (EIS) determination was adapted from the method as developed by the Department of Water and Sanitation (DWs) in 1999. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in **Table 3-8**.

Table 3-8: Description of Ecological Importance and Sensitivity categories (TBC, 2019)

EIS Category	Range of Mean	Recommended Ecological Management Class
Very High:	3.1 to 4.0	Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers
High	2.1 to 3.0	Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.
Moderate	1.1 to 2.0	Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.
Low Marginal	< 1.0	Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.

The EIS assessment was applied to the wetland units in order to assess the levels of sensitivity and ecological importance of the systems. The results of the assessment are shown in **Table 3-9** and **Figure 3-13**. Authorisation was granted in 2007 for the mining of HGM 2. The EIS for the two (2) valley bottom systems and HGM 3 were rated as high. The EIS of the remaining wetland systems were rated as moderate.

The high EIS rating is partially attributed to the location of the project area within the Olifants River catchment. The catchment is under stress due to mining, power stations, urbanisation and agriculture, and due to the ability of these systems to contribute towards water quality enhancement and regulation, a high importance and conservation value is placed on these systems. The following findings were also considered for the EIS classification:

- According to the Mpumalanga Highveld Wetlands (MPHG) dataset, the wetlands associated with the project area are predominantly in a moderately to largely modified state. In addition to this, no true ecological priority wetland systems are expected for the area;
- The moist grassland is regarded as having a high sensitivity due to its role as being the only remaining habitat, foraging source and migratory corridor for various faunal species present;
- None of the birds were species of conservation concern (SCC). Based on the various wetland habitats encountered in the area, the likelihood that bird SCC occur there is rated as moderate to high;
- Overall, mammal diversity in the project area was moderate to high, with eight (8) mammal species being recorded during a survey conducted in August 2018. Two (2) mammal SCC were recorded in the project area;

- One (1) amphibian species was recorded in the project area during the August 2018 survey based on visual observations; and
- The hydrological and direct human benefits were rated as moderately low for all the wetland units (TBC, 2019).

Table 3-9: EIS for the assessed wetland units (TBC, 2019)

Wetland Importance and Sensitivity	HGM 1	HGM 2	HGM 3	HGM 4	HGM 5	HGM 6
Ecological Importance & Sensitivity	2.2	2.3	2.3	1.6	1.7	1.7
Hydrological / Functional Importance	1.5	1.8	2.3	1.6	2.0	1.6
Direct Human Benefits	1.4	1.6	1.1	1.6	1.0	0.4

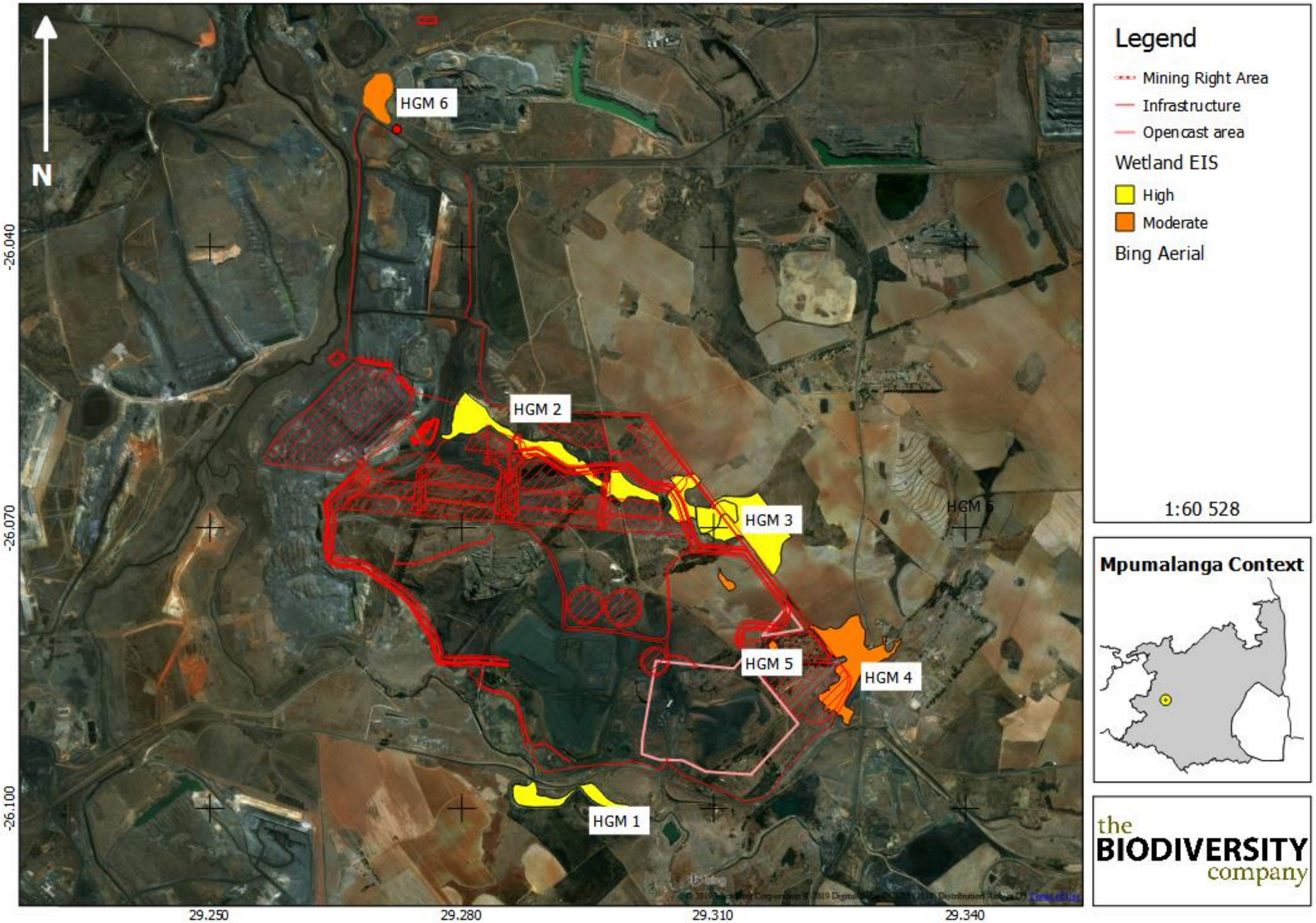

Figure 3-13: Ecological Importance and Sensitivity (EIS) of wetlands (TBC, 2019)

3.6.8 Aquatic ecosystem

3.6.8.1. *In situ water quality*

In situ water quality analysis results from the August 2018 survey are provided in **Table 3-10.** The sampling sites selected were located upstream (O1) to downstream (O5) of VDDC on the Olifants River and are shown in **Figure 3-14.**

The results of the *in situ* water quality assessment indicated pH ranges from 7.4 at O5 to 8.3 at O4. The levels of pH were within the recommended guidelines values for aquatic ecosystems of between 6.5-9.0. These guideline values were selected considering their direct applicability to local aquatic ecology. The levels of EC were recorded to range from 76 mS/m at O4 to 113 mS/m at O3 indicating the level of dissolved solids. Although no limits have been prescribed for the concentration of dissolved solids and their effect on aquatic ecology, elevated concentrations of dissolved solids are indicative of catchment land use modification. The alteration of land use in the catchment exposes soils and various minerals to increased weathering which typically results in an increase in dissolved solid concentrations in watercourses. Based on the geomorphological layout of the considered watercourse and the extensive coal mining and power generation activities within the catchment area, the levels of dissolved solids would be considered to be in excessive concentration. The spatial trends of dissolved solids indicated a decrease downstream of the confluence with the Steenkoolspruit (B11F-1273) at the monitoring point O4. The decrease can be attributed to a water transfer scheme from from the Grootdraai Dam on the Vaal River system into the Steenkoolspruit. The levels of dissolved oxygen were found to range from 5.6 mg/ℓ at O1 to 6.8 mg/ℓ at O3. The levels of dissolved oxygen would not present an adverse condition to aquatic ecology. The water temperatures were found to range from 14 °C at O3 to 18 °C at O4. The water temperatures observed during this study would not negatively impact on local aquatic ecology (TBC, 2019).

Table 3-10: *In situ* water quality results of August 2018 sampling (TBC, 2019)

Site		pH	EC (mS/m)	Dissolved Oxygen (mg/ℓ)	Temperature (°C)
Target Water Quality Guidelines for Aquatic Ecosystems		**6.5-9.0**	**N/A**	**>5.00**	**5-30**
O1	On Olifants River, upstream	7.8	97	5.6	15
O2	On Olifants River	7.9	90	6.4	15
O3	On Olifants River	8.0	113	6.8	14
O4	On Olifants River, adjacent/downstream	8.3	76	6.1	18
O5	On Olifants River, downstream	7.4	79	6.4	17

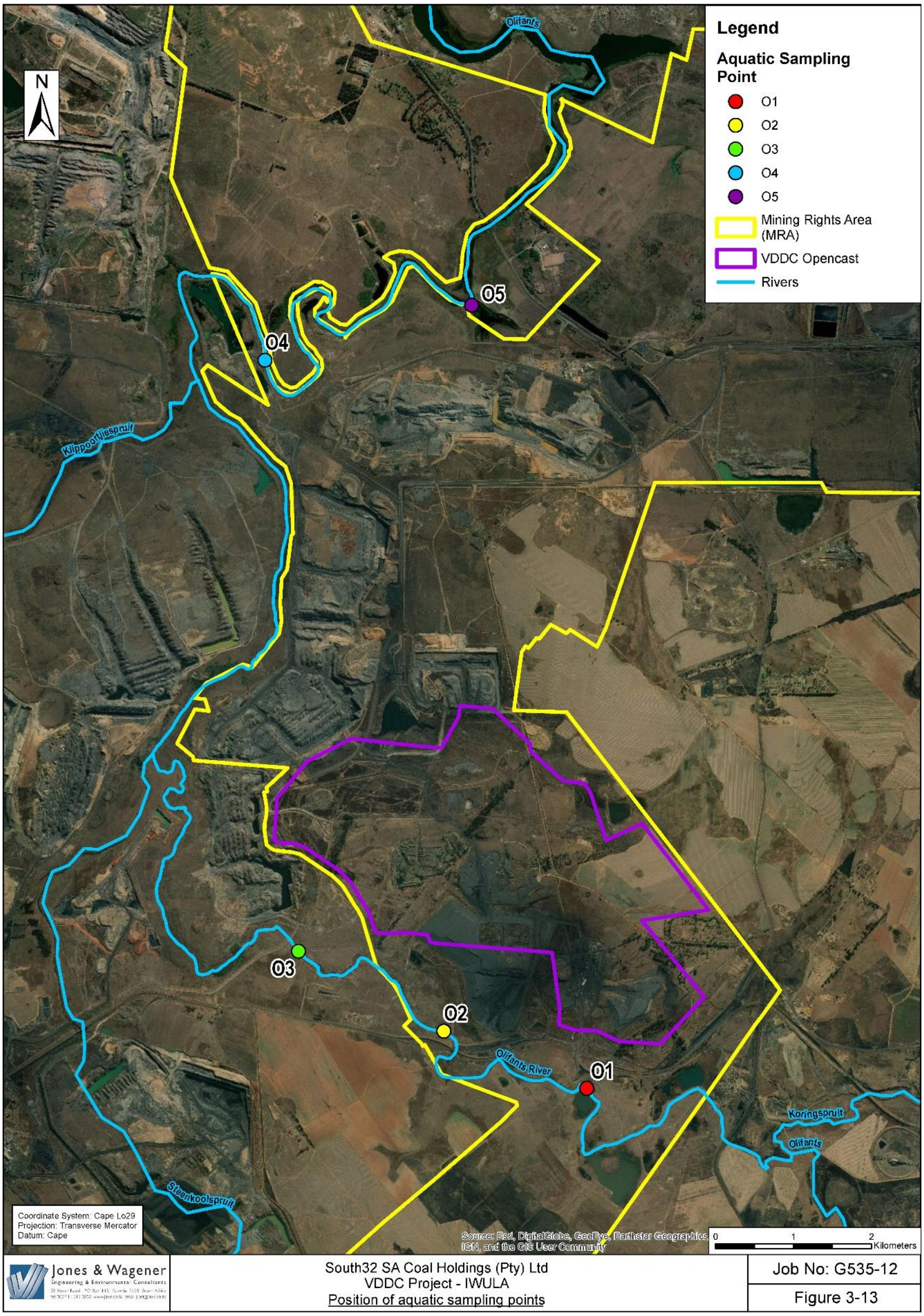

Figure 3-14: Position of aquatic sampling points

3.6.8.2. Intermediate Habitat Integrity Assessment

The results of the Intermediate Habitat Integrity Assessment for the Olifants River indicated seriously modified (class E) instream habitat. The degree of modification can be attributed to several factors including flow, bed and channel modification. The modification of the various components of the instream habitat can be attributed to historical activities such as river diversions for open pits and incline shafts adjacent to the river channel. Riparian habitats in the Olifants River reach were found to be largely modified (class D). Stands of alien invasive *Populus alba* (Poplar) were observed in several areas in proximity to the river reach. In addition, stands of alien invasive *Myriophyllum aquaticum* (Parrots feather) were also observed in the marginal zones of the Olifants River (TBC, 2019). Results for the instream intermediate habitat integrity assessment are indicated in **Table 3-11.**

Table 3-11: Instream Intermediate Habitat Integrity Assessment for the Olifants River (TBC, 2019)

Criterion	Average Score	Score
Instream		
Water abstraction	5.00	2.80
Flow modification	21.67	11.27
Bed modification	20.00	10.40
Channel modification	21.67	11.27
Water quality	15.00	8.40
Inundation	20.00	8.00
Exotic macrophytes	13.33	4.80
Exotic fauna	10.00	3.20
Solid waste disposal	5.00	1.20
Total Instream Score		**38**
Instream Category		**class E**
Riparian		
Indigenous vegetation removal	13.33	6.93
Exotic vegetation encroachment	15.00	7.20
Bank erosion	11.67	6.53
Channel modification	18.33	8.80
Water abstraction	5.00	2.60
Inundation	16.67	7.33
Flow modification	16.67	8.00
Water quality	15.00	7.80
Total Riparian Score		**44**
Riparian Category		**class D**

3.6.8.3. *Macroinvertebrate Community Assessment*

The results of the macroinvertebrate assessment using the South African Scoring System Version 5 (SASS5) for the sites located in the Olifants River are presented in **Table 3-12**. The results indicated SASS5 scores which ranged from 55 at site O5, to 103 at site O3. The number of taxa obtained at the sites ranged from 13 at site O5, to 22 at site O3. The average score per taxon (ASPT) values obtained at the sites ranged from 4.2 at sites O2 and O4, to 4.6 at site O3. The ecological classes were found to range from class D (largely modified) at sites O1, O4 and O5, to class B at site O3 (TBC, 2019).

Table 3-12: Macroinvertebrate Assessment Results Recorded in the Olifants River (TBC, 2019)

Site	SASS5	Taxa	ASPT	*Class (Dallas, 2007)
O1	61	14	4.3	class D**
O2	76	18	4.2	class C
O3	103	22	4.6	class B
O4	64	15	4.2	class D**
O5	55	13	4.3	class D**
*Highveld Lower Ecoregion **SASS5 Interpretation Not Applicable due to Impoundment Conditions				

A small component of the taxa sampled during the assessment were moderately sensitive to water quality impairment, these included *Atyidae*, *Aeshnidae* and *Ecnomidae*. However, the invertebrate assemblage at the sites were largely tolerant to water quality impairment. There were no taxa sampled which would represent sensitive families. It is noted that the SASS5 interpretation is not applicable at sites classified as impoundments. Therefore, the SASS5 interpretations at O1, O4 and O5 are not applicable. Despite this, the standard methods can still serve to effectively monitor the watercourse for future monitoring assessments. The results of the reach based Macroinvertebrate Response Assessment Index (MIRAI) is presented in **Table 3-13**.

Table 3-13: Macroinvertebrate Response Assessment Index for the Olifants River reach based on results obtained in August 2018 (TBC, 2019)

Invertebrate Metric Group	Score Calculated
Flow Modification	47
Habitat	43
Water Quality	28
Ecological Score	39
Invertebrate Category	class D/E

The results of the reach based MIRAI indicate a largely/seriously modified (class D/E) ecological category. The primary driver for the impaired conditions can be attributed to water quality modification. This result confirms the water quality results obtained during this study. It is likely that diffuse runoff from extensive coal mining activities compounded by urban and agricultural runoff has negatively impacted on the water quality of the Olifants River. Further, habitat quality in the watercourse was also determined to be negatively impacted. This has cumulatively impacted on the local invertebrate assemblage in that littoral habitats such as marginal vegetation in current has been lost due to inundation. This has resulted in the reduced Frequency of Occurrence of invertebrate families across the considered river reach (TBC, 2019).

3.6.8.4. *Fish community*

No listed fish species are expected in the considered river reach. Of the thirteen expected indigenous fish species in the river reach, eight have been captured in the river reach since 2001 (TBC, 2019).

3.6.8.5. *Overall Present Ecological Status of the Olifants River*

The results of the PES assessment derived seriously modified (class E) conditions in the Olifants River reach considered in this assessment. Instream habitat modification has resulted in modified biological responses. Instream habitat modification can be attributed to extensive coal mining and power generation activities in the Olifants River catchment compounded by diffuse agricultural and urban runoff. The results of the PES assessment for the Olifants River are provided in **Table 3-14.**

Table 3-14: Present Ecological Status of the Olifants River assessed in the August 2018 survey (TBC, 2019)

Aspect Assessed	Ecological Category
Instream Ecological Category	38
Riparian Ecological Category	44
Aquatic Invertebrate Ecological Category	39
Ecostatus	**class E**

3.6.8.6. *National Freshwater Ecosystem Priority Area (NFEPA) Status*

In an attempt to better conserve aquatic ecosystems, South Africa has recently categorised its river systems according to set ecological criteria (i.e. ecosystem representation, water yield, connectivity, unique features, and threatened taxa) to identify Freshwater Ecosystem Priority Areas (FEPAs). The FEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act, 2004 biodiversity goals.

Figure 3-15 shows the location of the VDDC study area in relation to wetland and river FEPAs. It can be seen that the study area overlaps with wetland areas in the northern-, central- and southern portions. No FEPA rivers are located within the VDDC project area.

The central wetland area (Vleishaft tributary) is shown as a non-FEPA river. This system was authorised to be mined in 2007 and has been partially mined through at the SKS section. The VDDC project area is situated to the north of the Olifants River, downstream of the Olifants River / Koringspruit confluence. Both these rivers are classified as non-FEPA rivers (TBC, 2019).

3.6.8.7. *Mpumalanga Biodiversity Sector Plan Freshwater Assessment*

The Mpumalanga Biodiversity Sector Plan (MBSP) Freshwater Assessment outlines priority areas for freshwater biodiversity in Mpumalanga. The resulting features are predominantly derived from the NFEPA products and layers include:

- Critical Biodiversity Area (CBA) Rivers, which is based on FEPA and free-flowing rivers;
- CBA Wetlands, which is based on FEPA wetlands;
- CBA Aquatic species, relating to Odonata & crab taxa of conservation concern only;
- Ecological Support Area (ESA) Wetland Clusters, which is based on FEPA wetland clusters; and
- ESA Wetlands, relating to all other non-FEPA wetlands.

The larger VDDC study area in relation to the MBSP Freshwater Assessment is indicated in **Figure 3-16** and overlaps with the following areas:

- ESA: Wetlands;
- Heavily Modified Areas (HMAs); and
- Other Natural Areas (ONAs) (TBC, 2019).

It is important to note that the ESA wetlands in the MBSP are based on non-FEPA wetlands. The central wetland area (Vleishaft tributary) is indicated as an ESA: Wetlands. This system has however been partially mined based on previous authorisations.

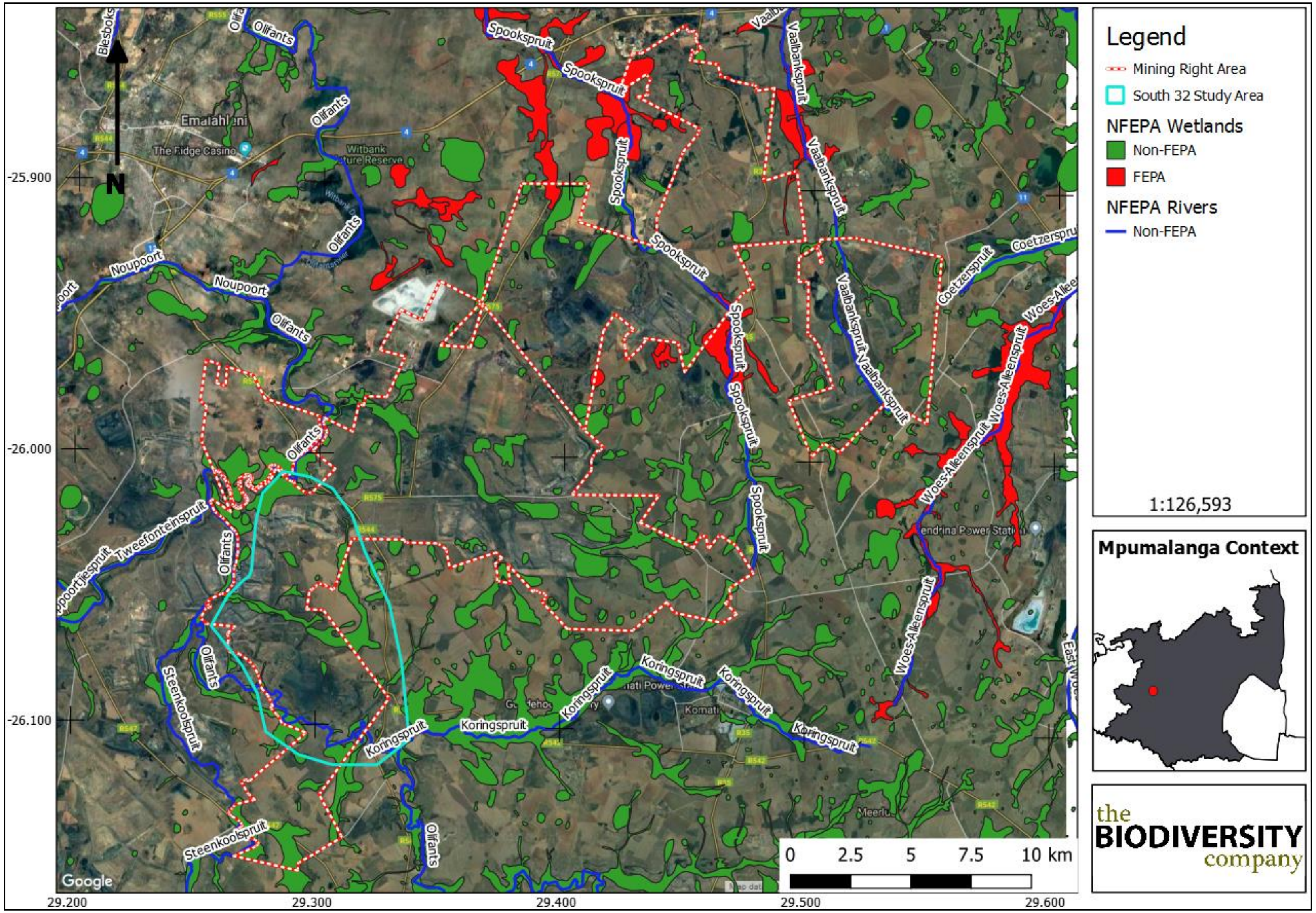

Figure 3-15: VDDC study area in relation to the National Freshwater Ecosystem Priority Areas (TBC, 2019)

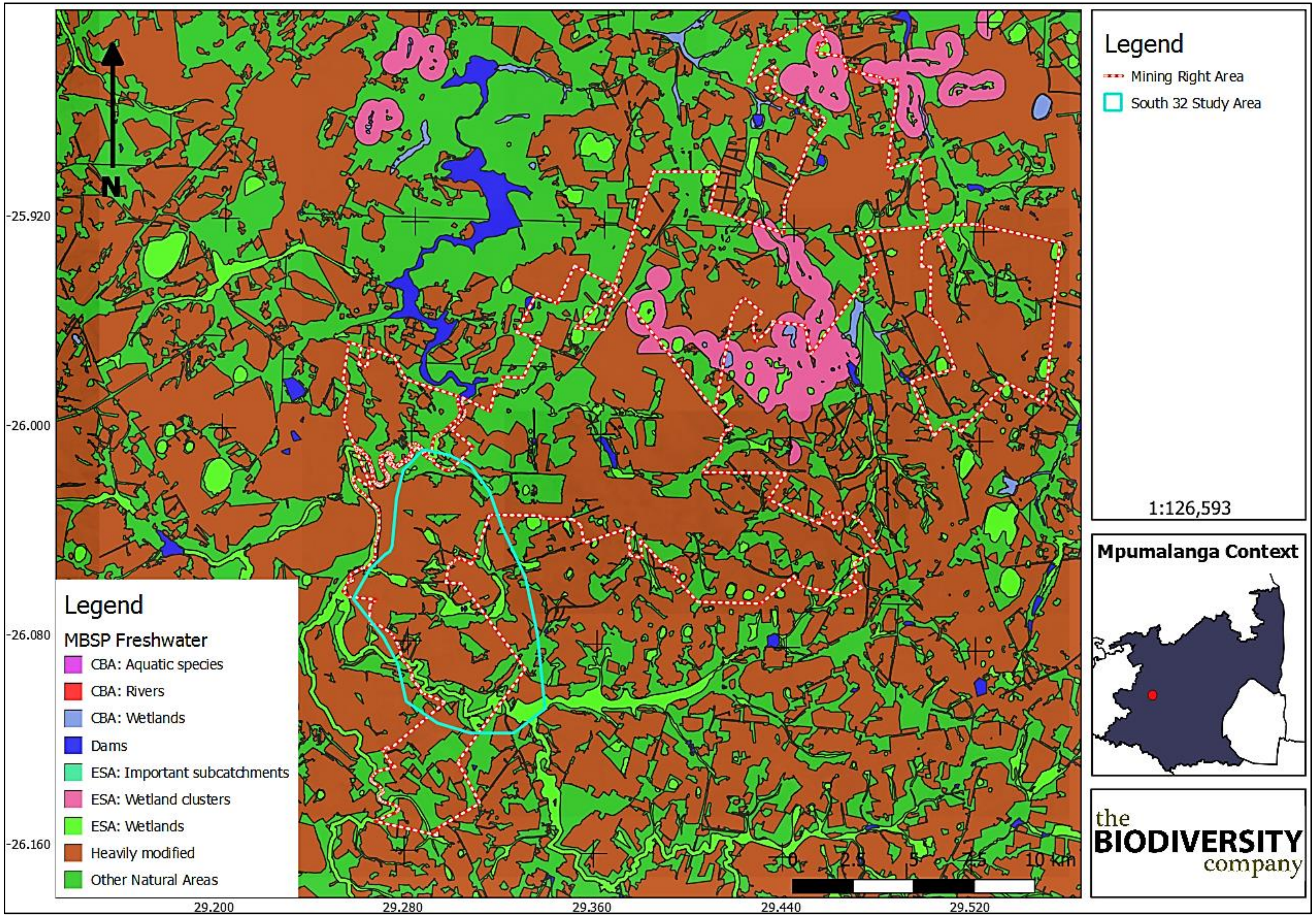

Figure 3-16: VDDC study area in relation to the MBSP Freshwater Assessment (TBC, 2019)

3.7 Groundwater

J&W conducted a geohydrological investigation for the VDDC infrastructure and mining project and a copy of the report is attached in the IWWMP (attached as **Appendix B**).

3.7.1 Regional geohydrology

The VDDC project is situated in the Great Karoo Basin in South Africa, consisting of the Karoo Supergroup. Geologically, the Karoo Supergroup is the largest stratigraphic unit in Southern Africa covering almost two thirds of the land surface. The basin hosts all the South African coal deposits and was formed in the great Gondwana basin which comprised parts of Southern Africa, India, Antarctica, Australia and South America.

The Karoo Supergroup comprises a sedimentary succession of sandstones, siltstones, shales and coal stratigraphic units. These stratigraphic units (from oldest to youngest) consist of the following:

- Dwyka Group – glacial marine deposit (comprising of diamictites and tillites) in the Carboniferous period;
- Ecca Group – fluvial deposition in the Permian period;
- Beaufort Group (terrestrial); and
- Stormberg Group (including basalts).

The first depositional sequence above the pre-Karoo formations comprises a sequence of diamictites, conglomerates and surface sandstones deposited by glacial and glacio-fluvial processes in glacial valleys (Dwyka Group). With the retreat of the ice sheets, lakes formed in the glacial valleys, which in time were transformed into swamps. This resulted in the formation of the lower coal seams. As a result of further shallowing of the valley slopes due to sedimentation within the channels, they began meandering and deltaic deposits were formed in shallow lakes on the flood plains.

The majority of the coal deposits in South Africa are contained in the Vryheid Formation (part of the Ecca Group) of the main basin and are restricted to the north eastern area of terrestrial deposition on a gently subsiding shelf platform. The strata, mostly shale, sandstone and coal seams, formed in fluvial environments.

The strata between the coal seams become finer upward in fluvial sequences, whereas delta and lacustrine sequences coarsen upward. As a general rule, grain size is coarser in shallow water “high energy” environments where waves or currents are present. Waves and currents transport finer sediments offshore into “low energy” environments, generally in deep, quiet water. Fine grain size indicates deposition in a “low energy”, quiet environment (J&W, 2019a).

3.7.2 Aquifer description

Based on a review of the previous investigations undertaken in the study area it is evident that three aquifers typically underlie the project are. These are:

- A shallow perched aquifer in the lower lying areas or depressions where a low, permeable, clayey ferricrete layer is overlain by alluvium and transported hillwash material. Wetlands commonly occur in these areas.
- A weathered aquifer, which extends to depths of approximately 20 metres below surface (mbs), depending on the depth of weathering. In the study area, this aquifer is expected to be clay-rich, with comparatively low aquifer parameters. This aquifer is

therefore not considered to be a major aquifer, although it does play a role in recharge to the deeper hard-rock aquifer; and

- A deeper fractured rock aquifer, which is characterised by fractures, faults and contact zones with dolerite intrusions in the Karoo sediments. This aquifer underlies the weathered aquifer and extends down to the bottom of the No. 2 coal seam.

A summary of the estimated aquifer thickness, based on the existing borehole database, is presented in **Table 3-15** below.

Table 3-15: Estimated aquifer thickness (J&W, 2019a)

Aquifer	Depth (mbs)	Geology
Perched	0 – 8.5	Sands including Alluvium & transported hillwash underlain by clay / ferricrete
Weathered	8.5 – 16	Weathered sandstone and siltstone underlain by carbonaceous shale and coal seams
Fractured	16-72	Slightly weathered to unweathered shale, sandstone and siltstone with coal seams underlain by basement rock

3.7.3 Aquifer Parameters

The calculated mean aquifer parameters for the boreholes tested during historic J&W investigations are presented in **Table 3-16**.

Transmissivity values of less than 1.0 m^2/day are typical of Karoo rocks. Within these aquifers, the groundwater can either be found in fractures or it can exist as inter-granular groundwater.

The average hydraulic conductivity is in the order of 0.030 to 0.0070 m/day. Since T = Kb, where b is aquifer thickness, it is understandable that the hydraulic conductivity is generally an order of magnitude less than the transmissivity.

Table 3-16: Mean aquifer parameters measured for boreholes in 2016 (J&W, 2019a)

Estimated Mean Parameter	Transmissivity (T)	Hydraulic Conductivity (K)	Storativity
	(m^2/day)	(m/day)	-
Weathered Aquifer			
Geometric Mean (2015)	1.0	0.080	N/A
Harmonic Mean (2015)	0.65	0.050	N/A
Calculated J&W Mean	**0.83**	**0.070**	N/A
JMA Slug Tests (2011)	-	0.040	-
Fractured Aquifer			
Geometric Mean (2015)	1.1	0.030	N/A
Harmonic Mean (2015)	0.73	0.020	N/A
Calculated Mean	**0.92**	**0.030**	N/A
JMA Slug Tests (2011)	**-**	0.0040	-

3.7.4 Groundwater recharge

Groundwater recharge can be defined as the process by which water is added from outside to the zone of saturation of an aquifer, either directly into a formation, or indirectly by way of another formation. The recharge in Karoo aquifers is generally in the range of between 2.0 – 5.0 % of the MAP, which is approximately 705 mm/a in the VDDC project area. The groundwater recharge in the study area is estimated to be 3.5 % of the MAP, which is equal to 25 mm/a.

3.7.5 Groundwater levels

The first important aspect when evaluating the hydrogeological regime and groundwater flow mechanisms is the groundwater gradients. Groundwater gradients, taking into consideration fluid pressure, are used to determine the hydraulic head which is the driving force behind groundwater flow.

An interpolation technique, using the available data, was used to simulate water levels over the entire model area. The interpolation technique used is referred to as Bayesian interpolation where water levels are correlated with the surface topography. The average depth to groundwater level for the study area was calculated to be 8.4 mbs when the boreholes drilled into the underground workings are not considered. When the underground workings boreholes are included the average depth increases to 25.8 mbs.

Typically, a linear relationship exists between the depth to groundwater and the topography, due to the fact that groundwater normally drains under gravity towards streams and rivers. The boreholes in the study area were evaluated either to prove or disprove if this concept is valid within this study area. All available static water levels (SWL) were plotted against topography. The results indicate a correlation of 93% between the topography and groundwater levels but the correlation is expected to improve to >95% if all the boreholes that were drilled into the underground workings are excluded. However, information on all the old boreholes could not be obtained to confirm if they intersect the workings and as such only the known underground workings boreholes are excluded from the graph. Another reason for the relatively low correlation is as a result of active dewatering occurring from the underground workings.

As groundwater levels follow topography, it can be assumed that groundwater flow takes place under unconfined to semi-confined conditions. It is indicated on **Figure 3-17**, that locally, and in general, groundwater flows from east to west towards the topographically low Olifants River at 1 505 mamsl.

