# 8.8 Surface Water Assessment

**SOUTH32 SA COAL HOLDINGS (PTY) LTD**

# VANDYKSDRIF CENTRAL (VDDC) MINING: INFRASTRUCTURE DEVELOPMENT SPECIALIST SURFACE WATER STUDY

<u>Report No.: JW188/18/G535 – Rev 1</u>

October 2019

Jones & Wagener
Engineering & Environmental Consultants

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Jones & Wagener

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## NEMA Appendix 6 requirements

| Regulation: GNR 326 | Description | Section in the Report |
|---|---|---|
| **Specialist Report** | | |
| Appendix 6 (a) | A specialist report prepared in terms of these Regulations must contain— details of— the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae; | Appendix B |
| Appendix 6 (b) | A declaration that the specialist is independent in a form as may be specified by the competent authority; | Appendix A |
| Appendix 6 (c) | An indication of the scope of, and the purpose for which, the report was prepared; | Section1.2 |
| Appendix 6 (cA) | An indication of the quality and age of base data used for the specialist report; | Section 5.6 |
| Appendix 6 (cB) | A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change; | Section 8 |
| Appendix 6 (d) | The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment; | N/A |
| Appendix 6 (e) | A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used; | Section1.4 |
| Appendix 6 (f) | Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a, site plan identifying site alternatives; | Section 7 and 8 |
| Appendix 6 (g) | An identification of any areas to be avoided, including buffers; | Section5.5.5 |
| Appendix 6 (h) | A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers; | Section5.5.5 |
| Appendix 6 (i) | A description of any assumptions made and any uncertainties or gaps in knowledge; | Section 10 |
| Appendix 6 (j) | A description of the findings and potential implications of such findings on the impact of the proposed activity or activities; | Section 8 |
| Appendix 6 (k) | Any mitigation measures for inclusion in the EMPr; | Section 8 |
| Appendix 6 (l) | Any conditions for inclusion in the environmental authorisation; | Section 8 |
| Appendix 6 (m) | Any monitoring requirements for inclusion in the EMPr or environmental authorisation; | Section 11 |
| Appendix 6 (n) | A reasoned opinion— whether the proposed activity, activities or portions thereof should be authorised;<br>(iA) regarding the acceptability of the proposed activity or activities; and if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan; | Section 13 |
| Appendix 6 (o) | A description of any consultation process that was undertaken during the course of preparing the specialist report; | Section5.10 |

| Regulation: GNR 326 | Description | Section in the Report |
|---|---|---|
| Appendix 6 (p) | A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and | Section5.10 |
| Appendix 6 (q) | Any other information requested by the competent authority. | N/A |

## SPECIALIST DECLARATION

I, Malini Veeragaloo, hereby declare that:

- I act as the independent specialist in this application.
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant.
- I declare that there are no circumstances that may compromise my objectivity in performing such work.
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity.
- I will comply with the Act, Regulations and all other applicable legislation.
- I have not, and will not engage in, conflicting interests in the undertaking of the activity.
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority.
- All the particulars furnished by me in this form are true and correct.
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

A detailed CV of the author included in **Appendix A**.

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MA Veeragaloo Pr Eng

## SYNOPSIS

South32 SA Coal Holdings (Pty) Ltd (South32) is the holder of an amended mining right for the Wolvekrans Colliery. The mine is located between the towns of eMalahleni and Kriel in the Nkangala District Municipality of the Mpumalanga Province.

The VDDC area of the Wolvekrans Colliery area falls within the footprint of historic underground mining operations known as Douglas Colliery. The Environmental Management Programme Report (EMPR) for the Douglas Colliery operations was amended and approved in 2007, to allow the opencast mining of the remaining coal reserves (extraction of remaining pillars, roof and floor) via opencast mining.

The mine has an original Environmental Authorisation (EA) (previously referred to as an approved Environmental Management Programme Report (EMPR)) dated February 2006 for opencast mining operations on the farms Steenkoolspruit 18 IS, Kleinkopje 15 IS and Vandyksdrift 19 IS. Applications for the dewatering of the flooded No. 2 seam workings were compiled and submitted in August 2016. Additional infrastructure is required in support of opencast mining of the pillars at the Vandyksdrift Central (VDDC) section of the Wolvekrans Colliery. However, planning for this infrastructure had not yet been undertaken, and it was therefore not included in the applications at the time.

Jones & Wagener Engineering and Environmental Consultants (J&W) was appointed by South32 as an independent Environmental Assessment Practitioner (EAP) to undertake an Integrated Regulatory Process (IRP) to obtain the required approvals/authorisations for the proposed infrastructure and mining development at the VDDC section.

Various specialist studies are required to support the regulatory process. One of the required studies is a surface water specialist study.

**Study Approach**

This surface water study entails a review characterising the surface water regime at the site and the catchment in which it resides, in terms of surface water quality and quantity.

It is important to note that Golder Associates updated the overall water balance for Wolvekrans Colliery to include the VDDC infrastructure and mining project (including areas that are authorised but does not form part of this environmental application process) (please refer to Report : "Inclusion of VDDC water management into Wolvekrans site wide water management plan", July 2019, Report number 19124625-327233-1). Input, in terms of the pit water make and surface runoff from the proposed infrastructure and mining areas were provided by J&W to Golder Associates.

An assessment of the impacts of the project on surface water, in terms of both quality and quantity, was conducted, as well as an assessment of the mitigation of the impacts. The method by which the impacts are quantified is to first assess the impact assuming no mitigation measures are applied, in order to provide a "worst case" scenario, thereafter the mitigation measures are evaluated and the residual impact indicated.

**Study Area**

The VDDC infrastructure development project is a brownfields project within the greater Wolvekrans Colliery mining right area. Wolvekrans Colliery is located between the towns of eMalahleni and Kriel, within the jurisdictional area of the eMalahleni Local Municipality (ELM) and the Nkangala District Municipality (NDM) of the Mpumalanga Province. The mine is situated approximately 30 km south-east of the town of eMalahleni, in close proximity to the Duvha Power Station.

VDDC is located on the western boundary of Wolvekrans Colliery. The Olifants River forms the southern boundary of this mining section.

**Proposed Infrastructure**

The new infrastructure to be developed (and which will be the subject of the IRP) includes:

- Topsoil dumps.
- Overburden dumps.
- ROM stockpiles and mixed ROM coal and slurry stockpile areas.
- The existing explosives magazine will be relocated to the north of Pit 4.
- 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.
- 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).
- Equipment, including water bowsers for dust suppression.
- Other infrastructure would include:
  - Opencast pit areas not previously authorised.
  - In pit sumps.
  - Proposed modular Water Treatment Plant (WTP).
  - Mechanical evaporators. The evaporators will be operated at 30 % efficiency.
  - Clean and dirty water canals and pipelines.
  - Future coal plant infrastructure area.

  The existing 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 new overburden dump in the south-eastern corner of the VDDC area.
- 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, LDV workshops will be used.
- No additional fuel or lube storage area, servicing bays or tyre bays are required.

**Baseline Assessment**

Information for the baseline assessment was abstracted from the November 2013 Surface Water Impact Study compiled by SRK for the VDDC Dewatering Project (Report Number 449019) as well as the 2004 Surface Water Study carried out by J&W for the Douglas Pillar Project EMPR (Report Number JW188/04/9347).

In terms of surface water quantity, the above information remains valid and is sufficient for the purposes of the baseline update. The floodlines for the area is more than 5 years old and South32 is in the process of updating these at the time of writing. However, it is not anticipated that the VDDC pit will encroach on the updated floodline and therefore the impacts assessed in this report will still remain relevant.

In terms of surface water quality within the study area there are visible impacts associated with mining activities both upstream and downstream of VDDC.

**Water balance**

The old 2 Seam underground workings have filled with water. This area will need to be dewatered prior to mining the VDDC pit and is therefore a key to the success of the proposed project.

The current plan is to make extensive use of mechanical evaporators to manage the pit water make and dewatering water from VDDC. The VDDC pit water balance as well as the estimated surface runoff, that can be expected from the proposed infrastructure areas was computed by J&W as input to the overall site wide water balance compiled by Golder Associates.

The water management plan for VDDC impacts on the site wide water balance as some of the infrastructure and mine workings such as Vleishaft Dam and Steenkoolspruit are planned to be used to manage the VDDC mine water make.

The total water make to be managed for the pit is estimated as follows:

- VDDC Opencast area:
  - Average water make over LOM = 4 760 $m^3$/day;
  - Peak summer water make = 12 950 $m^3$/day.

As mentioned above, Golder Associates were appointed to update the site wide water management model for the Wolvekrans Colliery to include the mine plan and catchment areas from the VDDC feasibility study with the above input provided by J&W.

- The following conclusions have been extracted from the Golder Associates report:
  - The dewatering rates during 2020 and 2021 are estimated to be about 27 000 $m^3$/d. During this period the site wide water balance model showed that the planned installed evaporator capacity will be insufficient to manage the water. South32 should consider installing the 8 evaporators at SKS by November 2019.
  - The extensive use of the evaporators will result in salt buildup in the water bodies over which the evaporators are spraying. Therefore, monitoring of salination of water due to brine evaporation will need to be undertaken and corrective action carried out if need be.
  - Vleishaft Dam is expected to spill during the period 2020 to 2022 which is during the initial VDDC dewatering period. The spills will report to the SKS pit. During this initial dewatering period, Golder Associate's model estimates that the SKS pit will decant into the adjacent Glencore workings. Therefore, the evaporators at SKS pit should be installed earlier than the planned implementation date of May 2020. After 2029, the 18 000 $m^3$/d of evaporator capacity installed at SKS pit will draw down the water level in the pit.

**Impact Assessment**

The loss of yield is quantified in the following table:

| 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* |

* Note: The runoff calculations are not accurate to three decimal places. However, the values remain indicative of the magnitude of the impact.

It is evident from the table above that the impact in surface water yield to the most downstream watercourse and Witbank Dam is LOW.

Impact on water quality with the mitigation measures described in the impact assessment, is considered to be HIGH to LOW in relation to the anticipated future activities in the area.

The surrounding and downstream surface water resources, namely the Olifants River, are considered stressed water resources in terms of both the quantity of water in the system and the quality of the water. The Olifants River also forms part of the water supply for irrigation water further downstream (from the Witbank Dam). Any impact on the quantity or quality of water in the system has the potential to affect the quality and assurance of supply to the community and agriculture.

The cumulative impact of the VDDC mining operation extension, with the mitigation measures described in the impact assessment, is considered to be MEDIUM to HIGH in relation to the current and anticipated future activities in the area, as the catchment is already impacted by mining activities.

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CV OF SPECIALIST

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RISK ASSESSMENT CRITERIA

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## Abbreviations used

| | |
|---|---|
| **BEEH** | **B**io-resources **E**ngineering and **E**nvironmental **H**ydrology |
| **BPG** | **B**est **P**ractise **G**uidelines |
| **DMR** | **D**epartment of **M**ineral **R**esources |
| **DWA** | **D**epartment of **W**ater **A**ffairs |
| **DWAF** | **D**epartment of **W**ater **A**ffairs and **F**orestry |
| **DWS** | **D**epartment of **W**ater and **S**anitation |
| **DWF** | **D**ry **W**eather **F**low |
| **EA** | **E**nvironmental **A**uthorisation |
| **EAP** | **E**nvironmental **A**ssessment **P**ractitioner |
| **EC** | **E**lectrical **C**onductivity |
| **EIA** | **E**nvironmental **I**mpact **A**ssessment |
| **EIAR** | **E**nvironmental **I**mpact **A**ssessment **R**eport |
| **EMPr** | **E**nvironmental **M**anagement **P**rogramme |
| **EMPR** | **E**nvironmental **M**anagement **P**rogram **R**eport |
| **GN** | **G**overnment **N**otice |
| **GNR** | **G**overnment **N**otice **R**egulation |
| **ICFR** | **I**nstitute for **C**ommercial **F**orestry **R**esearch |
| **IRP** | Integrated Regulatory Process |
| **IUA** | Integrated Unit of Analysis |
| **IWULA** | **I**ntegrated **W**ater **U**se **L**icence **A**pplication |
| **IWWMP** | **I**ntegrated **W**ater and **W**aste **M**anagement **P**lan |
| **J&W** | **J**ones **&** **W**agener |
| **LoM** | Life of Mine |
| **mamsl** | **m**etres **a**bove **m**ean **s**ea **l**evel |
| **MAP** | **M**ean **A**nnual **P**recipitation |
| **MAR** | **M**ean **A**nnual **R**unoff |
| **NEMA** | **N**ational **E**nvironmental **M**anagement **A**ct |
| **NEM:WA** | **N**ational **E**nvironmental **M**anagement: **W**aste **A**ct |
| **NWA** | **N**ational **W**ater **A**ct, 1998 (Act 36 of 1998) |
| **PCD** | **P**ollution **C**ontrol **D**am |
| **RMF** | **R**egional **M**aximum **F**lood |
| **ROM** | **R**un **O**f **M**ine |
| **RQO** | **R**esource **Q**uality **O**bjectives |
| **SANCOLD** | **S**outh **A**frican **N**ational **C**ommission **o**n **L**arge **D**ams |
| **SANS** | South African National Standard |
| **SAWS** | **S**outh **A**frican **W**eather **S**ervice |
| **SCS** | **S**oil **C**onservation **S**ervices |
| **SDF** | **S**tandard **D**esign **F**lood |

| | |
|---|---|
| **South32** | **South32 SA C**oal Holdings (Pty) Ltd |
| **SS** | **S**uspended **S**olids |
| **SKS** | **S**teen**k**ool**s**pruit |
| **TDS** | **T**otal **D**issolved **S**olids |
| **TWQG** | Target Water Quality Guidelines |
| **WR05** | **S**urface **W**ater **R**esources of South Africa 20**05** |
| **WR90** | **S**urface **W**ater **R**esources of South Africa 19**90** |
| **WRC** | **W**ater **R**esource **C**ommission |
| **WTP** | **W**ater **T**reatment **P**lant |

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SOUTH32 SA COAL HOLDINGS (PTY) LTD

VANDYKSDRIF CENTRAL (VDDC) MINING: INFRASTRUCTURE DEVELOPMENT
SPECIALIST SURFACE WATER
STUDY REPORT NO: JW188/18/G535 – Rev 1

# 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 (MPRDA) and notarially executed on the 21 May 2015 under DMR reference MP30/5/1/2/2/379MR, in respect of its Wolvekrans – Ifalethu Colliery. This mining right comprises of the following areas:

- Ifalethu Colliery (previously referred to as Wolvekrans North Section[1]) consisting of the Hartbeestfontein, Bankfontein (mining 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).

[1] This was previously referred to as Middelburg Colliery



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The water uses associated with the opencast mining have been authorised in terms of Water Use Licence (WUL) number 24084535 dated 10 October 2008, issued to Douglas Colliery Services Limited.

The No. 2 seam workings are flooded with water and must be dewatered to enable the open pit development to proceed. A dewatering strategy has therefore been developed and an application for Environmental Authorisation (EA) of the dewatering activities was submitted to the Department of Mineral Resources (DMR) (Jaco-K Consulting, 2016(a)); a decision in this regard is pending. The water use activities associated with this upfront 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;
- 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.

The proposed VDDC opencast pit boundary as determined through the pre-feasibility investigation also differs from the mining area approved in the 2007 EMPR amendment. An area of approximately 196 hectares in the latest mine lay-out was not included in the previous mine lay-out and is therefore not approved to be opencast mined.

Jones & Wagener Engineering and Environmental Consultants (J&W) was appointed by South32 as an independent Environmental Assessment Practitioner (EAP) to undertake an Integrated Regulatory Process (IRP) to obtain the required approvals/authorisations for the proposed infrastructure and mining development at the VDDC section.

Various specialist studies are required to support the regulatory process, one of which is a specialist surface water study.

## 1.2 Terms of reference

The terms of reference for the specialist surface water study are summarised below. Specific components to be addressed include the following:

### 1.2.1 Baseline assessment

The objective of the baseline study is to characterise the surface water regime at the site and the catchments in which it resides in terms of surface water quantity and quality.

Information for the baseline assessment was abstracted from the November 2013 Surface Water Impact Study compiled by SRK for the VDDC Dewatering Project (Report Number 449019) as well as the 2004 Surface Water Study carried out by J&W for the Douglas Pillar Project EMPR (Report Number JW188/04/9347). In terms of surface water quantity, the above information remains valid and is sufficient for the purposes of the baseline update, with the exception of additional surface water quality information, which was made available by South32. In addition to the above the floodlines for the area is more than 5 years old and South32 is in the process of updating these at the time of writing.

Please note that the surface water study does not include the delineation of sensitive areas such as pans and wetlands, or the assessment of aquatic ecology. Information regarding the aquatic ecology, pans and wetlands is included in separate specialist studies.

### 1.2.2 Site water management

This includes the compilation of a conceptual surface water management plan to mitigate the identified impacts, as well as the development of a surface water monitoring protocol. This includes the provision of information on the management of surface water around the planned activities, as well as the identification of pollution point sources.

The objective is to ensure compliance with legislation in terms of the management of both storm water and water affected by planned activities. The separation of clean and dirty water, with the diversion of clean water around dirty areas and the containment of dirty water on site, is necessary in order to achieve compliance.

### 1.2.3 Mine water balance

This includes the compilation of a site water balance in GoldSim and water flow diagrams for the proposed VDDC infrastructure areas only. The water balance was therefore limited to the proposed activities at VDDC.

It is important to note that Golder Associates has updated the overall water balance for Wolvekrans Colliery to incorporate the VDDC mining and infrastructure project. Input, in terms of the pit water make and surface runoff from the proposed infrastructure areas, was conducted by J&W and provided to Golder Associates.

The objective of the water balance is to quantify the water make over the life of the mine, during operations and post closure.

### 1.2.4 Impact assessment

This includes an assessment of the impact of the project and its components on surface water in the study area, in terms of both water quality and water quantity.

In addition, this includes the formulation of proposed mitigation measures for significant impacts, as well as monitoring required to measure the success of the mitigation measures, once implemented. The residual impact after implementation of the mitigation measures was also quantified.

## 1.3 Study area

The VDDC infrastructure development project is a brownfields project within the greater Wolvekrans Colliery mining right area. Wolvekrans Colliery is located between the towns of eMalahleni and Kriel, within the jurisdictional area of the eMalahleni Local Municipality (ELM) and the Nkangala District Municipality (NDM) of the Mpumalanga Province. The mine is situated approximately 30 km south-east of the town of eMalahleni, in close proximity to the Duvha Power Station. Locality plan given in **Figure 1.1.a** above.

VDDC is located on the western boundary of Wolvekrans Colliery. The Olifants River forms the southern boundary of this mining section.

The proposed infrastructure and mining development will take place on the farms Kleinkopje 15 IS, Vandyksdrift 19 IS, Wolvekrans 17 IS and Steenkoolspruit 18 IS.

## 1.4 Approach and methodology

The following actions were taken as part of the surface water specialist study for this project:

Information received from South32 as well as the design engineers (i.e. Worley), was reviewed and relevant issues were noted.

- Rainfall data was obtained from the Institute for Commercial Forestry Research (ICFR) database and the South African Weather Service (SAWS) and will be processed for use in the water balance modelling. In addition to this Golder Associates provided the critical stochastically generated rainfall for the water balance.
- Topographical maps and satellite imagery (Google Earth) were reviewed to assess the study area.
- Peak flood flows at relevant locations within the study area were extracted from previous studies undertaken in the area.
- Water quality data received from South32 was reviewed, collated and assessed.
- A site-specific water balance model was developed for the VDDC infrastructure areas. The water balance modelled the VDDC pit water balance (i.e. estimated pit water make over the Life of Mine (LOM)), as well as the estimated surface runoff, that can be expected from the proposed infrastructure areas, for the proposed VDDC infrastructure development project.
- Sketches and a description of the pollution control strategies around the various point sources was compiled using the storm water management proposed by the design engineers, Worley.
- The potential impacts associated with the proposed mining and related activities will be assessed according to the methodology stipulated by the lead environmental consultant (J&W). Impacts will be assessed for the construction, operational, decommissioning and post closure phases. Potential impacts will be detailed, then mitigation measures described, with residual impacts then being assessed.

# 2. LEGISLATIVE ASPECTS

## 2.1 Regulatory Requirements

The Acts and Regulations that pertain to the surface water for mining projects include:

- The Constitution of the Republic of South Africa, 1996 (Act 108 of 1996).
- The Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002).
- The Mineral and Petroleum Resources Development Amendment Act, 2008 (Act 49 of 2008).
- The National Water Act, 1998 (Act 36 of 1998) (hereafter referred to as NWA).
- The National Environmental Management Act, 1998 (Act 107 of 1998) (hereafter referred to as NEMA).
- National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEM:WA).
- Government Notice (GN) R704 of 4 June 1999: Regulation on use of water for mining and related activities aimed at the protection of water resources (hereafter referred to as GN R704).
- GN R139 of 24 February 2012: Regulations regarding the safety of dams in terms of Section 123(1) of the NWA.
- GN R991 of 18 May 1984: Requirements for the purification of waste water or effluent.
- GN 399 dated 26 March 2004: General Authorisations in terms of Section 39 of the NWA: S21(a) and (b) water uses, as extended in GN 970 dated 30 November 2012: Extension of time period for General Authorisations in terms of Section 39 of the NWA: S21(a) and (b) water uses – until withdrawn by Notice in the Government Gazette.
- GN 509 dated 27 July 2016: General Authorisation in terms of Section 39 of the NWA for water uses as defined in S21(c) or section 21(i).
- GN R324 to 327 of April 2017: NEMA EIA Regulations 2014, as amended.
- GN R636 of August 2013: National norms and standards for disposal of waste to landfill, in terms of NEM:WA.
- GN 466 of April 2016: Classes and Resource Quality Objectives for water resources in the catchment of the Olifants River, in terms of S13(4) of the NWA.

## 2.2 Applicable policies and/or guidelines

The following DWAF Best Practice Guideline (BPG) documents are relevant to this project:

- BPG for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A2: Water Management for Mine Residue Deposits, July 2008
- BPG for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A4: Pollution Control Dams, August 2007
- BPG for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A6: Water Management for Underground Mines, July 2008
- BPG for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G1: Storm Water Management, August 2006
- BPG for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G2: Water and Salt Balances, August 2006

- BPG for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G3: Water Monitoring Systems, July 2007
- BPG for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G4: Impact Prediction, December 2008
- BPG for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G5: Water Management Aspects for Mine Closure, December 2008
- BPG for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H1: Integrated Mine Water Management, December 2008
- BPG for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H2: Pollution Prevention and Minimization of Impacts, July 2008
- BPG for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H3: Water Reuse and Reclamation, June 2006.

# 3. DETAILS OF THE APPLICANT AND ENVIRONMENTAL ASSESSMENT PRACTITIONER

## 3.1 Details of the Applicant

**Table 3.1.a** below provides the details for the applicant responsible for the environmental applications for the proposed project.

**Table 3.1.a: Applicant details.**

| | | | |
|---|---|---|---|
| Project applicant: | South32 SA Coal Holdings (Pty) Ltd: Wolvekrans Colliery | | |
| Trading name (if any): | South32 SA Coal Holdings (Pty) Ltd | | |
| Contact person: | Thembani Mashamba | | |
| Postal address: | P.O Box 61820, Marshalltown, 2107 | | |
| Email: | thembani.mashamba@south32.net | Tel: | 011 376 2705 |

## 3.2 Details of the environmental consultant

The details of the EAP responsible for the IWULA in respect of this project are provided in **Table 3.2.a** below.

**Table 3.2.a: Environmental consultant details.**

| | | | | | |
|---|---|---|---|---|---|
| Environmental consultant | Jones & Wagener (Pty) Ltd | | | | |
| Contact person: | Tolmay Hopkins | | | | |
| Postal address: | PO Box 1434, Rivonia, 2128 | | | | |
| Email: | tolmay@jaws.co.za | Tel: | 011 519 0200 | Fax: | 011 519 0201 |

## 3.3 Details of the surface water specialists

The details of the Surface Water Specialist responsible for the Specialist Surface Water Study in respect of this project are provided in **Table 3.3.a** below. Details of the J&W project team members and their relevant experience are provided in **Table 3.3.b.**

**Table 3.3.a: Specialist consultant contact details**

| | | | | | |
|---|---|---|---|---|---|
| Specialist consultant | Jones & Wagener (Pty) Ltd | | | | |
| Contact person: | Malini Veeragaloo | | | | |
| Postal address: | PO Box 1434, Rivonia, 2128 | | | | |
| Email: | moodley@jaws.co.za | Tel: | 011 519 0200 | Fax: | 011 519 0201 |

**Table 3.3.b: J&W team members and relevant experience**

| Name | Email address | Experience | Responsibility |
|---|---|---|---|
| Malini Veeragaloo | moodley@jaws.co.za | BSc (Eng) 10 years experience | Water Balance and Surface Water Specialist Report |
| Michael Palmer | palmer@jaws.co.za | Pr Eng, MSc Eng Civil<br>20 years experience | Project Director<br>Review of: Surface Water Specialist Report |

# 4. DESCRIPTION OF THE PROJECT

## 4.1 Project location

Project location is given in section 1.3 above.

## 4.2 General description

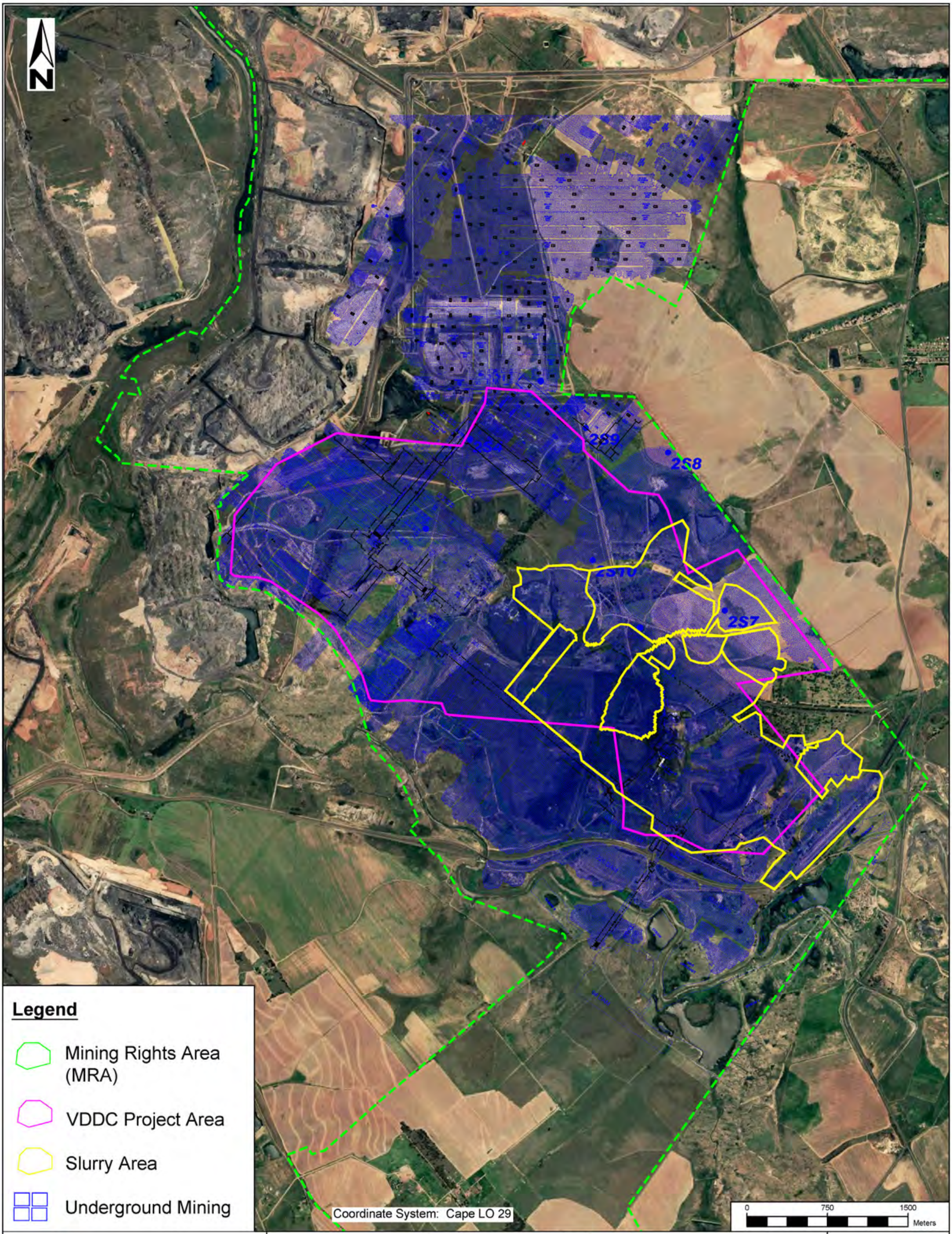
The VDDC area was identified as the most likely coal source to replace the Steenkoolspruit (SKS) operations, and to fulfil the current contracts and market obligations of the mining complex (South32, 2017a).

