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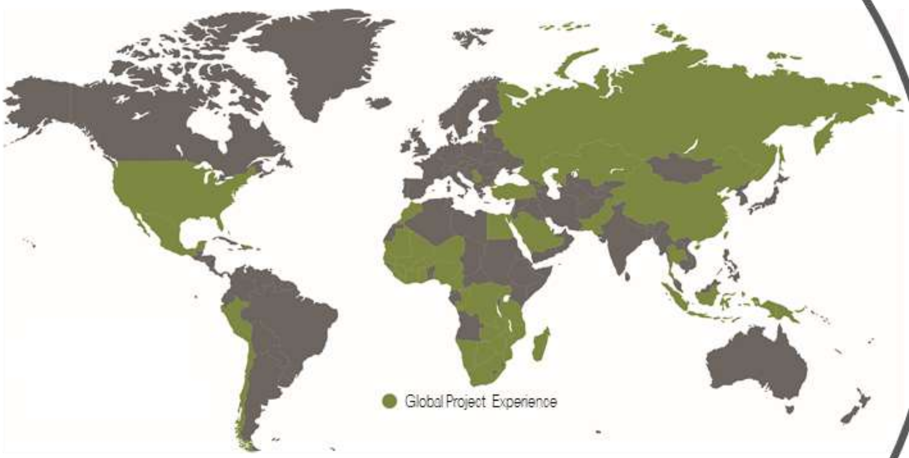

Providing innovative and sustainable solutions throughout the resources sector

Environmental Regulatory Process Comprising of an Amendment and Consolidation of the Environmental Management Programme (EMPr) and Integrated Water Use License (IWUL) associated with the Dorstfontein East Coal Mine

Surface Water Assessment

Prepared for:
Exxaro Central Coal (Pty) Ltd

Project Number:
EXX5725

September 2021

Digby Wells and Associates (South Africa) (Pty) Ltd
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Project Name:	Environmental Regulatory Process Comprising of an Amendment and Consolidation of the Environmental Management Programme (EMPr) and Integrated Water Use License (IWUL) associated with the Dorstfontein East Coal Mine
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Name	**Responsibility**	**Signature**	**Date**
Daniel Fundisi	Report writer		September 2021
Mashudu Rafundisani	Report reviewer		September 2021

EXECUTIVE SUMMARY

Exxaro Central Coal (Pty) Ltd (hereafter ECC) holds an approved Mining Right with reference number MP 30/5/1/2/3/2/1 (51) MR for opencast and underground mining at the Dorstfontein East Coal Mine (DECM) situated in the Mpumalanga Province. The current study aims to extend the existing approved underground mining area (approved under the ownership of Total Coal South Africa (Pty) Ltd) and introduce supporting infrastructure to achieve this. Exxaro Central Coal aims to extend the underground mining area of the 2 Seam and 4 Seam associated with the Mining Right. This report is a surface water assessment to identify potential impacts on water resources resulting from the proposed mining development.

The Mean Annual Precipitation (MAP) for the region was determined to be 676 mm. 90% of rainfall events during the wettest month of December will likely not exceed 182 mm. The Mean Annual Runoff (MAR) was determined to be 50.8 mm, which accounts for approximately 7% of the MAP. 90% of runoff events will likely not exceed 18.1 mm. The Mean Annual Evaporation (MAE) for the region was determined to be 1564 mm which is twice more than the MAP implying a negative water balance during the dry season.

Recent water quality analysis results upstream and downstream of the project site indicate that the concentration levels of most parameters including pH, Cl, SO_4 and Al at most of the sampled sites fall within acceptable DECM Water Use License (WUL) limits. Elevated Na is indicated at some of the sampled sites upstream and downstream of the DECM project area. The higher sodium concentrations possibly come from underlying weathered rock, grazing animals, fertilisers in nearby farms, sewage or from industrial effluent from residential communities upstream of the project site. Total Dissolved Solids (TDS) level downstream of the western boundary exceeds the WUL limit possibly resulting from activities of grazing animals in the area. Fluoride at site upstream of the DECM project site exceeds acceptable SAWQ guidelines for Aquatic Ecosystem but complies at all other monitoring sites.

The concentrations of Zinc and Aluminium exceed the acceptable South African Water Quality Guidelines (SAWQG) for Aquatic Ecosystems. High natural levels of zinc in river water are usually associated with higher concentrations of other metals such as lead and cadmium which are, however, below detection levels at this mine. Possible sources of elevated zinc can be coal mining activities in the area. Aluminium levels exceed the SAWQG for Aquatic Ecosystem but falls within the DECM WUL standard.

The proposed surface infrastructure which includes Sewage Treatment Plant (STP), Water Treatment Plant (WTP), Water Storage Tank and Discard Processing Plant will all be located within an area which already has existing storm water management infrastructure in place. No additional storm water infrastructure should be constructed.

The water balance indicates a water volume for dust suppression amounting to 344 032 m^3/annum and this water is obtained from Erickson Dams and the Mine Processing Plant. Most of this water is used during the dry season where high levels of dust emissions are expected since rainfall will be minimal or absent. The largest amount of water at DECM

circulates within the Erickson Dams 1, 2 & 3 with an approximate value of 1 352 260 m^3/annum. The Return Water Dam (RWD)/ Pollution Control Dam (PCD) and Mine Plant follow in water usage, having average volumes of 1 086 045 m^3/annum and 968 466 m^3/annum, respectively. Potable water which is used at the Mine Offices, Workshop and Change houses totals 62 057 m^3/annum. This water, originally from Erickson Dams 1, 2 & 3, is treated at the WTP before being pumped for use at the workshop, offices and change houses.

The Salt Balance shows that Erickson Dams and the Mine Processing Plant have higher concentrations of dissolved salts amounting to 230.38 kg/m^3/day and 171.87 kg/m^3/day, respectively. These facilities should closely be monitored in case of any spills or seepages into the environment for immediate detection, mitigation and/or management. The RWD/PCD is lined and total salts in circulation amount to 12.55 kg/m^3/day. Water levels in the RWD/PCD should also be monitored to prevent the occurrence of overflows.

Recommendations

The following is recommended to mitigate identified impacts:

- Site preparation for the construction of infrastructure should be confined to the existing development footprint area to minimise disturbance of soils and the probability of sedimentation and siltation of the nearby watercourses;
- Construction should be undertaken during the dry winter period to reduce sedimentation in nearby watercourses since there will be minimal to no occurrence of rainfall;
- The footprint of proposed infrastructure should be kept within the already disturbed area as proposed, where it is automatically integrated into the existing storm water management plan.
- All storage areas (fuels, paints, oils) used at the construction camp should be appropriately bunded and spill kits should be in place, and construction workers trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;
- Ensure that runoff from dirty areas is being directed to the existing storm water management infrastructure and should not be allowed to flow into the watercourses, unless DWS discharge authorisation has been granted upon compliance with relevant effluent discharge standards as stipulated in the National Water Act, 1998(Act No. 36 of 1998)(NWA);
- Water quality monitoring should continue downstream and upstream of the mine site, and within all surface water circuits at the mine to detect any contamination arising from operational activities;
- Servicing of vehicles and machinery should continue being conducted at designated, appropriately paved areas. All used oils should be disposed of by accredited vendors from the mine site;

- Disposal of general and other forms of waste should continue to be done into clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites;
- Disturbance of soils during infrastructure demolition should be restricted to relevant footprint areas;
- Movement of machinery and vehicles during infrastructure demolition should be restricted to designated access roads to minimise the extent of soil disturbance;
- Use of accredited contractors for removal or demolition of infrastructure during decommissioning is recommended; this will reduce the risk of waste generation and accidental spillages;
- Re-profiling and revegetation of disturbed landscapes post-closure should be conducted to facilitate free drainage as much as practically possible to support post-mining land use; and
- If decant occurs post-closure, a Reverse Osmosis Water Treatment Plant should be used to treat the AMD decant to DWS compliance levels before the treated water is released into the natural environment. Financial provision is made annually for a Reverse Osmosis Water Treatment Plant for use post-closure to treat AMD decant (Lorenz van de Heaver 2021, pers. comm).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Acronyms and Abbreviations

ALOS	Advanced Land Observing Satellite
AMD	Acid Mine Drainage
CMA	Catchment Management Agencies
DEM	Digital Elevation Model
DTM	Digital Terrain Model
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
BPG	Best Practice Guidelines
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
HEC-RAS	Hydrologic Environmental Centre River Analysis System
NWA	National Water Act
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MIPI	Midgley & Pitman
PCD	Pollution Control Dam
RM3	Rational Method Alternative 3
ROM	Run of Mine
SANAS	South African National Accreditation System
SAWG	South African Water Quality Guidelines
SDF	Standard Design Flood
STP	Sewage Treatment Plant
SQR	Sub-Quaternary Reaches
SWMP	Storm Water Management Plan
WHO	World Health Organisation
WMA	Water Management Area
WRC	Water Research Commission
WRD	Waste Rock Dump
WTP	Water Treatment Plant

1 Introduction

Exxaro Central Coal (Pty) Ltd (hereafter ECC) holds an approved Mining Right with reference number **MP 30/5/1/2/3/2/1 (51) MR** for opencast and underground mining at the Dorstfontein East Coal Mine (DECM) situated in the Mpumalanga Province. The current study aims to extend the existing approved underground mining area (approved under the ownership of Total Coal South Africa (Pty) Ltd) and introduce supporting infrastructure to achieve this. Exxaro Central Coal aims to extend the underground mining area of the 2 Seam and 4 Seam associated with the Mining Right. This report is a surface water assessment to identify potential impacts on water resources resulting from the proposed mining development.

The proposed study area is situated within the Emalahleni Local Municipality, in the Nkangala District Municipality in the province of Mpumalanga. The closest town is Kriel which is approximately 10 km from the proposed project area. The locality of the DECM project site within the Nkangala District Municipality is described in the table below and presented in (Figure 1.1).

<table>
<tr><td rowspan="14">Farm Name:</td><td>Farm Name</td><td>Farm Portion</td><td>Area (ha)</td></tr>
<tr><td>Bosch Krans 53 IS</td><td>12/53</td><td>311,83</td></tr>
<tr><td>Dorstfontein 71 IS</td><td>8/71</td><td>207,24</td></tr>
<tr><td>Dorstfontein 71 IS</td><td>2/71</td><td>664,68</td></tr>
<tr><td>Fentonia 54 IS</td><td>2/54</td><td>227,93</td></tr>
<tr><td>Fentonia 54 IS</td><td>3/54</td><td>331,16</td></tr>
<tr><td>Fentonia 54 IS</td><td>1/54</td><td>272,81</td></tr>
<tr><td>Rietkuil 57 IS</td><td>57</td><td>348,39</td></tr>
<tr><td>Welstand 55 IS</td><td>55</td><td>86,88</td></tr>
<tr><td>Welstand 55 IS</td><td>4/55</td><td>359,58</td></tr>
<tr><td>Welstand 55 IS</td><td>10/55</td><td>5,22</td></tr>
<tr><td>Welstand 55 IS</td><td>11/55</td><td>83,22</td></tr>
<tr><td>Welstand 55 IS</td><td>13/55</td><td>157,60</td></tr>
<tr><td>Welstand 55 IS</td><td>5/55</td><td>231,99</td></tr>
<tr><td>Application Area (Ha):</td><td colspan="3">3288,53 ha (surface area)</td></tr>
<tr><td>Magisterial District:</td><td colspan="3">Nkangala District Municipality</td></tr>
<tr><td>Distance and direction from nearest town:</td><td colspan="3">16 km north east of the town of Kriel.</td></tr>
</table>

21 digit Surveyor General Code for each farm portion:	T0IS00000000005300012 T0IS00000000007100008 T0IS00000000007100002 T0IS00000000005400002 T0IS00000000005400003 T0IS00000000005400001 T0IS00000000005700000 T0IS00000000005500000 T0IS00000000005500004 T0IS00000000005500010 T0IS00000000005500011 T0IS00000000005500013 T0IS00000000005500005

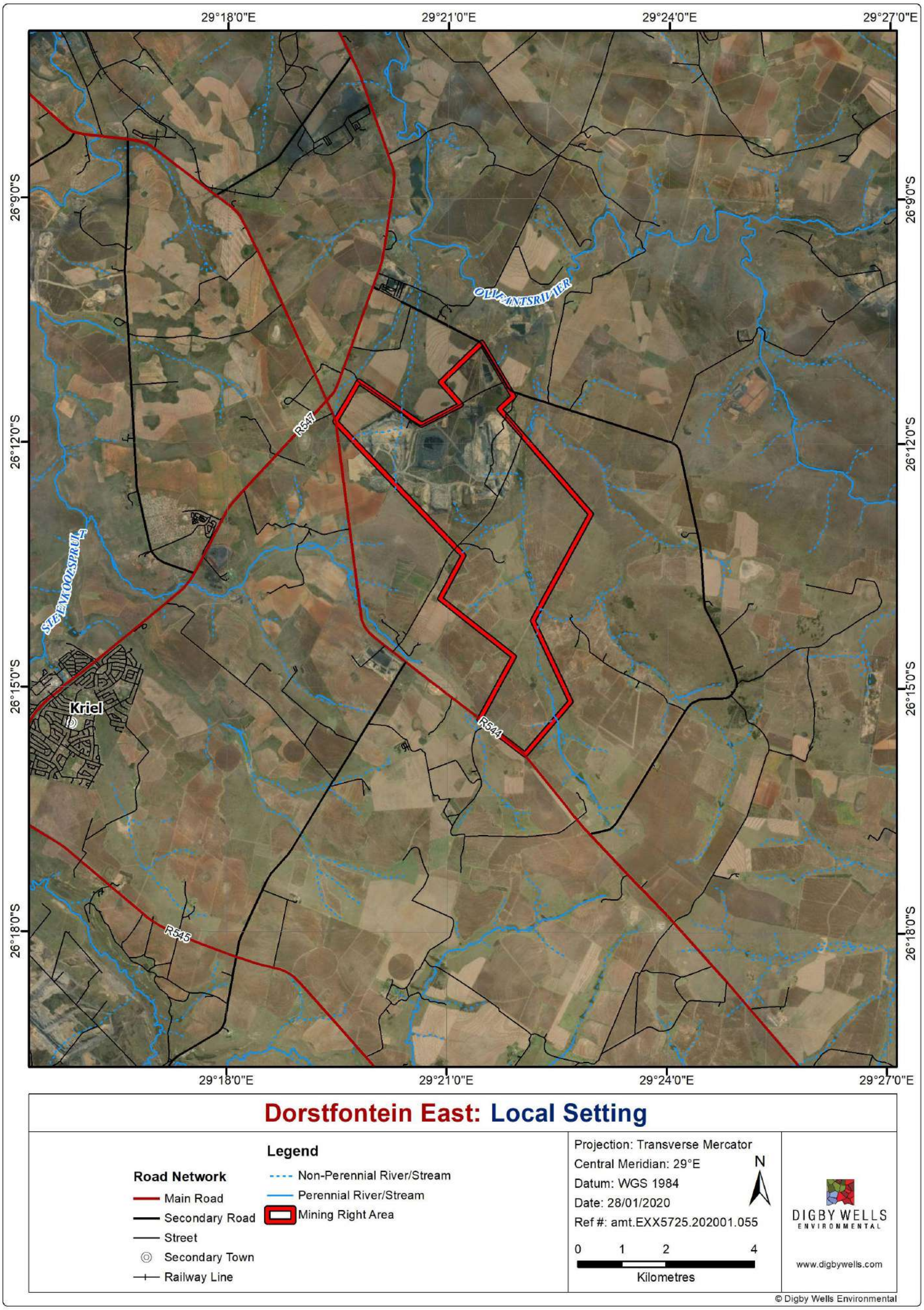


Figure 1.1:Locality of the Dorstfontein East Coal Mine project site

2 Project Description

This application pertains to the expansion of underground mining, and additional surface infrastructure. These activities are explained in more detail below.

2.1 Underground Mining

The project aims to expand the DECM's underground mining area within the existing Mining Right Areas MP30/5/1/2/51MR. DECM was previously owned by Total Coal South Africa (Pty) Ltd (Total) and was ceded to ECC on 20 August 2015 which has an approved Environmental Management Programme (EMPr), dated October 2017. Exxaro Central Coal is now applying to expand the underground mining areas as approved under Total. Subsequently, additional coal reserves have been identified for mining which are not covered under the existing approval. Exxaro Central Coal is also approved to undertake underground mining of deeper coal reserves at DECM. The underground mining operations will be accessed from the existing Pit 2 open cast and Dorstfontein West operations. Dorstfontein East Coal Mine, therefore, intends to further extend the Life-of-Mine (LoM) through the exploitation of these identified additional coal reserves between 2021 until 2034 (14 years).

