Application for an Integrated Water Use Licence in terms of section 40 of the National Water Act (Act 36 Of 1998) for the proposed Doornhoek Fluorspar Mine on various portions of farms Doornhoek 305 JP, Farm 306 JP, Knoflookfontein 310 JP, Strydfontein 326 JP, Rhenosterfontein 304 JP, Kwaggafontein 297 JP, Paardeplaats 296 JP, Saamgevoeg 320 JP And Witrand 325 JP, Zeerust District, North West Province

IWULA SUMMARY REPORT

Exigo³

An EOH Company

Technical Report: **AS-R-WUL-2017-02-03**

DMR Reference Numbers: **NW/30/5/1/2/3/2/1/10110EM & NW/30/5/1/2/2/10110MR**

Prepared for: **Department of Water and Sanitation (DWS)**

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IWULA SUMMARY REPORT

3 February 2017

Conducted on behalf of:

SA Fluorite (Pty) Limited & Southern Palace 398 (Pty) Limited

Compiled by:

M Grobler (B.Sc .Hons, M. OL, Pr. Sci Nat)
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Registered I&APs	Consultation as per comments and response table

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M Grobler	February2017	Exigo Executive - EAP

Executive Summary

Exigo Sustainability (Pty) Ltd (Exigo) was appointed by SA Fluorite (Pty) Limited & Southern Palace 398 (Pty) Limited to facilitate the Environmental Authorisation (EA), Mining Right Application (MRA) process and Integrated Water Use Licence Application (IWULA) for the proposed Doornhoek Fluorspar Mine.

The proposed Doornhoek Fluorspar Mine is located in the Zeerust District of the North West Province. The project falls under the jurisdiction of the Ditsobotla and Ramotshere Moiloa Local Municipalities located within the Ngaka Modiri Molema District Municipality (Refer to Figure 3-1)). The project area is located between Zeerust, Mahikeng and Lichtenburg and borders the eastern section of Mahikeng Local Municipality. The project site is located approximately 220 km west of Johannesburg and 18 km south of the town of Zeerust. The proposed site is adjacent to the existing Witkop open pit fluorspar mine. Figure 3-1 indicates the location of the project site. The following coordinates serve as the centre point of the site:

Latitude: 25°44'11.85"S; Longitude: 26°10'29.75"E

The project has the potential to contain in excess of 50 million tonnes of fluorspar and is believed to be one of the world's largest fluorspar deposits. The underground ore body has grades more than double that of the adjoining Witkop Mine (not currently mining fluorspar according to the team's knowledge) and resources sufficient to justify an initial life of mine of 30 years. The resource is proposed to be mined at 1.5 million tonnes per annum as follows:

- Resource Area A: Opencast mining up to a depth of approximately 60 m from year 5 to 10 (Latitude: 25°43'32.91"S; Longitude: 26°7'27.00"E)
- Resource Area C: Opencast mining up to a depth of approximately 90 m from year 20 to 30 (Latitude: 25°42'55.28"S; Longitude: 26°12'18.81"E)
- Resource Area D: Opencast mining up to a depth of approximately 90 m from year 10 to 20 with the possible mining of the areas to the side of the resource taking place from year 20 to 30 (Latitude: 25°43'53.57"S; Longitude: 26°12'35.42"E)

Construction of the mining infrastructure and access road(s) will take place during year 1 to 5. The planned infrastructure for the mining operations is as follows:

- Overburden stockpiles;
- Minerals processing plant and associated infrastructure;
- Tailings storage facility;
- Haul roads and access road;
- Mine offices;

- Water supply pipelines;
- Electrical reticulation and sub-stations; and
- Water Treatment Plant.

Route options 1 is currently the preferred access road option subject to a further road and/or logistics feasibility study prior to construction. A re-alignment of the existing route option 1 is recommended subject to detailed traffic and road designs. Reconstruction will in all likelihood be required. The re-alignment of the route option 1 will result in decreased floodline impacts. It is therefore recommended that a separate IWULA or amendment be conducted for the access road where the road occurs within the 1:100 year floodline and/or crosses drainages. The access road does not for part of this IWUL application.

A pre-application meeting was held with the DWS on the 22 February 2016 (Refer to Appendix 6 of the EIA&EMPR).

A pre-application site visit was also previously conducted with Ms Lethabo Ramashala and Mr Clement Makwela on the 25th of November 2014.

The proposed development will include the following water uses as set out in Section 21 of the National Water Act (Act 36 of 1998) processes.

Section 21a: Taking water from a resource

The required make up water demand is 116 654 m3/m (3830 m3/d) for the entire mining operations with an average potable requirement of 810 m3/m at full production. The water supply will be obtained from groundwater abstraction and fissure water. A total of 25 170m3/m (839 m3/d) is currently available from existing boreholes (DBH04, DBH05, DBH14 and DBH16), and will be licenced in this application as part of the construction phase water supply. The average sustainable yield of the relevant boreholes are as follows:

Table 1-1 Water Supply Boreholes

Basic Information			Sustainable yield (ℓ/s)					
Label	Longitude	Latitude	FC Analysis Sustainable yield (ℓ/s)	Sustainability Check - Cooper Jacob (ℓ/s)	Average Sustainable yield (ℓ/s)	Radius of Recharge zone (m)	Abstraction duty cycle (h)	Abstraction per annum (m^3/a)
DBH04	-25.685690	26.141840	0.72	0.65	0.69	480.11	12.00	21602.16
DBH05	-25.706600	26.156070	3.66	3.50	3.58	1242.37	12.00	112898.88
DBH09	-25.681480	26.202460	0.14	0.17	0.16	241.57	12.00	4888.08
DBH14	-25.695000	26.174880	2.60	2.75	2.68	914.30	12.00	84358.80
DBH16	-25.760780	26.129220	3.07	2.44	2.76	1322.57	12.00	86881.68
		Maximum	**3.66**	**3.50**	**3.58**	**1322.57**	**12.00**	**112898.88**
		Minimum	**0.14**	**0.17**	**0.16**	**241.57**	**12.00**	**4888.08**
		Average	**2.04**	**1.90**	**1.97**	**840.18**	**12.00**	**62125.92**

Total	**10.19**	**9.51**	**9.85**		**310629.60**

The open pits will be dewatered in order for mining activities to continue safely and a maximum of 60 000 m3/m of water will be pumped out of the underground. This water will be re-used in the mining processes.

Water supply for the operational phase is subject to further groundwater development which will take place in follow-up phases and be licenced accordingly in a separate IWULA to supply the required make-up water demand. It is suggested that groundwater exploration be focussed on compartment 1 (impacted due to mine dewatering) and compartments 2 and 8 preferentially.

Section 21b: Storing of water

- Groundwater will be stored in a raw water reservoir with a capacity of 392 m^3.
- Potable water will be stored in a clean water reservoir with a capacity of 106 m^3.
- A fire water reservoir with a complete fire suppression system of 106 m3.
- Spray water dam of 181 m3.
- Diversion Dam of 5422 m3 at Resource Area A (Diversion Dam A).
- Retention Dam of 646 m3 at Resource Area A (Retention Dam A1).
- Retention Dam of 396 m3 at Resource Area A (Retention Dam A2).
- Retention Dam of 704 m3 at Resource Area A (Retention Dam A3).
- Retention Dam of 752 m3 at Resource Area A (Retention Dam A4).
- Retention Dam of 33 204 m3 at Resource Area D (Retention Dam D).
- Retention dam of 56 900 m3 at Resource Area C. (Retention Dam C).

Section 21c: Impeding or diverting of a watercourse

- Mining infrastructure located within 500 m of a wetland/watercourse.
- Stream/drainage diversions.

Section 21g: Disposing of waste in a manner which may detrimentally impact on a water resource

The following waste facilities are envisaged:

- Tailings Storage Facility (TSF) with capacity of 30 000 000 m3 with containment barrier system and associated lined Return Water Dam (RWD).
- Process Water Reservoir with a capacity of 1375 m3.
- Storm Water Dam for overburden dump at Resource Area A with a capacity of 1700 m3 (SWD-A).

- Storm Water Dam for overburden dump at Resource Area C with a capacity of 19 000 m3 (SWD-C).
- Plant Storm Water Dam (SWD) with a capacity of 70 000 m3.
- TSF Storm Water Dam with a capacity of 10 840 m3 (TSF-SWD 1).
- TSF Storm Water Dam with a capacity of 52 708 m3 (TSF-SWD 2).
- TSF Storm Water Dam with a capacity of 15 470 m3 (TSF-SWD 3).
- Sewerage Treatment Plant (STP) with a capacity of 40 m^3/d and associated sewerage sludge tank with a storage capacity of 10 m3.
- Water Treatment Plant (WTP) with a capacity of 84 m^3/day will produce brine which will be disposed of in brine evaporation ponds.
- Overburden will be disposed of on two overburden dumps.
- Usage of water containing waste for dust suppression, drilling and blasting at a volume of 5625 m^3/m.
- Partial backfilling of open pits.

Section 21i: Altering the bed, banks, course or characteristics of a watercourse

- Mining infrastructure located within 500 m of a wetland/watercourse.
- Stream/drainage diversions.

Section 21j: Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people

The open pits will be dewatered in order for mining activities to continue safely and a maximum of **60 000 m^3/m** of water will be pumped out of the underground. This water will be re-used in the mining processes. As this is a simulated volume, the exact dewatering volume is unclear. Should there be any excess water due to dewatering, abstraction from boreholes will be adjusted accordingly.

The above mentioned water uses will take place on the farms Kafferskraal 306 (Portion 1, 5, 10, 24, 25, 26, 27, 29, 30), Rhenosterfontein 304 (Portion 9, 10), with possible extension to Knoflookfontein 310 (Portion 1 & 7).

An assessment of potential impacts identified for the mining development was undertaken. The impacts identified for assessment were assessed within numerous specialist studies. Specialist studies conducted for the project include a Hydrogeological Impact Assessment, Aquatic Impact Assessment, Wetland Impact Assessment, Geochemical Risk Assessment, Regional Water Balance Report, Floodline Study & SWMP, Social and Labour Plan and Socio-economic Impact Assessment, amongst others.

The findings of the specialist studies undertaken provide an assessment of both the benefits and potential negative impacts anticipated as a result of the proposed project. The findings conclude that provided that the recommended mitigation and management measures are implemented there are no environmental fatal flaws that should prevent the proposed project from proceeding.

In order to achieve appropriate environmental management standards and ensure that the findings of the environmental studies are implemented through practical measures, the recommendations from the EIA&EMPR will form part of the contract with the contractors appointed to construct and maintain the proposed mine and associated infrastructure. The EIA&EMPR would be used to ensure compliance with environmental specifications and management measures. The implementation of the EIA&EMPR for key cycle phases (i.e. construction, operations, decommissioning and closure) of the proposed project is considered to be fundamental in achieving the appropriate environmental management standards as detailed for this project.

List of Abbreviations

Table 1-2

Abbreviation	Description
DMR	Department of Mineral Resources
DWA	Department of Water Affairs (now Department of Water and Sanitation)
DWS	Department of Water and Sanitation
Exigo	Exigo Sustainability (Pty) Ltd (also previously known as AGES)
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMPR	Environmental Management Programme Report
GN	Government Notice
GRDM	Groundwater Resource Directed Measures
I&AP's	Interested and Affected Parties
ISP	Internal Strategic Perspective
IWULA	Integrated Water Use Licence Application
IWUL	Integrated Water Use License
IWWMP	Integrated Water and Waste Management Plan
LOM	Life of Mine
L/s	Liters per second
m3/d	Cubic meters per day
m3/m	Cubic meters per month
MAE	Mean Annual Evaporation
MAMSL	Meter Above Mean Sea Level
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MBGL	Meters Below Ground Level
MPRDA	Mineral and Petroleum Resources Development Act (MPRDA) (Act No. 28 of 2002)
NEMA	National Environmental Management Act (Act 107 of 1998)
NWA	National Water Act (Act 38 of 1998)
SPLUMA	Spatial Planning and Land Use Management Act (Act. 6 of 2013)
TDS	Total Dissolved Solids
WMA	Water Management Area
WM	With Mitigation
WOM	Without Mitigation

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1 INTRODUCTION

Exigo Sustainability (Pty) Ltd (Exigo) was appointed by SA Fluorite (Pty) Limited & Southern Palace 398 (Pty) Limited to facilitate the Environmental Authorisation (EA), Mining Right Application (MRA) process and Integrated Water Use Licence Application (IWULA) for the proposed Doornhoek Fluorspar Mine.

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- Minerals processing plant and associated infrastructure;
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- Haul roads and access road;

- Mine offices;
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- Water Treatment Plant.

Route option 1 is currently the preferred access road option subject to a further road and/or logistics feasibility study prior to construction. A re-alignment of the existing route option 1 is recommended subject to detailed traffic and road designs. Reconstruction will in all likelihood be required. The re-alignment of the route option 1 will result in decreased floodline impacts. It is therefore recommended that a separate IWULA or amendment be conducted for the access road where the road occurs within the 1:100 year floodline and/or crosses drainages. The access road does not form part of this IWUL application.

This document has been compiled in the form of an Integrated Water and Waste Management Plan (IWWMP) according to the External Guideline: Generic Water Use Authorisation Process published by DWS (previously DWA), August 2007 as well as the complete checklist for WULA Record of Recommendation and WUAAAC Meetings.

A pre-application meeting was held with the DWS on the 22 February 2016 (Refer to Appendix 6 of the EIA&EMPR.

A pre-application site visit was also previously conducted with Ms Lethabo Ramashala and Mr Clement Makwela on the 25th of November 2014.

2 THE APPLICANT

The name and address of the applicant as reflected in Table 2-1 below.

Table 2-1 Name and address of the applicant

Details of the Applicant	
Project Applicant:	SA Fluorite (Pty) Ltd & Southern Palace 398 (Pty) Ltd
Registration no:	2005/007424/07 & 2006/034075/07
Contact person:	Allan Saad
Telephone number:	012 361 6083
Fax number:	012 348 9458
Postal address:	PO Box 35270, Menlo Park, 0102
Email address:	asaad@mweb.co.za

3 PROPERTIES AND DEVELOPMENTS

3.1 Properties on which the water use will take place

The water uses will take place on various portions of the farms: Doornhoek 305 JP, Kafferskraal 306 JP, Knoflookfontein 310 JP, Rhenosterfontein 304 JP, Strydfontein 326 JP, Kwaggafontein 297 JP, Paardeplaas 296 JP, Witrand 325 JP and Saamgevoeg 320 JP, North West Province. Refer to Appendix 9 of the Final EIA&EMPR (Appendix C: Environmental Impact assessment and Environmental Management Programme Report (EIA&EMPR) including specialist reports).

The following coordinates serve as the centre point of the mine site:

Latitude: 25°44'11.85"S;

Longitude: 26°10'29.75"E

Datum: WGS84

The following water uses will take place on the farms: Farm 306 (Portion 1, 5, 10, 24, 25, 26, 27, 29, 30), Rhenosterfontein 304 (Portion 9, 10), with possible extension to Knoflookfontein 310 (Portion 1 & 7).

Table 3-1 Water use per property

Water use	Description	Property
21a	Abstracting ground/dewatering water	Rhenosterfontein 304 (Portion 9 & 10) Farm 306 (Portion 1, 24, 25, 26, 27, 29, &30) Knoflookfontein 310 (Portion 1)
21b	Potable Water Reservoir	Farm 306 (Portion 24, 25, 27 & 30)
21b	Fire Water Reservoir	Farm 306 (Portion 24, 25, 27 & 30)
21b	Spray Water Dam	Farm 306 (Portion 24, 25, 27 & 30)
21b	Raw Water Dam	Farm 306 (Portion 24, 25, 27 & 30)
21b	Various Storm Water Dams as part of Stream/drainage diversions	Rhenosterfontein 304 (Portion 6, 9 & 10) Farm 306 (25 & 30) Knoflookfontein 310 (Portion 1)
21c	Infrastructure within 500m of wetland/watercourse	Farm 306 (Portion 24, 25 & 30) Knoflookfontein 310 (Portion 1)
21c	Stream/drainage diversions - Diverting	Rhenosterfontein 304 (Portion 6, 9 & 10) Farm 306 (Portion 4, 10, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)
21g	Tailings Storage Facility	Farm 306 (Portion 5, 24, 25, 26, 27, 29 & 30)

21g	Return Water Dam	Farm 306 (Portion 5, 24, 25, 26, 27, 29 & 30)
21g	Storm Water Dam (Overburden dump at Resource A)	Rhenosterfontein 304 (Portion 9)
21g	Storm Water Dam (Overburden dump at Resource C)	Farm 306 (Portion 26)
21g	Storm Water Dams (plant and TSF)	Farm 306 (Potion 5, 10, 24, 27 & 29) Knoflookfontein (Portion 1 & 7)
21g	Process Water Dam	Farm 306 (Portion 24, 25, 27 & 30)
21g	Sewerage Treatment Plant & Sewerage Sludge Tank	Farm 306 (Portion 24, 25, 27 & 30)
21g	Water Treatment Plant & Brine Evaporation Pond	Farm 306 (Portion 24, 25, 27 & 30)
21g	Dust Suppression	Rhenosterfontein 304 (Portion 9 & 10) Farm 306 (Portion 1, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)
21g	Partial backfilling of open pits	Rhenosterfontein 304 (Portion 9 & 10) Farm 306 (Portion 1, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)
21i	Infrastructure within 500m of wetland/watercourse	Farm 306 (Portion 24, 25 & 30) Knoflookfontein 310 (Portion 1)
21i	Stream/drainage diversions – Diverting tributary of the Klein Marico River around open pits (Resource A, C & D)	Rhenosterfontein 304 (Portion 6, 9 & 10) Farm 306 (Portion 4, 10, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)
21j	Dewatering of mine	Rhenosterfontein 304 (Portion 9 & 10) Farm 306 (Portion 1, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)

3.2 Holder of mineral rights

The prospecting rights for the various properties are held by the applicant, SA Fluorite (Pty) Ltd and Southern Palace 398 (Pty) Ltd. A Mining Right Application (MRA) and an application for Environmental Authorisation (EA) were submitted to the Department of Mineral Resources (DMR) on the 13th of July 2016.

3.3 Holders of surface rights

The surface rights are held by various parties. Please refer to Table 6 of the Final EIA&EMPR (Appendix C: Environmental Impact assessment and Environmental Management Programme Report (EIA&EMPR) including specialist reports).

- SA Fluorite (Pty) Ltd and Southern Palace 398 (Pty) Ltd will enter into negotiations with the surface owners and the Department of Rural Development and Land Reform (DRDLR) where land is state owned, to obtain the required surface lease agreements prior to project initiation. SA Fluorite (Pty) Ltd was awarded a Prospecting Right on 28/03/2006 and Southern Palace 398 (Pty) Ltd on 17/07/2008. The current mining right application is in respect of the following minerals: copper ore, diamond, fluorspar, lead, tin ore, vanadium ore and zinc ore, on the farms Doornhoek 305 JP, Kafferskraal 306 JP, Knoflookfontein 310 JP, Rhenosterfontein 304 JP, Strydfontein 326 JP, Kwaggafontein 297 JP, Paardeplaas 296 JP, Witrand 325 JP and Saamgevoeg 320 JP. However it is anticipated that infrastructure and open pits will only be located on portions of the farms Kafferskraal 306 JP, Knoflookfontein 310 JP and Rhenosterfontein 304 JP (refer to Table 3-1).

Table 3-2 Holders of surface rights of directly affected properties

Farm and Portion	Deed	Size (Ha)	Surface Owner	Mineral Owner
Rhenosterfontein 304 JP				
Portion 6	**T4985/911**	298.9911	Josef Anton Mang	Southern Palace Pty Ltd
Portion 9	T2657/1986	59.9772	Mr HAJ Grobler	Southern Palace Pty Ltd
Portion 10	T21500/1991	116.6511	MR HAJ Grobler	Southern Palace Pty Ltd
Farm 306 JP				
Portion 1	T69379/2003	43.6118	Mondialeshelf Holdings Pty Ltd	SA Fluorite Pty Ltd
Portion 4	T123325/2002	266.3129	Mondialeshelf Holdings Pty Ltd	SA Fluorite Pty Ltd
Portion 5	T69379/2003	133.1508	Mondialeshelf Holdings Pty Ltd	SA Fluorite Pty Ltd
Portion 10	T69379/2003	133.1422	Mondialeshelf Holdings Pty Ltd	SA Fluorite Pty Ltd
Portion 24	T1541/2013	171.6790	Costispace Pty Ltd	SA Fluorite Pty Ltd
Portion 25	T1541/2013	85.8345	Costispace Pty Ltd	SA Fluorite Pty Ltd
Portion 26	T73320/2011	85.8388	Blue Anvil Holfings Pty Ltd	SA Fluorite Pty Ltd
Portion 27	T73320/2011	164.4227	Blue Anvil Holfings Pty Ltd	SA Fluorite Pty Ltd
Portion 29	T69379/2003	222.6912	Mondialeshelf Holdings Pty Ltd	SA Fluorite Pty Ltd
Portion 30	T1541/2013	77.5118	Costispace Pty Ltd	SA Fluorite Pty Ltd
Knoflookfontein 310 JP				

Portion 1	T63276/2008	503.7421	Fatima Green	SA Fluorite Pty Ltd
Portion 7	T56369/2016	233.8459	PC Boshoff Beleggings CC	SA Fluorite Pty Ltd

In terms of section 19(1)(c) of the MPRDA, SA Fluorite (Pty) Ltd and Southern Palace 398 (Pty) Ltd, as the holder of the above mentioned prospecting rights, has the exclusive right to apply for and be granted a mining right in respect of the minerals and the prospecting area as provided for in the said prospecting rights. The proposed mining activities require an environmental authorisation (EA) and mining right application (MRA) to be submitted along with an Environmental Management Program (EMPR), in terms of the National Environmental Management Act (107 of 1998) and the Mineral and Petroleum Resources Development Act (MPRDA) (Act No. 28 of 2002). A MRA and an application for EA (EA) were submitted to the Department of Mineral Resources (DMR) on the 13th of July 2016.

3.4 Magisterial District and Municipality

The proposed Doornhoek Fluorspar Mine is located in the Zeerust District of the North West Province. The project falls under the jurisdiction of the Ditsobotla and Ramotshere Moiloa Local Municipalities located within the Ngaka Modiri Molema District Municipality.

3.5 Direction and Distance to neighbouring towns/villages

The project area is located between Zeerust, Mahikeng and Lichtenburg and borders the eastern section of Mahikeng Local Municipality. The project site is located approximately 220 km west of Johannesburg and 18 km south of the town of Zeerust. The proposed site is adjacent to the existing Witkop open pit fluorspar mine.

3.6 Servitudes

There do not presently appear to be any registered servitudes (other than those associated with registered roads) which would prevent the development of the Doornhoek Fluorspar Mine, given that the company operates in a responsible manner, in accordance with acceptable town planning and legal practices.

3.7 The applicant’s right to the properties

The surface rights are held by various land owners as indicated in Section 3.3 above, and the applicant is currently in the process of obtaining the relevant surface lease agreements and/or purchase agreements. The lease agreements process will be agreed with the DLRD where relevant, and will be conducted with their guidance.

Figure 3-1 Regional Locality Map with Mining Right Area

4 LEGAL BACKGROUND AND METHODOLOGY

4.1 National Water Act

The National Water Act, Act no 36 of 1998 requires that a water use must be licensed unless it is listed in Schedule I of this act, is an existing lawful use, is permissible under a general authorisation, or if a responsible authority waives the need for a licence. A water use is defined in Section 21 of the National Water act as shown in information box A.

Information Box A

21. For the purposes of this Act, water use includes -
(a) taking water from a water resource;
(b) storing water;
(c) impeding or diverting the flow of water in a watercourse;
(d) engaging in a stream flow reduction activity contemplated in section 36;
(e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);
(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
(g) disposing of waste in a manner which may detrimentally impact on a water resource;
(h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
(i) altering the bed, banks, course or characteristics of a watercourse;
(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
(k) using water for recreational purposes.

4.2 Government Notice (GN) 704 Relevant Exemptions

All dirty water management facilities have been designed to comply with Regulation 704 (Government Gazette 20118, 4 June 1999), except where exemptions from certain requirements (Provision 3 of the Regulation) are being applied for. The following GN704 exemptions are being applied for.

Table 4-1: GN704 Exemptions applied for

GN 704 Section	Activity requiring exemption	Motivation for applying for exemption
Section 4 Restriction of Locality: *a) Structure within 1:100 year flood-line or within a horizontal distance of 100 m of a watercourse*	• Resource Area A, C and D within the 1:100 year floodline/100 m of water course • Pipeline crossings within 1:100 floodline • Conveyor crossing within 1:100 year floodline • Plant, TSF and overburden dumps within 100 m of tributaries of the Klein Marico River	• Clean water is diverted around the open pits via river and clean water diversions. The river diversions comply with Regulation 704. • A comprehensive Site Specific Storm Water Management Plan has been compiled in terms of this project and is appended to the EIA&EMPR as Appendix 7.11. This storm water management plan complies with the provisions of GN 704. • Clean and dirty water to be separated in terms of GN704 with the use of berms.