Coal produced will be mainly exported through the Richards Bay coal terminal.

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 (Southt32, 2017a).

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 4.2.a**).

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Vandyksdrift Central
Expected Slurry Footprint Area

Job No G535-391

**Figure 4.2.a**

## 4.3 Surface infrastructure

### 4.3.1 Existing infrastructure

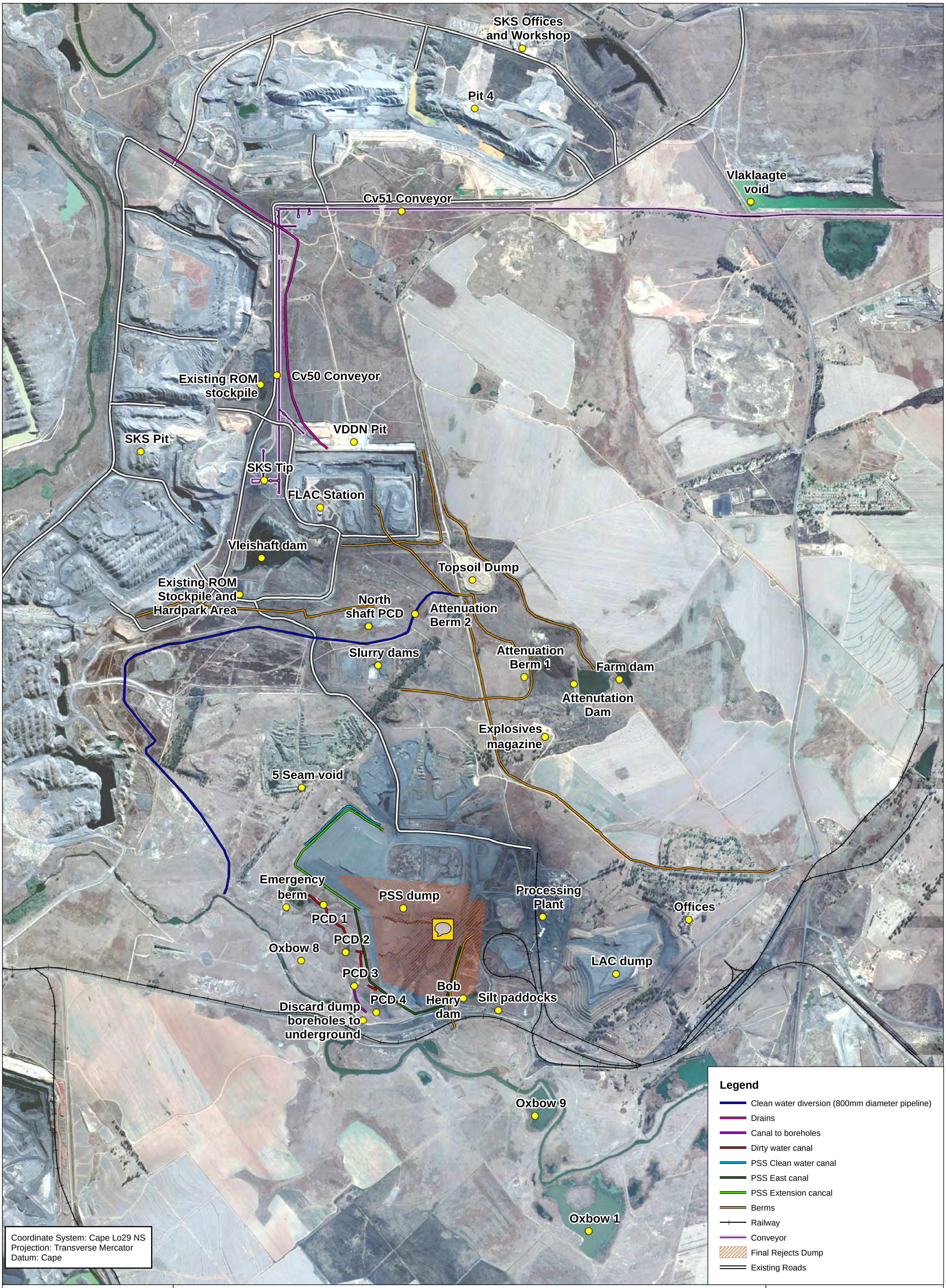
Existing infrastructure in the VDDC area is shown on **Figure 4.3.1.a** and includes the following:

- 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: All personnel transport, light delivery vehicles and heavy delivery vehicles up to 10 t single body trucks;
  - Current Wolvekrans main entrance (via Boschmanskrans (BMK) workshops): Heavy delivery vehicles and lowbeds; and
  - Current VDD main entrance (opposite Springbok village): Heavy delivery vehicles and lowbeds.
- Existing haul roads;
- Existing personnel vehicle parking;
- Existing bus turnaround;
- Existing facilities at the SKS operations:
  - 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.
- Existing topsoil dump is located on the north-eastern boundary of the VDDC section;
- Existing 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 it is expected that approximately 40% of the material will be recovered. Final rejects from the reclamation process is disposed of on the southern portion of the PSS dump on the Final Rejects Dump.
- Two existing 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;
  - A ROM stockpile area to the south of the Vleishaft Dam, of which a portion is currently used as a hard park area.

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Vandyksdrift Central
Existing Infrastructure

Job No: G535-391

Figure 4.3.1.a

- Existing power supply:

  The VDDC section is supplied from Eskom's Klein 132 kV Substation, which feeds the DMO 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).

  The existing electricity infrastructure is shown on **Figure 4.3.1.b**.

  A section of the Klein-Kromfontein 132 kV powerline must be relocated to allow opencast mining to proceed. This is the subject of a separate application that is undertaken by South32 in terms of a self-build agreement with Eskom. The EA for the powerline will be transferred to Eskom on completion of the construction phase.

- 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 to abstract 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 Dam and/or directly to the evaporation tanks that will be located at the evaporation sites where water will be evaporated using mechanical evaporators. Three evaporators sites have been identified, namely No. 5 Seam void, Vleishaft Dam and Vlaklaagte Void.

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

  A summary of the evaporator system is given in **Table 4.3.1.a** below.

**Table 4.3: Summary of evaporators (Taken from Golder Associates Water balance Report, page 8, Table 4)**

| Number of Evaporators | Location | Time Period | Capacity ($m^3/d$) |
|---|---|---|---|
| 8 – 2000 $m^3/d$ each | Vleishaft Dam | Currently operating | 4800 |
| 20 - 2000 $m^3/d$ each | Vlaklaagte South | Currently operating | 12000 |
| 12 - 3000 $m^3/d$ each | 5 Seam opencast | Installed in November 2019 | 10800 |
| 8 - 3000 $m^3/d$ each | Steenkoolspruit pit | Installed in May 2020 | 7200 |
| 20 - 3000 $m^3/d$ each | Steenkoolspruit pit | 12 evaporators moved from 5 Seam to SKS in 2023. 20 operating at SKS by June 2024 | 18000 |

### 4.3.2 Proposed infrastructure

The new infrastructure to be developed (and which will be the subject of the IRP) is shown on a **Figure 4 3.2.a** and includes:

- Topsoil dumps.
- Overburden dumps.
- ROM stockpiles and mixed ROM coal and slurry stockpile areas.
- The existing explosives magazine will be relocated to the north of Pit 4.
- 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.
- 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).
- Equipment, including water bowsers for dust suppression.
- Other infrastructure would include:
  - Opencast pit.
  - In pit sumps.
  - Proposed modular Water Treatment Plant (WTP).
  - Mechanical evaporators as detailed in **Table 4.3.1**.a above. The evaporators will be operated at 30 % efficiency.
- Clean and dirty water canals and pipelines.
- 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 new overburden dump in the south-eastern corner of the VDDC area.

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, LDV workshops will be used.

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



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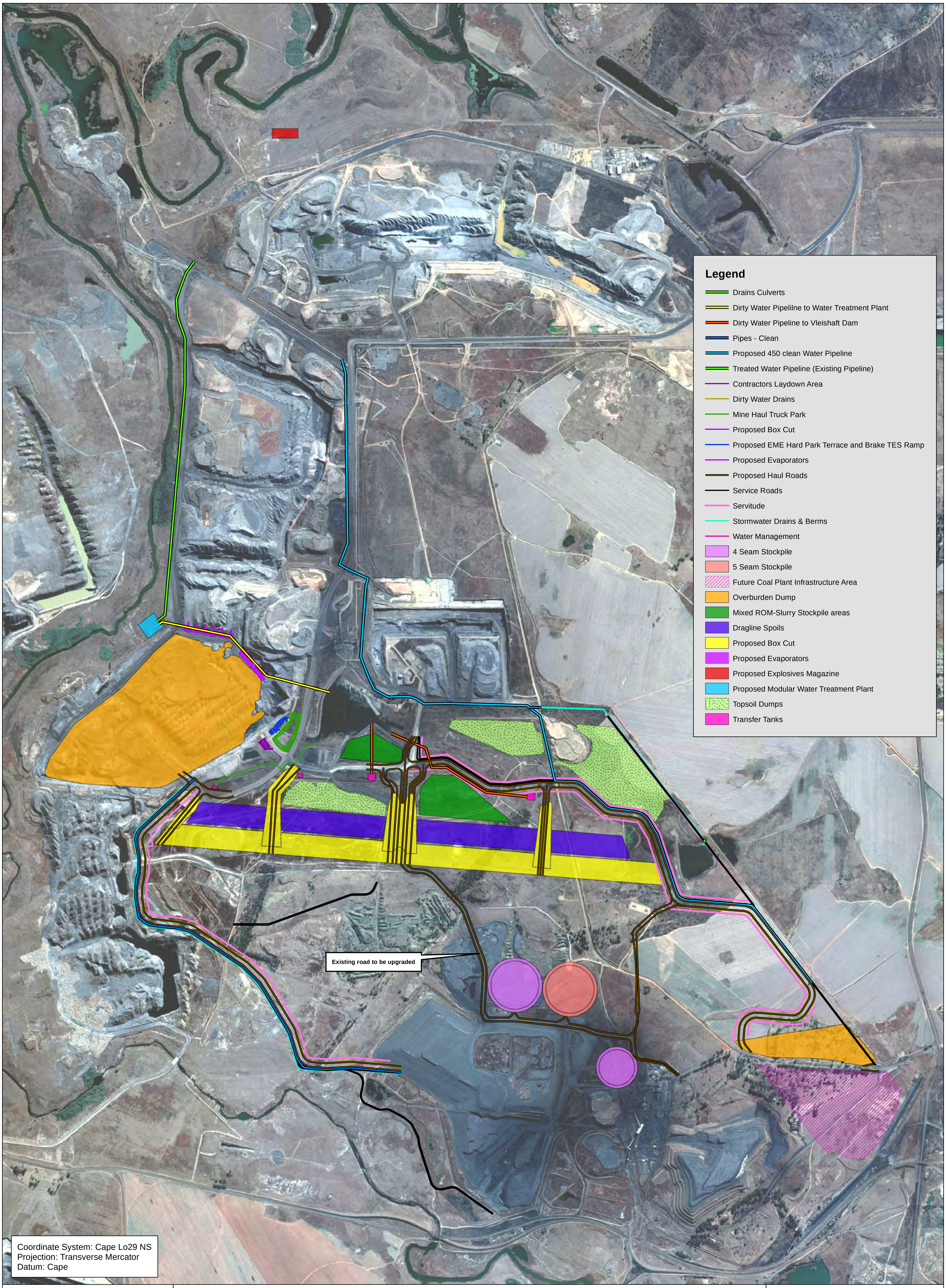
Vandyksdrift Central
Electricity Distribution

Job No: G535-391

Figure 4.3.1.b

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Vandyksdrift Central
Proposed Infrastructure

Job No: G535-391

Figure 4.3.2.a

## 4.4 Sources of water

### 4.4.1 Water consumption requirements

The water consumption requirements for the VDDC mining project is as follows:

- Potable water for human consumption or use in restrooms will be adequately catered for by the existing potable water supply existing at the SKS complex;
- Wash water for wash-down, either of vehicles, workshops or conveyor bunds. The water make from the upfront No. 2 Seam dewatering makes this a water positive operation. Therefore, the required volumes of process water and service water are adequately catered for.;
- Water for dust suppression on bulk materials handling systems which will be sourced from mine impacted water, i.e. the Vleishaft Dam;
- Water for dust suppression on haul roads which will be sourced from pit water;
- Fire water supplies are required at the new workshops at the SKS complex and will be taken from the existing fire water network.

## 4.5 Solid waste management

Solid waste has the potential to impact on surface water through contaminated runoff and seepage. The waste management proposed for the site is discussed below. It is anticipated that both hazardous and general waste will be produced.

### 4.5.1 Disposal of general waste

For this project VDDC will follow what is currently done at Wolvekrans Colliery. Wolvekrans Colliery disposes its general waste at the Middelburg municipal landfill site. This landfill site is licensed and after each disposal the mine receives a safe disposal certificate.

### 4.5.2 Disposal of industrial waste

All industrial waste, including wood, rubber, paper and refurbishable waste (i.e. pumps, valves etc.) will be sorted and stored in designated areas. Materials that can be recycled will be re-claimed, re-used or sold to scrap metal dealers as far as possible. Items such as used tyres and oil will be returned to suppliers for re-use.

Wood may be taken to an area outside the shaft area for use by the community. Plastic waste (i.e. PVC, HDP, plastic containers, electrical cables) that will be generated will be removed by a licenced waste removing contractor for recycling.

### 4.5.3 Disposal of hazardous waste

For this project VDDC will follow what is currently done at Wolvekrans Colliery. Wolvekrans Colliery contracts a registered waste removing company to remove and dispose of hazardous waste generated at the mine complex. The waste is taken to the Holfontein Hazardous waste site, a licensed waste facility, and safe disposal certificates are received for each waste disposal.

### 4.5.4 Disposal of healthcare risk waste

There will be no new clinics developed. All healthcare risk waste, including bandages, used dressings, urine cups, used HIV kits, used needles and syringes and used urines teat strips etc. will be placed in a designated container, at the existing Clinic known as Naledi Village Clinic, for disposal until collected and removed by an external registered medical waste company/contractor employed by the mine.

### 4.5.5 Disposal of mine residue

An area of the underground No. 2 Seam was historically used for disposal 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.

Slurry will be mined together with the ROM coal and the blended coal and slurry will be transferred to the mixed ROM coal and slurry stockpile areas, located to the south of the Vleishaft Dam. The mixed material will be allowed to dewater for a period, before it is removed via trucks to the existing SKS tip, from where it will be taken to the South Export Processing Plant using an overland conveyor. Water will be collected and conveyed via a silt trap to the Vleishaft Dam.

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.

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. A new overburden dump will be developed in the south-east of the project area and the existing overburden dump at the SKS pit will also be used.

All overburden dumps will be mined through”, with the exception of the south east overburden dump. The material from this dump will be removed and used in the concurrent rehabilitation of the opencast pit. The dump footprint will be rehabilitated.

The topsoil excavated from the box cut areas and areas cleared for the development of infrastructure will be placed in the designated 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 topsoil stockpile area in between the ramps. The box cut topsoil will be stockpiled due to the lack of direct placement option at the start of the opencast mining operations.

### 4.5.6 Disposal of waste from the water treatment plant

Mine impacted water will be pumped to the Vleishaft Dam and thereafter, to the evaporator sites, or to the proposed modular WTP or to Vlaklaagte void.

A summary of the mechanical evaporator sites is provided in **Table 4.3.1.a** above.

Surplus water which cannot be handled through the evaporation system, will be conveyed to a mobile, modular WTP with a maximum treatment capacity of 20 Mℓ/day. Brine from the WTP will be collected in existing tanks before being conveyed to the evaporators at the SKS void.

## 4.6 Liquid waste water management

### 4.6.1 Disposal of process effluent

It is not expected that the VDDC operation will produce any process effluent, with process water being recycled within the operations as far as is practicable. Any spills of process water during upset conditions will report via the dirty storm water system via a silt trap to the Vleishaft Dam and thereafter, to one of the evaporator sites, or to the proposed modular WTP.

### 4.6.2 Disposal of domestic waste water management

The disposal of domestic sewage is described in Section 4.7.1 below.

### 4.6.3 Disposal of treated mine water

Effluent from the WTP (i.e. treated mine water) will be conveyed via an existing mine water 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 for the Olifants River catchment as published in GN 466 in April 2016.

## 4.7 Water pollution management facilities

### 4.7.1 Domestic waste water management

During construction, chemical toilets will be used by the contractors. These will be emptied regularly for disposal at an authorised off-site sewage treatment plant.

Once operational, the existing facilities at the SKS complex will be used.

### 4.7.2 Storm water management

#### *4.7.2.1. Background*

An effective surface water management system will be essential to ensure efficient mining and to protect the natural water resource during the construction, operation and post closure phases of the mine. This will entail management of dirty water generated through the mining process (including the mine water make and run-off from mine infrastructure areas), as well as handling of clean water flowing towards the mining area.

Water management measures that are required will include the diversion of clean runoff from upstream of the mining areas around the site, and the containment of dirty runoff from the site in Vleishaft Dam, being the main pollution control dam (PCD) to which all surplus dirty water is pumped and thereafter, to one of the evaporator sites, or to the proposed modular WTP. These measures need to be designed to accommodate events up to at least the 1:50 year event, in line with GN R704.

Storm water that is generated around the mining area consists of clean and dirty runoff. This includes:

- Clean runoff from clean catchments draining towards the mining activities and infrastructure. Measures will be implemented to ensure that significant clean catchments are diverted away from the workings. Clean water diversions and flood protection measures will be designed to accommodate at least the 1:50 year event.

- Dirty runoff will be generated in the opencast and proposed infrastructure. Measures will be implemented to contain this runoff by directing it to the pollution control dam. At the proposed pit extension area, dirty runoff reporting to the pit will be collected in an in-pit sump from where it will be pumped to the Vleishaft Dam and thereafter, to one of the evaporator sites, to the proposed modular WTP or to Vlaklaagte void. The dirty water management system, including the pollution control dams, needs to be designed in accordance with GN R704 to accommodate the 1:50 year event as a minimum (i.e. 2% risk of spillage) with a minimum of 800 mm freeboard.

Storm water management measures are discussed in more detail below.

Layouts of the existing and proposed surface water management infrastructure are shown in **Figures 4.8.2.a** and **b** and are discussed in more detail below.

#### *4.7.2.2. Storm water management in clean areas*

In line with best practice and the requirements of the NWA, contaminated storm water runoff volumes will be minimised by preventing runoff from clean areas from entering the dirty areas. This will be achieved by means of clean water diversion canals that will collect clean runoff and divert it around the dirty areas.

All clean water diversions will be designed to accommodate the peak flow expected for at least a 1:50 year event.

In terms of clean water management, VDDC is an existing mine and has existing infrastructure including existing water management infrastructure. There are several existing clean water canals in the area. These are indicated in **Figure 4.8.2.a**.

As indicated in **Figure 4.8.2.a** there are several existing clean water canals that divert the clean upslope catchment from the north east and south west, as described below:

***Clean upslope catchment from the north and north east***

Prior to mining of the SKS pit as well as the VDD North area in the north west and north respectively, the clean upslope catchment to the east and north east was diverted by means of a series of clean water canal, berm and dam systems, discharging clean water into the Olifants River in the north west. Since the mining of SKS Pit and VDD North area, a portion of these canals have been mined through.


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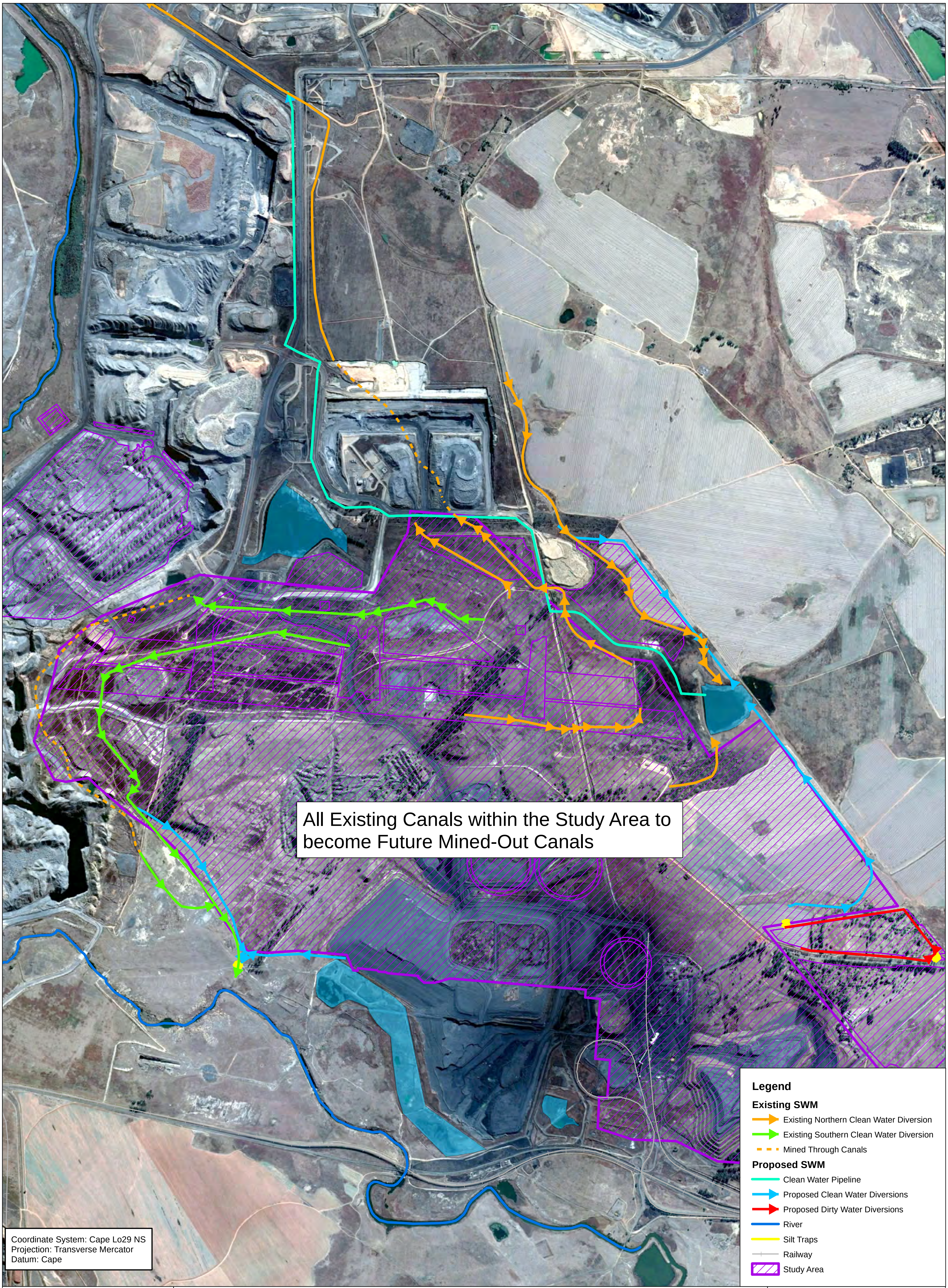
Figure 4.8.2.a

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Proposed SW Management

Job No: G535-391

Figure 4.8.2.b

The clean water dams, namely Attenuation Berm 1 and 2 and Attenuation Dam 1 (indicated as Attenuation Dam in the figure), lie within the Vleishaft tributary of the Olifants River and are utilised as clean water dams. Vleishaft Dam serves as the main PCD for the VDDC area. Due to the proposed infrastructure development, Attenuation Berm 1 and 2 will now be mined through, along with a portion of the existing clean water canals. This leaves Attenuation Dam 1 (indicated as Attenuation Dam in the figure), as the only clean water dam near the proposed mining area. This dam is located directly upstream of the proposed VDDC boxcut area and poses a potential risk to mining in this area as the stability of the dam wall is uncertain.

The current plan is to construct a pump and pipeline system to pump clean water from this dam to the Olifants River via an existing clean water canal, operating the dam as empty as possible at all times. However, it was recognised by South32 that the dam wall needs to be inspected to determine the status and any remedial or improvement work needed on the dam itself. There is also a farm dam, as indicated on **Figure 4.8.2.a**, that is upstream of Attenuation Dam 1 (indicated as Attenuation Dam in the figure), which needs to be taken into account in the above planning.

A storm water management plan and in particular the diversion of clean water, has been developed for the VDD North area by Golder Associates. The clean water diversion canals proposed for the VDDC area will need to tie into this proposed clean water system. This is proposed to be done as follows:

- The clean upslope catchment approaching from the east of the VDDC infrastructure area will be diverted via a canal and berm system towards Attenuation Dam 1. The VDD North clean water canal in the north will tie into this proposed canal.
- From Attenuation Dam 1 water will be pumped via two 450 mm diameter clean water diversion pipelines to the existing northern canal at VDD North, from where water will be discharged via a wetland area into the Olifants River.
- The treated effluent from the proposed WTP will be pumped via a separate pipeline which will then discharge into the northern canal.

***Clean upslope catchment from the west and south west***

Clean upslope catchment approaching from the west and south west is diverted by a series of canal and berm systems (to the south west of Vleishaft Dam) to the Olifants River in the south. Due to the proposed infrastructure and pit development, as part of the VDDC Infrastructure development project, the majority of these canal sections will be mined through. A portion of the existing canal to the north west of the PSS dumps will remain temporarily as the pit progresses and will eventually be mined through. A strip of clean upslope catchment from the south west will be diverted via new proposed clean water canals and berms to a proposed silt trap before discharging to the Olifants River.

***VDDC Opencast pit***

Runoff from clean catchments from the east draining towards the VDDC pit area will be diverted around the mining area, minimising clean runoff into the opencast workings and onto the mine infrastructure areas. These will be in the form of clean water cut-off canals and berms. Clean water diversions and flood protection measures will be designed to accommodate at least the 1:50 year event within the excavated canal with flood events of at least the 1:100 year being accommodated on the flood protection berm.

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

**New proposed hard park area**

The new proposed hard park area will be located within the designated dirty water footprint.

**Overburden dumps**

The overburden material has the potential to contain carbonaceous material and therefore potential to generate poor quality runoff due to contact of the water with carbonaceous material.

Overburden from the boxcut will be placed on four overburden dumps located in between the proposed ramps. In addition, provision has been made for one new overburden dump and the extension of an existing overburden dump. The new overburden dump will be developed in the south-east of the project area and the existing overburden dump at the SKS pit will be extended.

The existing overburden dump at the SKS pit as well as the four dumps between the ramps are located within the dirty water footprint. Runoff from clean catchments draining towards the overburden dump to the south-east of the project area will be diverted around the dumps by means of a diversion berm.

**Topsoil stockpiles**

Topsoil is considered clean. However, all proposed topsoil stockpiles are located within the dirty area. Clean runoff draining towards the stockpile area from the south and east will be diverted by means of clean water diversion canals and berms.

In addition to the canal/berm system, the design engineers have indicated that adequate energy dissipation and erosion protection will be provided at the discharge points.( Please refer to Worley's "The Mine Water Management Report", Section 7, Report/Document Number: C00820-000-CI-REP-0001, August 2019)

***ROM stockpiles and mixed ROM coal and slurry stockpiles***

These stockpiles will all be located within the designated dirty footprint. Clean runoff draining towards the stockpile areas from the south and east will be diverted by means of clean water diversion canals and berms.

In addition to the canal/berm system, the design engineers have indicated that adequate energy dissipation and erosion protection will be provided at the discharge points.

*4.7.2.3. Storm water management in dirty areas*

The dirty water containment facilities will be designed to ensure a risk of spill of dirty water to the environment of not more than once in 50 years (a 2% or lower risk in any one year). Infrastructure that will be provided to ensure the containment of contaminated water is described in the sections that follow, and is illustrated in **Figure 4.8.2.b**.