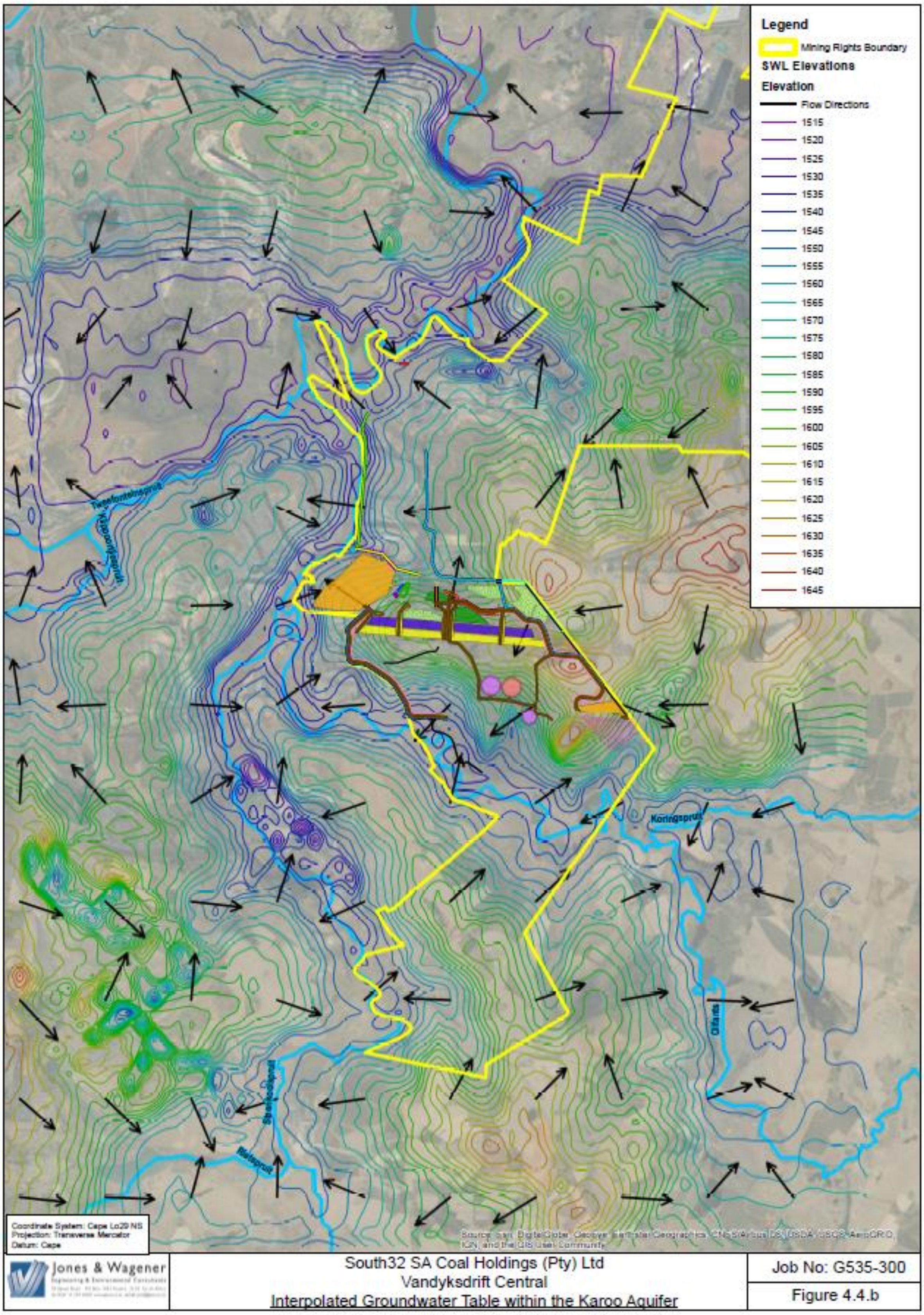

Figure 3-17: **Interpolated groundwater table within the Karoo Aquifer (J&W, 2019a)**

3.7.6 Hydrocensus

A hydrocensus was undertaken on the entire VDDC footprint to record the local and regional SWL on 1 and 6 August 2018. This information served as an important step in conceptualising the study area.

Being a brownfields area surrounded by mining complexes, no privately used boreholes were identified during the hydrocensus. In addition, due to access and logistical restrictions at the mine at the time, the hydrocensus did not yield sufficient data on the boreholes in the study area. As South32 already has a groundwater monitoring network in place, the existing borehole database for the VDDC and Steenkoolspruit areas was requested from South32 along with the groundwater qualities and associated water levels (J&W, 2019a).

A total of 35 boreholes were identified and used in the calibration of the numerical groundwater model. The results of the hydrocensus are presented in **Table 3-17**. The positions of the boreholes are indicated on **Figure 3-18**.

Table 3-17: Hydrocensus results (J&W, 2019a)

Borehole	Coordinates		SWL	Depth and Seam Information	Borehole Origin Information
	X	Y	mbs		
WBH2S4	28700.7	-2883425	No access		Boreholes drilled into the underground workings, provides indication of current underground water levels
WBH2S5	27742.72	-2883744	41.72	2 seam roof 52m 2 seam floor 55m	
WBH2S6	27354.51	-2884360	44.11	BH depth 65m 2 seam roof 61.5m 2 seam floor 65m	
WBH2S7	31163.55	-2885017	66.54	2 seam roof 74m 2 seam floor 78m	
WBH2S8	30610.12	-2883505	65.3	2 seam roof 64m 2 seam floor 65m	
WBH2S10	29902.32	-2884526	50.38	Slurry from 50m 2 seam roof 64m 2 seam floor 66m	
DGM-UB11	29644.26	-2887275	15.79		
DGM-UB72	29747.76	-2883560	37.59	BH depth 44m	
DGM-UB88	29054.41	-2880359	21.94		
DGM-UB110	29920.96	-2884397	51.68		
DGM-UB113	30826.66	-2885738	54.04		
DGM-UB114	29073.81	-2887383	17.27		
DGM-UB115	29825.42	-2888254	26.1		
DGM-BB34	28980.98	-2887137	3.48		Boreholes drilled into berm areas during Aug 1997 – Feb 1998 and 29-31 Mar 2004
DGM-BB132	31475.28	-2885752	9.08		
DGM-SB84	28884.37	-2880310	15.6		

Borehole	Coordinates		SWL	Depth and Seam Information	Borehole Origin Information
	X	Y	mbs		
DGM-SB122	28313.52	-2885852	6.66	BH depth 19m	Boreholes drilled into shallow weathered zone aquifer during Sep 1997 – Feb 1998 and Nov-Dec 2003
DGM-SB123	30122.55	-2886686	11.97	BH depth 16m	
DGM-SB124	29914.47	-2886498	1.63	Also known as BB71	
RB9	29409.94	-2887675	3.52		Unknown
UGS4S	30422.49	-2880135	16.37		
VD1N	31341	-2884422	11.62		
VD2N	32136	-2884860	No access		
VD3N (BH1)	29920	-2884130	43.63	Slurry in BH	
VD4N	27955	-2883881	42.23	Alt name Boorgat 1	
VD5N	27842	-2883965	Damaged		
VD6N	27694	-2884040	42.57	Alt name Boorgat 3	
VD7N	28372	-2886215	9.57		
VD8N	28377	-2886262	15.56		
VD9N	28315	-2885854	6.66	BH depth 19m	
VD10N	30066	-2880076	67.40	Datalogger installed	
P1	29101	-2887131	7.01	BH depth 10m	
P2	29054	-2887080	1.65	BH depth 12m	
P3	29004	-2887032	1.52	BH depth 10m	
P4	28943	-2886975	1.54	BH depth 12m	

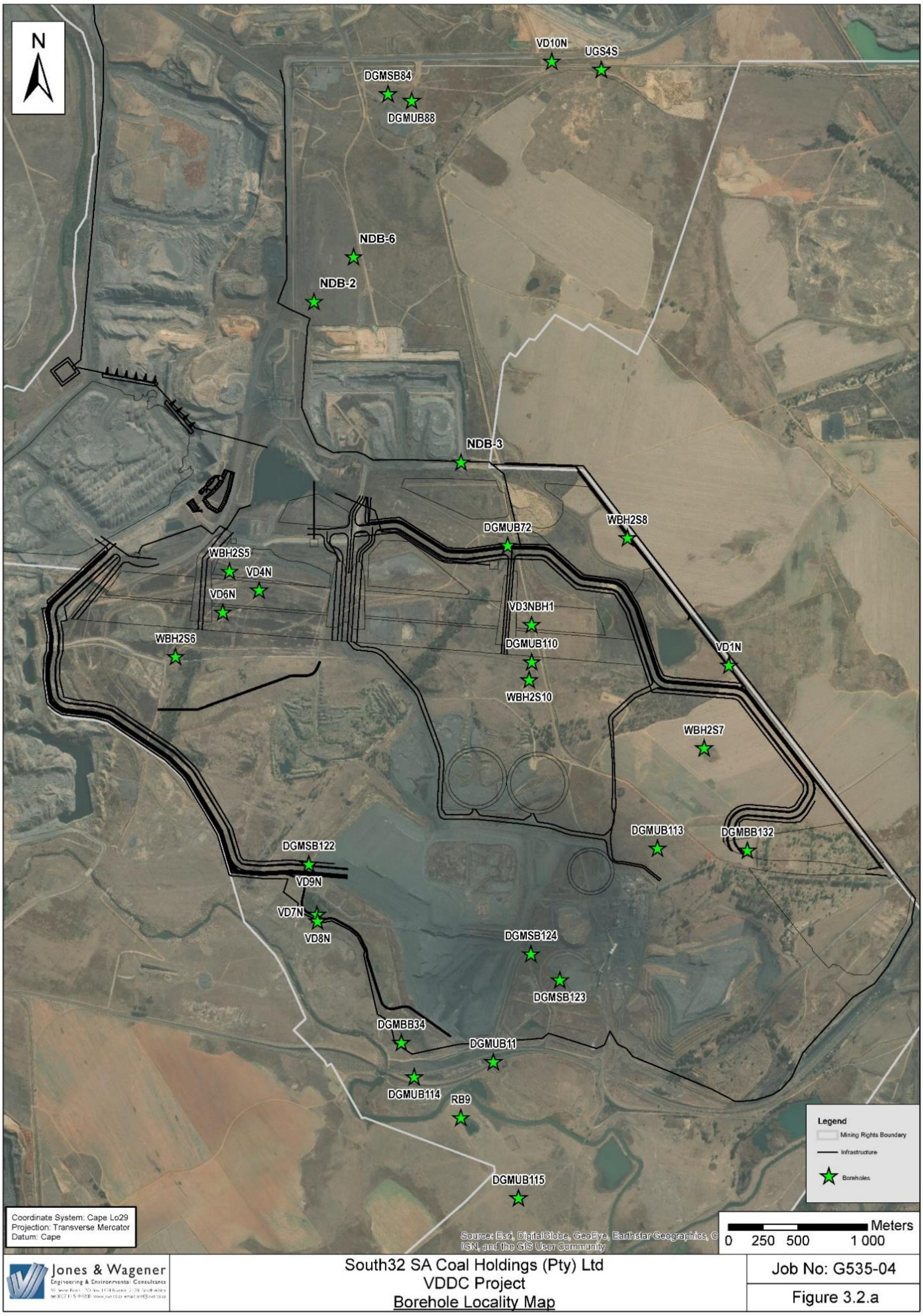

Figure 3-18: Borehole locality map (J&W, 2019a)

3.7.7 Groundwater quality

Recent water quality records dated from 2015 – 2018, were obtained for 11 boreholes which were deemed relevant to this assessment. In addition, the hydrochemistry results from a study conducted by J&W in 2016 were also considered.

The more recent (January 2018) groundwater quality results as obtained from South32, are compared with the maximum recommended concentrations for drinking water as defined by the SANS 241-1: 2015 Drinking Water Standard. Since the study area is located within a brownfields area where the natural environment has been impacted upon by mining for many decades, recent background water qualities with specific relevance to VDDC are limited. As such, the SANS 241 standards have therefore been used for the screening of all inorganic and trace element constituents.

The results of the screening for groundwater are presented in **Table 3-18** and **Table 3-19**. According to these results, elevated sulphate concentrations in boreholes VD3N (also referred to as SKS BH1) and NDB 6, as well as low pH in VD3N were recorded. The position of the monitoring boreholes used in the baseline assessment is indicated in **Figure 3-20**.

The Piper diagram shown in **Figure 3-19** indicates that most samples have been affected by mining activities which is illustrated by the samples plotting in the top quadrant of the quadrilateral diamond. Samples unaffected by mining activities but plotting in the bottom and right quadrants of the quadrilateral diamond indicate water that is older and has undergone ion-exchange within the aquifer.

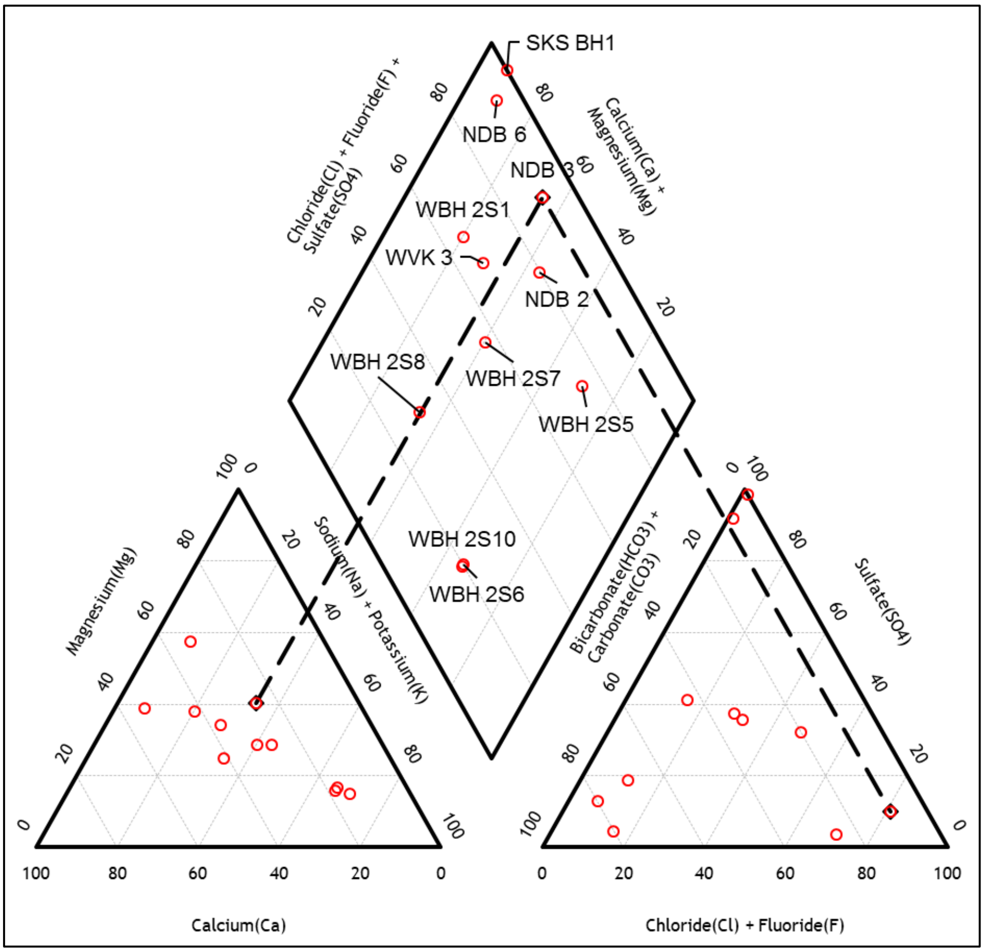

Figure 3-19: Piper diagram of groundwater sample chemistry (J&W, 2019a)

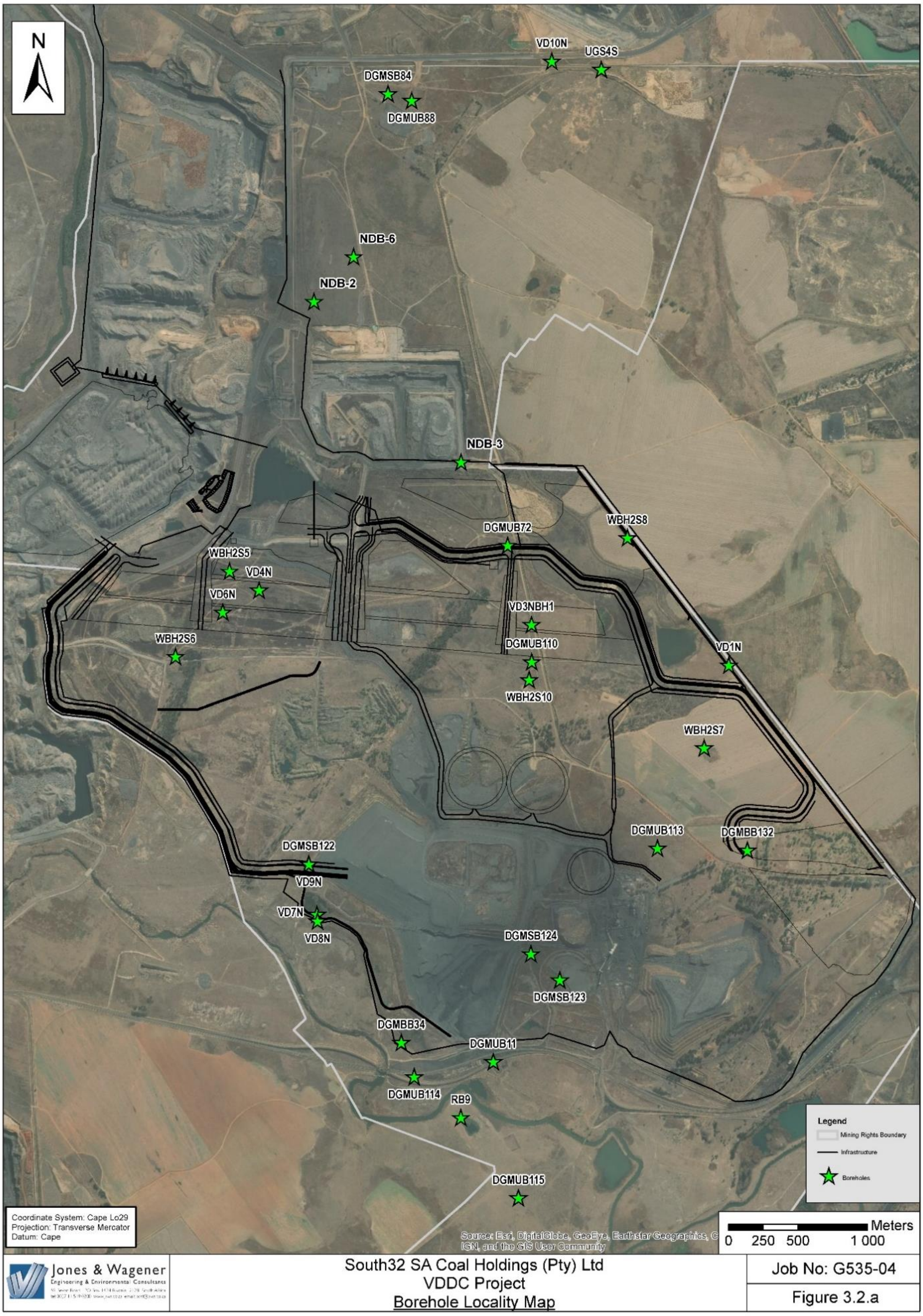

Figure 3-20: Position of monitoring boreholes used in baseline assessment (J&W, 2019a)

Table 3-18: Groundwater qualities compared to SANS 241-1:2015 guidelines for human consumption (dataset 1) (J&W, 2019a)

Parameter		Unit	SANS 241: 2015 Recommended Limits	Risk	Results					
					WBH 2S1	WBH 2S5	WBH 2S6	WBH 2S7	WBH 2S8	WBH 2S10
Physical & Aesthetic Determinants										
Electrical conductivity at 25C	EC	mS/m	≤ 170	Aesthetic	39.7	22.4	45.5	64.8	18.9	15.1
Total Dissolved Solids	TDS	mg/ℓ	≤ 1200	Aesthetic	252	116	278	424	104	82
pH at 25C		pH units	≥ 5 to ≤9.7	Aesthetic	7.04	6.88	7.78	7.58	7.35	7.31
Chemical Determinants - Macro Determinants										
Nitrate as N	NO_3	mg/ℓ	≤ 11	Acute Health	20.2	0.46	0.93	6.48	0.58	0.97
Sulphate	SO_4	mg/ℓ	Acute Health ≤500; Aesthetic ≤250	Acute Health/Aesthetic	36.1	3.26	28.8	125	15.5	2.69
Fluoride	F	µg/ℓ	≤1500	Chronic Health	0	0	1 290	420	0	340
Chloride	Cl	mg/ℓ	≤ 300	Aesthetic	20.1	46.6	11.7	33.8	7.34	7.02
Sodium	Na	mg/ℓ	≤ 200	Aesthetic	13.5	27.2	66.4	53.9	11.7	18.3
Total Iron	Fe	mg/ℓ	Acute Health ≤ 2; Aesthetic ≤0.3	Acute/Aesthetic	0	0	0.01	0.04	0	0.01
Total manganese	Mn	mg/ℓ	Acute Health ≤0.4; Aesthetic ≤0.1	Acute/Aesthetic	0	0	0	0.01	0	0
Aluminium	Al	µg/ℓ	≤ 300	Operational	10	0	20	10	30	50
Concentrations which exceed the guidelines for acceptable health risk for lifetime consumption as per the Drinking Water Standards (SANS 241)										

Table 3-19: Groundwater qualities compared to SANS 241-1:2015 guidelines for human consumption (dataset 2) (J&W, 2019a)

Parameter		Unit	SANS 241: 2015 Recommended Limits	Risk	Results				
					SKS BH1	WVK 3	NDB 2	NDB 3	NDB 6
Physical & Aesthetic Determinants									
Electrical conductivity at 25C	EC	mS/m	≤ 170	Aesthetic	140	22.7	9.73	42.2	430
Total Dissolved Solids	TDS	mg/ℓ	≤ 1200	Aesthetic	956	148	64	286	4206
pH at 25C		pH units	≥ 5 to ≤9.7	Aesthetic	3.19	6.55	5.81	6.08	7.1
Chemical Determinants - Macro Determinants									
Nitrate as N	NO_3	mg/ℓ	≤ 11	Acute Health	2	13.8	2.14	30.8	1.67
Sulphate	SO_4	mg/ℓ	Acute Health ≤500; Aesthetic ≤250	Acute Health/Aesthetic	652	17.7	12.2	7.48	2778
Fluoride	F	µg/ℓ	≤1500	Chronic Health	0	0	0	0	430
Chloride	Cl	mg/ℓ	≤ 300	Aesthetic	6.9	11.6	13.4	44.7	25.4
Sodium	Na	mg/ℓ	≤ 200	Aesthetic	16.5	10.8	7.34	19.8	127
Total Iron	Fe	mg/ℓ	Acute Health ≤ 2; Aesthetic ≤0.3	Acute/Aesthetic	2.06	0	0.31	0.01	0
Total manganese	Mn	mg/ℓ	Acute Health ≤0.4; Aesthetic ≤0.1	Acute/Aesthetic	1.42	0.02	0.06	0.1	8.62
Aluminium	Al	µg/ ℓ	≤ 300	Operational	6260	30	440	40	20
Concentrations which exceed the guidelines for acceptable health risk for lifetime consumption as per the Drinking Water Standards (SANS 241)									

3.7.8 Aquifer characterisation

3.7.8.1. Groundwater vulnerability

Aquifer vulnerability assessment indicates the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. Stated in another way, it is a measure of the degree of insulation that the natural and manmade factors provide to keep contamination away from groundwater. It can be summarised as follows:

- Vulnerability is high if natural factors provide little protection to shield groundwater from contaminating activities at the land surface;
- Vulnerability is low if natural factors provide relatively good protection and if there is little likelihood that contaminating activities will result in groundwater degradation.

The following factors influence groundwater vulnerability:

- *Depth to groundwater:* Indicates the distance and time required for pollutants to move through the unsaturated zone to the aquifer;
- *Recharge:* The primary source of groundwater is precipitation, which aids the movement of a pollutant to the aquifer;
- *Aquifer media:* The rock matrices and fractures which serve as water bearing units.
- *Soil media:* The soil media (consisting of the upper portion of the vadose zone) affects the rate at which the pollutants migrate to groundwater;
- *Topography:* Indicates whether pollutants will run off or remain on the surface allowing for infiltration to groundwater to occur;
- *Impact of the vadose zone:* The part of the geological profile beneath the earth's surface and above the first principal water-bearing aquifer. The vadose zone can retard the progress of the contaminants.

The Groundwater Decision Tool (GDT) was used to quantify the vulnerability of the aquifer underlying the site using the below assumptions.

- Depth to groundwater below the site was estimated from water levels measured during the hydrocensus inferred to be at mean of ~10 mbs;
- Groundwater recharge of ~25 mm/a (3.5% recharge);
- Sandy clay soil vadose zone;
- Gradient of 1% was assumed and used in the estimation.

The aquifer vulnerability for a contaminant released from surface to a specified position in the groundwater system after introduction at some location above the uppermost aquifer was determined using the criteria described below and assuming a worst-case scenario:

- *Highly vulnerable (> 60%),* the natural factors provide little protection to shield groundwater from contaminating activities at the land surface;
- *Medium Vulnerable (30 to 60%),* the natural factors provide some protection to shield groundwater from contaminating activities at the land surface, however based on the contaminant toxicity mitigation measures will be required to prevent any surface contamination from reaching the groundwater table;

- *Low Vulnerability (< 30%),* natural factors provide relatively good protection and if there is little likelihood that contaminating activities will result in groundwater degradation.

The calculated vulnerability value based on the GDT is 53%, which is medium vulnerability (J&W, 2019a).

3.7.8.2. *Aquifer classification*

The aquifer(s) underlying the subject area were classified in accordance with "*A South African Aquifer System Management Classification, December 1995".*

The main aquifers underlying the area were classified in accordance with the Aquifer System Management Classification document, published by the (then) DWAF in 1995. The aquifers were classified by using the following definitions:

- *Sole Aquifer System:* An aquifer which is used to supply 50% or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial;
- *Major Aquifer System:* Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (Electrical Conductivity of less than 150 mS/m);
- *Minor Aquifer System:* These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important for local supplies and in supplying base flow for rivers;
- *Non-Aquifer System:* These are formations with negligible permeability that are regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks, although imperceptible, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.

Based on information collected during the hydrocensus it can be concluded that the aquifer system in the study area can be classified as a "Minor Aquifer System", based on the fact that the local population is not dependent on groundwater (J&W, 2019a).

In order to achieve the Aquifer System Management and Second Variable Classifications, as well as the Groundwater Quality Management (GQM) Index, a point scoring system as presented in **Table 3-20** and **Table 3-21** was used.

Table 3-20: Ratings – Aquifer System Management and Second Variable Classifications (J&W, 2019a)

Aquifer System Management Classification		
Class	Points	Study area
Sole Source Aquifer System:	6	
Major Aquifer System:	4	
Minor Aquifer System:	2	2
Non-Aquifer System:	0	
Special Aquifer System:	0 – 6	

Aquifer System Management Classification		
Class	Points	Study area
Second Variable Classification (Weathering/Fracturing)		
Class	Points	Study area
High:	3	
Medium:	2	2
Low:	1	

Table 3-21: Ratings - Groundwater Quality Management (GQM) Classification System (J&W, 2019a)

Aquifer System Management Classification		
Class	Points	Study area
Sole Source Aquifer System:	6	
Major Aquifer System:	4	
Minor Aquifer System:	2	2
Non-Aquifer System:	0	
Special Aquifer System:	0 – 6	
Aquifer Vulnerability Classification		
Class	Points	Study area
High:	3	
Medium:	2	2
Low:	1	

As part of the aquifer classification, a Groundwater Quality Management (GQM) Index is used to define the level of groundwater protection required. The GQM Index is obtained by multiplying the rating of the aquifer system management and the aquifer vulnerability. The GQM index for the study area is presented in **Table 3-22**.

GQM Index = Aquifer System Management x Aquifer Vulnerability

= 2 x 2 = 4

Table 3-22: GQM Index for the study area (J&W, 2019a)

GQM Index	Level of Protection	Study Area
<1	Limited	
1 – 3	Low Level	
3 – 6	Medium Level	**4**
6 – 10	High Level	
>10	Strictly Non-Degradation	

The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer, in terms of the above, is classified as **medium.**

3.7.8.1. *Aquifer protection*

Based on the GQM Index of 4 that was estimated for the study area, a medium-level groundwater protection is required for the aquifer. Reasonable and sound groundwater protection measures based on the modelling will therefore be recommended to ensure that no cumulative pollution affects the aquifer, even in the long term.

The Department of Water and Sanitation's (DWS) water quality management objectives are to protect human health and the environment. Therefore, the significance of this aquifer classification is that measures must be taken to limit the risk to the following environments:

- The protection of the underlying aquifer;
- The protection of surface water drainage systems (J&W, 2019a).

3.7.9 Groundwater model

As part of the geohydrological investigation, a groundwater flow and transport model was developed. Key aspects of the groundwater model are summarised below, and more detail is available in the specialist report.

3.7.9.1. *Assumptions and limitations*

Specific assumptions related to the available field data include:

- The top of the aquifer is represented by the generated groundwater heads;
- The available geological / hydrogeological information was used to describe the different aquifers. The available information on the geology and field tests is considered as correct;
- Certain aquifer parameters have not been determined in the field and therefore had to be estimated (refer to **Table 3-23**).

It is important to note that a numerical groundwater model is a representation of the real system. It is therefore at most an approximation, and the level of accuracy depends on the quality of the data that is available. This implies that there are always errors associated with groundwater models due to uncertainty in the data and the capability of numerical methods to describe natural physical processes.

3.7.9.2. *Software Model Choice*

A three-dimensional numerical model was employed to simulate stresses to the aquifer system in both a spatial and temporal context. The finite element 3D-modelling package FEFLOW 7 (Finite Element subsurface FLOW system) was used. FEFLOW is a modular, three-dimensional finite element groundwater flow model, which was developed by DHI. FEFLOW uses finite element analysis to solve the groundwater flow equation of both saturated and unsaturated conditions, as well as mass and heat transport, also accounting for fluid density effects.

3.7.9.3. *Model Set-up and Boundaries*

The model domain represents a subset of the regional groundwater regime. For the model to be realistic, the boundary conditions should therefore be selected to coincide with physical hydrogeological boundaries such as watersheds. The model mesh consists of 375 613 mesh nodes and 642 144 mesh elements. Mesh quality is acceptable since obtuse angles greater than 90° total 2.1% and Delaunay-violating triangles total 0.03%.

Boundaries were chosen to include the area where the groundwater pollution plume could reasonably be expected to spread and simultaneously be far enough removed from site boundaries not to be affected by groundwater abstraction. The model domain is illustrated in **Figure 3-21.** The model boundaries resulted in an area of about 2 to 15 km around the project site, which is considered far enough for the expected groundwater effects not to be influenced by boundaries.

3.7.9.4. Groundwater Elevation and Gradient

The calibrated static water levels as modelled have been contoured (refer to **Figure 3-23**). Groundwater flow directions will be perpendicular to these contours and inversely proportional to the distance between contours. As can be expected, the groundwater flow is mainly from topographical high to low areas, eventually draining to the local streams.

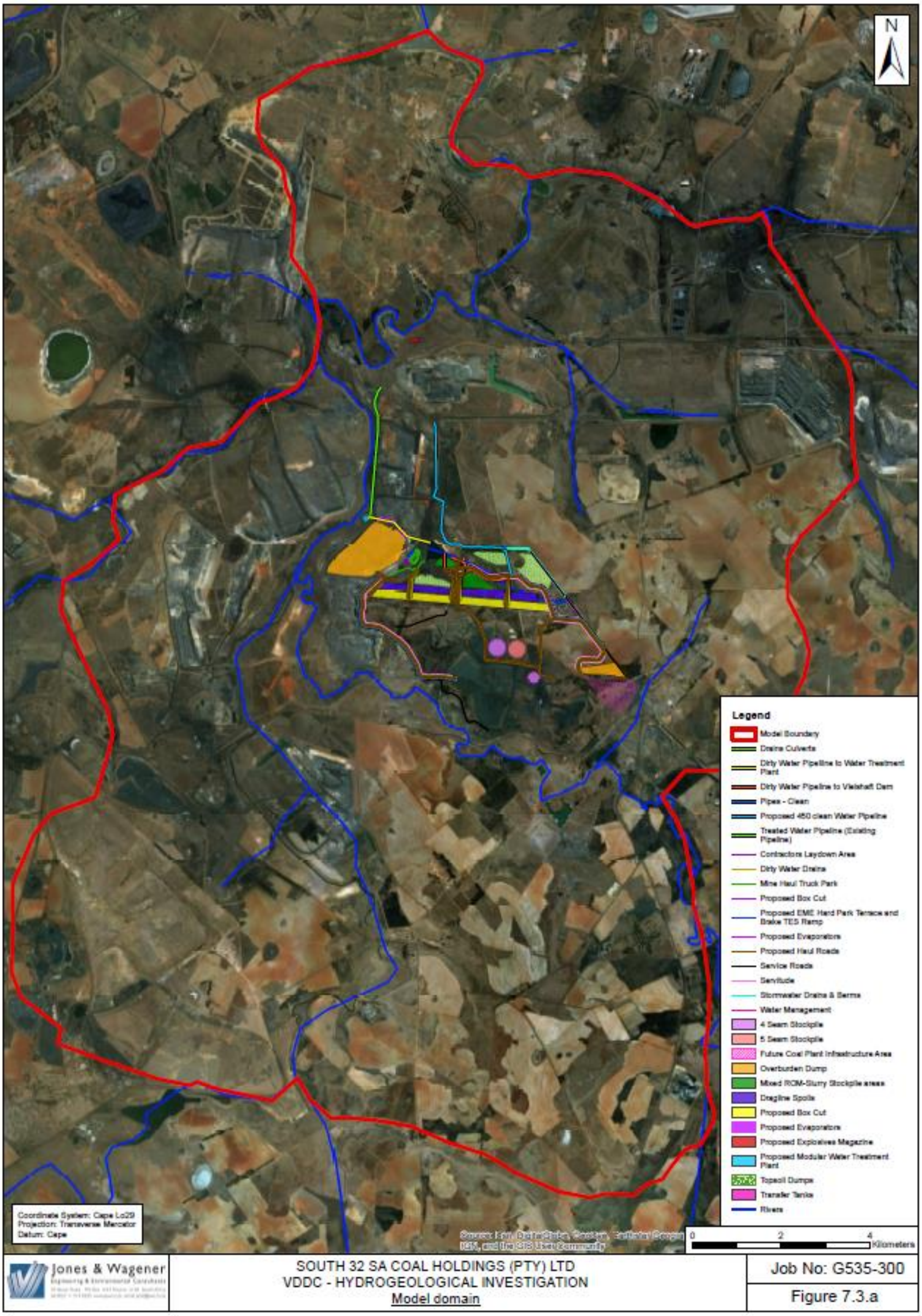

Figure 3-21: Model domain (J&W, 2019a)

3.7.9.5. *Geometric Structure of the Model*

The geometric structure of the model is outlined below.

Groundwater Sources and Sinks

Although the most relevant aquifer parameters are optimised by the calibration of the model, many parameters are calculated and/or judged by conventional means. The fixed assumptions and input parameters listed in **Table 3-23** were used for the numerical model of this area.

Table 3-23: Input parameters to the numerical flow model (J&W, 2019a)

Model Parameter	Value	Unit	Reference
Recharge to the aquifer	0.0001	m/d	Calculated
Recharge to the backfilled opencast mine	0.0004	m/d	Hodgson and Krantz (1998)
Boundaries	Topographic water divides and streams	-	Existing boundary conditions present at the site that would potentially include modelled impacts
Refinement	variable	m	Based on the scale of the mining area
Hydraulic conductivity	0.01	m/d	Existing hydrogeological report (Groundwater Complete, 2013)
Hydraulic anisotropy (vertical)	10	-	Anderson *et al.* (2015)
Effective porosity	5 declining to 3 with depth in each layer	%	Wang *et al*. (2009)
Layers	6	Count	Regolith, weathered aquifer, fractured aquifer and coal seam depths with varying hydraulic parameters.
Longitudinal dispersion	50	m	Schulze-Makuch (2005)
Head error range	15	m	Calculated as less than 10% of the difference between the maximum and minimum calculated head elevations (Diersch, 2013)

Conceptual Model

For this study, the subsurface was envisaged to consist of the following hydrogeological units:

- The upper few metres below surface consist of completely weathered material. This layer is anticipated to have a reasonable high hydraulic conductivity, but in general unsaturated. However, a seasonal aquifer perched on the bedrock probably does form in this layer, especially after high rainfall events. Flow in this perched aquifer is expected to follow the surface contours closely and emerge as fountains or seepage at lower elevations;
- The next few tens of metres can be subdivided into two aquifer systems comprising of slightly weathered, highly fractured sedimentary bedrock with a low hydraulic

conductivity and the backfill material which has a high hydraulic conductivity. The permanent groundwater level resides in this unit and is about 1 to 10 mbgl. The groundwater flow direction in this unit is influenced by regional topography and for the site flow would be in general from high lying areas to the rivers and streams in the area, for the fractured bedrock. The hydrodynamics of the area will be greatly influenced by the mine as its hydraulic properties are similar to that of a gravel system. The hydraulic conductivity of this aquifer was estimated at 100 m/d;

- Below a few tens of meters, the fracturing of the aquifer is less frequent and fractures less significant due to increased pressure. This results in an aquifer of lower hydraulic conductivity and very slow groundwater flow velocities. The hydraulic conductivity of this aquifer was estimated at 0.01 m/d and was estimated from pumping test data as well as literature.