In addition, a portion of Pit 3, which is approved for opencast mining, will now be included into the underground mining extension. The Pit 3 coal reserves are contained in Seam 4. The approved and proposed extension areas for underground mining are presented in Figure 2.1 and Figure 2.2.

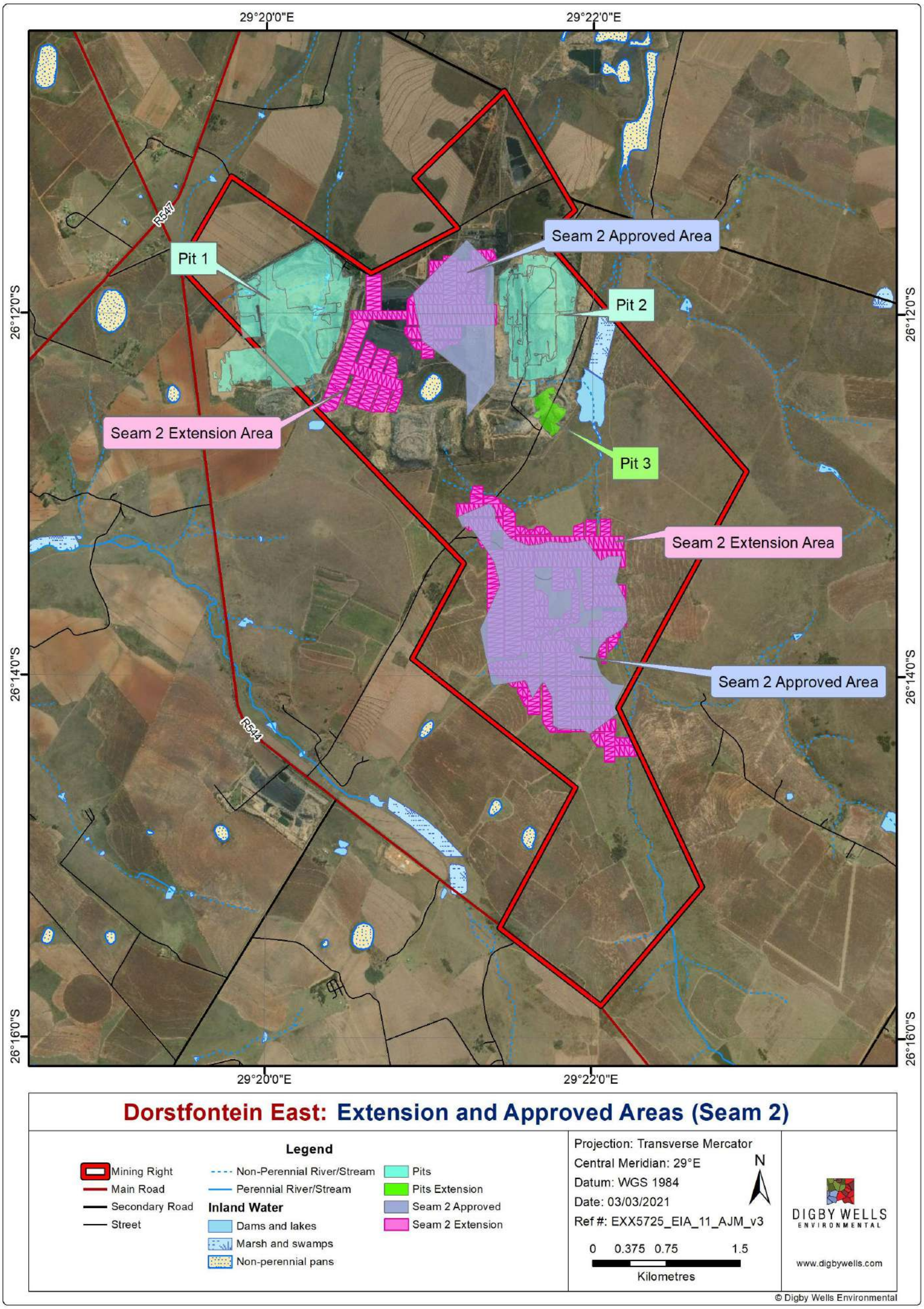


Figure 2.1: Approved and Proposed Underground Areas (Seam 2)

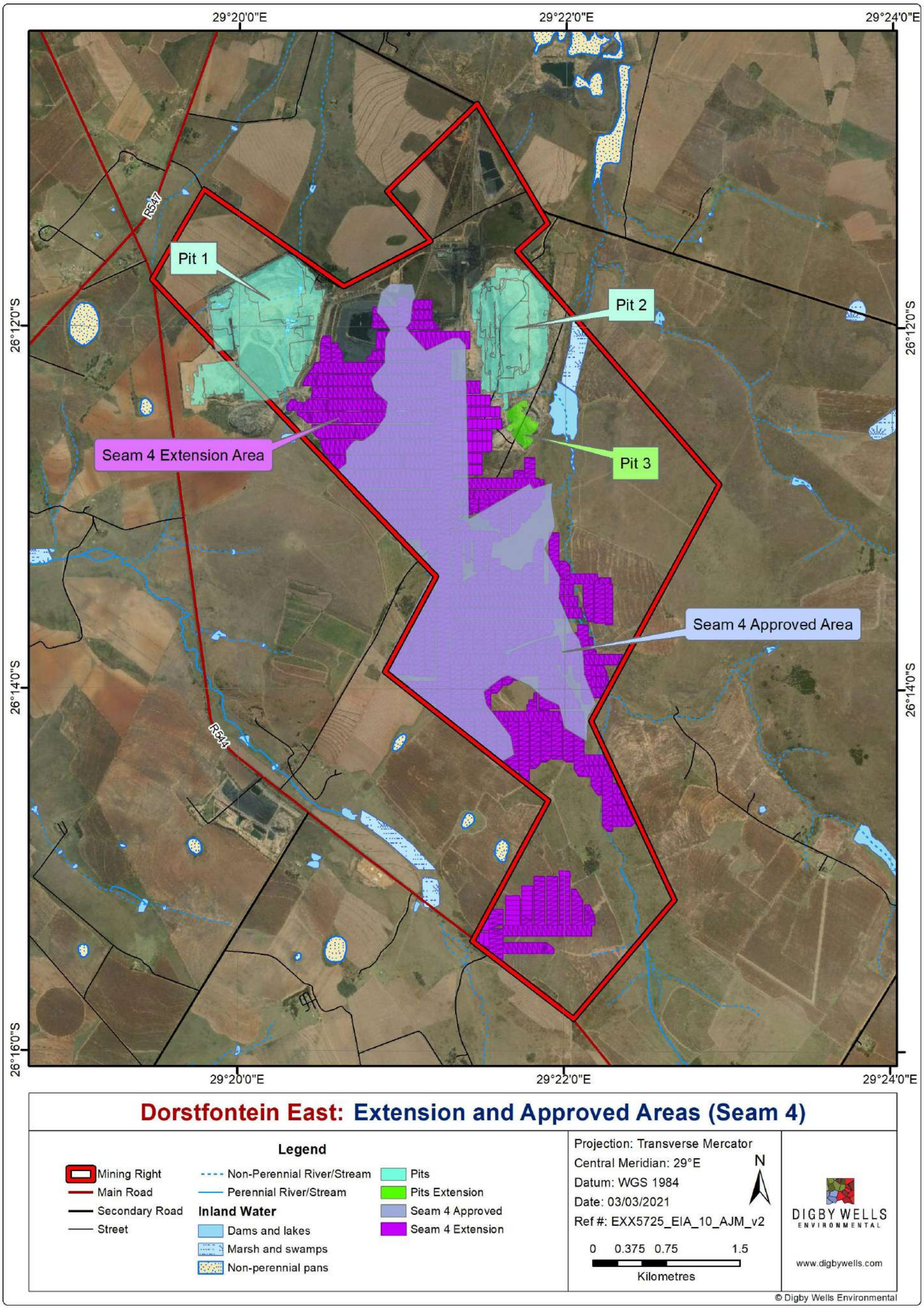


Figure 2.2: Approved and Proposed Underground Areas (Seam 4)

2.2 Additional Surface Infrastructure

For the proposed expansion, DECM will require a new Sewage Treatment Plant (STP), a new Water Treatment Plant (WTP), a water storage tank and a coal discard processing plant and these are shown in Figure 2.3.

2.2.1 Sewage Treatment Plant

Dorstfontein East Coal Mine, has an approved Sewage Treatment Plant on site, however, with the extension of underground operations additional sewage capacity is required. The plant will be located in a “dirty water area” in the main workshop and office area and will service up to 220 people per day. The treatment plant will require 45m^3 of water per day to process 16.2kg of organic load. The plant is 3m high, with a 2.3m diameter, with a 10m^3 volume. The STP will discharge into the existing pollution control dams (PCDs).

2.2.2 Water Treatment Plant

The proposed Water Treatment Plant is located north of the main workshop and office area, also within a previously disturbed area. The plant will treat domestic wastewater only, therefore, no gypsum or brine by-products will result from the treatment process. The effluent emanating from the plant will be collected by the existing pollution control dams (PCDs).

2.2.3 Water Storage Tank

Water from the PCDs will be stored in a raw water tank with a capacity of 300m^3. This dirty water will be fed into the sewage treatment plant.

2.2.4 Discard Processing Plant

A coal discard processing plant has been additionally proposed to treat 100 kilotons per month (ktpm) of re-mined coal discard. The plant will process discard from both the existing discard dump and the coal handling and preparation plant (CHPP). The plant will also accommodate all future DECM discard production. The product will be transported to the plant feed stockpile area by means of truck haul and from there, fed into the plant through a conveyor.

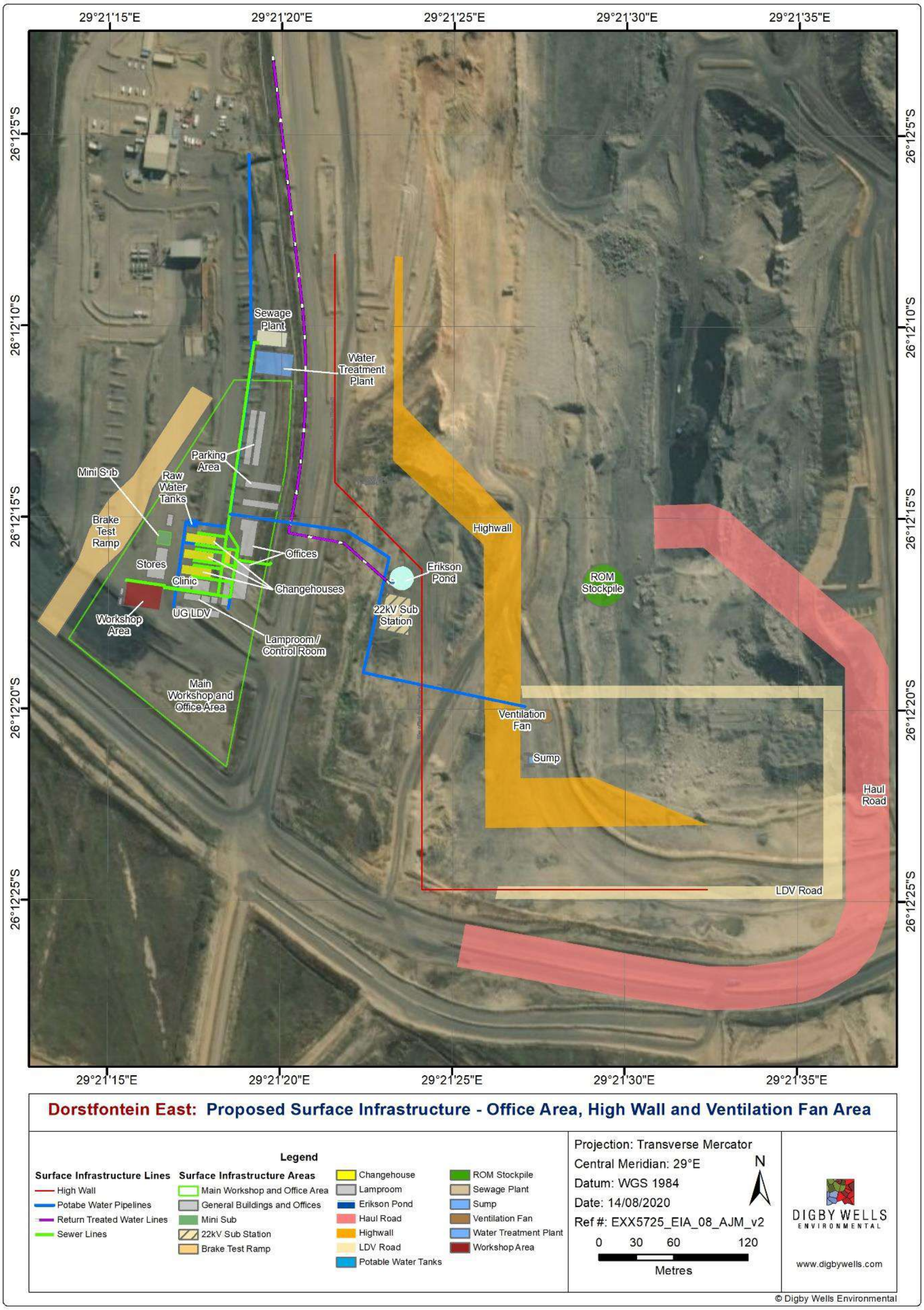


Figure 2.3: Proposed Surface Infrastructure at the Dorstfontein East Coal Mine

3 Listed Activities

The triggered listed activities are contained in Table 3-1.

Table 3-1: Listed Activities Applicable to the Project

Name of Activity	Areal extent of the activity	Listed Activity	Applicable Listing Notice	Waste Management Authorisation
Listing Notice 1				
Construction of access and haulage roads *The development of a road-* *(i) for which an environmental authorisation was obtained for the route determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Government Notice 545 of 2010; or* *(ii) with a reserve wider than 13,5 meters, or where no reserve exists where the road is wider than 8 metres;* *but excluding a road-* *(a) which is identified and included in activity 27 in Listing Notice 2 of 2014;* *(b) where the entire road falls within an urban area; or* *(c) which is 1 kilometre or shorter.*	As per approved engineering designs	X-24 *(ii)*	GN R983, under NEMA (as amended)	-

Name of Activity	Areal extent of the activity	Listed Activity	Applicable Listing Notice	Waste Management Authorisation
Operating sewage and water reticulation *The development and related operation of infrastructure exceeding 1 000 metres in length for the bulk transportation of sewage effluent, process water, wastewater, return water, industrial discharge or slimes-* *(i) with an internal diameter of 0,36 metres or more; or* *(ii) with a peak throughput of 120 litres per second or more;* *excluding where-* *(a) such infrastructure is for the bulk transportation of sewage, effluent, process water, wastewater, return water, industrial discharge or slimes inside a road reserve or railway line reserve; or* *(b) where such development will occur within an urban area.*	As per approved engineering designs	X-10	GN R 983 (under NEMA as amended)	GN R 921 under NEM: WA Category B 4 (10)
Power line construction *The development of facilities or infrastructure for the transmission and distribution of electricity-* *(i) outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts; or* *(ii) inside urban areas or industrial complexes with a capacity of 275 kilovolts or more*	22kV line, 2.3 km long	X- 11	GN R983, under NEMA (as amended)	-

Name of Activity	Areal extent of the activity	Listed Activity	Applicable Listing Notice	Waste Management Authorisation
Listing Notice 2				
Mining of coal by underground mining *Any activity including the operation of that activity which requires a mining right as contemplated in section 22 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002), including-* *(a) associated infrastructure, structures and earthworks directly related to the extraction of a mineral resource; or* *(b) the primary processing of a mineral resource including winning, extraction, classifying, concentrating, crushing, screening or washing.*	**Seam 2**: 92.1 ha (excluding approved area) **Seam 4**: 185.2 ha (excluding approved area)	X- 17	GN R 984 under NEMA	-
Water Use Licence *The development of facilities or infrastructure for any process or activity which requires a permit or licence in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent*	Inclusive of all water and sewage management infrastructure on site.	X- 6	GN R 984 under NEMA	GN R 921 under NEM: WA Category B 4 (11)

4 Methodology

4.1 Baseline Hydrology

The rainfall, evaporation and runoff data were obtained from the database provided by the Water Resources of South Africa 2012 study (WRC, 2015) and was used to determine the Mean Annual Precipitation (MAP), Mean Annual Evaporation (MAE) and the Mean Annual Runoff (MAR) for the Olifants River catchment. Time series rainfall-runoff and Symons Pan evaporation historical data for 1920 to 2009 were used to determine average hydro-meteorological parameters for the project site. These analyses were useful to provide insight into the general rainfall-runoff and evaporation dynamics for the site.