A number of dirty water canals drain dirty runoff to dirty water facilities. The Vleishaft Dam is an existing PCD that forms the main PCD for the VDDC Infrastructure Development project.

The North Shaft PCD is located to the south east of the Vleishaft Dam, but is not currently in use.

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 comprise a clean water canal which collects clean water west of the PSS Dump Extension, as well as a system of unlined canals which collects dirty runoff from the PSS Dump and conveys the water to four PCDs. Excess water from the PCDs is pumped to the underground workings via a borehole. Water is abstracted from the workings via boreholes for re-use in the South Export processing plant.

***VDDC 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 to the Vleishaft Dam and from there, to one of the evaporator sites, to the proposed modular WTP or to Vlaklaagte void.

The 4 and 5 seam coal stockpiles will move as the mining of the pit progresses and all runoff will drain to the Pit.

**New proposed hard park area**

The new proposed hard park area will be located within the designated dirty water footprint.

All dirty runoff will drain to SKS void.

**Overburden dumps**

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

Pollution control measures will be required at the new overburden dump located on the south-eastern boundary to collect dirty runoff and seepage. Runoff from this dump will be diverted via a canal and berm system to silt traps and a set of boreholes which will take all runoff 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 PCD (Veishaft dam).

**Topsoil stockpiles**

All topsoil stockpiles are located within the dirty area. Runoff generated from the topsoil stockpiles will drain via gravity to Vleishaft Dam.

***ROM stockpiles and mixed ROM coal and slurry stockpiles***

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

***Pollution control dams***

There are no new PCDs proposed for the VDDC infrastructure development project, as all dirty water generated in the opencast pit, as well as runoff generated from the infrastructure areas will be pumped to the existing PCD (i.e. Vleishaft Dam).

### 4.7.3 Mine water management

The proposed mining operations require the management of mine impacted water. Dirty areas that have been identified and included in the water management strategy are:

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

Surface runoff generated from various proposed and existing infrastructure that need to be considered include:

- Existing hard park area, which drains to Vleishaft Dam;
- New proposed hard park area, which drains to SKS void;
- Topsoil stockpile within dirty area, which drains to Vleishaft Dam;
- Overburden dump, which drains to old underground workings via boreholes;
- Overburden dump at SKS pit, which drains to SKS void;
- Existing ROM stockpile to the north, which drains to SKS void;
- Existing ROM stockpile to the south, which drains to Vleishaft Dam;
- Mixed ROM coal and slurry stockpiles, which drains to Vleishaft Dam;
- Dirty water management area, which drains to which drains to old underground workings via boreholes;
- 4 and 5 seam coal stockpiles, which drains to the VDDC Pit.

Mine impacted water will be pumped to the Vleishaft Dam and thereafter, to one of the evaporator sites, or to the proposed modular WTP.

Surplus water which cannot be managed through the evaporation system, will be conveyed to a mobile, modular WTP with a maximum treatment capacity of 20 Mℓ/day. Brine from the WTP will be collected in existing tanks before being conveyed to the evaporators at the SKS void.

Effluent from the WTP (i.e. treated mine water) will be conveyed via an existing mine water 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 for the Olifants River catchment, as published in GN 466 in April 2016.

### 4.7.4 Water storage facilities

#### *4.7.4.1. General description of dams*

***Existing dams***

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.

**Proposed dams**

No new surface water dams are proposed as part of the VDDC Infrastructure Development project.

### 4.7.5 Polluted water treatment facilities

#### *4.7.5.1. Mine water treatment*

Mine water treatment is discussed in detail under Section 4.5.6 and 4.6.3 above.

## 4.8 Watercourse alterations

The mining area is located adjacent to the Olifants River. The proposed WTP will discharge into an existing clean water canal (the northern canal). Therefore, alteration of flow in the Olifants River due to excess treated water from the WTP, being discharged into existing clean water canal prior to discharge to the Olifants River.

# 5. BASELINE ENVIRONMENTAL DESCRIPTION

The baseline environmental information is important for several reasons. This data forms the basis of the assessment of possible impacts, and the setting of objectives for closure. For surface water it is important that the mine is able to identify point sources that may be impacting on surface water so that the origin of any future impacts can be identified.

## 5.1 Regional Climate

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

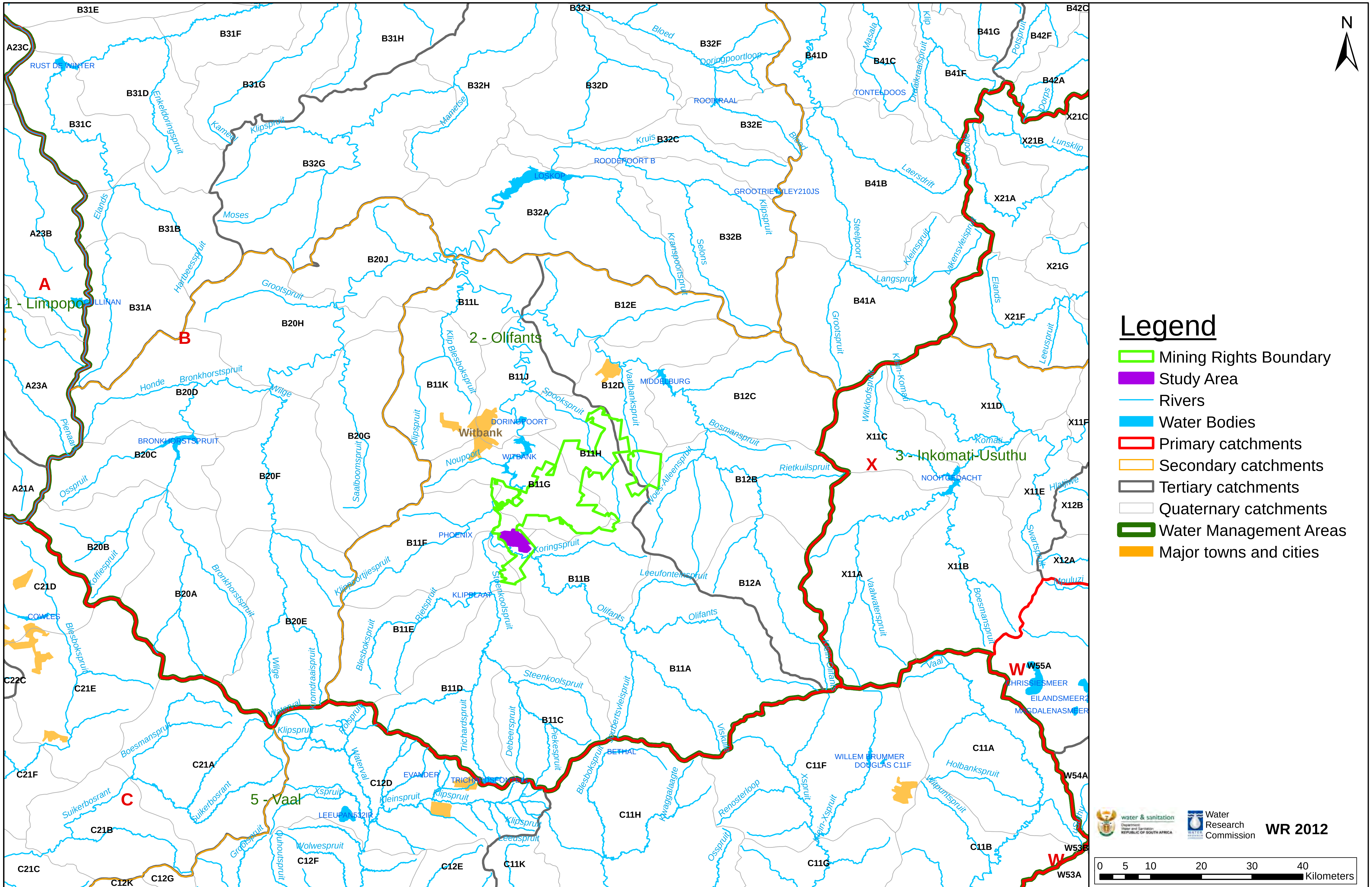
## 5.2 Catchment description

### 5.2.1 General description

The VDDC infrastructure and mining 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 project is largely situated within quaternary sub-catchment B11F and B11B with some infrastructure components located within B11G of the Limpopo-Olifants primary drainage region, as indicted in **Figure 5.2.a** taken from “Surface Water Resources of South Africa – 2012” (Midgley, Pitman & Middleton, 2012) (WR2012)).

The proposed infrastructure and mining development area drains towards the Olifants River. Prior to mining that took place in 2004, the drainage of the northern portion of the proposed infrastructure development area previously drained via the Vleishaft tributary (which was diverted then to facilitate future mining, with the Vleishaft Dam being used as a PCD) which flowed through the mine’s property.

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 to the Indian Ocean on the east African coastline.

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## Site in relation to quaternary Sub-Catchments

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Figure 5.2.a

## 5.3 Receiving water body

In terms of the catchment description, the receiving water body is an important concept. The receiving water body is the point below which the mine's impact on the catchment is considered to be negligible. This implies that aspects such as surface water users need only be defined down to the receiving water body.

The receiving water body for the assessment of potential surface water quality impacts of the VDDC Infrastructure and mining development project is taken as the Witbank Dam.

The use of this dam is motivated on the basis that:

- The Witbank Dam has been selected as it is located downstream of the proposed development within the Olifants River catchment area.
- Beyond the Witbank Dam, the potential impacts become extremely small due to the water volumes in the catchment and dilution effects.
- Further, by the time the water reaches the Witbank Dam, it is required to be suitable for use for 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 use of the Witbank Dam is based on the relatively small size of the disturbed areas compared to the catchment for the dam.
- The catchment for the Witbank Dam is reported as 579 $km^2$. The proposed VDDC infrastructure development area covers approximately 14.5 $km^2$. The mine area thus totals approximately 2.5% of the Witbank Dam catchment.
- 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 0.45 x $10^6$ $m^3$.

## 5.4 Rainfall and evaporation

### 5.4.1 Rainfall data

The Daily Rainfall Extraction Utility, developed by the Institute for Commercial Forestry Research (ICFR) in conjunction with the School of Bio-resources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, Pietermaritzburg, was used to obtain summary data for all rainfall stations within the vicinity of the site. This data was assessed in terms of length of record, completeness of the data set, mean annual precipitation (MAP) and location of the rainfall station with respect to the site and the catchment. Key data extracted from the database for the five most reliable stations is shown in **Table 5.4.1.a**. The ICFR database contains daily patched rainfall data for all official SAWS stations, and includes data up to August 2000.

After an assessment of the length of the record, MAP and the reliability of the data for the five rainfall stations, the Witbank, EDE and Blinkpan rainfall stations were disregarded. This was due to the limited length of the records and low reliability of the data sets. To further assess the two remaining rainfall stations, and select an appropriate and representative station for the site, each of the records were assessed to determine whether the records contained events exceeding the 1:50 year event.

**Table 5.4.1.a: Key data for selected rainfall stations (ICFR database)**

| Station number | Station name | Reliable (%) | MAP (mm) | Length of record (years) |
|---|---|---|---|---|
| 0515826_W | Middelburg (TNK) | 51.9 | 643 | 96 (1903 – 1999) |
| 0516201_W | EDE | 42.2 | 643 | 90 (1903 – 1993) |
| 0515412_W | Witbank (MUN) | 37.1 | 641 | 44 (1956 – 2000) |
| 0478546_W | Vandyksdrift | 59.8 | 686 | 82 (1928 – 2010) |
| 0478786 | Blinkpan | 25 | 643 | 13 (1987 – 2000) |

The top 100 ranked peaks from the two rainfall records were plotted along with the rainfall depths relating to various recurrence intervals, extracted from the SAWS design rainfall depths manual. For both rainfall stations it was found that only one event exceeded the 1:50 year event. Therefore, the Vandyksdrift rainfall station was selected as being the representative rainfall data set for the site. The Vandyksdrift rainfall station was found to have the most reliable data set with a high MAP.

It was found that, although data was available for the Vandyksdrift station after 1998, this data was not completely intact, with data missing and inconsistencies. Therefore, only data up until 1998 was considered for the station. A mass plot was produced for the record and is shown in **Figure 5.4.1.a.** A mass plot is a graph showing the cumulative rainfall depth with time for the full rainfall record. It is good indication of the reliability of the data set. A good mass plot will produce a straight line, with slight oscillations for seasonality. Any changes in the slope indicate a potential problem in the data set.

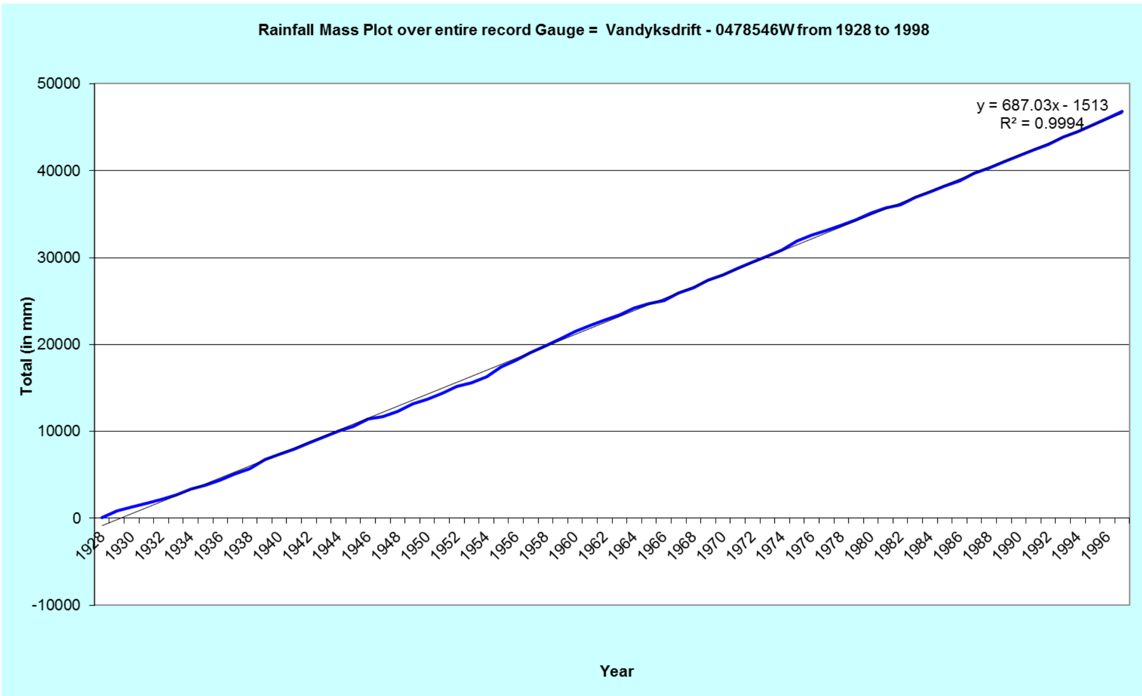


**Figure 5.4.1.a: Rainfall mass plot for the rainfall record**

The mass plot for the rainfall record is considered to be acceptable. The record has therefore been selected as being a representative rainfall data set for the site for the hydrological assessment.

The average monthly rainfall depths are presented in **Table 5.4.1.a.** The rainfall record is presented graphically in **Figure 5.4.1.a**. The entire rainfall record is presented graphically in **Figure 5.4.1.a.** Mean monthly rainfall is shown graphically, together with mean monthly evaporation, in **Figure 5.4.1.c**.

The site in relation to the regional MAP for the area, taken from WR2012 can be seen in **Figure 5.4.1.b**.

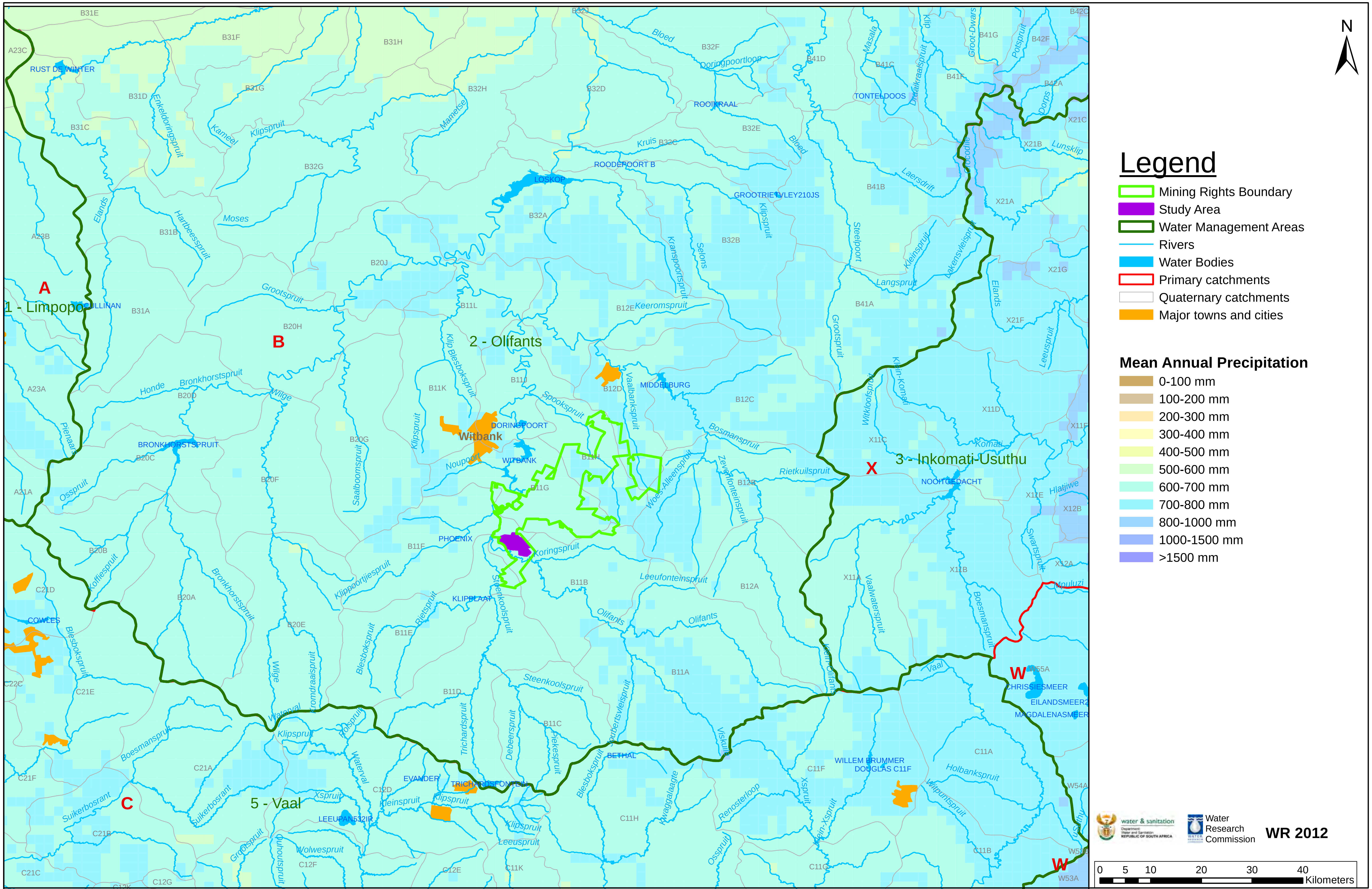


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Figure 5.4.1.b

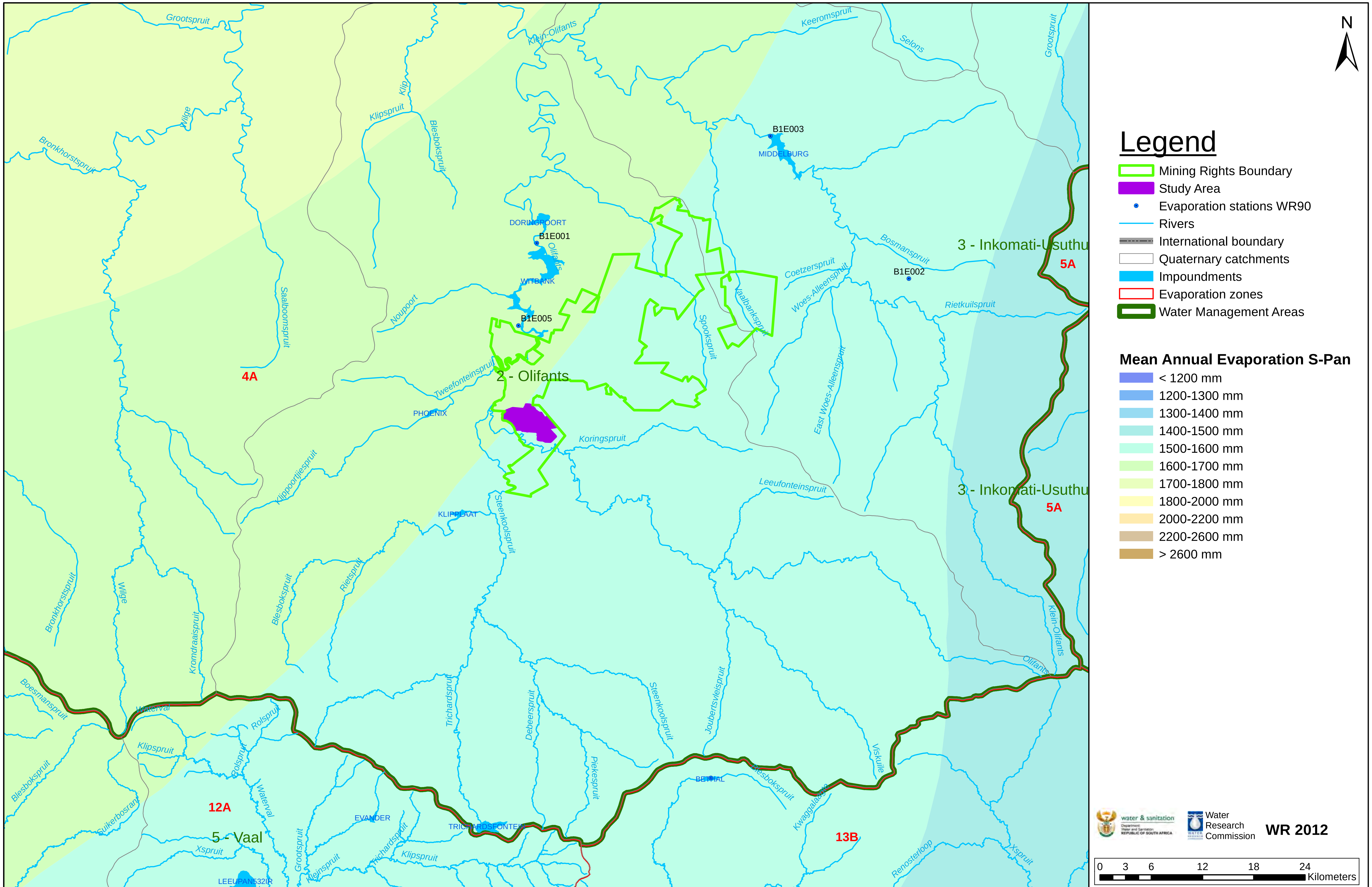


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Figure 5.4.1.c

### 5.4.2 Evaporation data

Evaporation data was taken from the evaporation station for Witbank Dam (B1E001). Monthly data for this station was only available for the period 1964 to 2009. Over the periods for which there was no monthly evaporation data, average evaporation depth, taken directly from the *WR90 report* for the Evaporation Zone into which the site falls. The Evaporation Zone is 4A. The Mean Annual Evaporation for this zone is 1600 mm. The average monthly evaporation depths are presented in **Table 5.4.2.a** and **Figure 5.4.2.b**. The site in relation to the regional MAE for the area, taken from WR2012 can be seen in **Figure 5.4.1.c**.

**Table 5.4.2.a: Average monthly rainfall depth for the Vandyksdrift rainfall record (0478546_W) and evaporation depths (from *WR90)***

| Month | Average rainfall (mm) | Average evaporation (mm) |
|---|---|---|
| October | 70 | 176 |
| November | 108 | 147 |
| December | 109 | 145 |
| January | 109 | 111 |
| February | 94 | 94 |
| March | 72 | 76 |
| April | 42 | 83 |
| May | 17 | 110 |
| June | 8 | 143 |
| July | 7 | 172 |
| August | 7 | 163 |
| September | 24 | 179 |
| **Annual Total** | **669** | **1600** |

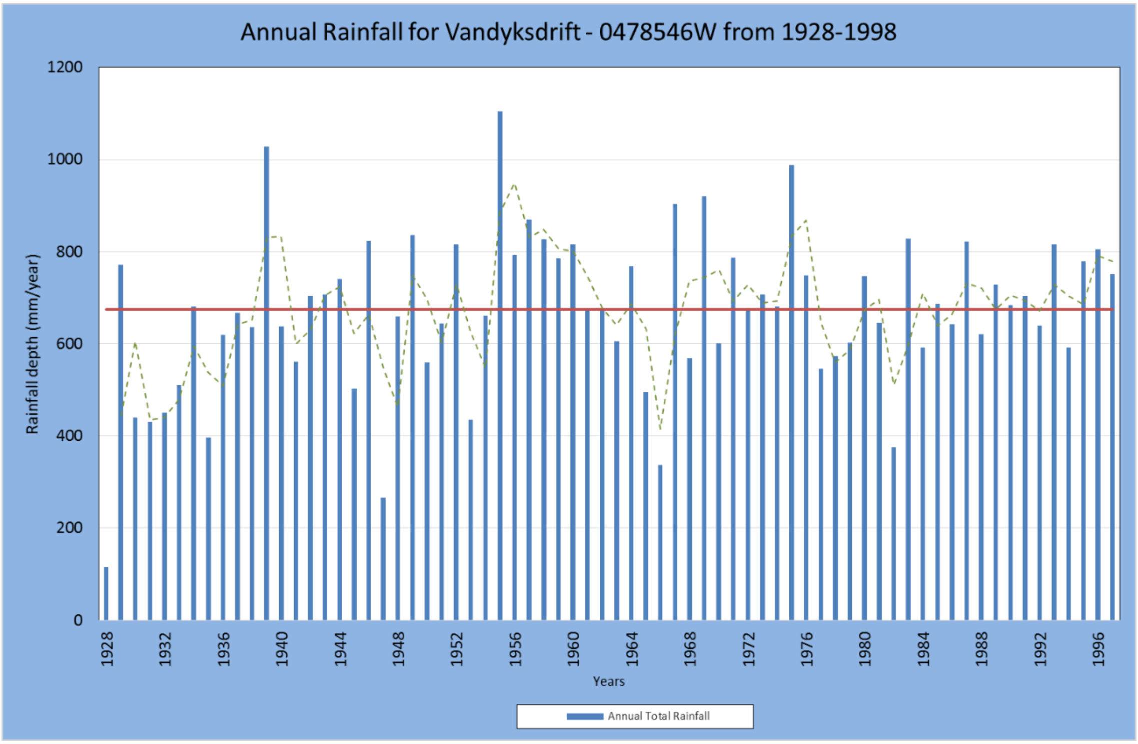


**Figure 5.4.2.a: Rainfall record for Vandyksdrift**

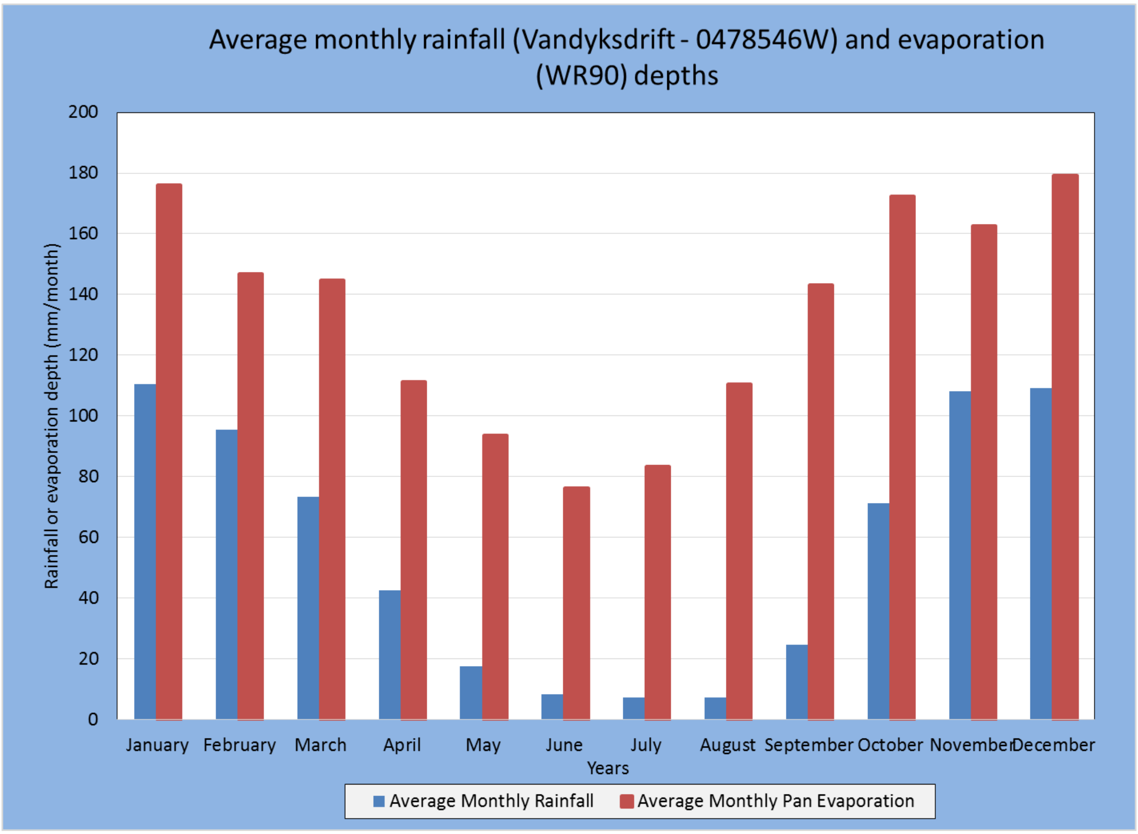


**Figure 5.4.2.b: Mean monthly rainfall and evaporation for Vandyksdrift**

### 5.4.3 Maximum rainfall intensities

#### *5.4.3.1. Rainfall extremes*

Apart from the normal criteria of being statistically consistent, normally measured by considering the mass plot and ensuring that it is linear, it is also important that the rain gauge have a long record, and within that record that it contain rainfall events that correspond to at least the 1:50 year event, since the legal requirement is that a mine should not spill dirty water to the environment more than once in 50 years (a 2% risk of spilling in any one year). The duration of the event can vary, and in most of the larger mines, the critical event is not the 24 hour event, but rather above average rainfall over a period of several months, typically with several extreme rainfall events occurring during a wetter than average period.