3.7.9.6. Steady state model calibration

Water level and quality data obtained during the hydrocensus were used to calibrate the steady state numerical groundwater flow model. The results obtained during the steady state scenarios were used as initial conditions to simulate dewatering and contaminant transport impacts. The observed groundwater levels were plotted against the simulated values in a scatter plot as shown in **Figure 3-22.** The distribution of the simulated values around the theoretical line indicates that the groundwater model does not have a notable bias to over simulate or under simulate the observed groundwater levels. The root mean squared error is 11.5 m which is less than 10% of the overall groundwater level variation observed onsite. This is considered to be acceptable for flow calibration purposes.

Simulated groundwater gradients are shown in **Figure 3-23**. This figure shows that the groundwater gradients generally mimic the surface topography as expected. Exceptions occur where localised dewatering occurs or where the influence of hydrogeological structures are unknown.

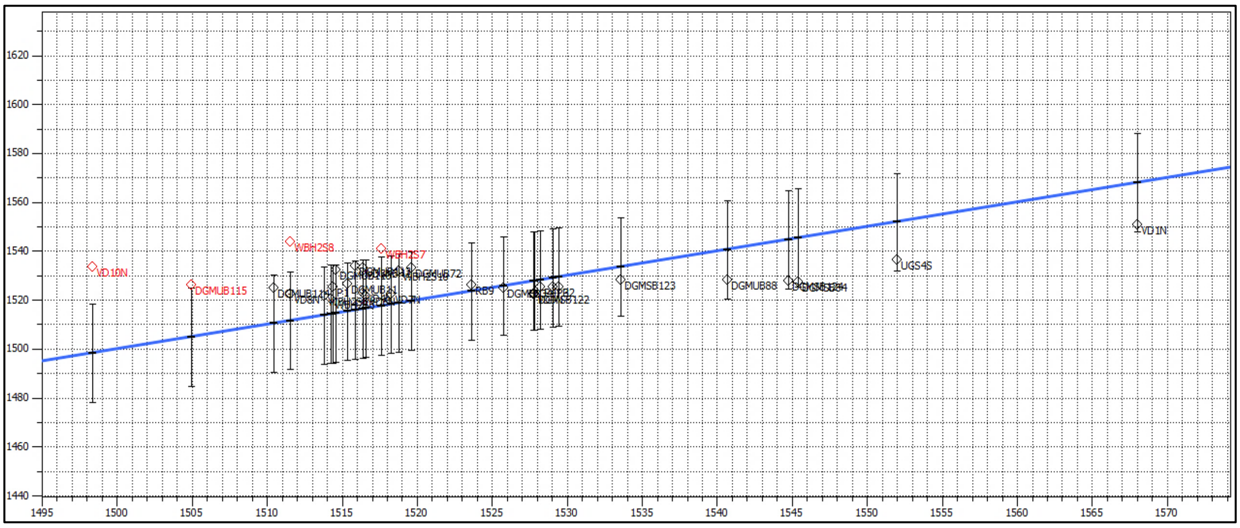

Figure 3-22: Water level calibration graph (J&W, 2019a)

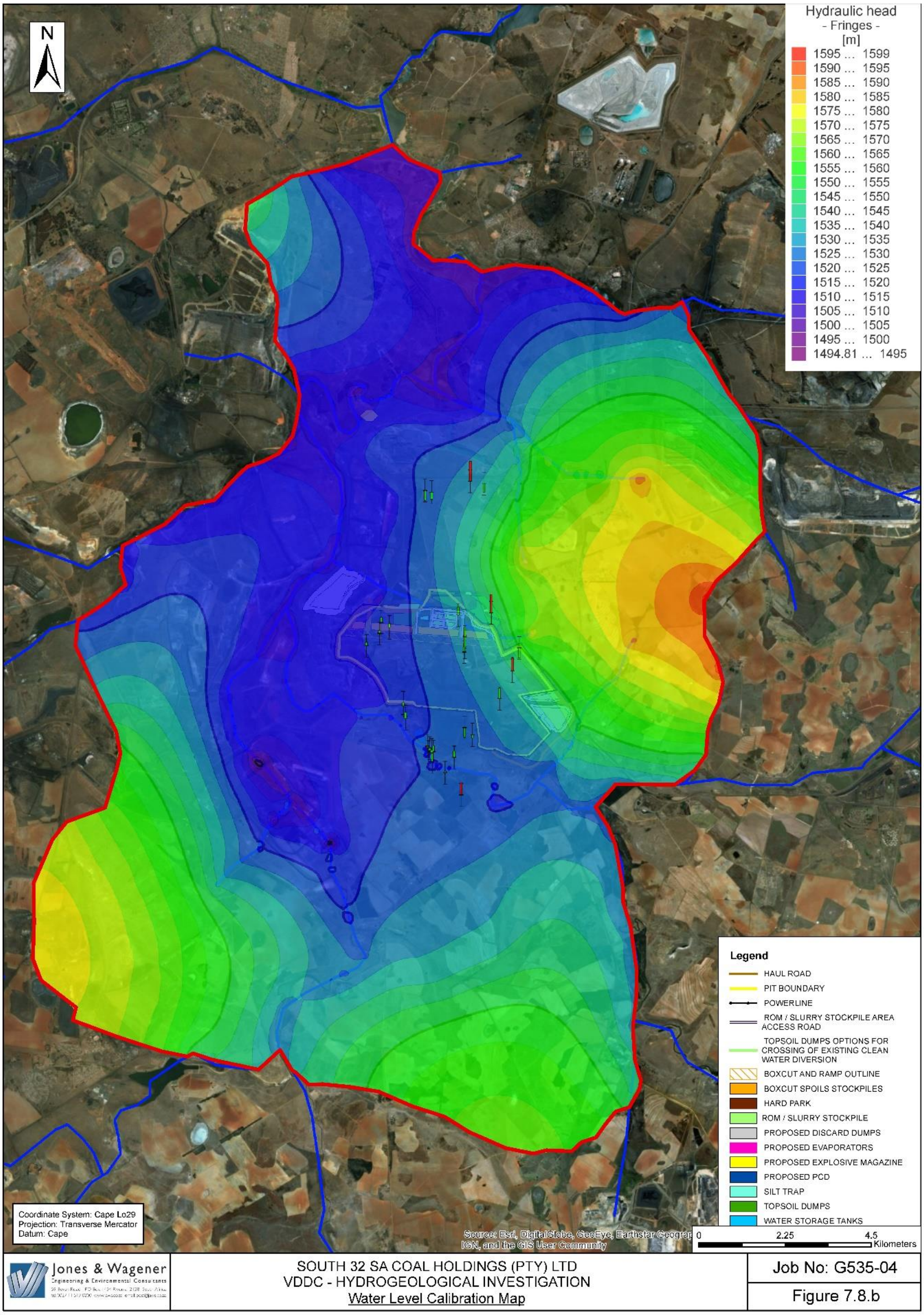

Figure 3-23: Water level calibration map (J&W, 2019a)

3.7.9.7. *Model scenarios*

The scenarios considered in the model set-up that were used to predict the impact on groundwater, is outlined below.

Pre-Development

This model represents the pre-mining scenario and is used for calibration purposes. The model is representative of steady-state natural conditions prior to the application of stresses to the aquifer and provides a baseline from which all following calculations are performed. All required hydraulic parameters are defined and calibrated in this model as a simplified mathematical representation of the hydrogeological scenario on and around the site.

During Mining/Operational Phase

This model represents the groundwater situation during operation of mining. A drain was thus imposed under the mining area at mining depth. The modelling included the following transport and dewatering scenarios:

Transport

- Overburden dumps;
- Mixed ROM coal and slurry stockpile areas;
- Final rejects dump (cumulative impact – existing authorised facility);
- Dragline spoils;
- Proposed evaporators;
- Vleishaft PCD (cumulative impact – existing authorised facility);
- No. 5 Seam and No. 4 Seam ROM stockpiles.

Dewatering

- Proposed VDDC opencast mine including expansion area outside 2007 approved EMPR amendment;
- Proposed No. 2 seam dewatering prior to mine development.

The numerical groundwater flow model indicates the associated flow directions and velocities and simulated inflow rates towards the mining activities.

Post-Mining/Decommissioning and Closure Phase

This models the post-mining scenario, assuming that the most likely recharge over the rehabilitated opencast will be 0.0004 m/d. This amounts to a recharge of about 20% of rainfall, which is probably a worst-case scenario. The modelling included the following transport and dewatering scenarios:

Transport

- Proposed VDDC opencast mine (after backfilling) including expansion area outside 2007 approved EMPR Amendment;
- Final rejects dump (cumulative impact – existing authorised facility).

Discharge

- Proposed VDDC opencast mine (after backfilling) including expansion area outside 2007 approved EMPR Amendment.

4. WATER USES

4.1 Water uses associated with the project

The following water uses as defined in the NWA are relevant to the project (described in detail below):

- S21(c): Impeding or diverting the flow of water in a watercourse;
- S21(i): Altering the bed, banks, course or characteristics of a watercourse;
- S21(f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
- S21(g): Disposing of waste in a manner which may detrimentally impact on a water resource;
- S21(j): Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

The water uses are discussed below and summarised in **Table 4-4**.

4.1.1 Section 21(c) &(i) water uses

There are several watercourses within the VDDC mining area (refer to section 3.6.7).

Opencast mining of the Vleishaft tributary has been approved in the WUL issued for the Douglas Middelburg Optimisation (DMO) project (WUL number 24084535) and a section of the tributary has been mined through when the SKS section was mined.

The development of infrastructure and the additional opencast mining areas not approved previously, may further impact on watercourses.

For ease of reference, the areas where infrastructure development or opencast mining will take place within the regulated area, i.e. the 1:100 year floodline and within 500 m of delineated watercourses, has been categorised as follows:

- Infrastructure area 1: Located in the west of the VDDC section, incorporating the footprint of the modular WTP and a portion of the footprint of the overburden dump to be located on the SKS void;
- Infrastructure area 2: Located in the west of the VDDC section, incorporating a portion of the footprint of the overburden dump to be located on the SKS void;
- Infrastructure area 3: Located in the south of the VDDC section, incorporating infrastructure within the western servitude that will be developed within 500 m of delineated watercourses, as well as a service road;
- Infrastructure area 4: The portion of infrastructure that will be developed within the northern and eastern sections of the VDDC section in the vicinity of the Vleishaft tributary;
- Opencast mining extension: Portions of the proposed opencast mining not previously authorised located within 500 m of delineated watercourses;

- Explosives magazine and discharge point of treated water from modular WTP, located to the north of the VDDC section. A new section of pipeline will be developed between an existing pipeline and the northern canal. This will be within 500 m of a delineated wetland and the Olifants River.

These areas are shown on **Figure 4-1**.

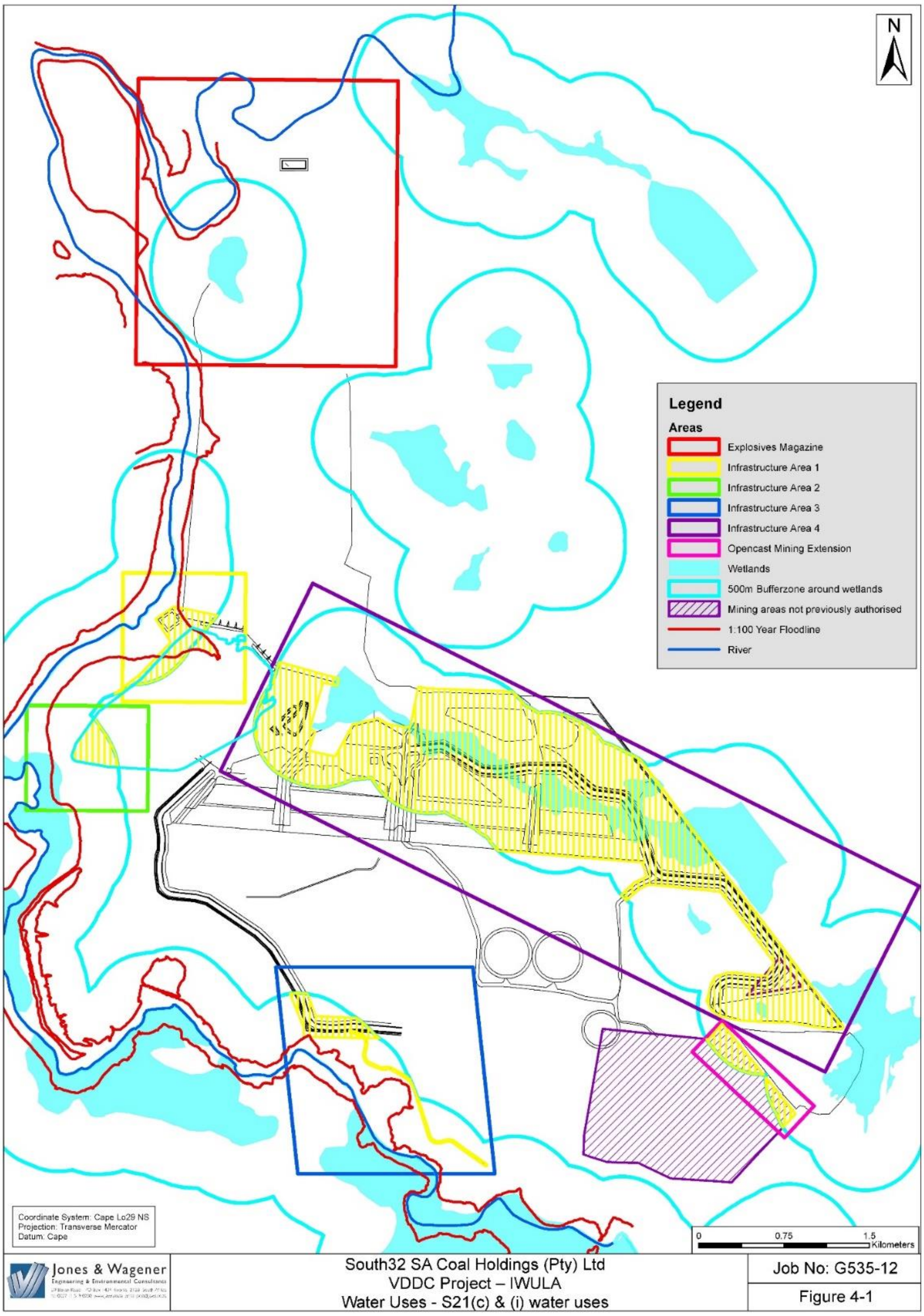

Figure 4-1: Overview of S21(c)&(i) water uses

4.1.1.1. Infrastructure area 1

Infrastructure will be developed within 500 m of the Olifants River, located to the west of the SKS pit. This includes a modular WTP, some of the evaporators to be located on the SKS void and a portion of the footprint of the overburden dump to be located on the SKS void (refer to **Figure 4-2**). The modular WTP and a portion of the footprint of the overburden dump to be located on the SKS void are located within the 1:100 year floodline.

This area has been extensively impacted as a result of mining activities and the infrastructure components will mainly be developed on the existing SKS void.

4.1.1.2. Infrastructure area 2

This includes a portion of the footprint of the overburden dump to be located on the SKS void (refer to **Figure 4-2**) and will not directly impact the watercourse. The overburden material will be stockpiled on the initial SKS pit excavations which have been partially backfilled. The material will eventually be placed back into the VDDC pit as part of the concurrent rehabilitation.

4.1.1.1. Infrastructure area 3

This involves the development of infrastructure as part of the western servitude within 500 m of delineated watercourses as indicated on **Figure 4-3**. The infrastructure includes the following:

- Haul road;
- Service road;
- Stormwater drains and berms;
- Clean water pipeline.

Clean Water Drain W2 as per engineering drawing C00820-05FH-CI-DGA-005-002 is located within Infrastructure Area 3.

Haul roads and service roads have been designed with side drains to manage the runoff from either the road surface or minor catchments formed by the road formations. These drains are unlined and regular culverts have been allowed for through drainage to the lower lying side of the road formations to ensure volumes and velocities of water in the side drains are kept to a minimum (Worley, 2019).

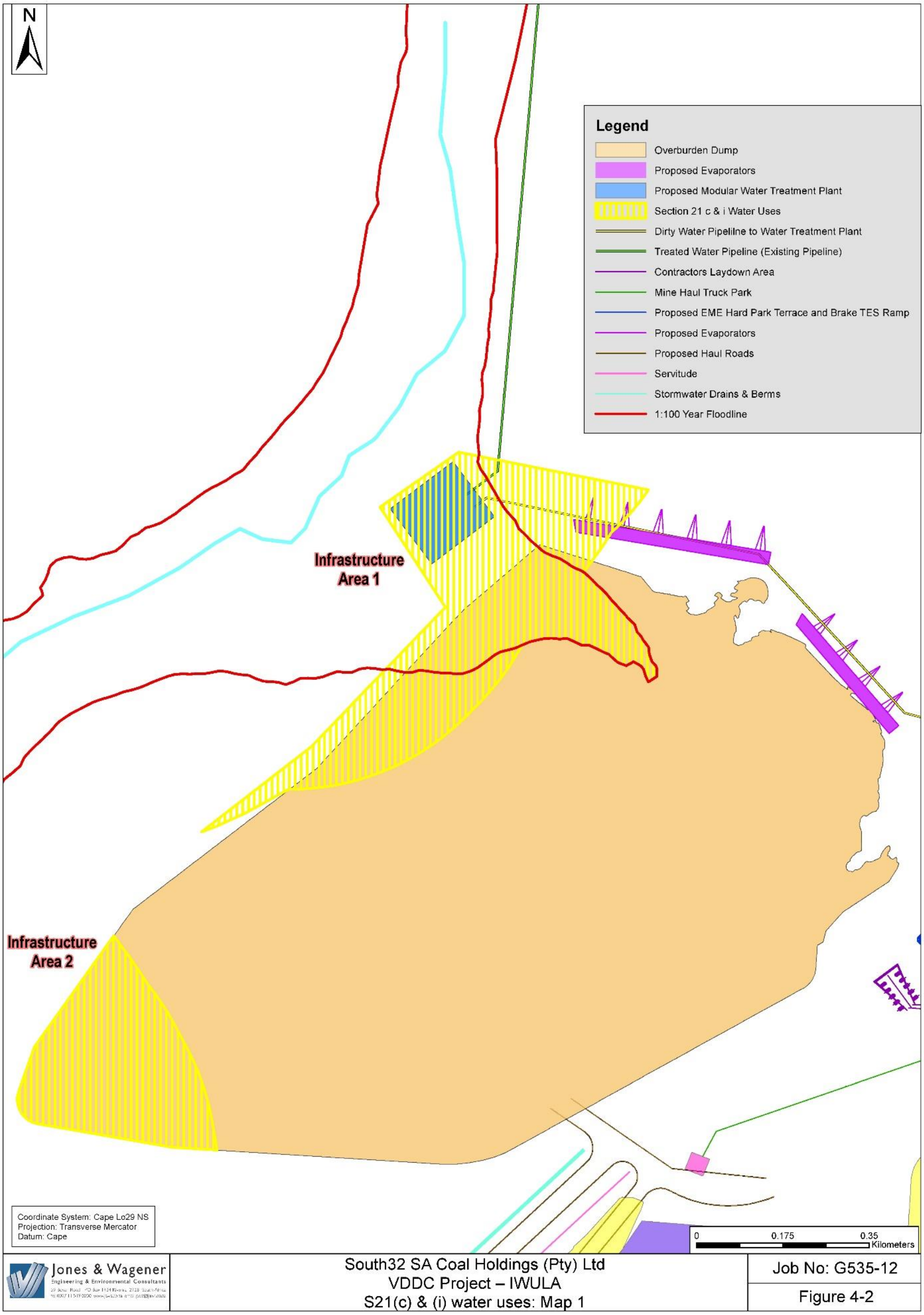

Figure 4-2: S21(c)&(i) water uses: Infrastructure Areas 1 and 2

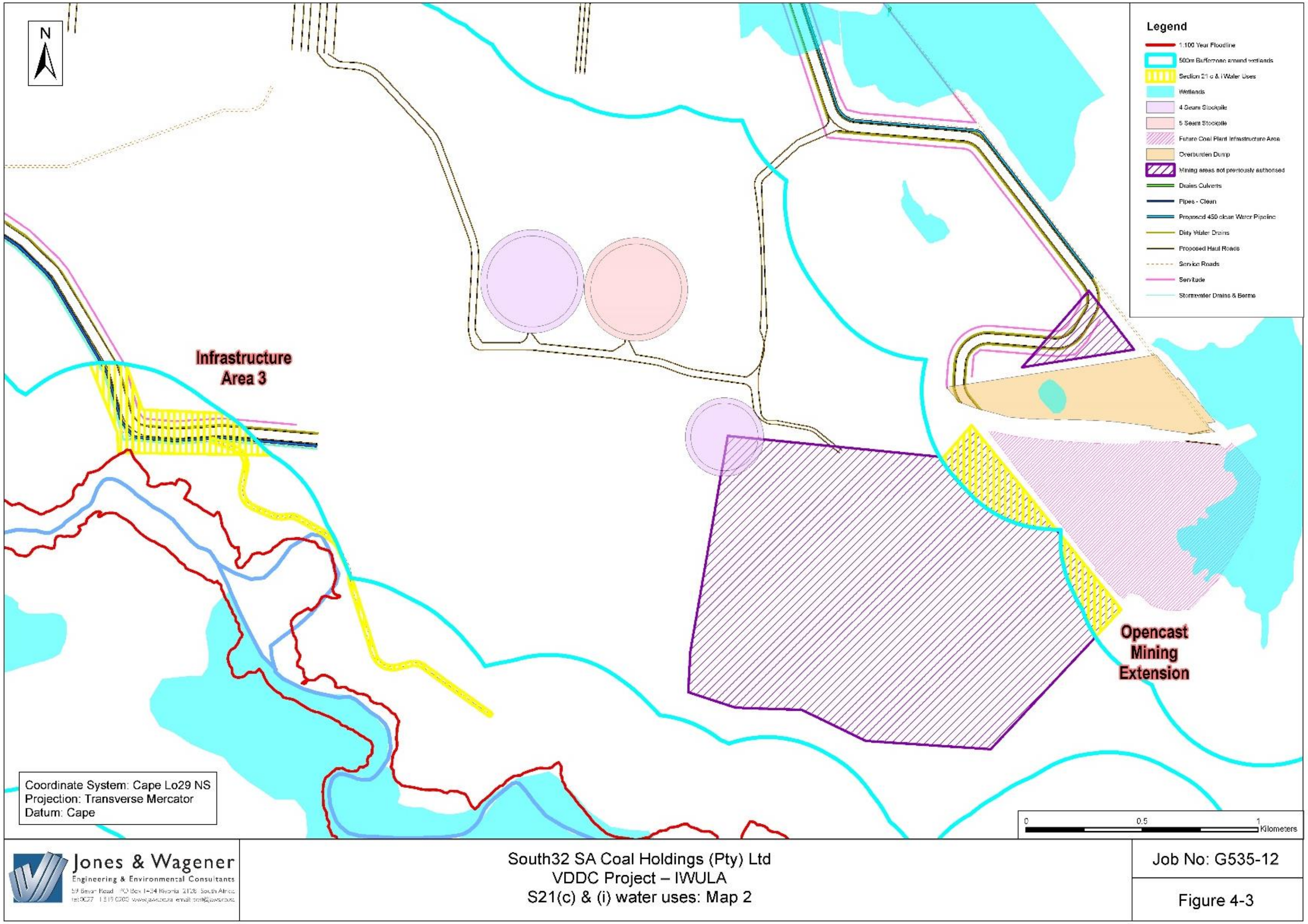

Figure 4-3: S21(c)&(i) water uses: Infrastructure area 3 and Opencast mining extension

4.1.1.2. *Infrastructure area 4*

Opencast mining of the Vleishaft tributary (HGM2) has been authorised in the 2007 EMPR Amendment and the 2008 DMO WUL and therefore the development of the boxcut within 500 m of the delineated watercourse is not a new water use which requires licensing, since it has been authorised.

The development of the following infrastructure within a watercourse and within 500 m of a watercourse, are new water uses which require authorisation:

- Portion of dragline spoils (overburden) to be developed between the ramps at the boxcut area;
- The two Mixed ROM coal and slurry stockpile areas will be located south and southeast of the Vleishaft PCD;
- The southern portion of the topsoil dump area will be developed over a seepage wetland;
- Proposed hard park and contractor's laydown area will be located within 500 m of the Vleishaft PCD;
- Eastern overburden dump will be developed over a seepage wetland;
- Infrastructure within the eastern servitude, including a haul road and service road, stormwater drains and berms, as well as pipelines, will be developed within 500 m of a wetland and will cross HGM 1.

It is important to note that a large portion of the area where the abovementioned infrastructure will be developed, will be opencast mined in future (as per the opencast mining approved in the 2007 EMPR amendment and the 2008 DMO WUL). The Eastern overburden dump, hard park area and Secondary Mixed ROM coal and slurry stockpile area will not be mined out. The impacts on the watercourses as a result of the infrastructure development will therefore be temporary in nature before the watercourses are mined through (refer to section 5.5 for more detail).

The infrastructure components within the eastern servitude are discussed in more detail below.

Clean water drain

Water from the clean catchment to the east of the mining right boundary will be diverted away from the mining area using clean storm water diversion drains. Clean water drains E1, E2 and E8 as per the Stage 1 Water Management Layout compiled by Worley (drawing number C0082-05DA-GE-DAL-0001-0001 attached in the IWWMP) are located within Infrastructure Area 4. The relevant design drawing references for these drains are listed in **Table 4-1**.

Table 4-1: Design drawing references for clean storm water drains in Infrastructure Area 4

Name of infrastructure	Design drawing reference number	Details
Clean storm water drain E1	C0082-05FH-CI-DGA-0001-001	Layout and long section
Clean storm water drain E2	C0082-05FH-CI-DGA-0002-001	Layout and long section – Sheet 1
	C0082-05FH-CI-DGA-0002-002	Layout and long section – Sheet 2
Clean storm water drain E8	C0082-05FH-CI-DGA-0004-001	Layout and long section

Haul road and service road watercourse crossings

The eastern haul road crosses the existing valley bottom in three areas. These crossings fall inside the dirty water management area and will eventually be mined out. Therefore, the engineering associated with these crossings is limited to navigating the wetland system and no other measures to manage pollution of the wetland have been provided for.

Each watercourse crossing includes the construction of earth fill embankments through the watercourse where culverts will convey water from one side of the fills to the other. The roadways include both a haul road and a service road.

These crossings are designed for the 1:50 year rainfall event and each crossing will consist of adequately sized pipe culverts. The foundation layer of the construction will be of dump rock so that natural flow is not interrupted. Embankment toes and high scour areas will be dressed with Armourflex (or similar) and all embankments are to be topsoiled and grassed (Worley, 2019).

Table 4-2: Details of watercourse crossings of Eastern Haul Road within Infrastructure Area 4

Distance from start	Culvert design	Design drawing reference number
~ 220 m	2 x 600 mm pipe culverts	C00820-05AB-CI-DGA-0002-001
~ 970 m	4 x 1 200 mm pipe culverts	C00820-05AB-CI-DGA-0002-002
~2 370 m	4 x 1 200 mm pipe culverts	C00820-05AB-CI-DGA-0002-003

The haul road wetland crossings include the following preparation:

- 300 mm Topsoil stripped to temporary topsoil stockpile for rehabilitation and topsoiling of embankments;
- Excavate 50 mm to 1 000 mm deep to remove unsuitable material (usually saturated clayey materials from wetlands, streams or other local areas with saturated sub-soils) and placed on temporary topsoil stockpile;
- Place 500 mm to 1 000 mm thick layer of selected dump rock compacted by method specification (i.e. 10 passes of 15 t vibratory roller until no further movement is measurable in the pioneer layer);
- Formation construction in minimum of 1 x 150 mm layer of G8 compacted to 93 % MOD AASHTO;
- 150 mm capping layer of G7 (from borrow pit or commercial sources) compacted to 95 % MOD AASHTO;
- 200 mm wearing course layer of G7 stabilised by Dust-a-Side;
- Finishing, topsoiling and grassing of backfilled and constructed excavations and embankments and construction of rock filled gabion mattresses on bidim underlay (Worley, 2019).

Refer to Drawing number C00820-05AB-CI-DSE-0001-001 for typical cross sections of haul roads and service roads.

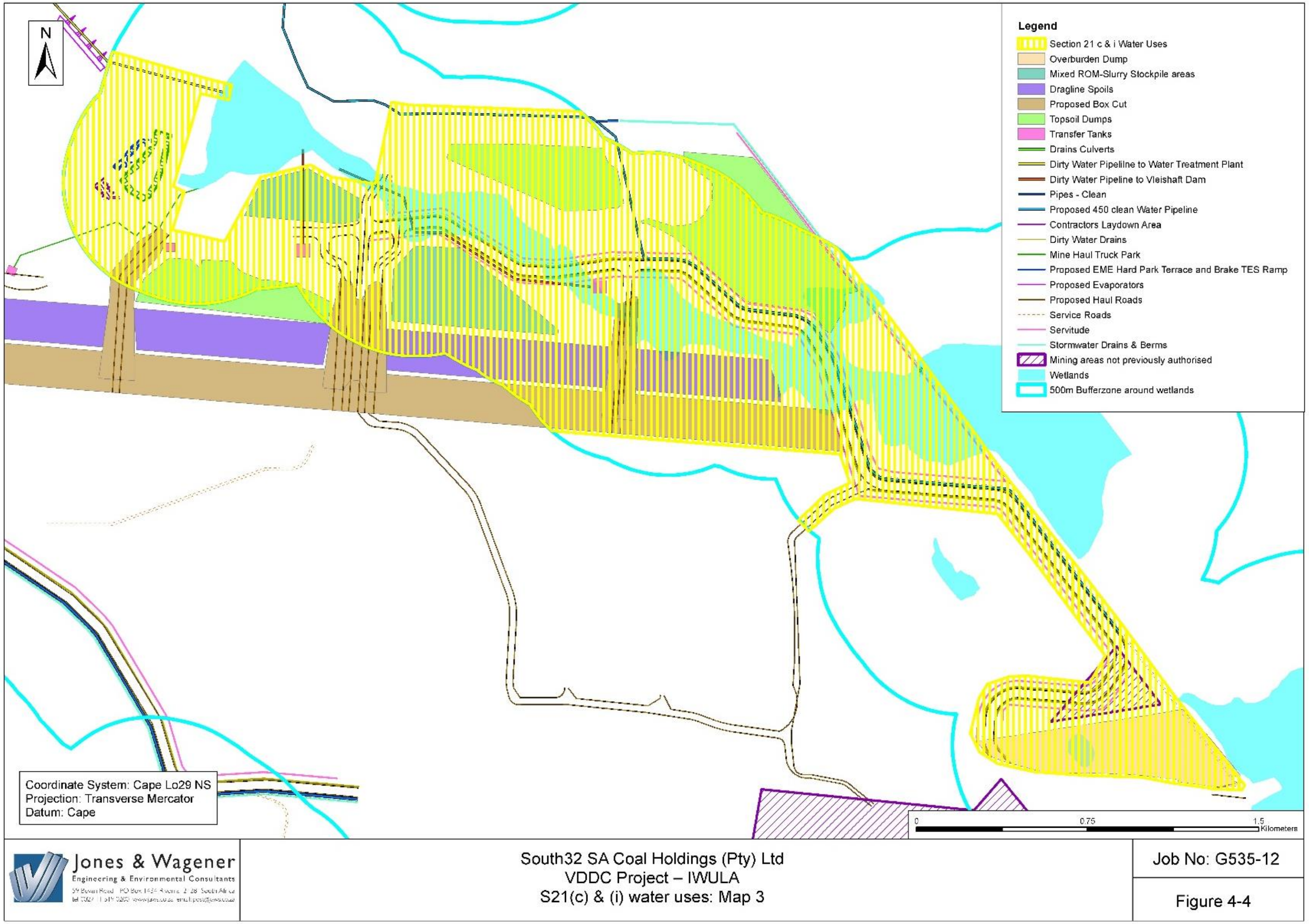

Figure 4-4: **S21(c)&(i) water uses: Infrastructure area 4**

4.1.1.3. *Discharge of treated water and explosives magazine*

Discharge of treated water from the modular WTP will be largely via an existing pipeline to the existing northern canal, from where it will discharge into a depression (HGM 6). A new section of pipeline will be required between the existing 450 mm diamter pipeline and the northern canal. This new section of pipeline will be approximately 700 m in length and will be constructed along the existing haul road. The extent of the new section of pipeline is indicated on design drawing C00820-05FF-CI-DAL-0001-002 attached in the IWWMP. Installation of the pipeline will take place outside of any delineated wetlands, but within 500 m of HGM 6 and the Olifants River.

From HGM 6, water will flow via an existing culvert underneath the haul road and discharge into the Olifants River. Potential changes in the characteristics of the wetland may occur as a result of the discharge.

The existing explosives magazine will be decommissioned since it is located within the proposed opencast mining footprint. The explosives magazine will therefore be relocated to the north of the project area. Since it will be located within rehabilitated mining areas within 500 m of the Olifants River, a separate risk assessment in terms of GN 509 was conducted for the development of the new explosive magazine. The water uses associated with the proposed new explosives magazine will therefore likely be authorised in terms of the General Authorisation (GA) for S21(c) and (i) water uses as published in GN 509, but is again included in this IWULA to ensure that all the water uses associated with the VDDC project are reflected.