Section 4 Restriction of Locality: *4(b) No opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100 m from any watercourse*	• Resource Area A, C and D within the 1:100 year floodline/100 m of water course • Diversion around Resource Area A, C and D of tributaries of the Klein Marico River	• A comprehensive Site Specific Storm Water Management Plan has been compiled in terms of this project and is appended to the EIA&EMPR as Appendix 7.11. The diversion complies with Regulation 704.
Section 4 Restriction of Locality: *c)* *No placement or disposal of any residue or substance which causes or is likely to cause pollution of a water resource, in the underground workings or opencast excavation.*	• Partial backfilling of overburden into open pits as a measure to minimise deposition on surface	• Leachate test work indicated that the overburden has a negligible potential to generate acid, salt and metal-rich leachate and can therefore be considered as having a low pollution potential (Hansen, 2016).
Section 5: Restrictions on use of material.	• Overburden for the tailings dam wall and road building	• Leachate test work indicated that the overburden has a negligible potential to generate acid, salt and metal-rich leachate and can therefore be considered as having a low pollution potential (Hansen, 2016). Also refer to report in Appendix 7.10 of the Final EIA&EMPR.

4.3 Approach

All management strategies to be implemented will be based on the below hierarchy of decision making as proposed by the department. This hierarchy is based on a pre-cautionary principal to set the priority for the mine water as well as waste management decisions hence actions. The hierarchy of decision-making can be summarized as follows:

Table 4-2 Hierarchy of Decision Making

Hierarchy of decision-making	
Pollution prevention	**Highest**
Re-use and reclamation	↑
Treatment	
Discharge or disposal	**Lowest**

This document will form part of the supporting documentation for an Integrated Water Use Licence Application for the proposed Fluorspar Mine Development. To ensure compliance with the National Water Act (Act 36 of 1998), the following process was followed with reference to Figure 4-1 below.

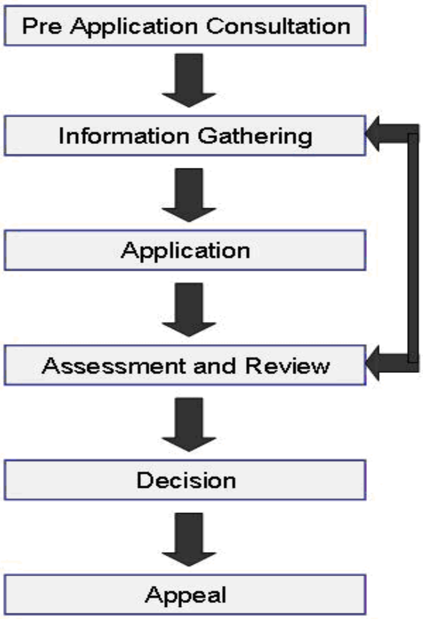

Figure 4-1 Licencing application process

4.4 Application forms

Application forms are detailed in Appendix A: Application Forms and summarized in Table 4-3 below.

Table 4-3 Summary of application forms

Description	Document reference
Company Registration	DW758
Section 21a	DW760
Registration – storage of water	DW761
Section 21 b	DW762
Section 21c	DW763
Section 21g	DW767
Section 21i	DW768
Supplementary – taking water from a water resource (pump technical data)	DW784
Supplementary - taking water from a water resource (mining use)	DW788
Supplementary – Section c & i	DW781suppl
Section 21j	DW805
Supplementary – property info	DW901
Supplementary – property owner	DW902
Supplementary – actual/monitored waste discharge (Section 21g)	DW904
Supplementary – Details of waste management facility	DW905
Dam classification	DW793

Please note that the DW 904 application form cannot be completed at this time as no actual/monitored waste discharge information is available at this stage. Please note that the

DW784 application form cannot be completed at this time as no pumps are installed and therefore no pump technical data is available at this stage. These forms will be submitted to the DWS as soon as the information becomes available.

4.5 Technical and supporting documentation

To follow is a brief description of all the documents accompanying this application:

- Application forms
- Proof of payment
- EIA&EMPR (including Hydrogeological report, Aquatic assessment report, Wetland assessment report, Floodline and Storm Water Management Plan and Public Participation Documentation)
- Surface water planning and design drawings
- Title deeds

5 PRESENT ENVIRONMENTAL SITUATION

The information contained in the following Section describes the baseline (existing or “status quo”) environmental conditions of environmental factors relevant to water resources and the proposed water uses of the project.

The aim of the descriptions presented in this section is to establish how the existing environmental conditions at this location in terms of specifically water resources may be affected by the project, and the potential risks that it could have on the project.

In conjunction with the Baseline Descriptions of Environmental aspects, potential impacts of the proposed project on those aspects are identified and assessed.

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need.

The following section will focus on potential impacts associated with water resources.

The baseline environmental description was sourced from desktop studies, aerial photographs, comments received from Interested and Affected Parties (I&APs) as well as a number of specialist studies that have been conducted on the site. The impact assessment is based on the findings of numerous specialist studies conducted on the proposed development site, as attached hereto (Appendix 7 of Appendix C: Environmental Impact assessment and Environmental Management Programme Report (EIA&EMPR) including specialist reports).

A map of the cadastral surroundings, surrounding land uses, as well as the project boundary is detailed in Figure 5-1 below.

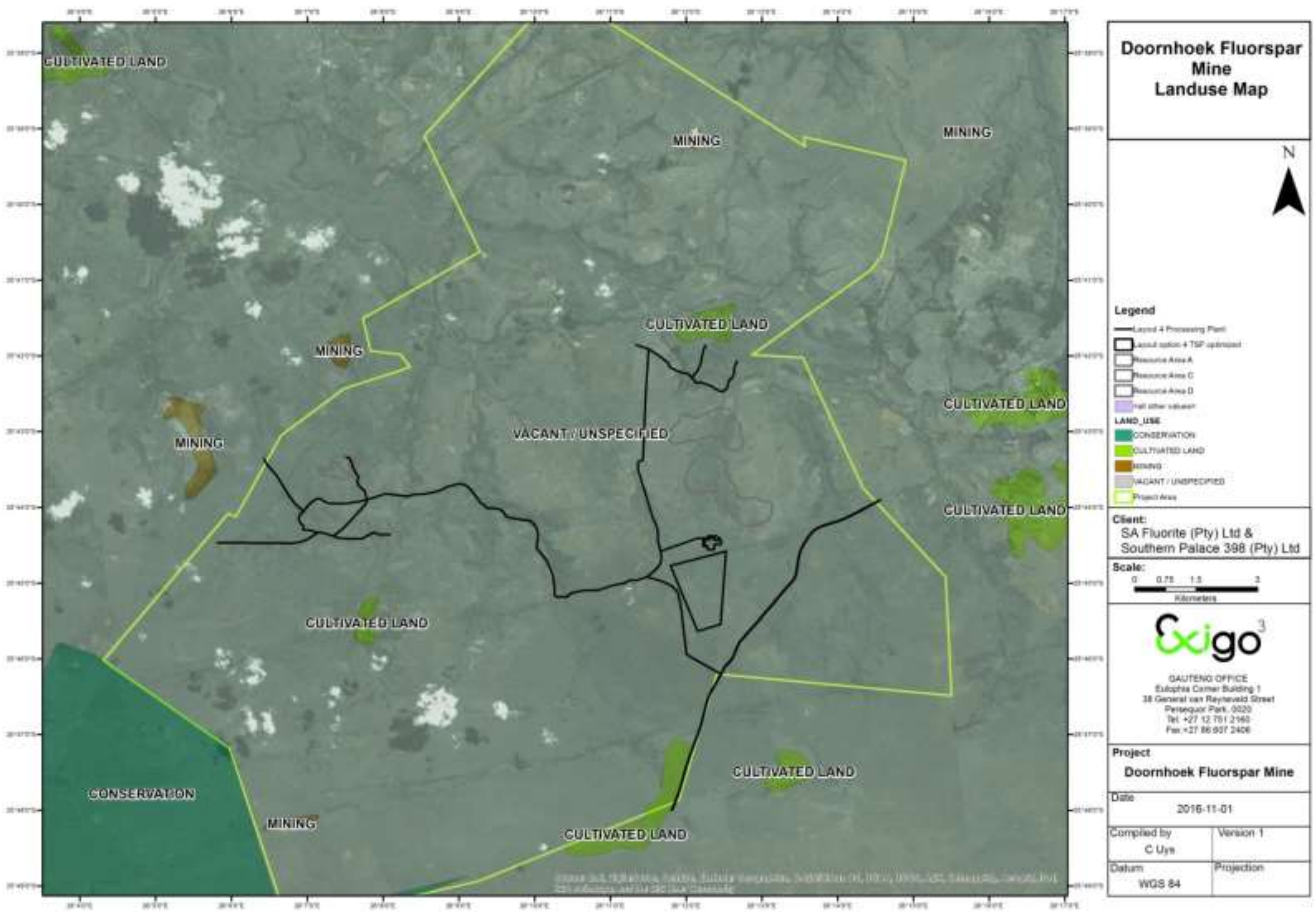

Figure 5-1 Locality Map including surrounding land uses

5.1 Biophysical environment

To follow is a brief description of the surrounding biophysical and socio-economic environment. A more detailed description of the biophysical and socio-economic environment is provided in the Final EIA&EMPR and relevant specialist studies (Appendix C: Environmental Impact assessment and Environmental Management Programme Report (EIA&EMPR) including specialist reports).

5.1.1 Climate

The site falls within the summer rainfall region with very dry winters and frost that occurs fairly frequently during winter.

5.1.1.1 Rainfall & Temperature

Climate refers to the summation of the daily, weekly and monthly changes of weather over a long period and it is influenced by latitude, altitude, direction and intensity of wind and the presence of large bodies of water such as the ocean, lakes, dams and rivers. The main climatic factors analysed for the site were long-term monthly average rainfall, temperature and relative humidity.

The area known as the Bankenveld, which occur in portions of Zeerust and Marico, can be separated from the Highveld region on the grounds of the differences shown in its climatic statistics. The project site has warm to hot summers and cool and dry to cold winters, with an average annual rainfall of 439mm. According to Groundwater Resource Directed Measures (GRDM) the Mean Annual Precipitation (MAP) is 566mm/a and the Mean Annual Runoff is 8mm/a for the entire catchment. The Mean Annual Evaporation (MAE) is 8mm/a.

The average maximum temperatures for the region have been recorded between November and January, with temperatures reaching a maximum of 31°C. The average minimum temperatures are reached during June and July with a minimum temperature of 1°C.

The rainfall pattern of Marico catchments is highly variable and unevenly distributed within the catchments. The intermittence of the rainfall results in frequent floods and local droughts.

As far as the temperatures are concerned it is noticeable that the daily average maximums are all more than 30.3ºC, while the minimum for Zeerust is below 0ºC. The absolute maximum temperature of Zeerust is in excess of 40.6ºC. The absolute minimums recorded varies between -3.3ºC and -7.8ºC.The days with temperatures below freezing is still in the order of 23 to 32, but days with temperatures of less than -2.5ºC are less than on the Highveld.

As far as precipitation is concerned it is noticeable that the averages are all in excess of 600mm. Zeerust receives on average 57.1 days with thunder and only 1.1 days with hail.

Figure 5-2 indicates the monthly climatic averages of the project area, while Table 5-1 indicate the temperature, precipitation and humidity levels for the Zeerust and Mafikeng weather stations:

Monthly Minimum, Maximum and Average Temperatures (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	17.4	17.3	15.7	12.0	10.2	6.5	6.0	8.2	11.9	14.0	15.1	17.7
Average	22.6	22.3	20.3	16.4	13.8	10.1	9.6	12.4	16.5	19.0	20.7	22.7
Maximum	27.0	26.8	24.8	21.0	18.1	14.6	13.9	17.1	21.3	23.9	25.7	27.1

Figure 5-2 Monthly minimum, maximum and average temperatures for the project areas (Airshed, 2016)

Table 5-1: Temperature, precipitation and humidity levels for the weather stations of the project area (Source: South African Weather Bureau)

STATIONS:	MEAN TEMPERATURES (ºC)		PRECIPITATION (mm)			MEAN RELATIVE HUMIDITY (%)	
	JAN	JUL	MEAN	HIGH	LOW	JAN	JUNE
MAFIKENG	30,4	3,0	553	868	265	65	35
ZEERUST	30,8	-0,8	600	1002	390	69	36

5.1.1.2 Wind

The long-term weather record indicates that wind speed, experienced in the project area, ranges from 0 to more than 10.0 ms-1. The maximum wind speed rarely rises beyond 10 ms-1. Figure 5-3 indicates wind direction and speed. The wind direction in the area is predominantly north-easterly. Day-time and night-time flow fields are similar with winds predominantly from the north-eat.

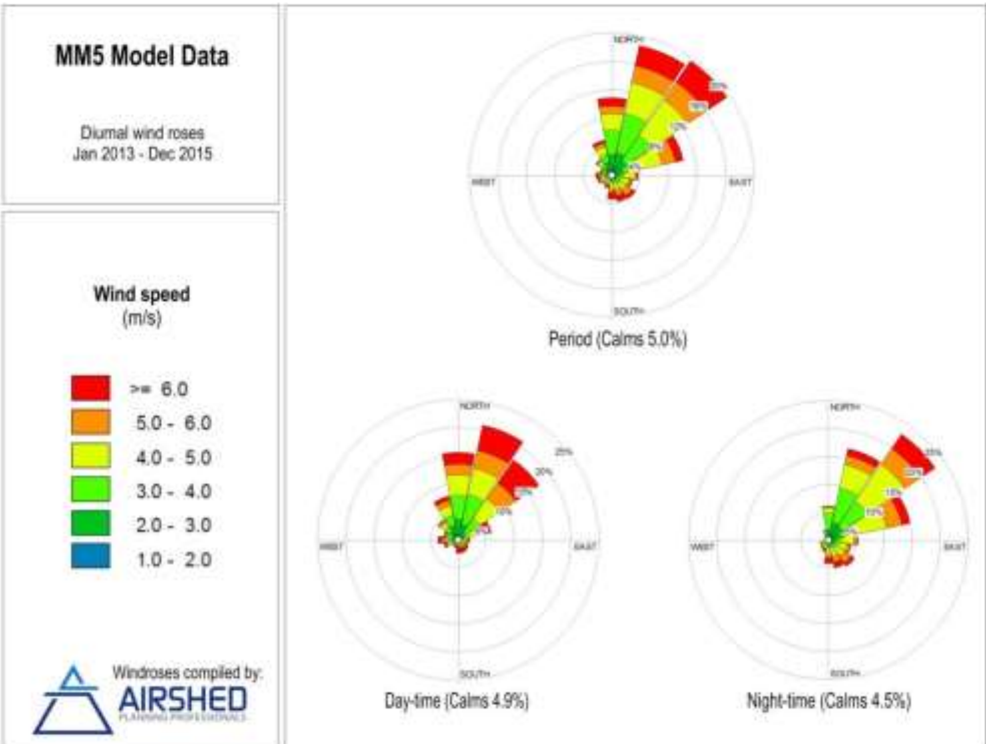

Figure 5-3 Period, day-, and night-time wind roses for the project area

(Airshed, 2016)

5.1.2 Topography

The project area is located at an altitude of approximately 1 342 metres above mean sea level (mamsl). The topography is relatively flat, dipping at a low angle in a north-westerly direction. The project area is defined as hills and lowlands in the northern section, while the southern section is classified as escarpment (ENPAT, 2000). The topography of the area is a mixture of terrains, ranging from flat to moderately undulating plains, outcrops, bottomlands (drainage channels) and slightly undulating hills. Refer to Figure 5-4 and Figure 5-5 for elevation profiles of the study area.

Figure 5-4: West-East Elevation Profile (exaggerated)

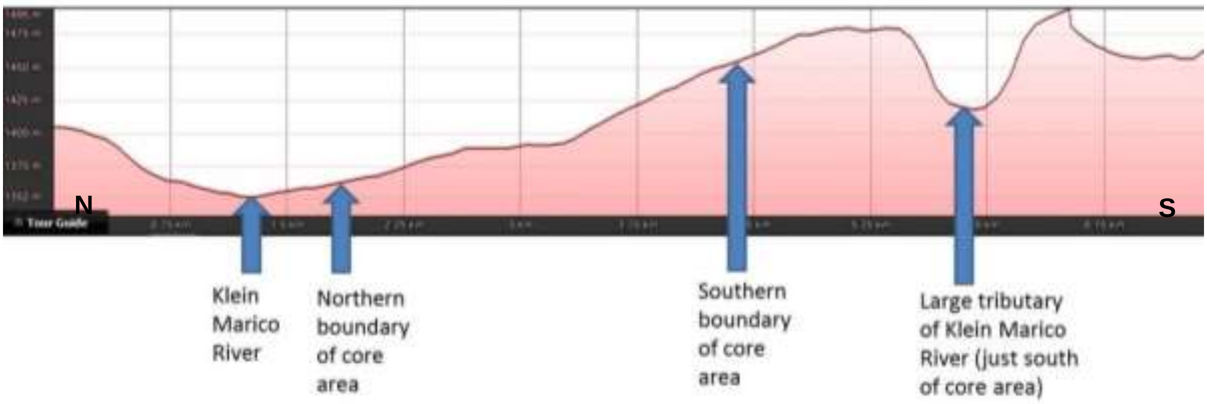

Figure 5-5: North-South Elevation Profile (exaggerated)

5.1.3 Geology

The following section describes the regional geology as depicted in the 1:250 000 geological maps sheets of Rustenburg (2526) and Mafikeng (2426). The project site is located on Vaalian age Chunniespoort group sediments (Transvaal Super Group). The Chunniespoort group is largely represented by dolomite, dolomitic limestone, chert and shale and is intruded by numerous basic dykes.

The fluorspar deposits are large bedded replacement deposits of the classical Mississippi Valley type. Fluorspar mineralisation occurs mainly associated with stromatolites in the Middle Frisco Zone and appears to have been introduced post deposition by hydrothermal brines. The fluorite occurs as a filling in permeable beds; within small gas cavities in the stromatolites and these are expected to be mined.

The stratigraphic sequence of interest to this study thus consists of the upper formations of the Malmani sub-group and the overlying Pretoria group shales and clastics. The upper formations of the Malmani sub-group include the Eccles and the Frisco formations.

The Eccles formation outcrops south of the project area and is characterised as a chert rich formation. The Frisco Formation overlies the Eccles formation. This unit hosts fluorite deposits and comprises stromatolitic dolomites. The Frisco formation is overlain by the clastic and iron-rich sediments of the Penge Formation which in turn is unconformable overlain by Pretoria Group shales and clastic sediment of the Rooiberg formation. Shales, Bevets conglomerates and the Polo Ground Member of the Timeball Hill formation overlies the Rooiberg formation and is found outcropping in the northern portion of the study area. A dolerite dyke has intruded this formation and outcrops on the northern portion of the Doornhoek farm. Both east-west trending and north south trending dolerite dykes are abundant in the project area.

Extensive geological mapping has been conducted on the farms Strydfontein 326, Witrand 325, Rhenosterfontein 304, Doornhoek 305, Farm 306, Knoflookfontein 310. Much of the study area consists of the dolomite package overlain by cherts of the Penge formation. In the northern sections of the study area the Pretoria group shales, conglomerates and quartzites are extensive.

Based on the geological cores and cross sectional mapping (SA Flourite (Pty) Ltd), The Frisco formation is subdivided into three units, the lower, middle and upper Frisco. The mineralisation zone is predominantly associated with the Middle Frisco unit and although of variable thickness the main mineralisation zone appears to be between 10-35 m thick

Cross sectional maps were available for the Rhenosterfontein 304, Doornhoek 305, Farm 306 and Knoflookfontein 310. The cross sections indicate that the sedimentary units dip gently. Numerous east-west trending and north-south trending normal faults transect the stratigraphic sequence (Meyer et al, 2016).

5.1.4 Land use & soils

The land use of the project area is mainly vacant or unspecified (ENPAT, 2002). Some patches of cultivated land and mining occur within the area. The Molemane Eye Nature Reserve borders the mining right area to the south east.

The soils covering the project area can be grouped into different land types. A landtype unit is a unique combination of soil pattern, terrain and macroclimate, the classification of which is used to determine the potential agricultural value of soils in an area. The landtypes, geology and associated soil types is presented in Table 5-2 below as classified by the Environmental Potential Atlas, South Africa (ENPAT, 2000). However, it must be noted that soil types are mostly determined by position on the landscape.

Deeper sandy soils are associated with flat topography whilst shallow, rocky soils are associated with the undulating hills and rocky outcrops. Existing agricultural activities are limited to the flat areas of the project area. As a result of the irregular undulating rocky areas, fairly steep rocky slopes, shallow rocky nature of the soils and intensity of rainfall the project area is very susceptible to water erosion, especially on roads and areas denuded of vegetation with a poor herbaceous basal cover.

Table 5-2: Landtype, soils and geology of the project area

Landtype	Soil	Geology
Ae59	Red-yellow apedal, freely drained soils; red, high base status, > 300 mm deep (no dunes)	Shale, slate, siltstone and hornfels of the Strubenkop, Silverton and Timeball Hill Formations; quartzite of the Timeball Hill and Daspoort Formations; dolerite dykes present. Rocks possess regional dip of 7 degrees to the north and north-east.
Ac71	Red-yellow apedal, freely drained soils; red and yellow, dystrophic and/or mesotrophic	Shale, slate, siltstone and quartzite of the Rooihoogte and Timeball Hill Formations, with dolerite dykes in places. Dolomite and chert of the Chunniespoort Group in the south-west.

5.1.5 Biodiversity

5.1.5.1 Vegetation at Doornhoek

The project area lies partially within the Grassland and Savanna Biome and therefore forms an important ecotone between the two biomes. Ecotones are transitional areas between adjacent but different habitats, ecosystems, landscapes, biomes, or ecoclimatic regions (Risser, 1993). Ecotones that are unique entities in the context of climate change are transition zones between ecoclimatic regions. Ecotones have narrow spatial extent, a steep ecological gradient and hence high species richness (Risser, 1993), a unique species combination, genetically unique populations (Lesica and Allendorf, 1994), and high intra-species genetic diversity (Safriel *et al*., 1994).

Although the site is classified mainly as Moot Plains Bushveld, representations of the Carletonville Dolomite Grassland was also observed in the area and subsequently this vegetation type is included as part of the focus area (Henning, 2016).

5.1.5.2 Endemic plants

Mucina and Rutherford (2006) identified the following plant species as endemic to the main vegetation types (Carletonville dolomite Grassland and Moot Plains Bushveld) in the region:

- Succulent shrub: *Delosperma davyi*

5.1.5.3 Red data species

Habitat degradation is one of the main reasons for plant species becoming extinct in a particular area. Threatened species are also seen as indicators of the overall health of an ecosystem (Hilton-Taylor, 1996). Although no threatened species and Species of Conservation Concern were listed for the Grids

2526CC and 2526CA (SANBI, POSA website October 2011), the following red data species was found during the site surveys (Table 5-3):

Table 5-3: Red data species found during the vegetation survey

Plant species	Status (NCNCA)	Habitat on site
Boophane disticha	Declining	Rocky grassland, woodland on rocky slopes

5.1.5.4 Protected Trees

Two tree species listed as protected under the national list of declared protected tree species as promulgated by the National Forest Act (NFA), 1998 (No. 84 of 1998) were observed in the project area. The trees species listed in the DAFF protected tree species list have a wide distribution in Southern Africa, although these trees have an importance in terms of medicinal, cultural and heritage value to local communities. The following protected tree species of concern occur in the area:

Table 5-4: Protected tree species of concern in the project area

Species	National Conservation status	Status in project area	Habitat of species
Acacia erioloba	Protected (NFA)	Isolated	Occur along old wagon-tracks as part of the historical areas of site
Securidaca longipedunculata	Protected (NFA)	Widespread	Shallow rocky soils with a sandy layer above on terraces and plateaus

Listed protected tree species in terms of the National Forest Act of 1998, may not be cut, disturbed, damaged, destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold – except under license granted by Department of Agriculture, Forestry and Fisheries (DAFF) or a delegated authority. Obtaining relevant permits are therefore required prior to any impact on the above protected trees.