Statistical rainfall extremes corresponding to various recurrence intervals where extracted from the Design Rainfall Depths of SAWS Rainfall Stations (Smithers and Schulze, WRC Project No K5/1060). These are shown in **Table 5.4.3.a**.

**Table 5.4.3.a: Statistical rainfall extremes for Vandyksdrift rainfall station (from WRC K5/1060)**

| Event | Rainfall depth (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1:2 | 1:5 | 1:10 | 120 | 1:50 | 1:100 | 1:200 |
| 1 day | 54 | 72 | 85 | 99 | 117 | 132 | 148 |

**Figure 5.4.3.a** illustrates the top 100 one day ranked rainfall peaks, along with the statistical rainfall extremes for Vandyksdrift, from the WRC. It is evident that, for the Vandyksdrift station, there are no events that has been recorded at the station, which are in excess of the 1:50 year event, making this record unsuitable for the water balance assessment. However, the rainfall record is still suitable for the hydrological assessment. Therefore, for the water balance modelling Langsloot/Secunda gauge will be used and further detail is given in Section 6.

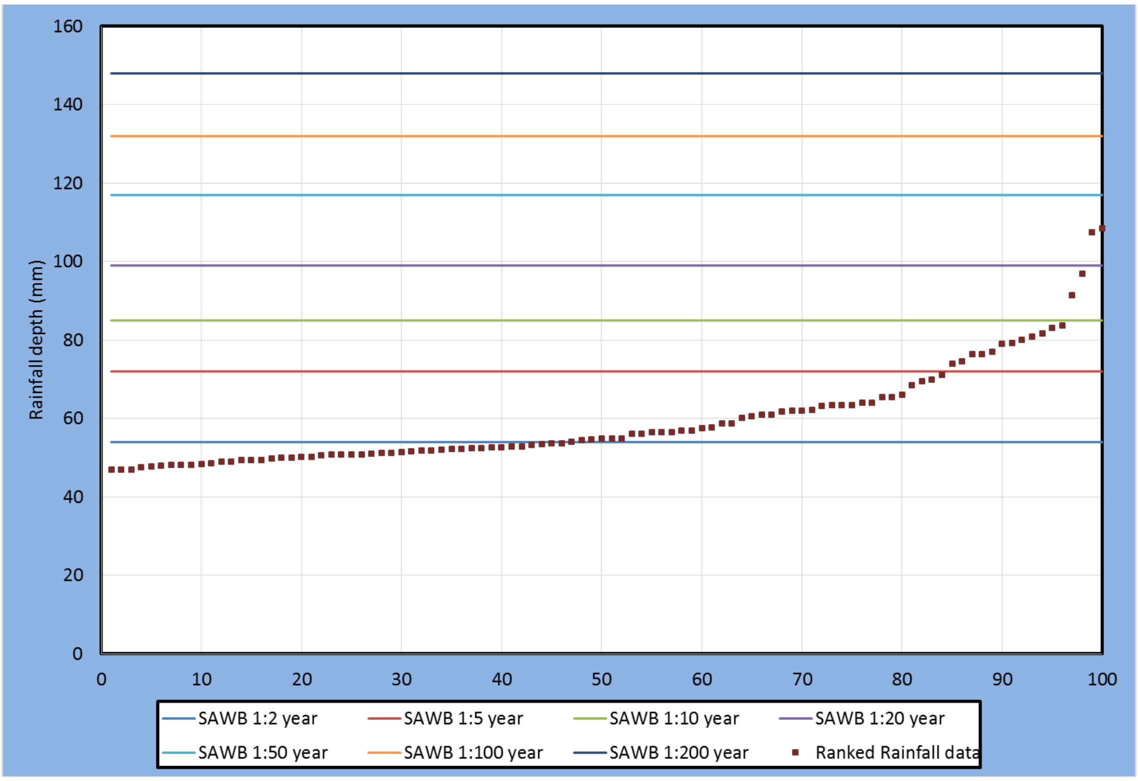


**Figure 5.4.3.a: Top 100 one day ranked rainfall peaks**

## 5.5 Surface water quantity

This section details the baseline surface water information related to water quantity, such as flood events and stream flow (in essence the hydrology).

### 5.5.1 Map of the catchment

The Witbank Dam catchment is shown in **Figure 5.2.a** above. Catchment areas upstream, downstream and within the project area are given in **Table 5.5.1.a** below.

**Table 5.5.1.a: Catchment areas**

| River | Measured at | Catchment ($km^2$) |
|---|---|---|
| Olifants River | Upstream of Vandyksdrift (Entrance of mine property) | 1350 |
| Olifants River | Downstream of mine property | 3309 |

### 5.5.2 Mean Annual Runoff (MAR)

The WRSM2012 synthetic generation model was used to obtain simulated monthly flow records at various points within the mine property. The rainfall input to the model was an averaged historical record of several rain gauges in the vicinity. The MAR is given in **Table 5.5.2.a**. The site in relation to the regional MAR for the area, taken from WR2012 can be seen in **Figure 5.5.2.a**.

**Table 5.5.2.a: Computed MAR**

| River | Measured at | MAR (x106$m^3$) | 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

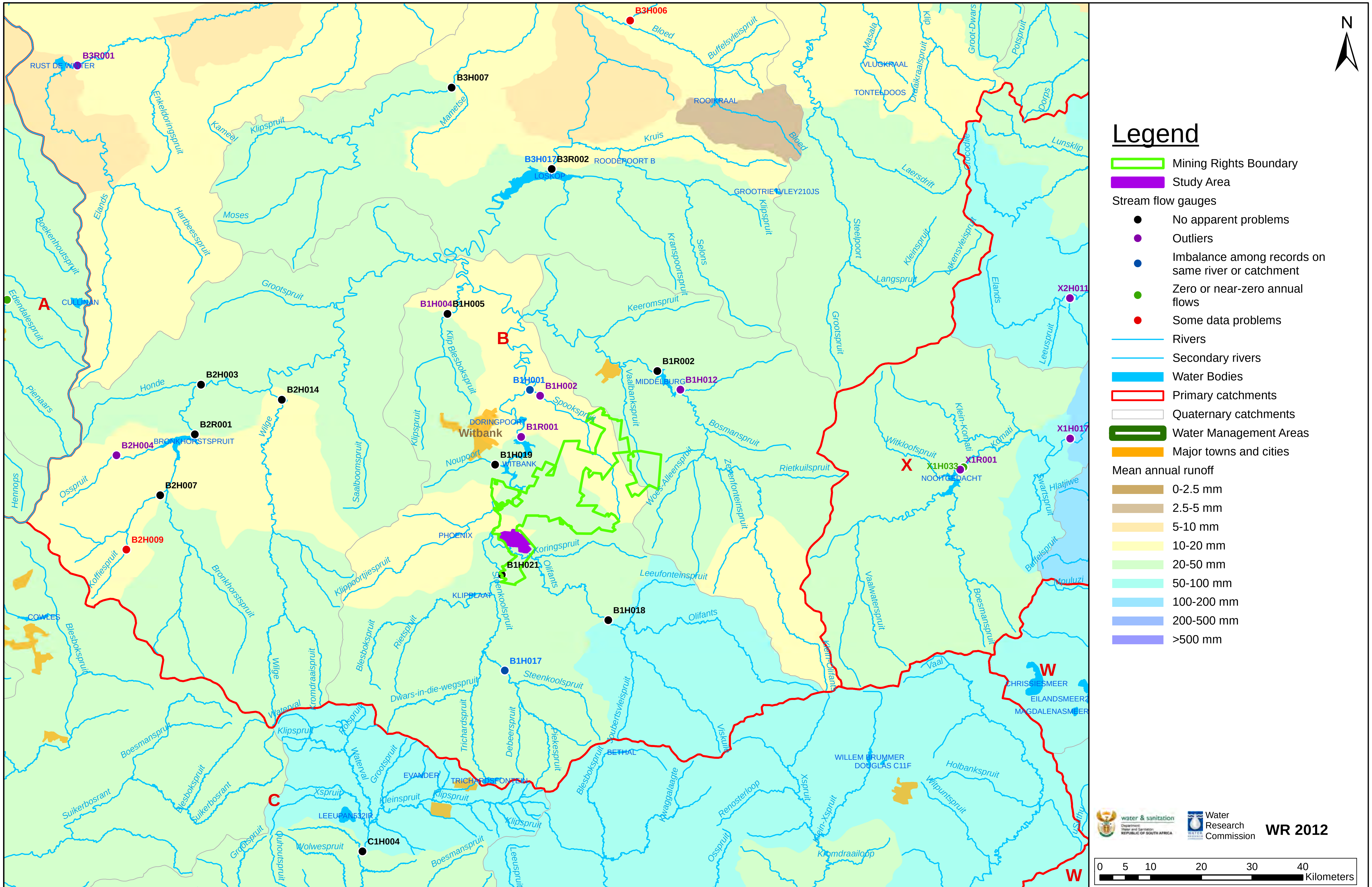


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Figure 5.5.2.a

### 5.5.3 Dry Weather Flow

A simulated stream flow record was generated (as described in **Section 5.5.2** above) at the downstream boundary of the mine. A flow-duration curve was then constructed for the simulated stream flow record. Based on the criterion that the dry weather flow is the flow in the stream that is equalled or exceeded 70% of the time, this flow was computed and corresponds to the flow during the winter months, shown for key points in **Table 5.5.3.a**.

**Table 5.5.3.a: Dry weather flows**

| River | Measured at | Dry weather flow ($m^3/s$) | Nature of stream flow |
|---|---|---|---|
| Olifants River | Entrance to mine property | 0.3 | Perennial |
| Steenkoolspruit | Immediately before confluence with Olifants River | 0.34 | Perennial |
| Olifants River | Exit from mine property | 0.71 | Perennial |

### 5.5.4 Flood Peaks and Volumes

The flood peaks for the 1:20, 1:50 and 1:100 year recurrence intervals were computed using the Rational Method (DWA implementation and Alternative implementation) and Unit Hydrograph techniques. Use was also made of the Regional Maximum Flood.

The volumes of the floods were based on the simplified hydrograph proposed by Kovacs, and the relationship between the Regional Maximum Flood and Mean Annual Runoff as derived from the measurement of various extreme flood events across South Africa documented in various Department of Water Affairs and Forestry (DWAF) publications.

**Table 5.5.4.a** lists these flood peaks and the Regional Maximum Flood together with the corresponding flood volumes on the Olifants River and Steenkoolspruit.

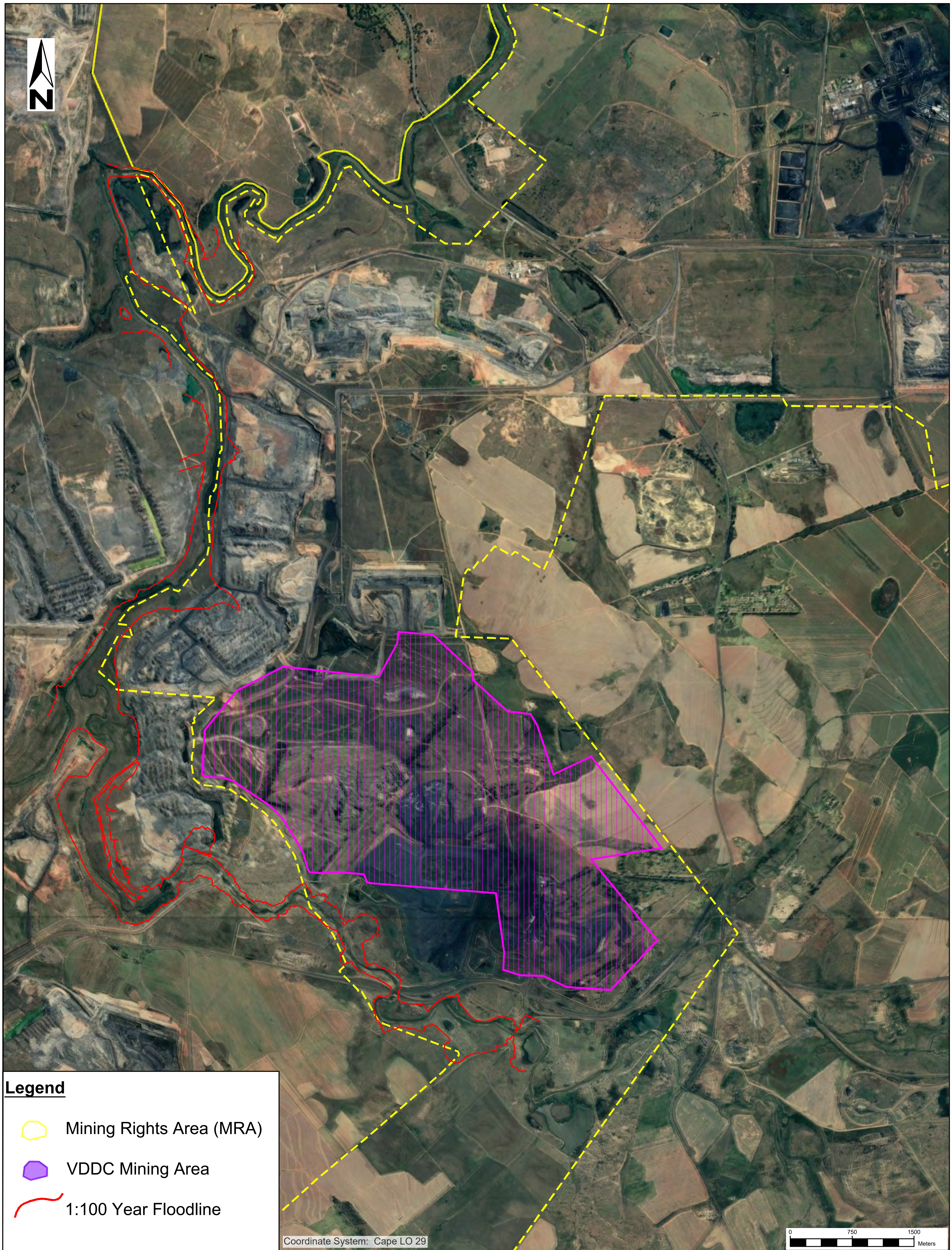
**Table 5.5.4.a: Computed flood peaks and volumes in the Olifants River, Steenkoolspruit and their tributaries affected by mining**

| River | Measured at | Recurrence Interval | Flood Peak ($m^3/s$) | Flood Volume ($x10^6m^3$) |
|---|---|---|---|---|
| Olifants River | Entrance to mine property | 20 year | 480 | 26 |
| | | 50 year | 760 | 41 |
| | | 100 year | 1150 | 58 |
| | | RMF | 350 | 196 |
| Olifants River | Immediately before confluence with Steenkoolspruit | 20 year | 490 | 27 |
| | | 50 year | 780 | 3 |
| | | 100 year | 1200 | 60 |
| | | RMF | 240 | 203 |

| River | Measured at | Recurrence Interval | Flood Peak ($m^3/s$) | Flood Volume ($x10^6m^3$) |
|---|---|---|---|---|
| Steenkoolspruit | Immediately before confluence with Olifants River | 20 year<br>50 year<br>100 year<br>RMF | 515<br>810<br>1250<br>2402 | 26<br>42<br>58<br>199 |
| Olifants River | Exit from mine property | 20 year<br>50 year<br>100 year<br>RMF | 823<br>1292<br>1837<br>3810 | 51<br>80<br>112<br>380 |

5.5.5 Floodlines

The 1:100 year recurrence interval pre-mining floodlines are shown on in **Figure 5.5.5.a,** taken from J&W 2004 report – "Surface Water Inputs to Douglas Pillar Project EMPR"- Report Number JW188/04/9347).

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1:100 Year Floodline

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**Figure 5.5.5.a**

## 5.6 Surface water quality

This section details sampling locations and water quality objectives, with respect to surface water and provides an assessment of the surface water quality and the impact of mining on the surrounding watercourses and catchments.

Wolvekrans Colliery is 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.

This section details sampling locations and water quality objectives, with respect to surface water and provides an assessment of the surface water quality and the impact of mining on the surrounding watercourses and catchments.

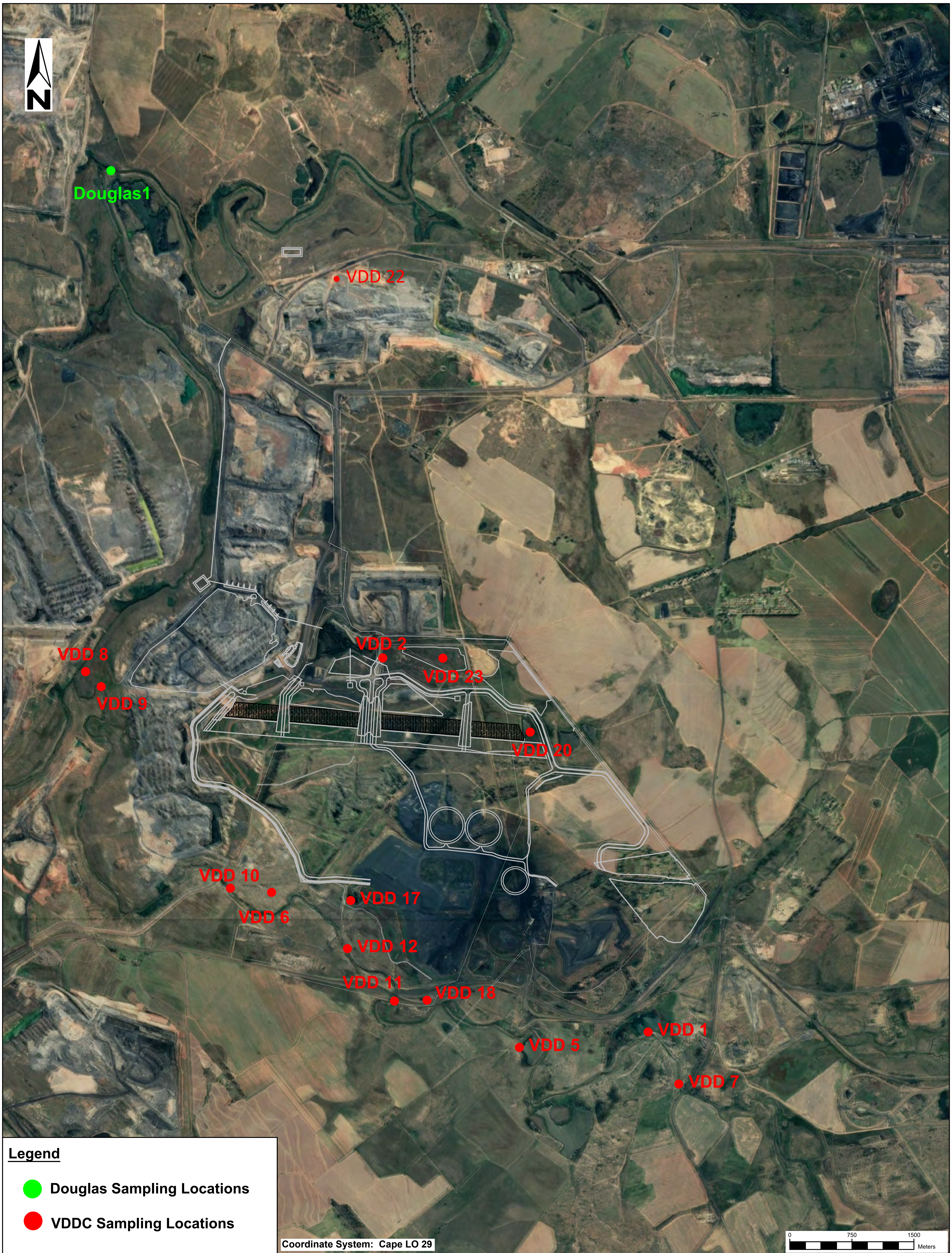
### 5.6.1 Surface water quality monitoring locations

The surface water monitoring locations are illustrated in

**Figure 5.6.1.a** and the coordinates of these points are given in **Table 5.6.1.a.**

**Table 5.6.1.a: List of surface water monitoring locations**

| Sampling Location | Description | Coordinates | |
|---|---|---|---|
| VDD 1 | 2538 V01 Springbokspruit @ entrance to mine property | S26°06.043' | E29°19.148' |
| VDD 2 | 2542 U/s of vlei shaft & V7 con. belt | S26°03.599' | E29°17.218' |
| VDD 5 | 2545 V09 Oxbow 9 ponded water | S26°06.146' | E29°18.214' |
| VDD 6 | 2551 V16 Olifants D/S of PSS discard dump | S26°05.135' | E29°16.416' |
| VDD 7 | V 22 Douglas Upstream Betal Bridge | S26°06.383' | E29°19.371' |
| VDD 8 | 2555 V30 Olifants D/S of confluence with Steenkoolspruit | S26°03.40.7 | E29°15.03.8' |
| VDD 9 | 2556 V31 Olifants U/S Steenkoolspruit confluence D/S pit | S26°03.791' | E29°15.177' |
| VDD 10 | 2557 V32 Olifants D/S tributary near defunct pit U/S pit | S26°05.108' | E29°16.116' |
| VDD 11 | 2558 V40 Plant water u/g railway boreholes @ small bridge | S26°05.844' | E29°17.308' |
| VDD 12 | 2547 V11 Olifants @ DWAF Weir U/S PSS discard dump | S26°05.502" | E29°16.967' |
| VDD 18 | 2569 VW Olifants tributary from PSS dump pollution control dam | S26°05.838 | E29°17.544 |
| VDD 20 | 2603 Attenuation dam1 | S26°04.081' | E29°18.287' |
| VDD 21 | 2604 Outlet of the Southern Canal | S26°05.109' | E29°16.629' |
| VDD22 | 2606 Exit of the Northern canal | S26°01.119' | E29°16.877' |
| VDD 23 | Attenuation Berm 2 | S26°03.599' | E29°17.653' |
| Douglas 1 | Douglas 1-2571 W02 Olifants River at Wolwekrans Weir. | S26°00.413' | E29°15.240' |

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Vandyksdrift Central
SW Monitoring Locations

Job No G535-391

Figure 5.6.1.a

### 5.6.2 Surface water quality objectives

There are various standards and objectives in terms of surface water quality, depending on what the end use is to be. Some of these include the DWS South African Target Water Quality Guidelines (TWQG) for different uses (e.g. Aquatic Ecosystems and Agricultural use) that were published in 1996 and the SANS 241 Drinking Water Quality Standard (2015).

In some cases, however, there are more specific standards in terms of the catchment itself, as determined by the Catchment Management Agency. The DWS published in 2016 Classes and Resource Quality Objectives of water resources for the Olifants River catchment. One of the key elements of this document is Resource Quality Objectives (RQO) in the Olifants River catchment. In this document the catchment is divided into various Integrated Unit of Analysis (IUA) areas and Resource Units. Each IUA has a set of water quality constituents for which limits have been set. The proposed VDDC project is located within IUA 1, which is referred to as the Upper Olifants River catchment and within Resource Unit 11.

A summary of the different standards, guidelines and objectives is provided in **Table 5.6.2.a**.

For the purpose of this assessment, the 2016 RQO was used to describe the current status of the water resources in the catchment, since this is the most recent objectives set specifically for the catchment. Where no limits are provided for a specific constituent, the SANS 241 standards were used as a guideline to indicate the level of impact.

Although the TWQO were also considered, these were not used in the assessment of the current water quality status in the catchment. The guidelines provide target water quality objectives for the specific water use and is more stringent in most cases than the SANS 241 Drinking Water Quality Standard. The aquatic ecosystem is always present as a potential water user. In the case of VDDC, although some agriculture is practiced in the larger catchment area, the area immediately downstream of the VDDC section, is mining.