4.2 Floodline Determination

4.2.1 Peak Flows

Catchment delineation was undertaken in Global Mapper using a Digital Elevation Model (DEM) generated from 5 m contours (National Geospatial Institute, 2013) augmented by Advanced Land Observing Satellite (ALOS) World 3D – 30m (AW3D30) global digital surface model (DSM) data (JAXA, 2015) for the study area. The ALOS dataset is stored in a raster GeoTIFF format referenced to the Hartebeesthoek 94 Datum (WGS84 ellipsoid).

Widely used and recommended methods including the Rational Method Alternative 3 (RM3), Standard Design Flood (SDF) and the Midgley & Pitman (MIPI) were used to calculate the 1:50-year and 1:100-year peak flows for delineated catchments at the project site (SANRAL, 2013). Design rainfall depths were determined using the Design Rainfall Programme for South Africa and the modified Hershfield equation as input to the RM3 and SDF methods, respectively.

4.2.2 Hydraulic Modelling

Hydraulic modelling was conducted in HEC-RAS 5.07 which allows pre-processing within the in-built RAS Mapper module. A Digital Terrain Model (DTM) was generated from the 5m DEM to make the topographic data compatible with RAS Mapper. The pre- processing involved generation of the channel geometry, including the river network, banks, flow paths and cross sections.

The HEC-RAS model simulates total energy of water by applying basic principles of mass, continuity, and momentum as well as roughness factors between all cross sections (US Army Corps of Engineers, 1995). A height is calculated at each cross-section, which represents the level to which water will rise at that section, given the calculated initial peak flows for the 1:50-year and 1:100-year events on all river sections.

Analyses are performed by modelling flows at the sub-catchment outlet of stream or channel sections first, moving upstream. Manning's Roughness Coefficient (n) for the channels were set at 0.8, and those for riverbanks were determined to be 1.3 representing natural channels with weeds, reeds and brush on the banks (Chow, 1959).

Please note that the study only determined indicative floodlines, hence can only be used for environmental purposes and not for detailed engineering designs.

4.3 Water Quality

Historical water quality was described based on previous reports (Aquatico, 2019) provided by Exxaro. Assessed variables included pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Hardness, chlorine (Cl), sodium (Na), sulphate (SO_4), fluorine (F), nitrate (NO_3), aluminium (Al), iron (Fe) and manganese (Mn). Additional surface water samples were collected to assess current water quality of water resources in the area. Collected samples were analysed at a South African National Standards (SANAS) accredited laboratory and results were interpreted to provide baseline conditions prior to commencement of proposed additional project activities.

The Department of Water and Sanitation (DWS) water quality guidelines for Livestock watering, irrigation and aquatic ecosystems were used as benchmarks against the laboratory results (DWA, 1996). These guidelines were selected based on dominant water uses in the area.

4.4 Storm Water Management Plan

The existing DECM Storm Water Management Plan (SWMP) was reviewed to ascertain compliance to the General Notice 704 (GN704) guidelines of the National Water Act, 36 of 1998 (NWA) and to determine adequacy to cover the proposed project activities. Key issues associated with management of stormwater which were considered in this study included:

- Separation of clean and dirty water catchments,
- Minimizing run-off,
- Avoiding erosion of exposed ground surfaces, and
- Avoiding sedimentation of drainage systems and minimizing exposure of polluted areas to stormwater.

Recommendations of stormwater management strategies were made to ensure adherence to the key issues outlined above.

4.5 Water Balance

The Water Balance was conducted in accordance with the DWS Best Practice Guidelines (BPG) G2: Water and Salt Balances (DWA, 2006). The static water balance compilation utilised results of the hydrological assessment to provide hydrological inputs as rainfall, runoff, and evaporation into modelling calculations. Water infrastructure for the mine were obtained from the mine layout plan provided by Exxaro. Linkages between water balance components were represented by flow diagram which showed inflows, outflows, and storages. Volumes and capacities of water infrastructure provided by Exxaro were used in the water balance and where gaps were observed, assumptions and approximations were determined.

4.6 Surface Water Impact Assessment

Potential and existing surface water impacts (quality and quantity) that may result from the proposed project activities, based on the established baseline conditions, were identified.

Impact Rating Methodology

The significance rating formula is as follows:

Significance = Consequence x Probability

Where

Consequence = Type of Impact x (Intensity + Spatial Scale + Duration)

And

Probability = Likelihood of an Impact Occurring

In addition, the formula for calculating consequence:

Type of Impact = ***+1*** *(Positive Impact) or* ***-1*** *(Negative Impact)*

The weighting assigned to the various parameters for positive and negative impacts is provided for in the formula and is presented in Table 4-1. The probability consequence matrix for impacts is displayed in Table 4-2, with the impact significance rating described in Table 4-3.

Table 4-1: Impact Assessment Parameter Ratings

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
7	Very significant impact on the environment. Irreparable and irreplaceable damage to highly valued species, habitat, or ecosystem. Persistent severe damage. Irreparable and irreplaceable damage to highly valued items of high cultural significance or complete breakdown of social order.	Noticeable, on-going social and environmental benefits which have improved the livelihoods and living standards of the local community in general and the environmental features.	International The effect will occur across international borders.	Permanent: No Mitigation The impact will remain long after the life of the Project. The impacts are irreversible.	Certain/Definite. There are sound scientific reasons to expect that the impact will definitely occur.
6	Significant impact on highly valued species, habitat, or ecosystem. Significant management and rehabilitation measures required to prevent irreplaceable impacts. Irreparable damage to highly valued items of cultural significance or breakdown of social order.	Great improvement to livelihoods and living standards of a large percentage of population, as well as significant increase in the quality of the receiving environment.	National Will affect the entire country.	Beyond Project Life The impact will remain for some time after the life of a Project.	Almost certain/Highly probable It is most likely that the impact will occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread positive benefits to local communities which improves livelihoods, as well as a positive improvement to the receiving environment.	Province/ Region Will affect the entire province or region.	Project Life The impact will cease after the operational life span of the Project.	Likely The impact may occur.
4	Serious medium-term environmental effects. Environmental damage can be reversed in less than a year. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense social benefits to some people. Average to intense environmental enhancements.	Municipal Area Will affect the whole municipal area.	Long term 6-15 years to reverse impacts.	Probable Has occurred here or elsewhere and could therefore occur.
3	Moderate, short-term effects but not affecting ecosystem function. Rehabilitation requires intervention of external specialists and can be done in less than a month. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some.	Local Extending across the site and to nearby settlements.	Medium term 1-5 years to reverse impacts.	Unlikely Has not happened yet but could happen once in the lifetime of the Project, therefore there is a possibility that the impact will occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by very few of population.	Limited Limited to the site and its immediate surroundings.	Short term Less than 1 year to completely reverse the impact.	Rare/improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the Project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.
1	Limited damage to minimal area of low significance that will have no impact on the environment. No irreplaceable loss of a significant aspect to the environment. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level social and environmental benefits felt by very few of the population.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month to completely reverse the impact.	Highly unlikely/None Expected never to happen.

Table 4-2: Probability Consequence Matrix for Impacts

Probability	Significance																																					
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
	Consequence																																					

Table 4-3: Significance Threshold Limits

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and/or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and/or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and/or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and/or social environment	Negligible (negative) (-)

Score	Description	Rating
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and/or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

5 Baseline Hydrology

5.1 Regional Drainage

The water resources of South Africa are divided into quaternary catchments, which are regarded as the principal water management units in the country (DWA, 2011). These catchments represent the fourth order of the hierarchical classification system, in which the primary catchments are the major units. The primary drainages are further grouped into or fall under Water Management Areas (WMA) and Catchment Management Agencies (CMAs). The Department of Water and Sanitation (DWS) has established nine WMAs and nine CMAs as

contained in the National Water Resource Strategy 2 (2013) in terms of Section 5 subsection 5(1) of the National Water Act, 1998 (Act No. 36 of 1998). The establishment of these WMAs and CMAs is to improve water governance in different regions of the country, to ensure a fair and equal distribution of the Nations freshwater resources, while making sure that the resource quality is sustained.

The proposed project area falls within primary drainage region B of the Olifants WMA and the B11B and B11D quaternary catchments, namely Sub-Quaternary Reaches (SQR) B11B-01327 (Olifants River) and B11D-01366 (Steenkoolspruit). The Olifants River is a third order stream, approximately 36 km in length, which drains from south-east along the north-eastern boundary of the Project Area. The Steenkoolspruit is a third order stream, approximately 16 km in length, which drains from south along the western boundary of the Project Area. The Project Area also includes numerous non-perennial drainage lines, which report to the Olifants River north-easterly. Both SQR's drain into the Olifants River, a major river which flows in a direction into Mozambique and then joins the Limpopo River and drains into the Indian Ocean. The regional setting and river systems associated with the DECM study area are indicated in Figure 5.1.

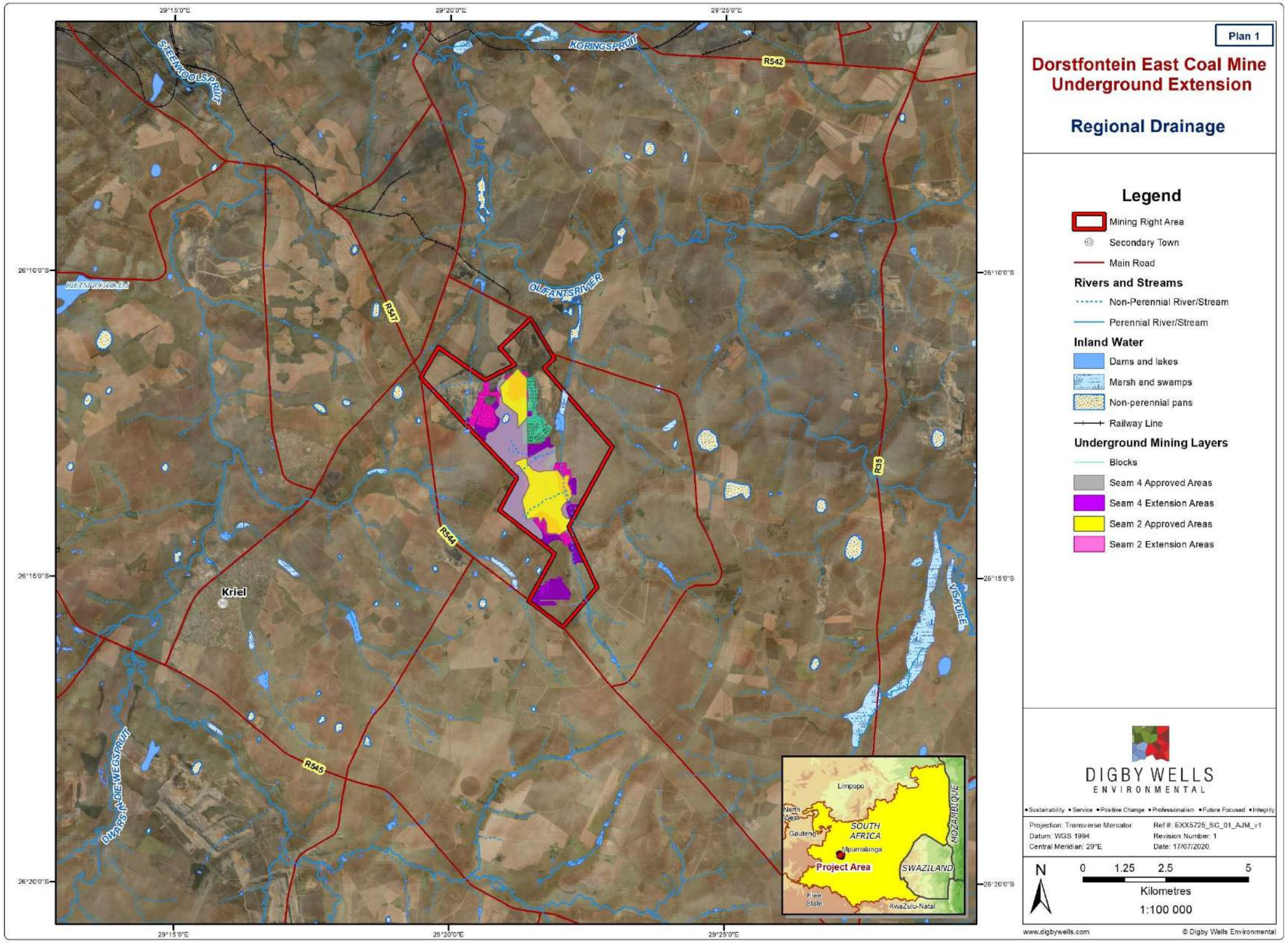
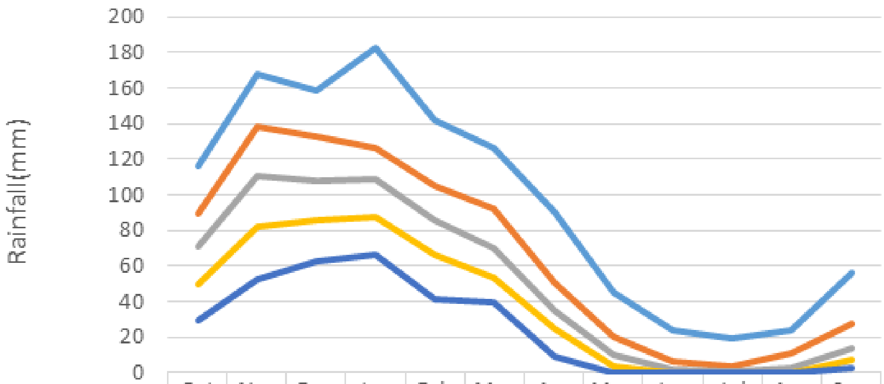


Figure 5.1: Regional setting of Dorstfontein East Coal Mine

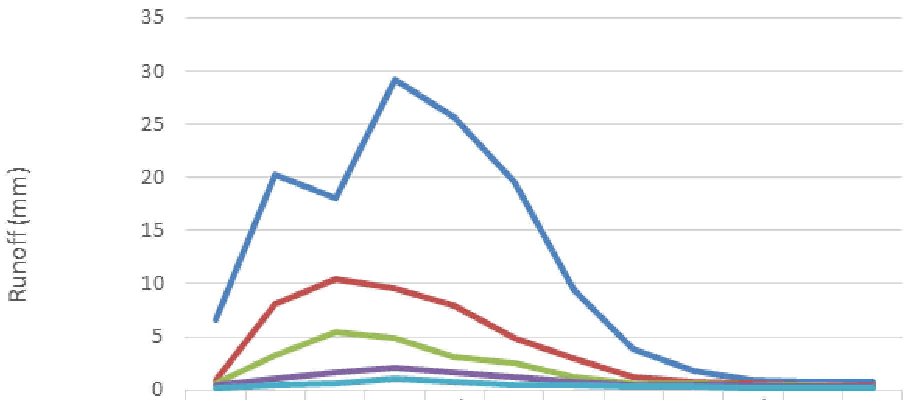
5.2 Rainfall, Runoff and Evaporation

The MAP for the region was determined to be 676 mm, whose distribution is likely to be as indicated in Figure 5.2. 90% of rainfall events during the wettest month of December will likely not exceed 182 mm. The Mean Annual Runoff (MAR) was determined to be 50.8 mm, which accounts for approximately 7% of the MAP. 90% of runoff events will likely not exceed 18.1 mm (Figure 5.3).