5.1.5.5 Medicinal Plants

Medicinal plants are an important aspect of the daily lives of many people and an important part of the Southern African cultural heritage. The impact of the proposed development on populations of medicinal plants will be very little, although certain plants play an important role in the culture. The following medicinal plant species occur in the project area (Van Wyk & Gericke, 1997) as indicated in Table 5-5:

Table 5-5: Medicinal plant species and their habitats in the project area

Species	Indigenous / exotic	Status	Habitat of species

Species	Indigenous / exotic	Status	Habitat of species
Acacia karroo	Indigenous	Widespread	Riparian woodland / floodplains / old fields on fertile soils
Acacia tortilis	Indigenous	Widespread	Woodlands on loamy to clayey soils including floodplains / old fields on fertile soils
Datura stramonium	Exotic	Widespread	Old fields / disturbed land
Dichrostachys cinerea	Indigenous	Widespread	Degraded woodland / natural woodland areas on sandy soils
Dombeya rotundifolia	Indigenous	Widespread	Riparian woodland / mountainous areas
Ehretia rigida	Indigenous	Localized	Termitaria / riparian woodland
Elephanthorhiza elephanthina	Indigenous	Widespread	Sandy plains
Euclea undulata	Indigenous	Widespread	Floodplains along rivers, riparian woodland and on termitaria
Grewia bicolor	Indigenous	Widespread	All habitats of area
Gomphocarpus fruticosa	Indigenous	Localized	Along floodplains of rivers / in seasonal zones of rivers
Lippia javanica	Indigenous	Widespread	Old fields / disturbed land
Pavonia burchellii	Indigenous	Localized	Shady areas under trees / among rocks
Ricinus communis	Exotic	Widespread	Varied habitats / disturbed land along river courses
Terminalia sericea	Indigenous	Widespread	Deep sandy soils on plains
Typha capensis	Indigenous	Localized	In standing water of pans / rivers
Vernonia oligocephala	Indigenous	Widespread	Throughout many vegetation units of Savanna Biome
Ximenia caffra	Indigenous	Widespread	Bushveld / rocky terrain, termite mounds
Ziziphus mucronata	Indigenous	Widespread	Riparian woodland / floodplains / old fields on fertile soils

The present legislation under the Conservation of Agricultural Resources Act, 1983 (Act No 43 of 1983) (CARA), regulation 16, states that bush encroachers, which are indigenous plants, require sound management practices to prevent them from becoming problematic. Typical bush encroacher species that occur in the area listed under CARA (Act No 43 of 1983) is included in Table 5-6 below:

Table 5-6: Listed encroacher species for the Doornhoek project area

Species	Status	Habitat of species
Acacia karroo	Widespread	Riparian woodland / floodplains / old fields on fertile soils

Species	Status	Habitat of species
Acacia tortilis	Widespread	Woodlands on loamy to clayey soils including floodplains / old fields on fertile soils
Dichrostachys cinerea	Widespread	Degraded woodland / natural woodland areas on sandy soils
Grewia bicolor	Widespread	All habitats of area
Grewia flava	Localized	Bushveld on floodplains / sandy soils
Terminalia sericea	Widespread	Deep sandy soils on plains

5.1.5.6 Vegetation Units of the project area

Vegetation units were identified according to plant species composition, previous land-use, soil types and topography. The state of the vegetation of the proposed mining site varies from being natural to completely degraded. The farms are currently zoned as agriculture.

The vegetation communities identified in the area are classified as physiographic physiognomic units, where physiognomic refers to the outer appearance of the vegetation, and physiographic refers to the position of the plant communities in the landscape. The physiographic-physiognomic units will be referred to as vegetation units in the following sections. These vegetation units are divided in terms of the topographical differences, previous land-use and soil differences that had the most definitive influence on the vegetation units. Each unit is described in terms of its characteristics.

The broad classification identified 6 vegetation units as indicated in Figure 5-8 as follows:

1. *Loudetia simplex – Urelytrum agrypyroides* rocky grassland;
    - Plateaus;
    - Undulating footslopes / plains;
2. Loudetia simplex rocky outcrops;
3. Mountainous woodland:
    - *Open Strychnos - Acacia caffra* woodland
    - *Olea – Strychnos – Combretum* woodland
    - *Strychnos – Combretum* woodland;
    - *Protea caffra* woodland
4. *Acacia karroo – Ziziphus mucronata - Olea europaea* woodland on valleys / plains:
    - Undulating terrain & valleys;
    - Bushclumps (stonewalls);
5. Degraded terrain
    - Degraded grassland / old fields

- Degraded woodland
- Old mining quarries / farmsteads

6. Drainage features
   - Mixed *Searsia lancea - Acacia karroo* riparian woodland & water courses
   - Floodplains.
   - Hillslope Seep wetlands

5.1.5.7 Critical Biodiversity & Ecological Support Areas (ESA) of the project area

The North West Biodiversity Conservation Assessment (NWBCA) identifies specific Critical Biodiversity Areas (CBAs) in the North West Province. Critical Biodiversity Areas (CBA's) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services (North West Department of Agriculture, Conservation, Environment and Rural Development, 2009).

In terms of section 52 of the NEMBA the Minister or an MEC may publish in the Gazette a list of ecosystems that are threatened and in need of protection. On 9 December 2011 a National List of threatened ecosystems in need of protection was published in GNR 1002. Section 5.2 of the national list provides for the implications of the listing on environmental authorisation applications. The aforesaid section refers to Listing Notice 3 and activities proposed in critically endangered or endangered ecosystem listed In terms of section 52 of the NEMBA. Under section 5.2 of the national list it is stated that "if any other development that requires environmental authorisation impacts on a threatened ecosystem, that impact should be avoided, minimised, mitigated and/or offset as appropriate. To date the North West province has not listed critical biodiversity areas or ecosystems – the only gazetted list that exists is the above National List published in 2011. The Province's technical report states that the provincial list will not be developed until the National List has been finalised (this is so that confusion / contradictions are avoided).

It follows from the above that the fact that an area has been listed as an ecosystem in terms of the NEMBA does not prohibit the undertaking of development activities but an environmental impact assessment will have to be undertaken and environmental authorisation obtained. Furthermore, mitigation measures must be identified and possible offsets.

The proposed site does not fall within any of the listed ecosystems as per GNR 1002.

In terms of the SANBI 2015 terrestrial CBA dataset, the majority of the terrestrial areas on site, especially with regards to the locality of the plant and TSF as well as Resource Area C and D are classified as ESA 1 with small occurrences of ESA 2 (refer to Figure 5-6). The terrestrial areas for the location of Resource Area A are classified as CBA 2.

ESA 1 areas are semi-natural ecologically functional landscapes that retain basic natural attributes:

- Ecosystems are still in a natural, near-natural or semi-natural state, and have not been previously developed;
- Ecosystems are moderately to significantly disturbed but are still able to maintain basic functionality;
- Individual species or other biodiversity indicators may be severely disturbed or reduced;
- These are areas with low irreplaceability with respect to biodiversity pattern targets only.

ESA 2 areas which have been substantially modified and where ecological functionality must be maintained as much as possible with the following attributes:

- Maintain current land use or restore area to a natural state;
- Ecosystems are NOT in a natural or near-natural state, and has been previously developed (e.g. ploughed);
- Ecosystems are significantly disturbed but are still able to maintain some ecological functionality;
- Individual species or other biodiversity indicators are severely disturbed or reduced and these are areas that have low irreplaceability with respect to biodiversity pattern targets only;
- These are areas with low irreplaceability with respect to biodiversity pattern

CBA 2 areas are near natural landscape with the following attributes:

- Ecosystems and species largely intact and undisturbed;
- Areas with intermediate irreplaceability or some flexibility in terms of area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets, although loss of these sites would require alternative sites to be added to the portfolio of CBAs.
- These are landscapes that are approaching but have not passed their limits of acceptable change (READ, 2015).

According to the North West Biodiversity Sector Plan (READ, 2015) the Marico River system, including its associated tributaries is a highly ecologically significant aquatic ecosystem as highlighted by them being designated as priority rivers (FEPA Rivers). The system is also defined as an aquatic Critical Biodiversity 2 (CBA 2 due to the clean, free-flowing nature of the Marico River and the presence of the Vulnerable Marico barb (Enteromius motebensis) and the Near Threatened Enteromius sp. ‘Waterberg barb’ which is considered near threatened and occurs in the upper reaches of the Klein Marico River system as well as the Groot Marico and Koster River systems. Whilst no specimens of E. motebensis were collected from assessed sites in the systems under investigation, such populations may exist on a regional scale.

The upper reaches of the Marico River are in a natural or near-natural ecological state (ecological category A/B: largely natural) and are important as they represent a representative sample of the diversity of freshwater ecosystem types in the province that should remain in a good ecological state.

According to the North West Biodiversity Sector Plan (READ, 2015) a Marico River Conservation Association has been established by landowners whom are striving for Biosphere Reserve status. The upper Groot Marico River and tributaries are also important for species evolutionary processes as the different catchments support three genetically distinct populations of the Vulnerable Marico barb (Enteromius motebensis). Diversification of fish and other aquatic organisms is likely to be a phenomenon common to all upper catchments of rivers arising in the Swartruggens and Magaliesberg mountains. The rivers and associated catchments that support threatened fish species are Fish Sanctuary Areas, which are designated as Freshwater Ecosystem Priority Areas if in a good ecological condition (A or B ecological category) or Fish Support Areas (lower than A or B ecological category). The Present Ecological State (PES) of the Klein-Marico River is categorised as a Class B: Largely Natural.

The CBA Map categories, in particular Protected Areas, CBAs and ESAs, should inform the development of municipal land use schemes in terms of the Spatial Planning and Land Use Management Act (Act. 6 of 2013) (SPLUMA) schedule 2 land use purposes (or other land use zones developed in terms of municipal bylaws), as well as land use change applications (e.g. rezoning). The guidelines also give the evaluators of EIAs an indication of appropriate land uses within each category. Importantly, the North West Biodiversity Sector Plan provides guidance on appropriate land uses but does not grant or remove existing land use rights or take the place of development application authorisation processes.

The following land management objectives apply to ESA 1 and CBA 2 areas and should guide land use planning and decision-making:

- ESA 1: Maintain in at least a semi-natural state as ecologically functional landscapes that retain basic natural attributes.
- CBA 2: Maintain in a natural or near-natural state that maximises the retention of biodiversity pattern and ecological process.

It is noted that a section of the road between Resource Area A and the plant runs through a CBA 1 area, however as noted in the Floodline and Stormwater Management Plan (Appendix 7.11 of the EIA&EMPR), it is recommended that the road be re-aligned to be located outside the 1:100 year floodline thus limiting the ecological and aquatic impact.

The following land use zones and associated activities are recommended for ESA 1 and CBA 2 areas (READ, 2015): (Y = Yes, N = No, R = Restricted)

Land Use Zone	Associated Land Use Activities	Allowance/Status
Environmental Conservation	Conservation management, low intensity eco-tourism activities and sustainable consumptive activities	Y

Environmental Management Overlay Zone	These are areas that are designated as priority areas for protection, namely CBA's and ESA's, and can include ONA's	Y
Tourism and Accommodation	Low Impact Tourism / Recreational and Accommodation	R
	High Impact Tourism / Recreational and Accommodation (e.g. golf estates)	N
Rural Residential	Low density rural housing or eco-estates	R
	Tradition Areas (existing) and Rural Communal Settlement (New)	N
Agriculture	Extensive Game Farming	Y
	Extensive Livestock Production	Y
	Game Breeding	N
	Arable Land – Dryland and Irrigated Crop Cultivation	N
	Agricultural infrastructure – Intensive Animal farming (e.g.) feedlot, dairy, piggery, chicken battery)	N
Municipal Commonage	Local Agri-economic Development	R
Open Space	Public or Private Open Space, including recreational areas, parks, etc.	R
Residential	Low, low-medium and medium-high, and high density urban residential development (Urban & Business Development)	N
Urban Influence	An amalgamation of land use zones, including institutional, urban influence, general mixed use, low impact mixed use, suburban mixed use and general business (Urban & Business Development)	N
Low or High Impact and General Industry	Low impact, general industry and high impact industry (Urban & Business Development)	N
Transport Services	Transportation service land uses e.g. airports, railway stations, petro-ports and truck stops, bus and taxi ranks and other transport depots (In NW – Linear Engineering Structures)	R
Roads and Railway	Excising and planned linear infrastructure such as hardened roads and railways, including activities and buildings associated with road construction and maintenance, e.g. toll booths, construction camps and road depots sites (Linear Engineering Structures)	R

Utilities	Linear engineering structures, such as pipelines, canals and power lines (Linear Engineering Structures)	R
	Small scale infrastructural installations, including wastewater treatment works and energy sub-stations	R
	Large scale infrastructure installations, including bulk water transfer schemes, impoundments (Water Projects & Transfers), and energy generation facilities (power stations)	N
	Renewable Energy (PV farms and solar arrays)	N
	Renewable Energy (wind farms)	R
Quarrying and Mining	Prospecting and Underground Mining	R
	Quarrying and open cast mining (includes surface mining, dumping & dredging)	N
	Hydraulic Fracturing (fracking)	N

It is important to note that land development applications may require environmental authorisations and town planning permission irrespective of the CBA Map category; and that these processes must be followed. Where development applications other than the preferred biodiversity-compatible land uses are submitted in terms of the NEMA EIA Regulations, integrated environmental management tools or land use legislation (SPLUMA regulations/municipal bylaws), the following is recommended:

- A screening exercise should be undertaken by a biodiversity or ecological specialist appointed by the Environment Assessment Practitioner (EAP), to verify the CBA Map category on site
- If the site is verified as a CBA 1, CBA 2, ESA 1 and/or ESA 2, land development applications other than the preferred biodiversity-compatible land uses should be investigated in detail and the mitigation hierarchy applied in full.
- If the application is pursued, the application should be informed by the specialist biodiversity or ecological assessment as undertaken during the screening phase (READ, 2015).

In the Province's Technical Report of March 2009 (which precedes the gazetting of the National List) it is stated that mining is not permitted. However, the aforesaid report does not supersede the National List (2011) and remains a guideline to be taken into account by Government when considering applications for development, including mining, in such areas.

Section 48 of the MPRDA contains certain statutory prohibitions on mining on land, read with section 48 of the National Environmental Management: Protected Areas Act prohibiting mining in protected areas. In all other areas the application for a mining right must be considered together with the impacts identified and mitigation measures proposed.

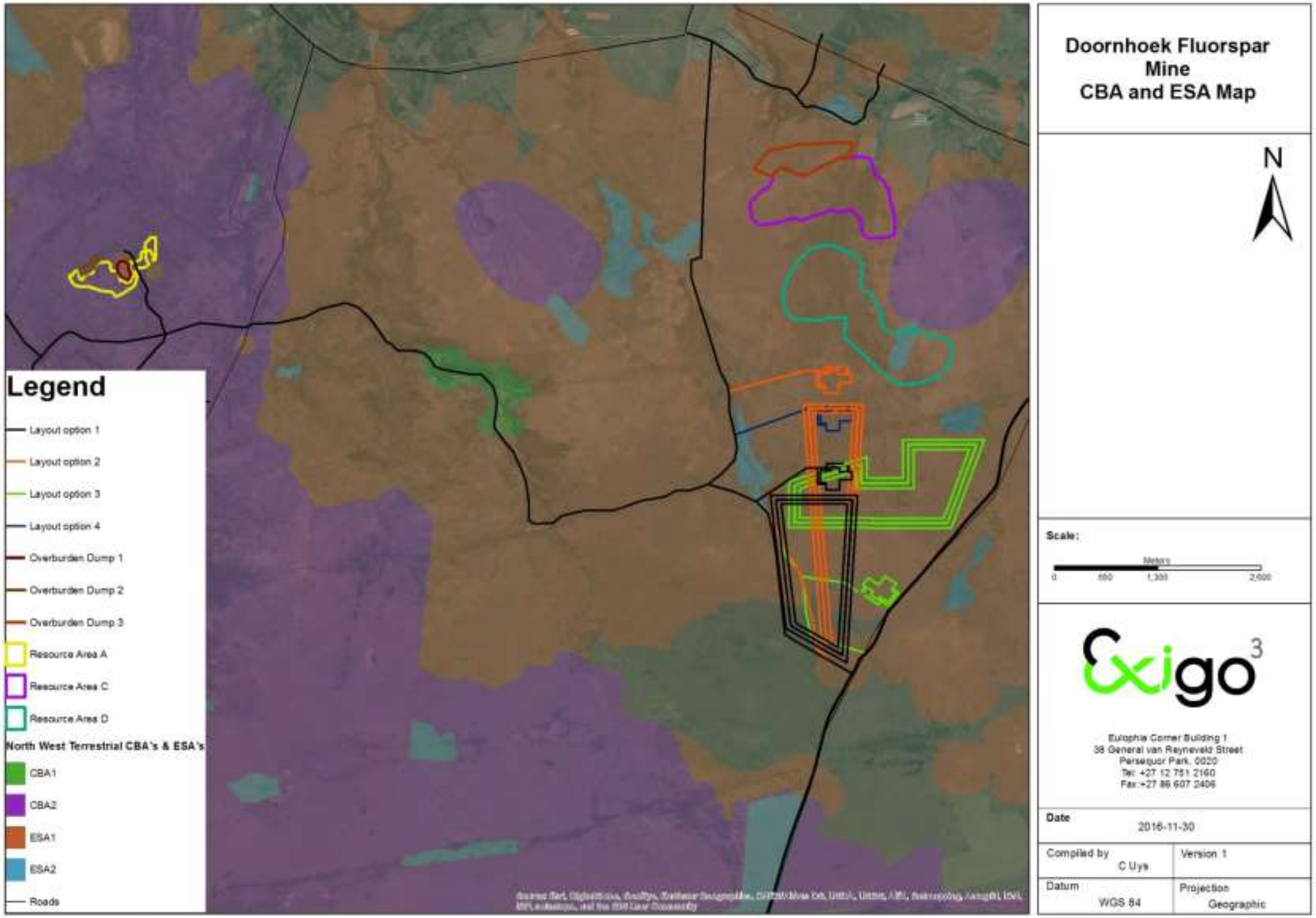

Figure 5-6 Terrestrial CBA and ESA areas of the study area (2015)

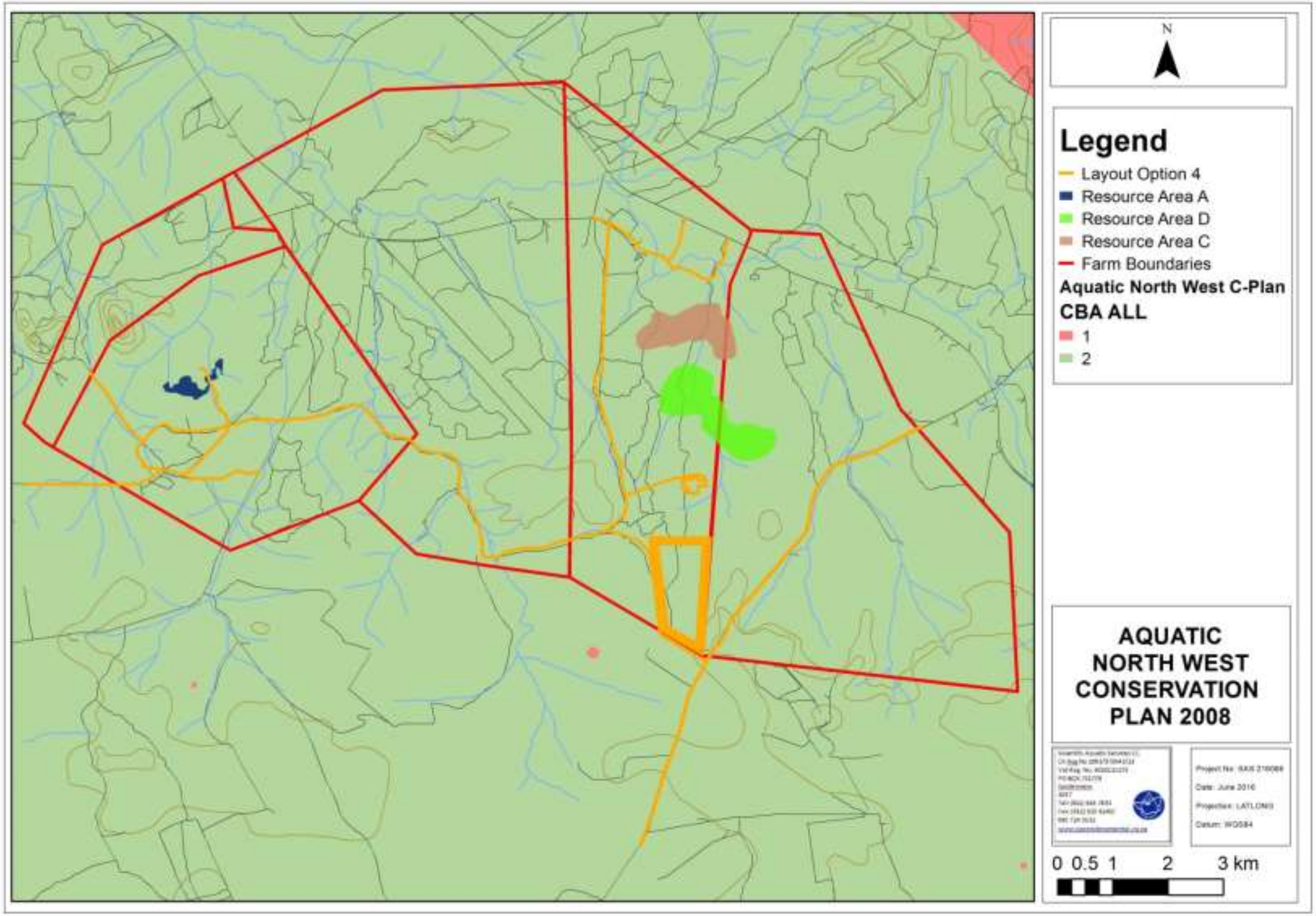

Figure 5-7 Aquatic CBA areas of the study area (2008; 2015 aquatic CBA dataset is not currently available for download)

Figure 5-8: Biome Map of the project area

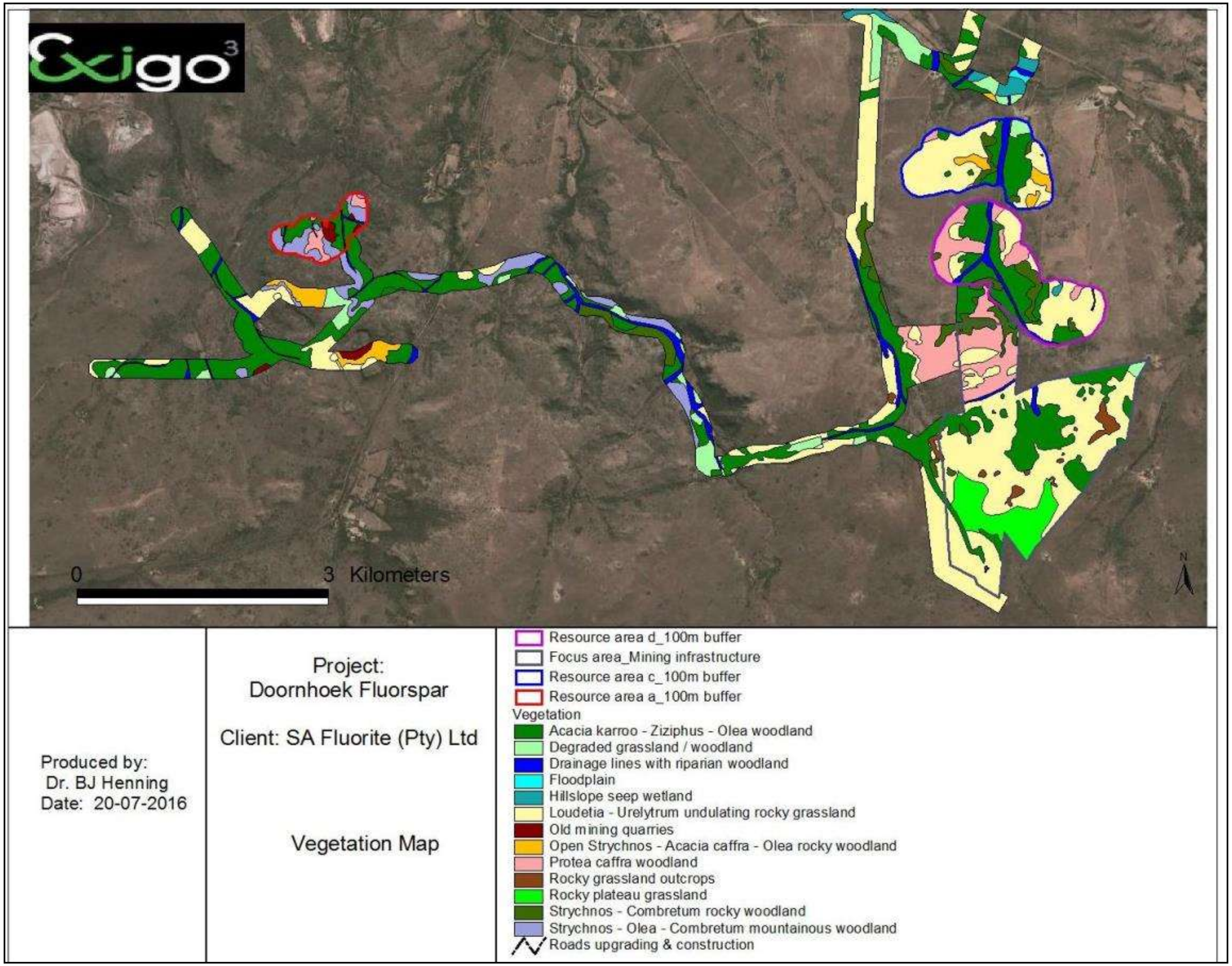

Figure 5-9 Vegetation Map of the Project Area

5.1.5.8 Fauna at Doornhoek

Five main fauna habitats potentially occur in the area namely:

1. Cliffs, rock-strewn hillsides and rocky hillslopes;
2. Riparian woodland and open water habitat;
3. Mixed broadleaf woodland habitat;
4. Grassland habitats
5. Old cultivated fields / degraded areas

<u>Habitat A: Ridges / outcrops</u>

The rocky habitat on site is an important habitat for various fauna species of conservation concern of which the most important would be reptiles (South African python), bats and smaller mammal species. The rocky ridges occupy isolated pockets of the project area. The ridges and outcrops create important microhabitats for fauna on site.