**Table 5.6.2.a: Standards, objectives and guidelines considered for the baseline assessment**

| Constituent | Unit | TWQG Agricultural Use: Irrigation (DWS, 1996) | TWQG Aquatic Ecosystems (DWS, 1996) | SANS 241: 2015 Drinking Water Standard | RQO for Olifants River IUA 1, Resource Unit 11 (2016) |
|---|---|---|---|---|---|
| **Physical** | | | | | |
| Electrical conductivity (EC) @ 25°C | mS/m | | | 170 | 111 |
| Chemical Oxygen Demand (COD) | mg/ℓ | | | | - |
| pH | - | 6.5-8.4 | Background +/-0.50 pH units | 5 to 9.7 | - |
| **Chemical, Inorganic** | | | | | |
| Alkalinity | mg $CaCO_3$/ℓ | | | | - |

| Constituent | Unit | TWQG Agricultural Use: Irrigation (DWS, 1996) | TWQG Aquatic Ecosystems (DWS, 1996) | SANS 241: 2015 Drinking Water Standard | RQO for Olifants River IUA 1, Resource Unit 11 (2016) |
|---|---|---|---|---|---|
| Boron (B) | mg/ℓ | ≤ 0.5 | | 2.4 | - |
| Calcium (Ca) | mg/ℓ | | | | - |
| Chloride (Cl) | mg/ℓ | ≤ 100 | | 300 | - |
| Fluoride (F) | mg/ℓ | ≤ 2 | ≤ 0.75 | 1.5 | - |
| Magnesium (Mg) | mg/ℓ | | | | - |
| Potassium (K) | mg/ℓ | | | | - |
| Sodium (Na) | mg/ℓ | ≤ 70 | | 200 | - |
| Sulphate ($SO_4$) | mg/ℓ | | | 500 | 500 |
| Total Dissolved Solids (TDS) | mg/ℓ | ≤ 40 | Background +/-10% | 1 200 | - |
| **Metals, Dissolved** | | | | | |
| Iron (Fe) | mg/ℓ | <= 5 | Background +/-10% | 2 | - |
| Aluminium (Al) | mg/ℓ | ≤ 5 | ≤ 0.005 for pH$<$6.5 and ≤ 0.01 for pH$>$6.5 | | - |
| Manganese (Mn) | mg/ℓ | ≤ 0.02 | ≤ 0.18 | 0.40 | - |
| Chromium VI (Cr VI) | mg/ℓ | ≤ 0.1 | ≤ 0.007 | | - |
| **Plant Nutrients** | | | | | |
| Nitrate ($NO_3$) | mg/ℓ as N | | | 11 | 4 |
| Ammonium ($NH_4$) | mg/ℓ as N | | ≤ 0.007 | 1.5 | 0.1 |
| Phosphate ($PO_4$) | mg/ℓ as P | | | | 0.125 |
| Nickel (Ni) | mg/ℓ | ≤ 0.2 | | 0.07 | - |
| Arsenic (As) | mg/ℓ | ≤ 0.1 | ≤ 0.01 | 0.010 | - |
| Antimony (Sb) | mg/ℓ | | | 0.020 | - |
| Barium (Ba) | mg/ℓ | | | 0.70 | - |
| Beryllium (Be) | mg/ℓ | ≤ 0.1 | | | - |
| Cadmium (Cd) | mg/ℓ | ≤ 0.01 | | 0.0030 | - |
| Total Chrome (Total Cr) | mg/ℓ | | | 0.050 | - |
| Cobalt (Co) | mg/ℓ | ≤ 0.05 | | 0.50 | - |
| Copper (Cu) | mg/ℓ | ≤ 0.2 | | 2.0 | - |
| Lead (Pb) | mg/ℓ | ≤ 0.2 | | 0.010 | - |
| Mercury (Hg) | mg/ℓ | | ≤ $4x10^{-5}$ | 0.006 | - |
| Molybdenum (Mo) | mg/ℓ | | | | - |
| Selenium (Se) | mg/ℓ | ≤ 0.02 | ≤ 0.002 | 0.010 | - |

| Constituent | Unit | TWQG Agricultural Use: Irrigation (DWS, 1996) | TWQG Aquatic Ecosystems (DWS, 1996) | SANS 241: 2015 Drinking Water Standard | RQO for Olifants River IUA 1, Resource Unit 11 (2016) |
|---|---|---|---|---|---|
| Tin (Sn) | mg/ℓ | | | | - |
| Vanadium (V) | mg/ℓ | ≤ 0.1 | | 0.20 | - |
| Zinc (Zn) | mg/ℓ | ≤ 1 | ≤ 0.002 | 5.0 | - |

### 5.6.3 Baseline water quality analysis

The summarised baseline water quality results, for the data provided by South32 for periods indicated in section 5.6 is shown in **Table 5.6.3.a**, where the average, maximum and minimum concentrations are presented, together with the coefficient of variation. It is important to note that the 2016 RQO do not provide limits for all constituents and therefore the SANS 241 guidelines were used in such cases. However, there are certain constituents for which no limitations are specified.

For **Table 5.6.3.a**, values in highlighted in red indicate where the RQO for the Olifants River catchments **or** the SANS 241 guidelines are exceeded.

**Table 5.6.3.a: Water quality monitoring results**

| 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 | | | |
| VDDC | 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 |
| | | 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 |

**Figure 5.6.3.a to Figure 5.6.3.b** indicate the average and maximum concentrations measured at each monitoring location, in terms of compliance with the RQO or SANS 241, for pH, sulphate ($SO_4$) and electrical conductivity (EC) respectively.

## 5.6.4 Baseline water quality interpretation

The values for various constituents measured around the proposed VDDC infrastructure and development area were compared to the RQO for the Olifants and SANS 241 guidelines; pH, $SO_4$, EC, Iron (Fe), Aluminium (Al) and Manganese (Mn) are discussed below:

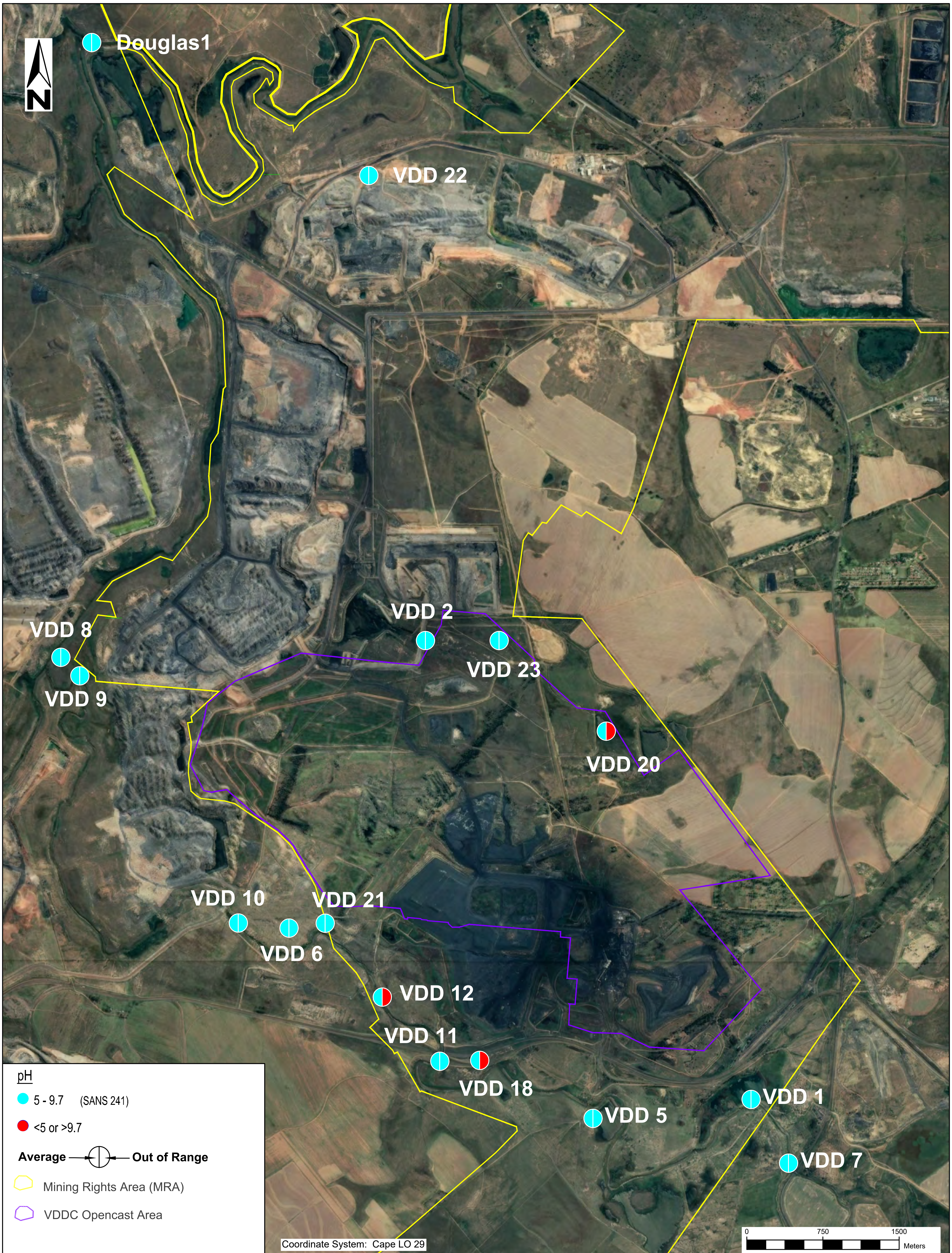
### *5.6.4.1. pH*

The pH of natural waters is a measurement of the acidity/alkalinity and is the result of complex acid-base equilibrium of various dissolved compounds. The pH of most raw water sources is within the range of 6.5 to 8.5 (DWAF, 1996). A decrease in the pH of water in a mining area will be an indication of acid mine drainage (AMD).

The results in **Table 5.6.3.a** indicate the following:

- On average, all of the monitoring points are within the required pH range of 5 to 9.7.
- 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 – 2569 VW Olifants tributary from PSS dump pollution control dam. 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 – 2603 Attenuation dam1 which may be due to agricultural activities.

pH levels are indicated in **Figure 5.6.4.a**

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South32 SA Coal Holdings (Pty) Ltd
VDDC Project
pH Levels

**Job No G535-391**

**Figure 5.6.4.a**

#### 5.6.4.2. *Sulphate ($SO_4$)*

The concentration of sulphates in natural surface water is typically low (~5mg/ℓ), although concentrations of several hundred mg/ℓ may occur where dissolution of sulphate minerals or discharge of sulphate-rich effluents takes place (DWAF, 1996). AMD decanting or seeping from mining areas can increase the sulphate in surface water significantly. Chemical fall-out during rain events in areas where coal burning takes place can also increase the sulphate content of surface water bodies.

Sulphate is a key indicator of water affected by coal mining. The results in **Table 5.6.3.a** indicate that for maximum recorded sulphate concentrations, all of the monitoring points exceed the required $SO_4$ concentration limit of 500mg/l with the exception of VDD8 - 2555 V30 Olifants D/S of confluence with Steenkoolspruit, VDD20 - 2603 Attenuation dam1, VDD18 2569 VW Olifants tributary from PSS dump pollution control dam and Douglas1- 2571 W02 Olifants River at Wolwekrans Weir.

On average, the majority of the monitoring points exceed the required $SO_4$ concentration limit, with the exception of VDD5 -2545 V09 Oxbow 9 ponded water, VDD9- 2556 V31 Olifants U/S Steenkoolspruit confluence D/S pit, VDD10- 2557 V32 Olifants D/S tributary near defunct pit U/S pit, VDD11-2558 V40 Plant water u/g railway boreholes @ small bridge, VDD12- 2547 V11 Olifants @ DWAF Weir U/S PSS discard dump and VDD 22-2606 Exit of the Northern canal Douglas 1.

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.

$SO_4$ concentrations are indicated in **Figure 5.6.4.b**.

#### 5.6.4.3. *Electrical Conductivity (EC)*

Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current, which is as a result of the presence of charged ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, potassium, calcium and magnesium (DWAF, 1996). It is therefore an indicator of the salinity, or total salt content, of water. Accumulation of salts can influence the potential to use the water downstream by water users.

The results in **Table 5.6.3.a** indicate that on average, elevated EC levels were noted at monitoring locations VDD1-2538 V01 Springbokspruit @ entrance to mine property,VDD2-2542 U/s of vlei shaft & V7 con. Belt, VDD6-2551 V16 Olifants D/S of PSS discard dump, VDD7- V 22 Douglas Upstream Betal Bridge, VDD21-2604 Outlet of the Southern Canal and VDD23- Attenuation Berm 2. Elevated EC for these locations may be attributed existing mining activities in the area.

EC levels are indicated in **Figure 5.6.4.b**. The monitoring data shows an impact on the water resources upstream of the VDDC mining area as a result of the land use activities.


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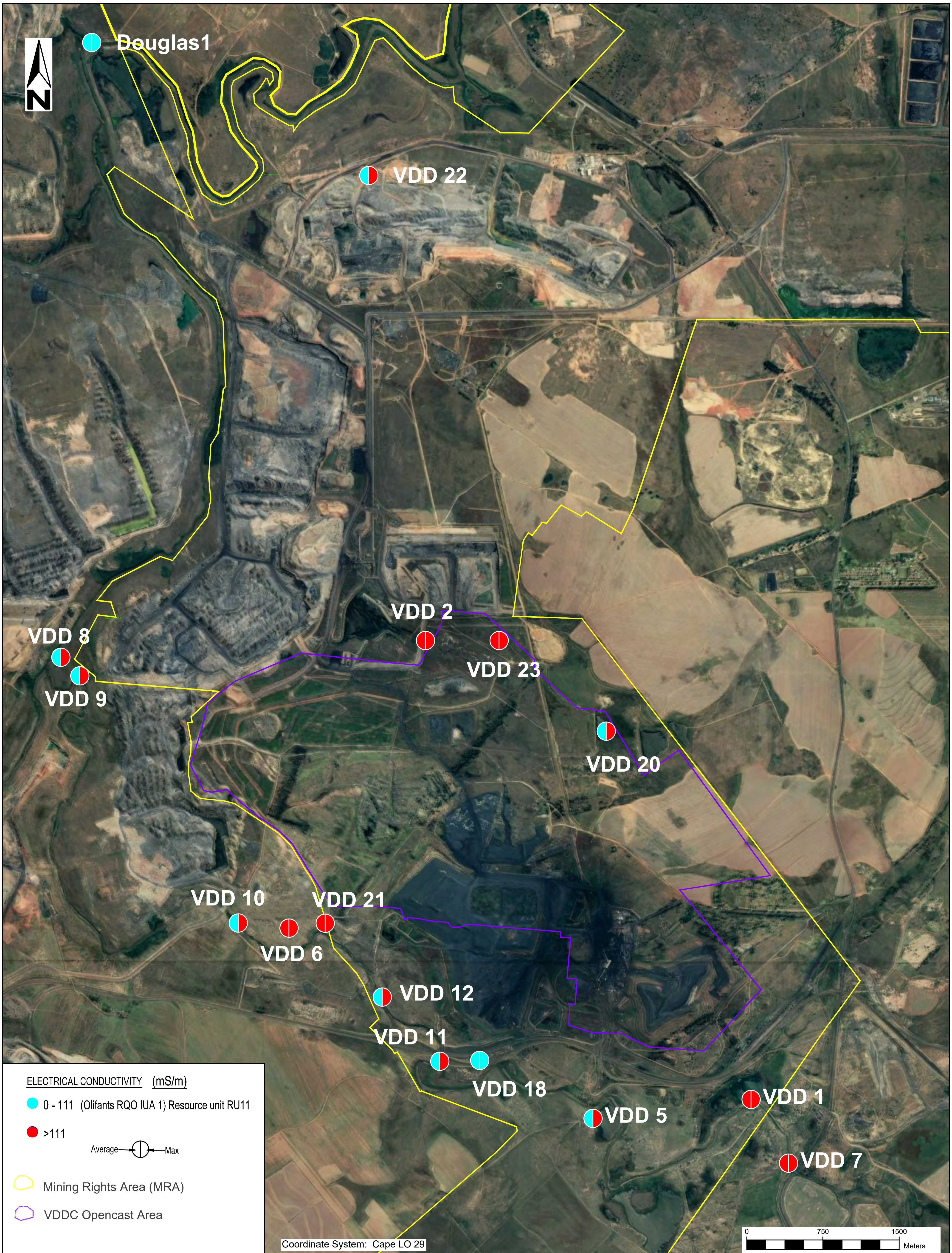
South32 SA Coal Holdings (Pty) Ltd
VDDC Project
**Sulphate Concentrations**

Job No G535-320

Figure 5.6.4.b

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South32 SA Coal Holdings (Pty) Ltd
VDDC Project
Electrical Conductivity Values

**Job No G535-391**

**Figure 5.6.4.c**

5.6.4.1. *Iron (Fe)*

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. The SANS 241 guidelines for iron is set as 2 mg/ℓ.

The results in **Table 5.6.3.a** 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- 2547 V11 Olifants @ DWAF Weir U/S PSS discard dump and VDD18 2569 VW Olifants tributary from PSS dump pollution control dam. Elevated iron concentrations may be due to mining and/or agricultural activities in the surrounding area.

5.6.4.2. Aluminium

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 Al and are not displayed in **Table 5.6.3.a**.

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 VDD 7-V 22 Douglas Upstream Bethal Bridge.

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.

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

5.6.4.3. *Manganese*

Manganese (Mn) is a relatively abundant element which constitutes 0.1% of the earth's crust. The median concentration in fresh water is 8 µg/ℓ, with a range of 0.02 to 130 µg/ℓ (DWAF, 1996).

The results are indicated in **Table 5.6.3.a**. On average, elevated manganese concentrations were noted at the following monitoring locations:

- VDD2 - 2542 U/s of vlei shaft & V7 con. Belt
- VDD6-2551 V16 Olifants D/S of PSS discard dump
- VDD7 – V22 Douglas Upstream Betal Bridge
- VDD18 - 2569 VW Olifants tributary from PSS dump pollution control dam

- VDD20 - 2603 Attenuation dam1
- VDD 22- 2606 Exit of the Northern canal Douglas 1
- VDD23- Attenuation Berm 2

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

#### *5.6.4.4. Other constituents*

Analysis of the other constituents in **Table 5.6.3.a** indicates the following:

- On average the TDS levels at the majority of monitoring points was highly elevated when compared to the SANS 241 guidelines, which can be attributed to mining in the area.
- On average the Na concentrations at majority of locations was within range when compared to the SANS241 guidelines, with the exception of VDD2 - 2542 U/s of vlei shaft & V7 con. belt, which can be attributed to mining in the area.
- The maximum recorded Nitrate ($NO_3$) concentrations were elevated at monitoring points VDD2-2542 U/s of vlei shaft & V7 con. belt, VDD7-V 22 Douglas Upstream Betal Bridge,VDD11-2558 V40 Plant water u/g railway boreholes @ small bridge and VDD18 2569 VW Olifants tributary from PSS dump pollution control dam, 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 VDD6-2551 V16 Olifants D/S of PSS discard dump, VDD8-2555 V30 Olifants D/S of confluence with Steenkoolspruit, VDD12-2547 V11 Olifants @ DWAF Weir U/S PSS discard dump, VDD20 - 2603 Attenuation dam1 and VDD23- Attenuation Berm 2 was 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, VDD20, VDD22 and VDD23. These are all within the mining area and therefore may be attributed to mining in the area.

Therefore, in terms of surface water quality within the study area there are visible impacts associated with mining activities both upstream and downstream of VDDC.

## 5.7 Biomonitoring

Biomonitoring is addressed in a separate specialist report .

## 5.8 Water authority

The water authority is the Department of Water and Sanitation, Mpumalanga Region.

## 5.9 Wetlands

The delineation of sensitive areas such as wetlands is addressed in a separate specialist report as part of this Scoping/EIA process.

## 5.10 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.

# 6. WATER BALANCE

The objective of the water balance modelling was to estimate the volumes of water that will be generated by the proposed activities, including effluent water and surface runoff from the dirty areas. This was assessed together with the water demands on the site to determine whether the site will operate with a water surplus or deficit and to determine the storage/treatment capacity required to ensure legal compliance, in terms of prevention of spills from the site. The water balance modelling is therefore a key input to the overall water management strategy for the site.

It is important to note that Golder Associates updated the overall water balance for Wolvekrans Colliery to include the VDDC infrastructure and mining project (including areas that are authorised but does not form part of this environmental application process) (please refer to Report : “Inclusion of VDDC water management into Wolvekrans site wide water management plan”, July 2019, Report number 19124625-327233-1). Input, in terms of the pit water make and surface runoff from the proposed infrastructure and mining areas were provided by J&W to Golder and Associates.

Therefore, the following section details the VDDC pit water balance (i.e. estimated pit water make over the LOM), as well as the estimated surface runoff, that can be expected from the proposed infrastructure areas. For the detailed overall water balance please refer to the Golder Associates water balance update.

## 6.1 Computational methodology

Daily rainfall data from the SAWS rainfall stations 0478292 Langsloot and 0478303 Secunda, together with monthly evaporation data estimated from the “Surface Water Resources of South Africa 2012”, also known as *WR2012*, were inputs to a hydrological model based on the Soil Conservation Services (SCS) method to determine runoff on a daily basis using antecedent conditions. The method (as adapted to South African conditions by Schmidt & Schulze) is believed to be highly suitable for the site, having been developed in catchments with areas of approximately 8 $km^2$, and smaller.

The underground water inflows were derived by the J&W geohydrological team, taking into account the upfront pre-mining dewatering required for the purposes of opencast mining.

Recharge and dewatering through fracturing of strata have been taken into account using the above information received from the J&W geohydrological team. These rates of inflow were then brought into the J&W surface model, where rainfall impacts and surface water make was subsequently assessed.

The surface runoff areas were measured from Block Plan (i.e. Rev1) layout drawings prepared by the design engineers (i.e. Worley). This data was entered into the pit water balance and runoff model.

The estimated VDDC pit water make and runoff volumes were subsequently calculated.

## 6.2 Assumptions, information used and limitations

### 6.2.1 Assumptions and information used

The overall schematic flow diagram showing the water make and surface runoff volumes, over the LOM for VDDC, is presented in **Figure 6.3.3.a** (which can be found in **Section 6.3.3** below). This figure indicates the average pit water make and surface runoff over the LOM.

The following activities have been included:

- Mining will commence in 2022 and end in 2043;
- Surface runoff from the following areas (as per the Block Plan received. Refer to **Table 6.2.a** for the relevant numbering on the Block Plan. Note that existing areas are not included in the table):
    - Existing hard park area, which drains to Vleishaft Dam;
    - New proposed hard park area, which drains to SKS void;
    - Topsoil dump within dirty area, which drains to Vleishaft Dam;
    - Overburden dump, which drains to old underground workings via boreholes;
    - Overburden dump at SKS pit, which drains to SKS void;
    - Existing ROM stockpile to the north, which drains to SKS void;
    - Existing ROM stockpile to the south, which drains to Vleishaft Dam;
    - Mixed ROM coal and slurry stockpiles, which drains to Vleishaft Dam;
    - Dirty water management area, to old underground workings via boreholes;
    - 4 and 5 seam coal stockpiles, which drains to the VDDC Pit.

The following key assumptions and information have been used:

- The mining areas used for the modelling are based on the LOM plans (File name: "*StripAdvancepitFloor.dwg"*) provided to J&W by South32;
- The surface runoff areas are based on the Block Plan provided by Worley (File name: C0082005AADAL0001001Rev1.dwg/pdf);
- As per email correspondence with South32 the following was confirmed and incorporated into the model:
    - A slope of 37° for all dumps/stockpiles were used to compute runoff from side slopes;
    - Pit ramps may vary in length from 500 m to 1000 m as the pit advances with an average of approximately 700 m over life of ramp, before being re-habilitated. Therefore, it was assumed that there will be 4 ramps, each 700 m long;
    - There will be a pre-mining dewatering of old underground workings;
    - Assumed that all water make will collect in the pit during mining of the pit, as well as the old underground recharge;
    - In terms of pre-strip, spoils and levelled spoils and rehab areas, the total disturbed length excluding the active face will be 522 m, sub-divided as follows:

| | Meters | | |
|---|---|---|---|
| Active face | 150<br>Pre-strip | 172<br>Spoils and levelled spoils | 200<br>Rehab |
| | 522 | | |

- For the potable water use, as per email correspondence with South32 on 11 June 2019, the potable water use at VDDC is as follows:
    - Existing water treatment plant (i.e. Middelburg Water Reclamation Plant (MWRP)) will supply 5 000 $m^3$/month for potable use;

- Of the 5 000 $m^3$/month, 2 682 $m^3$/month will be for domestic use, of which 70% will report to Sewage Treatment Plant and 30% will be consumed;
- The remaining 2 318 $m^3$/month will be used for vehicle washing, which will report to Pit 4A;

- Stochastically generated rainfall data (spanning 2019 to 2069) was supplied by Golder Associates.

A list of drawings from which information for the water balance was obtained is provided in **Table 6.2.b**.

**Table 6.2.a: Infrastructure areas for which runoff has been computed**

| Surface Area Description | No. as per Block Plan |
|---|---|
| New Proposed Hard Park Area | 12, 3, 4 |
| Topsoil Dump Within Dirty Area | 27A, B and C |
| Overburden Dump 1 | 51 |
| Overburden Dump At SKS Pit | 7 |
| Mixed ROM coal and slurry stockpiles | 39 |
| Dirty Water Management Area | 25 and 28 |
| 4 and 5 seam coal stockpile | 49 and 50 |

**Table 6.2.b List of Drawings received from Worley and South32**

| Drawing No. | File name/Details |
|---|---|
| StripAdvancepitFloor.dwg | Life of Mine |
| C0082005AADAL0001001Rev1.dwg | Block Plan |

### 6.2.2 Limitations

By their nature, models are theoretical estimates of natural phenomena that are too complex to be derived exactly. It is inevitable that there will be variations in the actual flows when compared to the predicted flows. This can only be addressed by the recalibration of modelled data with measured data, from which more reliable estimates of extreme and average water make and runoff volumes can be developed.

## 6.3 Pit water make and surface runoff volumes

### 6.3.1 Water make

The total mining water make is expected to be as follows:

- VDDC Opencast area:
  - Average water make over LOM = 4 760 $m^3$/day;
  - Peak summer water make = 12 950 $m^3$/day.
- The 2 seam underground workings:
  - Average pre-mining upfront dewatering required over two years prior to mining the VDDC opencast pit = 25 300 $m^3$/day;
  - Average recharge to the opencast pit as mining progresses = 2 100 $m^3$/day.

### 6.3.2 Surface runoff

As mentioned previously, surface runoff was required to be computed for the following areas:

- Existing hard park area;
- New proposed hard park area;
- Topsoil dump within dirty area;
- Topsoil dump to north and north east of VDDC;
- Overburden dump 1;
- Overburden dump at SKS pit;
- Existing ROM stockpile to the north;
- Existing ROM stockpile to the south;
- Mixed ROM coal and slurry stockpiles;
- Dirty water management area;
- 4 and 5 seam coal stockpiles.

#### *6.3.2.1. SCS runoff estimation*

Surface runoff volumes over the LOM can be seen in **Figure 6.3.3.a.**

The SCS runoff estimation typically requires historical daily rainfall data from a gauge in close proximity to the site. However, for this simulation, stochastically generated rainfall data was supplied by Golder Associates and subsequently utilised for the SCS runoff modelling.

The estimated SCS runoff depths computed for each surface runoff area (i.e. infrastructure area), was then multiplied by the delineated catchment area to determine the anticipated flow volume for each surface runoff area.

Computational parameters required for SCS runoff estimation include:

- Daily rainfall data – as received from Golder Associates;
- Evaporation data - taken directly from the WR90 report, with a Mean Annual Evaporation of 1 600 mm (Symons Pan);
- SCS curve number – a value of 75 has been used;
- Crop factor for evaporation.

#### *6.3.2.2. Daily rainfall data*

This data was provided by Golder Associates. Rainfall data was received in the form of a stochastically generated daily rainfall depth from 2019 till 2069 (i.e. beyond the extent of the modelling period).

#### *6.3.2.3. Evaporation data*

Monthly evaporation data was taken directly from the *WR90 report* for the Evaporation Zone into which the site falls. The Evaporation Zone is 4A. The Mean Annual Evaporation for this zone is 1600 mm. The average monthly evaporation depths are presented in **Table 1.3.2(a)** below.

**Table 6.3.2.a: Average monthly evaporation depths (from *WR90)***

| Month | Average evaporation (mm) |
|---|---|
| October | 176 |
| November | 147 |
| December | 145 |
| January | 111 |
| February | 94 |
| March | 76 |
| April | 83 |
| May | 110 |
| June | 143 |
| July | 172 |
| August | 163 |
| September | 179 |
| **Annual Total** | **1600** |

#### *6.3.2.4. SCS curve number*

The SCS runoff curve number is a catchment response index to rainfall. This curve number gives indicative conditions for the site based on soil and vegetation types and ensures the potential maximum retention of the soil is within reasonable limits for the anticipated conditions. The higher the curve number the higher the runoff response will be.

For this runoff estimation, the anticipated soil zones were determined from the South African Atlas of Agro-hydrology and Climatology (Reference: R.E Schulze, “South African Atlas of Agrohydology and Climatology,1997)_ and were translated into hydrological soil groupings based on data provided by Schmidt and Schulze (1987), and subsequently an applicable curve number for veld runoff (i.e. 75).