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90 Percentile	116	168	158	183	143	127	90	45	24	19	24	56
70 Percentile	89	139	133	126	105	92	50	20	6	4	11	27
50 Percentile	71	111	108	109	86	70	35	10	2	0	2	14
30 Percentile	49	82	86	88	66	53	24	4	0	0	0	7
10 Percentile	30	53	63	66	41	39	9	0	0	0	0	3

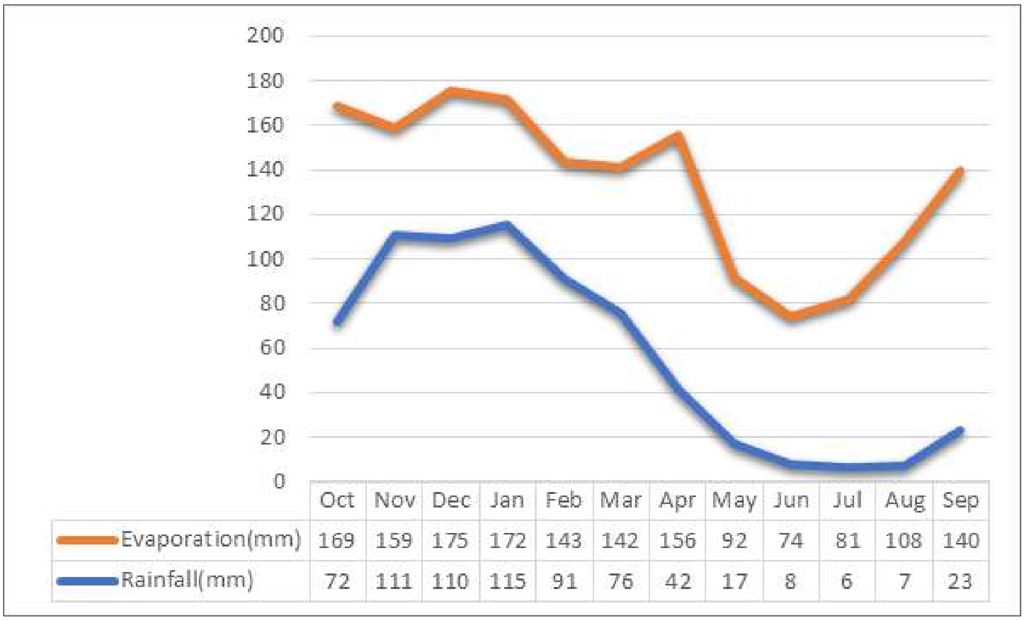
Figure 5.2: Rainfall distribution at the DECM



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90 Perecentile	6.7	20.2	18.1	29.1	25.7	19.5	9.4	3.9	1.7	0.9	0.7	0.8
70 Percentile	1.0	8.2	10.5	9.5	8.0	4.8	3.0	1.2	0.8	0.6	0.5	0.5
50 Percentile	0.6	3.3	5.4	4.9	3.1	2.5	1.1	0.7	0.6	0.5	0.4	0.4
30 Percentile	0.4	1.1	1.7	2.1	1.7	1.2	0.8	0.5	0.5	0.4	0.4	0.3
10 Percentile	0.3	0.4	0.7	1.0	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2

Figure 5.3: Runoff distribution at the DECM

The Mean Annual Evaporation (MAE) for the trans-quaternary catchment region was determined to be 1564 mm which is twice more than the MAP (Figure 5.4). This implies that the area experiences distinct wet and dry seasons, with the dry period receiving as little as 6 mm of rainfall per month.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation(mm)	169	159	175	172	143	142	156	92	74	81	108	140
Rainfall(mm)	72	111	110	115	91	76	42	17	8	6	7	23

Figure 5.4: Evaporation and rainfall trends at the DECM

6 Floodline Determination

6.1 Peak flows

Catchments were delineated for river systems draining the area and two of these are relevant to the DECM surface infrastructure development site (Figure 6.1). Peak flows for the subcatchments are presented in Table 4-1. Results from the RM3 method were used in hydraulic modelling since these were representative of the area due to site-specific runoff coefficients which were generated using an in-built RM3 module. The MIPI results helped in the selection of suitable peak flows because these were of the same order of magnitude to the RM3 method. The SDF results were deemed an over-estimate of peak flows for the site probably due to high regionalised runoff coefficients. Calculated peak flows are presented in Table 6-1.

Table 6-1: Calculated peak flows for streams at the DECM project site

Catchment	**RM3**		**SDF**		**MIPI**	
	1:50yr	1:100yr	1:50yr	1:100yr	1:50yr	1:100yr
	(m^3/s)					
CB1	60.2	81.7	150.4	190.4	71.9	90.8
CB2	168.9	229.4	329.6	417.4	162.4	205.2

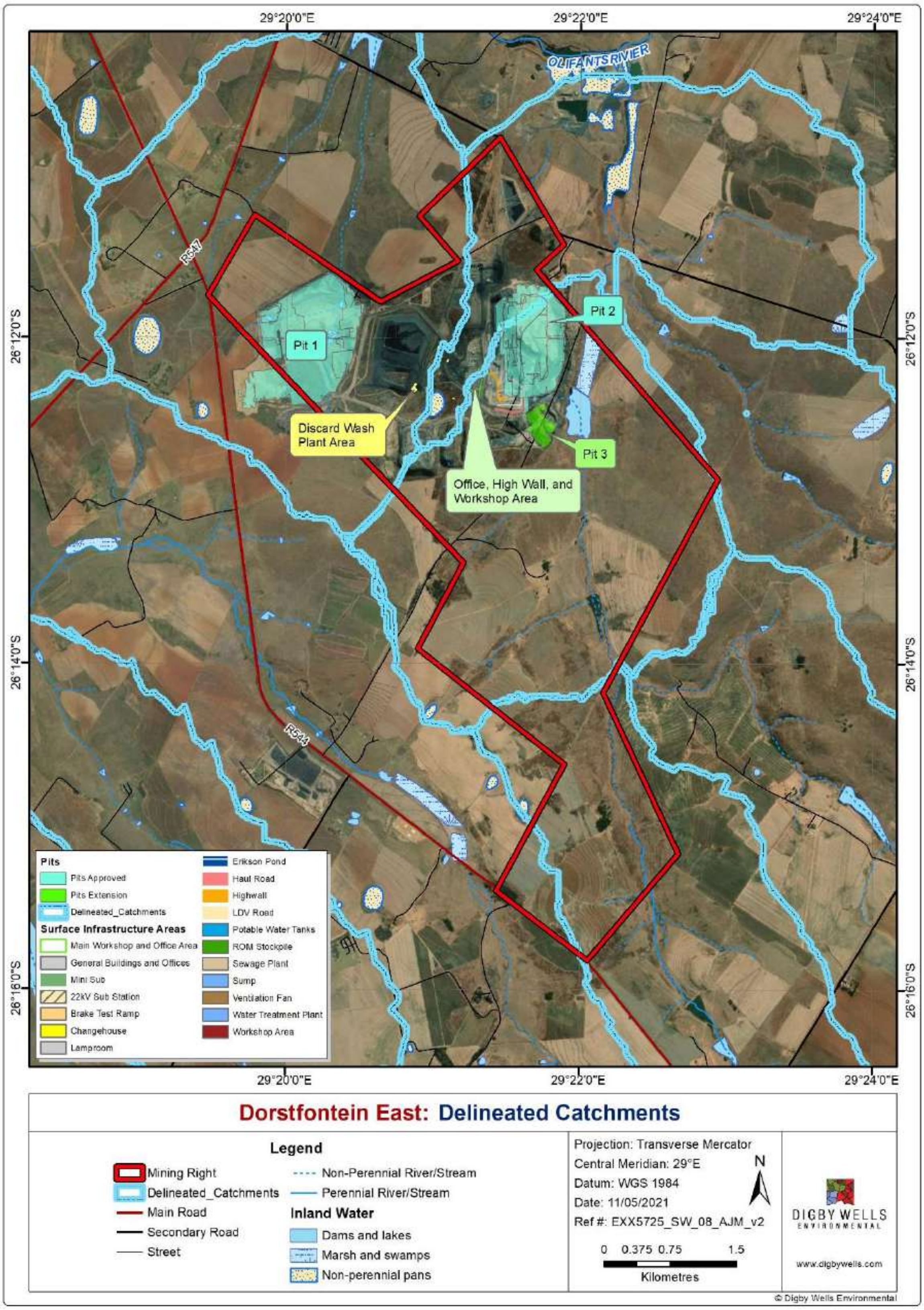


Figure 6.1: Delineated subcatchments at the DECM project site

6.2 Floodlines

The modelled 1:50-year and 1:100-year indicate that none of the proposed infrastructure falls within the floodwater way. The proposed infrastructure will be constructed within already disturbed areas and will, therefore, be outside the 1:50-year and 1:100-year floodlines.

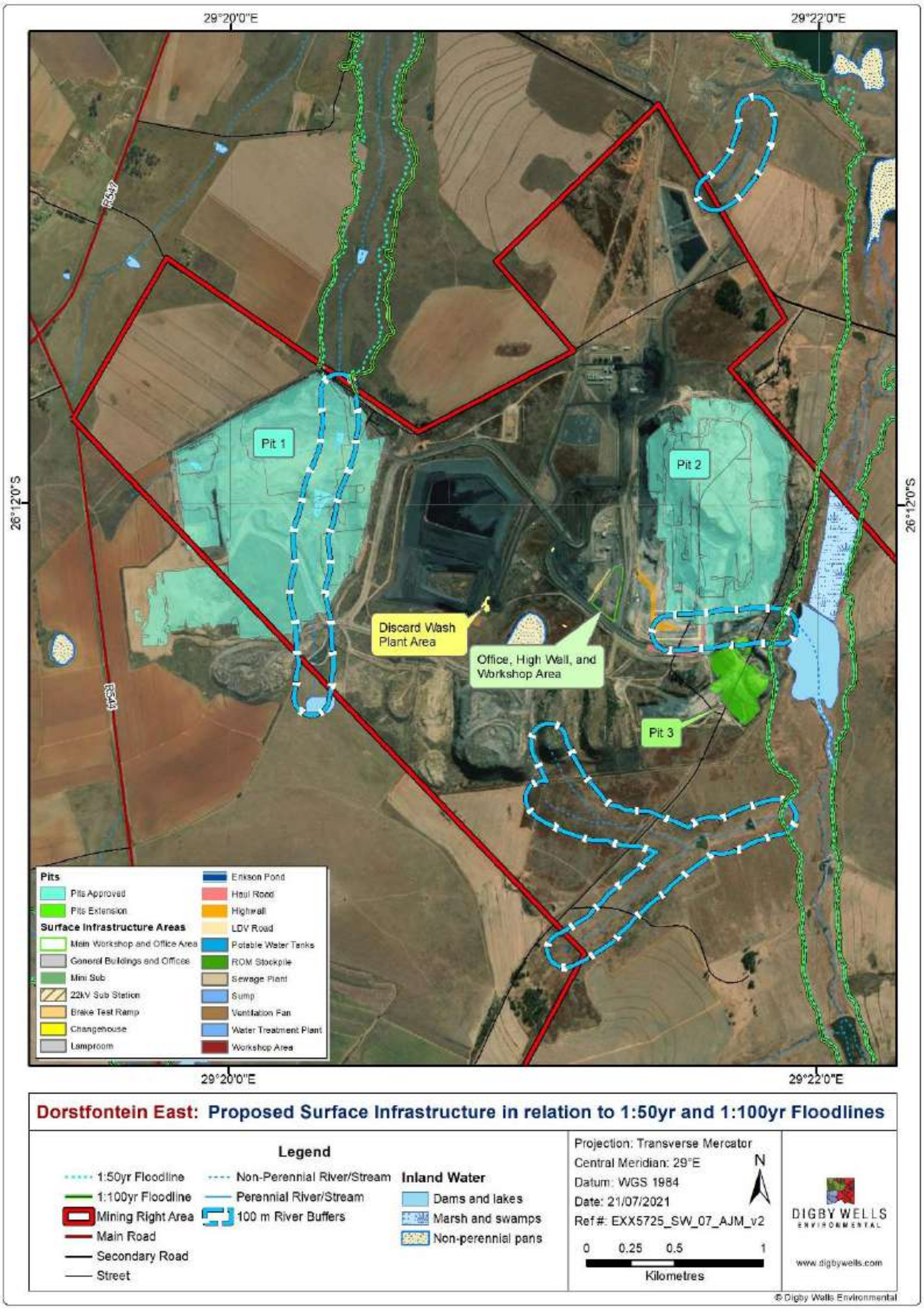


Figure 6.2: 1:50-year and 1:100-year floodlines for rivers at the DECM project site

7 Water Quality

The historical water quality data for Dorstfontein East was sourced from existing Aquatico Water Quality Assessment Reports for the site (Aquatico, 2019). The limits stipulated by the Dorstfontein East WUL (number: 04/B11B/ACGIJ/957) for Water Resource Protection were used to benchmark water quality for DECM. In addition, the South African Water Quality Guidelines: Aquatic Ecosystems (DWAF, 1996) was also included for comparison purposes as the DWA's mandate also requires it to protect the health and integrity of aquatic ecosystems.

7.1 Existing Water Quality Monitoring at DECM

7.2 Monitoring Points

Existing surface water monitoring localities and their descriptions at the DECM are presented in Table 7-1.

Table 7-1: Existing surface water monitoring localities at DECM

Locality	Description	Coordinates	
DCM East Surface Water			
DCM06	Upstream of Western tributary	S26.2183	E29.3676
DCM07	Downstream of Western tributary	S26.1907	E29.3688
DCM08	Pond downstream of Pit 1	S26.1939	E29.3395
ED01	Erichsen Dam 1	S26.1925	E29.3541
ED02	Erichsen Dam 2	S26.1925	E29.3543
ED03	Erichsen Dam 3	S26.1926	E29.3546
MP01	Downstream on western tributary of the Olifants River	S26.1714	E29.34
MP02	Downstream on western tributary of the Olifants River	S26.1728	E29.343
MP03	Bridge upstream of the old Transvaal Navigation Colliery	S26.1365	E29.345
MP04	Confluence of MP01 and MP02 tributaries with the Olifants River	S26.1555	E29.3436
MP05	Downstream of Transvaal Navigation Colliery	S26.1694	E29.3568
MP06	Upstream of mining activities on the Olifants River	S26.1681	E29.3746
Pan	Pan	S26.2054	E29.3504
PCD01	Pollution control dam 1	S26.1855	E29.3593
PCD02	Pollution control dam 2	S26.1861	E29.36
PCD03	Pollution control dam 3	S26.1878	E29.3597
RWDF	Return water discard facility	S29.3430	E29.3430
DCM East Sewage			
SOE	Sewage effluent (East)	S26.1932	E29.3565
DCM East Potable Water			
Potable water East	Potable water	S26.1935	E29.354
AM1	Andru Mining 1	S26.2014	E29.3545
AM2	**Andru Mining 2**	S26.1924	E29.3549
KW1	**Kwena Workshop 1**	S26.1931	E29.3550
KW2	**Kwena Workshop 2**	S26.1931	E29.3550
SLK	**SGS Lab Kitchen**	S26.1935	E29.3545
OFK	**Office Kitchen**	S26.1932	E29.3542
ECBH	Emalayinini Community Borehole	S26.1820	E29.3257
DCM East Pit Water			
MPW01	Mining Pit Water (Pit 1)	S26.2027	E29.3373
MPW03	Mining Pit Water (Pit 2)	S26.2091	E29.3614

7.3 Results from Existing Water Quality Monitoring

Sampling localities which include DCM07, MP02 and DCM06 were dry during the sampling period to June 2019, and therefore, these could not be sampled. Average quarterly results for the analyses performed on the sampled localities are presented in Table 7-2.

Based on the calculated average for the monitoring period to June 2019, the general physical quality of the surface water in the DECM area can be described as acidic (DCM08c & MP01), neutral and alkaline (Pan), non-saline to very saline (TDS 249 mg/l to 2378 mg/l with an overall average of 596.8 mg/l, classified as saline) and soft to very hard (total hardness of 62 mg/l to 423 mg/l with an overall average of 189 mg/l classified as moderately hard).

The average physico-chemical quality of the water from locality DCM06 could be described as neutral, non-saline and hard. The DECM WUL Water Resource limits were exceeded by the quarterly average pH value, as well as the concentrations of sodium and chloride. The limits stipulated by the SAWQG for Aquatic Ecosystems were exceeded by the average fluoride, aluminium and chromium concentrations during this quarter. The water quality can therefore be classified as good (Class 1) for domestic use (WRC, 1998).

The physico-chemical quality of the water from locality DCM08c in May 2019 could be described as acidic, non-saline and moderately soft. The DECM WUL Water Resource limits were exceeded by the quarterly average pH value. Both the WUL and the limits stipulated by the SAWQG for Aquatic Ecosystems were exceeded by the aluminium and manganese concentration, while the SAWQG for Aquatic Ecosystems were exceeded by the average chromium concentration during the quarterly period. The water quality can therefore be classified as marginal (Class 2) for domestic use (WRC, 1998).

At locality MP01, the water could be described as acidic, non-saline and moderately soft. The DECM WUL Water Resource limits were exceeded by the quarterly average pH value while both the WUL limits and the limits stipulated by the SAWQG for Aquatic Ecosystems were exceeded the average concentrations of aluminium and manganese and the SAWQG for Aquatic Ecosystems was exceeded by the average chromium concentration. Accordingly, the quarterly average water quality may be classified as marginal (Class 2) for domestic use (WRC, 1998).

The average concentrations of sodium recorded for localities MP03, MP04, MP05 and MP06 exceeded the limits stipulated by the water use license. The WUL limits were further exceeded by the quarterly average chloride concentrations calculated for MP03, MP04 and MP05 Pan. The average water qualities of these localities are very similar with neutral, non-saline and moderately hard to hard (MP03) physico-chemical properties. The water quality of these localities may be classified as ideal (Class 0; MP04 & MP05), good (Class 1; MP03 & MPP06) for domestic use (WRC, 1998).