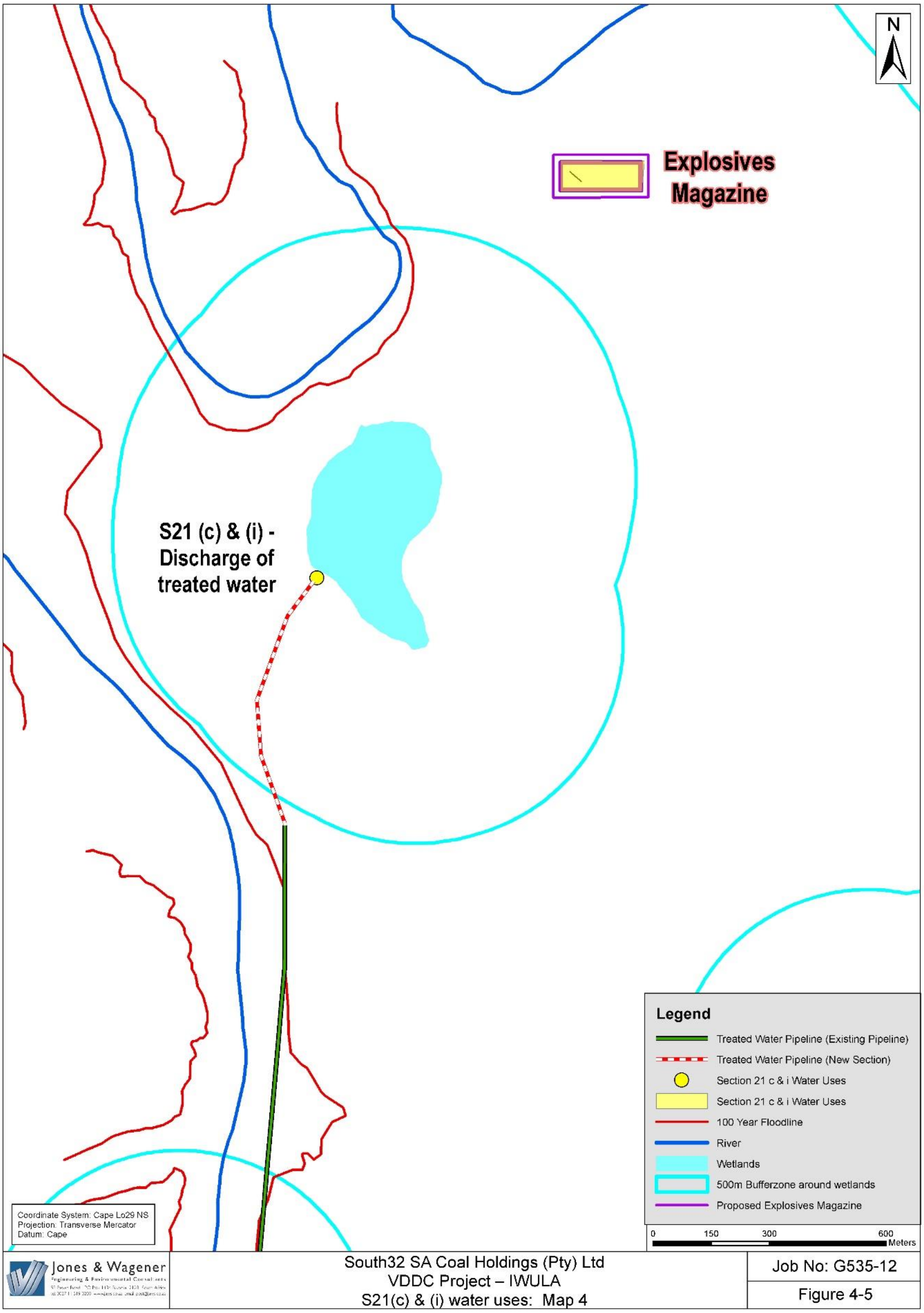

Figure 4-5: S21(c)&(i) water uses: Discharge of treated water and explosives magazine

4.1.2 Section 21(f) water uses

A modular WTP is planned with a treatment capacity of up to 20 Mℓ per day.

The WTP will be a vendor design and supply and has been scoped to deliver treated water that would meet the RQO of the Olifants river for discharge. The treatment plant is of modular, containerised design and consists of both the nanofiltration and brine handling circuits. It will be a scalable plant and the treatment capacity will be adjusted to respond to the operational needs. Brine from the WTP will be stored in existing tanks located at the SKS void, from where it will be conveyed to the evaporators to be located on the SKS void.

At maximum capacity of 20 Mℓ per day, approximately 13 200 m^3 of treated water per day will be conveyed via a pipeline and discharged into the existing northern canal. Conveyance of treated water will be through an existing 450 mm dimeter pipeline. A new section of pipeline (approximately 700 m) will be added between the existing pipeline and the northern canal along the existing haul road. No other infrastructure is required to give effect to the discharge.

From the northern canal, water is discharged via a wetland system (HGM 6) into the Olifants River.

4.1.3 Section 21(g) water uses

The following facilities will be developed which may have the potential to impact on the water resource (refer to **Figure 4-6**).

4.1.3.1. Overburden Dumps

The boxcut will be done using a combination of dragline and truck and shovel. Overburden from the boxcut will be placed on four overburden dumps located in between the proposed ramps. In addition, provision has been made for two overburden dumps.

Dragline spoils dumps

Four dragline spoils dumps (Dumps 1 to 4) will be developed between the ramps for the initial placement of overburden when the boxcut commences.

The stockpile areas will largely be developed on areas which have already been disturbed as a result of the previous mining activities. No specific base preparation will therefore be undertaken for the development of these stockpiles, apart from the removal of topsoil where still present.

Overburden material will be used in the concurrent rehabilitation of the pit as soon as steady state mining is achieved.

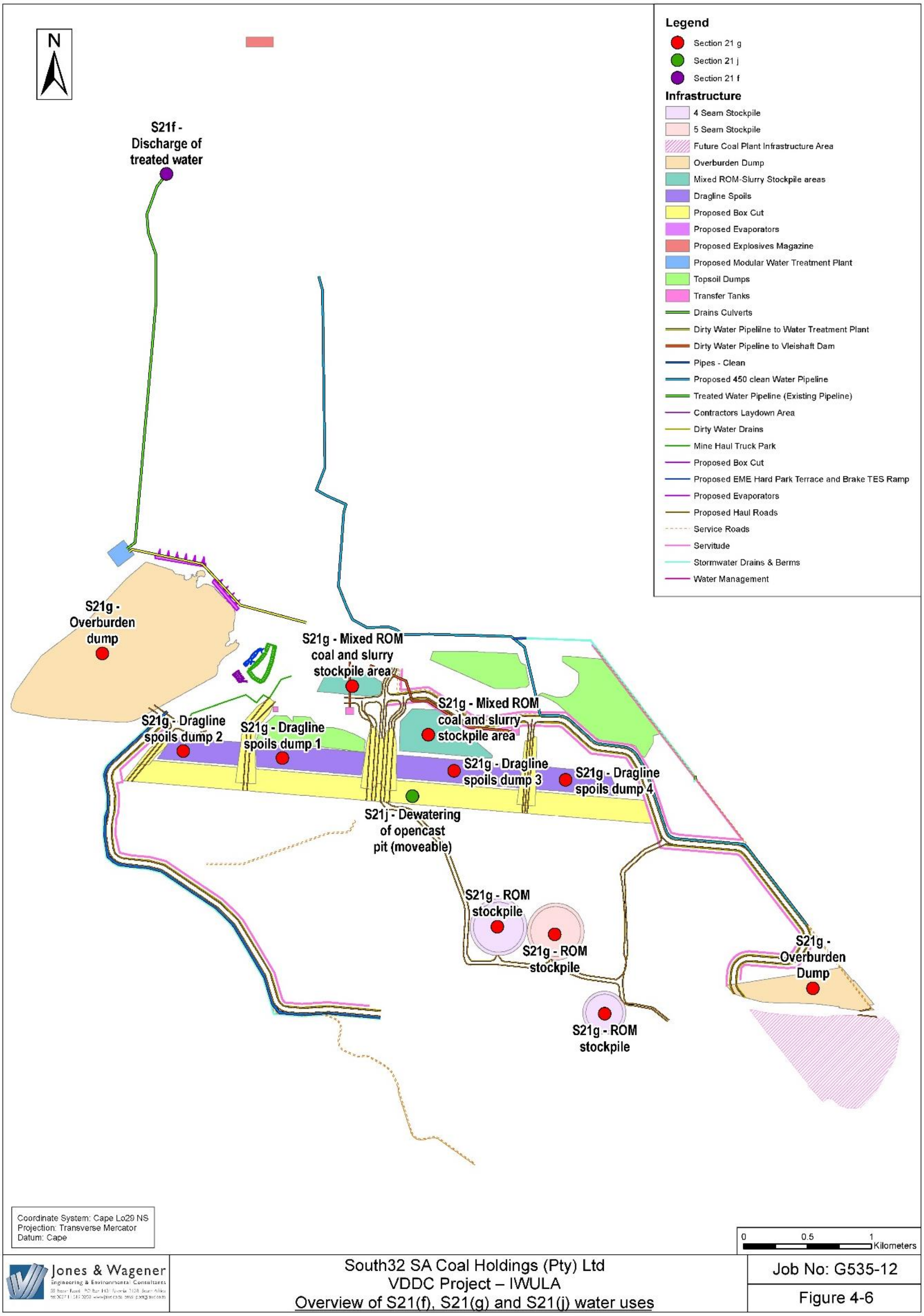

Figure 4-6: Overview of S21(f), S21(g) and S21(j) water uses

Eastern Overburden Dump

The proposed Eastern Overburden Dump will be developed in approximately July 2025 and decommissioned in approximately July 2037, the overburden material from this facility will be placed back in the pit and the area will be rehabilitated.

Previous assessments of the overburden at the SKS operation in terms of GNR 635, showed that overburden is a Type 3 waste and therefore a Class C barrier system will be applicable (refer to 5.1.5.1). However, the environmental risk associated with drainage from the spoils is similar to that of a Type 4 waste due to low concentrations of leachable constituents (Jacana, 2019).

Base preparation of the dump will therefore comprise of a Class D barrier system, comprising:

- 300 mm topsoil strip to stockpile;
- Rip and recompact to a depth of 300 mm; and
- Finishing, topsoiling and grassing of constructed embankments and disturbed area (Worley, 2019).

Perimeter pollution control drains will be constructed on all downstream slopes which are designed to retain all run-off and transported silt from the dump. Runoff from this facility will be diverted to silt traps and then to an existing borehole which will convey water into the underground workings. This will allow the water to be temporarily stored until it can be pumped via the mine dewatering system to the Vleishaft PCD.

Paddock embankments are to be hydroseeded with an appropriate mix for the season and slope direction. (Worley, 2019).

The total infrastructure development at the Eastern Overburden Dump is approximately 23 ha, of which the proposed dump footprint is 20.8 ha. The facility has available airspace of 5 356 500 m^3 and approximately 48 600 m^3 of overburden will be stockpiled per day.

The layout and details of the Eastern Overburden Dump are shown on Drawing C00820-02BA-CI-DRD-0001-001 and details of the polluted stormwater drain are shown on Drawing C00820-05DH-CI-DRD-0002-001. These drawings are included in the IWWMP attached as **Appendix B**.

The design of the silt trap is provided on Drawing C00820-05DI-CI-DGA-0001-001 (lay-out) and Drawing C00820-05DI-CI-DGA-0001-002 (sections). Water from the silt trap will be conveyed via pipeline to an existing borehole to the No. 2 Seam workings.

Overburden dump on SKS pit

The proposed Overburden Dump on the SKS pit is located to the north west of the VDDC pit, above the existing and partially backfilled SKS pit. The stockpile covers an area of approximately 132 ha. Since it will be located on the backfilled SKS pit, no further base preparation is required other than the dozing of access ways on the dump itself.

The facility has available airspace of 74 752 000 m^3 and approximately 48 600 m^3 of overburden will be stockpiled per day.

4.1.3.2. Mixed ROM coal and slurry stockpile areas

An area of the No. 2 Seam was historically used for placement of slurry from the processing plant. It is believed to be contained in the southeast portion of the deposit by underground seals and barrier pillars (refer to **Figure 2-2**). In these areas, slurry will be mined with the ROM coal, and the blended coal and slurry will be transferred to the stockpile areas. The mixed material will be allowed to dewater for a period, before it is removed to the existing SKS tip, from where it will be taken to the South Export

Processing Plant. Water will be collected and conveyed via a silt trap to the Vleishaft PCD.

The stockpiles are approximately 8 ha in size and is designed to provide for a maximum of 100 000 t of mixed ROM coal and slurry. Approximately 17 000 tonnes of mixed material will be stockpiled per day.

An assessment of the slurry stored in the underground workings by J&W in 2019 in terms of GNR 635 indicated that the slurry is a Type 3 waste and therefore storage facilities are to be equipped with a Class C barrier system. However, the requirement to conduct a waste assessment for mine residue facilities has been removed from the regulations related to the planning and management of residue stockpiles and replaced with a risk-based approach whereby resource-pathway-receptor modelling can be conducted to determine the barrier requirements for these facilities. An assessment was done by Jacana Environmentals and a Class D barrier design was recommended for the Mixed ROM coal and slurry stockpile areas (refer to the Memorandum attached in the IWWMP in **Appendix B**).

Base preparation of the stockpile areas will therefore comprise of the following:

- 300 mm topsoil strip;
- Rip and recompact 200 mm in situ material to 93% MOD AASHTO;
- Fills in 500 mm thick layers from dump rock stockpile, compacted to rock compaction specifications;
- 1 000 mm base layer compacted in 500 mm layers to rock compaction specifications.
- 200 mm wearing course layer of G7 and stabilised with Dust-a-side (Worley, 2019).

The stockpile terraces include concrete lined perimeter drains that convey polluted water runoff to a silt trap and then to the Vleishaft PCD.

The designs of the two Mixed ROM coal and slurry stockpile areas are indicated in **Table 4-3**. The design of the silt trap is provided on Drawing C00820-05DI-CI-DGA-0001-001 (lay-out) and Drawing C00820-05DI-CI-DGA-0001-002 (sections). Copies of the design drawings are attached in the IWWMP in **Appendix B**).

Table 4-3: Design drawings reference for Mixed ROM coal and slurry stockpile areas

Facility	Design drawing reference
Primary Mixed ROM coal and slurry stockpile areas (next to the ramps)	C00820-05BC-CI-DAL-0001-001 (Lay-out and details) C00820-05BC-CI-DAL-0002-001 (Drain 1 lay-out and section) C00820-05BC-CI-DAL-0002-002(Drain 2 lay-out and section)
Secondary Mixed ROM coal and slurry stockpile areas (south of the Vleishaft PCD)	C00820-05BC-CI-DAL-0003-001 (Lay-out and details) C00820-05BC-CI-DAL-0004-001 (Drainage lay-out and section, Sheet 1) C00820-05BC-CI-DAL-0004-002(Drainage lay-out and section, Sheet 2)

4.1.3.3. ROM stockpiles

ROM coal from the No. 4 and No. 5 seams will be placed on transfer stockpiles. Provision has been made for two stockpiles from the No. 4 seam and one stockpile for the No. 5 seam coal. It is anticipated that a maximum of 22 000 tonnes of coal from the No. 4 seam and 4 000 tonnes of coal from the No. 5 seam will be stockpiled per day.

These stockpiles will be located on a partially reclaimed area on the PSS dump footprint. The stockpile positions will be moved as mining progresses but will remain within the footprint of the existing PSS dump or areas previously used for the storage of discard.

Coal will be transported from these stockpiles via haul roads to the existing plant.

4.1.3.4. Dust suppression with mine impacted water

Mine water make (dirty water) will be reused for dust suppression on haul roads and stockpiles. This will be limited to the dirty water management area and therefore any contaminated runoff will be collected and contained within the dirty water management system. The estimated volume required from the Vleishaft PCD for this purpose is 2 400 m^3/day.

4.1.4 Section 21(j) water uses

In order to manage the inflow of water into the mining operations, temporary sumps will be developed in the pit floor where the water will be collected at the bottom of the pit (i.e. at lowest points) and pumped out of the pit. These temporary sumps will be situated at the bottom of each access ramp and the piping routed in a berm servitude on the side of the access ramp, up to transfer tanks situated at the top of the ramp. Since low points within the pit floor are expected to shift as the mining face advances, water management requirements will shift from one ramp to the next. Water will be pumped from the pit with self-priming diesel driven pumps mounted on trailers or skids to allow for easy movement (Worley, 2019).

The average pit water make over the life of mine (LOM) is 4 760 m^3/day and the peak pit water make (during summer) is 12 950 m^3/day (J&W, 2019b).

Water will be pumped to the Vleishaft PCD and from there, to one of the evaporator sites, or to the proposed modular WTP.

4.2 Summary of water uses

Key aspects of the water uses requiring authorisations are provided in **Table 4-4**. More details are provided in the water use tables included in **Appendix A**.

Table 4-4: Summary of water uses

Description of water use	Water use map reference	Property	Title Deed	Start date	Engineering drawing by Worley (included in IWWMP - Appendix B)
S21(c) Impeding or diverting the flow of water in a watercourse and/or S21(i) altering the bed, banks, course or characteristics of a watercourse					
Infrastructure area 1: Develop infrastructure within 500 m of a watercourse: Modular WTP and portion of overburden dump on SKS void	**Figure 4-2**	Ptn 2 of Steenkoolspruit 18 IS Ptn 4 of Kleinkopje 15 IS	T76581/1999 T76581/1999	2020	Not applicable
Infrastructure area 2: Develop infrastructure within 500 m of a watercourse: Portion of overburden dump on SKS void	**Figure 4-2**	Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	2020	Not applicable
Infrastructure area 3: Develop infrastructure within 500 m of a watercourse: Infrastructure within servitude, including haul road, service road, stormwater drains and berms and clean water pipeline	**Figure 4-3**	Ptn 2 of Steenkoolspruit 18 IS RE/3 of Vandyksdrift 19 IS	T76581/1999 T76548/1999	2020	*Clean stormwater drain W2:* C00820-05FH-CI-DGA-005-002
Infrastructure area 4: Develop infrastructure within a watercourse and within 500 m of watercourse: portion of VDDC boxcut, portion of dragline spoils, mixed ROM coal and slurry stockpile areas, portion of topsoil dump, proposed hard park, contractors laydown area, overburden dump as well as infrastructure within servitude (haul road, stormwater drains and berms).	**Figure 4-4**	Ptn 2 of Steenkoolspruit 18 IS RE/3 of Vandyksdrift 19 IS	T76581/1999 T76548/1999	2020	*Clean stormwater drains:* C0082-05FH-CI-DGA-0001-001 C0082-05FH-CI-DGA-0002-001 C0082-05FH-CI-DGA-0002-002 C0082-05FH-CI-DGA-0004-001 *Haul/service road crossings:* C00820-0548-CI-DGA-0002-001 C00820-0548-CI-DGA-0002-002 C00820-0548-CI-DGA-0002-003
Opencast mining extension	**Figure 4-3**	RE/3 of Vandyksdrift 19 IS	T76548/1999	2020	Not applicable
Explosives magazine	**Figure 4-5**	RE of Wolvekrans 17 IS	T76586/1999	2020	Not applicable
Discharge of treated water from modular WTP: new section of pipeline within 500 m of watercourse	**Figure 4-5**	Ptn 6 of Wolvekrans 17 IS	T76586/1999	2020	*New section of treated water pipeline:* C00820-05FF-CI-DAL-0001-002
S21(f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit					
Discharge of water from modular WTP into seepage wetland via existing northern canal	**Figure 4-6**	Ptn 6 of Wolvekrans 17 IS	T76586/1999	2020	Not applicable
Section 21(g): Disposal of waste in a manner that could detrimentally impact on a water course					
Dust suppression with mine impacted water	**Figure 4-6**	RE/3 of Vandyksdrift 19 IS Ptn 2 of Steenkoolspruit 18 IS Ptn 4 of Kleinkopje 15 IS	T76548/1999 T76581/1999 T76581/1999	2020	Not applicable
Eastern Overburden dump (with silt trap)		RE/3 of Vandyksdrift 19 IS Ptn 9 of Vandyksdrift 19 IS	T76548/1999 T76547/1999	2020	C00820-02BA-CI-DRD-0001-001 C00820-05DH-CI-DRD-0002-001.
Overburden dump on SKS void		Ptn 2 of Steenkoolspruit 18 IS Ptn 4 of Kleinkopje 15 IS	T76581/1999 T76581/1999	2020	Not applicable
Dragline spoils dump 1		Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	2020	Not applicable
Dragline spoils dump 2		Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	2020	Not applicable
Dragline spoils dump 3		Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	2020	Not applicable

Description of water use	Water use map reference	Property	Title Deed	Start date	Engineering drawing by Worley (included in IWWMP - Appendix B)
		RE/3 of Vandyksdrift 19 IS	T76548/1999		
Dragline spoils dump 4		RE/3 of Vandyksdrift 19 IS	T76548/1999	2020	Not applicable
Secondary Mixed ROM coal and slurry stockpile area with silt trap (south of Vleishaft PCD)		Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	2020	C00820-05BC-CI-DAL-0003-001 C00820-05BC-CI-DAL-0004-001 C00820-05BC-CI-DAL-0004-002
Primary Mixed ROM coal and slurry stockpile area with silt trap (next to ramps)		Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	2020	C00820-05BC-CI-DAL-0001-001 C00820-05BC-CI-DAL-0002-001 C00820-05BC-CI-DAL-0002-002
4 Seam ROM stockpile		RE/3 of Vandyksdrift 19 IS	T76548/1999	2020	Not applicable
5 Seam ROM stockpile		RE/3 of Vandyksdrift 19 IS	T76548/1999	2020	Not applicable
4 Seam ROM stockpile		RE/3 of Vandyksdrift 19 IS	T76548/1999	2020	Not applicable
Section 21(j): Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people					
Dewatering of pit as mining proceeds	**Figure 4-6**	RE/3 of Vandyksdrift 19 IS Ptn 10 of Vandyksdrift 19 IS Ptn 2 of Steenkoolspruit 18 IS	T76548/1999 T76547/1999 T76581/1999	2020	Not applicable

4.3 Potential pollution sources

The sources that could potentially impact on the water resource and the potential mechanism of impact are indicated in **Table 4-5**. These has been assessed for the VDDC project in section 5.

Table 4-5 Potential pollution sources

Potential pollution source	Description	Potential mechanism of impact
CONSTRUCTION PHASE		
General earthworks	Stripping of topsoil and civil works undertaken.	Increased turbidity and suspended solids enter watercourses.
Construction vehicles and equipment/machinery	Movement of construction vehicles close to, or through, watercourses.	Increased turbidity and suspended solids.
	Servicing of construction vehicles close to watercourses.	Increase in hydrocarbon concentrations.
Exposed soil during construction	Contamination of watercourses due to erosion.	Increased erosion and turbidity of the surrounding watercourses.
OPERATIONAL PHASE		
Overburden dump on SKS pit and dragline spoil dumps	Temporary stockpiles for storage of overburden material until it is used in concurrent rehabilitation. No base preparation or additional measures.	Seepage into aquifer, or contaminated runoff entering surface water sources. Damage to wetlands.
Eastern overburden dump	Temporary stockpile for storage of overburden material until it is used in concurrent rehabilitation. Equipped with Class D barrier system and storm water management measures (drains and silt trap). The stockpile will be developed over a seepage wetland and in close proximity to HGM 4.	
Primary and Secondary Mixed ROM coal and slurry stockpile areas	Temporary stockpile areas for the storage of mixed material to allow to dewater. Equipped with Class D barrier, stormwater drains and silt trap.	Seepage into aquifer, or contaminated runoff entering surface water sources.
ROM stockpiles	Temporary stockpile areas which move as mining progresses. Located within dirty water management area (the PSS dump footprint).	Seepage into aquifer or contaminated runoff to surface.
Dirty water drains, canals and pipelines	Dirty water drains/canals maintenance.	Dirty water may enter the environment if drains/canals are blocked or overflow.
Silt traps	Silt trap design capacity/maintenance.	Silt may enter environment by means of stormwater runoff if silt traps are blocked or overflow.

Potential pollution source	Description	Potential mechanism of impact
Mechanical evaporators	Contaminated spray relating to wind direction/intensity. Salinisation of water to be evaporated over time.	Dirty water spray may enter watercourses if wind direction changes/intensity increases. Deterioration in quality of water (increased TDS) that is evaporated over time as a result of the evaporation of brine from the WTP with the mine impacted water.
Discharge of treated water	Mine impacted water treated in the modular WTP to RQO for Olifants River is discharged into water resource.	Change in water quality and quantity of the river downstream. Erosion at the discharge point resulting in increased suspended solids.
Dust suppression using mine-impacted water	Quality/quantity of mine-affected water used for dust suppression.	Seepage into aquifer and runoff into surface water resources.
Opencast mine areas not authorised previously	Workings located close to wetland areas.	Potential damage to wetlands.
Coal transport via existing roads	Spillage of carbonaceous material into watercourses along route	Increased turbidity, suspended solids, sulphate and TDS
DECOMMISSIONING AND POST-CLOSURE PHASE		
Decant from mining area	Decant of impacted water from mined out areas	Increase in sulphate and TDS in surface water and groundwater

5. IMPACT ASSESSMENT

5.1 Geochemical impact prediction: coal, overburden and discard

A number of geochemical assessments have been undertaken for the area and these are summarised below:

5.1.1 Acid-base Accounting and Long-term Mine Water Chemistry at Douglas Colliery by Hodgson *et al*. dated 1999

Core rock and coal samples were tested to investigate the long-term hydro chemical character of the opencast and underground mine water at the (then) Douglas Colliery, by performing acid-base accounting and leaching tests on the samples, as well as geochemical modelling.

In terms of future salt load, a sulphate generation rate of 50 tonnes/day was suggested for Douglas Colliery. This was predicted to result in an average sulphate concentration of 1 800 mg/ℓ in the seepage water. In areas of low water through flow, the sulphate concentration was expected to rise to saturation levels. At a pH of 6.5 and a calcium concentration of 250 – 380 mg/ℓ, the sulphate concentration was predicted to be in the range of 1 825 – 3 300 mg/ℓ. At pH-levels below 3.0, sulphate concentrations were assessed to potentially increase to well over 4 000 mg/ℓ.

The overall conclusion was that eventual acidification of the opencast water at Douglas Colliery was unavoidable. The scale of mining was seen as simply too large and that mining has progressed too far to make a meaningful and permanent change at that stage. The final fate of the underground water in terms of acidity was concluded to depend on issues such as its interconnectivity to opencast, and the surface and the rate of flooding. It was therefore recommended that Douglas Colliery should provide for neutralisation of the mine water in their closure plan. Controlled flood release of treated water or irrigation were seen as the preferred option to dispose of this water. It was considered inevitable that the mine water at Douglas Colliery would eventually acidify to the extent that acid water will be the dominant type (J&W, 2019a).

5.1.2 Geochemical Assessment as part of Douglas EMPR Amendment by PHD dated 2004

An application for the amendment of the Douglas Colliery EMPR was undertaken in support of expanding their operations to include additional opencast operations at Steenkoolspruit and Kleinkopje, as well as pillar mining operations at Vandyksdrift.

The objective was to carry out a screening level geochemical assessment of the long-term water quality impact associated with the proposed new mining development including evaluation of the existing acid base-accounting (ABA) data, salt balance and metal leaching potential and kinetic geochemical modelling for long-term water quality prediction. The modelling was undertaken as a preliminary screening-level study with a number of simplistic assumptions being made.

The study showed that, overall, waste rock had less acid generation potential than the coal seams, which all had strong acid potential. Furthermore, equilibrium modelling results indicated that the waste rock material had a moderate Neutralising Potential (NP), but substantial Net Neutralising Potential (NNP) (>20), indicating that the potential for acid mine drainage (AMD) generation from the waste rock material is low.

The kinetic geochemical modelling, using the sparse existing data that could be extrapolated to the site, suggested that the ABA results were misleading and that the long-term prognosis for the mine is one of neutral pH with relatively low salinity water at the time of eventual pit discharge (J&W, 2019a).

5.1.3 VDDC project: Mineral Residue Assessment Report by J&W dated 2014

The objectives of the geochemical assessment were to:

- Determine the pollution potential of the residue materials;
- Assess the likelihood of the residue materials generating AMD;
- Assess the residues in terms of GNR 635.

Samples of the coal discard, coal rejects, slurry (from the Discard Processing Plant, and the slurry ponds on the PSS dump), as well as overburden material from the SKS operations were collected and sent for leach and static tests.

The major minerals in the coal rejects and coal slurry samples were graphite and kaolinite whereas the overburden sample did not contain any detectable concentrations of graphite. All the samples contained varying percentages of pyrite (FeS), which could result in the generation of AMD.

Based on the total concentrations (TCs) of the various coal waste samples it was noted that the coal discard, coal rejects and slurries generally contained elevated concentrations of antimony, arsenic, barium, cadmium and lead, while the overburden material contained elevated concentrations of antimony, cadmium, chromium, iron, lead and zinc. The overburden contained the highest total concentrations of cadmium, cobalt, chromium, copper, manganese, nickel, vanadium and zinc of all the residues tested.

The paste pH of most of the coal discard, slurry and overburden samples was acidic with the potential to generate acidic seepage or runoff. The slurry from the discharge into the slimes dam had acidic paste pH and the potential to generate acidic seepage and runoff in the short term.

The coal discard, slurries and overburden were assessed as Type 3 wastes in terms of GNR 635.

It was noted that the overburden ABA assessment was based on only one composite sample of unknown rock type and may therefore not have been representative of the overburden as a whole. Kinetic testing of representative samples of the overburden was suggested to evaluate its AMD potential (J&W, 2019a). This was addressed by J&W in 2016 – see **section 5.1.4**.

5.1.4 Geochemistry assessment as part of geohydrological investigation for the storage of water in the SKS pit by J&W dated 2016

The primary objectives of this assessment were as follows:

- To determine the geochemical nature of the material in the backfilled SKS pit;
- To determine the long-term net acid generation potential;
- To identify metals that may be present in drainage from the pit; and
- Perform geochemical modelling in order to predict future discharge water qualities from the pit.

The coal seams, as well as some of the sedimentary host rocks are known to generate AMD when exposed through mining. At that stage, the largest part of the SKS pit was already backfilled with waste rock, but some mining was taking place and planned on the eastern side of the pit. The SKS pit was also considered for storage of water pumped from underground from nearby opencast mining of old underground pillars at VDDC. In this report the potential and degree of AMD that may occur at the SKS pit was addressed.

The study showed that in the backfilled SKS pit, AMD Stage 1 will be present for the first 10 - 25 years after closure. Thereafter Stage 2 (acidification) will commence in certain parts of the backfill situated in the oxic part of the unsaturated zone. The maximum sulphate concentration will be reached about 50 - 75 years after closure where after the sulphate may slightly decrease (J&W, 2019a).

5.1.5 Geochemical Characterisation for Wolvekrans Colliery by Golder Associates, dated 2018

A detailed and comprehensive geochemistry assessment was conducted by Golder Associates in early 2018 for the entire Wolvekans Colliery.

The study results relevant to the VDDC project, can be summarised as follows:

5.1.5.1. Characteristics of Spoils, Coarse Discard, Slurry and Coal

- Mineralogy results indicated that pyrite and carbonates were heterogeneously distributed in spoils, coal slurry and discard materials, and Siderite was the most ubiquitous carbonate in spoils and calcite was widespread in the coal materials;
- The sulfide content was generally low for spoils (< 0.3%), variable for slurry (0.07 – 0.71%) and high for coarse discard (0.32 – 3.0%) and coal (0.20 – 4.8%);
- Acid generation potential of spoils was variable: the spoils are expected to produce near-neutral to saline acid rock drainage in the short term, and metalliferous acid rock drainage in the long term as confirmed by kinetic tests, which indicated that the neutralisation potential will be depleted before sulphides;
- The discard materials are likely to produce near-neutral drainage with low metal content in the short term to acid rock drainage with low to high metal content in the long term as confirmed by both static and kinetic tests;
- The slurry had uncertain to acid generating potential and the drainage is likely to be near-neutral to acid rock drainage with low metal content in the short and long term;

- The coal had low to acid generating potential and the drainage is expected to be near-neutral mine drainage with low metals in the short term;
- Discard from PSS dump and LAC dump and slurry materials from PSS dump are assessed as Type 3 waste;
- Coal samples collected from SKS pit and spoils from SKS main pit are not Type 4 waste, since at least one parameter exceed TCT0, but it does not meet the definition of Type 3 waste due to low risk from leachate;
- Discard is classified as hazardous, while spoils, slurry and coal were classified as non-hazardous in terms of SANS10234;
- The main environmental risks from spoils materials and pit water are saline to acid rock drainage with elevated levels of TDS, EC, sulphate, fluoride, calcium, magnesium, sodium, aluminium, iron, manganese and cobalt;
- The main environmental risk from discard and slurry materials in acid rock drainage are elevated levels of TDS, EC, sulphate, calcium, manganese, aluminium, iron, copper, cobalt and selenium (Golder Associates, 2018).

5.1.5.2. Risk Profile of Pits and Residue Facilities

- The following sections were modelled as having pits with moderate to high AMD risk:
  - Wolvekrans – some of the pits in this section have acidic outflow;
  - Vandyksdrift;
  - Steenkoolspruit, although circum-neutral seepage with high TDS has been modelled from spoils kinetics;
- The acid rock drainage from pits exceeded the water quality guidelines and the Department of Water and Sanitation (DWS) 2016 Water Quality Planning Limits (WQPL) for pH, TDS, EC, sulphate, fluoride, aluminium, calcium, cobalt, copper, iron, magnesium, manganese, nickel and zinc, while the saline drainage from pits exceeded guidelines and WQPL for TDS, EC, sulphate, fluoride, nitrate, boron, cadmium, cobalt, magnesium, manganese, molybdenum, sodium and sodium adsorption ratio;
- Coarse discard has acid rock drainage risk:
  - LAC Discard Dump: kinetic modelling predicted acidic drainage in the short-term (pH 4-5) and long-term (pH 5-6), with extremely high sulphate levels in the short-term (5 000 – 10 000 mg/ℓ) dropping to high levels in the long-term (2 000 – 2 500 mg/ℓ); and
  - Wolvekrans Discard Dump west of the Olifants river: the stream draining this dump is acidic (pH 3-4) and has high sulphate levels (2 000 – 3 000 mg/ℓ), despite the dump being rehabilitated and revegetated.
- Slurry has a moderate acid rock drainage risk (Golder Associates, 2018).

5.1.6 Barrier design of Eastern overburden dump

As outlined above, the overburden was assessed as Type 3 wastes in terms of GNR 635 and therefore a Class C barrier design would be applicable. However, in terms of GNR 990, a competent person must recommend the pollution control measures suitable for a specific residue stockpile or residue deposit on the basis of a risk analysis. The need to comply with default designs as per GNR 636 in terms of NEM:WA are not necessarily applicable, i.e. a barrier system other than a Class C barrier system may not be required.

In line with the risk based approach, Jacana Environmentals assessed the risks associated with the mine residue based on the geochemical and waste assessments that were conducted, as well as the outcome of the groundwater flow- and transport model. The environmental risk associated with drainage from the spoils is similar to that of a Type 4 waste, due to low concentrations of leachable constituents. In terms of the potential impact, the worst-case scenario has been modelled, i.e. these facilities are unlined and a recharge of 20% over the footprint area has been assumed. Based on this, the groundwater modelling indicates a very low risk of contamination of the Olifants River and its tributary to the east of the proposed Eastern overburden dump (Jacana, 2019). A copy of the Memorandum is attached in the IWWMP in **Appendix B.** Based on the recommendation by Jacana Environmentals, a Type D barrier design was proposed by Worley as described in section 4.1.3.1.

5.2 Geochemical impact prediction: coal slurry in underground workings

The previous studies outlined above considered discard, coal slurry from surface sources, as well as coal and overburden from the SKS operations. These were regarded as sufficient to obtain an understanding of the geochemical characteristics of the material at the VDDC operations. Apart from the geochemical interpretation of the results based on the tests conducted, a SANS 10234 classification was also done by Golder Associates of the coal, surface slurry, discard and overburden and a GNR 635 waste assessment to determine the barrier systems required for the coal, coal slurry discard and overburden material.

The only mine residue not characterised previously, was the slurry stored in the underground workings. A study was therefore undertaken in 2019 by J&W and a copy of the report is attached in the IWWMP.

The objectives of the study were as follows:

- Conduct a geochemical assessment of the fine coal slurry;
- Conduct a SANS 10234 classification of the fine coal slurry as required in terms of GNR 634;
- Develop a Safety Data Sheet (SDS) for the fine coal slurry based on the SANS 10234 classification results;
- Conduct a waste assessment for stockpile and disposal purposes as required in GNR 635.