Runoff was either calculated based on a percentage of veld runoff or as a percentage of rainfall. The area and runoff factors for each surface infrastructure area documented below in **Table 6.3.2.b**

**Table 6.3.2.b: Surface areas and runoff**

| Surface Area | Area (ha) | Runoff as % of veld runoff | Runoff as % of rainfall |
|---|---|---|---|
| Existing Hard Park area | 4.10 | N/A | 90% |
| New Proposed Hard Park area | 5.30 | N/A | 90% |
| Topsoil dump within dirty area | 14.30 | 90% | N/A |
| Topsoil dump within dirty area | 47.20 | 90% | N/A |
| Overburden dump 1 | 21.10 | 90% | N/A |
| Overburden dump at SKS pit | 135.70 | 90% | N/A |
| Existing ROM stockpile to the north | 3.00 | 90% | N/A |
| Existing ROM stockpile to the south | 4.50 | 90% | N/A |
| Mixed ROM coal and slurry stockpiles | 25.90 | 90% | N/A |
| Dirty water management area | 54.00 | N/A | 90% |
| 4 and 5 seam coal stockpiles | 31.20 | 90% | N/A |

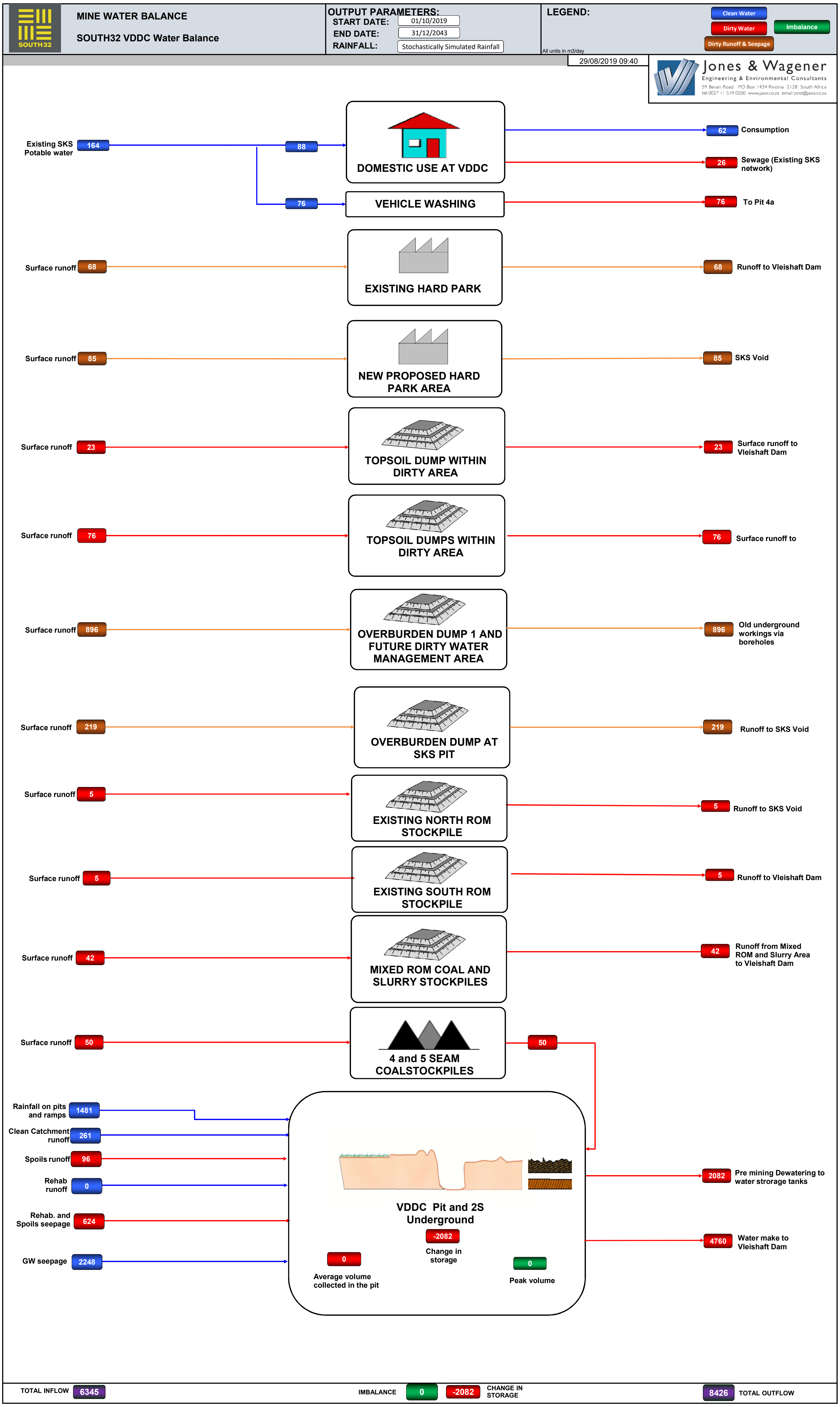
#### *6.3.2.5. Crop factors*

Crop factors were used in the model to modify evapotranspiration rates in order to vary antecedent moisture conditions for the soil. A higher evapotranspiration rate will translate to lower antecedent moisture conditions and therefore higher infiltration and lower runoff.

For this analysis crop factors were obtained from the WR90 report for Karoo and Karroid and used in the runoff estimation.

### 6.3.3 Schematic water balance diagram

The schematic water balance diagram is presented in **Figure 6.3.3.a** for the average water flows over the life of mine and over the operational period for the opencast workings (2022 to 2043).



MINE WATER BALANCE
SOUTH32 VDDC Water Balance
SOUTH32
OUTPUT PARAMETERS:
START DATE: 01/10/2019
END DATE: 31/12/2043
RAINFALL: Stochastically Simulated Rainfall
LEGEND:
Clean Water
Dirty Water
Imbalance
Dirty Runoff & Seepage
All units in m3/day
29/08/2019 09:40
Jones & Wagener
Engineering & Environmental Consultants
Existing SKS Potable water 164
88
76
DOMESTIC USE AT VDDC
VEHICLE WASHING
62 Consumption
26 Sewage (Existing SKS network)
76 To Pit 4a
Surface runoff 68
EXISTING HARD PARK
68 Runoff to Vleishaft Dam
Surface runoff 85
NEW PROPOSED HARD PARK AREA
85 SKS Void
Surface runoff 23
TOPSOIL DUMP WITHIN DIRTY AREA
23 Surface runoff to Vleishaft Dam
Surface runoff 76
TOPSOIL DUMPS WITHIN DIRTY AREA
76 Surface runoff to
Surface runoff 896
OVERBURDEN DUMP 1 AND FUTURE DIRTY WATER MANAGEMENT AREA
896 Old underground workings via boreholes
Surface runoff 219
OVERBURDEN DUMP AT SKS PIT
219 Runoff to SKS Void
Surface runoff 5
EXISTING NORTH ROM STOCKPILE
5 Runoff to SKS Void
Surface runoff 5
EXISTING SOUTH ROM STOCKPILE
5 Runoff to Vleishaft Dam
Surface runoff 42
MIXED ROM COAL AND SLURRY STOCKPILES
42 Runoff from Mixed ROM and Slurry Area to Vleishaft Dam
Surface runoff 50
4 and 5 SEAM COALSTOCKPILES
50
Rainfall on pits and ramps 1481
Clean Catchment runoff 261
Spoils runoff 96
Rehab runoff 0
Rehab. and Spoils seepage 624
GW seepage 2248
VDDC Pit and 2S Underground
-2082
Change in storage
0
Average volume collected in the pit
0
Peak volume
2082 Pre mining Dewatering to water strorage tanks
4760 Water make to Vleishaft Dam
TOTAL INFLOW 6345
IMBALANCE 0
-2082 CHANGE IN STORAGE
8426 TOTAL OUTFLOW

## 6.4 Conclusions

The old 2 Seam underground workings have filled with water. This area will need to be dewatered prior to mining the VDDC pit and is therefore a key to the success of the proposed project.

The current plan is to make extensive use of mechanical evaporators to manage the pit water make and dewatering water from VDDC. Timing and location of the mechanical evaporators are provided in Table 4.3.1.a. The VDDC pit water balance as well as the estimated surface runoff, that can be expected from the proposed infrastructure areas was computed by J&W as input to the overall site wide water balance compiled by Golder Associates.

The water management plan for VDDC impacts on the site wide water balance as some of the infrastructure and mine workings such as Vleishaft Dam and Steenkoolspruit are planned to be used to manage the VDDC mine water make.

The total water make to be managed for the pit is estimated as follows:

- VDDC Opencast area:
  - Average water make over LOM = 4 760 $m^3$/day;
  - Peak summer water make = 12 950 $m^3$/day.

As mentioned above, Golder Associates were appointed to update the site wide water management model for the Wolvekrans Colliery to include the mine plan and catchment areas from the VDDC feasibility study with the above input provided by J&W.

The following conclusions have been extracted from the Golder Associates report:

- The dewatering rates during 2020 and 2021 are estimated to be about 27 000 $m^3$/d. During this period the site wide water balance model showed that the planned installed evaporator capacity will be insufficient to manage the water. South32 should consider installing the 8 evaporators at SKS by November 2019.
- The extensive use of the evaporators will result in salt buildup in the water bodies over which the evaporators are spraying. Therefore, monitoring of salination of water due to brine evaporation will need to be undertaken and corrective action carried out if need be.
- Vleishaft Dam is expected to spill during the period 2020 to 2022 which is during the initial VDDC dewatering period. The spills will report to the SKS pit. During this initial dewatering period, Golder Associate's model estimates that the SKS pit will decant into the adjacent Glencore workings. Therefore, the evaporators at SKS pit should be installed earlier than the planned implementation date of May 2020. After 2029, the 18 000 $m^3$/d of evaporator capacity installed at SKS pit will draw down the water level in the pit.

# 7. CONSIDERATION OF ALTERNATIVES

Various alternatives were evaluated in terms of the overall water management, including the following issues:

## 7.1 Clean water management

In so far as is practically possible all clean catchment draining towards the dirty areas at VDDC will be diverted around the dirty areas, in order to minimise the generation of contaminated water, as well as maximise the clean runoff draining to the natural system, thereby minimising the impact on catchment yield.

## 7.2 Minimising the generation of dirty water make

All storm water generated on the site is considered dirty and will be contained in the opencast pit or old underground workings before being directed to the Vleishaft Dam and from there, to one of the evaporator sites, or to the proposed modular WTP or to Vlaklaagte void.

The mixing of clean and dirty water will be avoided, and the footprint of the dirty water areas have been minimised as far as is practically possible.

## 7.3 Maximising the reuse of dirty water

Dirty water will be collected and stored at Vleishaft Dam. Surplus water will be pumped from Vleishaft Dam, to one of the evaporator sites, or to the proposed modular WTP or to Vlaklaagte void.

## 7.4 Implementing treatment where required

Surplus water which cannot be handled through the evaporation system, will be conveyed to a mobile, modular WTP with a maximum treatment capacity of 20 Mℓ/day.

Brine from the WTP will be collected in existing tanks and before being conveyed to the evaporators at the SKS void.

Effluent from the WTP (i.e. treated mine water) will be conveyed via an existing mine water pipeline to the existing northern clean water canal, from where it will discharge via a wetland area into the Olifants River.

## 7.5 Alternatives in terms of process development

These are detailed in the main EMPr document.

# 8. ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATION MEASURES

In order to quantify the potential impacts, the general format of the assessment is to first assess the impact assuming no mitigation measures are applied. In some instances, these impacts could not result without extreme or unlawful practices, such as discharging all of the affected water from the mining facilities into the river system. However, this provides a basis for the "worst case" scenario, from which mitigation measures can be evaluated (such as containment or treatment for example). The residual impact after implementation of the mitigation measures is then assessed and indicated.

Cumulative impacts are also assessed as and where this is practical.

The format of the impact assessment is as follows:

- Section 8.1: The impact assessment methodology and rating system is described.
- Section 8.2: The nature of the various activities is described in terms of the phases of the project, from construction through to post closure.
- Section 8.3: The activities are assessed, detailing the potential impacts, proposed mitigation and residual impact over the full life cycle of the project.
- Section 8.4: The proposed mitigations are summarised to form a summarised water management plan.

A summarised water management plan is provided in Section 10.

## 8.1 Impact assessment methodology and rating system

The rating of impacts was undertaken according to the impact rating and assessment process outlined in **Appendix B**.

## 8.2 Activities to be undertaken at the Vandyksdrift Central (VDDC) area that could potentially affect surface water

There are five main phases within the proposed project, namely:

- Planning Phase.
- Construction Phase.
- Operational Phase.
- Decommissioning Phase.
- Closure Phase.

Each of these phases is outlined below.

### 8.2.1 Planning Phase

During the planning phase, the proposed project is conceptualised. This includes undertaking preliminary/ conceptual and detailed designs of the proposed infrastructure development and opencast mining, environmental screening, specialist environmental baseline investigations and the application for the required Integrated Environmental Authorisation and WUL.

### 8.2.2 Construction phase

Once the relevant authorisations have been received, construction activities will commence. This involves the establishment of the facilities and infrastructure as specified in Section 4 above.

Activities to be undertaken that may potentially impact on surface water include the following:

- General construction activities:
  - Civil works.
  - Movement of materials and equipment.
  - Servicing of construction vehicles and equipment.
- Construction of mine surface infrastructure
- Construction of the pit:
  - Earthworks, access roads and ramps.
  - Excavation and stockpile waste material.
  - Concrete and steel work.
- Construction of water management infrastructure:
  - Clean and dirty water canals.
  - Sediment traps.
  - Pump stations and pipelines.
- Construction of roads:
  - Access and internal roads.
- Construction of a WTP

Rehabilitation of any surrounding areas impacted by the construction of infrastructure components must occur immediately after the construction thereof except if there are plans to mine in these areas in the near future.

#### 8.2.3 Operational Phase

The infrastructure will be utilised during this phase when mining commences. Topsoil stripping will be conducted, and topsoil stockpiles will be placed separately for use during rehabilitation. Boxcut spoils dumps will be established, and overburden will be stripped and stockpiled following blasting. Coal will be extracted and transported to the No. 4 and No. 5 seam stockpiles or to the mixed ROM coal and slurry stockpile areas. Mine-affected water will be collected and managed as described above.

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 overburden will be levelled and the topsoil replaced and re-vegetated.

The operational phase ends when the last reserves have been extracted.

The activities that can impact on surface water include the following:

- Opencast mining operation.
- Alteration of flows in watercourse due to WTP treated effluent discharges.

- WTP operation.
- Transport of coal to the existing crushing and screening plant
- Loading and unloading of coal.
- Operation and maintenance of the water management system around the opencast operations.
- Cleaning, repair and maintenance activities along roads.
- Dust and fire suppression water management.
- Operation of the water management system, including sediment management and management of the water levels in the PCD and the pumping systems.
- Stockpiling of mine residues and ROM coal.

#### 8.2.4 Decommissioning Phase

This is the period directly after cessation of operational activities. It includes the removal of all operation-related equipment that has no beneficial re-use potential, as well as reclamation, rehabilitation and/or restoration of any final remaining areas (e.g. backfilling of final ramps and voids, landform shaping, topsoiling and seeding).

#### 8.2.5 Closure Phase

The point in time when all decommissioning and rehabilitation activities have ceased, monitoring has been completed and the mine applies for a closure certificate.

### 8.3 Surface water impact assessment and mitigation measures

The impacts are described in terms of the nature of the activity that could potentially impact on surface water, the nature of the impact if not mitigated, possible mitigation measures and the long-term impact.

Cumulative impacts are not addressed in the tables in **Section 8.3**, but are noted in **Section 8.4**.

#### 8.3.1 Construction Phase

##### *8.3.1.1. Impact on surface water quality*

The construction phase impacts on surface water quality are detailed in **Impact Tables C1** to **C3**

##### *8.3.1.2. Impact on surface water quantity – catchment yield and flow rates*

The construction phase impacts on surface water quantity are detailed in **Impact Table C4**.

#### 8.3.2 Operational Phase

##### *8.3.2.1. Impact on surface water quality*

The operational phase impacts on surface water quality are detailed in **Impact Tables O1** to **O4, O6** to **O9, O11**.

*8.3.2.2. Impact on surface water quantity – catchment yield*

The operational phase impacts on surface water quantity are detailed in **Impact Tables O5** and **O10** to **O11**.

### 8.3.3 Decommissioning and Closure Phases

*8.3.3.1. Impact on surface water quality*

The decommissioning and closure phase impacts on surface water quality are detailed in **Impact Tables D1, D2 and PC1**.

*8.3.3.2. Impact on surface water quantity – catchment yield*

During decommissioning and closure the affected areas will be rehabilitated to generate clean runoff and will be restored to free draining conditions. Until the water management infrastructure is decommissioned the impact on catchment yield will remain as per the Operational Phase.

### 8.3.4 Post Closure Residual Impacts

*8.3.4.1. Impact on surface water quality*

Post closure the site will be rehabilitated, grassed and made free draining. All of the contaminated materials will have been removed from the site.

The impact on water quality is detailed in **Impact Table PC1**

*8.3.4.2. Impact on surface water quantity – catchment yield*

Post closure all areas, including the shaft area, will be rehabilitated and made free draining. There will therefore be no long-term impact on catchment yield.

## 8.4 Cumulative impacts

The Wolvekrans Colliery and Ifalethu Colliery within the mining right area, form a large portion of surface disturbance in relation to the other activities in the area that could potentially impact on surface water. The VDDC area is small in relation to the existing Wolvekrans and Ifalethu Collieries mining area. However, it does add to the surface disturbance of Wolvekrans Colliery as a whole.

There are other existing coal mining operations in the region, Kleinkopje in the west, Black Wattle Colliery to the north, as well as Mavela Colliery and Muhanga Mine on the banks of the Spookspruit downstream of the Middelburg Water Reclamation Plant located at Ifalethu Colliery, but these are small in relation to Wolwekrans and Ifalethu Colliery and iMpunzi Complex..

In addition, there are numerous coal mines in the Olifants River catchment, both upstream and downstream of the mine, as well as surrounding agricultural activities, power stations and industrial areas that also potentially impact on the water quality and quantity in the catchment. Wolvekrans Colliery does form a large portion of this area.

The cumulative impact of the VDDC mining operation extension, with the mitigation measures described in the impact assessment, is considered to be medium to high in relation to the current and anticipated future activities in the area, as the catchment is already impacted by mining activities. The cumulative impact of all of the coal mines in the area has resulted in deterioration of water quality and quantity in the region. Every new mine contributes to the further reduction and / or deterioration of the water resources in the Mpumalanga region and in particular the Olifants River catchment. It is essential that good water management be implemented at VDDC to limit further contributions to the existing impacts in the catchment.

## Impact C1 Construction Phase – General mine development – Impact on surface water quality

| PHASE | CONSTRUCTION PHASE |
|---|---|
| ACTIVITY | **General mine development** |
| | Construction laydown areas, construction works, movement of materials and construction equipment |
| ASPECT | Water Quality – discharge of contaminated water |
| IMPACT DEFINITION | Pollution of surface water resources |

**IMPACT DESCRIPTION AND EVALUATION**

During the construction phase topsoil will be stripped and civil works, in the form of earthworks and terracing will be undertaken as part of the preparation of the area for the mine and infrastructure development.

Impacts may arise from:

- Erosion of soils during rainfall events, with elevated suspended solids in the runoff water.
- Resultant elevated suspended solids in the watercourses, as well as sedimentation in the watercourses.
- Hydrocarbon spillages from fuel storage, servicing areas or construction equipment itself, with resultant elevated hydrocarbon concentrations in runoff water and watercourses.

The surrounding and downstream surface water resources, namely the Olifants River, are considered stressed water resources in terms of both the quantity of water in the system and the quality of the water. The Olifants River also forms part of the water supply for irrigation water further downstream (from the Witbank Dam). Any impact on the quantity or quality of water in the system has the potential to affect the quality and assurance of supply to the community and agriculture.

**IMPACT BEFORE MANAGEMENT**

| Significance | Extent | Duration | Probability | RATING | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| *Low* | *Local* | *Short-term* | *Very Likely* | ***LOW*** | *2* | *Probable* |
| *2* | *3* | *2* | *4* | ***1.87*** | | |

**MANAGEMENT MEASURES**

The following mitigation measures will be implemented:

- The footprint of disturbed areas will be minimised.
- “No-go” zones will be delineated for construction plant and personnel where they are in close proximity to the Olifants River.
- Diversion of clean upslope runoff away from the new proposed pit to be constructed first before establishment of box-cuts.
- The construction area will largely be within the existing dirty water management area of the mine. Stormwater will be managed in terms of the existing system..
- Surface water management infrastructure, such as storm water canals, sediment traps and sumps are to be constructed first at the south east overburden stockpiles and dirty water management infrastructure area to ensure that contaminated runoff and dirty water spills are contained.
- Servicing of construction vehicles will take place only in dedicated areas that are equipped with drip trays.
- 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.
- Erosion protection measures will be implemented at steep areas.
- A waste management plan will be developed 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, which will entail the use of portable chemical toilets.
- Existing water quality monitoring will continue downstream of the construction areas, before and during construction where practical, in order to detect any increase in suspended solids or turbidity.

<table>
<tr><td>PHASE</td><td colspan="6">CONSTRUCTION PHASE</td></tr>
<tr><td rowspan="2">ACTIVITY</td><td colspan="6">General mine development</td></tr>
<tr><td colspan="6">Construction laydown areas, construction works, movement of materials and construction equipment</td></tr>
<tr><td>ASPECT</td><td colspan="6">Water Quality – discharge of contaminated water</td></tr>
<tr><td>IMPACT DEFINITION</td><td colspan="6">Pollution of surface water resources</td></tr>
<tr><td colspan="7"><ul><li>If erosion is evident, or the water quality monitoring indicates an increase in suspended solids, water management around the construction areas will be reviewed.</li></ul></td></tr>
<tr><td colspan="7">IMPACT AFTER MANAGEMENT</td></tr>
<tr><td>Significance</td><td>Extent</td><td>Duration</td><td>Probability</td><td>RATING</td><td>Impact Class</td><td>Confidence</td></tr>
<tr><td>Very Low</td><td>Study Area</td><td>Short-term</td><td>Could happen</td><td>VERY LOW</td><td rowspan="2">1</td><td rowspan="2">Probable</td></tr>
<tr><td>1</td><td>2</td><td>2</td><td>3</td><td>1.0</td></tr>
<tr><td colspan="7"></td></tr>
</table>

## Impact C2 Construction Phase – Removal of material from the initial boxcuts – Impact on surface water quality

| PHASE | CONSTRUCTION PHASE |
|---|---|
| ACTIVITY | **Initial boxcut**<br>Removal of material from the boxcut |
| ASPECT | Water Quality – discharge of contaminated water |
| IMPACT DEFINITION | Pollution of surface water resources |

**IMPACT DESCRIPTION AND EVALUATION**

The construction phase is considered to end once carbonaceous material, in the form of the coal seam, is exposed within the boxcut. However, much of the overburden removed prior to the exposing of coal has the potential to contain some carbonaceous material.

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 one new overburden dump to be developed in the south-east of the project area and an extension of an existing overburden dump at the SKS pit.

All overburden dumps will be mined through with the exception of the south east overburden dump. The material from this dump will be removed and used in the concurrent rehabilitation of the opencast pit. The dump footprint will be rehabilitated.

Impacts may arise from:

- Erosion during rainfall events, resulting in increased turbidity and suspended solids in the runoff water, reporting to the local watercourses.
- Deposition of sediments in the local watercourses, impacting on the aquatic ecology.
- Overburden stockpiles will potentially contain carbonaceous material, with the potential to affect downstream watercourses by increasing sulphate and TDS concentrations.
- Increase in turbidity and suspended solids.

**IMPACT BEFORE MANAGEMENT**

| Significance | Extent | Duration | Probability | RATING | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| *Moderate* | *Local* | *Medium term* | *Very Likely* | ***MODERATE*** | *3* | *Definite* |
| *3* | *3* | *3* | *4* | ***2.4*** | | |

**MANAGEMENT MEASURES**

The following mitigation measures will be implemented:

- Runoff and seepage from the overburden dumps located in between the proposed ramps will be directed to Vleishaft Dam.
- Runoff and seepage from the overburden dumps located at the SKS pit will drain to the SKS void.
- Runoff and seepage from the overburden dumps in the south-east of the project area will be diverted via a canal and berm system to silt traps and a set of boreholes which will take all runoff 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 PCD (Veishaft dam).
- Existing monitoring of the water qualities will continue in the streams downstream of the boxcuts and overburden dumps will be undertaken, in order to identify the potential impacts on water quality.

**IMPACT AFTER MANAGEMENT**

| Significance | Extent | Duration | Probability | RATING | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| *Very Low* | *Local* | *Medium term* | *Unlikely* | ***VERY LOW*** | *2* | *Definite* |
| *1* | *3* | *3* | *2* | ***0.93*** | | |

| PHASE | CONSTRUCTION PHASE |
|---|---|
| ACTIVITY | **Initial boxcut** |
| | Removal of material from the boxcut |
| ASPECT | Water Quality – discharge of contaminated water |
| IMPACT DEFINITION | Pollution of surface water resources |
| | |

**Impact C3 Construction Phase – Dewatering of water ingress to boxcut – Impact on surface water quality**

| PHASE | CONSTRUCTION PHASE | | | | | |
|---|---|---|---|---|---|---|
| ACTIVITY | **Initial boxcut** | | | | | |
| | Dewatering of water ingress to boxcut | | | | | |
| ASPECT | Water Quality – discharge of contaminated water | | | | | |
| IMPACT DEFINITION | Pollution of surface water resources | | | | | |
| **IMPACT DESCRIPTION AND EVALUATION** | | | | | | |
| In order to mine the VDDC reserve, the water contained in the old underground workings must be removed prior to mining. This will be achieved by drilling a number of boreholes into the old underground workings and to abstract the water via these boreholes.<br>Water will be pumped from the boreholes accessing different underground compartments and will be transferred via borehole connector pipelines to the Vleishaft Dam and/or directly to the evaporation tanks that will be located at the evaporation sites where water will be evaporated using mechanical evaporators. This has been authorised.<br>Water that enters the boxcut, both from groundwater seepage from the headwalls of the pit, recharge from the old underground workings and direct rainfall, is expected to be largely clean. However, there is a possibility that this water will make contact with carbonaceous and pyritic materials. The water quality from the boxcut is therefore likely to be slightly to moderately impacted in terms of sulphate, TDS and suspended solids.<br>Impacts may arise from:<br>• Deposition of sediments in the local watercourses, impacting on the aquatic ecology.<br>• Discharge of the potentially impacted water to the environment, with a resultant increase in sulphate and TDS concentrations in the natural watercourses. | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Moderate* | *Local* | *Medium term* | *Very Likely* | ***MODERATE*** | *3* | *Definite* |
| *3* | *3* | *3* | *4* | ***2.4*** | | |
| **MANAGEMENT MEASURES** | | | | | | |
| The following mitigation measures will be implemented:<br>• The water will be contained at the site, at in-pit sumps and pumped from here to either Vleishaft Dam for reuse in the existing mining operations or pumped to existing mechanical evaporators for disposal.<br>• Surface water management measures, such as clean upslope diversion canals and berms to divert clean catchment away from mine workings, will be implemented.<br>• A Water Use Licence for the dewatering of groundwater encountered during mining has been issued. | | | | | | |
| **IMPACT AFTER MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Low* | *Local* | *Short term* | *Unlikely* | ***VERY LOW*** | *2* | *Definite* |
| *2* | *3* | *2* | *2* | ***0.93*** | | |

**Impact C4 Construction Phase – mine surface infrastructure, and boxcut area – Impact on surface water quantity**

| PHASE | CONSTRUCTION PHASE | | | | | |
|---|---|---|---|---|---|---|
| ACTIVITY | **Mine surface infrastructure, and boxcut areas**<br>Construction Laydown areas, construction works, movement of materials and construction equipment, excavation of boxcut and incline shaft | | | | | |
| ASPECT | Water Quantity – containment of runoff from the site | | | | | |
| IMPACT DEFINITION | Reduction in catchment yield | | | | | |
| **IMPACT DESCRIPTION AND EVALUATION** | | | | | | |
| During construction, surface runoff will not ne released to the catchment., as all proposed activities are within the dirty footprint<br>All runoff and rainfall in the boxcut pits will be contained in the dirty water system and will therefore be lost to the catchment.<br>The loss in yield during the construction phase will be significantly lower than during the operational phase, which is quantified in **Table O5** below, and is therefore not quantified individually here, given that the construction of the boxcuts will take place while the rest of the mine is operational.<br>Impacts may arise from:<br>• Containment of contaminated runoff water emanating from the site, with no release to the catchment.<br>Although runoff from dirty areas will be contained (see management measures below) and the probability of impact is definite, its significance has still been assessed as LOW on the basis of the very small volumes of water that will be contained. | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Very Low* | *Study Area* | *Medium term* | *It's going to happen* | ***LOW*** | *1* | *Definite* |
| *1* | *2* | *3* | *5* | ***2*** | | |
| **MANAGEMENT MEASURES** | | | | | | |
| The following mitigation measures will be implemented:<br>• The aerial extent of the disturbed and potentially contaminated areas will be kept to a minimum.<br>• Areas where dirty construction activities are carried out (e.g. servicing areas and workshops, fuel storage areas, waste storage areas) will be minimised and surrounded by bunds.<br>• Upslope runoff will be diverted around construction activities to minimise the volume of dirty water generated and contained.<br>• Surplus dirty water will be sent to existing mechanical evaporators for disposal. | | | | | | |
| **IMPACT AFTER MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Very Low* | *Study Area* | *Short-term* | *It's going to happen* | ***LOW*** | *1* | *Definite* |
| *1* | *2* | *2* | *5* | ***1.67*** | | |

**Impact O1 Operational Phase – Mine water discharge – Impact on surface water quality**

| PHASE | OPERATIONAL PHASE |
|---|---|
| ACTIVITY | **Mine water discharge – pit water make** |
| | Discharge of mine water to the natural watercourses |
| ASPECT | Water Quality – discharge of contaminated water |
| IMPACT DEFINITION | Pollution of surface water resources |

**IMPACT DESCRIPTION AND EVALUATION**

It is important to note that the mine water balance assessment undertaken by Golder (reference "Inclusion of VDDC water management into Wolvekrans site wide water management plan" report 19124625-327233-1, July 2019) is aimed at ensuring that the mine does not spill water during the operational phase, except for extreme events related to rainfall, with a risk of recurrence of 2% or less in any one year. The water management measures detailed in Section 4 and the Golder July 2019 report are mitigation measures, focusing primarily on the storage, reuse and treatment of water.