Although larger mammal species may not be as common in this habitat type, smaller species such as the dassie and Jameson's red rock rabbit are important prey species to predators in this habitat type. Dassies are the main prey of leopard in the rocky areas (Walker, 1986). The scavenger, the brown hyena, also seems to prefer these rocky areas to hide during the daytime. Other typical nocturnal animals which may occur in this habitat type include large spotted genet, small spotted genet, and species with a wide habitat tolerance such as, African wild cat, porcupine, pangolin, honey badger and striped polecat.

<u>Habitat B: Open water habitat type and riparian woodland</u>

The open water habitat type is associated with the perennial rivers and dams in the project area. These areas provide habitat and feeding grounds for various amphibians, fish species and avifauna. Mammal species that will specifically utilize this habitat are the Cape clawless otter. Otters are dependent on their food source such as crabs, frogs, fish or other aquatic life in the river ecosystems.

The shallow water habitat that occurs along the dam shores and rivers throughout the year is more suitable for waterbirds that forage along its banks. Threatened birds prefer these dense habitat types associated with riparian woodland in the area.

The riparian woodland along the banks of the riverine systems is important habitat for various birds, mammals and Herpetofauna (reptiles and amphibians).

The unique biota identified on a regional level (not necessarily within the mine focus area) includes:

- **Fish:** The cichlid fish (*Tilapia sparmanii*) is genetically distinct from other known conspecific populations;
- **Insecta:**
    - Four new mayfly (*Ephemeroptera*) species;

  - Eight new caddisfly (*Tricoptera*) species, most of these only occurring at the site;

- **Crustacea:** Four new seed shrimp (*Ostracods*) distribution records and one new species

Habitat C: Mixed woodland associated with plains and valleys

The woodland area of the lower-lying plains and open valleys play an important role as habitat for various generalized fauna species. Birds and arboreal reptiles would utilize the larger tree species for breeding, roosting and foraging.

Habitat D: Pristine grasslands

The grassland habitat occurs in the southern and eastern sections of the project area. It would appear as though the changes in climate and lack of fire have changed most of the grasslands that used to occur in the larger area into woodlands (Grobler, pers. Comm). Grasslands in all their variations are currently one of South Africa's most threatened biomes, with only 2.5% formally conserved and more than 60% already irreversibly transformed. The primary threats to grassland habitat for fauna include degradation and conversion mainly as a result of large scale agriculture development, urbanisation, prospecting and mining. Although the Giant Bullfrog and Oribi used to occur in the grasslands of the area, it would appear as though it disappeared although more studies are needed to show whether this is in fact the case. Species typical of the grasslands in the region include species such as Jameson's red rock rabbit, secretary bird, steenbok and redwing francolin.

Habitat E: Old fields and cultivated land

The region has a long history of agricultural and urban settlement and these areas support a relatively low faunal diversity, with few threatened or sensitive species. However, Savanna and grassland habitats are usually interconnected, allowing easy movement for fauna. The degraded habitat types associated with cultivation and urban areas still provide important feeding grounds to some fauna in the area. The abandoned croplands present in this landscape increase the connectivity by 25%.

Common fauna documented and potentially occurring in the project area:

As a result of anthropogenic disturbance in the larger area and the limitations created by game fences, only the most tolerant generalists of the larger vertebrates still occur in the project area outside the nature reserves. Examples are grey duiker, bushbuck, steenbok and baboon. The more sensitive habitat-specialist species like honey badger, leopard, brown hyena and caracal have retreated into areas of lower disturbance such as the surrounding ridges and riparian woodland.

Most mammal species are highly mobile and will move away during construction. The most important corridors that need to be preserved for free-roaming mammal species in the area include the perennial Klein Marico River (optimal habitat for the red data species cape clawless otter), rocky ridges, rocky grasslands and riparian woodland.

There is a long list of red data bird species that have a geographical distribution that includes the site.

The presence of the habitat of these species is mostly confined to the open water habitat, riparian woodland and rocky habitats observed on site. These habitat types will be avoided during the proposed development and it is therefore highly unlikely that species utilizing these habitat types will be impacted on.

The only reptile species listed in the IUCN red data categories that could potentially be impacted on is the South African python. The proposed mining activities should allow the species to still have optimal living conditions on the remainder of the area (specifically the rocky outcrop areas and tall grassland floodplains that represent optimal habitat for the species). Although highly charismatic, individuals could be killed by workers when encountered on the construction site, since P. natalensis is highly valued in the "muthi" trade (Branch, 1988).

<u>Red data fauna</u>

The table below indicates the potential and confirmed red data species occurring in the project area for each of the major groups:

English Name	**Conservation status**
BIRDS	
African Marsh Harrier	Vulnerable
Black Harrier	Near threatened
Black Stork	Near threatened
Blackwinged Pratincole	Near threatened
Blue Crane	Vulnerable
Cape Vulture	Vulnerable
Caspian Tern	Near threatened
Chestnutbanded Plover	Near threatened
Greater Flamingo	Near threatened
Halfcollared Kingfisher	Near threatened
Kori Bustard	Vulnerable
Lanner Falcon	Near threatened
Lappetfaced Vulture	Vulnerable
Lesser Flamingo	Near threatened
Lesser Kestrel	Vulnerable
Marabou Stork	Near threatened
Martial Eagle	Vulnerable
Melodious Lark	Near threatened
Pallid Harrier	Near threatened
Peregrine Falcon	Near threatened
Pinkbacked Pelican	Vulnerable
Redbilled Oxpecker	Near threatened
Secretarybird	Near threatened
Shortclawed Lark	Near threatened
Tawny Eagle	Vulnerable

English Name	Conservation status
BIRDS	
White Pelican	Near threatened
Whitebacked Vulture	Vulnerable
Whitebellied Korhaan	Vulnerable
Yellowbilled Stork	Near threatened
MAMMALS	
Cheetah	Vulnerable
South African Hedgehog	Near threatened
Reddish grey musk shrew	Data deficient
Tiny musk shrew	Data deficient
Lesser red musk shrew	Data deficient
Swamp musk shrew	Data deficient
Lesser grey-brown musk shrew	Data deficient
Roan antelope	Vulnerable
Sundevall's leaf-nosed bat	Data deficient
Brown hyena	Near threatened
Single striped mouse	Data deficient
Serval	Near threatened
Pangolin	Vulnerable
Honey badger	Near threatened
Schreiber's long-fingered bat	Near threatened
White tailed rat	Endangered
Rusty bat	Near threatened
African weasel	Data deficient
Darling's horseshoe bat	Near threatened
Bushveld gerbil	Data deficient
HERPETOFAUNA	
South African Python	Vulnerable
Giant bullfrog	Near threatened

5.1.6 Wetlands

Five major wetland types were identified on site namely:

1. Floodplain wetland;
2. Valley bottom wetlands associated with the low-lying valleys of the project area:
    - Channelled;
    - Unchannelled
3. Valleyhead seep wetlands associated with the origin of low-lying rivers and channelled valley bottom wetlands;
4. Hillslope seep wetlands;

5. Depressions:
    - Man-made dams.

The wetland areas are presented in

Figure **5-10**. For planning purposes wetland areas were also delineated for a larger area outside of the focus area indicated in

Figure **5-10**.

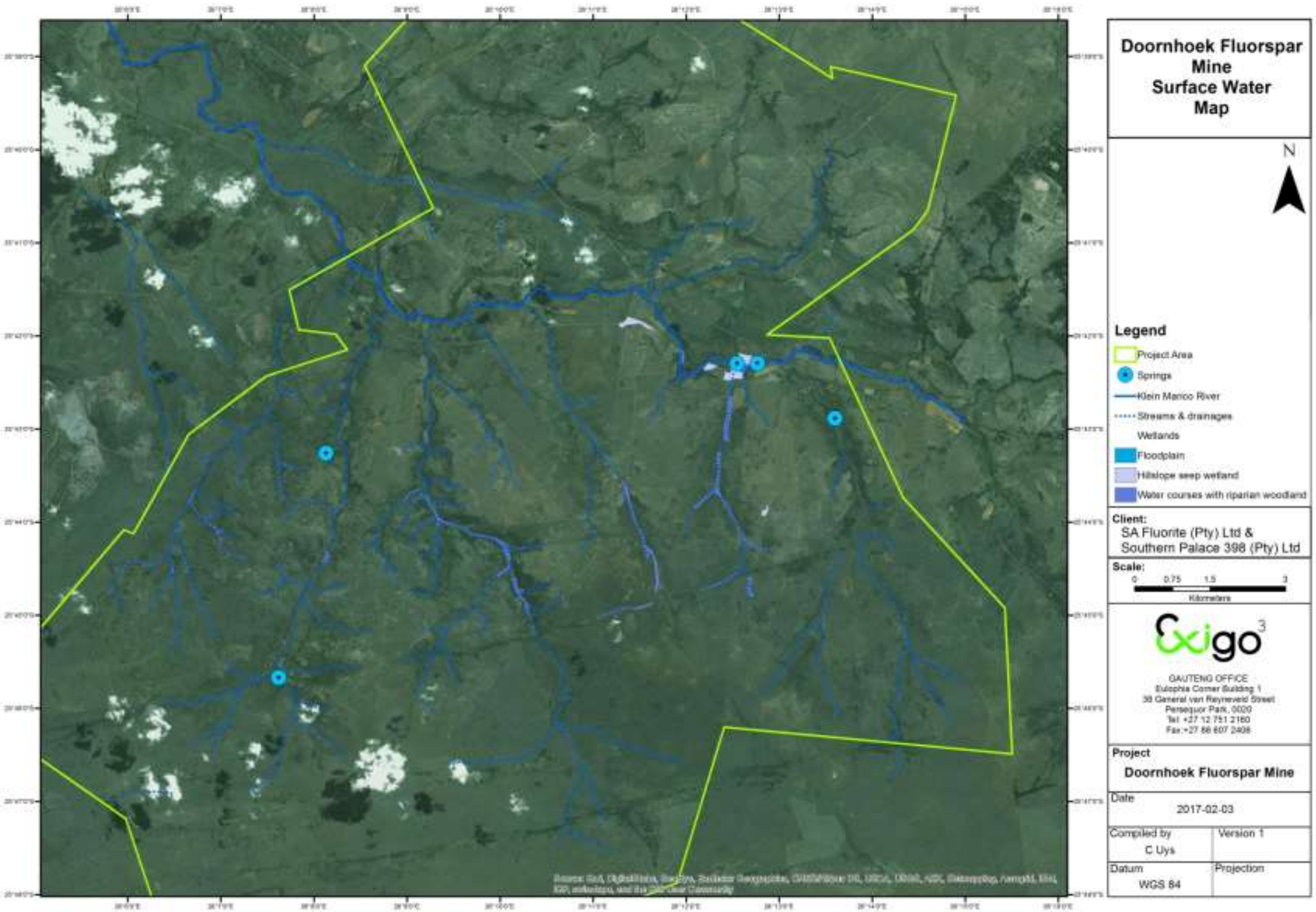

Figure 5-10 Wetland map for the proposed Doornhoek Fluorspar Mining Right Area

The current impacts associated with the site are reflected in the results of the wetland integrity assessments. Evidence was observed on site of transformation of the floristic characteristics of the site. Impacting activities which may have altered the expected floristic composition include overgrazing, impoundments, road crossings, mining and agricultural activities.

All of the above impacts have resulted in the current condition of the wetlands on site departing significantly from the reference or unimpacted condition of the wetland. This is reflected in the results of the PES assessment which indicates that the Klein Marico River floodplains are in a moderately modified condition (PES C) mainly due to alien species invasion, erosion and sedimentation of the river ecosystem, while the tributaries of the Klein Marico is largely in a natural state. The springs and areas below the springs represent the most natural areas within the study area (PES score 4.0 – Class A: Largely Natural). The water quality in the springs is unchanged from reference conditions and the ecosystem largely intact, although canalisation and water abstraction have caused small changes to the ecosystem from reference conditions.

The EIS of the wetland indicated that the springs in the project area and areas below the springs in the valley bottom wetlands is highly sensitive from an ecological point of view considering that many red data fauna utilize this area as a source of water and habitat, while the floodplain wetland of the Klein Marico River have been altered by alien species invasion and impoundments and is an important corridor for the ecosystem at a local scale.

The Hydrological Functional and Importance (HFI) of all the wetland in the project area are considered to be Moderate and play a small role in moderating the quantity and quality of water of the Klein Marico River. The Klein Marico River floodplains and valley bottom wetlands with associated seeps do have a slightly better value in terms of the HFI.

Direct Human Benefits obtained from the wetlands on site were considered to be Moderate for the perennial water sources in the project area (Klein Marico River and springs), while the non-perennial wetlands have a Very Low value in terms of direct human benefit indicating that the locals therefore have a low dependency on the wetland and seldom benefit from it.

5.1.7 Surface Water

5.1.7.1 Surface Water at Doornhoek

The study area is situated within quaternary catchment A31D. The focus area is at an elevation of approximately 1450 mamsl. The topography of the catchment gently slopes in a northerly-westerly direction. The mean annual runoff (MAR) determined from quaternary catchment A31D is 9.04 Mm^3/a (WR 2005).

Quaternary catchment A31D falls within the Crocodile (West) and Marico water management area. The quaternary catchment is drained by the perennial Klein Marico River (which drains through the project area), a tributary of the Groot Marico River, which in turn is a tributary of the Marico which flows into the Limpopo River north of the project site.

A general orientation of the project area in relation to the WMA and sub-catchments is given by Figure 5-11.

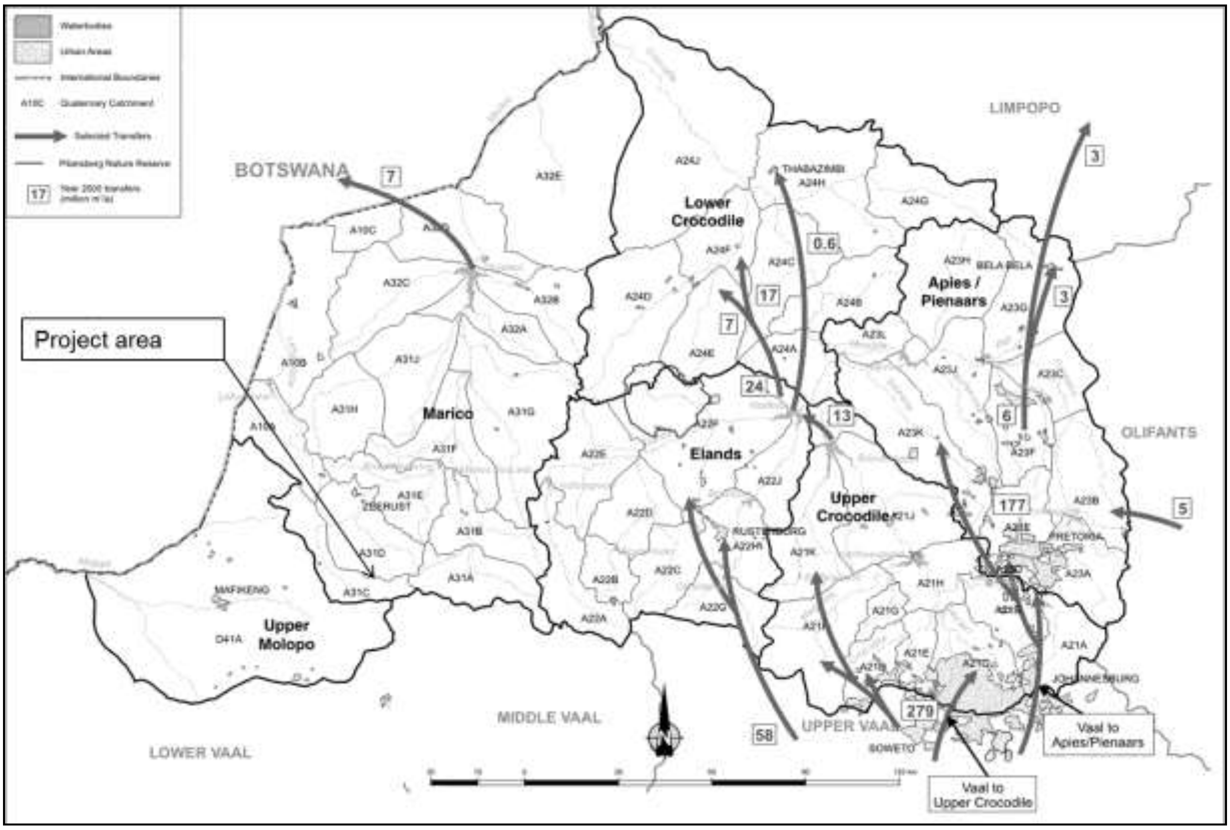

Figure 5-11 Project area in relation to the Crocodile (West) and Marico WMA

The Marico sub-management area corresponds to the catchment of the Marico River. Main tributaries of the Marico River include the Klein and Groot Marico rivers. This sub-area forms the western part of the WMA. The Groot Marico River is fed by a number of springs within the Groot Marico dolomitic aquifer compartment. These dolomitic eyes include the Molemane Eye and the Marico Eye.

The project area is drained mainly by surface run-off (i.e. sheetwash) with surface water flowing into the rivers and streams that bisect the area. The storm water collects along roads and footpaths cutting through the area, to drain into the regionally channels indicated above. It must be noted that surface flow along these rivers generally only occurs in the period directly after precipitation events or a wet rainy season, and that these rivers may exhibit a large base-flow component with groundwater flow occurring within the sandy sediments lining its channel.

Dolomitic eyes are water bodies fed by groundwater originating from fractures in the underlying dolomite. The fractures and intrusions of geological formations impenetrable to water in the dolomite form aquifers, dolomite compartments and dolomitic eyes. Aquifers are subterranean waterways/tunnels and reservoirs from which water is forced above ground through openings (fractures), which are called dolomitic eyes or springs. The dolomite area covers approximately 4022 km^2 of the North West Province and forms the main watershed of the east-flowing Limpopo River system and the west-flowing Molopo River. The interdependence of ground and surface water is apparent in the ecology of the dolomitic eyes. These eyes are influenced by the water quality and quantity of both the surface water and the ground water. The sources of the Molopo, Molemane and Marico rivers are unique dolomitic eyes (springs) and associated wetland systems.

An Aquatic Ecology Feasibility Study was undertaken by Scientific Aquatic Services in October 2014, where the Present Ecological State of the aquatic resources in the vicinity of the study area was assessed. A further study of the aquatic resources present was conducted in May 2016 as part of the baseline assessment for the proposed Doornhoek mining project. A literature review was undertaken and the aquatic Ecological Importance and Sensitivity (EIS) assessment performed is in agreement with literature cited. Based on the findings of the assessment it is evident that aquatic features associated with the Klein Marico River have an EIS which can be considered moderate to high. The Klein Marico River system can therefore be defined as being unique on a local to national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species), not usually very sensitive to flow modifications and often have substantial capacity for use.

Figure 5-12 visually presents the locations of the various points along the various river systems, assessed, while Table 5-7 presents a description of the monitoring points.

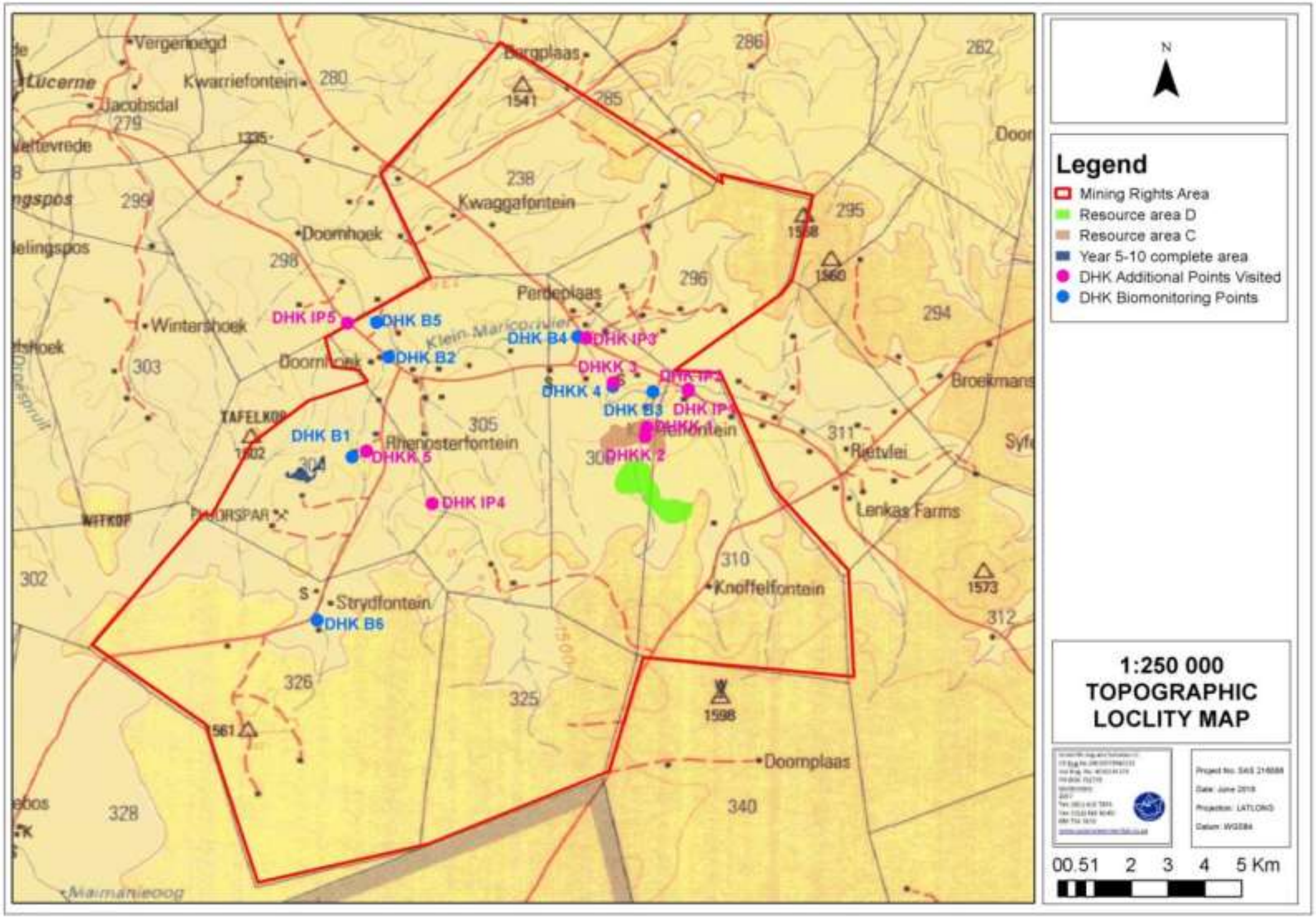

Figure 5-12 **Riverine aquatic ecological assessment points presented on a 1:250 000 topographical map (Scientific Aquatic Services, 2016)**

Table 5-7 Location of the biomonitoring points

Site	Detailed Site Description	GPS coordinates	
		South	East
DHK B1	A spring forming the source of a major unnamed tributary of the Klein Marico river	25°43'15.63"	26° 8'7.98"
DHK B2	A point further downstream on the unnamed tributary of the Klein Marico River and downstream of all possible mining activities	25°41'47.50"	26° 8'40.29"
DHK B3	The most upstream point on the Klein Marico river, a short distance downstream of one of the main springs feeding the system	25°42'18.05"	26°12'33.33"
DHK B4	A point located in the middle of the segment of interest of the Klein Marico River	25°41'29.66"	26°11'26.75"
DHK B5	A point located on the downstream edge of the segment of interest of the Klein Marico River and downstream of all potential mining activities	25°41'16.85"	26° 8'29.55"
DHK B6	A spring forming the source of an unnamed tributary of the Klein Marico River	25°45'39.40"	26° 7'37.38"
DHK IP1	The Spring on the Klein Marico River located to the east of the proposed mining area	25°42'17.71"	26°13'4.67"
DHK IP2	Upstream of the Spring on the Klein Marico River located to the east of the proposed mining area	25°42'15.87"	26°13'4.44"
DHK IP3	A small drainage line feeding into the Klein Marico river in the vicinity of point DHK B4	25°41'30.76"	26°11'34.39"
DHK IP4	A Major drainage feature feeding into the Klein Marico River and indicated as the Klein Marico river on some maps	25°43'56.65	26° 9'18.81"
DHK IP5	An unnamed tributary of the Klein Marico River on the western edge of the study area and located downstream of an existing mining operation	25°41'17.81"	26° 8'4.00"
DHKK 1	A small drainage line feeding into the Klein Marico river upstream of point DHK B3	25°42'82.5"	26° 12'4.63"
DHKK 2	A small drainage line feeding into the Klein Marico river upstream of point DHK B3 and DHKK 1.	25°42'96.4"	26° 12'4.44"
DHKK 3	A point located in the middle of the segment of interest on the Klein Marico River between sites DHK B3 and DHK B4.	25°42'16.6"	26° 11'9.71"
DHKK 4	A point located in the middle of the segment of interest on the Klein Marico River between sites DHK B3 and DHK B4 and upstream of site DHKK 3.	25°42'22.7"	26° 11'9.70"
DHKK 5	A small drainage line feeding into an unnamed tributary of the Klein Marico river in the vicinity of site DHK B1.	25°42'17.3"	26° 8'3.47"

Table 5-8 on the next page summarizes the results obtained for the respective sites assessed. The following are key concepts in order to understand the table below:

- Intermediate Habitat Integrity Assessment (IHIA) - Method to rate habitat integrity of riverine taking habitat conditions and impacts into consideration.
- Invertebrate Habitat assessment System (IHAS) - Used to determine specific habitat suitability for aquatic macro-invertebrates, as well as to aid in the interpretation of the

results of the South African Scoring System version 5 (SASS5) scores.