The average pH value and concentrations of pH levels, TDS, sodium and chloride calculated for the Pan locality exceeded the limits stipulated by the WUL, while a high average fluoride concentration and aluminium and chromium concentrations exceeded the Aquatic Ecosystems guideline.

Table 7-2: Average quarterly results for DECM area-samples resource localities (June 2019)

VARIABLE	UNITS	DCM East WUL Water Resource Limits	SAWQG TWQGR for Aquatic Ecosystems	MONITORING LOCALITIES							
				DCM06	DCM08c	MP01	MP03	MP04	MP05	MP06	Pan
pH @ 25°C	pH	6.5/8.4	-	8.44	5.3	5.5	8	8.2	8.13	7.87	9.4
Electrical conductivity (EC) @ 25°C	mS/m	-	-	64.9	37.1	35.8	62.2	53.3	52.5	50.9	319
Total hardness	mg CaCO3/l	-	-	211	65	62	225	182	175	175	423
Total Dissolved solids @ 180°C	mg/l	-	-	441	254	249	415	357	347	331	2378
Calcium (Ca)	mg/l	-	-	24	13	13	41.7	34.3	32.3	35	22.3
Magnesium (Mg)	mg/l	-	-	37	8	7.33	29.3	23.3	23	21.3	89.3
Sodium (Na)	mg/l	21.12	-	64.4	14	14	42	38	38	35.3	690
Potassium (K)	mg/l	-	-	9.54	26	26	7.07	6.7	6.63	6.13	4.57
Total alkalinity	mg CaCO3/l	-	-	288	2.5	2.5	180	155	152	169	1400
Chloride (Cl)	mg/l	25	-	39.7	24	24.7	26	25.7	25.7	21	277
Sulphate (SO_4)	mg/l	400	-	25.5	119	105	115	87	84	71	152
Nitrate (NO_3) as N	mg/l	-	-	*0.066*	*0.05*	*0.067*	*0.05*	*0.05*	*0.05*	*0.133*	*0.05*
Ammonium (NH_4) as N	mg/l	-	-	0.274	4.5	4.23	0.133	*0.083*	*0.083*	*0.117*	0.233
Orthophosphate (PO_4) as P	mg/l	-	-	*0.053*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	0.833
Fluoride (F)	mg/l	-	0.75	0.9	0.5	0.333	0.633	0.633	0.7	0.867	3.4
Aluminium (Al)	mg/l	0.18	0.005	*0.034*	0.2	0.508	*0.05*	*0.05*	*0.05*	*0.05*	0.154
Iron (Fe)	mg/l	-	-	*0.038*	0.066	0.717	*0.013*	*0.034*	0.039	0.062	0.216
Manganese (Mn)	mg/l	0.18	0.18	*0.039*	1.34	1.31	*0.018*	*0.013*	*0.042*	*0.013*	0.03
Chromium (Cr)	mg/l	-	0.007	*0.009*	*0.013*	*0.013*	*0.013*	*0.013*	*0.013*	*0.013*	*0.013*
Sodium Adsorption Ratio	SAR	-	-	1.94	0.8	0.8	1.2	1.2	1.23	1.17	14.67
Bicarbonate alkalinity	mg CaCO3/l	-	-	269	5	*2.5*	180	155	163	181	929
Carbonate alkalinity	mg CaCO3/l	-	-	*20.1*	-	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	472
Langelier Saturation Index	LSI	-	-	0.59	-4.6	-4.37	0.33	0.33	0.27	0.15	2.23
Calcium hardness	mg CaCO3/l	-	-	60	33	32	104	86	81	87	56
Magnesium hardness	mg CaCO3/l	-	-	152	32	30	121	96	94	88	367

A general overview of constituent parameters that add up to the overall TDS concentration of the Pan monitoring locality is presented in Figure 7.1. Based on these results, the high salinity of the Pan is primarily dominated by sodium and alkalinity. The water quality of the Pan may be classified as poor (Class 3) for domestic use (WRC, 1998).

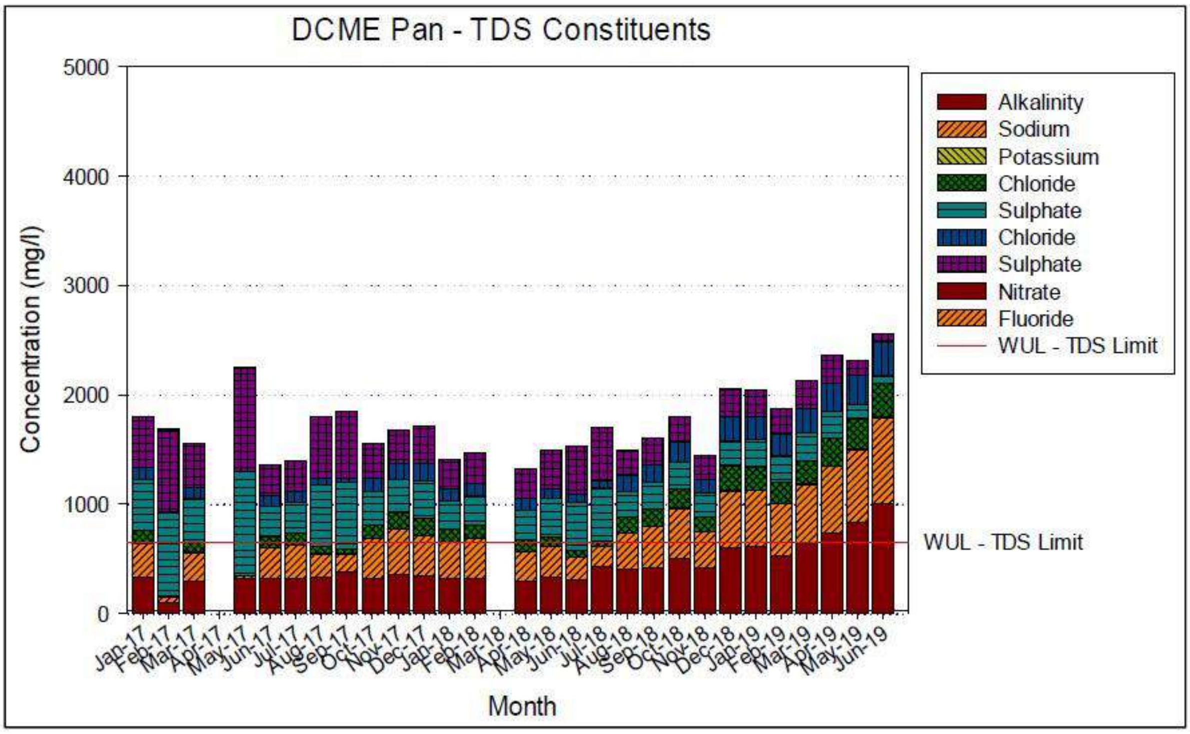


Figure 7.1: Concentration of TDS and its constituents for the DECM Area Pan (January 2017-June 2019)

7.3.1 Water Quality Upstream and Downstream of the Olifants River

Spatial assessment tables were used to compare upstream and downstream sampling localities. These tables quantify potential impacts observed from the upstream aquatic environment towards the downstream environment by highlighting any variable concentrations which can be assumed to be contributions to the total degradation (in red) or improvement (indicated in green) of downstream water quality by the mine situated between these two localities or any other potential contributor residing between them. This does not necessarily mean the contribution of any parameter exceeded the permissible concentration of that variable but is merely an indication of change in concentration.

Table 7-3 (below) compares the average qualities recorded for localities MP03 (locality upstream of the old Transvaal Navigation Colliery) and MP05 (downstream of the old Transvaal Navigation Colliery). There were slight increases on some of the variables in a downstream direction, but on the concentration of many variables there was an improvement or no change at all.

Table 7-3:Water Quality Upstream and Downstream of the Olifants River from April to June 2019

VARIABLE	UNIT	DCM East WUL Water Resource Limits	Locality		CALCULATED CHANGE
			Upstream	Downstream	
			MP03	MP05	
pH @ 25°C	pH	6.5/8.4	8	8.13	0.13
Electrical conductivity (EC) @ 25°C	mS/m	-	62.2	52.5	-9.7
Total Dissolved solids @ 180°C	mg/l	650.0 mg/l	415	347	-68
Total hardness	mg CaCO3/l	-	225	175	-50
Calcium (Ca)	mg/l	-	41.7	32.3	-9.4
Magnesium (Mg)	mg/l	-	29.3	23	-6.3
Sodium (Na)	mg/l	21.12 mg/l	42	38	-4
Potassium (K)	mg/l	-	7.07	6.63	-0.44
Total alkalinity	mg CaCO3/l	-	180	152	-28
Chloride (Cl)	mg/l	25.0 mg/l	26	25.7	-0.3
Sulphate (SO_4)	mg/l	400.0 mg/l	115	84	-31
Nitrate (NO_3) as N	mg/l	-	*0.05*	*0.05*	0
Ammonium (NH_4) as N	mg/l	-	0.133	*0.083*	-0.05
Orthophosphate (PO_4) as P	mg/l	-	*0.05*	*0.05*	0
Fluoride (F)	mg/l	-	0.633	0.7	0.067
Aluminium (Al)	mg/l	0.18 mg/l	*0.05*	*0.05*	0
Iron (Fe)	mg/l	-	*0.013*	0.039	0.026
Manganese (Mn)	mg/l	0.18 mg/l	*0.018*	*0.042*	0.024
Chromium (Cr)	mg/l	-	*0.013*	*0.013*	0
Sodium Adsorption Ratio	SAR	-	1.2	1.23	0.03
Bicarbonate alkalinity	mg CaCO3/l	-	180	163	-17
Carbonate alkalinity	mg CaCO3/l	-	2.5	2.5	0
Langelier Saturation Index	LSI	-	0.33	0.27	-0.06
Calcium hardness	mg CaCO3/l	-	104	81	-23
Magnesium hardness	mg CaCO3/l	-	121	94	-27

When comparing MP06 to locality MP03 (the furthest upstream and furthest downstream localities monitored), slight increases in the average concentrations of some of the variables are observed (Table 7-4). This is not unexpected as the concentrations of dissolved substances do generally increase as they are carried downstream by the flow of the river.

Table 7-4: Spatial Assessment indicating potential impacts on the aquatic environment of the Olifants River during April to June 2019.

VARIABLE	UNIT	DCM East WUL Water Resource Limits	Locality		CALCULATED CHANGE
			Upstream	Downstream	
			MP06	MP03	
pH @ 25°C	pH	6.5/8.4	7.87	8	0.13
Electrical conductivity (EC) @ 25°C	mS/m	-	50.9	62.2	11.3
Total Dissolved solids @ 180°C	mg/l	650.0 mg/l	331	415	84
Total hardness	mg CaCO3/l	-	175	225	50
Calcium (Ca)	mg/l	-	35	41.7	6.7
Magnesium (Mg)	mg/l	-	21.3	29.3	8
Sodium (Na)	mg/l	21.12 mg/l	35.3	42	6.7
Potassium (K)	mg/l	-	6.13	7.07	0.94
Total alkalinity	mg CaCO3/l	-	169	180	11
Chloride (Cl)	mg/l	25.0 mg/l	21	26	5
Sulphate (SO_4)	mg/l	400.0 mg/l	71	115	44
Nitrate (NO_3) as N	mg/l	-	*0.133*	*0.05*	-0.083
Ammonium (NH_4) as N	mg/l	-	*0.117*	0.133	0.016
Orthophosphate (PO_4) as P	mg/l	-	*0.05*	*0.05*	0
Fluoride (F)	mg/l	-	0.867	0.633	-0.234
Aluminium (Al)	mg/l	0.18 mg/l	*0.05*	*0.05*	0
Iron (Fe)	mg/l	-	0.062	*0.013*	-0.049
Manganese (Mn)	mg/l	0.18 mg/l	*0.013*	*0.018*	0.005
Chromium (Cr)	mg/l	-	*0.013*	*0.013*	0
Sodium Adsorption Ratio	SAR	-	1.17	1.2	0.03
Bicarbonate alkalinity	mg CaCO3/l	-	181	180	-1
Carbonate alkalinity	mg CaCO3/l	-	2.5	2.5	0
Langelier Saturation Index	LSI	-	0.15	0.33	0.18
Calcium hardness	mg CaCO3/l	-	87	104	17
Magnesium hardness	mg CaCO3/l	-	88	121	33

7.4 Additional Sampling in Adjacent Rivers

A site visit was undertaken on the 5th of February 2020 to assess the condition of the project site with respect to surface water resources and to sample streams close to the project site.

7.4.1 Sampling Points

The assessment and interpretation of surface water quality was undertaken for five points on the Olifants River and its tributaries upstream and downstream of the DECM to cover the proposed extension of the mine. The surface water quality results and coordinates of sampling points are presented in Table 7-5. The water quality was benchmarked against the DECM WUL and the Aquatic Ecosystems water quality guidelines (DWA, 1996).

7.4.2 Discussion of the Additional Sampling Water Quality Results

The following interpretations are made based on the laboratory results obtained for the 5 sites:

The water quality was analysed for 5 sampling points namely, UPSW1, UPSW2, WPSW3, UWBSW4 and DWBSW5. As per the DECM Water Resource WUL, the concentration of pH, Cl, SO_4 and Al for all the sampled sites fall within the acceptable DECM WUL limit. Sodium concentration at sites UPSW1, UPSW2 and UWBSW3 and DWBSW5 lies above the acceptable DECM WUL limits. This elevated sodium concentrations possibly come from grazing animals in the area or from mining residues.

The TDS concentration for site DWBSW5 has exceeded the DECM WUL limit with a possible source being activities of grazing animals in the area. Fluoride at site UPSW4 lies above the acceptable SAWQ guidelines for Aquatic Ecosystem but complies at all other monitoring sites.

The concentrations of Zinc and Aluminium lie above the acceptable SAWQG for Aquatic Ecosystem. High natural levels of zinc in river water are usually associated with higher concentrations of other metals such as lead and cadmium which are, however, below detection levels at this mine. Possible sources of elevated zinc can be coal mining activities in the area. Although Aluminium levels exceed the SAWQG for Aquatic Ecosystem, the parameter is within the DECM WUL standard.

Table 7-5: Surface Water Quality Results for February 2020

Parameter (mg/L)	UPSW1	UPSW2	WPSW3	UWBSW4	DWBSW5	DCM East WUL Water Resource Limits	SAWQG TWQR for Aquatic Ecosystem
	-26.253284; 29.405361	-26.278296; 29.387332	-26.231964; 29.329921	-26.280835; 29.316266	-26.229095; 29.290761		
pH	7.5	8.1	7.6	7.4	7.6	6.5 to 8.4	NS
Electrical Conductivity	42.3	82.7	63.3	42.9	79.6	NS	NS
Total Dissolved Solids	374	546	548	402	730	650	NS
Suspended Solids	6.7	9.3	20	39	14.0	NS	NS
Total Alkalinity as CaCO3	160	452	280	160	292	NS	NS
P-Alkalinity as CaCO3	<5	<5	<5	<5	<5	NS	NS
Chloride as Cl	13	4	24	25	16	25	NS
Sulphate as SO4	35	43	48	44	154	400	NS
Fluoride as F	0.5	0.3	0.7	1.0	0.7	NS	0.75
Nitrate as N	2.8	0.2	0.2	0.2	0.2	NS	NS
Nitrite as N	<0.05	<0.05	<0.05	0.1	<0.05	NS	NS
Bromide as Br *	2.1	1.2	3.7	3.0	2.3	NS	NS
Total Phosphate as P	<0.2	<0.2	<0.2	<0.2	<0.2	NS	NS
Free & Saline Ammonia as N	0.2	0.2	0.2	0.3	0.2	NS	NS
Silver	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Aluminium	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	0.18	0.005
Arsenic	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	0.01
Gold	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Boron	0.026	0.014	0.015	0.013	0.006	NS	NS
Barium	0.100	0.085	0.075	0.108	0.098	NS	NS
Beryllium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Bismuth	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Calcium	43	80	45	30	74	NS	NS
Cadmium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	0.0004
Cerium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Cobalt	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Chromium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	0.007
Caesium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Copper	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	0.0014
Iron	0.029	< 0.025	0.100	0.553	< 0.025	NS	NS
Gallium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Mercury	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Potassium	4.8	4.2	8.0	5.3	6.1	NS	NS
Lanthanum	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Lithium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Lutetium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Magnesium	16	57	45	21	55	NS	NS
Manganese	< 0.025	< 0.025	1.13	2.25	< 0.025	0.18	0.18
Molybdenum	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Sodium	22	27	20	25	23	21.12	NS
Nickel	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Osmium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Phosphorus	< 0.010	< 0.010	< 0.010	< 0.010	0.032	NS	NS
Lead	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	0.0012
Palladium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Praseodymium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Platinum	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Rubidium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Rhodium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Ruthenium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Antimony	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Scandium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Selenium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	0.002
Terbium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Tellurium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Thorium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Thulium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Uranium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Vanadium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS
Zinc	0.062	0.057	0.019	0.035	0.012	NS	0.002
Zirconium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS

KEY:	
Exceeds the standard	(green)
No Standard	NS

8 Storm Water Management Plan Update

During the site visit on the 5th of February 2020 an assessment of the DECM storm water management infrastructure was conducted. Onsite assessment findings led to the conclusion that DECM has a well-established and operational storm water management system which will adequately cover the newly proposed activities which fall within the SWMP. The runoff in the mining areas is being treated as dirty water and contained for reuse. Diversion channels are in place to divert clean water from dirty areas and join it back to the natural environment. The specific DECM project area assessment observations are detailed in this section.