However, to merely indicate that the mine will not spill dirty water does not allow an assessment of the potential impact of non-compliance with the mitigation measures proposed. In order to assess the impact without mitigation, this impact assessment assumes that all dirty water is discharged to the catchment, where after detail is provided on how this will be prevented, and the impact after management is then assessed.

Impacts may arise from:

- Clean runoff entering the mine affected areas and coming into contact with carbonaceous material, with resultant high salinity, particularly sulphate content.
- Dirty runoff and mine water make discharging to the environment.

The potential impact on aquatic life or downstream users of water within the rivers is highly dependent on the pH of the water discharged. This is because acidic conditions will result in mobilisation of metals, and this would be a major contributing factor to the potential toxicity of the water.

**IMPACT BEFORE MANAGEMENT**

| Significance | Extent | Duration | Probability | RATING | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| *High* | *Regional* | *Medium to Long term* | *Very Likely* | ***HIGH*** | **4** | Definite |
| *4* | *4* | *4* | *4* | ***3.2*** | | |

**MANAGEMENT MEASURES**

The mine water balance will be managed as detailed in Section 4 and the Golder July 2019 water balance report. These measures will include the following:

- Pumping of all dirty water generated at the VDDC workings and proposed infrastructure areas to Vleishaft Dam.
- Reuse of dirty water in the operations at VDDC.
- Treatment of excess dirty water (water pumped from Vleishaft Dam to the mobile water treatment plant or evaporators).
- Provision of water management facilities with a risk of spill that is lower than 2% in any one year as per the Golder water balance.
- A surface water quality monitoring programme will be implemented, as detailed in Section 11, to detect any impacts.
- A water balance monitoring programme will be implemented, as detailed in Section 11, to enable calibration of the water balance.

**IMPACT AFTER MANAGEMENT**

| Significance | Extent | Duration | Probability | RATING | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| *Moderate* | *Regional* | *Medium to Long term* | *Unlikely* | ***LOW*** | **3** | Probable |
| *3* | *4* | *3* | *2* | ***1.33*** | | |

**Impact O2 Operational Phase – Mine development area (infrastructure area) – Impact on surface water quality**

| PHASE | OPERATIONAL PHASE |
|---|---|
| ACTIVITY | **Mine development area** |
| | Opencast pit and related infrastructure |
| ASPECT | Water Quality – contaminated runoff |
| IMPACT DEFINITION | Pollution of surface water resources |

**IMPACT DESCRIPTION AND EVALUATION**

The required surface infrastructure at the pit will be constructed at the start of mining and will remain in place for the duration of mining.

The overburden material has the potential to generate poor quality runoff due to contact of the water with carbonaceous material.

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 and the existing overburden dump at the SKS pit will also be used.

The overburden material has the potential to contain carbonaceous material and therefore potential to generate poor quality runoff due to contact of the water with carbonaceous material.

Impacts associated with the opencast pit are as a result of runoff entering the pits and coming into contact with carbonaceous material.

Impacts may arise from:

- Contaminated storm water runoff, that discharges from the site, with resultant deterioration in water quality within the Olifants River, associated with increased suspended solids, hydrocarbons (oils and greases), siltation of carbonaceous materials, and an increase in salinity and potential decrease in pH in the watercourses.
- Contaminated seepage from the overburden dumps, with potentially elevated sulphate and TDS.
- Leakage of contaminated water from pipelines, poorly maintained storm water channels, sumps, sediment traps and oil skimmers, etc.
- Erosion at the clean canal discharge points could result in the formation of erosion gullies on surface, with elevated suspended solids in the runoff water, potentially impacting on the water quality in the watercourses in terms of suspended solids and deposition of silt.
- Increase in sulphate, turbidity, suspended solids and TDS due to runoff entering the pits and becoming contaminated.

**IMPACT BEFORE MANAGEMENT**

| Significance | Extent | Duration | Probability | RATING | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| Very High | Regional | Medium term | Very Likely | HIGH | 4 | Probable |
| *5* | *4* | *3* | *4* | ***3.2*** | | |

**MANAGEMENT MEASURES**

The following mitigation measures will be implemented:

- All proposed infrastructure areas with the potential to generate dirty storm water runoff, washdown water will be located within the designated dirty water areas.
- Clean runoff will be diverted around the designated dirty areas by means of cut-off canals, sized to accommodate at least the 1:50 year peak flow event.
- Adequate erosion protection will be provided at the clean canal discharge locations.
- With regard to general and hazardous wastes, For this project VDDC will follow what is currently done at Wolvekrans Colliery (please refer to Section 4.5).
- All pipeline routes will be inspected regularly to enable early detection of leaks.
- All contaminated storm water generated at the proposed activities will be collected and pumped to Vleishaft Dam.

| PHASE | OPERATIONAL PHASE | | | | | |
|---|---|---|---|---|---|---|
| ACTIVITY | **Mine development area** | | | | | |
| | Opencast pit and related infrastructure | | | | | |
| ASPECT | Water Quality – contaminated runoff | | | | | |
| IMPACT DEFINITION | Pollution of surface water resources | | | | | |

- Runoff from clean catchments draining towards the overburden dumps located in the south east of the project area will be diverted around the dumps.
- An inspection and maintenance plan will be implemented on the storm water system to ensure that all sediment handling facilities are maintained and that storm water canals and pipelines remain unblocked and free flowing – monthly inspections will 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.
- A surface water quality monitoring programme will be implemented to detect any impacts.
- All overburden dumps will be mined through with the exception of the south east overburden dump. The material from this dump will be removed and used in the concurrent rehabilitation of the opencast pit. The dump footprint will be rehabilitated.

**IMPACT AFTER MANAGEMENT**

| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| *Moderate* | *Regional* | *Medium term* | *Unlikely* | ***LOW*** | 2 | Probable |
| *3* | *4* | *3* | *2* | ***1.33*** | | |

**Impact O3 Operational Phase – Dust Suppression with contaminated water – Impact on surface water quality**

| | | | | | | |
|---|---|---|---|---|---|---|
| **PHASE** | **OPERATIONAL PHASE** | | | | | |
| **ACTIVITY** | **Dust Suppression**<br>Dust suppression on haul roads and stockpiles | | | | | |
| **ASPECT** | Water Quality – spillage of contaminated water and coal particulates | | | | | |
| **IMPACT DEFINITION** | Pollution of surface water resources | | | | | |
| **IMPACT DESCRIPTION AND EVALUATION** | | | | | | |
| Dust suppression will be provided on surface along haul roads and on stockpile areas. This water will become contaminated once it comes into contact with the dirty surface.<br>Impacts may arise from:<br>• Spillage of dust suppression water to the watercourses or associated watercourses, with resultant deterioration in water quality, in terms of elevated salinity, particularly sulphate.<br>• General dust suppression water contaminating the surface and washing off during rainfall events, with resultant deterioration in water quality, in terms of elevated salinity, particularly sulphate | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Moderate* | *Local* | *Medium term* | *Very Likely* | ***MODERATE*** | **3** | Probable |
| *3* | *3* | *3* | *4* | ***2.4*** | | |
| **MANAGEMENT MEASURES** | | | | | | |
| The following mitigation measures will be implemented:<br>• A formal procedure for dust suppression will be developed and implemented. This will ensure that dust suppression application rates are carefully controlled to prevent the application of excessive water and to prevent ponding and runoff of dust suppression water into the watercourses.<br>• No dust suppression should be carried out on surfaces that are already moist.<br>• Dust suppression with contaminated water should be confined to isolated dirty water management areas. | | | | | | |
| **IMPACT AFTER MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Low* | *Site* | *Medium term* | *Unlikely* | ***VERY LOW*** | **1** | Probable |
| *2* | *1* | *3* | *2* | ***0.8*** | | |

**Impact O4 Operational Phase – Transportation of Coal – Impact on surface water quality**

| | | | | | | |
|---|---|---|---|---|---|---|
| **PHASE** | **OPERATIONAL PHASE** | | | | | |
| **ACTIVITY** | **Transportation of coal** | | | | | |
| | Transport of coal via haul roads for processing | | | | | |
| **ASPECT** | Water Quality – spillage of contaminated water and coal particulates | | | | | |
| **IMPACT DEFINITION** | Pollution of surface water resources | | | | | |
| **IMPACT DESCRIPTION AND EVALUATION** | | | | | | |
| Transport of coal by road has the potential to impact on watercourses and general runoff quality, primarily due to spillage of coal from overloaded trucks, as well as contaminated water from the load boxes of the trucks on inclines.<br>Existing haul roads will be used to transport coal from the active VDDC pit to the coal processing area at the South Export Processing Plant. Potential impacts and mitigations are given below:<br>Impacts may arise from:<br>• Coal spillage, or spillage of water transported from the pit with the coal from the haul trucks onto the haul roads, with resultant contamination of storm water, particularly with elevated salinity and sulphate.<br>• Storm water runoff coming into contact with these emissions would suffer a deterioration in water quality, with increased salinity, particularly sulphate. | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Low* | *Local* | *Medium term* | *Could Happen* | ***LOW*** | 2 | Probable |
| *2* | *3* | *3* | *3* | ***1.6*** | | |
| **MANAGEMENT MEASURES** | | | | | | |
| The following mitigation measures will be implemented:<br>• The majority of haul roads and haulage of coal will take place within the dedicated dirty water area, with runoff draining either to the opencast pit or to Vleishaft Dam, where it will be contained.<br>• 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.<br>• 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.<br>• Loading of trucks will be carefully controlled to ensure that overloading will not take place. | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Very Low* | *Local* | *Medium term* | *Unlikely* | ***VERY LOW*** | 1 | Probable |
| *1* | *3* | *3* | *2* | ***0.93*** | | |

**Impact O5** **Operational Phase – VDDC mining operation – Impact on surface water quantity**

| | |
|---|---|
| **PHASE** | **OPERATIONAL PHASE** |
| **ACTIVITY** | **VDDC mining operation** |
| | Isolation of dirty catchment |
| **ASPECT** | Water Quantity – containment of runoff from the site |
| **IMPACT DEFINITION** | Reduction in catchment yield |

**IMPACT DESCRIPTION AND EVALUATION**

The loss in yield associated with mining at the VDDC operation will be primarily due to the pit areas and associated infrastructure, which will be isolated from the catchment due to the containment of dirty runoff. Although it is planned to undertake concurrent rehabilitation, so that the dirty water make, as well as the loss of yield to the catchment will be minimised, the assessment below assumes the worst case, being no concurrent rehabilitation, so that the opencast pit, as well as all overburden dumps would be isolated from the clean catchment.

Loss in yield is assessed for Witbank Dam in the area.

The loss of yield is quantified in the following table:

| 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* |

* Note: The runoff calculations are not accurate to three decimal places. However, the values remain indicative of the magnitude of the impact.

It is evident from the table above that the impact in surface water yield to the most downstream watercourse and Witbank Dam is LOW.

**IMPACT ON WATERCOURSES**

**LOCAL SCALE: Immediately downstream of site and at Witbank Dam**

**Impact before management**

| Significance | Extent | Duration | Probability | RATING | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| *Moderate* | *Regional* | *Medium term* | *Unlikely* | ***LOW*** | 2 | Probable |
| *3* | *4* | *3* | *2* | ***1.33*** | | |

**Management measures**

The following mitigation measures will be implemented:

- Concurrent rehabilitation 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.
- The site layout has been designed to minimise the dirty footprint, and therefore to minimise the impact on the catchment yield. No further mitigation is considered necessary.

| PHASE | OPERATIONAL PHASE | | | | | |
|---|---|---|---|---|---|---|
| ACTIVITY | **VDDC mining operation** | | | | | |
| | Isolation of dirty catchment | | | | | |
| ASPECT | Water Quantity – containment of runoff from the site | | | | | |
| IMPACT DEFINITION | Reduction in catchment yield | | | | | |
| **Impact after management** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Moderate* | *Regional* | *Medium term* | *Unlikely* | ***LOW*** | 2 | Probable |
| *3* | *4* | *3* | *2* | ***1.33*** | | |
| | | | | | | |
| **REGIONAL SCALE: Loskop Dam** | | | | | | |
| **Impact before management** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Low* | *Site* | *Medium term* | *Unlikely* | ***VERY LOW*** | **1** | Probable |
| *2* | *1* | *3* | *2* | ***0.8*** | | |
| **Impact after management** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Low* | *Site* | *Medium term* | *Unlikely* | ***VERY LOW*** | **1** | Probable |
| *2* | *1* | *3* | *2* | ***0.8*** | | |
| | | | | | | |

**Impact O6 Operational Phase – Operation of a mobile water treatment plant – Impact on surface water quality**

| PHASE | OPERATIONAL PHASE | | | | | |
|---|---|---|---|---|---|---|
| ACTIVITY | **Mobile water treatment plant**<br>Operation of the water treatment plant, treatment of contaminated mine water | | | | | |
| ASPECT | Water Quality – Runoff from WTP | | | | | |
| IMPACT DEFINITION | Pollution of surface water resources | | | | | |
| **IMPACT DESCRIPTION AND EVALUATION** | | | | | | |
| Mine impacted water will be pumped to the Vleishaft Dam and thereafter, to one of the evaporator sites, or to the proposed modular WTP or to Vlaklaagte void.<br>Surplus water which cannot be handled through the evaporation system, will be conveyed to a mobile, modular WTP with a maximum treatment capacity of 20 Mℓ/day. Brine from the WTP will be collected in existing tanks and before being conveyed to the evaporators at the SKS void.<br>Effluent from the WTP (i.e. treated mine water) will be conveyed via an existing mine water 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 for the Olifants River catchment as published in GN 466 in April 2016.<br>Impacts may arise from:<br>• Spillage of chemical additives, which could result in deterioration of water quality in the watercourses.<br>• Spillage of the water treatment waste products, in the form of brine to the receiving environment.<br>• Discharge of water that does not meet the discharge standards, or untreated water during upset conditions at the WTP. | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| High | Regional | Long term | Very Likely | ***HIGH*** | 4 | Probable |
| *4* | *4* | *4* | *4* | ***3.2*** | | |
| **MANAGEMENT MEASURES** | | | | | | |
| The following mitigation measures will be implemented:<br>• The WTP will be isolated within a designated dirty water area and containerised. All spills from the treatment plant will be collected in a sump, from where water will be directed to the Vleishaft Dam or SKS Pit.<br>• All chemicals and additives will be stored in dedicated bunded areas, where any spills will be contained.<br>• An inspection and maintenance plan will be implemented to ensure that the water treatment plant always operates within specification.<br>• Discharge water quality will be continuously monitored for early detection of discharge water quality problems.<br>• Should upset conditions occur, or poor discharge water quality be detected, the WTP discharge will be directed to the Vleishaft Dam or SKS Pit. | | | | | | |
| **IMPACT AFTER MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| Low | Study Area | Long term | Unlikely | **LOW** | 2 | Probable |
| *2* | *2* | *4* | *2* | ***1.06*** | | |
| **CUMULATIVE IMPACT** | | | | | | |
| Cumulative impacts not assessed here, see Section 8.5. | | | | | | |

## Impact O7 Operational Phase – Handling and storage of waste from water treatment plant – Impact on surface water quality

| | | | | | | |
|---|---|---|---|---|---|---|
| **PHASE** | **OPERATIONAL PHASE** | | | | | |
| **ACTIVITY** | **Water treatment plant** | | | | | |
| | Handling and storage of waste from the WTP | | | | | |
| **ASPECT** | Water Quality – discharge of contaminated water due to contact with waste products | | | | | |
| **IMPACT DEFINITION** | Pollution of surface water resources | | | | | |
| **IMPACT DESCRIPTION AND EVALUATION** | | | | | | |
| The proposed water treatment plant will generate a liquid waste (brine). Brine from the WTP will be collected in existing tanks and before being conveyed to the evaporators at the SKS void.<br>Impacts may arise from:<br>• Spillage of brine onto the ground surface.<br>• Inadequate lining systems, or leakage from the liners at the tanks into which the Brine will be pumped. | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| High | Regional | Long term | Very Likely | ***HIGH*** | 4 | Probable |
| *4* | *4* | *4* | *4* | ***3.2*** | | |
| **MANAGEMENT MEASURES** | | | | | | |
| The following mitigation measures will be implemented:<br>• The existing closed tanks are located within the designated dirty water area. All spills will be will be pumped to the Vleishaft Dam.<br>• An inspection and maintenance plan will be implemented to ensure that the tanks always operate within specification. | | | | | | |
| **IMPACT AFTER MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| Low | Study Area | Long term | Unlikely | **LOW** | 2 | Probable |
| *2* | *2* | *4* | *2* | ***1.06*** | | |
| **CUMULATIVE IMPACT** | | | | | | |
| Cumulative impacts not assessed here, see Section 8.5. | | | | | | |

**Impact O8 Operational Phase – Discharge of treated water from the water treatment plant – Impact on surface water quality**

<table>
<tr><td colspan="2">PHASE</td><td colspan="5">OPERATIONAL PHASE</td></tr>
<tr><td colspan="2" rowspan="2">ACTIVITY</td><td colspan="5">Water treatment plant</td></tr>
<tr><td colspan="5">Discharge of treated water to the Olifants River</td></tr>
<tr><td colspan="2">ASPECT</td><td colspan="5">Water Quality – discharge of treated water</td></tr>
<tr><td colspan="2">IMPACT DEFINITION</td><td colspan="5">Pollution of surface water resources</td></tr>
<tr><td colspan="7">IMPACT DESCRIPTION AND EVALUATION</td></tr>
<tr><td colspan="7">Effluent from the WTP (i.e. treated mine water) will be conveyed via an existing mine water 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 for the Olifants River catchment as published in GN 466 in April 2016.<br>The release of surplus treated water into the catchment will influence the water quality of the receiving resource and erosion may occur at the discharge point.<br>The baseline water quality shows that the Olifants River is already heavily impacted. The quality of water should therefore improve due to dilution effects.</td></tr>
<tr><td colspan="7">IMPACT BEFORE MANAGEMENT</td></tr>
<tr><td>Significance</td><td>Extent</td><td>Duration</td><td>Probability</td><td>RATING</td><td>Impact Class</td><td>Confidence</td></tr>
<tr><td>High</td><td>Regional</td><td>Long term</td><td>Very Likely</td><td>HIGH POSITIVE</td><td rowspan="2">4</td><td rowspan="2">Possible</td></tr>
<tr><td>4</td><td>4</td><td>4</td><td>4</td><td>3.2</td></tr>
<tr><td colspan="7">MANAGEMENT MEASURES</td></tr>
<tr><td colspan="7">The following mitigation measures will be implemented:<br>• Erosion protection measures at the discharge point<br>• The quality of the water discharged will be closely monitored to ensure that it complies with the specified RQO at all times.</td></tr>
<tr><td colspan="7">IMPACT AFTER MANAGEMENT</td></tr>
<tr><td>Significance</td><td>Extent</td><td>Duration</td><td>Probability</td><td>RATING</td><td>Impact Class</td><td>Confidence</td></tr>
<tr><td>High</td><td>Regional</td><td>Long term</td><td>Very Likely</td><td>HIGH POSITIVE</td><td rowspan="2">4</td><td rowspan="2">Possible</td></tr>
<tr><td>4</td><td>4</td><td>4</td><td>4</td><td>3.2</td></tr>
<tr><td colspan="7">CUMULATIVE IMPACT</td></tr>
<tr><td colspan="7">Cumulative impacts not assessed here, see Section 8.5.</td></tr>
</table>

**Impact O9 Operational Phase – Discharge of water through forced evaporation– Impact on surface water quality**

| PHASE | OPERATIONAL PHASE |
|---|---|
| ACTIVITY | **Mechanical Evaporators** |
| | Forced evaporation |
| ASPECT | Water Quality – discharge of water from the evaporators |
| IMPACT DEFINITION | Pollution of surface water resources |

**IMPACT DESCRIPTION AND EVALUATION**

| Number of Evaporators | Location | Time Period | Capacity ($m^3$/d) |
|---|---|---|---|
| 8 – 2000 $m^3$/d each | Vleishaft Dam | Currently operating | 4800 |
| 20 - 2000 $m^3$/d each | Vlaklaagte South | Currently operating | 12000 |
| 12 - 3000 $m^3$/d each | 5 Seam opencast | Installed in November 2019 | 10800 |
| 8 - 3000 $m^3$/d each | Steenkoolspruit pit | Installed in May 2020 | 7200 |
| 20 - 3000 $m^3$/d each | Steenkoolspruit pit | 12 evaporators moved from 5 Seam to SKS in 2023. 20 operating at SKS by June 2024 | 18000 |

The evaporator timing and location is provided in Table above:

Surplus water which cannot be handled through the evaporation system, will be conveyed to a mobile, modular WTP with a maximum treatment capacity of 20 Mℓ/day. Brine from the WTP will be collected in existing tanks and before being conveyed to the evaporators at the SKS void. The extensive use of the evaporators will result in salt buildup in the water bodies over which the evaporators are spraying.

The release of contaminated water into the catchment will influence the water quality of the receiving resource due to wind-blown contamination. The baseline water quality shows that the Olifants River is already heavily impacted.

**IMPACT BEFORE MANAGEMENT**

| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| *Moderate* | *Regional* | *Medium to Long term* | *Very Likely* | ***MODERATE*** | 3 | Possible |
| *3* | *4* | *4* | *4* | ***2.93*** | | |

**MANAGEMENT MEASURES**

The following mitigation measures will be implemented:

- Forced evaporation not to happen during high wind conditions. The average daily wind speed during summer months has been around 18 km/h which drops to around 14km/h in winter months. August and September tends to be windier. In recent years the maximum sustained wind speed has reached 65 km/h, that's the equivalent of around 40 mph, or 35 knots. (from http://www.myweather2.com/City-Town/South-Africa/Witbank/climate-profile.aspx).
- Ongoing surface water monitoring of surrounding watercourses.
- Where forced evaporation occurs over seeded areas, it is recommended that monitoring of soils by a soils specialist be undertaken. The need for this monitoring is to be assessed by the soils specialist.
- Forced evaporation to spray only over pits and not close to the South32 boundary or over clean areas.
- Forced evaporation not to take place in close proximity to watercourses. Where evaporators are in close proximity to watercourses (i.e. evaporators at SKS void) monitoring at these areas to take place more frequently due to proximity to the Olifants River.

<table>
<tr><td>PHASE</td><td colspan="6">OPERATIONAL PHASE</td></tr>
<tr><td rowspan="2">ACTIVITY</td><td colspan="6">Mechanical Evaporators</td></tr>
<tr><td colspan="6">Forced evaporation</td></tr>
<tr><td>ASPECT</td><td colspan="6">Water Quality – discharge of water from the evaporators</td></tr>
<tr><td>IMPACT DEFINITION</td><td colspan="6">Pollution of surface water resources</td></tr>
<tr><td colspan="7">• Need to monitor salination of water due to brine evaporation and corrective action taken if need be.</td></tr>
<tr><td colspan="7">IMPACT AFTER MANAGEMENT</td></tr>
<tr><td>Significance</td><td>Extent</td><td>Duration</td><td>Probability</td><td>RATING</td><td>Impact Class</td><td>Confidence</td></tr>
<tr><td>Low</td><td>Regional</td><td>Medium to Long term</td><td>Could Happen</td><td>LOW</td><td rowspan="2">2</td><td rowspan="2">Possible</td></tr>
<tr><td>2</td><td>4</td><td>3</td><td>3</td><td>1.80</td></tr>
<tr><td colspan="7">CUMULATIVE IMPACT</td></tr>
<tr><td colspan="7">Cumulative impacts not assessed here, see Section 8.5.</td></tr>
</table>

**Impact 010 Operational Phase – Discharge of treated water from the water treatment plant – Impact on surface water quantity**

<table>
<tr><td>PHASE</td><td colspan="6">OPERATIONAL PHASE</td></tr>
<tr><td rowspan="2">ACTIVITY</td><td colspan="6">Mobile Water Treatment Plant</td></tr>
<tr><td colspan="6">Discharge of treated water to the Olifants River</td></tr>
<tr><td>ASPECT</td><td colspan="6">Water Quantity – discharge of treated water</td></tr>
<tr><td>IMPACT DEFINITION</td><td colspan="6">Pollution of surface water resources</td></tr>
<tr><td colspan="7">IMPACT DESCRIPTION AND EVALUATION</td></tr>
<tr><td colspan="7">The discharge of treated water to the river system will result in a net increase in the flow of water in the Olifants River. While this has a net positive impact on the availability of water in the system as well as assist with the offset in yield loss due to mining as quantified in Table O5, it has the potential to negatively impact on the aquatic ecology by changing the seasonal flow patterns in the river system.<br>This net percentage increase in flow during summer and winter cannot be quantified due to limited information regarding discharge rates to the Olifants River. However, the potential impacts have been assessed below and should be are-assessed once discharge rates are available.<br>The potential impacts to the ecology of the river systems due to the discharge of treated water falls outside the scope of this surface water assessment and will be assessed as part of the aquatic ecology and wetland assessments.</td></tr>
<tr><td colspan="7">IMPACT BEFORE MANAGEMENT</td></tr>
<tr><td>Significance</td><td>Extent</td><td>Duration</td><td>Probability</td><td>RATING</td><td>Impact Class</td><td>Confidence</td></tr>
<tr><td>Moderate</td><td>Regional</td><td>Medium to Long term</td><td>Very Likely</td><td>MODERATE Positive</td><td rowspan="2">3</td><td rowspan="2">Possible</td></tr>
<tr><td>3</td><td>4</td><td>3</td><td>4</td><td>2.66</td></tr>
<tr><td colspan="7">MANAGEMENT MEASURES</td></tr>
<tr><td colspan="7">No mitigation as increase in yield is positive.</td></tr>
<tr><td colspan="7">IMPACT AFTER MANAGEMENT</td></tr>
<tr><td>Significance</td><td>Extent</td><td>Duration</td><td>Probability</td><td>RATING</td><td>Impact Class</td><td>Confidence</td></tr>
<tr><td>Moderate</td><td>Regional</td><td>Medium to Long term</td><td>Very Likely</td><td>MODERATE Positive</td><td rowspan="2">3</td><td rowspan="2">Possible</td></tr>
<tr><td>3</td><td>4</td><td>3</td><td>4</td><td>2.66</td></tr>
<tr><td colspan="7">CUMULATIVE IMPACT</td></tr>
<tr><td colspan="7">Cumulative impacts not assessed here, see Section 8.5.</td></tr>
</table>

### Impact O11 Operational Phase – Consequence of extreme floods – Impact on surface water quality and quantity

| | | | | | | |
|---|---|---|---|---|---|---|
| **PHASE** | **OPERATIONAL PHASE** | | | | | |
| **ACTIVITY** | **VDDC Infrastructure Development** | | | | | |
| | All activities | | | | | |
| **ASPECT** | Flooding of mine or mine infrastructure during extreme flood events | | | | | |
| **IMPACT DEFINITION** | Impact on mining operation | | | | | |
| **IMPACT DESCRIPTION AND EVALUATION** | | | | | | |
| GN R704 stipulates that no mine workings may be placed within the 1:50 year floodline and no mine residue deposits or dumps may be placed within the 1:100 year floodline, or a distance of 100 m from any watercourse, whichever is the greater. Should mine workings and infrastructure be placed within these designated areas and no mitigation measures are implemented, under extreme flooding conditions in the watercourses (Olifants River) the workings could be flooded, with consequent contamination of the flood waters, as well as loss of production or even life if the flooding in the pit is severe.<br>The proposed VDDC pit does not encroach on the 2004, 1:100 year floodline of the Olifants River. However, South32 is in the process of updating these floodlines as the available floodlines for the area are more than 5 years old. However, it is not anticipated that the VDDC pit will encroach on the updated floodline and therefore the impact below will still remain relevant.<br>In addition to the above, Attenuation Dam 1, which is an existing dam, is located directly upstream of the proposed VDDC boxcut area and poses a potential risk to mining in this area, as the stability of the dam wall is uncertain.<br>It was recognised by South32 that the dam wall needs to be inspected to determine the status and any work needed on the dam itself. There is also a farm dam, that is upstream of the Attenuation Dam 1 that needs to be taken into account in the above planning. | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Moderate* | *Regional* | *Medium term* | *Unlikely* | ***LOW*** | 2 | Probable |
| *3* | *4* | *3* | *2* | ***1.33*** | | |
| **MANAGEMENT MEASURES** | | | | | | |
| The following mitigation measures will be implemented:<br>• No mining within these restricted areas will take place without the relevant authorisations, in terms of GN R704 exemptions and Section 21(c) and (i) water use licenses (in terms of the NWA).<br>• Investigate into upgrading and stabilise the Attenuation Dam 1 dam wall, to reduce the potential risk to mining in this area before mining commences. | | | | | | |
| **IMPACT AFTER MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *Moderate* | *Local* | *Incidental* | *Unlikely* | ***VERY LOW*** | 1 | Probable |
| *3* | *3* | *1* | *2* | ***0.93*** | | |

**Impact D1 Decommissioning and Closure Phase – General decommissioning and rehabilitation – Impact on surface water quality**

| PHASE | DECOMMISSIONING AND CLOSURE PHASE |
|---|---|
| ACTIVITY | **General decommissioning and rehabilitation including water management infrastructure** |
| | Demolition camps, demolition works, movement of materials and construction equipment |
| ASPECT | Water Quality – discharge of contaminated water |
| IMPACT DEFINITION | Pollution of surface water resources |

**IMPACT DESCRIPTION AND EVALUATION**

Impacts resulting from general rehabilitation and decommissioning works will be similar to those during the construction phase, with earthworks related to rehabilitation and the movement of construction equipment on the site.