5.2.1 Acid Based Accounting

The results from the X-ray powder diffraction (XRD) analysis of the fine coal showed that the major minerals in the fine coal sample in descending order are kaolinite, quartz, muscovite, microcline, goethite and dolomite. The amorphous (graphite) percentage in the sample was 54.45%. It is noted the XRD results did not indicate any pyrite (FeS) or siderite ($FeCO_3$), which can result in the generation of AMD.

Based on the information obtained, the coal slurry has concentrations of arsenic, barium, iron, molybdenum and zinc which are elevated above the average Alloway Crustal Abundance concentrations of the particular elements, which is simply an indication of the average abundance of an element in the earth's crust. By calculating the ratio of the elemental concentrations to the average composition of the earth's crust (Crustal abundances) an indication can be obtained whether the concentration of a particular element is raised above the average crustal abundance due to natural processes.

The coal slurry sample was subjected to ABA and Net Acid Generation (NAG) potential testing. Two assessments methods were used, namely the MEND and the AMIRA method (please refer to the report attached in the IWWMP (Appendix B) for details on the methodologies). The results are summarised in **Table 5-1**.

The Neutralising Potential Ratio results of the coal slurry is below one, the Net Acid Generating (NAG) Potential is positive at NAG pH below 7.0 and the sample is therefore classified as Potentially Acid Generating (PAG) according to both the AMIRA and MEND systems (J&W, 2019d).

Table 5-1: Acid generation potential results of coal slurry from underground workings

Parameter	VDDC coal slurry
Paste pH	Not determined
Total Sulfur (%)	0.50
Sulphate sulfur	0.43
Sulphide sulfur	0.07
AMIRA method	
Acid Potential (AP) (kg/t)	16
Neutralization Potential (NP)	12
Nett Neutralization Potential (NNP)	-3.64
Neutralising Potential Ratio (NP/AP)	0.766
MEND method	
pH 4.5	
NAG pH	6.2
Nett Acid Producing Potential (kg H_2SO_4/t) TS	<0.01
pH 7	
NAG pH	6.2
Nett Acid Producing Potential (kg H_2SO_4/t) TS	0.02
AMD Assessment	
MEND - Based on total sulfur	Potentially Acid Generating
AMIRA - Based on total sulfur	Potentially Acid Generating
Overall	Potentially Acid Generating

5.2.2 SANS 10234 Classification

The results from the various analyses were used to classify the coal slurry in terms of SANS 10234.

5.2.2.1. *Physical Hazards Classification*

The classification in terms of physical hazards is summarised in **Table 5-2**.

Table 5-2: Physical hazard classification of coal slurry in terms of SANS 10234

Aspect	Classification	Comment
Explosives	Not classified	The coal slurry is assumed not to be explosive. Coal in general may, however, generate flammable volatiles, which may lead to explosions in a confined space
Flammable gases	Not classified	
Oxidizing gases	Not classified	
Gases under pressure	Not classified	
Flammable liquids	Not classified	
Flammable solids	Not classified	It is known that coal may contain flammable volatiles that may lead to spontaneous combustion

5.2.2.2. *Human Health Hazard Classification*

The outcome of the human health hazard assessment is summarised in **Table 5-3**.

Table 5-3: Human health hazard classification of coal slurry in terms of SANS 10234

Aspect	Classification	Comment
Acute toxicity	Not classified	
Skin and eye corrosion and irritation	Not classified	Although SANS 10234:2008 does not include a specific hazard class for mechanical irritation, it is noted that dust and grit from dry coal slurry may cause mechanical abrasion, and thus irritation in case of prolonged exposure of the unprotected skin and eyes.
Skin and respiratory sensitisation	Not classified	
Germ cell mutagenicity	Not classified	
Carcinogenicity	Not classified	
Reproductive toxicity	Not classified	
Specific target organ toxicity	Based on the presence of quartz in the slurry, the coal slurry is classified as a Category 2 STOT-RE, which may cause damage to the lungs through prolonged or repeated inhalation in the case of dry slurry. The result of repeated exposure is not necessarily silicosis, but suitable respiratory equipment is recommended if dust is generated during use or handling	Applicable SANS Hazard Code: *H373: May cause damage to lungs through prolonged or repeated inhalation*

Aspiration hazards	None of the constituents of the slurry are specifically classified as aspiration hazards and it is not classified as corrosive. However, the slurry is muddy; therefore, it was classified as a Category 2 aspiration hazard	Applicable SANS Hazard Code: *H305: May be harmful if swallowed and enters airways.*

5.2.2.3. Aquatic environment hazards

It was concluded that the coal slurry is not hazardous to aquatic life, whether during or after short- or long-term exposure in the aquatic environment.

5.2.2.4. Health and safety measures to be implemented at the Mixed ROM coal and slurry stockpile areas

Based on the SANS 10234 classification conducted, the following measures should be implemented at the mixed ROM and coal slurry stockpile areas as specified in the SDS.

The applicable hazard pictogram and hazard labels must appear at the entrances of the mixed ROM coal and coal slurry storage and processing areas, as well as transport vehicles. Signage indicating the required personal protective equipment that must be worn, must also be displayed at the entrances.

The following personal protective equipment must be worn in relation to the fine coal slurry:

- Protective clothing and eye protection;
- Protective gloves when handling the coal slurry by hand;
- Respiratory protection (manufacturer/supplier to specify equipment) in case of repeated exposure to fine coal dust, i.e., employees exposed during working hours on a continuous daily basis.

As coal dust may cause explosions, all electrical equipment used at the mixed ROM coal and slurry stockpile areas must be earthed, while confined spaces must be well ventilated.

During firefighting, full body protective clothing and positive pressure, self-contained breathing apparatus with a full-face piece should be worn (J&W, 2019d).

5.2.3 Waste assessment of coal slurry from underground workings

Based on the analytical results obtained from the distilled water leach and the TC analysis performed on the fine coal slurry, the slurry is assessed as a Type 3 waste requiring stockpiling and disposal on facilities with a Class C barrier system, provided there are no site specific risks, such as a sensitive groundwater environment, that require a more conservative barrier system.

The Type 3 waste assessment was the result of the LC value of lead (Pb) exceeding its specific LCT0 values, and the TCs of barium (Ba), copper (Cu) and lead (Pb) exceeding their respective TCT0 concentration values.

Note that total chromium VI and total fluoride were not analysed. Total chromium VI concentration was, however, less than 5 mg/kg in a coal slurry sample from the PSS Dump assessed by J&W in 2014, while the total fluoride concentration was 564 mg/kg. The total fluoride concentration of 564 mg/kg resulted in a Type 3 waste assessment. An assessment of coal slurry from the Discard Processing Plant at the same time confirmed the total chromium VI and total fluoride concentrations (J&W, 2019d).

5.2.4 Barrier design of Mixed ROM coal and slurry stockpile areas

The slurry stored in the underground workings was assessed as Type 3 wastes in terms of GNR 635 and therefore a Class C barrier design would be applicable. However, in line with GNR 990, a risk based approach was followed by Jacana Environmental to assess the risks associated with the mine residue based on the geochemical and waste assessments that were conducted, as well as the outcome of the groundwater flow- and transport model.

In terms of the potential impact, the worst-case scenario has been modelled, i.e. these facilities are unlined and a recharge of 20% over the footprint area has been assumed. Based on this, the groundwater modelling indicates a very low risk of contamination of the Olifants River and its tributary to the east of the proposed Eastern overburden dump (Jacana, 2019). A copy of the Memorandum is attached in the IWWMP in **Appendix B.** Based on the recommendation by Jacana Environmentals, a Type D barrier design was proposed by Worley as described in section 4.1.3.2.

5.3 Impact on groundwater

A detailed geohydrological assessment was undertaken by J&W and a copy of the report is attached in the IWWMP. This included the development of a three-dimensional FEFLOW groundwater model to simulate flow and transport as described in section 3.7.9. The main outcome of the assessment is outlined below.

5.3.1 Cone of depression

During the operational phase, it is expected that the main impact on the groundwater environment will be dewatering of the surrounding aquifer. Water entering the pit will have to be pumped out to enable mining activities to continue. This will cause a lowering in the groundwater table in- and adjacent to the mine.

The dewatering of the aquifer has been calculated for the proposed opencast using the calibrated numerical model referred to above. It should be noted that dewatering of the historic underground workings was also calculated based on the IWULA for the VDDC dewatering project compiled by Jaco-K Consulting in 2016. This report stated that an average dewatering rate of 24 Mℓ/d would be extracted from the workings. Therefore, drawdown was calculated after 2 years of this dewatering when opencast mining would commence. Further to this, the mining sequence was also taken in consideration when calculating the drawdown. The calculated drawdown of groundwater levels is depicted as contours of drawdown in **Figure 5-1**.

The dewatering of the VDDC opencast mining area is expected to result in a maximum drawdown of 20 – 60 m, with a cone of depression of 200 – 250 m from the edge of the pit. The tributary of the Olifants River to the south-east of the mining area is likely to be impacted as a result of the drawdown caused by the mining activities and related dewatering. Surface water users that make use of this tributary may therefore be affected due to reduced baseflow.

During the decommissioning phase (i.e. after mining has ceased) it is assumed that dewatering of the opencast will cease, and it will be allowed to flood. The groundwater regime will return to a state of equilibrium once mining has stopped and the removal of water from the mining void has been discontinued.

The rise in groundwater level is predicted to be relatively quick and the water levels are expected to recover in about 2-5 years. The quick recovery is ascribed to the elevated hydraulic conductivity of the surrounding bedrock due to historic mining activities as well as connections to surrounding defunct underground and opencast mines. The following possible impacts were identified at this stage:

- Following closure of the mine, the groundwater level will rise to an equilibrium that will differ from the pre-mining level due to the disturbance of the bedrock;
- Groundwater quality within the mined areas is expected to deteriorate due to chemical interactions between the geological material and the groundwater. The resulting groundwater pollution plume is expected to commence with downstream movement;
- Continued groundwater contamination is likely to be released from the waste storage facilities, if not removed (J&W, 2019a).

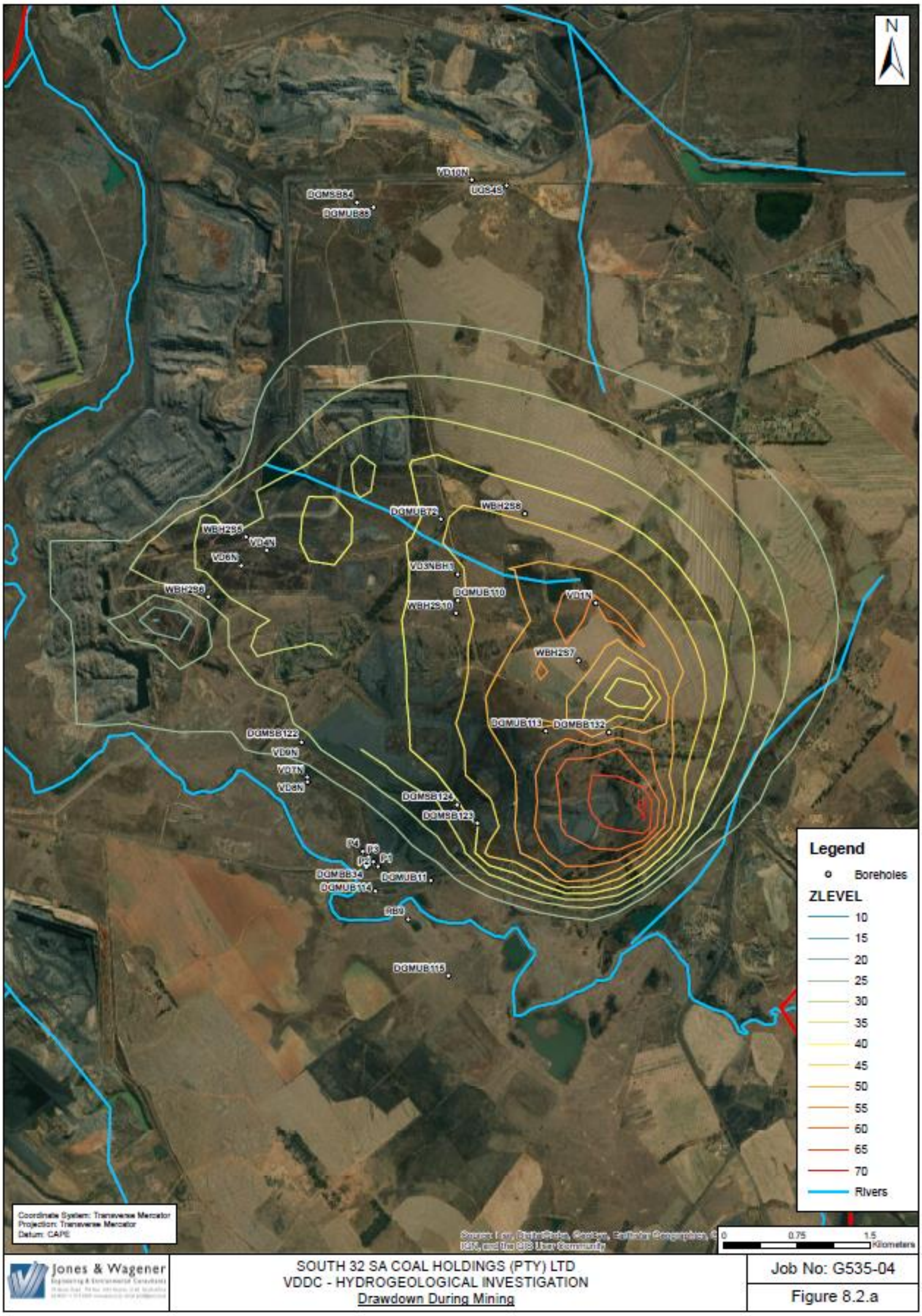

Figure 5-1: Modelled drawdown during mining (J&W, 2019a)

5.3.2 Impact on groundwater quality

5.3.2.1. During operation

During the operational phase, the flow in the aquifer will be directed towards the mine and very little groundwater pollution affecting private users and surface water is thus expected (refer to **Figure 5-2**). Additionally, current contaminated groundwater could also flow into the mine, diverting the current contaminant plume from the defunct underground mine.

It should be noted that the potential pollution sources were modelled as if the facilities remain in position for the entire LOM, whereas these facilities will in fact be moved or removed as mining progresses, e.g. boxcut spoils dumps will only remain on surface until steady state mining is achieved and will then be used in the backfilling of the pit as part of concurrent rehabilitation. In addition, it was assumed that the stockpile areas will not be provided with any barrier system, whereas the Eastern overburden dump and the Mixed ROM coal and slurry stockpile areas will be provided with a barrier system. The modelled impact therefore represents worst case scenario (J&W, 2019a). The modelled impact indicates that the contamination spread will be localised during the operational phase and that flow in the aquifer will be directed towards the opencast pit area, from where water will be pumped and managed in the dirty water management system. Very limited impact is therefore expected on groundwater users and surface water resources during this phase.

5.3.2.2. Decommissioning and post-closure

Once the normal groundwater flow conditions have been re-instated, polluted water could potentially migrate away from the mining area. As some discards and exposed reactive mineral surfaces will remain in the mine, this outflow could be contaminated as a result of mine drainage. As sulphate is normally a significant solute in drainage from mines, sulphate concentration from the mine has been modelled as a conservative (non-reacting) indicator pollution associated with mining. A starting concentration of 3 000 mg/ℓ has been assumed as a worst-case scenario based on the J&W report of 2016. However, geological material is a transient contaminant source and decreases in the concentration of released contaminants are expected over time. A 1% decrease in contaminant concentrations in the mine were incorporated into the transport modelling. This relates to sulfide mineral oxidation and dilution effects depleting the source of sulphate (J&W, 2019a).

The migration of contaminated water from mining and the extent of the pollution plume 10, 25, 50 and 100 years after the operations have ceased, were modelled and are indicated in **Figure 5-3** to **Figure 5-6**.

Expected mine water decant from the mining operations is discussed in section 5.3.3**.**

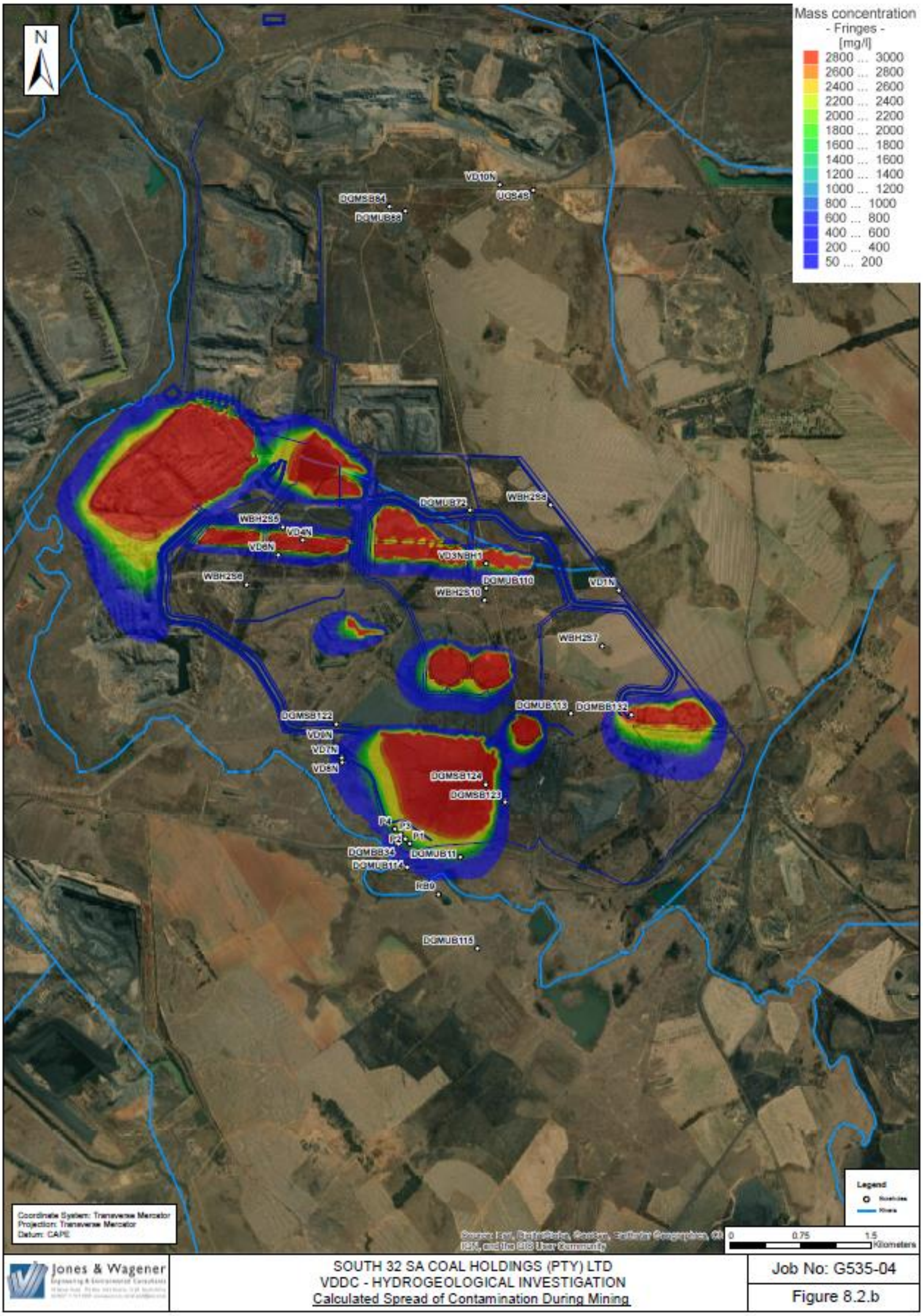

Figure 5-2: Calculated spread of contamination during mining (J&W, 2019a)

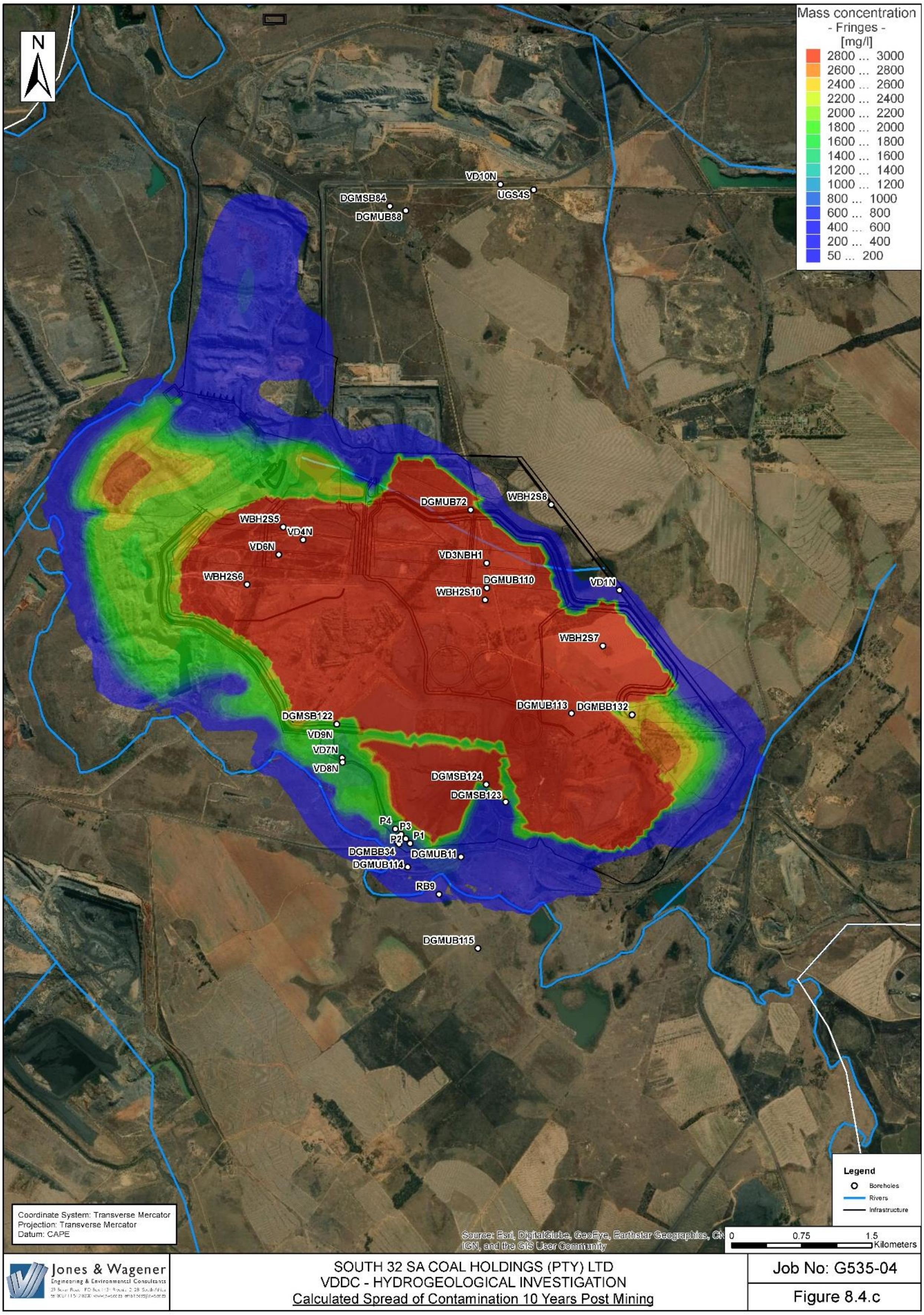

Figure 5-3:Modelled contamination plume 10 years post mining (J&W, 2019a)

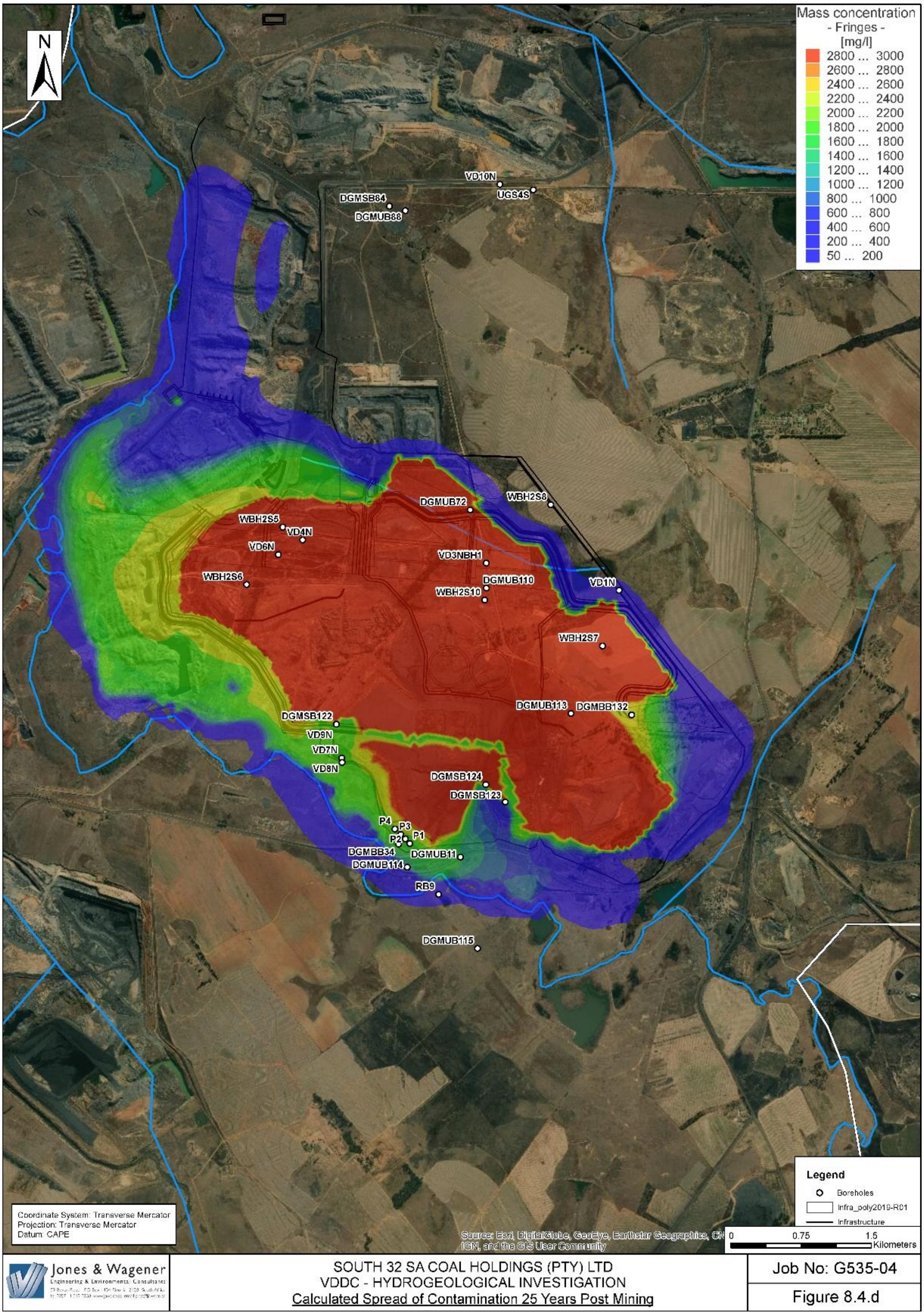

Figure 5-4:Modelled contamination plume 25 years post mining (J&W, 2019a)

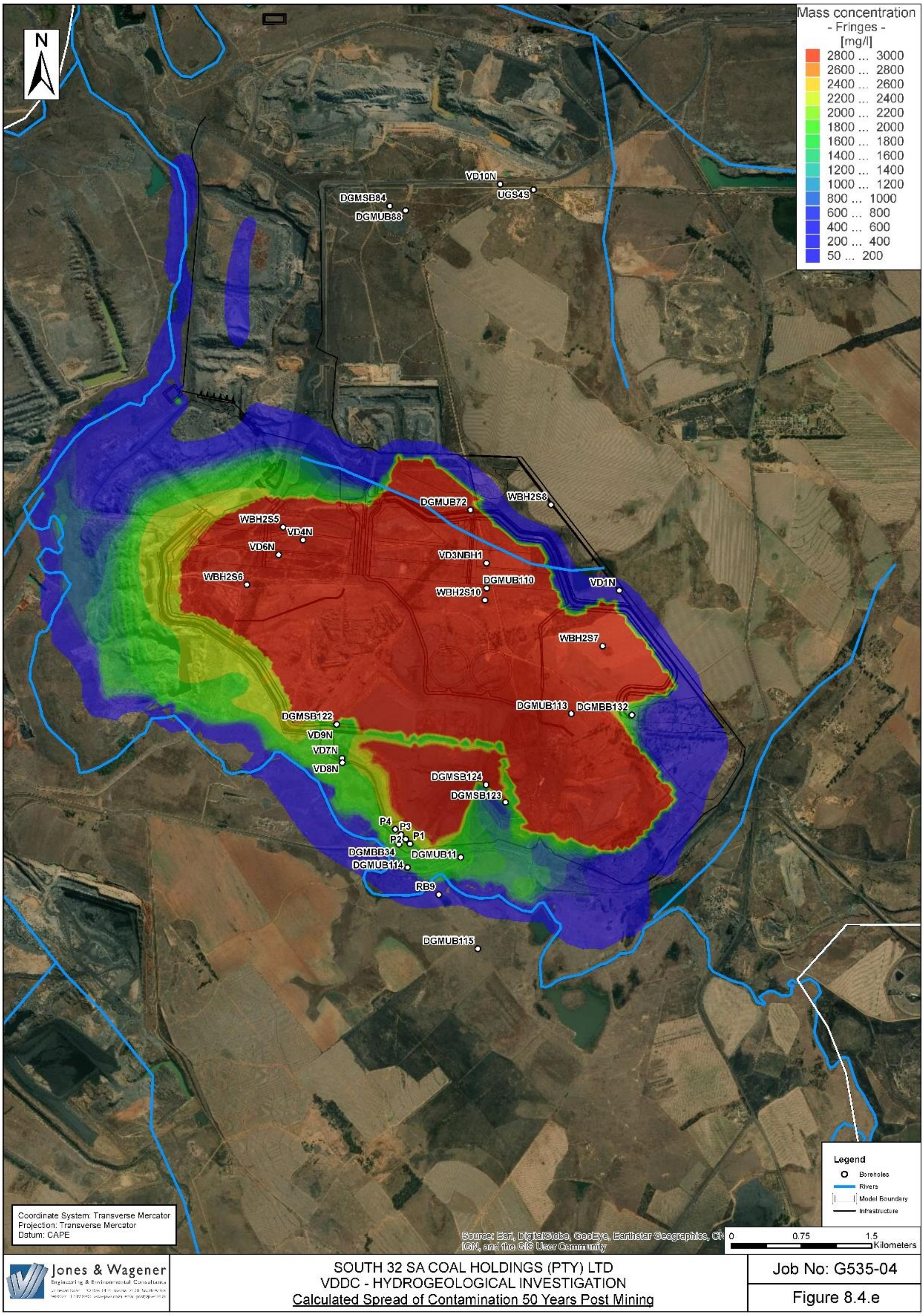

Figure 5-5: Modelled contamination plume 50 years post mining (J&W, 2019a)

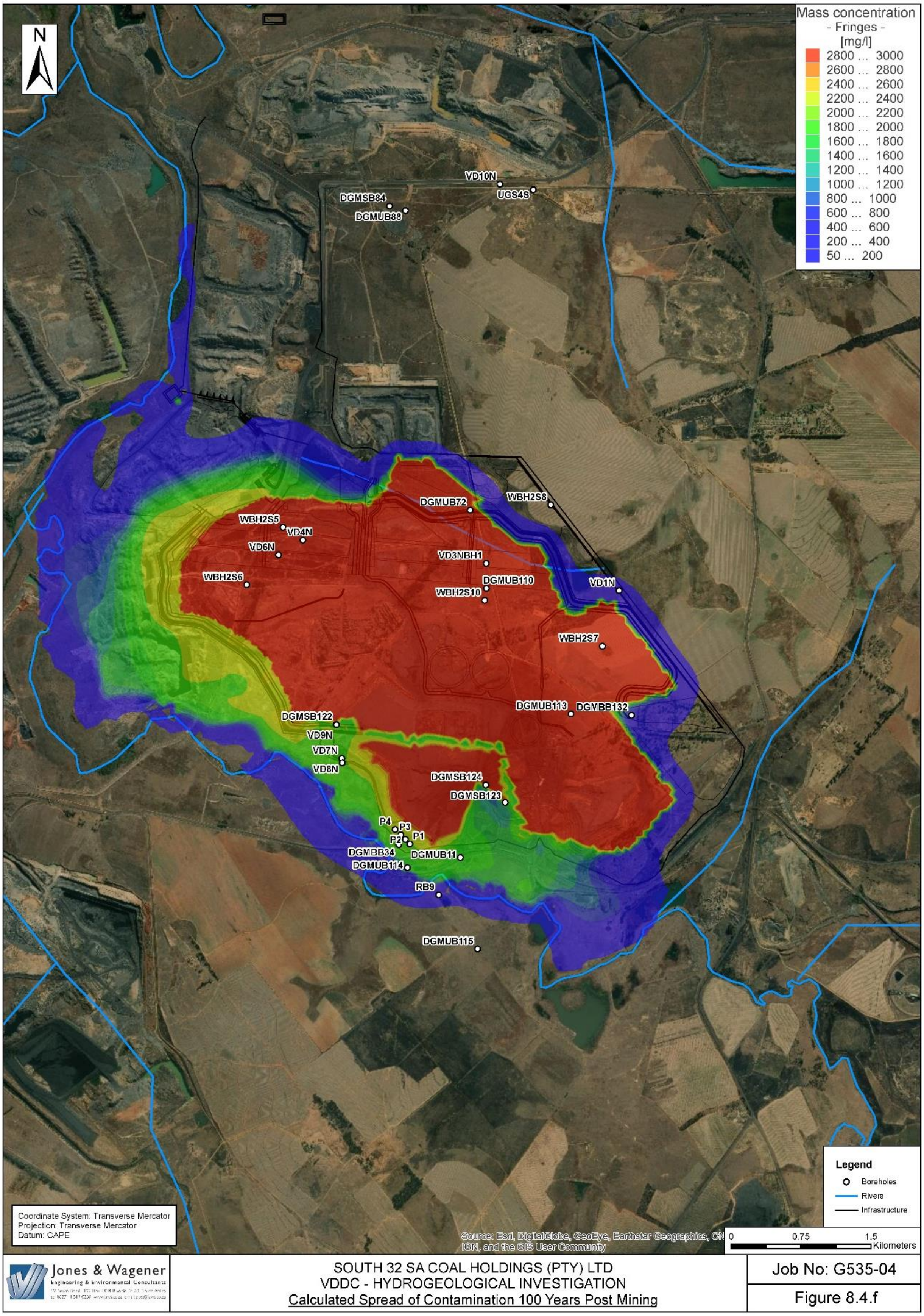

Figure 5-6:Modelled contamination plume 100 years post mining (J&W, 2019a)

5.3.3 Mine water decant

Following the cessation of opencast mining and the associated dewatering, it is assumed to lead to groundwater rebound. This estimated rebound time in years for the opencast after cessation of pumping is approximately five (5) years.

After rebound has reached equilibrium, decant has the potential to occur due to excessive rainfall and surface water run-off water entering the backfilled pit, as well as the hydraulic parameters of the backfill material. The percentage of the rainfall/runoff that is recharged into the rehabilitated opencast and potential discharge depends on:

- The slope of the rehabilitated pit and its direct surroundings;
- The thickness and composition of the topsoil. i.e. clay content and compaction;
- The vegetation of the rehabilitation and its direct surroundings;
- The amount of rainfall and intensity of the rainfall events; and
- The size of the ramps and the final voids.