Identified dirty water areas include the following:

- Discard Dumps;
- Coal Stockpiles;
- Topsoil Stockpiles;
- Waste Rock Dumps;
- Mine Plant area;
- Railway Loadout Terminal;
- Workshop area;
- Mine Pits; and
- Sumps.

Field investigation indicated that separation of clean and dirty catchments is in place as recommended by the GN704 guidelines. Concrete-lined channels are used to convey dirty water from dirty areas such as Discard Dumps to the Pollution Control Dam (PCD) (see Figure 8.1). Perimeter berms are in place and these are used divert clean water so that it does not mix-up with contaminated storm water from dirty catchments. The storm water system for the mine is generally operational, and in compliance to best practice standards. For details of the existing storm water management plan layout refer to previous reports for the site (Digby Wells, 2015; SRK Consulting, 2016). Regular maintenance of the system should be conducted so that storm water channels will not silt-up due to sediments carried by overland flow. Berms should be checked and maintained in the event of breaching by heavy runoff events during the rainy season. Dimensions of typical existing dirty water channels at DECM are presented in Table 8-1.

Table 8-1: General dimensions of lined dirty storm water channels at DECM

Component	Classification	Cross-Section	Bottom Width (m)	Left Slope (m/m) (H:V)	Right Slope (m/m) (H:V)
Channel or Drain	Dirty	Trapezoidal	1	2	2

8.1 Discard Dumps

Discard dump penstock outlets discharge seepage into an open concrete channel (Figure 8.1) at the foot of the dump which passes through a silt trap before being pumped to PCDs through a pipeline.

Figure 8.1: Trapezoidal channel collecting water from discard dump penstock outlets

8.2 Workshops and Plant Area

Existing trapezoidal concrete channels collect dirty storm runoff from the Mine Plant, Workshops, Run of Mine (RoM) Stockpile and convey it to the PCDs.

Several conveyor transfer points are located within the dirty areas thus any dirty water originating at these points falls within the dirty water system.

8.3 Pollution Control Dams

Three PCDs exist at the DECM site for containment of dirty water. Silt traps filter sediments from dirty water before it gets into the PCDs (Figure 8.2). The PCDs are adjoined to allow overflow from one dam to the other in cases of high rainfall events. Dirty runoff from the Railway Load-out Terminal (RLT) collects in concrete-lined drains and pumped for containment to a PCD.

Figure 8.2: Side view of PCDs at DECM project site

8.4 Storm water management plan for proposed surface infrastructure

The proposed infrastructure which include Workshop, Change House, Offices, Run of Mine (ROM) Stockpile Conveyor at portal, Portal ventilation fan and Stone Dust Silo will all be located within an area which already has existing storm water management infrastructure in place. Their footprint should be kept within this area and should be integrated into the existing storm water management plan.

The areas where the proposed Ventilation Shaft and the new 11kV Substation will be installed should be developed to minimise the extent of paved surfaces at the ground level to control runoff and reduce erosion that results from accelerated flow velocities. These areas will be treated as clean catchments which will not require any diversion storm water infrastructure.

9 Water Balance Update

9.1 Inflows and Outflows

Inflows or sources of water at the DECM are presented in Table 9-1. Water outflows and or uses at the DECM are presented in

Table 9-2.

Table 9-1: Water inflows or sources at the DECM

Process Unit	Inflow
Mine Plant	Erickson Dam 1,2,3

Co-disposal Facility	Mine Plant
	Rainfall
Return Water Dam and PCD	Pit Dewatering
	Coal Stockpile Area (Runoff)
	Rainfall
	Tailing Storage Facility
	Sewage Treatment Plant
Sewage Treatment Plant	Offices and Change House
PCD (Railway Loadout Area)	Railway Loadout Terminal (Runoff)
Offices and Change House	Water Treatment Plant
Water Treatment Plant	Erickson Dam 1,2,3
Erickson Dam 1,2,3	TNC Mines
	Rainfall
	Return Water Dam
Pit 1	Rainfall/Runoff
	Groundwater inflow
Pit 2 & Dorstfontein West Operations (U/G Workings)	Rainfall
	Runoff
	Groundwater inflow
Pit 3 U/G Mining Extension (Seam 4)	Rainfall
	Runoff
	Groundwater inflow
Overburden Dump	Rainfall/Runoff

Table 9-2: Water outflows and/or uses at the DECM

Process Unit	Outflow
Mine Plant	Co-Disposal Facility
	Moisture in Product
	Dust Suppression
Co-disposal Facility	Evaporation
	Return Water Dam
Return Water Dam and PCD	Evaporation
	Erickson Dam 1,2,3

Sewage Treatment Plant	Return Water Dam and PCD
PCD	Evaporation
Offices and Change House	Consumption
	Offices and Change House
Water Treatment Plant	Offices and Change House
Erickson Dam 1,2,3	Evaporation
	Mine Plant
	Dust Suppression
	Water Treatment Plant
Pit 1	Losses (Evaporation/Storage)
	Recharge/Infiltration
Pit 2 & Dorstfontein West Operations (U/G Workings)	Losses (Evaporation/Storage)
	De-watering
	Recharge/infiltration
Pit 3 U/G Mining Extension (Seam 4)	Evaporation
	De-watering
Overburden Stockpile	Losses

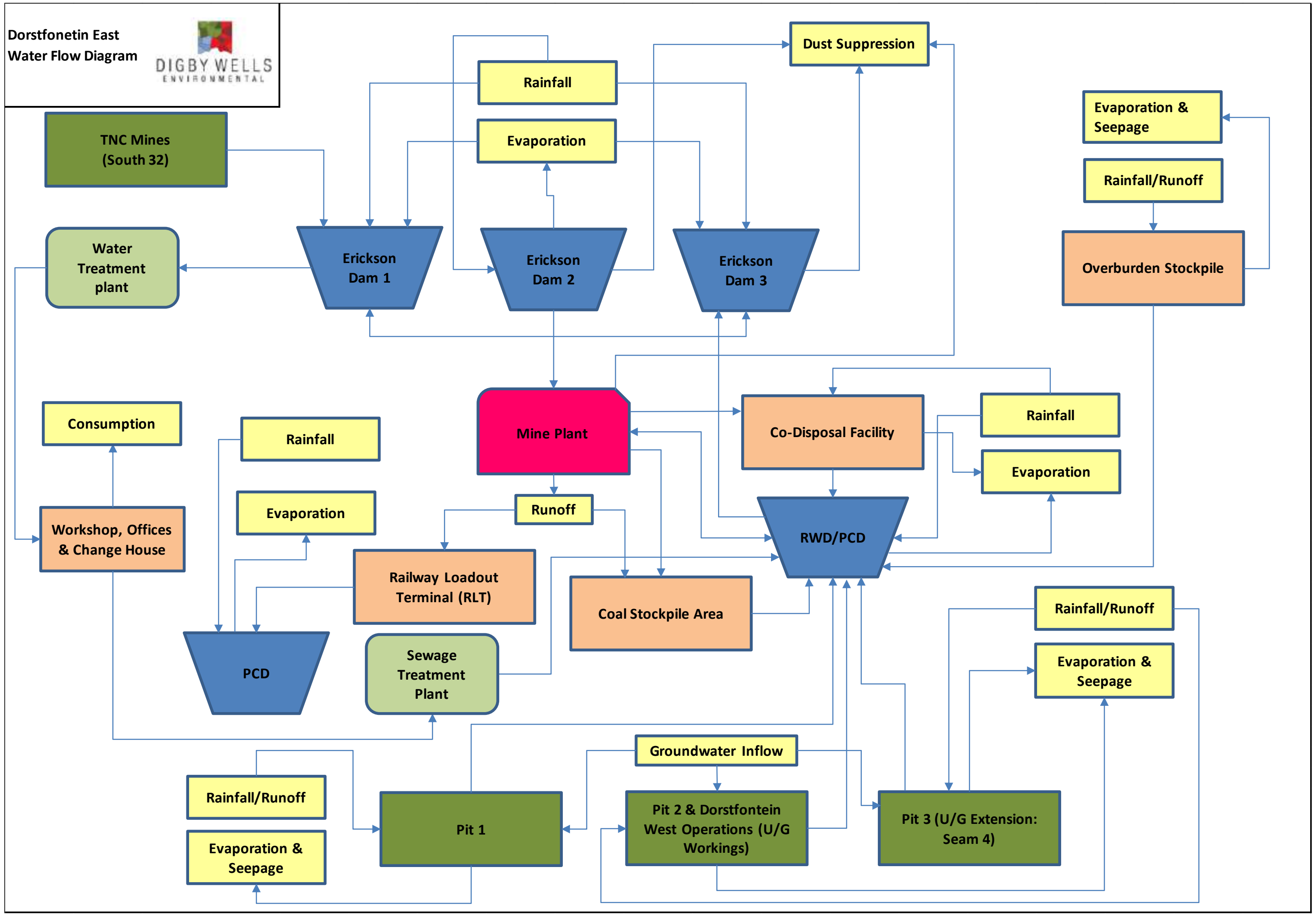


Figure 9.1: Water flow diagram for DECM

9.2 Calculations and Assumptions

The following assumptions and calculations were made to develop and update the water and salt balance for the DECM operations:

The Run of Mine (RoM) is 2 156 648 tons per annum as provided by the client (Personal Communication with Mr Lorenzo Van Den Heever, 2017). This tonnage was used to calculate the amount of interstitial moisture present in the coal product based on the following two assumptions:

- The mined product is a hard coal containing approximately 53% carbon and less moisture (World Coal Institute, 2005).
- Moisture in product was assumed to be 7 % of the ROM (Donahue and Rais, 2009).

9.2.1 Rainfall and Evaporation Used in the Water Balance

Monthly rainfall data used in the DECM water balance is presented in Table 9-3. This was derived from monthly rainfall time series records of 89 years from 1920 to 2009 (WRC, 2015). Areas of the open storage facilities were obtained from the previous DECM water balance report (GCS, 2018).

Table 9-3: Average monthly rainfall for Quaternaries B11B and B11D (WRC, 2015)

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rainfall (mm)	72	111	110	115	91	76	42	17	8	6	7	23

Water stored in open storage facilities will evaporate, when available, and the amount of water expected to evaporate was determined with the aid of S-Pan evaporation values for the catchment (WRC, 2015).

A mean annual precipitation of 676 mm and surface areas presented in Table 9-5 were used to calculate inflows into an open water body, such as dams.

Annual unit runoff (per square meter) which corresponds to 7% of MAP was used to calculate runoff/seepage from the Railway Loadout Terminal and Mine Plant areas that is contained in the PCDs.

A mean annual Symons Pan Evaporation (evaporation expected from an open body of water) for the area of 1 599 mm/annum distributed as indicated in Table 9-4, was applied to water facilities based on measured surface areas as presented in Table 9-5. Associated rainfall volumes falling directly on open storage facilities are presented in Table 9-5.

Groundwater inflows were estimated to be between 800 m^3/day and 2 500 m^3/day depending on the mined area (Digby Wells, 2021) for the period between 2011 and 2018. An average dewatering volume of 1750 m^3/day was used which was split between Pit 2 and Pit 3. Dewatering for the pits is lower than computed groundwater inflows (Digby Wells, 2021).

Runoff from the overburden stockpile was assumed to be 40% of rainfall.

- It is assumed that Pits 1 and 2 are being allowed to store sub-surface water in the backfilled spoils. Infiltration and recharge into the spoils were assumed to be 60% of rainfall/runoff (Hodgson & Krantz, 1998).
- Losses due to seepage from Pits 1 and 2 were assumed to be 40% of water received.

Table 9-4: Average monthly Symons Pan evaporation for Quaternaries B11B and B11D (WRC, 2015)

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation(mm)	169	159	175	172	143	142	156	92	74	81	108	140

Table 9-5: Data used for the DECM Water and Salt balance

Mine Facility	Area (m^2)	Rainfall (m^3)	Evaporation (m^3)	Runoff (m^3)
Co-disposal Facility	120 776	83 335	193 121	-
Return Water Dam and PCD	75 502	52 096	117 179	-
Erickson Dam 1,2,3	1 590	1 097	2 542	-
Coal Stockpile Area	20 979	-	-	1 028
Railway Loadout Terminal	48 777	-	-	2 390
PCD (RLT)	8 151	5 624	8 014	-
Mine Plant	85 185	-	-	4 174
Pit 1	1 792 730	-	-	87 844
Pit 2	848 965	-	-	41 599
Pit 2 surface water	10 857	7491	16828	-
Pit 3	216 960	-	-	10 631
Pit 3 surface water	12 200	-	-	-
Overburden Stockpile	592 313	-	-	245 218

9.3 Water Balance

Calculated annual and monthly water balances for the DECM are presented in Table 9-6 and Table 9-7, respectively. The water balance indicates a water volume for dust suppression amounting to 344 032 m^3/annum and this water is obtained from Erickson Dams and the Mine Plant. Most of this water is used during the dry season where high levels of dust emissions are expected since rainfall will be minimal or absent. The largest amount of water at DECM circulates within the Erickson Dams 1, 2 & 3 with an approximate value of 1 352 260 m^3/annum. The RWD/PCD and Mine Plant follow in water usage, having average volumes of 1 086 045 m^3/annum and 968 466 m^3/annum, respectively. Potable water which is used at the Mine Offices, Workshop and Change houses totals 62 057 m^3/annum. This water, originally from Erickson Dams 1, 2 & 3, is treated at the WTP before being pumped for use at the workshop, offices and change houses. The volume of effluent treated at the sewage treatment plant is in the order of 55 851 m^3/annum.

Table 9-6: Annual average water balance for the DECM

Annual Average Water Balance for Dorstfontein East Coal Mine					
		Water In		**Water Out**	**Balance**
Facility Name	**Water Circuit/stream**	**Quantity (m^3/a)**	**Water Circuit/stream**	**Quantity (m^3/a)**	
Erickson Dams 1, 2 & 3			To: Evaporation	2 561	
	From: Rainfall	1 075	To: Mine Plant	964 435	
	From: TNC Mines (South32)	294 365	To: Water Treatment Plant	62 057	
	From: RWD/PCD	1 056 820	To: Dust Suppression	323 206	
	Total	**1 352 259.74**		**1 352 259.74**	-
Water Treatment Plant	From: Erickson Dams 1,2 & 3	62 057	To: Offices; Workshop & Changehouse	62 057	
	Total	**62 057.00**		**62 057.00**	-
Mine Plant			To: Co-Disposal Facility	876 099	
	From: Erickson Dams 1,2 & 3	964 435	To: Moisture in Product (Interstitial)	67 510	
	From: Runoff	4 031	To: Dust Suppression	20 826	
			To: Coal Stockpile Area	2 015	
			To: Railway Load Terminal (RLT)	2 015	
	Total	**968 465.60**		**968 465.60**	-
Co-Disposal Facility	From: Rainfall	81 637	To: Evaporation	194 570	
	From: Mine Plant	876 099	To: RWD/PCD	763 166	
	Total	**957 736.36**		**957 736.36**	-
RWD/PCD	From: Rainfall	51 035			
	From: Pit Dewatering (Pits 1,2 & 3)	15 684			
	From: Co-Disposal Facility	763 166	To: Evaporation	29 225	
	From: Overburden Stockpile	130 783	To: Erickson Dams 1,2 & 3	1 056 820	
	From: Coal Stockpile Area	69 526			
	From: Sewage Treatment Plant	55 851			
	Total	**1 086 045.11**		**1 086 045.11**	-
PCD (RLT)	From: Rainfall	5 510	To: Evaporation	7 818	
	From: Runoff (from RLT)	2 308			
	Total	**7 817.51**		**7 817.51**	-
Coal Stockpile Area	From: Mine Plant	67 510			
	From: Runoff (from Plant Area)	2 015	To: RWD/PCD	69 526	
	Total	**69 525.75**		**69 525.75**	-
Workshop; Offices and Changehouse			To: Consumption	6 206	
	From: Water Treatment Plant	62 057	To: Sewage Treatment Plant	55 851	
	Total	**62 057.00**		**62 057.00**	
Sewage Treatment Plant	From: Workshop; Offices & Changehouse	55 851	To: RWD/PCD	55 851	
	Total	**55 851.30**		**55 851.30**	-
Pit 1	From: Rainfall/Runoff	121 178	To: Evaporation	308 483	
	From: Groundwater inflow	401 675	To: Seepage/reacharge	209 141	
			To: RWD/PCD	5 228	
	Total	**522 852.50**		**522 852.50**	-
Pit 2 Underground Workings	From: Rainfall/Runoff	7 339	To: Evaporation	113 305	
	From: Groundwater inflow	190 216	To: Seepage/reacharge	79 022	
			To: RWD/PCD	5 228	
	Total	**197 554.19**		**197 554.19**	-
Pit 3 U/G Extension: Seam 4	From: Rainfall/Runoff	9 688	To: Evaporation	29 751	
	From: Groundwater inflow	48 610	To: Seepage/reacharge	23 319	
			To: RWD/PCD	5 228	
	Total	**58 298.22**		**58 298.22**	-
Overburden Stockpile	From: Rainfall/Runoff	160 147	To: Evaporation	29 364	
			To: RWD/PCD	130 783	
	Total	**160 147.27**		**160 147.27**	-
Total Water Balance		**5 560 667.54**		**5 560 667.54**	