The water management berms and canals isolate active areas from the catchment by diverting upslope clean runoff around the active areas and containing runoff generated on the active areas. These can only be removed once the area has been rehabilitated, but may result in increased erosion if not properly planned.

Impacts may arise from:

- Erosion of soils during rainfall events, with elevated suspended solids in the runoff water.
- Resultant elevated suspended solids in the watercourses, as well as sedimentation in the watercourses.
- Hydrocarbon spillages from fuel storage, servicing areas or construction equipment itself, with resultant elevated hydrocarbon concentrations in runoff water and watercourses.

These impacts are expected to be relatively small, with the resultant impact post decommissioning being positive in comparison with the operational phase.

**IMPACT BEFORE MANAGEMENT**

| Significance | Extent | Duration | Probability | RATING | Impact Class | Confidence |
|---|---|---|---|---|---|---|
| *Low* | *Local* | *Short-term* | *Very Likely* | ***LOW*** | 2 | Definite |
| *2* | *3* | *2* | *4* | ***1.87*** | | |

**MANAGEMENT MEASURES**

The following mitigation measures will be implemented:

- The footprint of disturbed areas will be minimised.
- "No-go" zones will be delineated for construction plant and personnel particularly if these are located adjacent to the Olifants River on the western boundary of the site..
- The storm water management infrastructure will be decommissioned last, if at all, to ensure adequate storm water management during the rehabilitation phase.
- Servicing of construction vehicles will take place only in dedicated areas that are equipped with drip trays.
- Bunded containment and settlement facilities will be provided for hazardous materials, such as fuel and oil.
- Spill-sorb or a similar type 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.
- 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.
- If erosion is evident, or the water quality monitoring indicates an increase in suspended solids, water management around the decommissioning areas will be reviewed.

| PHASE | DECOMMISSIONING AND CLOSURE PHASE | | | | | |
|---|---|---|---|---|---|---|
| ACTIVITY | **General decommissioning and rehabilitation including water management infrastructure** | | | | | |
| | Demolition camps, demolition works, movement of materials and construction equipment | | | | | |
| **ASPECT** | Water Quality – discharge of contaminated water | | | | | |
| **IMPACT DEFINITION** | Pollution of surface water resources | | | | | |
| **IMPACT AFTER MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| Very Low | *Study Area* | *Short-term* | Unlikely | **VERY LOW** | 1 | Definite |
| *1* | *2* | *2* | *2* | ***0.67*** | | |
| | | | | | | |

**Impact D2 Decommissioning and Closure Phase – Mine water balance – Impact on surface water quality**

| PHASE | DECOMMISSIONING AND CLOSURE PHASE | | | | | |
|---|---|---|---|---|---|---|
| ACTIVITY | **Mine water balance** | | | | | |
| | Recovery of water levels and possible decant | | | | | |
| ASPECT | Water Quality – discharge of contaminated water (mine water decant) | | | | | |
| IMPACT DEFINITION | Pollution of surface water resources | | | | | |
| **IMPACT DESCRIPTION AND EVALUATION** | | | | | | |
| Once the pit has been backfilled and re-shaped, dewatering will cease and water levels will begin to recover in the workings.<br>Decant from this mine is expected to take place at the Olifants River tributary to the south-east of the site via subsurface discharge at approximately 1 530 mamsl and approximately 0.5 ℓ/s (please refer to the Groundwater study, JW190/18/G535-04, July 2019). According to Golder Associate's water balance SKS pit will decant into the adjacent Glencore workings.<br>The predicted time to decant for VDDC pit is within 5 years after mining.<br>The time to decant at VDDC pit will therefore take place after the decommissioning phase.<br>Note: Decant elevations and decant times are provisional, and will be confirmed as models are calibrated with actual inflows. | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| High | Regional | Long term | It's going to happen | **HIGH** | **4** | Definite |
| 4 | 4 | 4 | *5* | ***4.0*** | | |
| **MANAGEMENT MEASURES** | | | | | | |
| Mitigation measures will include the following:<br>• The pit will be backfilled without a final void, rehabilitated and made free-draining.<br>• 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.<br>• The water level in the workings will be actively managed to ensure it remains below the decant elevation.<br>• The post closure mine water make will be pumped from the mine workings to the Vleishaft Dam and thereafter, to one of the evaporator sites, or to the modular WTP or to Vlaklaagte void.<br>• The treated water will be discharged to the environment.<br>• A detailed decant management plan will be developed at mine closure which will involve passive treatment only. | | | | | | |
| **IMPACT AFTER MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| Low | Local | Short term | Very Likely | **LOW** | 2 | Definite |
| 2 | 3 | 2 | *4* | ***1.86*** | | |

**Impact PC1 Post Closure – Potential for acid mine drainage (AMD) and poor quality leachate – Impact on surface water quality**

| | | | | | | |
|---|---|---|---|---|---|---|
| **PHASE** | **POST CLOSURE PHASE** | | | | | |
| **ACTIVITY** | **Potential for decant of AMD** | | | | | |
| | Decant of mine water make | | | | | |
| **ASPECT** | Water Quality – discharge of contaminated water | | | | | |
| **IMPACT DEFINITION** | Pollution of surface water resources | | | | | |
| **IMPACT DESCRIPTION AND EVALUATION** | | | | | | |
| Post closure, the infrastructure areas will have been rehabilitated and made free draining. Similarly, the entire opencast will also have been rehabilitated and made free draining.<br>Two aspects have been considered here, namely the volume of decant that could be generated, and the potential quality of the decant.<br>If the water levels in the rehabilitated opencast are not controlled, the potential time to decant is estimated to be with 5 years after mining ceases.<br><br>If the decant is not managed (as detailed below), there could be an impact on both the downstream catchment.<br>The expected post closure mine water quality for key parameters, is as follows:<br>• The Sulphate levels are expected to be around 2000 - 3000 mg/l (please refer to the Groundwater study, JW190/18/G535-04, July 2019).<br>It is considered valuable to assess the potential sulphate loading of the mine on the catchment. This assessment is based on the assumption that the entire water make were to be discharged to the catchment.<br>The water balance indicates that an average water make in the order of 5 800 $m^3$/day can be expected. Based on a sulphate concentration of around 3000 mg/l, this equates to around 17.4 tons $SO_4$ per day, or around 6351 tons $SO_4$ per year.<br>The estimates given above are proposed to be refined over the life of mine as follows:<br>• On-going sampling and monitoring of parameters important to the final water quality and water volumes<br>• Quantification and verification of the groundwater model, the water balance model, and the geochemical model<br>• Evaluation and reassessment of alternative options for the final water use and required associated water quality, together with the technologies required to achieve the required quality. | | | | | | |
| **IMPACT BEFORE MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |
| *High* | *Regional* | *Long term* | *It's going to happen* | ***HIGH*** | 4 | Probable |
| 4 | 4 | 4 | *5* | ***4*** | | |
| **MANAGEMENT MEASURES** | | | | | | |
| Mitigation measures will include the following:<br>▪ The pit will be backfilled without a final void, rehabilitated and made free-draining in order to minimise the post closure water make.<br>▪ 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.<br>▪ The water level in the workings will be actively managed to ensure it remains below the decant elevation.<br>▪ The post closure mine water make will need to be pumped from the mine workings. A post closure water management plan will need to be developed.<br>▪ Discharge of clean water to the river system. | | | | | | |
| **IMPACT AFTER MANAGEMENT** | | | | | | |
| Significance | Extent | Duration | Probability | **RATING** | Impact Class | Confidence |

| | | | | | | |
|---|---|---|---|---|---|---|
| **PHASE** | **POST CLOSURE PHASE** | | | | | |
| **ACTIVITY** | **Potential for decant of AMD** | | | | | |
| | Decant of mine water make | | | | | |
| **ASPECT** | Water Quality – discharge of contaminated water | | | | | |
| **IMPACT DEFINITION** | Pollution of surface water resources | | | | | |
| *Low* | *Regional* | *Long term* | *Unlikely* | ***LOW*** | 2 | Probable |
| 4 | 4 | 4 | 2 | ***1.6*** | | |
| | | | | | | |

# 9. FINANCIAL PROVISION

For the operational phase, the water management costs are included in the infrastructure costs in most respects, including pollution control dams and the associated storm water canals, pumps and pipes.

At closure these facilities will be demolished and removed and the area will be rehabilitated. The cost related to this will be included in the overall closure costing.

Post closure the area will be rehabilitated and will not generate dirty runoff. The mine water make will need to be managed. The financial provision required for this will be dependent on the pumping / treatment strategy adopted. South32 water treatment technology post closure will be semi-passive and passive treatment.

The rise of water will be closely monitored (during operations and post closure) to ensure that the environmental safe level is not exceeded and that appropriate management measures, disposal (i.e. via mechanical evaporators) and treatment facilities are constructed in time to treat the surplus water once the environmental safe level is reached. The water will then be actively maintained at or below the environmental safe level.

A detailed decant management plan will be developed at mine closure. Ultimately water treatment solutions, either passive or active, will be implemented.

Monitoring of the water table rebound will continue post-decommissioning phase and the modelling updated to quantify the long-term impacts. If necessary, the management measures should be revised based on the modelling results.

# 10. SUMMARISED WATER MANAGEMENT PLAN

In **Section 8**, mitigation measures have been indicated to manage the impacts assessed. These measures need to be incorporated into an Integrated Water and Waste Management Plan (IWWMP) that can be used to implement, audit and measure the performance of the water management measures detailed in the EMPr.

This section is intended to only provide inputs on key aspects of the water management plan.

## 10.1 Construction Phase

### 10.1.1 Key issues and objectives

- To prevent the contamination of surface water runoff from the cleared construction site areas.
- To minimise erosion in the construction site areas and to minimise siltation in the adjacent watercourses.
- To prevent contamination of surface water runoff from the VDDC pit and infrastructure area of construction.
- To ensure that the required water management infrastructure is constructed timeously.

### 10.1.2 Key strategies

Areas where impacts in terms of construction activities could occur are listed below:

- Construction of water management infrastructure:
    - The upstream diversion of clean catchments and tying into existing clean water management measures should be constructed first in order to minimise the flow of water across the construction site.
    - The construction of the dirty water management measures at the proposed overburden dump to the south east of the project area.
- Construction of the laydown area.
- Construction of infrastructure.
- The mine infrastructure will be constructed after the water management infrastructure, most notably the clean water diversion and sumps at the VDDC pit area.
- Control of suspended solids. Should wet conditions occur during construction, suspended solids in the watercourses must be monitored and silt traps must be provided on construction areas, should suspended solids be detected.

### 10.1.3 Monitoring

Monitoring of water quality is undertaken under the mine's current water quality monitoring programme. An assessment of the current status of surface water quality has been included in the baseline surface water assessment. Monitoring will continue throughout the construction and operational phases. A monitoring programme for the proposed activities is detailed in **Section 11.**

## 10.2 Operational Phase

### 10.2.1 Key issues and objectives

- To minimise the impact of the proposed mining activity on the catchment yield.
- To identify and control surface runoff that may be affected by the planned activities.
- To ensure that the risk of spilling this water into the clean catchment is:
    - In line with licensing requirements.
    - In line with legislative requirements.
    - Commensurate with the risks to downstream users associated with any spillage. This is taken currently at a 2% or lower risk in any one year.
- To prevent clean runoff from upstream / upslope areas from spilling into the dirty water systems for flood events up to at least the 1:50 year recurrence interval.
- To ensure adequate monitoring so that the objectives of the water management system can be met.

### 10.2.2 Key strategies

The key management strategy is to keep clean water clean and to minimise the generation of dirty water. This is to be achieved by diverting runoff from clean catchments around the dirty areas and minimising the extent of dirty areas as far as is practicable. Clean and dirty water systems should be designed and managed to have a risk of spill of 2% or less in any one year (1:50 year recurrence interval event). The key strategies include:

Minimising loss of catchment yield:

- The loss in yield is dependent on the on-site management and planning activities, including the following:
- Placement of upstream diversion berms/ canals so that the maximum volume of upstream runoff can be diverted around the dirty areas, back to the receiving environment.
- Investigating and implementing water conservation and demand management, together with maximising recycling and reuse strategies on the site.
- Implementation of a water flow, pumping and dam water level monitoring programme to enable calibration of the water balance model and efficient management of the site water balance.
- Managing the generation of dirty water.
- The dirty water footprint will be minimised by diverting clean runoff around the dirty areas. Clean water cut-off canals, with capacity to accommodate at least the 1:50 year peak flow event, will be provided. Adequate erosion protection will be provided at the canal discharge points.
- Provision has been made to collect, evaporate and treat dirty water generated for discharge. The proponent has committed to having a 2% or lower risk of spilling in any one year.
- The risk of spilling is a function of adequate storage capacity, balanced against the reuse of water in the mining operations, as well as treatment at the mobile WTP.

- In line with best practice, the Vleishaft Dam will be operated as empty as possible at all times to ensure that sufficient storm water retention capacity is available at all times.
- Ongoing calibration of the water balance is required to ensure that the estimates in terms of water make-up, water shortages and storage requirements are evaluated during the life of the mine. Key strategies to address these issues involve:
  - Monitoring of water volumes pumped and stored.
  - Documentation of any problems in reusing dirty water, such as operational difficulties.
  - Ongoing rainfall monitoring.
  - Management of water pumped / draining into the Vleishaft Dam, including documentation of water volumes abstracted for use in the mine.
  - Adjustment for any changes in process or infrastructure layout, where these could affect the water balance.
  - Ongoing monitoring of water levels within Vleishaft Dam, as well as any spillages.
  - Ongoing monitoring of water volumes supplied from the voids, including recycled water.
- These points indicate that the water management will be a dynamic and ongoing process, aimed at ensuring compliance with legal requirements and good environmental practice over the life of mine.

#### 10.2.3 Monitoring

The objective of the surface water monitoring system is to ensure that the water management system performs in accordance with specifications, to act as an early warning system of contaminated surface water, to verify compliance with license requirements, and for reporting purposes. The objective of these systems will be achieved if there is an acceptable impact (attributable to the proposed opencast mining operations) on the receiving environment.

Monitoring requirements are detailed in **Section 11**.

### 10.3 Decommissioning

#### 10.3.1 Key issues and objectives

- To limit the risk of increased erosion on site and downstream, relating to areas being rehabilitated and consequently impacting on water quality.
- To ensure that the area is decommissioned and rehabilitated “from the inside out”, thereby preventing spillage of any dirty water or waste in the process.
- To remove all carbonaceous and mining related material on surface at the pits and infrastructure areas.
- To make the rehabilitated areas free draining.

#### 10.3.2 Key strategies

- Dismantling and removal of the entire mine's surface infrastructure, unless required to remain in place as a result of the post closure land use.
- Removal of all carbonaceous material and other contaminants / waste materials from the site.
- Pits backfilled to ground level by placing the overburden material back into the void. The backfilled pits will be shaped to ensure that they are made free draining, making allowance for future settlement of the backfill.
- Shaping and grassing of the pits and mine surface infrastructure area.
- Erosion protection: The general area is susceptible to erosion. During rehabilitation, the areas where grass has not yet been established will be monitored to ensure that there is not excessive erosion prior to the grass establishing, and where necessary additional erosion protection such as the use of dump rock (non-carbonaceous, from commercial sources) or repair of gullies will be undertaken until such time that the rehabilitated surfaces can be shown to be sustainable.

#### 10.3.3 Monitoring

Monitoring during decommissioning will be based on the operational phase monitoring, adapted to suit the final works to be implemented during this phase. However, in terms of surface water this will be primarily downstream of the area, as for the operational phase.

#### 10.3.4 Knowledge gaps

The final land use for the site has been determined as grazing. This may influence the rehabilitation strategy. The rehabilitation designs indicate that the pit will be backfilled to ground level by placing the overburden material back into the void. The backfilled pit will be shaped to ensure that they are made free draining, making allowance for future settlement of the backfill.

### 10.4 Post Closure

#### 10.4.1 Key issues and objectives

- To manage the post closure water make.
- To manage the rehabilitated area post closure.

#### 10.4.2 Key strategies

Water management to avoid decant:

- If left to fill with no intervention, it is expected that the water level within the new mine workings will recover over a period of approximately 5 years from the date mining ceases, depending on pit floor elevations, topography and adjacent geological material.
- Water levels in the workings will need to be kept below decant level to prevent decant to the natural watercourses.
- Wolvekrans Colliery is committed to responsible environmental management, which includes containment and treatment of decant water to ensure that there is

no downstream impact on water quality associated with future decant from the mine.

Management of rehabilitated area:

- The key strategy is to ensure that the rehabilitation in terms of shaped land form and vegetation cover is maintained in the long term to ensure long term sustainability of the rehabilitated area.

### 10.4.3 Monitoring

Monitoring post closure will be undertaken only where required to prove the sustainability of the site. In terms of surface water, this relates primarily to managing the surface topography (monitoring for erosion), and water quality downstream of the site.

### 10.4.4 Knowledge gaps

The water balance model and final water qualities are conceptual at this stage. These will need to be verified over the life of mine. The final land use for the site is not certain at this stage. The required post closure water management measures and monitoring may be influenced by the final land use.

# 11. MONITORING AND AUDITING

The objective of the surface water monitoring system is to ensure that the water management system performs in accordance with specifications, to act as a pollution early warning system, to check compliance with license requirements and for reporting purposes. The objectives of these systems will be achieved if there is no impact (attributable to the VDDC Infrastructure Development project) on the in-stream and downstream fitness for use criteria.

## 11.1 Water quality monitoring

### 11.1.1 Monitoring locations

In order to detect impacts attributable to an activity, water quality monitoring would usually be carried out upstream and downstream of the site.

The proposed monitoring locations for the VDDC Infrastructure and mining project are shown in **Figure 11.1.1.a**. The locations are described in **Table 11.1.1.a**. These locations are to be added to the existing monitoring programme, detailed in Section 6.

**Table 11.1.1.a: Details of proposed surface water quality monitoring locations**

| Monitoring location | Description | Co-ordinate | |
|---|---|---|---|
| P1 | WTP Discharge | S26 01 30.88 | E29 16 05.44 |
| P2 | At clean water canal at proposed South East overburden Dump | S26 04 54.72 | E29 18 54.69 |
| P3 | At dirty water canal at proposed South East overburden Dump | S26 00 04.36 | E29 17 33.15 |
| P4 | Upstream of Discharge of WTP and downstream of Evaporator site | S26 05 17.17 | E29 19 23.50 |

### 11.1.2 Water quality sampling and analysis

During the Construction and Operational Phases of the VDDC project, rivers and dams should be sampled on a monthly basis.

Monitoring during the Decommissioning Phase will be based on the Operational Phase monitoring, adapted to suit the final works to be implemented during this phase. However, in terms of surface water this will be primarily downstream of the area, as for the Operational Phase.

Monitoring during the Post Closure Phase will be undertaken only where required to prove the sustainability of the site. In terms of surface water, this relates primarily to managing the surface topography (monitoring for settlements), and water quality and levels within the mined out area.

Any infrastructure (PCDs) that will remain on site, post closure, will continue to be included in the surface water monitoring programme and should be monitored in terms of water quality and water levels on a monthly basis. The water quality parameters that are currently being monitored at VDDC project are indicated in **Table 11.1.2.a.**

**Table 11.1.2.a: Surface Water Quality monitoring parameters**

| Location | Constituent |
|---|---|
| Existing sampling points as detailed in Section 6 | pH Value at 25°C<br>Conductivity in mS/m<br>Total Dissolved Solids<br>Suspended Solids<br>Iron as Fe<br>Total Alkalinity as CaCO3<br>Calcium as Ca<br>Chloride as Cl<br>Magnesium as Mg<br>Nitrate & Nitrite as N<br>Ortho Phosphate $PO_4$ as P<br>Potassium as K<br>Sodium as Na<br>Sulphate as $SO_4$<br>Aluminium as Al<br>Fluoride as F<br>Manganese as Mn |

The recommended frequency of sampling and additional variables to those indicated in **Table 11.1.2.a** to be analysed are detailed in **Table 11.1.2.b.**

Samples will be grab samples, which will include:

- Filtered and unfiltered samples.
- Acid preservation of samples for metals analysis.
- All samples will be analysed by an accredited laboratory.

**Table 11.1.2.b: Proposed additional Surface water quality sampling and analysis**

| Location | Constituent | Frequency |
|---|---|---|
| All existing and proposed monitoring points | Zinc as Zn (total and dissolved)<br>Boron as B (total)<br>Antimony as Sb (total)<br>Molybdenum as Mo (total)<br>Lead as Pb (total)<br>Mercury as Hg (total)<br>Selenium (total)<br>Ammonia as N<br>Aluminum as Al (total and dissolved)<br>Iron as Fe (total and dissolved)<br>Manganese as Mn (total and dissolved) | Monthly |
| | Bacterial analysis<br>Total Coliforms and E coli | Every six months |

## 11.2 Water quantity monitoring (water balance monitoring)

For efficient management of water on the site, a good understanding of the site water balance will be required. To achieve this, the following monitoring will be needed:

- Rainfall – to be measured daily on the site.
- Evaporation – this is not essential but would be useful for calibration of the water balance model.
- Dam water levels – to be measured monthly.
- Flows – including the following, to be measured monthly:
  - Mine water make pumped from the opencast workings.
  - Inflows to the Vleishaft Dam.
  - Water pumped from the Pollution Control Dam for reuse in the operations.
  - Water recycled at the Evaporators.
  - Volume treated in the WTP.
  - Volume of treated water discharged from the WTP.


| | | |
|---|---|---|
| Jones & Wagener<br>Engineering & Environmental Consultants | South32 SA Coal Holdings (Pty) Ltd<br>Vandyksdrift Central<br>Proposed SW Monitoring Locations | Job No: G535-391<br>Figure 11.1.1.a |

## 11.3 Data management and reporting

### 11.3.1 Monthly

The monthly report is an internal environmental data report which is used to keep records of changing water qualities at the site. The report will include:

- Sites that are sampled.
- Water qualities for the relevant constituents.
- Dam levels and flow rates on site.
- Highlight significant issues that require immediate corrective / preventative action.

### 11.3.2 Annually

The water quality annual report consists of all the active environmental components, and for the chapter on surface water, the following components should be included:

- Data audit
  - Verification of data.
  - Compliance interpretation using RQO and SANS 241 Drinking Water Standard and management unit objectives.
  - Setting of new objectives or recommendation of corrective measures.
  - Comparison of historical and present chemistry assessment
  - Assessment of historical and present pollution sources.
  - Dam level status report.

## 11.4 Performance assessment/ audit

Annual audits should be carried out to determine the effectiveness of the water management systems that are in place. These should include a combined GN R704 audit as well as an Integrated Water and waste management Plan (IWWMP).

## 12. EMERGENCY AND REMEDIATION PROCEDURE

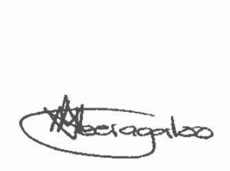
This section is detailed in the main EIAR.

## 13. CONCLUSION

The following conclusions can be drawn from the surface water study:

- The baseline surface water quality assessment within the study area indicate potential impacts associated with mining activities both upstream and downstream of VDDC.
- The old 2 Seam underground workings have filled with water. This area will need to be dewatered prior to mining the VDDC pit and is therefore a key to the success of the proposed project.
- Mine impacted water will be pumped to the Vleishaft Dam and thereafter, to one of the evaporator sites, or to Vlaklaagte void, or to the proposed modular, mobile WTP. Timing and location of the mechanical evaporators are provided in Section 4.3.
- Surplus water which cannot be handled through the evaporation system, will be conveyed to a mobile, modular WTP with a maximum treatment capacity of 20 Mℓ/day. Brine from the WTP will be collected in existing tanks before being conveyed to the evaporators at the SKS void.
- Effluent from the WTP (i.e. treated mine water) will be conveyed via an existing mine water 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 for the Olifants River catchment as published in GN 466 in April 2016.
- The cumulative impact of the VDDC mining operation extension, with the mitigation measures described in the impact assessment, is considered to be medium to high in relation to the current and anticipated future activities in the area, as the catchment is already impacted by mining activities.
- Surface water impacts from the site can be effectively mitigated by applying best practice water management principles.
- The success of surface water impact management will be judged on the basis of successful prevention of spills from the site.
- The following conclusions were extracted from the site wide water balance modelling carried out by Golder Associates:
  - The dewatering rates during 2020 and 2021 are estimated to be about 27 000 $m^3$/d. During this period the site wide water balance model showed that the planned installed evaporator capacity will be insufficient to manage the water. South32 should consider installing the 8 evaporators at SKS by November 2019.
  - The extensive use of the evaporators will result in salt buildup in the water bodies over which the evaporators are spraying. Therefore, monitoring of salination of water due to brine evaporation will need to be undertaken and corrective action carried out if need be.

- o
- o Vleishaft Dam is expected to spill during the period 2020 to 2022 which is during the initial VDDC dewatering period. The spills will report to the SKS pit. During this initial dewatering period, Golder Associate's model estimates that the SKS pit will decant into the adjacent Glencore workings. Therefore, the evaporators at SKS pit should be installed earlier than the planned implementation date of May 2020. After 2029, the 18 000 $m^3$/d of evaporator capacity installed at SKS pit will draw down the water level in the pit.



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5 September 2018
*Document source: https://joneswagener.sharepoint.com/JonesWagenerProjects/G535VDDCIRP/Shared Documents/PRJ/REP/SurfaceWater/ImpactAssessment/Rev1/G535-00_REP-mvmpth_r1_VDDC_IA_20191004.docx*
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VANDYKSDRIF CENTRAL (VDDC) MINING: INFRASTRUCTURE DEVELOPMENT
SPECIALIST SURFACE WATER
STUDY

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# APPENDIX A

## CV OF SPECIALIST

# APPENDIX B

## RISK ASSESSMENT CRITERIA