The predicted discharge areas are shown in **Figure 5-7**. Please note that predicted discharge areas may vary from exact discharge areas due to sub-surface heterogeneity, however the general areas of predicted discharge should be consistent. The calculated subsurface mine water movement resulting in decant will move through the south-eastern edge of the backfilled pit of VDDC. The calculated sub-surface decant elevation is approximately 1 530 mamsl with a discharge volume of approximately 0.5 ℓ/s. The water level in the backfilled pit should be maintained approximately 5 m below the sub-surface discharge elevation as a safe management level. Please note that this decant rate and elevation is based on a model that incorporates an intact geological barrier between the VDDC opencast and the SKS and Glencore backfilled pits to the west. Should this not be the case, the decant location, rate and elevation is expected to be different (J&W, 2019a).

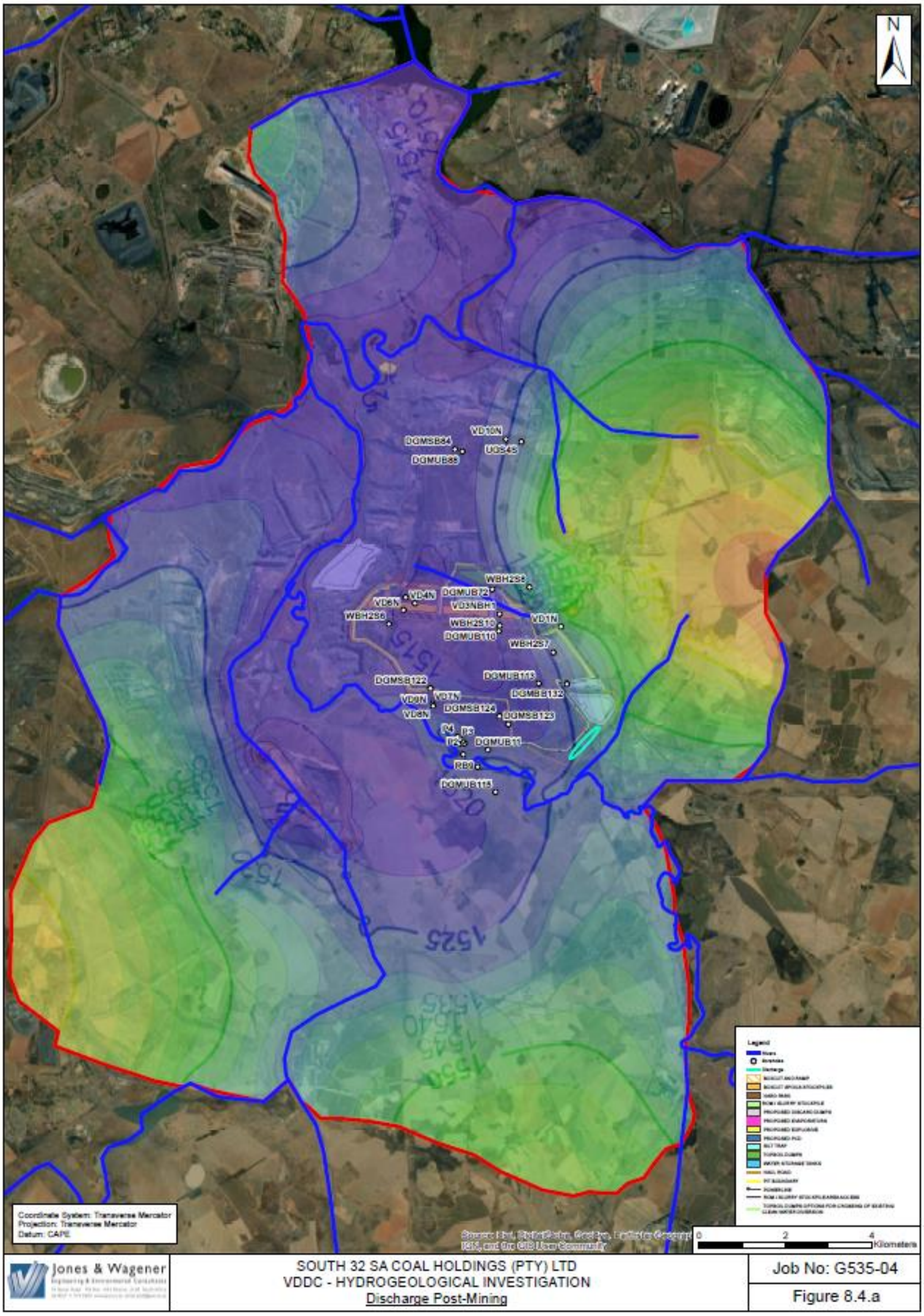

Figure 5-7: Discharge post mining (J&W, 2019a)

5.4 Impact on surface water

A detailed surface water assessment was undertaken by J&W and is attached in the IWWMP in **Appendix B**. The detailed assessment of impacts on the surface water resources, as well as the proposed mitigation measures, are shown in **Table 5-8** to **Table 5-10**.

5.4.1 Surface water quality

Impacts on surface water resources include impact on surface water quality, which may arise from:

- Clean runoff entering the mine affected areas and coming into contact with carbonaceous material, with resultant deterioration in water quality;
- Dirty runoff and mine water make discharging to the environment, with resultant deterioration in water quality within the Olifants River;
- Contaminated seepage from the overburden dumps, with potentially elevated sulphate and TDS;
- Leakage of mine impacted water from pipelines, storm water drains (if not maintained) and silt trap;
- Erosion at the clean water discharge points, resulting in the formation of erosion gullies, with elevated suspended solids in the runoff water, potentially impacting on the water quality in the Olifants River and south-eastern tributary in terms of suspended solids and deposition of silt;
- Dust suppression with mine impacted water contaminating the surface resulting in contaminated runoff during rainfall events, with resultant deterioration in water quality;
- Coal spillage, or spillage of water transported with the coal with haul trucks from the pit onto the haul roads, with resultant contamination of storm water;
- Spillage of chemical additives or waste products at the modular WTP, resulting in the deterioration of water quality in the watercourses;
- Discharge of water that does not meet the discharge standards, or untreated water during upset conditions at the WTP resulting in water quality deterioration;
- The release of surplus treated water into the catchment will influence the water quality of the receiving resource. The baseline water quality shows that the Olifants River is already heavily impacted, and the quality of water is expected to improve due to dilution effects.

The potential impact associated with the management of storm water can be mitigated through the implementation of appropriate stormwater management measures such as the separation of clean and dirty runoff, and the containment of dirty water. Details on the proposed mitigation measures are described in the impact rating tables.

5.4.2 Catchment yield

The proposed mining and infrastructure development will also have an impact on the catchment yield and flow rates of the systems.

The loss in catchment yield associated with the proposed VDDC project will be primarily due to the pit area and associated infrastructure, since these areas will be isolated from the catchment due to the containment of dirty runoff. It is planned to undertake concurrent rehabilitation, which will minimise the dirty water make, as well as the reduction in catchment yield.

The Witbank Dam has been selected as the receiving water body for the VDDC project as it is located downstream of the proposed development within the Olifants River catchment area. Beyond the WItbank Dam, the potential impact of the mine becomes extremely small due to the water volumes in the catchment and dilution effects.

An assessment was done of the impact of the proposed development on catchment yield for the Witbank Dam and is indicated in **Table 5-4**. It should be noted that this calculation was done assuming worst case, i.e. that no concurrent rehabilitation will take place.

Table 5-4: Calculated loss of yield (J&W, 2019b)

Location	Catchment area (km^2)	MAR Pre-Construction ($x10^6$ m^3)	MAR during operations ($x10^6$ m^3)	Percentage reduction (%)
VDDC opencast pit	11.4	0.36	0	100
New proposed infrastructure	1.6	0.05	0	100
Extension/replacement of existing infrastructure	1.4	0.04	0	100
VDDC Infrastructure and mining project in total	14.5	0.45	0	100
Olifants River downstream of the mine property	3309	188.1	187.65	0.24
Witbank Dam	579	190	189.5	0.24

The impact in surface water yield to the Olifants River downstream of the project area and the Witbank Dam is low, with an expected reduction of 0.24% (J&W, 2019b).

5.5 Impact on wetlands

The impacts on wetlands and the aquatic environment was assessed by TBC and a copy of the report is attached in the IWWMP attached in **Appendix B**.

The main aspect to consider in this regard is that opencast mining of the Vleishaft tributary (referred to as HGM 2 in the wetland assessment – refer to **section 3.6.7.1** and **Figure 3-12**) was authorised in the DMO WUL issued in October 2008. In terms of this WUL, the destruction of 355.4 ha of wetlands through opencast mining was authorised as S21(c) and S21(i) water uses. The VDDC pit is located within the opencast mining area indicated in the 2007 EMPR[6], except for the changes in the south as discussed in 2.1.3.2). The additional opencast mining areas in the south due to the change in the pit lay-out does not result in the further destruction of wetlands. The additional opencast area in the south is, however, located within 500 m of delineated wetlands and was therefore included as a S21(c)&(i) water use in section 4.1.1. There are therefore no changes to the extent of direct impact on wetlands.

The proposed infrastructure development within, or close to HMG2, is also located within the opencast mining area indicated in the 2007 EMPR and the mining of this system has been authorised in the 2008 DMO WUL.

HGM 5, a depression of less than 1.5 ha will be lost due to the development of the Eastern overburden dump.

[6] Refer to light blue line shown on Figure 2-5

A total wetland area of 198.9 ha was delineated for the VDDC infrastructure and mining project, with 120 ha expected to be lost/impacted as a result on the proposed infrastructure and mining development. This represents a 60% loss of wetland area. The total extent of HGM 2 has already been authorised to be opencast mined as stated above. Any impact associated with the proposed infrastructure development will therefore be of temporary nature (approximately 20 years) until the infrastructure is decommissioned and the area opencast mined.

A wetland offset strategy was compiled in support of the 2007 approval for the mining of the wetland and addresses the impact associated with the total development in HGM 2.

No direct impacts are expected for the unchanneled valley bottom wetland, which is associated with HGM 4, and any indirect impacts may be mitigated due to the presence of the railway line and existing PCD's. These structures are likely to intercept any contaminated surface run-off, preventing contamination of the unchanneled system.

The ecological integrity and functioning of the channelled valley bottom wetland associated with the Olifants River (HGM 1) is unlikely to be affected by the project (TBC, 2019).

The detailed assessment of impacts on the wetland systems are shown in **Table 5-8** to **Table 5-10**.

5.6 Impact on aquatic ecosystems

An assessment of the impact of the proposed development was done as part of the biodiversity and wetland assessment by TBC (attached in the IWWMP in **Appendix B**).

No direct contact between the instream and riparian areas, and the proposed infrastructure are anticipated. Some of the infrastructure will, however, be developed within 500 m of these areas. Diffuse runoff and seepage from the activities may have an impact on the aquatic ecosystems.

The proposed discharge of treated water into a wetland feeding into the Olifants River will result in an increase in the overall water volumes in the Olifants River. This may serve to inundate additional riverine habitat. This impact is dependent on the existing water levels in the Olifants River. It is noted that following the inundation of additional habitats associated with discharge of treated water volumes, an equilibrium would be established within the short term and therefore this habitat impact is not expected to last for the entirety of the discharge period. It is assumed that the treated water will be of good quality (the RQO for this catchment of the Olifants River) and the discharge of the treated water would therefore likely serve to reduce the salinity in the system, which would be a positive impact to the watercourse (TBC, 2019).

The detailed assessment of impacts on the wetland systems are shown in **Table 5-8** to **Table 5-10**.

5.7 Impact assessment methodology and outcome

5.7.1 Impact assessment methodology

In order to ensure uniformity, a standard impact assessment methodology will be utilised so that a wide range of impacts can be compared. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology will be used to describe the impacts for each of the aforementioned assessment criteria. A summary of each of the qualitative descriptors along with the equivalent quantitative rating scale for each of the aforementioned criteria is given in **Table 5-5**.

Table 5-5: Quantitative rating and equivalent descriptors for the impact assessment criteria

RATING	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY
1	Very low	Isolated corridor / proposed corridor	Incidental	Practically impossible
2	Low	Study area	Short-term	Unlikely
3	Moderate	Local	Medium-term	Could happen
4	High	Regional / Provincial	Long-term	Very Likely
5	Very high	Global / National	Permanent	It's going to happen / has occurred

Quantitative Description of Impacts

To allow for impacts to be described in a quantitative manner in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus, the total value of the impact is described as the function of significance, spatial and temporal scale as described below.

$$\textbf{\textit{Impact Risk}} = \frac{(\text{SIGNIFICANCE} + \textit{Spatial} + \text{Temporal})}{3} \times \frac{\text{Probability}}{5}$$

An example of how this rating scale is applied is shown in **Table 5-6**.

Table 5-6: Example of Rating Scale

IMPACT	SIGNIFICANCE	SPATIAL SCALE	TEMPORAL SCALE	PROBABILITY	RATING
	LOW	Local	Medium Term	Could Happen	
Impact to air	2	3	3	3	1.6

Note: The significance, spatial and temporal scales are added to give a total of 8, that is divided by 3 to give a criterion rating of 2.67. The probability (3) is divided by 5 to give a probability rating of 0.6. The criteria rating of 2.67 is then multiplied by the probability rating (0.6) to give the final rating of 1.6. The impact risk is then classified according to 5 classes as described in **Table 5-7**.

Table 5-7: Impact Risk Classes

RATING	IMPACT CLASS	DESCRIPTION
NEGATIVE IMPACTS		
0.1 – 1.0	1	Very Low
1.1 – 2.0	2	Low
2.1 – 3.0	3	Moderate
3.1 – 4.0	4	High
4.1 – 5.0	5	Very High
POSITIVE IMPACTS		
Rating as for negative impacts		Positive impact

Therefore, with reference to the example used above, an impact rating of 1.6 will fall in the Impact Class 2, which will be considered to be a low impact.

5.7.2 Impact assessment rating

The outcome of the impact rating is provided in **Table 5-8** to **Table 5-10**.

Table 5-8: Impact rating for potential impacts on the water resource: Construction phase

ACTIVITY	ASPECTS AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
Site clearing, vegetation removal & stripping of topsoil	Loss and degradation of wetland systems	Loss of wetland ecosystem services, or degradation of these services. A considerable cumulative impact considering the extent of mining and development in the area, and the already lost wetland areas and associated services.	Significance	4	3.33	• Use existing access routes, where possible • Strip and stockpile topsoil and subsoil separately • Demarcate footprint areas to be cleared to avoid unnecessary clearing. Exposed areas must be ripped and vegetated to increase surface roughness • Minimise vehicle speed to reduce dust generation • Implement dust suppression such as wetting of roads • All personnel and contractors must undergo Environmental Awareness Training, where among other topics, wetland systems must be discussed. An attendance register must be kept as proof • Compile an alien invasive plant management plan prior to construction and implement throughout all project phases.	Significance	3	2.33
			Magnitude - Spatial	3			Magnitude - Spatial	2	
			Magnitude - Temporal	3			Magnitude - Temporal	2	
			Probability	5			Probability	5	
	Erosion and sedimentation of wetland areas	The exposed soils and stockpiles created are susceptible to erosion due to wind and runoff, resulting in sedimentation and increased turbidity of downstream watercourses.	Significance	4	2.67		Significance	4	1.80
			Magnitude - Spatial	4			Magnitude - Spatial	3	
			Magnitude - Temporal	2			Magnitude - Temporal	2	
			Probability	4			Probability	3	
Construction of laydown areas, construction works, movement of materials and construction equipment	Groundwater quality	Hydrocarbon spillages may seep into the underlying aquifer systems and result in the contamination of groundwater	Significance	2	0.93	• Avoid soil contamination by hydrocarbons or concrete-containing water. Supply vehicles, machinery and equipment with drip trays when leaking • Hazardous material to be stored in sealable containers within bunded area • Equipment, machinery, and vehicles must be repaired immediately or removed from site is leaking and a maintenance log must be kept • Contaminated soil must be removed and disposed of at a licenced facility	Significance	2	0.40
			Magnitude - Spatial	3			Magnitude - Spatial	2	
			Magnitude - Temporal	2			Magnitude - Temporal	2	
			Probability	2			Probability	1	
	Surface Water Quality	Change in aquatic ecosystem as a result of change in water quality due to erosion of soils during rainfall events, as well as hydrocarbon spillages from machinery, vehicles and equipment.	Significance	4	2.67	• Minimise the disturbed footprint area as far as possible. • Delineate "No-go" zones where the construction activities, construction plant and personnel are in close proximity to the Olifants River or wetland areas not authorised to be mined/developed. • Divert clean runoff around the development footprint. The clean water diversion is to be constructed first, before establishment of the boxcut. • The construction area will largely be within the existing dirty water management area of the mine. Manage storm water in terms of the existing storm water management system, i.e. all runoff is directed to the Vleishaft PCD from where it is re-used. • Construct surface water management infrastructure, such as storm water canals and silt traps first at the eastern overburden stockpile and dirty water management infrastructure area, to ensure that contaminated runoff and dirty water spills are contained. • Servicing of construction vehicles may take place only in dedicated areas that are equipped with drip trays.	Significance	4	2.00
			Magnitude - Spatial	3			Magnitude - Spatial	3	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	4			Probability	3	
		Spills and leaks from machinery, equipment and vehicles entering wetlands and impact on water quality within these systems. The storage and mixing of substances on site also pose a risk to wetlands.	Significance	4	2.40		Significance	4	1.80
			Magnitude - Spatial	3			Magnitude - Spatial	3	
			Magnitude - Temporal	2			Magnitude - Temporal	2	
			Probability	4			Probability	3	

ACTIVITY	ASPECTS AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
		Pollution of rivers/streams due to discharge of contaminated water as a result of erosion of soils during rainfall events, as well as hydrocarbon spillages from machinery, vehicles and equipment.	Significance	2	1.87	• Repair leaking equipment immediately or remove from site to facilitate repair. • Bunded containment and settlement facilities will be provided for hazardous materials, such as fuel and oil. • Spill-sorb or a similar product will be kept on site and used to clean up hydrocarbon spills in the event that they should occur. • Remove all contaminated soil and place in appropriate containers. Contaminated soil may only be disposed of in a licenced facility. • Implement appropriate erosion protection measures at steep areas. • Develop and implement a waste management plan for the construction phase. • Appropriate sewage management will be implemented during the construction phase that would tie into the existing sewage management strategy at Wolvekrans Colliery, i.e. portable chemical toilets which are regularly serviced. • Implement dust suppression measures and adhere to mine driving rules to prevent excessive dust generation. • Continue with existing water quality monitoring up- and downstream of the construction areas, before and during construction where practical, in order to detect any increase in suspended solids or turbidity. • Review water management around the construction areas if erosion is evident, or if the water quality monitoring indicates an increase in suspended solids.	Significance	1	1.00
			Magnitude - Spatial	3			Magnitude - Spatial	2	
			Magnitude - Temporal	2			Magnitude - Temporal	2	
			Probability	4			Probability	3	
	Surface Water Quantity	Reduction in catchment yield as a result of containment of contaminated runoff water emanating from the site, with no release to the catchment. Change in surface flow characteristics of rivers and wetlands.	Significance	1	2.00	• Minimise the disturbed areas and potentially contaminated areas as far as possible. • Minimise the aerial extent where dirty construction activities are carried out (e.g. servicing areas and workshops, fuel storage areas, waste storage areas) and ensure appropriate bunding of these areas. • Divert upslope runoff around the construction activities to minimise the volume of dirty water generated and contained. • Pump surplus dirty water to existing mechanical evaporators for disposal or re-use on the mine in terms of existing authorisations.	Significance	1	1.67
			Magnitude - Spatial	2			Magnitude - Spatial	2	
			Magnitude - Temporal	3			Magnitude - Temporal	2	
			Probability	5			Probability	5	
		Altered flow result in change in hydrology and catchment yield, resulting in change to aquatic ecosystem	Significance	3	2.13		Significance	3	1.07
			Magnitude - Spatial	2			Magnitude - Spatial	2	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	4			Probability	2	

ACTIVITY	ASPECTS AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
Removal of material from the boxcut and dewatering of boxcu	Surface Water Quality	Discharge of contaminated water as a result of erosion of spoil stockpiles during rainfall events, deposition of sediments in local watercourses, and an increase in sulphate and TDS from overburden stockpiles	Significance	3	2.40	• Direct runoff and seepage from the overburden dumps located in between the ramps to Vleishaft PCD. • Drain runoff and seepage from the overburden dumps located at the SKS pit to the SKS void. • Divert runoff and seepage from the Eastern overburden dump via a canal and berm system to silt traps and existing boreholes which will take all runoff into the underground workings.	Significance	1	0.93
			Magnitude - Spatial	3			Magnitude - Spatial	3	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	4			Probability	2	
		Discharge of contaminated water from the boxcut (which is likely to be slightly to moderately impacted in terms of sulphate, TDS and suspended solids) into watercourses. with a resultant increase in sulphate and TDS concentrations	Significance	3	2.40	• Contain water on site at in-pit sumps and pump from there to either Vleishaft PCD for reuse in the existing mining operations to mechanical evaporators for disposal. • Implement surface water management measures such as clean water diversion canals and berms to divert clean catchment away from mine workings • Comply with conditions in the relevant Water Use Licence/s	Significance	2	0.93
			Magnitude - Spatial	3			Magnitude - Spatial	3	
			Magnitude - Temporal	3			Magnitude - Temporal	2	
			Probability	4			Probability	2	

Table 5-9: Impact rating for potential impacts on the water resource: Operational phase

ACTIVITY	ASPECT AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
Operation of surface infrastructure associated with opencast mining	Water quality impairment of wetlands due to spills and leaks, as well as sedimentation with resultant deterioration in PES	Spills and leaks from machinery, equipment and vehicles as well as the storage and mixing of substances on site, pose a risk to wetlands if contaminated runoff or material with pollution potential enters wetlands. Sedimentation of wetlands if contaminated runoff from stockpile enters wetlands	Significance	4	2.67	• Separate clean and dirty water. Clean water must be diverted and directed around working areas, and measures or structures created to manage the discharge to avoid scouring and erosion. • Ablution facilities must be provided for all staff and maintained for proper and correct use. • Waste must be collected in appropriate containers to accommodate the expected volume of waste, these bins must be serviced. Recycling of waste must be encouraged, and in the event waste cannot be recycled, the waste must be disposed of at a licenced facility. • Dust suppression must be implemented, and mine driving rules must be maintained. • Spills of hydrocarbons must be prevented as far as possible. Spill kits must be available and on hand to clean these spills. • Where applicable, hazardous materials must be stored in leak-proof, sealable containers or packaging. Materials must also be stored in bunded areas which can accommodate the required volumes. • Drip trays or any form of oil absorbent material must be placed underneath vehicles/machinery and equipment when leaking or when being serviced. • No servicing of equipment on natural or rehabilitated areas. • Leaking equipment shall be repaired immediately or be removed from site to facilitate repair. • All vehicles and equipment must be well maintained to ensure that there are no oil or fuel leakages. • All contaminated soil shall be removed and be placed in appropriate containers. Contaminated soil may only be disposed of in a licenced facility. • A specialist Contractor shall be used for the bio-remediation of contaminated soil where the required remediation material and expertise is not available on site. • All personnel and contractors to undergo Environmental Awareness Training. A signed register of attendance must be kept for proof. • Implement an alien invasive plant management plan, to control and prevent the spread of invasive aliens. • Implement and maintain a suitable stormwater management plan. • Dirty water must be contained in suitable containment facilities and re-used or treated before it is discharged into the water resource.	Significance	4	2.00
			Magnitude - Spatial	3			Magnitude - Spatial	3	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	4			Probability	3	
Waste management and storage associated with opencast mining	Groundwater quality	Potential deterioration in quality of baseflow to rivers and water abstracted from boreholes as a result	Significance	4	2.67	• Eastern overburden dump and Mixed ROM coal and slurry areas must be lined with at least compacted clay to prevent contamination from entering the aquifer system.	Significance	3	1.07

ACTIVITY	ASPECT AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
		of seepage from the following facilities: • Overburden dumps and Dragline Spoils • Mixed ROM and slurry stockpile areas • Mechanical evaporators • Final Rejects Dump • No. 5 Seam and No. 4 Seam Stockpiles • Vleishaft PCD	Magnitude - Spatial	2		• Groundwater monitoring must be continue upgradient and downgradient of these facilities to monitor and intercept any potential contamination timeously. • Groundwater monitoring must continue at designated positions based on infrastructure layout, as recommended. • Evaporation sprayers are likely to cause significant contaminant build-up over time at the selected discharge points. However, this contamination is likely to be similar to the geochemical nature of backfill material where the sprayers will be constructed. Modelling indicates no impact to sensitive receptors and it is likely that mobilised contamination will move into the VDDC opencast. No actions are therefore required in the vicinity of the sprayers during mining except occasional removal of salt build-up and disposal at an appropriate facility.	Magnitude - Spatial	2	
			Magnitude - Temporal	4			Magnitude - Temporal	3	
			Probability	4			Probability	2	
Opencast pit and related infrastructure	Surface Water Quality	Pollution of surface water resources by contaminated stormwater runoff entering watercourses, contaminated seepage from overburden dumps, leakage of contaminated water from pipelines, erosion at clean canal discharge points, and clean water runoff entering the dirty water management area.	Significance	5	3.20	• All infrastructure areas with the potential to generate dirty stormwater runoff, including washdown water, will be located within the designated dirty water area. • Divert clean runoff around the designated dirty areas by means of cut-off canals, sized to accommodate at least the 1:50 year peak flow event. • Install adequate erosion protection measures at the clean canal discharge locations. • Manage general and hazardous wastes according to the existing waste management plan for Wolvekrans Colliery. • Inspect all pipeline routes regularly to enable early detection of leaks. • Collect all contaminated stormwater generated within the dirty water management area and pump to Vleishaft PCD. • Divert runoff from clean catchments draining towards the overburden dumps located in the south east of the project area around the dumps. • Implement an inspection and maintenance plan on the storm water system to ensure that all silt traps are maintained and that storm water canals and pipelines remain unblocked and free flowing (monthly inspections to be carried out). • Spill-sorb or a similar type product must be kept on site and used to clean up hydrocarbon spills in the event that they should occur. • Use the overburden stockpiles in the concurrent rehabilitation of the opencast pit	Significance	3	1.33
			Magnitude - Spatial	4			Magnitude - Spatial	4	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	4			Probability	2	
Dust suppression on haul roads and stockpiles using mine impacted water	Surface Water Quality	Pollution of surface water resources by spillage of dust suppression water into the watercourses, and contaminated runoff from areas, with resultant deterioration in water quality, in terms of elevated salinity, particularly sulphate.	Significance	3	2.40	• Develop and implement a formal procedure for dust suppression to ensure that dust suppression application rates are carefully controlled to prevent the excessive application of water, ponding and excessive runoff of dust suppression water into the watercourses. • No dust suppression should be carried out on surfaces that are already moist. • Dust suppression with contaminated water should be confined to isolated dirty water management areas.	Significance	2	0.80
			Magnitude - Spatial	3			Magnitude - Spatial	1	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	4			Probability	2	

ACTIVITY	ASPECT AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
Transport of coal via haul roads for processing	Surface Water Quality	Spillage of contaminated water and coal particulates resulting in pollution of surface water resources	Significance	2	1.60	• The majority of haul roads and haulage of coal will take place within the dedicated dirty water management area, with runoff draining either to the opencast pit or to Vleishaft PCD where it will be contained. • All dirty water containment facilities should be designed, operated and maintained to have a risk of spill of 2% or less (1:50 year recurrence interval) in any one year. • As far as is practical, ROM coal should be allowed to drain within the pit before being loaded onto the haul trucks, to prevent spillage of water from the haul truck load boxes onto the haul roads. • Loading of trucks will be carefully controlled to ensure that overloading will not take place.	Significance	1	0.93
			Magnitude - Spatial	3			Magnitude - Spatial	3	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	3			Probability	2	
Isolation of dirty catchment as a result of containment of runoff from dirty water management areas	Surface Water Quantity	Containment of runoff from dirty water management area alter the infiltration of the catchment, reduce the availability of water and change surface flow characteristics of wetlands.	Significance	3	2.40	• Divert clean runoff around the working areas. • The site layout has been designed to minimise the dirty footprint, and therefore to minimise the impact on the catchment yield. • Rehabilitate areas no longer in use, or that will not be mined in future, to increase the footprint of the clean water management area from which clean runoff is discharged into the environment. • Concurrent rehabilitation of the opencast mining area will take place, and the rehabilitation will be shaped to be free draining. • Where rehabilitated areas are sloped towards the active opencast pit, berms and canals will be constructed to maximise the area that is free draining. • Discharge treated water from the modular WTP to compensate for loss.	Significance	4	1.80
			Magnitude - Spatial	3			Magnitude - Spatial	3	
			Magnitude - Temporal	3			Magnitude - Temporal	2	
			Probability	4			Probability	3	
		Change in flow resulting in change in aquatic ecosystem	Significance	3	2.40		Significance	3	1.60
			Magnitude - Spatial	2			Magnitude - Spatial	2	
			Magnitude - Temporal	4			Magnitude - Temporal	3	
			Probability	4			Probability	3	
		Local reduction in catchment yield (i.e. immediately downstream and at Witbank Dam)	Significance	3	1.33		Significance	3	1.33
			Magnitude - Spatial	4			Magnitude - Spatial	4	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	2			Probability	2	
		Regional reduction in catchment yield (i.e. Loskop Dam)	Significance	2	0.8		Significance	2	0.8
			Magnitude - Spatial	1			Magnitude - Spatial	1	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	2			Probability	2	
Operation of modular WTP	Surface Water Quality	Pollution of surface water resources by • Spillage of chemical additives, which could result in deterioration of water quality in the watercourses	Significance	4	3.20	• The modular WTP will be isolated within a designated dirty water management area and containerised. • All spills from the WTP will be collected in a sump, from which water will drain to the SKS pit. • All chemicals and additives will be stored in dedicated bunded areas, where spills will be contained.	Significance	2	1.07
			Magnitude - Spatial	4			Magnitude - Spatial	2	

ACTIVITY	ASPECT AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
		• Spillage of the water treatment waste products (brine) to the receiving environment • Discharge of water that does not meet the discharge standards, or untreated water during upset conditions at the WTP	Magnitude - Temporal	4		• An inspection and maintenance plan will be implemented to ensure that the water treatment plant always operates within specification. • Discharge water quality will be continuously monitored for early detection of water quality non-compliant to discharge standard. • Should inclement conditions occur, or poor discharge water quality be detected, the WTP discharge will be directed to the Vleishaft PCD or the SKS pit.	Magnitude - Temporal	4	
			Probability	4			Probability	2	
Handling and storage of waste from the WTP	Surface Water Quality	Pollution of surface water resources by: • Spillage of brine onto the ground surface or into water resources; • Inadequate containment systems where brine is stored; • Leakage from containment facilities for brine	Significance	4	3.20	• Brine will be stored in the existing closed tanks at the SKS pit and are located within the designated dirty water management area. • Spills will enter the SKS pit or will be pumped to the Vleishaft PCD. • Implement an inspection and maintenance plan to ensure that the tanks always operate within specification.	Significance	2	1.06
			Magnitude - Spatial	4			Magnitude - Spatial	2	
			Magnitude - Temporal	4			Magnitude - Temporal	4	
			Probability	4			Probability	2	
Discharge of treated water from the modular WTP via wetland system to the Olifants River	Surface Water Quality	Release of surplus treated water into the catchment will influence the water quality of the receiving resource. Due to the current impacted state of the Olifants River, the quality of water should improve due to dilution effects. Some erosion may occur at the discharge point.	Significance	4	3.20	• Install and maintain erosion protection measures at the discharge point • The quality of the water discharged will be closely monitored to ensure that it complies with the specified RQO at all times	Significance	4	3.20
			Magnitude - Spatial	4			Magnitude - Spatial	4	
			Magnitude - Temporal	4			Magnitude - Temporal	4	
			Probability	4			Probability	4	
		Discharge of treated water into wetland system resulting in reduced salinity	Significance	1	0.40		Significance	1	0.40
			Magnitude - Spatial	1			Magnitude - Spatial	1	
			Magnitude - Temporal	1			Magnitude - Temporal	1	
			Probability	2			Probability	2	
		Inundation of aquatic habitats as a result of additional water volumes	Significance	1	0.80		Significance	1	0.80
			Magnitude - Spatial	1			Magnitude - Spatial	1	
			Magnitude - Temporal	1			Magnitude - Temporal	1	
			Probability	4			Probability	4	
	Surface Water Quantity	An increase in water flow may have the potential to negatively impact on the aquatic ecology by changing the seasonal flow patterns in the river system.	Significance	3	2.66	• No mitigations are proposed as increase in yield is positive	Significance	3	2.66
			Magnitude - Spatial	4			Magnitude - Spatial	4	
			Magnitude - Temporal	3			Magnitude - Temporal	3	
			Probability	4			Probability	4	

ACTIVITY	ASPECT AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
		Release of surplus treated water into the catchment will increase in yield, which is regarded as positive. The change in the water quantity of the receiving resource and may impact on the aquatic ecology by changing the seasonal flow patterns in the river system and also result in altered hydrology of the wetland into which the discharge form the Northern Canal takes place.	Significance	1	0.80	• Maintain energy dissipating structures, where necessary • All personnel and contractors must undergo Environmental Awareness Training, where among other topics, wetland systems must be discussed. An attendance register must be kept as proof	Significance	1	0.80
			Magnitude - Spatial	1			Magnitude - Spatial	1	
			Magnitude - Temporal	1			Magnitude - Temporal	1	
			Probability	4			Probability	4	
Forced evaporation at mechanical evaporators on SKS pit	Surface water quality	Wind-blown contamination results in the release of contaminated water into the catchment, with resultant deterioration in water quality. Salinisation of water to be evaporated over time due to combined evaporation of brine from WTP.	Significance	3	2.93	• Mechanical evporation to be temporarily halted during high wind conditions. • Where forced evaporation occurs over seeded areas, it is recommended that monitoring of soils by a soils specialist be undertaken. The detailes for this monitoring is to be outlined by a soil specialist. • Limit forced evaporation to spray only over pits. Where evaporators are in close proximity to watercourses (i.e. evaporators at SKS void) monitoring should be implemented and corrective action taken if monitoring show an impact on water quality. • Monitor salination of water managed through the evaporation system due to the combined evaporation with brine from the WTP and take corrective action if needed.	Significance	2	1.80
			Magnitude - Spatial	4			Magnitude - Spatial	4	
			Magnitude - Temporal	4			Magnitude - Temporal	3	
			Probability	4			Probability	3	
Mining and infrastructure development within floodlines	Flooding (surface water)	Flooding of mine or mine infrastructure during extreme flood events with impact on mining operations	Significance	3	1.33	• No mining within these restricted areas will take place without the relevant authorisations, in terms of GNR 704 exemptions and Section 21(c) and (i) WUL • Conduct an investigation into the status of Attenuation Dam 1 dam wall, to determine any required upgrading or stabilisation to reduce the potential risk to mining in this area before mining commences.	Significance	3	0.93
			Magnitude - Spatial	4			Magnitude - Spatial	3	
			Magnitude - Temporal	3			Magnitude - Temporal	1	
			Probability	2			Probability	2	
Opencast mining not previously authorised	Lowering of groundwater levels during mining	Dewatering of the surrounding aquifer as a result of pumping from pit as opencast mining proceeds. Surrounding water users may experience a decrease in available volumes such as baseflow to rivers and borehole abstraction availability	Significance	3	2.40	• Separate clean and dirty water to limit the dirty water make. • Monitor static groundwater levels on a quarterly basis in all boreholes within a zone of one kilometre surrounding the mine to ensure that any deviation of the groundwater flow from the idealised predictions is detected in time and can be reacted on appropriately. • Should surface water monitoring shows that watercourses are affected by mine dewatering, discharge of clean water into the watercourses should be considered. Timing and volumes should be determined by a surface water specialist.	Significance	2	0.27
			Magnitude - Spatial	3			Magnitude - Spatial	1	