Table 9-7: Monthly average water balance for the DECM

Monthly Average Water Balance for Dorstfontein East Coal Mine					
Facility Name	Water Circuit/stream	Water In Quantity (m3/mon)	Water Circuit/stream	Water Out Quantity (m3/mon)	Balance
Erickson Dams 1, 2 & 3			To: Evaporation	213	
	From: Rainfall	90	To: Mine Plant	80 370	
	From: TNC Mines (South32)	24 530	To: Water Treatment Plant	5 171	
	From: RWD/PCD	88 068	To: Dust Suppression	26 934	
	Total	**112 688.31**		**112 688.31**	-
Water Treatment Plant					
	From: Erickson Dams 1,2 & 3	5 171	To: Offices; Workshop & Changehouse	5 171	
	Total	**5 171.42**		**5 171.42**	-
Mine Plant			To: Co-Disposal Facility	73 008	
	From: Erickson Dams 1,2 & 3	80 370	To: Moisture in Product (Interstitial)	5 626	
	From: Runoff	336	To: Dust Suppression	1 735	
			To: Coal Stockpile Area	168	
			To: Railway Load Terminal (RLT)	168	
	Total	**80 705.47**		**80 705.47**	-
Co-Disposal Facility					
	From: Rainfall	6 803	To: Evaporation	16 214	
	From: Mine Plant	73 008	To: RWD/PCD	63 597	
	Total	**79 811.36**		**79 811.36**	-
RWD/PCD	From: Rainfall	4 253			
	From: Pit Dewatering (Pits 1,2 & 3)	1 307			
	From: Co-Disposal Facility	63 597	To: Evaporation	2 435	
	From: Overburden Stockpile	10 899	To: Erickson Dams 1,2 & 3	88 068	
	From: Coal Stockpile Area	5 794			
	From: Sewage Treatment Plant	4 654			
	Total	**90 503.76**		**90 503.76**	-
PCD (RLT)					
	From: Rainfall	459	To: Evaporation	651	
	From: Runoff (from RLT)	192			
	Total	**651.46**		**651.46**	-
Coal Stockpile Area					
	From: Mine Plant	5 626			
	From: Runoff (from Plant Area)	168	To: RWD/PCD	5 794	
	Total	**5 793.81**		**5 793.81**	-
Workshop; Offices and Changehouse					
			To: Consumption	517	
	From: Water Treatment Plant	5 171	To: Sewage Treatment Plant	4 654	
	Total				
Sewage Treatment Plant					
	From: Workshop; Offices & Changehouse	4 654	To: RWD/PCD	4 654	
	Total	**4 654.28**		**4 654.28**	-
Pit 1					
	From: Rainfall/Runoff	10 098	To: Evaporation	25 707	
	From: Groundwater inflow	33 473	To: Seepage/recharge	17 428	
			To: RWD/PCD	436	
	Total	**43 571.04**		**43 571.04**	-
Pit 2 Underground Workings					
	From: Rainfall/Runoff	612	To: Evaporation	9 442	
	From: Groundwater inflow	15 851	To: Seepage/recharge	6 585	
			To: RWD/PCD	436	
	Total	**16 462.85**		**16 462.85**	-
Pit 3 U/G Extension: Seam 4					
	From: Rainfall/Runoff	807	To: Evaporation	2 479	
	From: Groundwater inflow	4 051	To: Seepage/reacharge	1 943	
			To: RWD/PCD	436	
	Total	**4 858.18**		**4 858.18**	-
Overburden Stockpile					
	From: Rainfall/Runoff	13 346	To: Evaporation	2 447	
			To: RWD/PCD	10 899	
	Total	**13 345.61**		**13 345.61**	-
Total Water Balance		**458 217.54**		**458 217.54**	

9.4 Salt Balance

Annual average water flow volumes were converted to daily flow volumes and multiplied by the daily SO_4 concentration to produce daily average W&SB (See Table 9-8). Sulphates were used in the W&SB because sulphur is recognised as one of the major impurities in coal with a concentration of up to 10% of the coal ore (Zhou, 1989). Although TDS could have been used, the effect of the abundant pollutant (sulphur) would have been masked since TDS accounts for all dissolved salts including trace-elements.

The Salt Balance shows that Erickson Dams and the Mine Plant have higher concentrations of dissolved salts amounting to 230.38 kg/m^3/day and 171.87 kg/m^3/day, respectively. These facilities should closely be monitored in case of any spills or seepages into the environment for immediate detection, mitigation and/or management. The RWD/PCD is lined and total salts in circulation amount to 12.55 kg/m^3/day. Water levels in the RWD/PCD should also be monitored to prevent the occurrence of overflows.

Table 9-8: Daily average water and salt balances for the DECM

Daily Average Water and Salt Balance for Dorstfontein East Coal Mine							
Facility Name	Water Circuit/stream	Salt In Quantity (Kg/m^3)/day	Water In Quantity (m^3/day)	Water Circuit/stream	Salt Out Quantity (m^3/day)	Water Out Quantity (kg/m^3)/da	Balance
Erickson Dams 1, 2 & 3				To: Evaporation	-	7	
	From: Rainfall	0.034	3	To: Mine Plant	170.48	2 635	
	From: TNC Mines (South32)	4.5	804	To: Water Treatment Plant	2.03	170	
	From: RWD/PCD	226	2 887	To: Dust Suppression	57.87	883	
	Total	**230.38**	**3 694.70**		**230.38**	**3 694.70**	-
Water Treatment Plant				To: Offices; Workshop & Changehouse	1.96	170	
	From: Erickson Dams 1,2 & 3	11.06	170	To: Salt residue remaining in WTP	9.10		
	Total	**11.06**	**169.55**		**11.06**	**169.55**	-
Mine Plant				To: Co-Disposal Facility	5.77	2 394	
	From: Erickson Dams 1,2 & 3	172	2 635	To: Moisture in Product (Interstitial)	14.43	184	
	From: Runoff	0.0007	11	To: Dust Suppression	4.45	57	
				To: Coal Stockpile Area	146.78	5.5	
				To: Railway Load Terminal (RLT)	0.43	5.5	
	Total	**171.87**	**2 646.08**		**171.87**	**2 646.08**	-
Co-Disposal Facility	From: Rainfall	2.6	223	To: Evaporation	-	532	
	From: Mine Plant	1.7	2 394	To: RWD/PCD	4.22	2 085	
	Total	**4.22**	**2 616.77**		**4.22**	**2 616.77**	-
RWD/PCD	From: Rainfall	1.61	139				
	From: Pit Dewatering (Pits 1,2 & 3)	2.11	43				
	From: Co-Disposal Facility	5.03	2 085	To: Evaporation	-	80	
	From: Overburden Stockpile	0.86	357	To: Erickson Dams 1,2 & 3	12.55	2 887	
	From: Coal Stockpile Area	0.46	190				
	From: Sewage Treatment Plant	2.49	153				
	Total	**12.55**	**2 967.34**		**12.55**	**2 967.34**	-
PCD (RLT)	From: Rainfall	0.174	15	To: Evaporation	-	21	
	From: Runoff (from RLT)	0.001	6.3	To: Salt residue remaining in PCD (RLT)	0.17		
	Total	**0.17**	**21.36**		**0.17**	**21.36**	-
Coal Stockpile Area	From: Mine Plant	0.13	184	To: RWD/PCD	0.13	190	
	From: Runoff (from Plant Area)	0.004	5.5				
	Total	**0.13**	**189.96**		**0.13**	**189.96**	-
Workshop; Offices and Changehouse				To: Consumption	0.20	17	
	From: Water Treatment Plant	2.0	170	To: Sewage Treatment Plant	1.80	153	
	Total	**2.00**	**169.55**		**2.00**	**169.55**	-
Sewage Treatment Plant	From: Workshop; Offices & Changehouse	2.49	153	To: RWD/PCD	2.49	153	
	Total	**2.49**	**152.60**		**2.49**	**152.60**	-
Pit 1	From: Rainfall/Runoff	16	331	To: Evaporation	-	843	
	From: Groundwater inflow	54	1 097	To: Seepage/reacharge	28.09	571	
				To: RWD/PCD	42.14	14	
	Total	**70.24**	**1 428.56**		**70.24**	**1 428.56**	-
Pit 2 Underground Workings	From: Rainfall/Runoff	0.08	20	To: Evaporation	-	310	
	From: Groundwater inflow	25.55	520	To: Seepage/reacharge	10.62	216	
				To: RWD/PCD	15.02	14	
	Total	**25.64**	**539.77**		**25.64**	**539.77**	-
Pit 3 U/G Extension: Seam 4	From: Rainfall/Runoff	0.11	26	To: Evaporation	0.00	81	
	From: Groundwater inflow	6.53	133	To: Seepage/reacharge	3.13	64	
				To: RWD/PCD	3.51	14	
	Total	**6.64**	**159.28**		**6.64**	**159.28**	-
Overburden Stockpile	From: Rainfall/Runoff	1.05	438	To: Evaporation	-	80	
				To: RWD/PCD	1.05	357	
	Total	**1.05**	**437.56**		**1.05**	**437.56**	-
Total Water & Salt Balances		**538.43**	**15 193.08**		**538.43**	**15 193.08**	

10 Impact Assessment

The surface water impact assessment was completed in the manner described in Section 4.6. The potential surface water impacts were assessed considering the project lifetime including Construction, Operation and Decommissioning/Closure phases. Similar projects were researched on to identify additional impacts and risks and were compared to the context of the proposed development.

10.1 Construction Phase

Activities during the construction phase that may have potential impacts (Table 10-1) on the surface water resources are described and the appropriate management/mitigation measures are provided below.

Table 10-1: Interaction and Impacts of Activity

Interaction	Impact
Site preparation and excavations. Stockpiling of spoils and discard.	Sedimentation and siltation of nearby watercourses most likely leading to deteriorated water quality
Washing off, of oils, fuels and other hydrocarbon spills during the construction of facilities such as offices, ablutions, storerooms, workshops, storage dams, process plant, roads, pipelines, power lines and conveyors.	Surface water contamination and deterioration of water quality

10.1.1 Impact Description: Sedimentation and possible siltation of nearby watercourses due to site clearance and excavations

Disturbance of soils during land clearance can lead to sedimentation and possible siltation of nearby watercourses.

10.1.2 Impact Description: Surface water contamination from hydrocarbon materials including oils and fuels

Oils, fuels and other hydrocarbons from earthmoving equipment used during the construction of facilities such as offices, ablutions, storerooms, workshops, storage dams, process plant, roads, pipelines, power lines and conveyors. This impact will lead to the deterioration of water quality, affecting aquatic life and downstream water users.

10.1.2.1 Management/ Mitigation Measures

The following mitigation measures are recommended during the construction activities:

- Site preparation for the construction of infrastructure should be confined to the existing development footprint area to minimise disturbance of soils and the probability of sedimentation and siltation of the nearby watercourses.
- Ensure that additional proposed infrastructure should be within the existing storm water management plan as proposed, to ensure continued control of any dirty runoff on site.
- Construction should be undertaken during the dry winter period, where possible, to reduce sedimentation in nearby watercourses since there will be minimal to no occurrence of rainfall.
- All storage areas (fuels, paints, oils) used at the construction camp should be appropriately bunded and spill kits should be in place, and construction workers trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills.

Table 10-2: Impact significance rating for the construction phase

Impact: Sedimentation and possible siltation of nearby watercourses due to construction of additional infrastructure			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	5	The impact will likely occur for the duration of the project	40-Minor (negative)
Intensity	2	This will have minor to medium-term impacts resulting in a reduction in water quality for immediate downstream users and the aquatic life	
Spatial scale	3	The impacts will be localised to the nearby water resources from where the silt is being generated to the immediate downstream	
Probability	4	Without appropriate mitigation, it is probable that this impact will occur	
Post-mitigation			
Duration	2	The impact will likely only occur during the construction phase	14-Negligible (negative)
Intensity	2	Should the impact occur, it will have minor medium-term impacts resulting in a reduction in water quality for downstream users and the aquatic life	

Impact: Sedimentation and possible siltation of nearby watercourses due to construction of additional infrastructure			
Dimension	**Rating**	**Motivation**	**Significance**
Spatial scale	3	The impacts will be localised to the nearby water resources from where the silt is being generated to the immediate downstream	
Probability	2	If mitigation measures are correctly implemented, it will be rare/improbable for this impact to occur.	

Impact: Surface water contamination from hydrocarbon materials including oils and fuels during construction			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	5	The impact will mainly occur during the construction phase but may occur throughout the LOM	55-Minor (negative)
Intensity	4	This will moderately impact the water quality and the ecosystem functionality for downstream users	
Spatial scale	2	Limited to the site and its immediate surroundings	
Probability	5	Likely: The impact may occur	
Post-mitigation			
Duration	2	The impact will likely only occur during the construction phase	12-Negligible (negative)
Intensity	2	Minor effects on biological or physical environment	
Spatial scale	2	Limited to the site and its immediate surroundings	
Probability	2	With the existing measures already in place. It will be rare/improbable for this impact to occur.	

10.2 Operation Phase

Activities during the operation phase that may have potential impacts (Table 10-3) on the surface water resources are described and the appropriate management/mitigation measures are provided below.

Table 10-3: Interaction and Impacts of Activity

Interaction	Impact
Hydrocarbon and chemical spillages and leakages from equipment, moving vehicles and machinery during mining, processing, loading and hauling of the product coal	Surface water contamination by hydrocarbon waste and deterioration of surface water quality
Runoff from contaminated areas such as Waste Rock Dumps (WRDs), STP and discard processing plant may pollute nearby surface water resources.	Surface water contamination by runoff from dirty areas and deterioration of surface water quality.

10.2.1 Impact Description: Surface water contamination from spillage and leakage of hydrocarbon waste

Operational machinery and haulage trucks at the mine site are potential sources of hydrocarbon and chemical spills and leakages. When not properly managed hydrocarbon and chemical spills and leakages will contaminate surface water resources in proximity to the DCM operations. The impact arising from hydrocarbon spillage and leakage will extend into the decommissioning phase of the project, when infrastructure will be demolished, and demolition material transported to final designated areas.

10.2.2 Impact Description: Surface water contamination by runoff from dirty water areas.

Water contamination may occur as a result of runoff from contaminated surfaces and from any dirty water discharges or effluent within the mine into nearby watercourses. The dirty water areas include Waste Rock Dumps (WRDs), STP, Mine Plant and discard processing plant. Contamination of surface water resources will lead to the deterioration of water quality affecting aquatic ecosystems and downstream water users.

10.2.2.1 Management/ Mitigation Measures

The mitigation measures described below are currently being undertaken on the existing DCM operations and these should continue to ensure as low impacts on water resources as practically possible.

- Ensure that runoff from dirty areas is being directed to the existing storm water management infrastructure and should not be allowed to flow into the watercourses, unless DWS discharge authorisation has been granted upon compliance with relevant effluent discharge standards as stipulated in the National Water Act (NWA);
- Water quality monitoring should continue downstream and upstream of the mine site, and within all surface water circuits at the mine to detect any contamination arising from operational activities;

- The hydrocarbon and chemical storage areas should continue to be located on hard-standing areas (paved or concrete surface that is impermeable), roofed and bunded in accordance with SANS1200 specifications. This helps to prevent mobilisation of leaked hazardous substances;
- Mine workers should be trained in the use of spill kits to contain and immediately clean up any leakages or spills and inductions should be conducted for new employees.
- Servicing of vehicles and machinery should continue being conducted at designated, appropriately paved areas. All used oils should be disposed of by accredited vendors from the mine site; and
- Disposal of general and other forms of waste should continue to be done into clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites.