- Vegetation Response Assessment Index (VEGRAI) - Designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results.
- South African Scoring System 5 (SASS 5) Dickens & Graham (2001) – Assessment of Aquatic macro-invertebrate communities in order to assess river health.
- Macro-invertebrate Response Assessment Index (MIRAI) – Assessment of the four major components of a stream system that determine productivity, with particular reference to aquatic organisms, are flow regime, physical habitat structure, water quality and energy inputs.
- Fish Response Assessment Index (FRAI) - Index employs preferences and intolerances of the reference fish assemblage, as well as the response of the actual (present) fish assemblage to particular drivers to indicate a change from reference conditions

Table 5-8 Summary of aquatic assessment results

Index		Unnamed tributary of the Klein Marico River		Klein Marico River			
		DHK B1	DHK B2	DHK B3	DHK B4	DHK B5	DHKK 4
IHIA	October 2014	D	D	B	B	C	NA*
	May 2016	D	D	C	C	NA*	A
IHAS	October 2014	Inadequate	Inadequate	Borderline adequate	Inadequate	Inadequate	NA*
	May 2016	Adequate	Inadequate	Inadequate	Inadequate	NA*	Inadequate
VEGRAI	October 2014	B		E			
	May 2016	B		E			
SASS5 Dickens and Graham (2001)	October 2014	E	D	D	D	D	NA*
	May 2016	C	E	D	D	NA*	D
SASS5 Dallas (2007)	October 2014	D	A	D	C	D	NA*
	May 2016	D	E/F	D	D	NA*	D
MIRAI	October 2014	D	D	C	C	C	NA*
	May 2016	C	D	D	C	NA*	C
FRAI automated	October 2014	F		F			

	May 2016	E/F		E			
FRAI refined	October 2014	D/E		D/E			
	May 2016	D/E		D			
Integrated Ecological Category		C	C/D	D	C/D	C/D	C

Based on the findings of the aquatic study, both the unnamed tributary and Klein Marico River can be considered water stressed systems with moderate ecological importance and sensitivity.

Although not collected from the sites assessed, Marico barbs (*E. motebensis*) may potentially occur within the larger regional area based on known distribution. This species is a vulnerable red data list species and care should be taken to avoid larger scale impacts within the system.

The overall PES for the Klein Marico River, which occurs in the vicinity of the proposed Doornhoek mining project, appears to improve in a downstream direction and fall into largely to moderately modified conditions (Class D to Class C). The overall PES of the unnamed tributary of the Klein Marico Tributary decreases slightly in a downstream direction, but may also be classified as largely to moderately modified from natural conditions (Class D to Class C). The overall Integrated Ecological Category for these two systems thus falls within the Desired Ecological Management Class (according to the DWS RQS PES/EIS database) for a stream of this nature in the Klein Marico River Catchment. Prior to any potential impacts from mining, the systems present are already under considerable threat from the following:

- Reduced in-stream flow, stream connectivity and catchment yield;
- Impacts from cattle watering and agricultural return flows;
- Deteriorating water quality with specific reference to salinization and decreased oxygen levels resulting from the impacts mentioned above;
- Alien vegetation encroachment;
- Erosion; and
- Sedimentation.

It is deemed essential that all effort is made to ensure that impacts on the Klein Marico River and tributaries as a result of the proposed mining project are minimised. Specific mention is made of mining activities that will affect in-stream flow and stream connectivity, negative impacts on water quality, erosion and sedimentation. In addition, impacts from alien vegetation encroachment in the catchment may also occur.

5.1.8 Groundwater

5.1.8.1 Crocodile (West) Marico Water Management Area Internal Strategic Perspective (ISP)

The National Water Act (NWA, 1998) requires that for each Water Management Area (WMA) a Catchment Management Agency (CMA) be established. The CMA will guide the management of the water resources of the WMA. The Marico, Upper Molopo and Upper Ngotwane catchments are part of the Crocodile (West) and Marico WMA.

Commercial irrigation, urban water use and rural domestic water use forms the three major water user sectors. Irrigation is the major water user in the greater Marico area along the Groot Marico River and the Klein Marico. The major source of supply to the water users and uses are the dolomitic aquifers of the Grootfontein compartments and the Molopo Springs.

The ISP found that the available water resources of the Marico catchments do not meet the water requirements at the appropriate levels of assurance of supply i.e. the catchments are in deficit. The ISP also found that the available water resources of the catchments are not well understood, especially the long term sustainable yield from groundwater resources abstracted from dolomites. Groundwater is widely available in chert horizons and karst zones with borehole yields between 5 and 20 L/s common and feasible. The aquifers in the catchments are important sources of stream base flow for the Groot Marico and the tributaries (DWAF, 2004).

In essence, the ISP concludes that groundwater management in the catchments are of utmost importance. The current water balance indicates a deficit in supply versus demand and little to no possibility of surface water resources being established. Groundwater resources is the only viable option, provided the development is accompanied by a detailed analyses and license application process.

Additionally, certain strategies such as alien vegetation eradication along the Klein Marico riparian zones will increase the water balance and possibly off set negative impacts.

5.1.8.2 Aquifer geometry and boundaries

The predominant geological units consist of dolomites, cherts and shales. Weathering of the Pretoria group shales and quartzites, the upper most lithological units in the study area, creates a good medium for groundwater storage and likely permit significant flow where bounded by a dolerite dyke which commonly intersects the strata. The underlying dolomitic package likely has variable permeability largely governed by the presence and absence of chert layers. As depicted in the stratigraphic sequence and observed from the geological cores viewed during the site visit, the upper sequence of the dolerites is largely laminar. These units likely have poor permeability and secondary structures such as faults and joints are important to groundwater flow.

A band of chert underlies the laminar dolomites and overlies the main mineralisation zone. The cherts are likely to exhibit appreciable groundwater flow. Below the mineralisation zone the dolomites are characterised as massive and again secondary structures form preferential flow paths for groundwater flow. As no hydrogeologically significant unit defines the aquifer base, the thickness of the aquifer is considered as ± 100 m. Sub-vertical dolerite dykes cross cut the sedimentary units of the region. These dykes are inferred to have low permeability relative to the country rock and thus act as barriers to groundwater flow and essentially compartmentalise the aquifer. This inference was based largely on the occurrence and location of springs within the study area as indicated in

Figure **5-10**.

5.1.8.3 Compartment mapping

Through evaluation of the data sources the dyke structures in vicinity of the proposed mine were mapped. The identified dykes were then overlain across a simplified geological map and compartments were mapped according to the intersecting dyke structures (

Figure 5-13).

Twenty-three compartments were identified. The focus area of the proposed mine is situated over three compartments demarcated as compartments 1, 3 and 4. The identification of springs along the dyke separating compartments 1, 2 and from 4 and 5 indicates that the dyke is likely semi-impermeable to impermeable. Therefore water table drawdown associated with a mining operation in compartments 1, 2 and 3 are likely not to extend southerly into compartments 4 and 5 (

Figure 5-13).

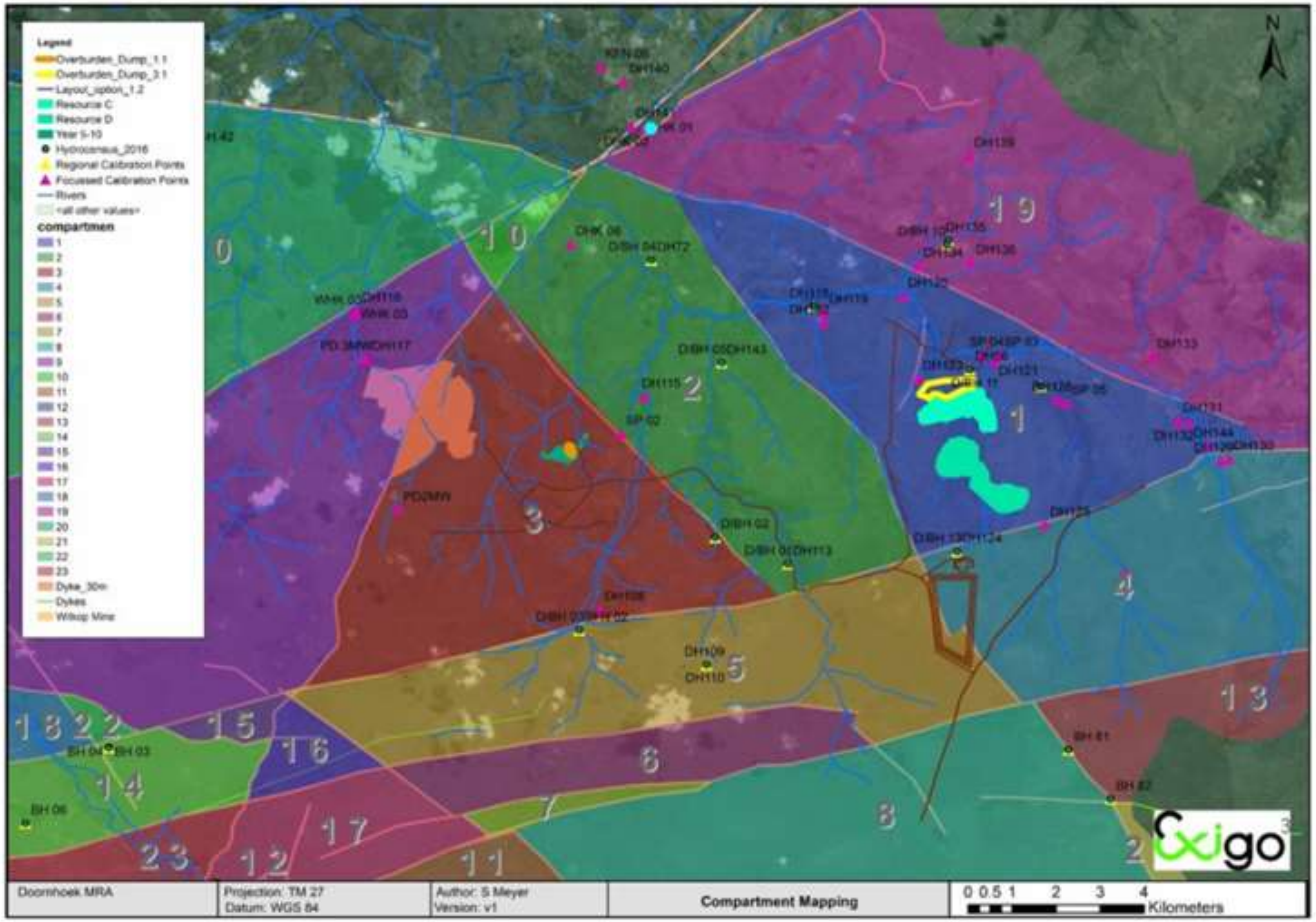

Figure 5-13 Compartment mapping for influence assessment

5.1.8.4 Compartments and Dyke Characteristics

The resource is located in a dolomitic aquifer. The aquifer is likely compartmentalised by dolerite dykes structures which cross cut the country rocks.

Compartment 1 housing a portion of the resource and Compartment 19, west of the resource area are the most sensitive compartments due to the large number of springs, the Klein Marico River and the significant number of water users in the compartments.

The dykes structure separating compartments 1, 2 and 3 from compartments 4 and 5 (south of the resource) displayed a positive gravity anomaly compared with the dolomitic country rocks and was inferred to represent un-weathered dolerite. Weathered margins adjacent to the dyke structure could not be identified. The dyke has a thickness of approximately 50 m.

The dyke structure separating compartment 3 and 9 did not show a significant anomaly compared with the other structures targeted. This finding was alike to the observation made based on the magnetic data. Due to a lack of springs observed on this structure is probable that this dyke is not impermeable and hence an interconnection between compartment 3 and 9 exists. This will be required to be validated through long duration pump tests.

5.1.8.5 Aquifer parameters (Hydraulic conductivity and Storativity)

Aquifer parameters, hydraulic conductivity and storativity are necessary parameters for the characterisation of an aquifer. Common to fractured aquifers, the hydraulic conductivity was found to be largely controlled by the proximity of the tested borehole to geological structures. Table 5-9 summarises aquifer parameters derived from tests in various hydrostratigraphic units. Country dolomite rock units display low median hydraulic conductivities in the order of 0.05 m2/d, while boreholes located on the dyke margins show median hydraulic conductivity values in the order of 4.3 m2/d. Tests carried out in the shale and quartzite units indicate hydraulic conductivity values of 0.01 to 0.23 m2/d respectively which is also representative of literature values (Spitz and Moreno, 1996). Alluvial units targeted indicate relatively higher hydraulic conductivity values of 0.37 to 4.36 m2/d as expected. While hydraulic conductivity can be effectively estimated from field tests, storativity can only be estimated with a level of confidence from a numerical model calibrated against transient water levels.

Table 5-9 Statistical summary: aquifer testing

Borehole	Formation targeted	Hydraulic Conductivity(m/d)
DH117	Dolomite	0.05
1T1	Dolomite	0.51
1T2	Dolerite Dyke & Alluvial material	0.90
DH125	Dolerite Dyke & Alluvial material	4.50
RH12-045	Dolerite Dyke & Alluvial material	4.31
RHRC12-066D	Chert/dolomite	0.02

RHRC12-022D	Chert/dolomite	0.03
KKPQ12-229	Chert/dolomite	0.37
DBH04	Dolerite	0.30
DBH05	Shale/Quartzite& Fault zone	0.23
DBH09	Shale	0.01
DBH14	Alluvial material	4.06
DBH16	Alluvial material	0.37
MIN		**0.01**
MAX		**4.50**
AVERAGE		**1.20**
STANDARD DEVIATION		**1.78**
5th PERCENTILE		**0.02**

5.1.8.6 Recharge

The water chemistry in the study area typically has a Ca-Mg-HCO3 signature which is indicative of freshly recharged groundwater. The low chloride concentrations observed in groundwater coupled with moderate rainfall conditions is further evidence of high recharge on the dolomite aquifers. Due to the low chloride concentrations (harmonic mean <2 mg/ℓ), the chloride mass balance method for determining recharge is not accurate.

- According to the Vegter recharge map recharge in the area is on the order of 65 mm/a in southern portion of the catchment, decreasing to approximately 45 mm/a in the northern portion of the catchment.
- According to the Harvest Potential Map, recharge within the catchment is in the order of 25 - 50 mm/a.
- Based on the Acru map, recharge to the vadose zone is in the order of 10 mm/a.

5.1.8.7 Water users and usages

The registered water users located in quaternary catchments A31D and A31C were sourced from the Department of water affairs (DWA) Water use authorisation and registration management system (WARMS). Water users that do not receive their water from a service provider, local authority, water board, irrigation board, government water scheme or other bulk supplier and who are using water for irrigation, mining purposes, industrial use, feedlots, or in terms of a General Authorisation must register on this database.

The registered water users per compartment are provided in Table 5-10. There are 50 registrations in the vicinity of the proposed mine. Eighteen of these registered users occur within compartments 1, 2 and 3 are thus likely to be effected by mine dewatering at the proposed operations. The largest number of registered users occurs in compartment 19 east of the focus area. As discussed in previous sections there is possibility for groundwater drawdown associated with the mining activities to impact this compartment, thus these users may potentially be affected by the proposed operation.

The compartment with the highest registered water use is compartment 9. These allocations are registered to the Witkop Mine operation. This operation is however no longer active and this allocation is unlikely being utilised annually.

Table 5-10 Registered Water Users- Warms database.

Compartment	No of registrations	Total of all registered volumes (m^3/a)
Compartment 1	12	194517
Compartment 19	20	234977
Compartment 2	4	59757
Compartment 20	6	257710
Compartment 3	2	96606
Compartment 4	2	86880
Compartment 5	2	116741
Compartment 9	2	2324000
Total	**50**	**3371188**

5.1.8.8 Hydrocensus User Survey

A hydrocensus as part of the pre-feasibility phase of the project was conducted between the 18th to the 21st of July 2013 and was reported on in Ages Report No. G 13/030 2013-07-29. An updated hydrocensus survey was also conducted during May 2016. As the hydrocensus forms the basis of the numerical modelling exercise detailed in ensuing sections, the work conducted and the major findings from the prefeasibility hydrocensus have been listed below.

Hydrosensus 2013:

- A total of 59 sites were visited over this period. This included 53 boreholes, 5 springs and 1 surface water site. Several surface water sites were included in the hydrocensus planning however upstream of the proposed mine area the stream beds were dry and therefore could not be sampled.
- Of the sites visited 68% serve as water supply sources while the remaining 32% are not in use. The principle water uses are domestic consumption, livestock watering and irrigation. Of the 53 boreholes visited 38 were equipped with pumps. 77% were equipped with submersible pumps, 10% with mono pumps, 8% with wind pumps and 3% with wind pumps and submersible pumps.
- The general condition of the boreholes, the number of sites in use and the equipment fitted to boreholes indicates a reliance on groundwater resources in the area.
- A total of 46 water levels were measured during the June 2013 hydrocensus. Three wells were artesian, 39 wells were static, 3 wells were recovering and 1 well was pumping. The

average, maximum, minimum and standard deviation of the wells per compartment is given is indicated in Table 5-11. Also refer to Figure 5-14.

Table 5-11 A statistical analysis of water levels per compartment (hydrocensus2013).

Compartment no.	Average (mbgl)	Maximum	Minimum	Standard deviation	Number of wells
		(mbgl)	(mbgl)		
Compartment 1	15	77	0	20.6	13
Compartment 2	11.7	16	4.2	4.5	5
Compartment 3	16.8	44.1	6.2	26.8	2
Compartment 4	14.6	22.6	4	7.8	4
Compartment 5	20.2	37.4	0	18.9	3
Compartment 9	4.4	5.1	3.7	0.5	5
Compartment 19	13.2	17.6	4.6	5.3	5
Boreholes North of site	29.8	79.5	10.3	23.4	7

- The standard deviation calculated for compartments 1, 3, 5 and boreholes north of the project site is high. This indicates large variability between measured water levels in these compartments.
- The maximum water level of 77.00 mbgl in compartment 1 correspond to an abandoned mine shaft in this compartment. The water level in the shaft was in 2011 was approximately 23 mbgl, subsequently the shaft was dewatered resulting in the 2013 measured water level.
- Boreholes D132 and DH123 are used for water supply explaining the drawdown in these wells compared to others in the compartment. With the exception of these three boreholes there is similarity in observed water levels of compartment 1 and compartment 2.
- Only two water levels could be measured in compartment 3. The high standard deviation is a consequence of too few samples. Of interest however, Borehole DH 108 has a measured water level of 44.12 mbgl. This borehole is not equipped and therefor is not being pumped. This well is situated just north of the dyke separating compartment 3 and 5.
- SNF 01 is situated just south of this dyke and is artesian. The discrepancy in water level at the two sites situated approximately 600 m from one another confirms the interpretation that the dyke separating the mentioned compartment is impermeable.
- The variability of water levels measured north of the project site is attributed to over abstraction. This is particularly evident at borehole DHK 02 which has measured water level of 79.5 mbgl (the deepest in the study area).

Hydrosensus 2016:

- A total of 116 sites were visited over this period. This included 112 boreholes, 3 springs and 2 surface water sites.
- Of the sites visited 78% serve as water supply sources while the remaining 22% are not in use. The principle water uses are domestic consumption, livestock watering and irrigation. Of the 112 boreholes visited 83% were equipped with pumps. 75% were equipped with submersible pumps, 10% with mono pumps, 12% with wind pumps and 3% with wind pumps and submersible pumps.
- The general condition of the boreholes, the number of sites in use and the equipment fitted to boreholes indicates a reliance on groundwater resources in the area.
- A total of 92 water levels were measured during the May 2016 hydrocensus. The average, maximum, minimum and standard deviation of the wells are indicated in Figure 5-15.
- Figure 5-16 and Figure 5-17 indicate the relative depth to groundwater as well as regional groundwater flow direction for the proposed project area and visited hydrocensus localities.