ACTIVITY	ASPECT AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
			Magnitude - Temporal	3		The monitoring results must be interpreted annually by a qualified hydrogeologist and the monitoring network should be audited every 5 years. • Update the numerical model using measured the measured inflows, water levels and any potential future drilling and pump test information, to re-calibrate and refine the impact prediction. This should be done every 5 years during operation of the opencast. • Dewatering and groundwater abstraction for mining purposes should be monitored so as to prevent negative impacts on the underlying aquifer. • Areas in the opencast where the defunct underground is intersected could be sealed with blasted overburden with engineered designs to limit groundwater ingress.	Magnitude - Temporal	1	
			Probability	4			Probability	1	
Discharge of mine water make from opencast pit to the natural watercourses	Surface Water Quality	Pollution of surface water resources by runoff entering mining areas and coming into contact with carbonaceous material, and dirty runoff and mine water make discharging into the environment resulting in deterioration of water quality. Dewatering of wetland systems due to reduction in baseflow.	Significance	4	3.20	• Pump all dirty water generated at the VDDC workings and proposed infrastructure areas to Vleishaft PCD. • Reuse dirty water in the operations at VDDC, where possible. • Treat excess dirty water (water pumped from Vleishaft PCD to the mobile WTP or evaporators). • Provide of water management facilities with a risk of spill that is lower than 2% in any one year as per the Golder water balance. • Continue with the surface water quality monitoring programme and expand the existing network as per the specialist recommendation. • -Implement a water balance monitoring programme will be implemented to enable calibration of the water balance.	Significance	3	1.33
			Magnitude - Spatial	4			Magnitude - Spatial	4	
			Magnitude - Temporal	4			Magnitude - Temporal	3	
			Probability	4			Probability	2	

Table 5-10: Impact rating for potential impacts on the water resource: Decommissioning and post closure phase

ACTIVITY	ASPECT AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
Ripping of compacted areas, replacement of soil and shaping	Erosion and sedimentation of wetland areas	Exposed soils during decommissioning of infrastructure are susceptible to wind and runoff erosion, resulting in sedimentation of downstream wetlands.	Significance Magnitude - Spatial Magnitude - Temporal Probability	3 4 3 3	2.00	• Consider passive water treatment such as artificial wetlands at predicted decant areas • Rehabilitation plan must minimise water ingress into the project area • Minimise vehicle speed to reduce dust generation • Avoid soil contamination by hydrocarbons or concrete-containing water by supplying vehicles, machinery and equipment with drip trays/absorbent material when stationary • Hazardous material to be stored in sealable containers within bunded areas • Equipment, machinery, and vehicles must not be serviced within regulated wetland areas • Equipment, machinery, and vehicles must be maintained to prevent/limit leakage of fuel and oil • Contaminated soil must be removed and disposed of at a licenced facility • Continue to implement alien invasive plant management plan	Significance Magnitude - Spatial Magnitude - Temporal Probability	2 3 3 3	1.60
Use and maintenance of machines, vehicles and equipment.	Water quality impairment and deterioration of wetlands	Sedimentation from rehabilitated areas. Spills and leaks from machinery, equipment and vehicles will also impact on water quality.	Significance Magnitude - Spatial Magnitude - Temporal Probability	3 3 3 4	2.40		Significance Magnitude - Spatial Magnitude - Temporal Probability	3 3 3 3	1.80
Shaping and contouring of the area to achieve final land use	Altered and lost hydrodynamics and flow regime for the catchment area	The sloping and landscaping will restore to some extent the hydrodynamics of the catchment, but this will not be natural.	Significance Magnitude - Spatial Magnitude - Temporal Probability	3 4 3 4	2.67		Significance Magnitude - Spatial Magnitude - Temporal Probability	3 3 3 3	1.80
Decommissioning of surface infrastructure associated with opencast mining	Change in water quality resulting in deterioration of aquatic ecosystem	Increased dissolved solids, increased dissolved metals, alteration of pH, increased suspended solids	Significance Magnitude - Spatial Magnitude - Temporal Probability	5 4 5 4	3.73	• Heavy vehicles must not be allowed to indiscriminately drive within riparian habitats. • Watercourse crossings must be outside of the riparian and instream areas. • Rehabilitate diversion berms and/or trenches where they are no longer required. • Rip and re-vegetate the disturbed areas as soon as possible. • Passive or active water treatment should be implemented where water quality is not within regulatory limits.	Significance Magnitude - Spatial Magnitude - Temporal Probability	3 3 5 1	0.73
Rehabilitated opencast pit	Discharge of contaminated mine water after mining (decant)	Contaminated water may impact surrounding watercourses	Significance Magnitude - Spatial Magnitude - Temporal	4 2 5	2.93	• Implement mine closure and rehabilitation procedures for the pit area • Water level in the backfilled pit should not exceed 1 530 mamsl when pumping groundwater to control the water level in the backfilled opencast areas, thereby preventing decant • Maintain the water level in the pit 5 metres below the sub-surface discharge elevation as a safe management level. Alternatively, an interception trench must be constructed to capture contaminated subsurface seepage • All sulphate containing waste material should be stored at the bottom of the opencast and flooded as soon as possible • A water management strategy, which includes a decant management plan, must be developed • Backfill material should be compacted and surface water flow should be routed around the backfilled opencast to reduce recharge	Significance Magnitude - Spatial Magnitude - Temporal	2 1 1	0.53

ACTIVITY	ASPECT AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
			Probability	4		• Groundwater monitoring boreholes should be sited at designated positions based on mining layout, to comply with the design requirements of a groundwater monitoring system, as recommended • Monitoring results must be interpreted annually by a qualified hydrogeologist and the monitoring network should be audited annually to ensure compliance with regulations	Probability	2	
Waste management and storage during decommissioning	Groundwater quality	Potential deterioration in quality of baseflow to rivers and water abstracted from boreholes as a result of seepage from the following facilities: • Mechanical evaporators • Final Rejects Dump • Vleishaft PCD	Significance	4	2.93	• Vleishaft PCD, mechanical evaporators (and associated salt build-up), to be removed and the area remediated the area as per the rehabilitation plan • Capping of the final rejects dump must be implemented as per approved rehabilitation designs • Maintain monitoring and contaminated seepage management at the final rejects dump to minimise contamination of groundwater.	Significance	3	0.60
			Magnitude - Spatial	3			Magnitude - Spatial	2	
			Magnitude - Temporal	4			Magnitude - Temporal	4	
			Probability	4			Probability	1	
General decommissioning and rehabilitation, including decommissioning of water management infrastructure	Surface Water Quality	Pollution of surface water resources as a result of: • Erosion of soils during rainfall events resulting in elevated suspended solids in watercourses • Hydrocarbon spillages from machinery, vehicles, and equipment.	Significance	2	1.87	• Delineate "no-go" zones where the decommissioning activities are near the Olifants River. • Decommission the storm water management measures last, if at all, to ensure adequate storm water management during the rehabilitation phase. • 'Equipment, machinery, and vehicles will only be serviced in dedicated areas that are bunded and equipped with drip trays. • Hazardous material to be stored in sealable containers within bunded areas. • Spill-sorb or a similar product will be kept on site, and used to clean up hydrocarbon spills in the event that they should occur. • Erosion protection measures will be implemented at steep areas as determined by a surface water specialist-Erosion protection measures will be implemented at steep areas. • A waste management plan will be developed for the decommissioning phase, which will include the handling of contaminated materials / soils found on site. • All traces of hydrocarbons and residual waste will be removed before infrastructure is demolished. • Contaminated soils will be excavated and placed on the discard facilities prior to their rehabilitation, or removed from site by an appropriately licensed waste contractor. • An appropriate sewage management strategy will be implemented during the decommissioning phase. • Water quality monitoring will be undertaken downstream of the decommissioning areas, before and during decommissioning where practical, in order to detect any increase in suspended solids or turbidity.	Significance	1	0.67
			Magnitude - Spatial	3			Magnitude - Spatial	2	
			Magnitude - Temporal	2			Magnitude - Temporal	2	
			Probability	4			Probability	2	

ACTIVITY	ASPECT AFFECTED	POTENTIAL IMPACT	PRE-MITIGATION	Score	Rating	MITIGATION	POST-MITIGATION	Score	Rating
Recovery of water levels and possible decant of mine water make	Surface Water Quality	Discharge of contaminated water. The water balance indicates that an average water make in the order of 5 800 m³/day can be expected. Based on a sulphate concentration of around 3 000 mg/ℓ, this equates to around 17.4 tons SO_4 per day, or around 6 351 tons SO_4 per year.	Significance	4	4.00	• The pit will be backfilled without a final void, rehabilitated and made free-draining in order to minimise the post closure water make. • Monitoring of water levels in the mine and the associated water quality is committed to. This will allow both calibration of the post mining water quality and water volumes. • The water level in the workings will be actively managed to ensure it remains below the decant elevation. • A post-closure decant management plan will be developed and will consider aspects such as passive treatment.	Significance	2	1.87
			Magnitude - Spatial	4			Magnitude - Spatial	3	
			Magnitude - Temporal	4			Magnitude - Temporal	2	
			Probability	5			Probability	4	

5.7.3 Impact assessment outcome

The main aspect to consider when assessing the impacts associated with the proposed infrastructure and mining development, is that the opencast mining was approved in the 2007 EMPR Amendment. The mining of the Vleishaft tributary (referred to as HGM 2 in the wetland assessment) was authorised in the DMO WUL issued in October 2008 as S21(c) and S21(i) water uses.

The bulk of the new infrastructure that will be developed is located within, or close to, this wetland system. Any impact associated with the proposed infrastructure development will therefore be of temporary nature until the infrastructure is decommissioned and the area opencast mined. Irrespective, mitigation measures to be implemented during the different development phases have been proposed to limit the impacts. The additional loss of wetland, or impact on remaining wetlands, is minimal compared to the loss in wetland that has already been authorised.

The main impact during the operational phase will be the lowering of the groundwater levels due to the dewatering of the pit to ensure that mining may proceed safely. The dewatering of the VDDC opencast mining area is expected to result in a maximum drawdown of 20 – 60 m, with a cone of depression of 200 – 250 m from the edge of the pit. The tributary of the Olifants River to the south-east of the mining area is likely to be impacted as a result of the drawdown.

Surface water impacts from the proposed development can be effectively mitigated by applying best practice water management principles. All dirty water generated on the site will be directed to the Vleishaft PCD and either re-used for dust suppression, managed through the mechanical evaporation system, or will be treated in the modular WTP before it is discharged back into the Olifants River system. Surface water quality monitoring has shown that the system is currently impacted as a result of mining and other land uses in the area. Discharge of water which complies to the RQO for the catchment is expected to result in an improvement in the water quality downstream of the discharge. It is, however, imperative that water quality of the treated water complies with the RQO.

Forced evaporation of mine impacted water and brine from the modular WTP through the proposed mechanical evaporators will require monitoring to ensure that there is no impact on the Olifants River as a result of spray drift. Evaporation should be limited to the SKS void and the dirty water management area. Increased salinisation of the water to be evaporated at these mechanical evaporators and the resultant impact on the efficiency of the evaporators and on the water resources should be closely monitored. Corrective action should be taken if needed.

The cessation of opencast mining and the associated the dewatering, will lead to groundwater rebound. This estimated rebound time is approximately five (5) years. After rebound has reached equilibrium, decant has the potential to occur.

The predicted discharge area is to the south-east of the VDDC mining operations. The calculated sub-surface decant elevation is approximately 1 530 mamsl, with a discharge volume of approximately 0.5 ℓ/s. The water level in the pit should therefore be maintained approximately 5 m below the sub-surface discharge elevation as a safe management level (J&W, 2019a). Water levels within the pit therefore have to be monitored to ensure that the decant levels are not reached. A water management strategy, which includes a decant management plan, should be developed to limit the impact associated with the potential decant. It has also been recommended that the groundwater model be calibrated and updated as mining proceeds to confirm and improve the assumptions in the model. Specifically, the assumption regarding the integrity of the geological barrier between the VDDC opencast pit and the SKS and Glencore backfilled pits to the west, since this will have implications on the potential decant position, level and volume.

With the successful implementation of the mitigation measures contained in this document, it is expected that all potential impacts associated with the proposed infrastructure and mining development will be mitigated to a low, or very low, rating.

5.8 Alternatives considered

Alternatives considered for the VDDC infrastructure and mining development project are as follows:

5.8.1.1. Dirty water management alternatives

Initially it was proposed to develop a new PCD to the southwest of the existing PSS dump (refer to **Figure 5-8**). The proposed dam was in close proximity to the Olifants River, and a section of the dam was located within the 1:100 year floodline. An alternative considered for the development of a new PCD included an extension to the existing Bob Henry dam to accommodate the additional mine-affected water that would be associated with the opencast mining.

Following further investigation and concern regarding the proximity of the PCD to the Olifants River, the PCD initially proposed has been removed from the project layout. The dirty water make from the operations will be managed through mechanical evaporators to be located at the SKS void and provision has been made for a modular WTP with a treatment capacity of up to 20 Mℓ/day to ensure that dirty water make from the mine is adequately managed. Treated water from the modular WTP will be discharged back into the Olifants River.

5.8.1.2. Topsoil dump alternatives

An alternative location was considered for the development of a topsoil dump, to the south of the existing LAC discard dump (refer to the position of the preferred and alternative topsoil stockpile areas as indicated on **Figure 5-8**). The preferred location for the stockpiling of topsoil is an extension of the existing topsoil dump to the east of the proposed mining and infrastructure development, and has the following advantages:

- All topsoil stockpiled will be located within the same area;
- Reduced transport cost associated with hauling of topsoil to the stockpile, compared to a stockpile located in the far south;
- Not located within the vicinity of a natural watercourse, compared to the alternative in the south, which is located in close vicinity of the Olifants River.

The impact of vehicle movement, potential dust and erosion from the stockpile on the water quality of a watercourse is therefore expected to be less than the alternative option located next to the Olifants River.

During further investigations, the need for a topsoil stockpile between the ramps of the mining areas was also identified. This will be required should the existing 132 kV powerline that crosses the proposed topsoil stockpile area not be relocated before stockpiling of topsoil needs to take place (the authorisation for the relocation of a portion of the powerline is addressed in a separate application).

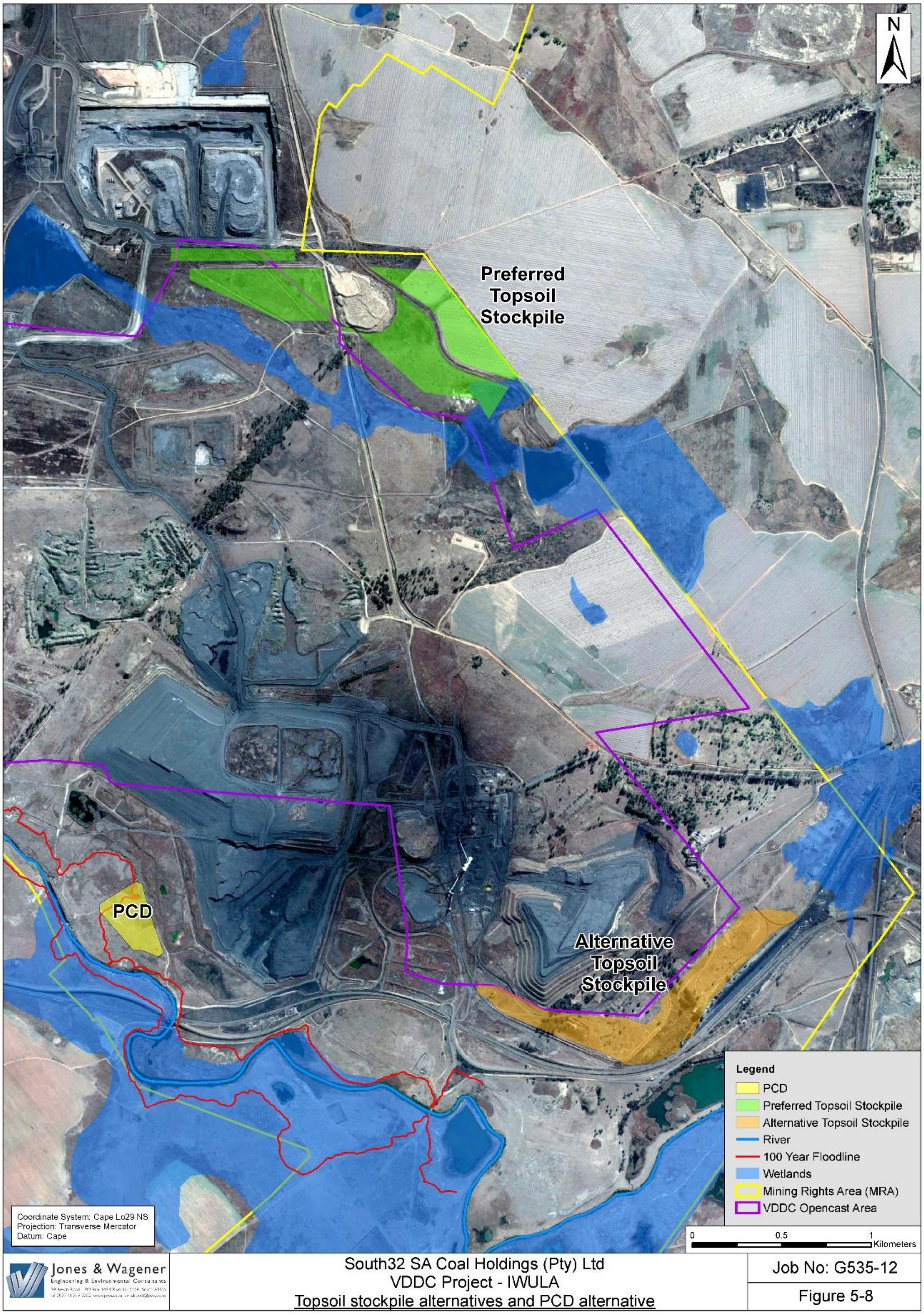

Figure 5-8: Alternative locations of topsoil stockpile and position of PCD initially considered

6. MITIGATION

6.1 Environmental Management Programme

A detailed Environmental Management Programme (EMPr) has been compiled as part of the application for Environmental Authorisation. This includes the mitigation measures listed in **Table 5-8** to **Table 5-10**.

6.2 Integrated Water and Waste Management Plan

A detailed Integrated Water and Waste Management Plan (IWWMP) has been developed for the project and is documented in report number JW340/19/G535-14, attached as **Appendix B**.

6.3 Wetland mitigation / off-set

The DMO WUL stipulates that the extent of offsite mitigation will be a ratio of 1:2. A wetland offset strategy and rehabilitation plan was developed and submitted to the DWS as required in terms of the WUL. The total loss of wetland associated with the VDDC infrastructure and mining development, has been accounted for in this study.

An implementation strategy for the wetland offset strategy and rehabilitation plan is being drafted and will be discussed with the DWS once finalised.

7. MONITORING AND CONTROL

A detailed monitoring programme (surface water, groundwater, and bio-monitoring, as well as technical monitoring) is included in the IWWMP (attached as **Appendix C**).

The audit system described in the IWWMP should be adhered to.

8. MOTIVATION FOR LICENCE APPLICATION

8.1 Authorisations required

8.1.1 Water uses requiring authorisation

A detailed description of the water uses for the proposed VDDC infrastructure development is provided in **section 4.1**.

8.1.2 Existing lawful water uses

Existing water uses at the mine have been authorised in terms of the following WUL's issued by the DWS (copies attached as **Appendix C**):

- DMO water use licence: 24084535 dated 10 October 2008;
- VDDC Dewatering water use licence: 06/B11F/GCIJ/7943 dated 19 July 2018.

The water uses authorised in terms of these licences are provided in **Table 8-1**.

In addition, WUL 2406113 was issued for the PSS Discard Dump Extension on 13 December 2002. This WUL, however, expired in December 2012.

Table 8-1: Existing lawful water uses

S21(b) Storing water				
Property	**Co-ordinates**	**Description of water use**	**Capacity**	**Licence number**
Vandyksdrift 19 IS	No co-ordinates stated in WUL	Storage of water in dam within Vleishaft Tributary	313 000 m^3	25084535

S21(c) Impeding or diverting the flow of water in a watercourse and S21(i) Altering the bed, banks, course or characteristics of a watercourse				
Property	**Co-ordinates**		**Description of water use**	**Licence number**
Vandyksdrift 19 IS, Kleinkopje 15 IS, Steenkoolspruit 18 IS	No co-ordinates stated in WUL		Diversions (at Northern water canal)	25084535
			Destruction of 355.4 ha of wetlands (opencast mining)	25084535
Portion 3 of Vandyksdrift 19 IS	26° 04' 15.179." S	29° 18' 46.847" E	Drilling of a borehole within 500 m of a wetland	06/B11F/GCIJ/7943
Portion 3 of Vandyksdrift 19 IS	Start: 26° 04' 15.179" S End: 26° 04' 24.337" S	 29° 18' 46.847" E 29° 18' 55.724" E	Installation of borehole connector pipes within 500 m of a wetland	06/B11F/GCIJ/7943
Portion 3 of Vandyksdrift 19 IS	Start PM10: 26° 04' 37.002" S End PM10: 26° 04' 55.952" S Start PM12 26° 04' 53.105" S End PM13 26° 04' 51.15" S	 29° 18' 9.518" E 29° 18' 11.534" E 29° 18' 11.83" E 29° 18' 14.486" E	Installation of main connector pipes within 500 m of wetlands	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS	BH1-A: 26° 03' 34.322" S BH1-E: 26° 03' 40.406" S BH1-F:	 29° 17' 17.279" E 29° 17' 19.453" E	Boreholes within wetlands	06/B11F/GCIJ/7943

S21(c) Impeding or diverting the flow of water in a watercourse and S21(i) Altering the bed, banks, course or characteristics of a watercourse				
Property	**Co-ordinates**		**Description of water use**	**Licence number**
	26° 03' 38.207'' S BH1-H: 26° 03' 44.212'' S	29° 17' 28.09'' E 29° 17' 36.186'' E		
Portion 2 of Steenkoolspruit 18 IS	PM10 (start): 26° 04' 43.025'' S PM07 (End) 26° 03' 34.434'' S PM05 (start): 26° 03' 22.856'' S PM08 (End): 26° 03' 35.467'' S PM01 (start): 26° 01' 50.707'' S PM02 (End): 26° 01' 50.722'' S PM11 (start): 26° 04' 37.002'' S PM12 (start): 26° 04' 55.952'' S	 29° 16' 44.872'' E 29° 16' 52.838'' E 29° 16' 45.145'' E 29° 16' 52.831'' E 29° 18' 42.408'' E 29° 18' 40.406'' E 29° 18' 9.518'' E 29° 18' 11.534'' E	Connector pipes within wetlands	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS	PM11 (start): 26° 04' 37.002'' S PM12 (end): 26° 04' 55.952'' S PM13 (start): 26° 04' 53.105'' S PM14 (end): 26° 04' 51.15'' S	 29° 18' 9.518'' E 29° 18' 11.534'' E 29° 18' 11.83'' E 29° 18' 14.486'' E	Main connector pipes within wetlands	06/B11F/GCIJ/7943
Portion 3 of Vandyksdrift 19 IS	Haul roads:		Activities within 500 m from wetlands (haul roads and service roads)	06/B11F/GCIJ/7943

S21(c) Impeding or diverting the flow of water in a watercourse and S21(i) Altering the bed, banks, course or characteristics of a watercourse				
Property	**Co-ordinates**		**Description of water use**	**Licence number**
	26° 05’ 09.535” S 26° 03’ 45.403” S 26° 03’ 53.759” S Service roads: 26° 04’ 04.483” S 26° 04’ 39.223” S	29° 16’ 46.733” E 29° 18’ 17.737” E 29° 18’ 24.656” E 29° 17’ 56.616” E 29° 19’ 6.985” E		
Portion 3 of Vandyksdrift 19 IS	26° 05’ 7.537” S	29° 18’ 10.012” E	Activities within 500 m from wetlands (Tank H)	06/B11F/GCIJ/7943
Portion 3 of Vandyksdrift 19 IS	26° 04’ 28.553” S	29° 18’ 57.632” E	Activities within 500 m from wetlands (Tank I)	06/B11F/GCIJ/7943
Portion 3 of Vandyksdrift 19 IS	26° 04’ 33.028” S	29° 18’ 05.18” E	Activities within 500 m from wetlands (Tank J)	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS	Haul roads: 26° 04’ 23.279” S 26° 03’ 46.984” S Service roads: 26° 03’ 48.406” S 26° 04’ 46.675” S	 29° 16’ 51.1” E 29° 16’ 50.426” E 29° 17’ 6.896” E 29° 16’ 45.696” E	Activities within 500 m from wetlands (Haul roads and service roads)	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS, Portion 4 of Kleinkopje 15 IS	26° 03’ 23.9” S	29° 16’ 56.348” E	Activities within 500 m from wetlands (Tank T01)	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS	26° 04’ 30.954” S	29° 17’ 01.799” E	Activities within 500 m from wetlands (Tank A)	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS	26° 04’ 44.058” S	29° 16’ 47.96” E	Activities within 500 m from wetlands (Tank F)	06/B11F/GCIJ/7943

S21(g) Disposing of waste in a manner which may detrimentally impact on a water resource					
Property	**Co-ordinates**	**Description of water use**	**Capacity of facility**	**Volume**	**Licence number**
Portion 2 of Steenkoolspruit 18 IS	No co-ordinates stated in WUL	Dirty water dam		2 190 000 m^3	25084535

S21(g) Disposing of waste in a manner which may detrimentally impact on a water resource						
Property	**Co-ordinates**		**Description of water use**	**Capacity of facility**	**Volume**	**Licence number**
Portion 3 of Vandyksdrift 19 IS	26° 05' 42.47'' S	29° 17' 34.63'' E	Storing of removed water from underground workings before being pumped to the Vleishaft PCD – Tank G	915 m^3	5 700 m^3/a	06/B11F/GCIJ/7943
Portion 3 of Vandyksdrift 19 IS	26° 05' 7.54'' S	29° 18' 10.01'' E	Storing of removed water from underground workings before being pumped to the Vleishaft PCD – Tank H	341 m^3	3 800 m^3/a	06/B11F/GCIJ/7943
Portion 3 of Vandyksdrift 19 IS	26° 04' 28.55'' S	29° 18' 57.63'' E	Storing of removed water from underground workings before being pumped to the Vleishaft PCD – Tank I	96 m^3	3 800 m^3/a	06/B11F/GCIJ/7943
Portion 3 of Vandyksdrift 19 IS	26° 04' 33.03'' S	29° 18' 05.18'' E	Storing of removed water from underground workings before being pumped to the Vleishaft PCD – Tank J	163 m^3	5 700 m^3/a	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS	26° 04' 30.95'' S	29° 17' 01.80'' E	Storing of removed water from underground workings before being pumped to the Vleishaft PCD – Tank A	453 m^3	32 000 m^3/a	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS	26° 04' 12.75'' S	29° 16' 50.88'' E	Storing of removed water from underground workings before being pumped to the Vleishaft PCD – Tank D	1424 m^3	8 550 m^3/a	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS	26° 04' 13.72'' S	29° 16' 13.49'' E	Storing of removed water from underground workings before being pumped to the Vleishaft PCD – Tank E	98 m^3	2 850 m^3/a	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS	26° 04' 44.06'' S	29° 16' 47.96'' E	Storing of removed water from underground workings before	1162 m^3	6 650 m^3/a	06/B11F/GCIJ/7943

S21(g) Disposing of waste in a manner which may detrimentally impact on a water resource						
Property	**Co-ordinates**		**Description of water use**	**Capacity of facility**	**Volume**	**Licence number**
			being pumped to the Vleishaft PCD – Tank F			
Portion 4 of Kleinkopje 15 IS	26° 03' 23.9'' S	29° 16' 56.35'' E	Storing of removed water from underground workings before being pumped to the Vleishaft PCD – Tank T01	1162 m^3	64 000 m^3/a	06/B11F/GCIJ/7943
RE of Wolvekrans 17 IS	26° 01' 49.67'' S	29° 18' 20.44'' E	Transfer tank used as part of the network to pump the water from Vleishaft PCD to MWRP – Tank RH06	80000 m^3	10 000 m^3/a	06/B11F/GCIJ/7943
Portion 4 of Kleinkopje 15 IS, Portion 9 of Kleinkopje 15 IS, Portion 14 of Kleinkopje 15 IS, Portion 2 of Steenkoolspruit 18 IS	OC02: 26° 02' 15.605'' S OC03: 26° 02' 5.82'' S OC05: 26° 02' 44.57'' S OC06: 26° 02' 26.372'' S OC07: 26° 02' 52.354'' S OC08: 26° 02' 54.899'' S	29° 16' 11.795'' E 29° 16' 44.072'' E 29° 16' 8.288'' E 29° 16' 44.98'' E 29° 16' 7.774'' E 29° 16' 29.669'' E	Disposal of water removed from the old underground workings in the Steenkoolspruit mined out opencast pit	N/A	Average of: 10 000 m^3/day; 300 000 m^3/month,; 1 200 000 m^3/a; Maximum of 10 000 m^3/day	06/B11F/GCIJ/7943
Portion 2 of Steenkoolspruit 18 IS, Portion 3 of Vandyksdrift 19 IS, Portion 10 of Vandyksdrift 19 IS, Portion 4 of Kleinkopje 15 IS, Portion 14 of Kleinkopje 15 IS, Portion 9 of Kleinkopje 15 IS, RE of Wolvekrans 17 IS	Dust suppression on all haul roads and access roads		Suppression of dust on roads, water abstracted from Vleishaft PCD	N/A	292 000 m^3/a	06/B11F/GCIJ/7943

S21(g) Disposing of waste in a manner which may detrimentally impact on a water resource						
Property	**Co-ordinates**		**Description of water use**	**Capacity of facility**	**Volume**	**Licence number**
Portion 2 of Steenkoolspruit 18 IS	26° 03' 18.55" S 26° 03' 35.30" S 26° 03' 36.34" S 26° 03' 35.73" S 26° 03' 25.80" S	29° 16' 50.35" E 29° 16' 43.56" E 29° 16' 53.94" E 29° 17' 08.16" E 29° 16' 58.56" E	Pollution Control Dam (Vleishaft Dam). Disposal and storage of affected storm water and water pumped from the pit to the dam. Also, the disposal and storage of water pumped from the old underground workings	313 000 m^3	19 236 230 m^3/a	06/B11F/GCIJ/7943

S21(j) Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people					
Property	**Co-ordinates**		**Description of water use**	**Volume**	**Licence number**
Vandyksdrift 19 IS, Kleinkopje 15 IS, Steenkoolspruit 18 IS	26° 03' 24.4"	29° 16' 45.5" E	Removal of water found underground for storage and re-use	2 091 000 m^3/a	25084535
Portion 3 of Vandyksdrift 19 IS	26° 04' 18.595" S 26° 04' 15.179" S 26° 04' 12.853" S 26° 04' 38.136" S 26° 04' 27.53" S 26° 04' 27.055" S 26° 04' 36.469" S 26° 04' 49.184" S 26° 04' 47.896" S 26° 05' 15.922" S 26° 04' 48.684" S 26° 04' 48.227" S 26° 04' 46.535" S 26° 04' 48.479" S 26° 04' 46.175" S	29° 17' 54.188" E 29° 18' 46.847" E 29° 17' 51.756" E 29° 18' 39.092" E 29° 18' 57.384" E 29° 17' 46.482" E 29° 17' 7.127" E 29° 17' 8.138" E 29° 17' 9.658" E 29° 17' 15.594" E 29° 17' 24.932" E 29° 17' 42.652" E 29° 17' 51.13" E 29° 17' 65.51" E 29° 19' 13.523" E	Dewatering from underground workings for Compartment A	3 381 053 m^3/a	06/B11F/GCIJ/7943

S21(j) Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people					
Property	**Co-ordinates**		**Description of water use**	**Volume**	**Licence number**
	26° 04' 57.734" S	29° 18' 28.782" E			
	26° 05' 5.438" S	29° 18' 2.83" E			
	26° 05' 33.104" S	29° 18' 4.19" E			
	26° 05' 25.39" S	29° 17' 4.39" E			
	26° 05' 35.459" S	29° 17' 48.116" E			
	26° 05' 30.311" S	29° 18' 10.771" E			
	26° 05' 48.084" S	29° 18'18.522" E			
Portion 10 of Vandyksdrift 19 IS	26° 05' 18.802" S	29° 18' 14.666" E	Dewatering from underground workings for Compartment B	307 368.4 m^3/a	06/B11F/GCIJ/7943
	26° 05' 14.69" S	29° 18' 16.945" E			
Portion 4 of Kleinkopje 15 IS	26° 03' 24.664" S	29° 16' 56.496" E	Dewatering from underground workings for Compartment C	768 421.1 m^3/a	06/B11F/GCIJ/7943
	26° 03' 25.592" S	29° 17' 19.403" E			
	26° 03' 25.661" S	29° 17' 25.037" E			
	26° 03' 16.445" S	29° 17' 41.132" E			
	26° 03' 12.024" S	29° 17' 42.13" E			
Portion 2 of Steenkoolspruit 18 IS	26° 03' 34.322" S	29° 17' 17.279" E	Dewatering from underground workings for Compartment D	4 303 158 m^3/a	06/B11F/GCIJ/7943
	26° 03' 33.084" S	29° 17' 24.846" E			
	26° 03' 33.512" S	29° 17' 26.401" E			
	26° 03' 29.707" S	29° 17' 35.693" E			
	26° 03' 40.406" S	29° 17' 19.453" E			
	26° 03' 38.207" S	29° 17' 28.09" E			
	26° 03' 49.795" S	29° 17' 5.798" E			
	26° 03' 44.212" S	29° 17' 36.186" E			
	26° 04' 0.527" S	29° 16' 56.453" E			
	26° 04' 4.336" S	29° 16' 52.874" E			
	26° 04' 7.489" S	29° 16' 49.588" E			
	26° 04' 11.86" S	29° 16' 47.107" E			
	26° 04' 21.983" S	29° 17' 3.782" E			
	26° 04' 40.649" S	29° 16' 56.417" E			

S21(j) Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people					
Property	Co-ordinates		Description of water use	Volume	Licence number
	26° 04' 41.455" S	29° 16' 53.472" E			
	26° 03' 42.7" S	29° 16' 38.374" E			
	26° 03' 43.952" S	29° 16' 33.355" E			
	26° 03' 46.404" S	29° 16' 31.213" E			
	26° 03' 51.181" S	29° 16' 27.606" E			
	26° 04' 3.353" S	29° 16' 47.849" E			
	26° 03' 56.059" S	29° 16' 24.899" E			
	26° 04' 10.488" S	29° 16' 15.622" E			
	26° 04' 13.717" S	29° 16' 40.022" E			
	26° 04' 14.714" S	29° 16' 46.394" E			
	26° 04' 14.495" S	29° 16' 6.949" E			
	26° 04' 17.688" S	29° 16' 9.527" E			
	26° 04' 16.698" S	29° 16' 58.552" E			
	26° 04' 43.608" S	29° 16' 39.763" E			

8.1.3 Relevant exemptions

Application is herewith made for exemption from the following regulations of GNR 704 dated 4 June 1999:

Regulation 4(a): Locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year floodline or within a horizontal distance of 100 m from any watercourse

Relevant activities

Infrastructure area 1 (refer to **Figure 4-2**): The modular WTP and a portion of the overburden dump to be located on the SKS void are located within the 1:100 year floodline.