Table 10-4: Impact Significance Rating for Operational Phase

Dimension	Rating	Motivation	Significance
Impact: Water Contamination from hydrocarbon and chemical spillages and leakages			
Duration	5	The impact will only likely occur during the entire life of the project	48- Minor (negative)
Intensity	4	This will moderately impact the water quality and the ecosystem functionality for downstream users.	
Spatial scale	3	The impacts will be localised but may extend to downstream environments	
Probability	4	Without appropriate mitigation, it is probable that this impact will occur.	
Post-mitigation			
Duration	5	The impact will only likely occur for the LOM	27-Negligible (negative)
Intensity	2	With proper management of hydrocarbon and chemicals on site the impact will rarely be of significance and water quality in nearby watercourses will be maintained for optimal functionality of ecosystems and downstream	
Spatial scale	2	With proper management, the impact will be localised to relevant operational areas within the mine's footprint.	

Dimension	Rating	Motivation	Significance
Probability	3	With the implementation of recommended mitigation measures the impact's probability of occurrence will be very low.	

Dimension	Rating	Motivation	Significance
Impact: Water Contamination from runoff from dirty water areas			
Duration	6	The impact will remain for some time after the life of the mining project.	70-Minor (negative)
Intensity	4	Moderate environmental impairment of ecosystem function that may take several years to rehabilitate	
Spatial scale	4	The impacts will be localised to the nearby watercourses but may extend to the downstream water users	
Probability	5	The impact will occur	
Post-mitigation			
Duration	4	The impact will only likely persist in the absence of proper monitoring and maintenance of storm water management plan infrastructure on site.	32-Negligible (negative)
Intensity	2	Proper and continued implementation of storm water management plan and water quality monitoring will lower the intensity of the impact.	
Spatial scale	2	The impacts will be localised to incident areas due to effective stormwater control and water quality monitoring.	
Probability	4	The impact will probably occur	

10.3 Decommissioning Phase

Activities during the decommissioning and closure phase that potentially impact on surface water resources are described in this section. Potential impacts on the surface water resources are described (Table 10-5) and appropriate management/mitigation measures are provided below.

Table 10-5: Interactions and Impacts of Activity

Interaction	Impact
Disturbance of soils during removal of infrastructure at decommissioning	In-stream water quality and quantity deterioration from sedimentation and siltation
Spillages of hydrocarbons (oils, fuels and grease) by vehicles and machinery used during demolition and transportation of material from decommissioned infrastructure	Surface water contamination due to hydrocarbon waste spillages
Reaction of sulphide compounds in extracted coal residues with water and oxygen, causing Acid Mine Drainage (AMD) and decant to low-lying areas	Potential surface water pollution from possible decant of acidic water from decommissioned mine pits

10.3.1 Impact Description: In-stream water quality and quantity deterioration from sedimentation and siltation

Demolition and removal of infrastructure will expose and disturb the soil and leave it prone to erosion which leads to increased sedimentation and possible siltation of nearby watercourses.

10.3.2 Impact Description: Surface water contamination leading to deteriorated quality due to hydrocarbon waste spillages

Water contamination may occur from spillages of hydrocarbons (oils, fuels and grease) by vehicles and machinery used during infrastructure demolition activities.

10.3.3 Impact Description: Surface water contamination resulting from acid mine drainage into nearby water courses

AMD causes acidification and metal contamination of surface and ground water bodies when mine materials containing metal sulphides are exposed to oxidizing conditions. Heavy metal contaminated and acidified groundwater discharges into streams at points where the water table is close to the surface. The oxidation of iron sulphide precipitates sulphuric acid which lowers in-stream water pH. Acidic water environments are detrimental to most aquatic life species, and they affect irrigation and livestock watering functions for downstream water users.

10.3.3.1 Management/ Mitigation Measures

The following mitigation measures are recommended:

- Disturbance of soils during infrastructure demolition should be restricted to relevant footprint areas;

- Movement of machinery and vehicles during infrastructure demolition should be restricted to designated access roads to minimise the extent of soil disturbance;
- Use of accredited contractors for removal or demolition of infrastructure during decommissioning is recommended; this will reduce the risk of waste generation and accidental spillages;
- Re-profiling and revegetation of disturbed landscapes post-closure should be conducted to facilitate free drainage as much as practically possible to support post-mining land use; and
- If decant occurs post-closure, a Reverse Osmosis Water Treatment Plant should be used to treat the AMD decant to DWS compliance levels before the treated water is released into the natural environment. Financial provision is made annually for a Reverse Osmosis Water Treatment Plant for use post-closure to treat AMD decant (Lorenz van de Heaver 2021, pers. comm).

Table 10-6: Impact Significance Rating for Decommissioning Phase

Dimension	Rating	Motivation	Significance
Impact: In-stream water quality and quantity deterioration from sedimentation and siltation			
Duration	6	The impact will likely occur during the demolition of infrastructure and may extend beyond closure if not mitigated	60- Minor (negative)
Intensity	4	This will moderately impact the water quality and the ecosystem functionality for downstream users.	
Spatial scale	2	The impacts will be localised to the nearby watercourses from where the silt is being generated to downstream reaches.	
Probability	5	This impact will likely occur.	
Post-mitigation			
Duration	2	The impact will likely occur during the decommissioning phase if mitigated.	24-Negligible (negative)
Intensity	2	Should the impact occur it will have a minor effect resulting in reduction of water quality for the downstream users.	
Spatial scale	2	With proper management, the impact will be localised to nearby watercourses from where the silt is being generated downstream	

Dimension	Rating	Motivation	Significance
Probability	4	With the implementation of recommended mitigation measures the impact's probability of occurrence will be very low.	

Dimension	Rating	Motivation	Significance
Impact: Water contamination from Acid Mine Drainage decant into surface water resources			
Duration	7	The impact will remain beyond the life of the project.	96-Moderate (negative)
Intensity	5	High significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem.	
Spatial scale	4	The impacts will be localised to the immediate surroundings of the mine site.	
Probability	6	It is most likely that the impact will occur.	
Post-mitigation			
Duration	6	The impact will occur beyond the Life of Mine	40-Minor (negative)
Intensity	2	With mitigation the AMD impact will have low to moderate intensity	
Spatial scale	2	Limited to the site and its immediate surroundings.	
Probability	4	It is probable that the impact will occur.	

10.4 Unplanned Events and Low Risks

The potential risks or unplanned events involve accidental spillages of hazardous substances from waste storage facilities into adjacent surroundings during the operation phase. This may lead to impacts on water quality in the surrounding streams, should runoff from these contaminated areas enter the system. This could also happen due to pipeline leakage or burst, dam wall breach or failure and dam overflows.

A summary of the risks from unplanned events, together with the management measures are presented in Table 10-7.

Table 10-7: Impacts from unplanned events and their management measures

Unplanned event	Potential impact	Mitigation/ Management/ Monitoring
Hazardous material spillage; pipeline burst or leakage, dam overflows	Surface water contamination	An emergency response plan and spill kits should be in place and accessible to the responsible monitoring team in case of pipeline bursts, dam spillages, breaches or failure accidents. The Material Safety Data Sheets (MSDS) should be kept on site for the Life of Mine for anytime reference in terms of best practice guidelines for handling, storage and disposal of materials. The wastewater storage dams (e.g. return water dam) should regularly be inspected in order to identify concerns regarding breach, failure, overflow or seepages.
Accidental spillage or overflows of sewage effluent	Surface water contamination and proliferation of algae in streams	Quick clean-ups should be practised to minimise contamination of water resources

11 Monitoring Programme

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented.

This report recommends or provides a surface water monitoring programme with clearly defined monitoring points to be implemented by the mine throughout the life of mine and post closure. All water quality results should be benchmarked to relevant water quality objectives to determine any impact on the quality of water (positive/negative). The surface water monitoring plan is summarised as follows:

Table 11-1: Surface Water Monitoring Plan

Monitoring Element	Comment	Frequency	Responsibility
Water quality	Water quality monitoring should continue to include historical monitoring points as well as the newly sampled points in adjacent rivers. Parameters should include but not limited to; pH, Electrical Conductivity, Aluminium, Sulphates, Phosphates, Iron, Manganese, Calcium, Magnesium, Nitrate, Ammonia, Fluoride, Chloride, Total dissolved solids, Suspended Solids; Sodium, Uranium, Potassium, heavy metals (e.g. As, Ni, Cu, Pb, Cr, Bo, Hg) It is also recommended to monitor water quality within the mine water dams or water containment facilities to determine the concentration levels in case of an overflow or need for discharge.	-Monthly during operation and decommissioning; (hydrocarbons can be done on a quarterly basis at all surface water monitoring points in Table 11-2). Monitoring needs to carry on three years after the project has ceased, as is standard or best practice to detect residual impacts.	Environmental Officer
Water quantity	Flow monitoring should be carried out between flow linkages to obtain accurate flow volumes	In operational areas where automatic flow meters are in place, daily records need to be kept	Environmental Officer
Physical structures and Storm Water Management Plan (SWMP) performance	Personnel should have a walk around facilities to determine the facilities conditions and pick out any anomalies such as leaks or overflows and system malfunctions. Storm water channels, and existing mine dams are inspected for silting and blockages of inflows, pipelines for hydraulic integrity; monitor the overall SWMP performance.	Continuous process and formal report after every 3 years	Environmental Officer
Meteorological data	Measure rainfall to provide more accurate rainfall records, if possible	Real time system with tipping bucket rain gauge or alternatively using bulk rain gauge.	Environmental Officer

11.1 Monitoring Points

The proposed monitoring points and their descriptions are presented in Table 11-2.

Table 11-2: Monitoring points and associated descriptions

Monitoring Point	Description	Coordinates
Historical Points		
ED01	Ericksen Dam 1	S26.1925 E29.3541
ED02	Ericksen Dam 2	S26.1925 E29.3543
ED03	Ericksen Dam 3	S26.1926 E29.3546
DCM06	Upstream of Western tributary	S26.2183 E29.3676
DCM07	Downstream of Western tributary	S26.1907 E29.3688
DCM08	Pond downstream of Pit 1	S26.1939 E29.3395
MP01	Downstream on western tributary of the Olifants River	S26.1714 E29.34
MP02	Downstream on western tributary of the Olifants River	S26.1728 E29.343
MP03	Bridge upstream of the old Transvaal Navigation Colliery	S26.1365 E29.345
MP04	Confluence of MP01 and MP02 tributaries with the Olifants River	S26.1555 E29.3436
MP05	Downstream of Transvaal Navigation Colliery	S26.1694 E29.3568
MP06	Upstream of mining activities on the Olifants River	S26.1681 E29.3746
Pan	Pan	S26.2054 E290.3504
PCD01	Pollution Control Dam 1	S26.1855 E29.3593
PCD02	Pollution Control Dam 2	S26.1861 E29.36
PCD03	Pollution Control Dam 3	S26.1878 E29.3597
RWDF	Return Water Discard Facility	S29.3430 E29.3430
Additional Proposed Points		
UPSW1	Upstream of eastern boundary tributary 1	S26.2533; E29.4054
UPSW2	Upstream of eastern boundary tributary 2	S26.2783; E29.3873
WPSW3	South of proposed opencast excavation	S26.2301; E29.3279
UWBSW4	Upstream western boundary	S26.2808; E29.3163
DWBSW5	Downstream western boundary	S26.2291; E29.2908

12 Stakeholder Engagement Comments Received

No comments received from stakeholders.

13 Recommendations

The following is recommended to mitigate identified impacts:

- Site preparation for the construction of infrastructure should be confined to the existing development footprint area to minimise disturbance of soils and the probability of sedimentation and siltation of the nearby watercourses;
- Construction should be undertaken during the dry winter period to reduce sedimentation in nearby watercourses since there will be minimal to no occurrence of rainfall;
- The footprint of proposed infrastructure should be kept within the already disturbed area as proposed, where it is automatically integrated into the existing storm water management plan.
- All storage areas (fuels, paints, oils) used at the construction camp should be appropriately bunded and spill kits should be in place, and construction workers trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;
- Ensure that runoff from dirty areas is being directed to the existing storm water management infrastructure and should not be allowed to flow into the watercourses, unless DWS discharge authorisation has been granted upon compliance with relevant effluent discharge standards as stipulated in the National Water Act (NWA);
- Water quality monitoring should continue downstream and upstream of the mine site, and within all surface water circuits at the mine to detect any contamination arising from operational activities;
- Servicing of vehicles and machinery should continue being conducted at designated, appropriately paved areas. All used oils should be disposed of by accredited vendors from the mine site;
- Disposal of general and other forms of waste should continue to be done into clearly marked skip bins which are collected by approved contractors for final disposal to appropriate disposal sites;
- Disturbance of soils during infrastructure demolition should be restricted to relevant footprint areas;
- Movement of machinery and vehicles during infrastructure demolition should be restricted to designated access roads to minimise the extent of soil disturbance;

- Use of accredited contractors for removal or demolition of infrastructure during decommissioning is recommended; this will reduce the risk of waste generation and accidental spillages;
- Re-profiling and revegetation of disturbed landscapes post-closure should be conducted to facilitate free drainage as much as practically possible to support post-mining land use; and
- If decant occurs post-closure, passive treatment with lime or other alkaline compounds can be applied to neutralise AMD at the decant points. Should passive treatment fall short, active or electrolytic water treatment (e.g. Reverse Osmosis) should be considered.

14 Reasoned Opinion Whether Project Should Proceed or Not

It is the specialist's opinion that there is no hydrological reason why the proposed project cannot be implemented, provided all the recommended mitigation and management measures are adhered to.

15 Conclusions

The MAP for the region was determined to be 676 mm. 90% of rainfall events during the wettest month of December will likely not exceed 182 mm. The MAR was determined to be 50.8 mm, which accounts for approximately 7% of the MAP. 90% of runoff events will likely not exceed 18.1 mm. The MAE for the region was determined to be 1564 mm which is twice more than the MAP. This implies that the area experiences distinct wet and dry seasons, with the dry period receiving as little as 6 mm of rainfall per month.

Recent water quality analysis results upstream and downstream of the project site indicate that the concentration levels of most parameters including pH, Cl, SO_4 and Al at most of the sampled sites fall within acceptable DECM WUL limits. Elevated Na is indicated at some of the sampled sites (i.e. UPSW1, UPSW2 and UWBSW3 and DWBSW5). The higher sodium concentrations possibly come from underlying weathered rock, grazing animals, fertilisers in nearby farms, sewage or from industrial effluent from residential communities upstream of the project site. TDS level at DWBSW5 exceeds the WUL limit possibly resulting from activities of grazing animals in the area. Fluoride at site UPSW4 lies above the acceptable SAWQ guidelines for Aquatic Ecosystem but complies at all other monitoring sites.

The concentrations of Zinc and Aluminium exceed the acceptable SAWQG for Aquatic Ecosystems. High natural levels of zinc in river water are usually associated with higher concentrations of other metals such as lead and cadmium which are, however, below detection levels at this mine. Possible sources of elevated zinc can be coal mining activities in the area. Aluminium levels exceed the SAWQG for Aquatic Ecosystem but falls within the DECM WUL standard.

The proposed surface infrastructure which includes STP, WTP, Water Storage Tank and Discard Processing Plant all be located within an area which already has existing storm water management infrastructure in place. No additional storm water infrastructure should be constructed.

The water balance indicates a water volume for dust suppression amounting to 344 032 m^3/annum and this water is obtained from Erickson Dams and the Mine Plant. Most of this water is used during the dry season where high levels of dust emissions are expected since rainfall will be minimal or absent. The largest amount of water at DECM circulates within the Erickson Dams 1, 2 & 3 with an approximate value of 1 352 260 m^3/annum. The RWD/PCD and Mine Plant follow in water usage, having average volumes of 1 086 045 m^3/annum and 968 466 m^3/annum, respectively. Potable water which is used at the Mine Offices, Workshop and Change houses totals 62 057 m^3/annum. This water, originally from Erickson Dams 1, 2 & 3, is treated at the WTP before being pumped for use at the workshop, offices and change houses. The volume of effluent treated at the sewage treatment plant is in the order of 55 851 m^3/annum.

The Salt Balance shows that Erickson Dams and the Mine Plant have higher concentrations of dissolved salts amounting to 230.38 kg/m^3/day and 171.87 kg/m^3/day, respectively. These facilities should closely be monitored in case of any spills or seepages into the environment for immediate detection, mitigation and/or management. The RWD/PCD is lined and total salts in circulation amount to 12.55 kg/m^3/day. Water levels in the RWD/PCD should also be monitored to prevent the occurrence of overflows.

16 References

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Appendix A: Appendix Title

DIGBY WELLS
ENVIRONMENTAL

Appendix B: Appendix Title