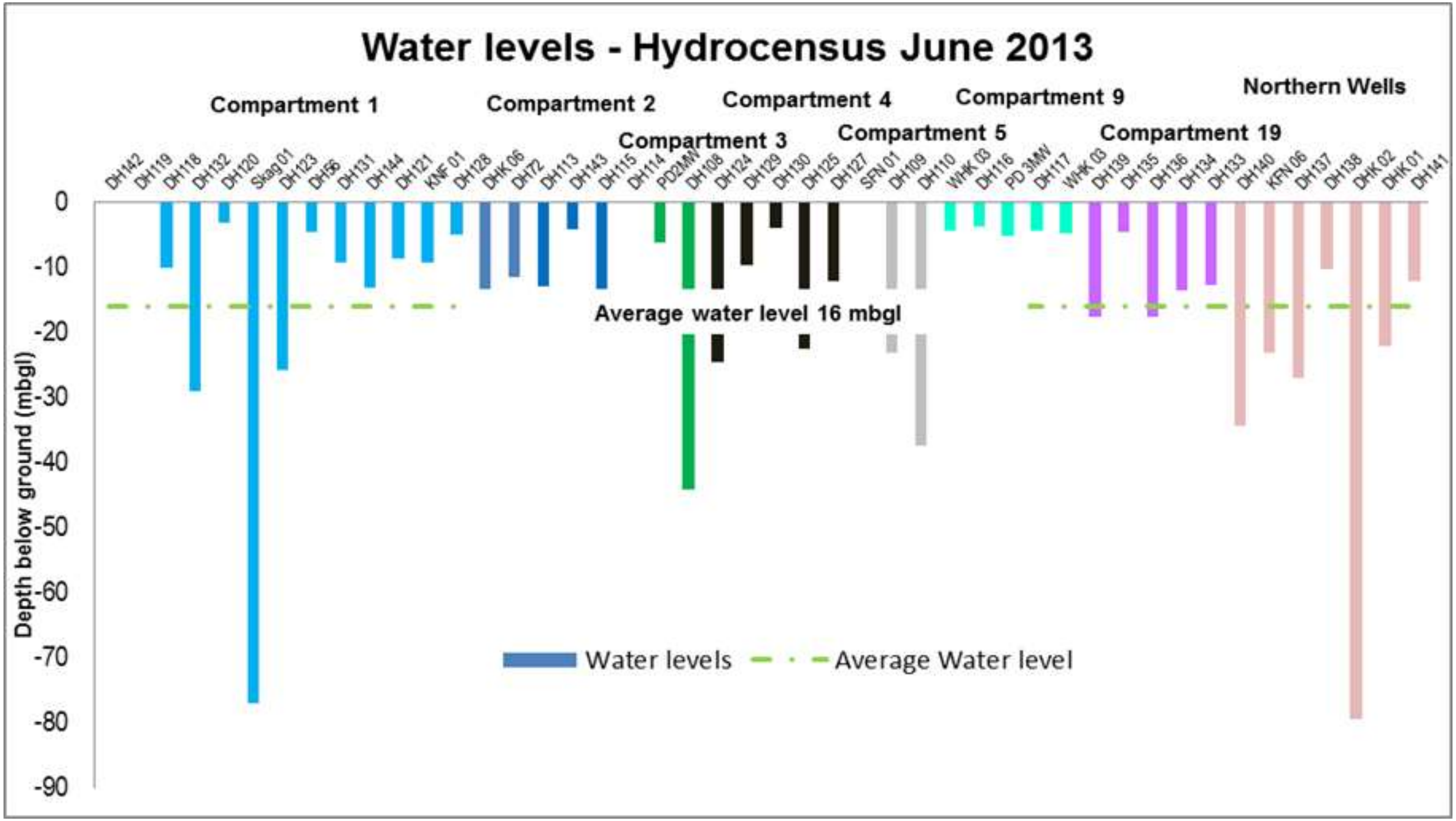

Figure 5-14 **Measured water levels – hydrocensus 2013**

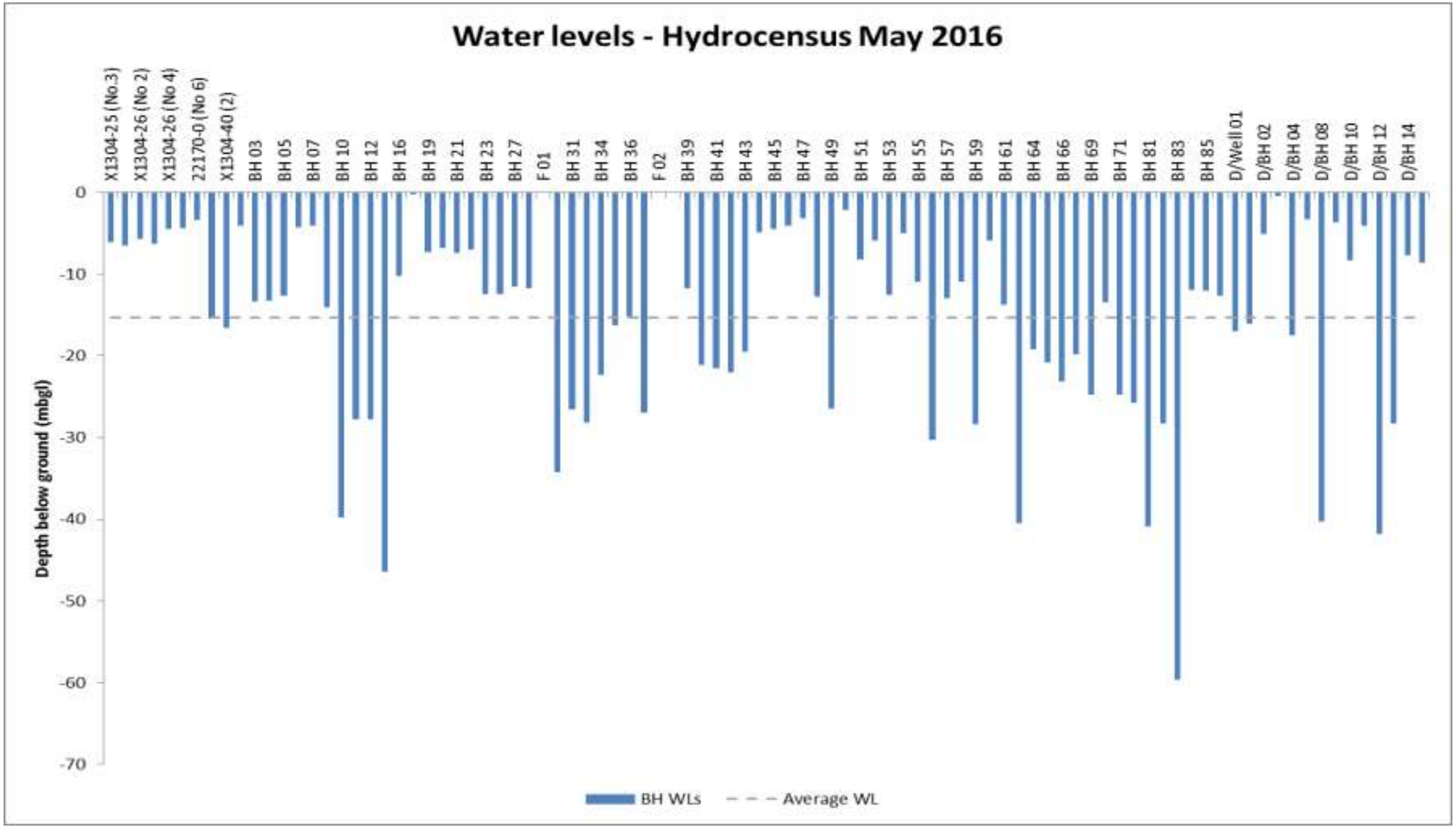

Figure 5-15 Measured water levels – hydrocensus 2016

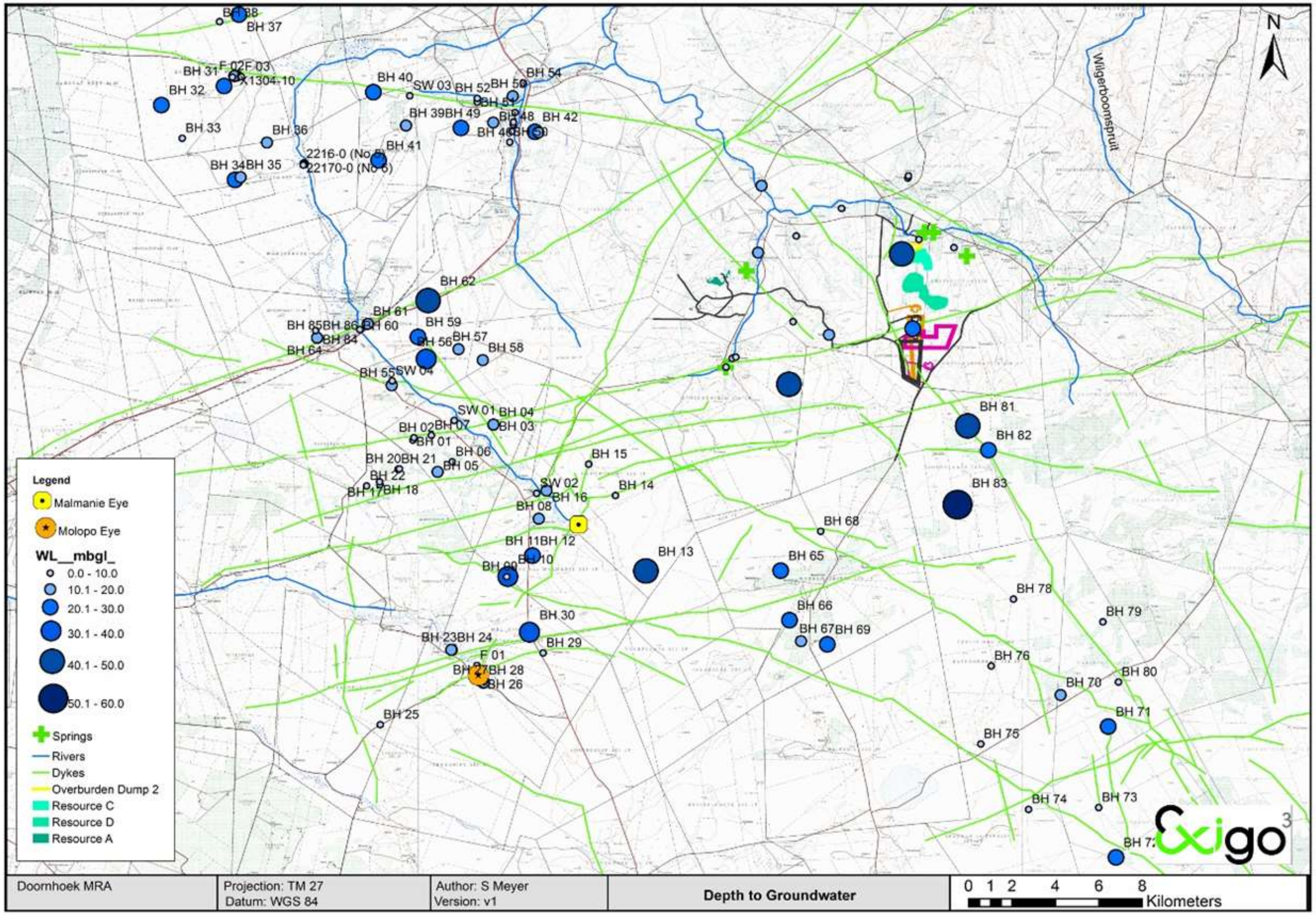

Figure 5-16 Depth to groundwater

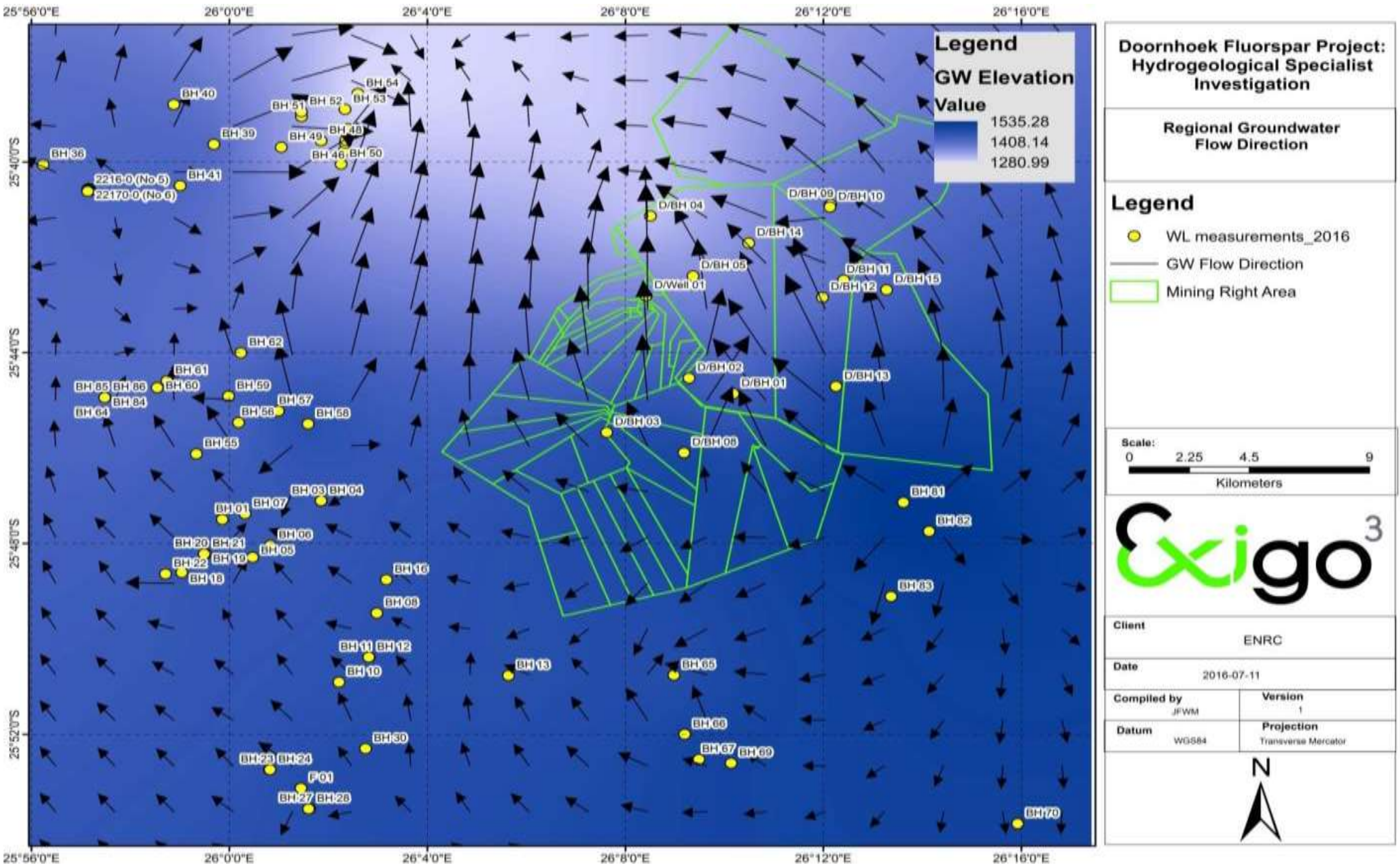

Figure 5-17 **Groundwater elevation and flow directions**

5.1.8.9 Hydrochemistry

The major findings from the hydrochemistry study are listed as follows:

- Groundwater quality of the selected sampling sites is in accordance with most constituent concentration limits specified in SANS 241:2011. Exceptions include elevated fluoride which is a consequence of the fluorspar deposits in the study area, manganese which is commonly associated with dolomite aquifers and elevated selenium which was only observed in the May 2013 monitoring data, this trend should be evaluated in future monitoring (Figure 5-18 and Figure 5-19).
- The water quality of boreholes in compartment 9 is of inferior water quality likely owing to mining activities at the Witkop mine. With the exception of this compartment the water chemistry is typical of rock water interaction.
- The current land uses do not negatively impact on groundwater quality in the study area.
- The water chemistry in the study area typically has a Ca-Mg-HCO3 signature which is indicative of freshly recharged groundwater. The low chloride concentrations observed in groundwater coupled with moderate rainfall conditions is further evidence of high recharge on the dolomite aquifers.
- Figure 5-20 depicts the spatial hydrochemistry distribution of sampling localities.

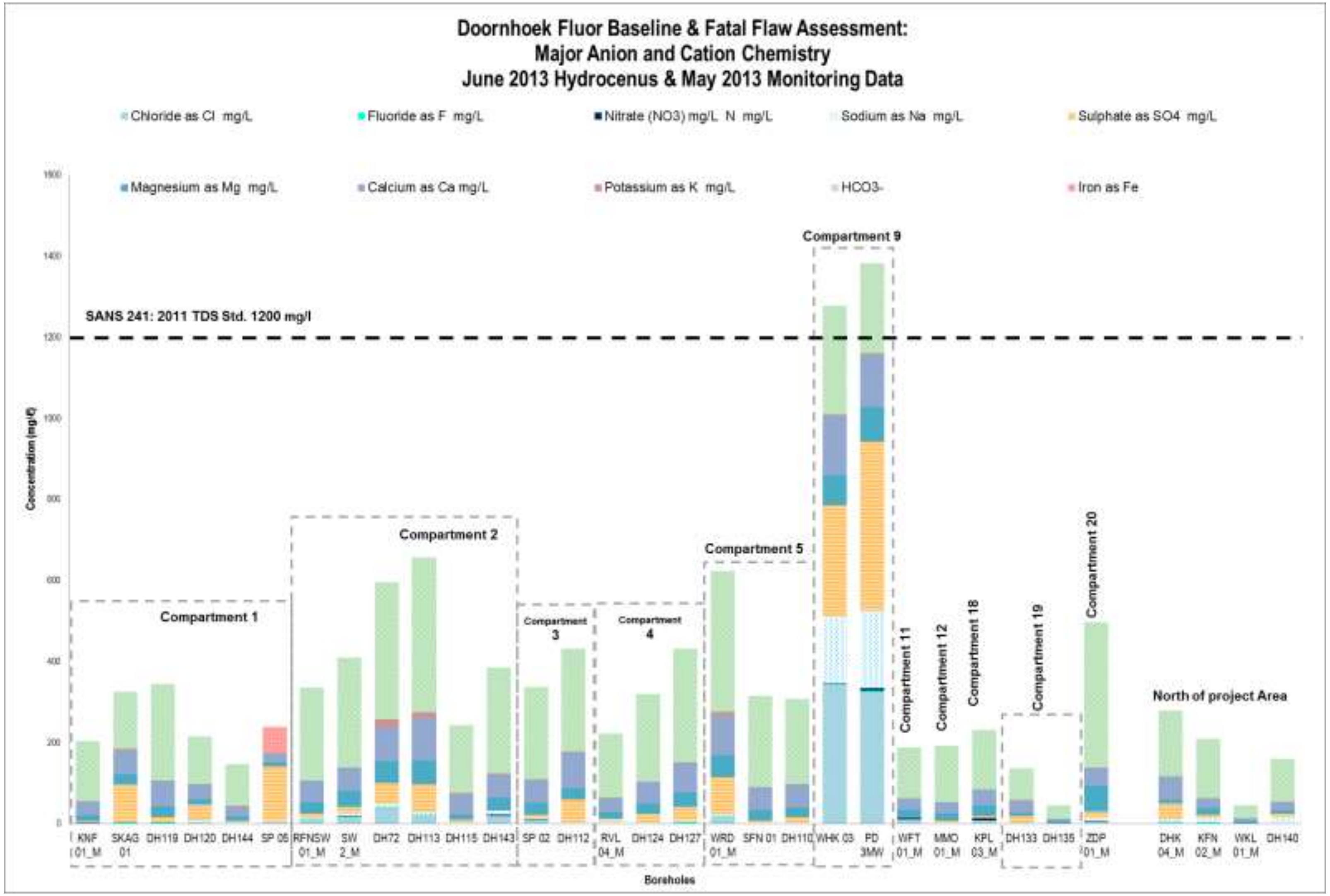

Figure 5-18 Hydrochemistry 2013

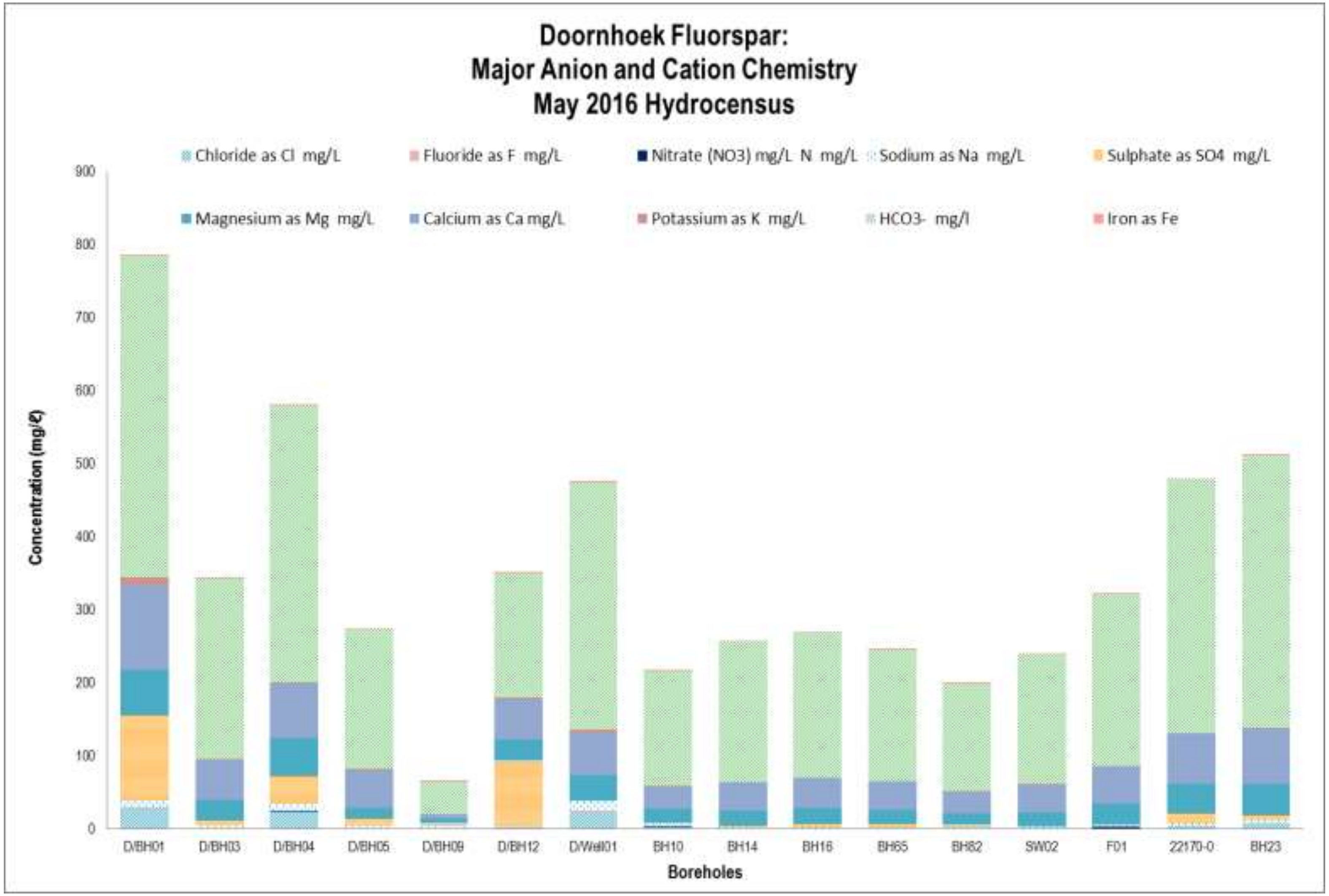

Figure 5-19 Hydrochemistry 2016

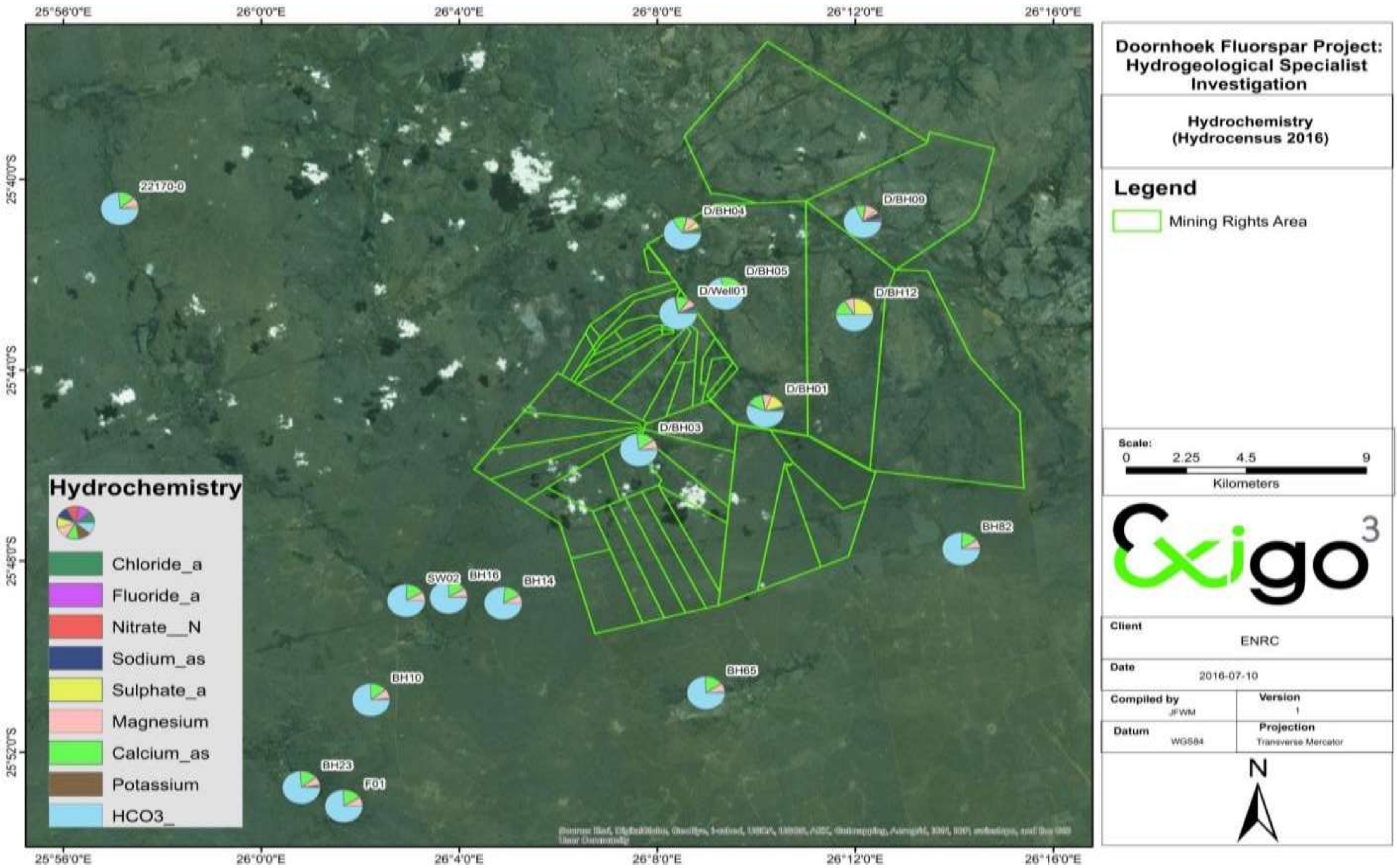

Figure 5-20 Spatial distribution hydrochemistry – hydrocensus 2016

5.1.8.10 Numerical groundwater flow model

A numerical groundwater flow model has been utilised to aid in decision making, understanding the sensitivity of the system and provide focus to the field work to be conducted in ensuing phases of this project. Previously, limited field work data has been conducted and the historical model was viewed as high level and has been qualified rather than calibrated. The fieldwork component was updated and this data was used in the model reconstruction, recalibration and additional simulations.

In addition, the client supplied updated mining schedules and mine site layouts. This data was used in the update of the numerical model as well as the detailed simulations. The work conducted with regards to the hydrogeological impacts was compiled by a competent person as defined, amongst other, in Regulation 6(6) of GNR. 632.

- **Boundaries**

The external boundaries of the model were delineated to coincide with topographical features such as surface water divides, rivers and drainage lines, cognisance of the underlying geology was however also considered in development.

  - Hydraulic head boundaries (Blue): The rivers are defined as hydraulic head boundaries where the fixed head is assumed to be equal to topographical elevation. A maximum flow constraint of zero has been applied to the boundary condition in order to simulate gaining type rivers systems i.e. the rivers remove groundwater from the system but do not recharge the aquifer zones. Sensitivity scenarios i.e. possible influence of the Klein Marico River on mine dewatering volumes were simulated.
  - No Flow type boundaries (Green): As mentioned, groundwater divides have been assumed to correlate with surface water divides. Thus all water sheds have been defined as no flow type boundaries i.e. boundaries where flow lines are parallel with boundary.