Infrastructure area 4 (refer to **Figure 4-4**): The Mixed ROM coal and slurry stockpile areas, the eastern servitude (including the haul road, service road and dirty water drains), portions of the topsoil stockpiles, as well as the Eastern overburden dump will be located within a delineated watercourse, or within 100 m of delineated watercourses.

Motivation

The position of the proposed new infrastructure is largely determined by the position of the opencast mining area approved in the 2007 approved EMPR Amendment and the DMO WUL in 2008. Due to the extent of current mining activities, as well as the proximity of the project to the Olifants River, there is limited space available within the VDDC area for the development of additional infrastructure. The locality of the proposed infrastructure therefore had to be optimised within these constraints.

The proposed WTP will be of modular, containerised design and the treatment capacity will be adjusted according to the mine's operational needs. It will be located directly west of the SKS mining area and to the east of the Olifants River. Due to its containerised design and the proposed mitigation measures, it is not expected to have a significant impact on the watercourses.

The footprint of the overburden dump to be located on the SKS void, will be entirely on the void. Any impact as a result of seepage or contaminated runoff will therefore enter the SKS void and is not expected to directly impact on the watercourses.

Infrastructure area 4 is largely located within the area that was authorised to be opencast mined previously, except for the secondary Mixed ROM coal and slurry stockpile area (located to the south of the Vleishaft PCD) and the Eastern overburden dump. A small depression of less than 1.5 ha will be lost due to the development of the Eastern overburden dump. The secondary Mixed ROM coal and slurry stockpile area will not result in any further direct disturbance of watercourses.

In terms of the DMO WUL, the destruction of 355.4 ha of wetlands (referred to as HGM 2) through opencast mining was authorised as S21(c) and S21(i) water uses. Any impact associated with the proposed infrastructure development in this area will therefore be of temporary nature until the infrastructure is decommissioned and the area opencast mined. A wetland offset strategy was compiled in support of the DMO WUL and addresses the impact associated with the total development in HGM 2. This will therefore also be relevant to any initial impact as a result of the infrastructure development.

The development of these facilities in close proximity to a watercourse have been identified as S21(c) and S21(i) water uses and included in this IWULA (refer to section 4.1.1). A detailed impact assessment is outlined in section 5.

Regulation 4(b): Except in relation to a matter contemplated in regulation 10, carry on any underground or opencast mining, prospecting and any other operation or activity within the 1:50 year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, whichever is the greatest

Relevant activities

Opencast mining at VDDC, and specifically opencast mining of HGM 2 (previously known as the Vleishaft Tributary) was approved in the DMO WUL in 2008. Changes to the opencast pit extent have been made since the initial approval to include an additional area of 196 ha. These additional mining areas not previously authorised are shown on **Figure 4-3**.

It should however be noted that although a WUL for the opencast mining through the Vleishaft Tributary was granted in 2008, an exemption from GNR 704 was not granted. This application therefore includes the application for exemption from Regulation 4(b) for the larger opencast area (i.e. the total VDDC mining extent).

Motivation

In terms of the DMO WUL, the destruction of 355.4 ha of wetlands (referred to as HGM 2 or the Vleishaft Tributary) through opencast mining was authorised as S21(c) and S21(i) water uses. A wetland offset strategy was compiled in support of that application and addresses the impacts associated with the development on the watercourse. The locality of the development was determined by the mineral resources. The area has previously been mined using bord an pillar mining and the DMO application was therefore to allow the mining of the remaining No. 5, No. 4, No. 2 and No. 1 seams to proceed through opencast operations.

The previous mine layout has been optimised through a pre-feasibility investigation and an area of approximately 196 hectares has been added to the previous approved opencast mining area. This is to optimise the operations from a financial and resource utilisation perspective, with the aim to extend the life of mine and therefore to limit premature job losses. The eastern most section of the additional mining areas is located within 100 m of a seepage wetland, without any further direct impact on wetlands.

The wetland offset strategy that was compiled in support of the DMO WUL is therefore still relevant and should be implemented.

These additional opencast areas have been identified as S21(c) and S21(i) water uses and included in this IWULA (refer to section 4.1.1 for more detail). The impacts associated with these water uses were assessed in detail in section 5.

Regulation 4(c): Place or dispose of any residue or substance which causes or is likely to cause pollution of a water resource, in the workings of any underground or opencast mine excavation, prospecting diggings, pit or any other excavation

Relevant activities

Residue is defined in GNR 704 as follows: "*any debris, discard, tailings, slimes, screenings, slurry, waste rock, foundry sand, beneficiation plant waste, ash, and any other waste product derived from or incidental to the operation of a mine or activity which is stockpiled, stored or accumulated for potential re-use or recycling or which is disposed of*".

This application relates to the use of overburden in the rehabilitation of opencast pits as part of the normal roll-over mining method. Overburden could contain carbonaceous material with the potential to pollute, hence the inclusion in the application for exemption from Regulation 4(c).

Motivation

It should be noted that Wolvekrans Colliery is an active mine and this application is limited to the proposed VDDC opencast areas not previously authorised. Overburden material will be used in the concurrent rehabilitation of the opencast area using the roll-over method as per normal mining practices.

Details on the geochemical assessment undertaken on the overburden material is provided in section 5.1. The overburden is expected to produce near-neutral to saline acid rock drainage in the short term, and metalliferous acid rock drainage in the long term (Golder, 2018).

The potential impact on groundwater (taking into consideration the full extent of the opencast mining) is addressed in sections 5.3 and 5.7. Following cessation of mining, the groundwater level will rise to an equilibrium that will differ from the pre-mining level due to the disturbance of the bedrock. This estimated rebound time in years for the opencast after cessation of pumping is approximately five (5) years. Groundwater quality within the mined areas is expected to deteriorate due to chemical interactions between the geological material and the groundwater.

The impact as a result of decant is discussed in section 5.3.3 and the modelled discharge (decant) areas are shown in **Figure 5-7**. The calculated subsurface mine water movement resulting in decant is expected towards the south-eastern edge of the backfilled pit. The calculated sub-surface decant elevation is approximately 1 530 mamsl with a discharge volume of approximately 0.5 ℓ/s. The water level in the backfilled pit will therefore be maintained approximately 5 m below the sub-surface discharge elevation as a safe management level. It is imperative that the groundwater model be calibrated and revised every five (5) years to ensure that the assumptions made in the predictive groundwater model are correct. A water management strategy, including a decant management plan, will be developed at least five (5) years prior to closure of the mine.

Material from the desiltation of silt traps will also be placed back into the pit as per the current practice at the mine and the impact associated with this is minimal compared to the opencast mining and backfilling of the void.

Regulation 5: Residues or substances which cause or are likely to cause pollution of a water resource may not be used for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource

Relevant activities

Haul roads and service roads will be constructed using discard material.

Motivation

The haul roads and service roads will be mined out as the opencast mining proceeds and are therefore of temporary nature. The impact associated with the construction of roads with discard material will therefore be temporary in nature before opencast mining and its associated impacts commences. Any groundwater contamination will report to the pit as a result of the cone of depression following dewatering of the pit.

The roads will be located within the dirty water management area and therefore any contaminated runoff will be collected, contained and managed in the dirty water management system.

8.1.4 General Authorisations

The authorisation for development of the explosives magazine within 500 m of the Olifants River in terms of the NWA was expedited due to the urgency to relocate the magazine. The development is expected to be authorised in terms of GN 509, the GA for S21(c) and S21(i) water uses.

8.2 Section 27 motivation

8.2.1 S27(1)(a) Existing lawful water uses

A summary of the existing lawful water uses is provided in **Section 8.1.2**.

8.2.2 S27(1)(b) Redress the results of past racial and gender discrimination

South32 has 3.10% black ownership, with black women ownership at 1.59%. A copy of the Broad-Based Black Economic Empowerment (BBBEE) certificate is attached in **Appendix D**. South32 owns 90% of South Africa Energy Coal, while employees own 2% through an Employee Share Ownership Programme. The remaining 8% is held by Pembani Holdings, a Black Empowerment company.

South32 aims to ensure that empowerment and sustainable growth in South Africa are enhanced through:

- Facilitation of economic empowerment through broad-based equity ownership structures;
- Working towards equitable representation and the upskilling of historically disadvantaged workforce at all levels;
- Development of black small and medium enterprises and the creation of opportunities for growth for existing black enterprises;
- Increasing our footprint through focused sustainable community development;
- Improvement of housing and living conditions of employees and ensuring that plans are aligned with company values and the Mining Charter requirements;
- Promotion of the use of employees for core production areas and recruiting from within local communities[7].

A Social and Labour Plan (SLP) has been compiled in which issues related to redressing of past racial and gender discrimination are further addressed. This includes a commitment to the strategic objectives of the Employment Equity Act, 1998 (Act 55 of 1998) that include having individuals from previously disadvantaged groups (including women) represented in all positions of skills, responsibility and at all levels within the five year period addressed by the SLP (i.e. 1 July 2017 to 30 June 2022). The employment equity strategies applied include the following:

- Capacity building through a leadership development programme as part of the talent pool management process. Twelve (12) employees per annum will be placed in the leadership development programme at a total cost of R 2.4 million per annum;
- Fast tracking the career progression of those employees, especially from designated groups, identified as having significant potential and aspiration.

[7] https://www.south32.net/our-operations/south-africa

In terms of the mine’s contribution to the local economy and the social well-being of surrounding communities, a number of local economic development programmes are supported (South32, 2017c).

8.2.3 S27(1)(c) Efficient and beneficial use of water in the public interest

The execution of the water uses addressed in this IWULA is regarded as beneficial to the public due to the positive economic impact the continued mining operation will have on the local, regional and national economy.

The proposed infrastructure development is in support of opencast mining approved in the 2007 EMPR Amendment and the 2008 DMO WUL. The proposed VDDC opencast mine layout has been optimised through a pre-feasibility investigation and an area of approximately 196 hectares has been added to the previous approved opencast mining area. This is to optimise the operations from a financial perspective. The aim is therefore to limit premature job losses.

8.2.4 S27(1)(d) Socio economic impact of the water uses if authorised or of the failure to authorise the water uses

Wolvekrans Colliery is an existing operational mine which employs 914 people and operates as an export mine. Opencast mining at the VDDC section has been identified as the area that is most likely to replace the operations at SKS and therefore to extend the life of mine and ensure the fulfilment of the mine’s existing export entitlement allocation.

From a socio-economic perspective, the following considerations are of relevance:

- The proposed development is within the existing mining right area, with no direct impact on communities’ dependency on ecosystem services;
- The proposed opencast extension and infrastructure development at VDDC will ensure the life extension of the Wolvekrans Colliery up to 2046. Although it is unlikely that new work opportunities will be available for locals, a temporary increase in work opportunities may realise during the construction phase of the project, which will contribute to the local and regional economy. It is therefore not expected that there will be any significant change to employment opportunities;
- The mine’s current Environmental Awareness Programme and Health and Safety Programme will continue to ensure that the workers are informed of the risks and dangers associated with their work and the measures that need to be taken to ensure that they are adequately protected;
- According to the eMalahleni Integrated Development Plan, mining is the most prominent employment sector in the ELM, within which the mine is located, with a contribution of 23% to the employment. The average annual economic growth rate for eMalahleni was at 2.4% over the period 1996 to 2015. The forecasted average annual gross domestic product (GDP) growth for eMalahleni for 2015-2020 is anticipated to be approximately 2% per annum, in line with national and provincial growth expectations. ELM experienced population growth rates higher than their economic growth rates, which has significant negative implications from a GDP per capita and an infrastructure-, service delivery-, and job creation point of view. Should the VDDC project not continue, authorised opencast mining will not be able to continue, and the coal reserves left in the old underground workings will not be accessible and coal will have to be sourced from elsewhere. This will result in job losses for the current

employees of the mine and will have implications for the local economy (Batho Earth, 2019);

- Continued operation of Wolvekrans Colliery and the export of coal will contribute to the country's GDP;
- The proposed development is within an existing mining right area and therefore the impact on visual character, sense of place and noise levels are minimal;
- The opencast mining not previously authorised, will impact on a graveyard containing 13 graves and these graves will have to be relocated before mining commences.

Should the water uses outlined in this IWULA not be authorised, the approved mining operations will unlikely proceed since the infrastructure required to support the opencast mining will not be developed. This will likely result in cessation of mining operations and premature closure of the mine. This will have a negative impact on the current employees and the local economy. The benefits to the regional and national economies as outlined above, will also not be realised.

8.2.5 S27(1)(e) Applicable catchment management strategy

The catchment management strategy for the Olifants River Water Management Area has not been developed. However, a number of studies and planning initiatives have been undertaken by the DWS for this area. This includes inter alia:

- Development of a Water Quality Management Plan for the Witbank Dam and Middelburg Dam catchments (1993);
- Assessment of the impact of abandoned and defunct coal mines within the Loskop Dam Catchment (2001);
- Ecological Water Requirements Assessment for the Olifants River (2001);
- Validation study for the Olifants River Water Management Area (WMA) (2006);
- Development of a Reconciliation Strategy for the Olifants WMA;
- Development of the Upper Olifants River Catchment Wetland Management Framework (2007);
- Development of and Integrated Water Resource Management Plan for the Upper and Middle Olifants Catchment (2009);
- Promulgation of the classes and resource quality objective of water resources for the catchments of the Olifants River catchment in GN 466 on 22 April 2016;
- Publishing the Reserve determination of water resources for the catchments of the Olifants and Letaba Rivers in the Government Gazette (GN 932 on 7 September 2018).

The measures included in the IWWMP and this IWULA are aimed at preventing discharge of water affected by mining into the water resource and limiting impacts on the water resource through the separation of clean and dirty water, proper containment of dirty water and the treatment of dirty water to acceptable standards prior to discharge to the receiving environment.

8.2.6 S27(1)(f) Impact of the water uses on the water resource and on other water users

A detailed assessment of the potential impact of the VDDC infrastructure and mining development on the water resource was provided in section 5.

The water requirements for the VDDC project will be sourced from the mine's existing allocation and sources. No additional provision is therefore required.

The location for the proposed infrastructure development is largely within a brownfields site, indicating that disturbance has already taken place in the area. The Olifants River is located to the south and the west of the project area and has already been impacted as result of mining and agricultural activities in the area. There are no NFEPA rivers or wetlands within the proposed development area. The remainder of the Vleishaft tributary was authorised to be mined in 2007. The development of the proposed infrastructure, and the opencast mining not previously authorised, is therefore unlikely to significantly alter the ecological integrity from its current authorised state, provided that appropriate mitigation measures are implemented. This includes appropriate water- and waste management measures which will entail the following:

- Clean- and dirty water will be separated by means of berms and canals. Clean water will be diverted away from the mining area to prevent it from coming into contact with material with a pollution potential. Mine impacted water will be contained and will be evaporated through mechanical evaporators or treated in a modular WTP to an acceptable standard before it is discharged back into the Olifants River;
- The proposed infrastructure includes measures to ensure that the potential pollution sources generated by the opencast mining activities are managed in an environmentally responsible manner:
  - Overburden dumps will be developed for the stockpiling of material before it is used in the progressive rehabilitation of the opencast pit;
  - Slurry that has been disposed of in portions of the old No. 2 Seam underground workings, will be mined out with the remaining pillars and will be placed on mixed ROM coal and slurry stockpile areas before it is processed in the existing coal processing facility;
  - Management of mine-affected water will be done by means of mechanical evaporators and the proposed modular WTP. Mechanical evaporators will be located on old mining voids;
  - Dust suppression will be implemented as per the mine's current dust control programme.

Monitoring and auditing as outlined in the IWWMP, as well as the conditions of the WUL, needs to be implemented to ensure that the impact associated with the VDDC project are measures and corrective action taken, if necessary.

8.2.7 S27(1)(g) Class and resource quality objectives

Resource Class

The Minister of Water and Sanitation published, the classes and resource quality objective of water resources for the catchments of the Olifants River catchment in GN 466 on 22 April 2016 in terms of S13(4) of the NWA. The purpose is to ensure ecological sustainability by taking into consideration the social and economic needs of competing interests of all who rely on the water resources.

Water resources are classified in terms of their permissible utilisation and protection. The proposed classification of the Upper Olifants River catchment is Class III, requiring sustainable minimal protection and indicating high utilisation.

In terms of the Government Notice, quaternary drainage region B11B is to be maintained in Ecological Category C, and quaternary drainage regions B11F and B11G are to be maintained in Ecological Category D.

Resource Quality Objectives

The RQO's for the Olifants River have been published in GN 466 on 22 April 2016. VDDC is located within Resource Unit 11 of Integrated Unit of Analysis 1, the Upper Olifants River catchment.

8.2.8 S27(1)(h) Investments already made and to be made by the water user

Wolvekrans Colliery started operating in the 1980's and have made significant contributions to the local, national and international economies since then. Significant investments have been made to establish and maintain the operations.

The capital expenditure associated with the VDDC project is in excess of R 2 billion.

8.2.9 S27(1)(i) Strategic importance of water uses

The water uses associated with the proposed VDDC infrastructure and mining development at the Wolvekrans Colliery are needed to:

- Ensure that the opencast mining approved in the 2007 EMPR Amendment and 2008 DMO WUL continue and no premature job losses are incurred;
- Enable South32 to fulfil the mine's existing export entitlement allocation; and
- Contribute to the country's GDP and maintain good trade relations through exports.

8.2.10 S27(1)(j) Quality of water resource which may be required for the Reserve and to meet international obligations

The Reserve is the quantity and quality of the water required to satisfy the basic human needs by securing a basic water supply and to protect the aquatic ecosystem in order to secure ecologically sustainable development and use of the relevant water resource. The Reserve determination of water resources for the catchments of the Olifants and Letaba Rivers was published in GN 932 on 7 September 2018 and is relevant to this IWULA.

The water quality at Ecological Specifications (EcoSpecs) for surface water at point EWR1 as contained in the Reserve, is indicated in **Table 8-2**.

Table 8-2: Ecological Specifications relating to physico-chemical data as per Reserve published in GN 932

Water quality metrics		EcoSpec: REC
Major ions	Mg	The 95th percentile of the data must be ≤ 70 mg/ℓ
	SO_4	The 95th percentile of the data must be ≤ 250 mg/ℓ
	Na	The 95th percentile of the data must be ≤ 115 mg/ℓ
	Cl	The 95th percentile of the data must be ≤ 175 mg/ℓ
	Ca	The 95th percentile of the data must be ≤ 80 mg/ℓ
Physical variables	EC	The 95th percentile of the data must be ≤ 85 mS/m
	pH	The 5th and 95th percentile of the data must range from 5.6 – 9.2
	Temperature	Variation of 2° or 10% from background average temperature

	Dissolved oxygen	The 5th percentile of the data must be ≥ 6.0 mg/ℓ
	Turbidity	Vary (small amount) from natural turbidity range: minor silting of instream habitats acceptable
Nutrients	Nitrite & Nitrite	The 50th percentile of the data must be ≤ 3.0 mg/ℓ
	PO_4-P	The 50th percentile of the data must be ≤ 0.091 mg/ℓ
Response variables	Chl-a phytoplakton	The 50th percentile of the data must be ≤ 20 µg/ℓ
	Chl-a periphyton	The 50th percentile of the data must be ≤ 21 mg/m^2
	Ammonia	The 95th percentile of the data must be ≤ 43.75 µg/ℓ
	Atrazine	The 95th percentile of the data must be ≤ 48.75 µg/ℓ
	Fluoride	The 95th percentile of the data must be ≤ 3.52 mg/ℓ

It is noted that the groundwater quality for the B11B, B11F and B11G was not assessed due to insufficient information (i.e. lack of representative groundwater quality data).

8.2.11 S27(1)(k) Probable duration of any undertaking for which a water use is to be authorised

The proposed mining expansion is scheduled until 2046. Water uses associated with the operation will therefore commence and end within these timeframes. The different infrastructure components will be decommissioned as the mining progresses into a specific area, to allow opencast mining to proceed.

8.3 Supporting documents

The following additional documents are submitted in support of the application for a water use licence:

- Detailed water use tables (**Appendix A**);
- IWWMP (**Appendix B**), which includes the following;
    - Specialist reports:
        - Surface water report;
        - Geohydrological report;
        - Biodiversity and wetland report;
        - Geochemical and waste assessment of slurry found underground;
        - Geochemical assessment for Wolvekrans Colliery by Golder Associates;
        - Memorandum on the waste classification and barrier design for mine residue facilities by Jacana Environmentals;
        - Site wide water balance by Golder Associates.
    - Design drawings by Worley;
- Copies of existing WULs (**Appendix C**);
- Copy of BBBEE certificate (**Appendix D**);
- Public participation documents (**Appendix E**); and
- Proof of payment of the application fee (**Appendix F**).

9. PUBLIC CONSULTATION

At the onset of the process, an Integrated Regulatory Process (IRP) was followed, including an integrated public consultation process which combined the public consultation for the application for EA in terms of NEMA, application for a waste management licence in terms of NEM:WA, as well as the application for a WUL in terms of the NWA.. The public consultation process is outlined below, and document proof is provided in **Appendix E**.

9.1.1 Project announcement and availability of the Consultation Scoping Report (part of the IRP process)

The project and the availability of the Consultation Scoping Report (CSR) was announced to the public by means of the following:

- Advertisements in the Witbank News newspaper on 5 October 2018;
- Distribution of Background Information Documents from 4 October 2018;
- Placement of site notices on and around the site;
- Telephonic notification to key stakeholders and landowners;
- Notification to landowners via registered mail; and
- Loading of notification documents on the J&W website.

The CSR was made available to the public from 8 October to 7 November 2018.

Several changes were made to the proposed infrastructure and a Revised CSR was compiled and made available for public review from 7 August to 9 September 2019.

The Interested and Affected Parties (I&APs) comments on the CSR and Revised CSR were captured in a Comments and Response Report (CRR). No specific comments related to water or waste management were received during this initial consultation process.

9.1.2 Notification of availability of Revised CSR

The changes to the project and the availability of the Revised CSR was announced by means of the following:

- Distribution of notification to all I&APs registered on the stakeholder database on 2 August 2019;
- Advertisement in the Witbank News newspaper on 2 August 2019;
- Loading of notification documents on the J&W website.

The Revised CSR was made available for public review from 7 August to 9 September 2019.

No comments were received on the Revised CSR and the CRR therefore remained unchanged.

9.1.3 Notification of availability of Final Scoping Report

Once the Final Scoping Report was compiled, it was made available to the public. This was done by means of:

- Emails to all I&APs registered on the stakeholder database; and

- Uploading the report on the J&W website.

Notifications regarding the availability of the Final Scoping Report was sent to registered I&APs on 27 September 2019 and the request made that any further comment be sent to the DMR directly, with a copy to the Public Participation office.

9.1.4 Public Review of Consultation Environmental Impact Assessment Report (EIAR) and Environmental Management Programme (EMPr), as well as Draft IWULA and IWWMP

The Consultation EIAR/EMPr (which incorporates the waste management licence application), as well as the Draft IWULA and IWWMP will be made available for public comment by following the same procedure as for the Revised CSR:

- Distribution of notification to all I&APs registered on the stakeholder database;
- Advertisement in the Witbank News newspaper;
- Loading of notification documents on the J&W website.

The CEIAR and EMPr will be available for public review from 2 December 2019 to 23 January 2020. The Draft IWULA and IWWMP will be made available for an extended period, from 2 December 2019 to 24 February 2020.

9.1.5 Announcement of the authority's decision

Once a decision is reached by the DWS on the IWULA, the I&APs will be notified of the decision and the appeal process to be followed.

10. CONCLUSION AND RECOMMENDATIONS

10.1 Conclusions

Wolvekrans Colliery has been in operation since the 1980's. The aim of the proposed VDDC infrastructure and mining project is to ensure that opencast mining approved in the 2007 EMPR Amendment and 2008 DMO WUL can be successfully and sustainably executed. This will sustain production at the mine until 2046 and will result in a positive socio-economic impact since jobs will be sustained, as well as the contribution to the local economy.

The proposed project is situated within the existing mining right boundary in an area which has been extensively altered as a result of mining activities. The impact associated with the proposed mining can be mitigated to acceptable levels through the implementation of the measures described in this document.

10.2 Recommended licence conditions

The following conditions are recommended for inclusion in the WUL:

- The groundwater model should be calibrated and updated every five (5) years as mining proceeds to confirm and improve the assumptions in the model, specifically regarding the integrity of the barrier pillar with adjacent mining operations. A water management plan, which includes a decant management plan, should be developed to ensure that the water levels in the VDDC pit are maintained to below decant level;

- The operational water balance should be continuously monitored and reviewed on an annual basis. The predictive mine water balance and salt balance should be reviewed every five (5) years commensurate with the update of the groundwater model. The updated models should be used to review the adequacy of the water management measures, i.e. mechanical evaporation and treatment at the modular WTP for discharge, as well as dirty water storage requirements;
- The IWWMP should be reviewed and updated as required to take cognisance of any changes in the water balance, any resultant changes in the water and waste management measures, as well as changes to the mining schedule or development;
- Monitoring of surface water, groundwater and the aquatic ecosystem should be done according to the monitoring programme outlined in the IWWMP;
- Annual external audits should be conducted for compliance with licence conditions;
- An Operations, Maintenance and Emergency Preparedness Manual should be developed for all water and waste containment facilities.

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Appendix A

DETAILED WATER USE TABLES

APPENDIX A - Table of Contents

Table A.1(a) S21(c) and (i) water uses

Water Use Name	Co-ordinates		Property	Title Deed	Start Date	Quaternary Catchment	Watercourse	PES	EIS
Infrastructure area 1	26° 3'02.79"S 26° 3'05.32"S 26° 3'23.14"S 26° 3'27.64"S 26° 3'13.05"S 26° 3'06.45"S	29°15'55.57"E 29°16'09.35"E 29°15'51.73"E 29°15'37.31"E 29°15'54.59"E 29°15'49.89"E	Ptn 2 of Steenkoolspruit 18 IS Ptn 4 of Kleinkopje 15 IS	T76581/1999 T76581/1999	2020	B11F	Olifants River (riparian area)	E	D*
Infrastructure area 2	26° 3'34.51"S 26° 3'48.78"S 26° 3'45.86"S	29°15'30.50"E 29°15'38.15"E 29°15'23.44"E	Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	2020	B11F B11B	Olifants River (floodplain)	E	C/D*
Infrastructure area 3	26° 4'53.42"S 26° 4'53.35"S 26° 4'59.67"S 26° 5'00.27"S 26° 5'05.92"S 26° 5'42.41"S 26° 5'05.68"S	29°16'32.53"E 29°16'38.11"E 29°16'40.75"E 29°16'53.45"E 29°17'00.58"E 29°17'34.94"E 29°16'36.93"E	Ptn 2 of Steenkoolspruit 18 IS RE/3 of Vandyksdrift 19 IS	T76581/1999 T76548/1999	2020	B11B	Olifants River (riparian area)	E	C*
Infrastructure area 4	26° 3'18.87"S 26° 3'26.64"S 26° 3'45.76"S 26° 5'01.97"S 26° 4'55.91"S 26° 4'11.99"S 26° 3'52.37"S 26° 3'33.41"S	29°16'29.21"E 29°17'43.02"E 29°18'22.76"E 29°19'27.71"E 29°18'44.62"E 29°17'37.84"E 29°16'33.51"E 29°16'21.70"E	Ptn 2 of Steenkoolspruit 18 IS RE/3 of Vandyksdrift 19 IS	T76581/1999 T76548/1999	2020	B11B B11	Unnamed unchannelled valley bottom wetland and associated seepage wetland (previously referred to as Vleishaft Tributary)	D	High**
Opencast mining extension	26° 8'05.92"S 26° 5'01.21"S 26° 5'27.26"S 26° 5'31.15"S"	29°18'44.29"E 29°18'49.21"E 29°19'12.46"E 29°19'08.45"E"	RE/3 of Vandyksdrift 19 IS	T76548/1999	2020	B11B	Unnamed unchannelled valley bottom wetland and associated seepage wetland	C	Moderate**
Explosives magazine	26° 0'55.26"S 26° 0'55.16"S 26° 0'57.76"S 26° 0'58.04"S"	29°16'29.45"E 29°16'36.97"E 29°16'37.19"E 29°16'29.42"E"	RE of Wolvekrans 17 IS	T76586/1999	2020	B11G	Olifants River	E	D*
Discharge of treated water from modular WTP: new section of pipeline within 500 m of watercourse	26° 1'30.33"S	29°16'06.92"E	Ptn 6 of Wolvekrans 17 IS	T76586/1999	2020	B11G	Unnamed depression	C	Moderate**

* Resource Class according to GN 466
** TBC, 2019

Table A.1(b) S21(f) water uses

Water Use Name	Co-ordinates		Property	Title Deed	Name of Water Resource	Quaternary Catchment	Start Date	End Date	Total volume per year (m³)	Max volume per day (m³)	Calculated Monthly Discharge Pattern											
											J	F	M	A	M	J	J	A	S	O	N	D
Discharge of water from modular WTP	26° 1'30.33"S	29°16'06.92"E	Ptn 6 of Wolvekrans 17 IS	T76586/1999	Unnamed depression	B11G	2020	2049	4 752 000	8 712	396 000 m³ per month											

Table A.1(c) S21(g) water uses

Water Use Name	Co-ordinates		Property	Title Deed	Total volume of waste per year	Maximum volume of waste per day	Available airspace	Area (ha)	Start Date
Dust suppression with mine impacted water	Entire mining and infrastructure area		RE/3 of Vandyksdrift 19 IS Ptn 2 of Steenkoolspruit 18 IS Ptn 4 of Kleinkopje 15 IS	T76548/1999 T76581/1999 T76581/1999"	720 000 m³/a	2 400 m³/day	N/A	~ 1 400	2020
Eastern Overburden dump	26° 4'56.44"S 26° 4'51.21"S 26° 5'02.31"S 26° 4'58.38"S 26° 4'56.30"S	29°18'45.59"E 29°19'17.83"E 29°19'27.02"E 29°18'47.16"E 29°18'45.13"E	RE/3 of Vandyksdrift 19 IS Ptn 9 of Vandyksdrift 19 IS	T76548/1999 T76547/1999	2 679 000 m³/a	48 600 m³/day	5 356 500 m³	23	2020
Overburden dump on SKS void	26° 3'08.54"S 26° 3'10.44"S 26° 3'21.19"S 26° 3'37.52"S 26° 3'49.28"S 26° 3'46.44"S	29°16'01.83"E 29°16'17.50"E 29°16'26.61"E 29°16'21.74"E 29°15'58.74"E 29°15'22.43"E	RE/3 of Vandyksdrift 19 IS Ptn 9 of Vandyksdrift 19 IS"	T76548/1999 T76547/1999	18 067 400 m³/a	48 600 m³/day	74 752 000 m³	134	2020
Dragline spoils dump 1	26° 3'53.37"S 26° 3'54.44"S 26° 4'00.69"S 26° 3'59.09"S	29°16'08.86"E 29°16'28.10"E 29°16'27.33"E 29°16'04.88"E	Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	1 938 858 m³/a	140 000 m³/day	535 6500 m³	11	2020
Dragline spoils dump 2	26° 3'53.37"S 26° 3'54.44"S 26° 4'00.69"S 26° 3'59.09"S	29°16'32.50"E 29°17'03.36"E 29°17'02.13"E 29°16'32.78"E	Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	2 596 685 m³/a	140 000 m³/day	74 752 000 m³	16	2020
Dragline spoils dump 3	26° 3'57.74"S 26° 4'00.32"S 26° 4'06.29"S 26° 4'03.68"S	29°17'12.28"E 29°17'47.59"E 29°17'46.47"E 29°17'12.19"E	Ptn 2 of Steenkoolspruit 18 IS RE/3 of Vandyksdrift 19 IS	T76581/1999 T76548/1999	2 942 909 m³/a	140 000 m³/day	1 938 858 m³	18	2020
Dragline spoils dump 4	26° 4'00.63"S 26° 4'02.03"S	29°17'51.61"E 29°18'12.26"E	RE/3 of Vandyksdrift 19 IS	T76548/1999	1 921 546 m³/a	140 000 m³/day	1 921 546 m³	12	2020

Water Use Name	Co-ordinates		Property	Title Deed	Total volume of waste per year	Maximum volume of waste per day	Available airspace	Area (ha)	Start Date
	26° 4'08.10"S 26° 4'06.48"S	29°18'14.64"E 29°17'51.38"E							
Mixed ROM coal and slurry stockpile area 1 (south of Vleishaft dam)	26° 3'36.71"S 26° 3'35.03"S 26° 3'39.50"S 26° 3'42.63"S 26° 3'41.93"S	29°16'52.35"E 29°16'59.99"E 29°17'08.06"E 29°17'07.62"E 29°16'49.83"E	Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	5.1 million tonnes	17 000 tonnes	100 000 tonnes	8.5	2020
Mixed ROM coal and slurry stockpile area 2 (next to ramps)	26° 3'45.95"S 26° 3'46.38"S 26° 3'58.61"S 26° 3'56.88"S 26° 3'49.39"S	29°17'16.43"E 29°17'24.18"E 29°17'39.31"E 29°17'12.97"E 29°17'13.33"E	Ptn 2 of Steenkoolspruit 18 IS	T76581/1999	5.1 million tonnes	17 000 tonnes	100 000 tonnes	17.5	2020
4 Seam ROM stockpile	26° 4'34.31"S 26° 4'42.26"S 26° 4'49.06"S 26° 4'42.26"S	29°17'40.53"E 29°17'49.20"E 29°17'41.32"E 29°17'32.82"E	RE/3 of Vandyksdrift 19 IS	T76548/1999	1 647 000 tonnes	22 000 tonnes	1 204 000	16	2020
5 Seam ROM stockpile	26° 4'35.35"S 26° 4'42.75"S 26° 4'50.22"S 26° 4'43.36"S	29°17'56.99"E 29°18'05.43"E 29°17'56.77"E 29°17'49.20"E	RE/3 of Vandyksdrift 19 IS	T76548/1999	430 000 tonnes	4 000 tonnes		16	2020
4 Seam ROM stockpile	26° 4'57.39"S 26° 5'03.14"S 26° 5'09.02"S 26° 5'03.55"S	29°18'11.00"E 29°18'17.12"E 29°18'10.17"E 29°18'00.84"E	RE/3 of Vandyksdrift 19 IS	T76548/1999	1 647 000 tonnes	22 000 tonnes	660 000	8.5	2020

Table A.1(d) S21(j) water uses

Water Use Name	Co-ordinates	Start Date	Property	Title Deed	Total volume removed per year	Maximum volume removed per day
Dewatering of pit as mining proceeds	Moveable pumps to be used as mining progresses	2020	RE/3 of Vandyksdrift 19 IS Ptn 10 of Vandyksdrift 19 IS Ptn 2 of Steenkoolspruit 18 IS	T76548/1999 T76547/1999 T76581/1999	57 120 m^3/a	12 950 m^3/day

Appendix B

INTEGRATED WATER AND WASTE MANAGEMENT PLAN

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Appendix C

COPIES OF EXISTING WATER USE LICENCES

APPENDIX C - Table of Contents

Appendix D

BBBEE CERTIFICATE

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Appendix E

PUBLIC PARTICIPATION DOCUMENTS

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Please refer to Appendix 7 of the Environmental Impact Assessment Report (report number JW285/19/G535-10) for a copy

Appendix F

PROOF OF PAYMENT OF APPLICATION FEE

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To be included in Final Report