- **Sources**

Recharge is the primary source of inflow to the model domain. Due to a lack of suitable field data for estimating recharge, initial values for model development were derived from literature. The probable recharge values were determined through model qualification; these values are provided in Table 5-12 below.

- **Sinks**

Since the closure of the Witkop mine the primary sink in the catchment is groundwater abstraction for livestock watering and domestic purposes. The volume of water abstracted and the distribution of abstraction boreholes was sourced from the WARMS data base. The distribution of abstraction wells simulated within the flow model is depicted in Table 5-12.

- **Aquifer parameters**

Hydraulic conductivity for model development was obtained from falling head tests, aquifer tests and literature. Through model qualification process hydraulic conductivity values describing the aquifer zones were determined.

Storativity values were assumed from literature as no suitable tests have yet been conducted to calibrate the model to obtain storage parameters.

- Summary of model inputs, data sources and uncertainty

Model input parameters, data sources and data uncertainty are provide in Table 5-12 below:

Table 5-12 Model input parameters, data sources and uncertainty

Input parameter	Scale	Source, parameter or assumption description	Data uncertainty
Topography (DEM)		The topographic elevations were interpolated from the 1:50 000 scale 20 m contour intervals.	Low
Rivers, streams, drainages	1:50 000	Digitised from topographical maps and aerial imagery.	Low
Lithology	1:250 000	GCS geological map sheets - Rustenburg (2526)and Mafikeng (2426) and ENRC detailed mapping	Moderate
Geological structures		High resolution aerial magnetic survey and gravity surveys. While the positions and extent are known the hydraulic characteristics are associated with uncertainty.	Moderate
Mine Layout		A mine layout was supplied by the client	Low
Boreholes and pumping rates		AGES hydrocensus 2013, Exigo Monitoring 2013 -2015, WARMS and aquifer tests conducted during 2016.	Moderate
Rainfall		Collected from rainfall stations within the catchment.	Low-moderate
Steady State Modelling Parameters – Flow Model			
Boundary conditions		Northern model boundary – Fixed hydraulic head boundary with a max flow constraint = 0 m3/d	Low-moderate
		Eastern, western and southern boundaries are no flow boundaries correlating with surface water divides.	Low-Moderate
		Rivers and drainages within the model domain are described by fixed head boundary conditions and maximum flow constraints of 0 m3/d. Similarly the dyke structures are assigned as seepage faces so as to simulate spring flows within the model domain.	Low-moderate
Recharge		Recharge could not be estimated from the existing data and was assumed from literature and refined through model qualification.	Moderate

Input parameter	Scale	Source, parameter or assumption description	Data uncertainty
Hydraulic Conductivity		The hydraulic conductivity was estimated from falling head tests literature and aquifer test.	Low
Aquifer thickness		The aquifer thickness is 150 m – the aquifer likely extends deeper than 150 m however no data exists to validate the exact depth.	Moderate
Transient State Modelling Parameters & Mass transport model			
Initial Hydraulic Heads		Simulated heads obtained from simulated steady state conditions as calibrated.	Moderate
Specific Storage		The volume of water that a unit volume of aquifer releases from or takes into storage per unit change in head. S = Ss x D. Ss, refer to section 4.4.4 of the Hydrogeological Impact Assessment.	High
Effective Porosity		Porosity is the ratio of the volume of void space to the total volume of the rock of earth material. Assumed conservative porosity of 3% was used in the transient simulations.	High
Longitudinal dispersion coefficient		No field work has been conducted to determine the dispersivity. An approximation of 20 m was used.	High
Transverse dispersion coefficient		Transverse dispersivity was assumed to be 10 x smaller than the longitudinal dispersivity (2 m)	High

- **Summary of model sensitivity**

The model shows negligible sensitivity to transmissivity in a range ±10% of the base case. Thus limited additional data will be required to constrain the transmissivity of the country rock.

The model shows negligible sensitivity to a reduced recharge of 10% relative to base case and marginal sensitivity to increased recharge of 10% relative to base case.

5.1.8.11 Geochemical Risk Assessment

A geochemical assessment of mine waste leachate potential, which is aimed at identifying potential geochemical risks associated with the tailings and overburden, was conducted for the Doornhoek Fluorite project by Exigo in 2014 as part of a baseline assessment. The study included an assessment of acid mine drainage (AMD) by using static acid base accounting (ABA) and net acid generation (NAG) tests.

The study also included an assessment of potential geochemical risks associated with the leaching of potential contaminants from effluent leaching from the mine residue. A static distilled water leach test, which also forms part of the current NEMWAA regulations, was used and analysed. The results were compared to the SANS 241-1:2011 drinking water guideline values.

A mineralogical analysis was also conducted, which confirmed the abundance of carbonate minerals, especially dolomite [CaMg(CO3)2]. It also showed that the mineral fluorite [CaF2] is the most dominant fluoride containing mineral present in the ore and host rocks. The present study is being initiated for the following two purposes. The first is for legal compliance with the NEMWAA Regulations. The second is to evaluate the medium to long term behaviour of the mine waste, as the waste classification regulations assessment methodologies do not take dynamic geochemical processes into account. This model allows the quantification of risks taking time into account and allows the waste to be placed in the internationally accepted source pathway- receptor assessment methodology, which is also preferred by the Department of Environmental Affairs (Hansen, 2016).

The detailed geochemical model was used as reference to obtain the baseline and possible leachate parameters associated with the mining infrastructure, especially the overburden dump and TSF position and alternatives. For the operational phase, the model results indicated that sulphate values in the tailings pore water exceed regulatory values and groundwater baseline values. Additionally, fluoride values in the tailings will range from 0.9 mg/L to 2.7 mg/L, with the later value the maximum. The mine residue material results associated with the overburden dumps indicated sulphide to be below detection limits and fluoride similar to the baseline values (Hansen, 2016). The work conducted with regards to the geochemical impacts was compiled by a competent person as defined, amongst other, in Regulation 6(6) of GNR. 632.

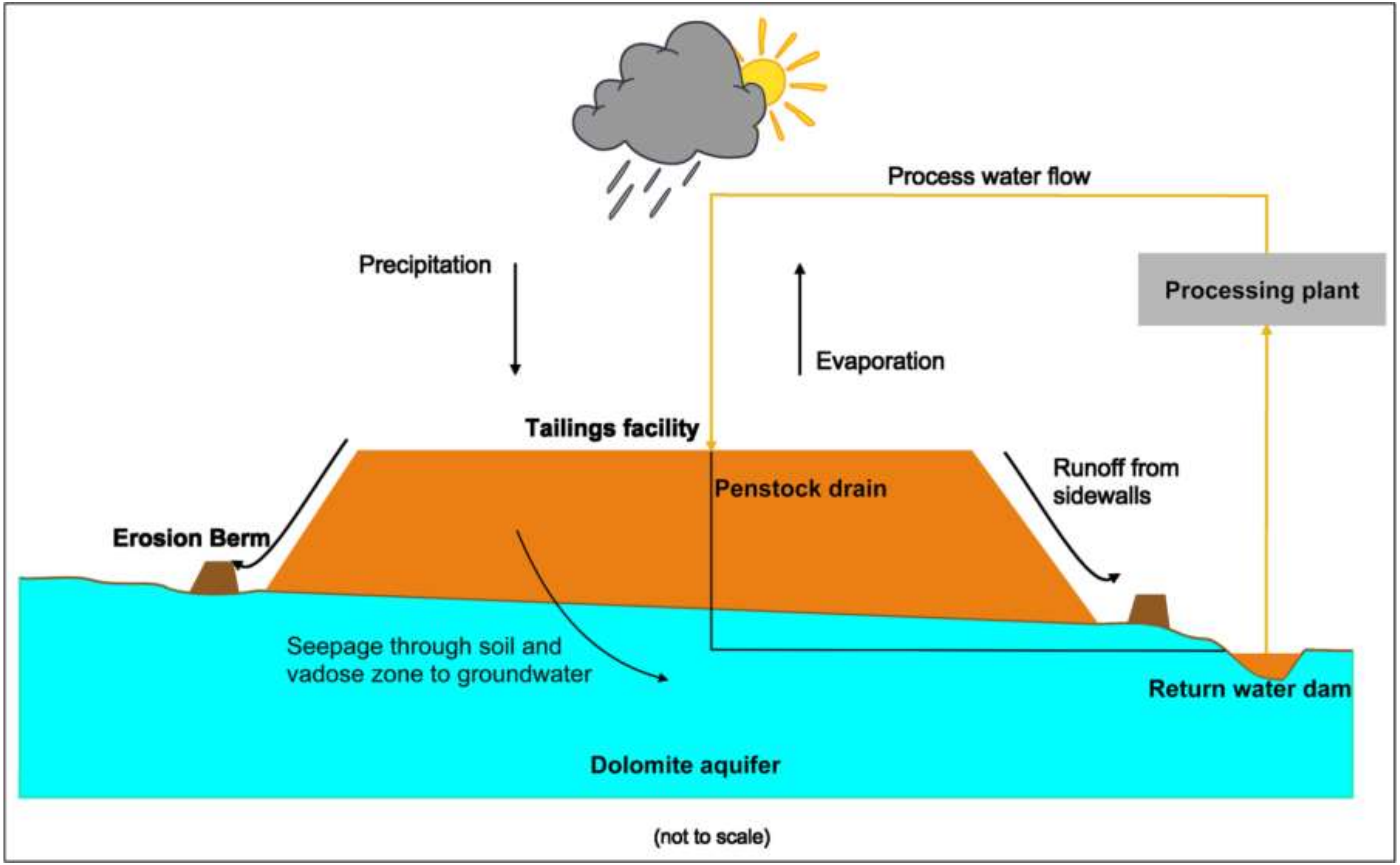

Figure 5-21 Conceptual model of the tailings as a geochemical system showing the most important water flow paths

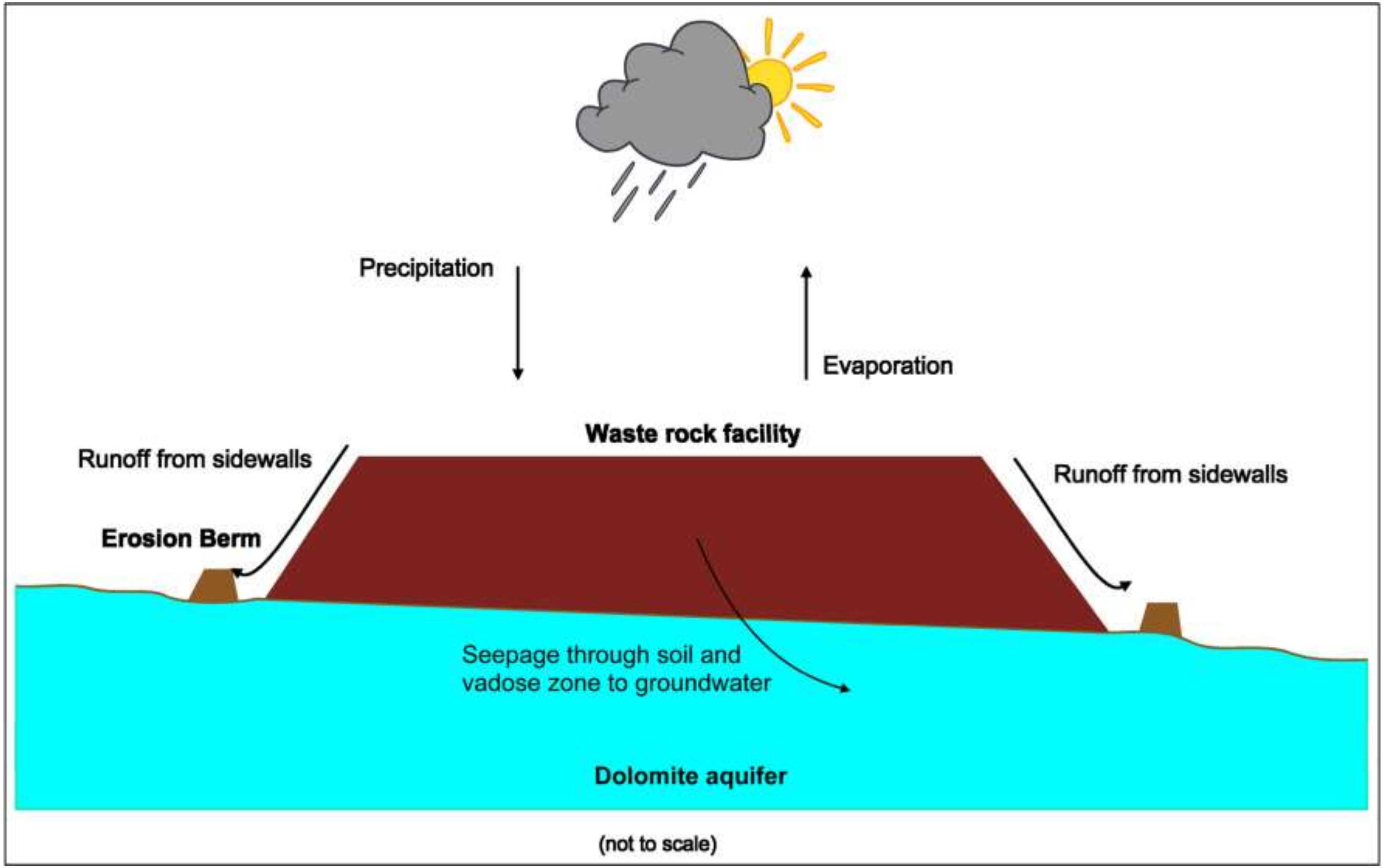

Figure 5-22 Conceptual model of the waste as a geochemical system showing the most important water flow paths

5.2 Socio-economic environment

The majority of the mining right area is located in the Ditsobotla Local Municipality (DLM), with a portion being extended over to the Ramotshere Moiloa Local Municipality (RMLM). Most of the surface infrastructure and Resource Area C and D are located in the RMLM while Resource Area A is located in the DLM. Both of these municipalities form part of the Ngaka Modiri Molema District Municipality (DM) in the North West Province.

NMMDM is one of the four districts of North West province in South Africa. Its capital is Mahikeng, which is also the capital of the province. The municipal area covers approximately 28 206 km^2 and hosts a population of approximately 842 699 which amounts to a population density of 29.9/km^2. There are approximately 227 001 households in the district municipality.

NMMDM is mainly a rural and agricultural area with a dotting of a few secondary cities of Mahikeng-Mmabatho, Lichtenburg and Zeerust. Therefore it is rational to expect that the economic output depth will not be very extensive. Further, the type of industrial and economic activities prevailing in the district will be adding a very small portion to the overall provincial output as measured in GGVAs.

The figure below depicts the sector contribution to the gross and the employment figures.

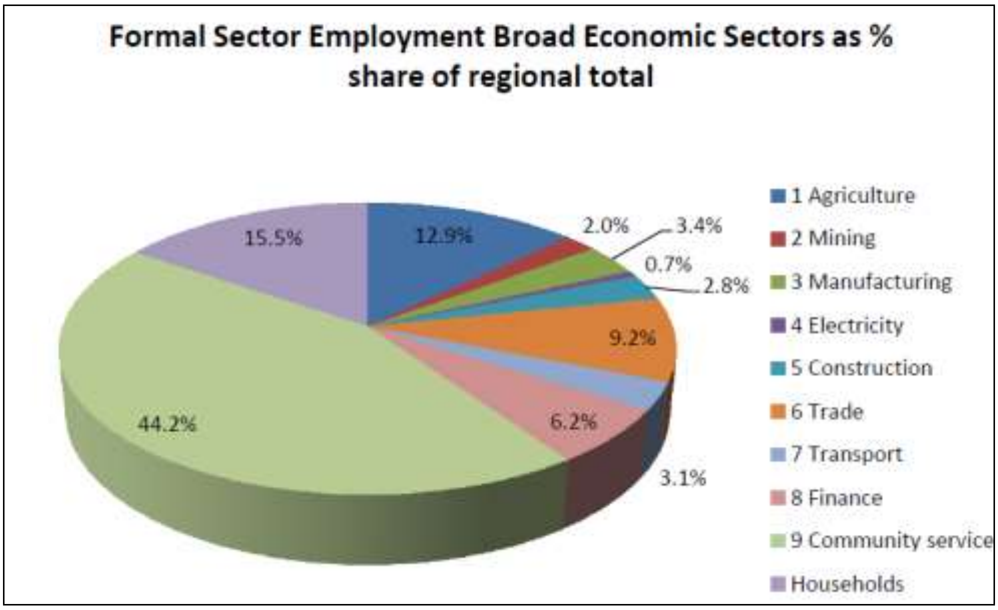

Figure 5-23: Formal Sector Employment (Draft NMMDM IDP 2012-2016)

As can be seen from **Figure 5-23** above, the service industry is the main employer in the district with about 44% contribution to the economic sector. Key economic drivers such as manufacturing and agriculture contribute 3.4% and 12.9% respectively. The unemployment rate in the district is hovering above the national rate of 25%, to about 35%. According to the draft NMMDM IDP (2012-2016) there were about 80 000 unemployed people in the district municipality in 2010.

The following conclusions can be made with regard to development challenges in Ngaka Modiri Molema District Municipality:

- The area is generally highly underserviced in terms of both social and economic infrastructure;

- The area is very large in respect to the settlements across various municipalities;
- That such dispersed settlement patterns have a bearing on the costs (both of erecting the infrastructure, operating and maintain it);
- That the affordability levels given the poverty and human development challenges latent in the area makes viability of municipalities to establish, operate and maintain infrastructure o daunting prospect;
- That the most economically productive and skilled individuals are drawn away from the district;
- That the structure of the economy requires a serious overhaul through targeted and accelerated interventions, and
- That diversification while maintaining the triple bottom-line principle is critical (NMMDM IDP, 2012-2016).

The district municipality shares an international border with Botswana on the North and comprises the following five local municipalities:

Local municipality	Population	%	Dominant language
Mafikeng	259 478	34.01%	Tswana
Ditsobotla	147 596	19.34%	Tswana
Ramotshere Moiloa	137 439	18.01%	Tswana
Tswaing	114 150	14.96%	Tswana
Ratlou	104 322	13.67%	Tswana

Ditsobotla Municipality has a geographical area of 6 465 km^2 and is divided into 21 municipal wards. The population density is approximately 26.1/km^2 with a total population of 168 902 (www.wikipedia.org).

The gender distribution in the Ditsobotla Municipality is 50.5 % males and 49.5 % females.

Figure 5-24 indicates that about 60% of the population of Ditsobotla Municipality is made up of people aged from 15 to 64 years. This group represents the economically active section of the population. About 35% of the population is made up of children aged 14 and less, while 5% is made up of the older generation, who are 65 and above.

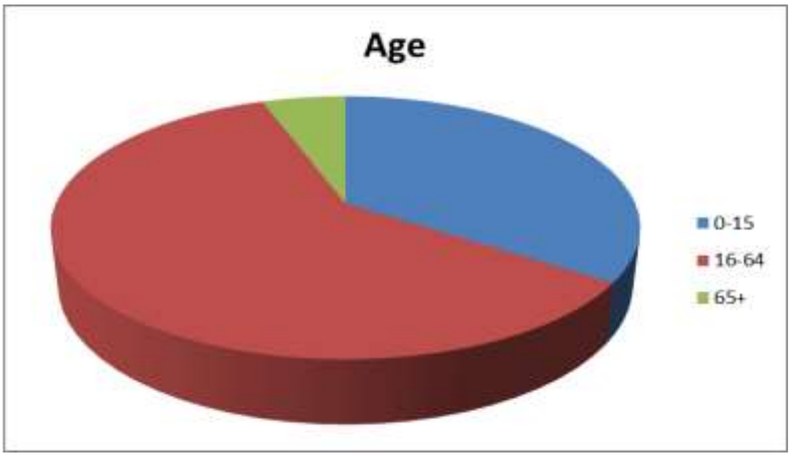

Figure 5-24: Age group (www.statssa.co.za)

The following figures were taken from the Census 2011 (www.statssa.co.za) data and provide detail on the socio-economic situation experienced in the area.

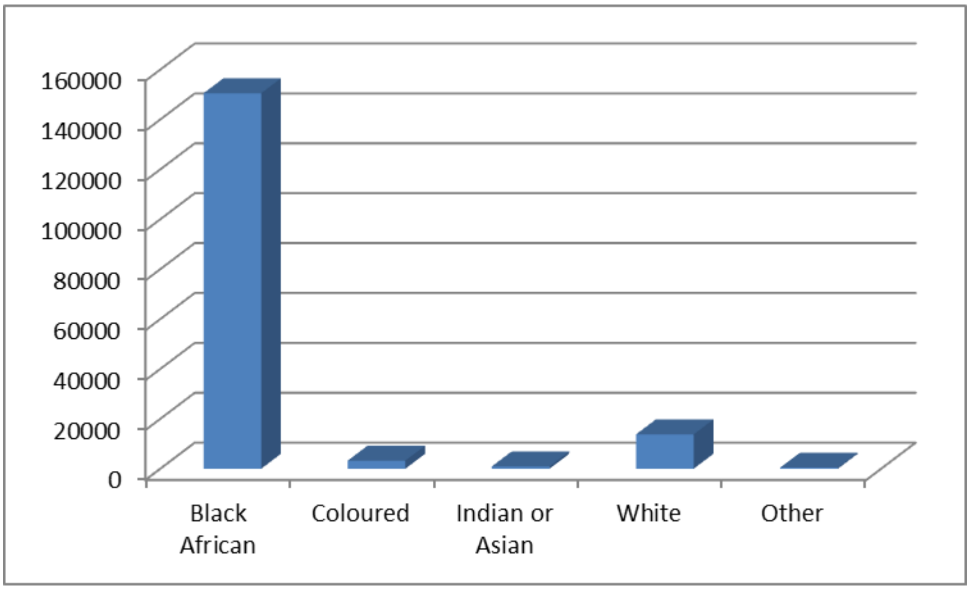

Figure 5-25: Population

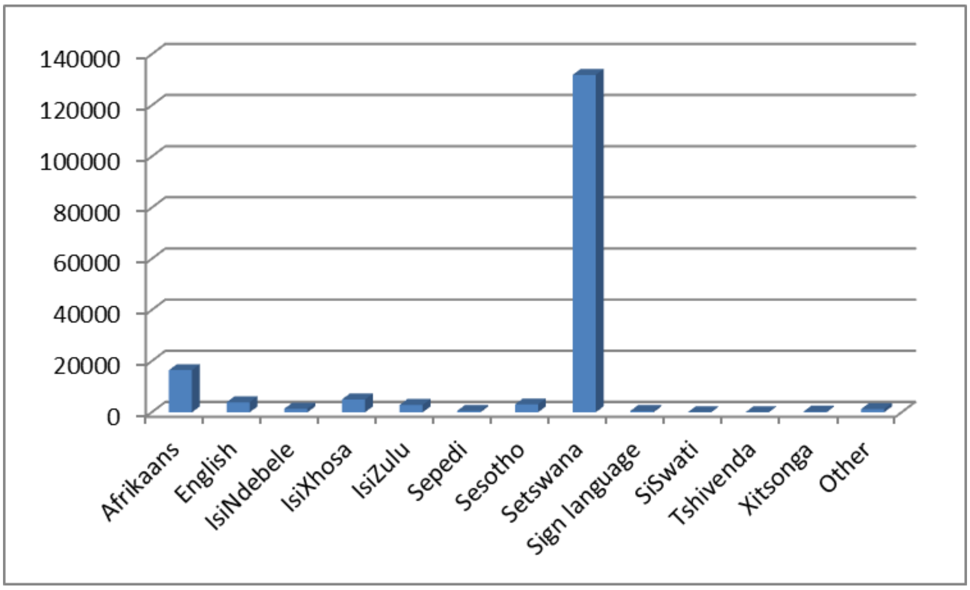

Figure 5-26: Language

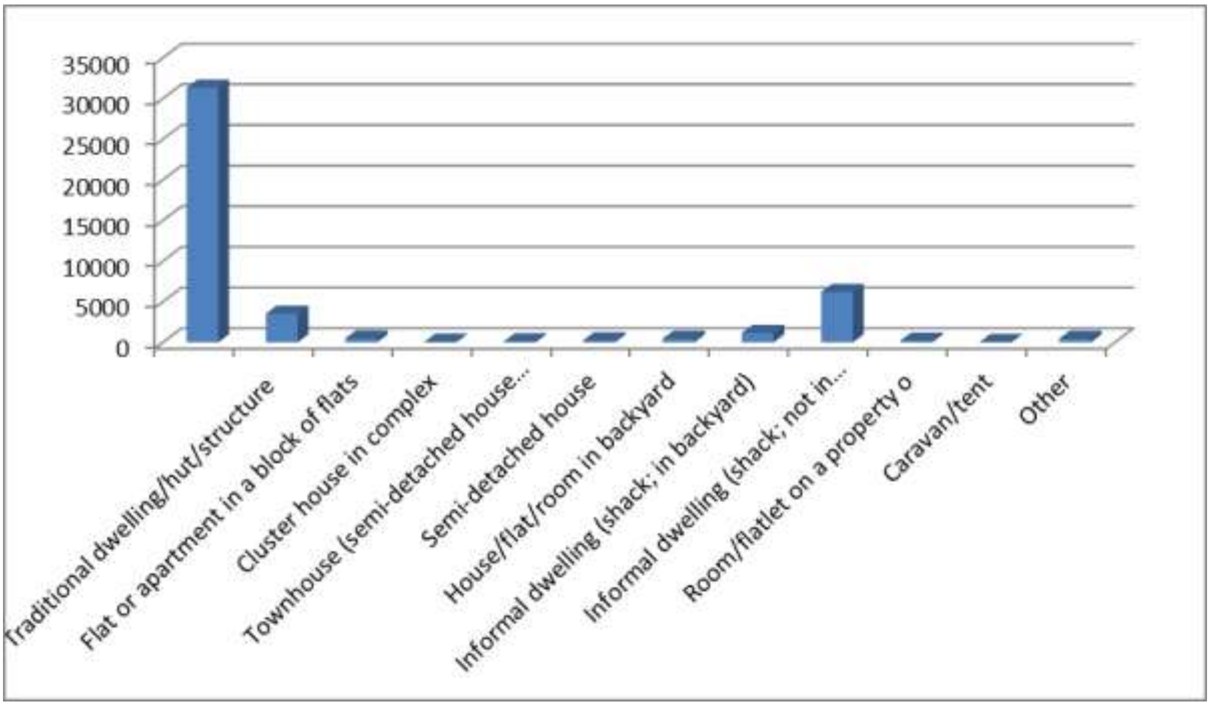

Figure 5-27: Type of main dwelling

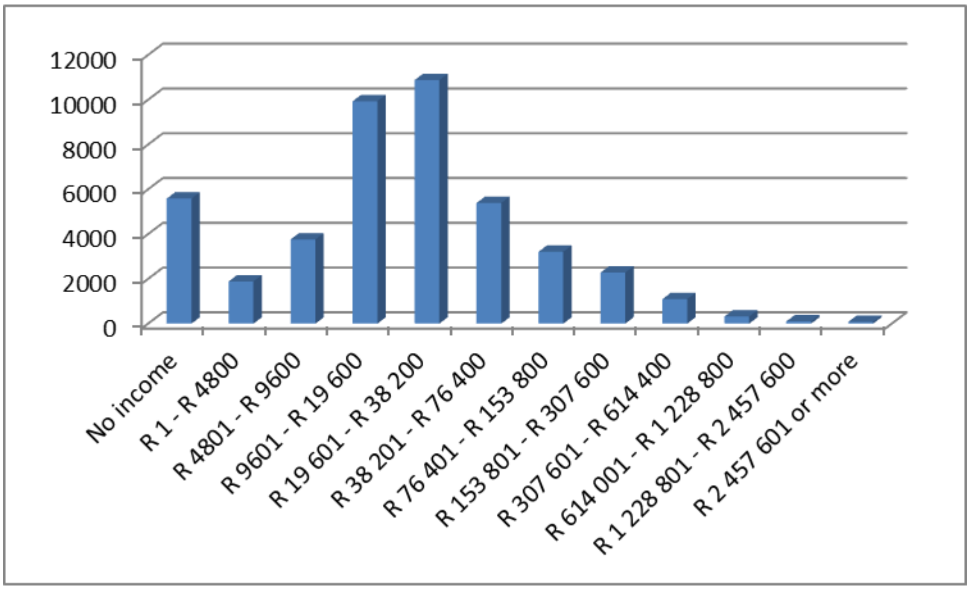

Figure 5-28: Annual Household Income

The municipality is situated in the semi-arid area of the central plateau in South Africa and as a result water scarcity is a common and pressing problem. The municipality has however been able to provide water to the community as depicted in Figure 5-29 below:

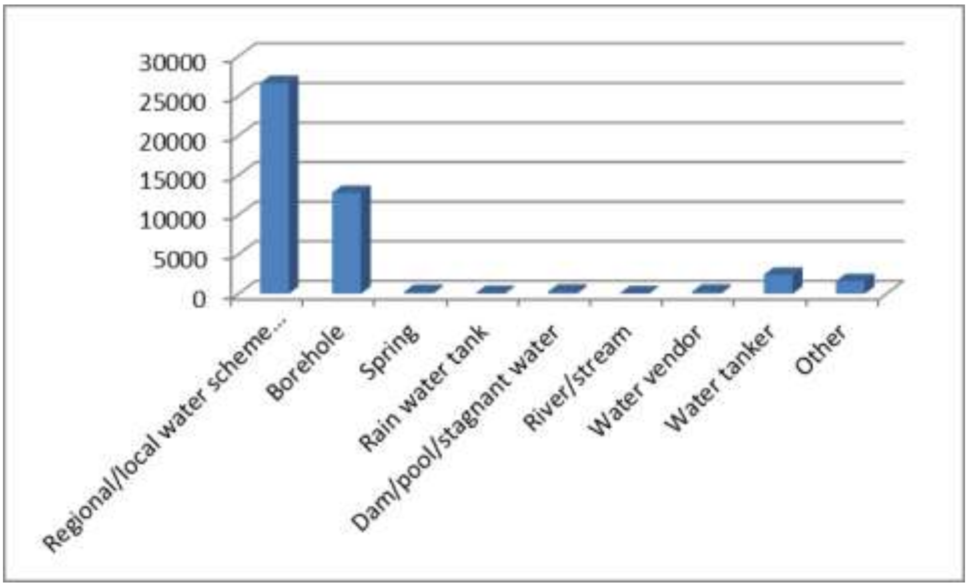

Figure 5-29: Source of water

6 CURRENT ACTIVITIES AND EXISTING DEVELOPMENTS INCLUDE:

This is an application for a new Integrated Water Use Licence (IWUL) there are no existing water use activities taking place on site.

6.1 Proposed development

The proposed Doornhoek fluorspar mine will predominantly mine fluorspar along with the associated minerals (copper ore, diamond, lead, tin ore, vanadium ore and zinc ore). Lead, Zinc and copper are often associated with fluorspar deposits and vanadium is known to occur in the area. These minerals may be extracted simultaneously with the fluorspar or may be extracted later. Open pit mining would be carried out using a typical drill and blast operation, loading of ore and overburden by excavators and hauling by dump trucks. The stripping ratio for the 1.5 Million tons per annum (Mtpa) open pit scenario averages 3.8 waste to ore (w:o) ratio over the life of mine (LOM). Overburden would be hauled to a designated overburden dump during the early years of the LOM.

Due to the large area applied for and the extent of the orebody, it is estimated that the project will take at least five years of pre-development prior to any mining activities commencing. Therefore a five (5) to six (6) year pre-production period is anticipated, including the plant construction which will take 2-3 years.

Upon granting of the mining right (MR), the first year will involve negotiations with the landowners for access rights, lease or purchase agreements for road construction through their property in order to reach the orebody. Once this has been achieved construction will begin on the access roads. The main haul road construction will begin in the 3rd year after the MR has been approved in conjunction with the construction of the mine offices. Construction of the Tailings Storage Facility (TSF) and processing plant will commence in year 4 after the granting of a MR. This will be followed by pre-stripping and ramping up to reach full scale mining in the years following.

Envisaged mine infrastructure will comprise of the following:

- Ore Handling and Storage facilities
- Overburden and topsoil dumps
- General Buildings
- Potable and Service Water Dams, including a Storm Water Dam
- Processing Plant
- Emergency and Power facilities (substations)
- Fuel Storage
- Site Access Road and Haul Roads
- Tailings Storage Facility (TSF)
- Water and sewage reticulation

- Sewage Treatment Plant
- Water Treatment Plant

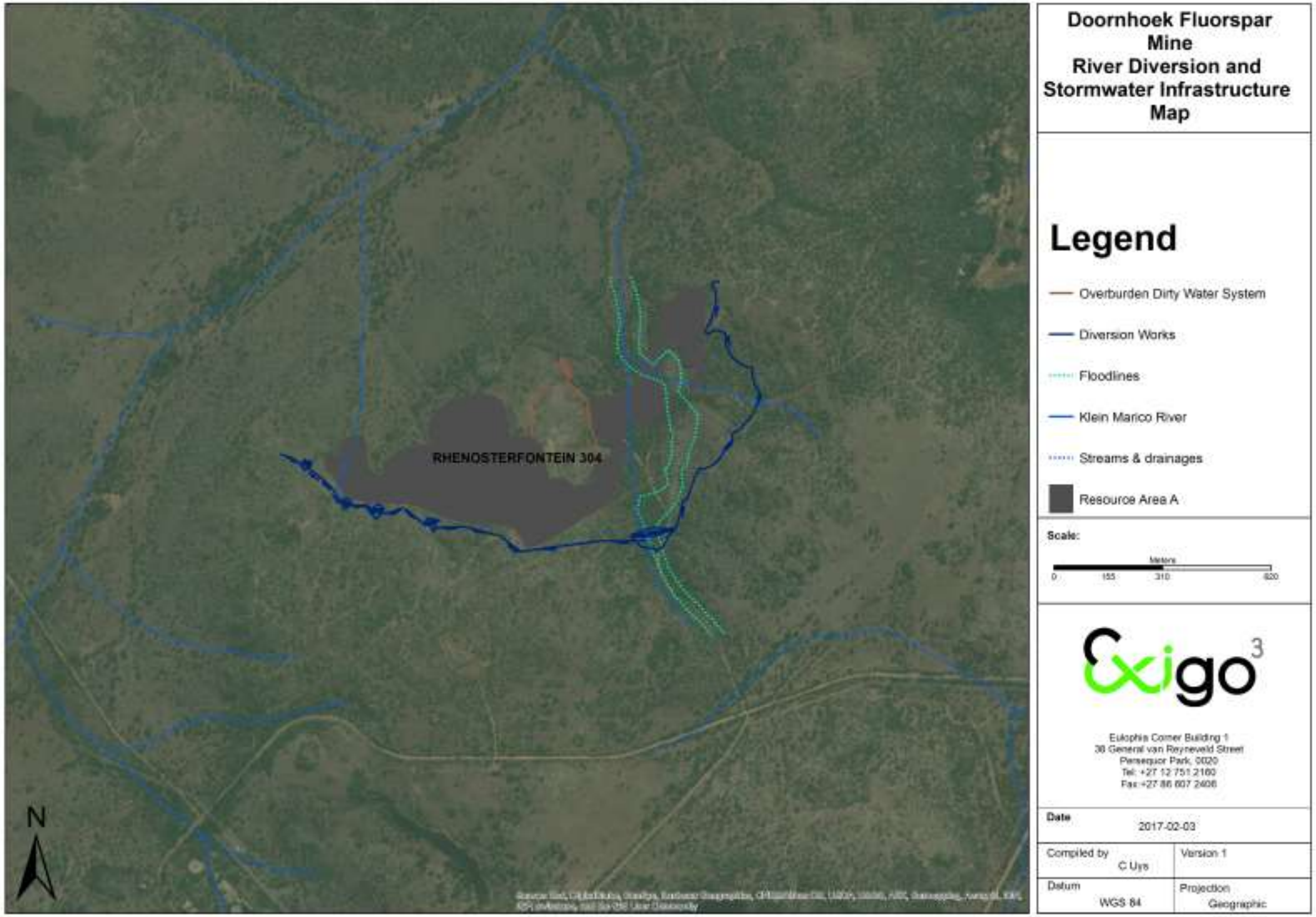

Figure 6-1 Proposed Layout with Storm Water Infrastructure and Diversion Works for Resource Area A

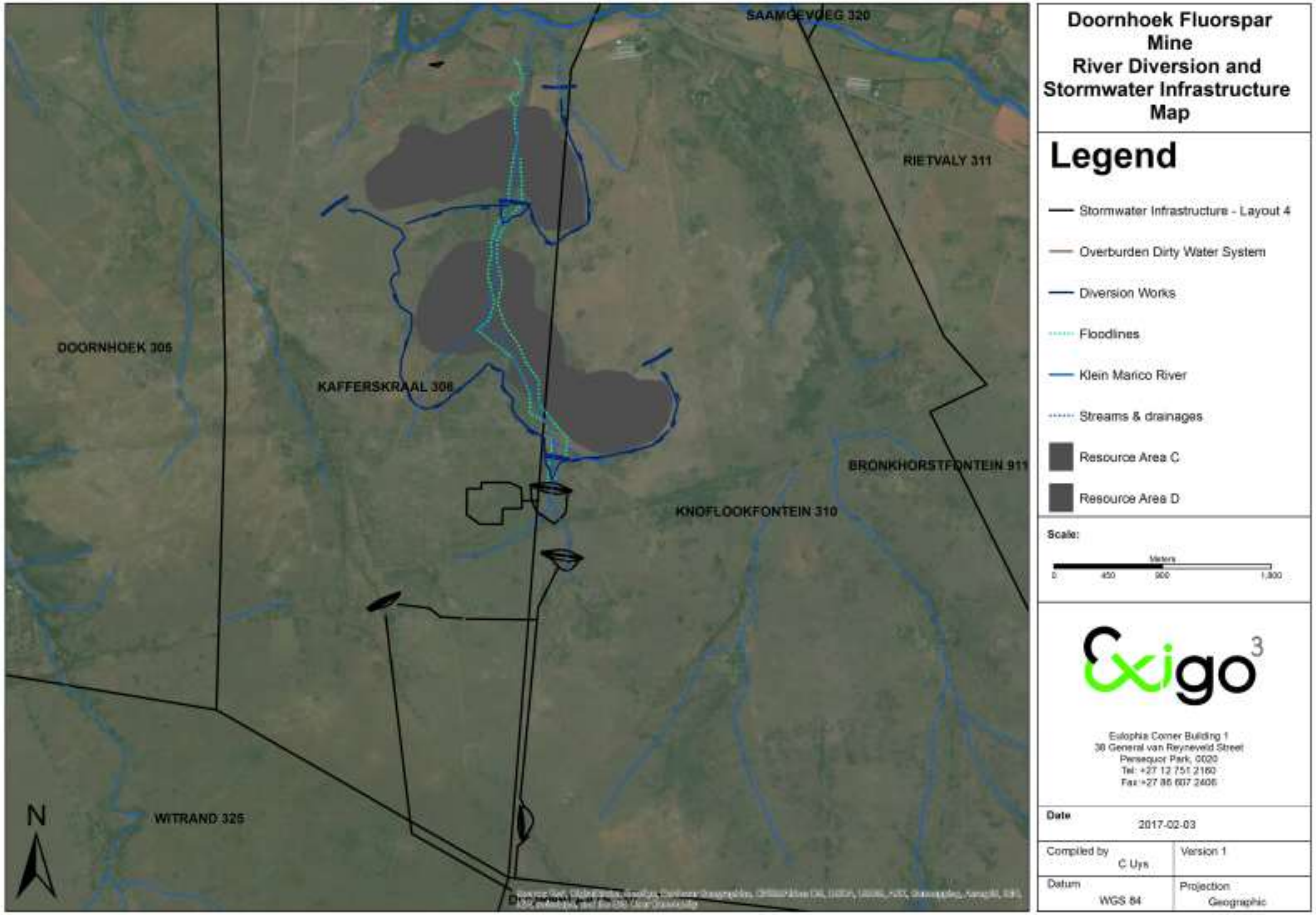

Figure 6-2 Proposed Layout with Storm Water Infrastructure and Diversion Works for Resource Area C and D

6.2 Legal assessment of existing and proposed new water use

6.2.1 Existing water uses

There are no existing water uses on site that the applicant is aware of. This report supports the application for a new Integrated Water Use Licence.

6.2.2 Proposed water uses that requires licensing

Various water uses associated with the project will require water use licensing in terms of Section 21 of the NWA. Below is a brief summary of the water uses to be licensed as well as relevant information regarding the specific water use.

Table 6-1 Water uses to be licensed

Water use no	Action	Feature	Water use
21 (a)	Taking water	Taking of water from the following resources: groundwater, pumping water from underground	Taking water from a water resource
21 (b)	Water storage	Potable Water Reservoir	Storing water
		Fire Water Reservoir	
		Spray Water Dam	
		Raw Water Dam	
		Various Storm Water Dams as part of Stream/drainage diversions	
21 (c)	Impeding the watercourse	Mining infrastructure located within 500 m of a wetland/watercourse.	Impeding or diverting of a watercourse
		Stream/drainage diversions - Diverting	
21 (g)	Disposal of waste or water containing waste	Tailings Storage Facility	Disposing of waste in a matter which may detrimentally impact on a water resource
		Return Water Dam	
		Storm Water Dam (Overburden dump at Resource A)	
		Storm Water Dam (Overburden dump at Resource C)	
		Storm Water Dams (plant and TSF)	
		Process Water Dam	
		Sewerage Treatment Plant & Sewerage Sludge Tank	
		Water Treatment Plant & Brine Evaporation Pond	
		Overburden Dumps	
		Dust Suppression	
		Partial backfilling of open pits	
21 (i)	Altering the bed, banks, course or characteristics of a watercourse	Mining infrastructure located within 500 m of a wetland/watercourse.	Altering the bed, banks, course or characteristics of a watercourse

		Stream/drainage diversions - Diverting	
21 (j)	Underground fissure water	Dewatering of mine	Removing, discharging or disposing of groundwater in open pits it is necessary for the efficient continuation of an activity or for the safety of people

The proposed development will include the following water uses as set out in section 21 of the National Water Act (Act 36 of 1998) processes:

Section 21a: Taking water from a resource

The required make up water demand is 116 654 m3/m (3830 m3/d) for the entire mining operations with an average potable requirement of 810 m3/m at full production. The water supply will be obtained from groundwater abstraction and fissure water. A total of 25 170 m3/m (839 m3/d) is currently available from existing boreholes (DBH04, DBH05, DBH14 and DBH16), and will be licenced in this application as part of the construction phase water supply. The average sustainable yield of the relevant boreholes are as follows:

Table 6-2 Water Supply Boreholes

Basic Information			Sustainable yield (ℓ/s)					
Label	Longitude	Latitude	FC Analysis Sustainable yield (ℓ/s)	Sustainability Check - Cooper Jacob (ℓ/s)	Average Sustainable yield (ℓ/s)	Radius of Recharge zone (m)	Abstraction duty cycle (h)	Abstraction per annum (m³/a)
DBH04	-25.685690	26.141840	0.72	0.65	0.69	480.11	12.00	21602.16
DBH05	-25.706600	26.156070	3.66	3.50	3.58	1242.37	12.00	112898.88
DBH09	-25.681480	26.202460	0.14	0.17	0.16	241.57	12.00	4888.08
DBH14	-25.695000	26.174880	2.60	2.75	2.68	914.30	12.00	84358.80
DBH16	-25.760780	26.129220	3.07	2.44	2.76	1322.57	12.00	86881.68
Maximum			**3.66**	**3.50**	**3.58**	**1322.57**	**12.00**	**112898.88**
Minimum			**0.14**	**0.17**	**0.16**	**241.57**	**12.00**	**4888.08**
Average			**2.04**	**1.90**	**1.97**	**840.18**	**12.00**	**62125.92**
Total			**10.19**	**9.51**	**9.85**			**310629.60**

The open pits will be dewatered in order for mining activities to continue safely and a maximum of **60 000 m3/m** of water will be pumped out of the underground. This water will be re-used in the mining processes.

Water supply for the operational phase is subject to further groundwater development which will take place in follow-up phases and be licenced accordingly in a separate IWULA to supply the required make-up water demand. It is suggested that groundwater exploration be focussed on compartment 1 (impacted due to mine dewatering) and compartments 2 and 8 preferentially.

Section 21b: Storing of water

Groundwater will be stored in a raw water reservoir with a capacity of **392** m³.

Potable water will be stored in a clean water reservoir with a capacity of **106 m³.**

A fire water reservoir with a complete fire suppression system of **106 m3**.

Spray water dam of **181 m3**.

Diversion Dam of **5422 m3** at Resource Area A (Diversion Dam A).

Retention Dam of **646 m3** at Resource Area A (Retention Dam A1).

Retention Dam of **396 m3** at Resource Area A (Retention Dam A2).

Retention Dam of **704 m3** at Resource Area A (Retention Dam A3).

Retention Dam of **752 m3** at Resource Area A (Retention Dam A4).

Retention Dam of **33 204 m3** at Resource Area D (Retention Dam D).

Retention dam of **56 900 m3** at Resource Area C. (Retention Dam C).

Section 21c: Impeding or diverting of a watercourse

Mining infrastructure located within 500 m of a wetland/watercourse.

Stream/drainage diversions.

Section 21g: Disposing of waste in a manner which may detrimentally impact on a water resource

The following waste facilities are envisaged:

- Tailings Storage Facility (TSF) with capacity of **30 000 000 m3** with containment barrier system and lined Return Water Dam (RWD).
- Process Water Reservoir with a capacity of **1375 m3**.
- Storm Water Dam for overburden dump at Resource Area A with a capacity of **1700 m3** (SWD-A).
- Storm Water Dam for overburden dump at Resource Area C with a capacity of **19 000 m3** (SWD-C).
- Plant Storm Water Dam (SWD) with a capacity of **70 000 m3**.
- TSF Storm Water Dam with a capacity of **10 840 m3** (TSF-SWD 1).
- TSF Storm Water Dam with a capacity of **52 708 m3** (TSF-SWD 2).
- TSF Storm Water Dam with a capacity of **15 470 m3** (TSF-SWD 3).

- Sewerage Treatment Plant (STP) with a capacity of 40 m^3/d and associated sewerage sludge tank with a storage capacity of **10 m^3.**
- Water Treatment Plant (WTP) with a capacity of 84 m^3/day will produce brine which will be disposed of in brine evaporation ponds.
- Overburden will be disposed of on two overburden dumps.
- Usage of water containing waste for dust suppression, drilling and blasting at a volume of **5625 m^3/m**.
- Partial backfilling of open pits.

Section 21i: Altering the bed, banks, course or characteristics of a watercourse

Mining infrastructure located within 500 m of a wetland/watercourse.

Stream/drainage diversions.

Section 21j: Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people

The open pits will be dewatered in order for mining activities to continue safely and a maximum of **60 000 m^3/m** of water will be pumped out of the underground. This water will be re-used in the mining processes. As this is a simulated volume, the exact dewatering volume is unclear. Should there be any excess water due to dewatering, abstraction from boreholes will be adjusted accordingly.

6.2.3 Application for Exemption from certain provisions of GN 704

In terms of GNR 704 of 4 June 1999 (GNR 704), certain legal obligations arise with respect to the management of water resources in mining areas.

Regulation 3 of GN 704 states that the Minister may exempt an applicant from complying with certain provisions of GN704 subject to certain conditions. The Doornhoek Fluorspar Mine is applying for exemption of certain provisions of GN704 as it is not practically possible to adhere to these regulations in full during the implementation of the project. All reasonable measures will however be implemented to ensure that the objectives of the regulations are still met.

A summary of the provisions for which exemption is applied for is provided in the table below.

GN 704 Section	Activity requiring exemption	Motivation for applying for exemption

Section 4 Restriction of Locality: *a) Structure within 1:100 year flood-line or within a horizontal distance of 100 m of a watercourse*	• Resource Area A, C and D within the 1:100 year floodline/100 m of water course • Pipeline crossings within 1:100 floodline • Conveyor crossing within 1:100 year floodline • Plant, TSF and overburden dumps within 100 m of tributaries of the Klein Marico River	• Clean water is diverted around the open pits via river and clean water diversions. The river diversions comply with Regulation 704. • A comprehensive Site Specific Storm Water Management Plan has been compiled in terms of this project and is appended to the EIA&EMPR as Appendix 7.11. This storm water management plan complies with the provisions of GN 704. • Clean and dirty water to be separated in terms of GN704 with the use of berms.
Section 4 Restriction of Locality: *4(b) No opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100 m from any watercourse*	• Resource Area A, C and D within the 1:100 year floodline/100 m of water course • Diversion around Resource Area A, C and D of tributaries of the Klein Marico River	• A comprehensive Site Specific Storm Water Management Plan has been compiled in terms of this project and is appended to the EIA&EMPR as Appendix 7.11. The diversion complies with Regulation 704.
Section 4 Restriction of Locality: *c)* *No placement or disposal of any residue or substance which causes or is likely to cause pollution of a water resource, in the underground workings or opencast excavation.*	• Partial backfilling of overburden into open pits as a measure to minimise deposition on surface	• Leachate test work indicated that the overburden has a negligible potential to generate acid, salt and metal-rich leachate and can therefore be considered as having a low pollution potential (Hansen, 2016).
Section 5: Restrictions on use of material.	• Overburden for the tailings dam wall and road building	• Leachate test work indicated that the overburden has a negligible potential to generate acid, salt and metal-rich leachate and can therefore be considered as having a low pollution potential (Hansen, 2016). Also refer to report in Appendix 7.10 of the Final EIA&EMPR.

6.3 Required licence period

The licence period for the above mentioned water uses would be required for the entire LOM, which is 30 years.

7 WATER RESOURCES

7.1 Affected water resources

The water resources that might be affected include the Klein Marico River as well as the local groundwater and dolomitic aquifer.

7.2 Volumes

The required make up water demand is 116 654 m3/m (3830 m3/d) for the entire mining operations with an average potable requirement of 810 m3/m at full production. The water supply will be obtained from groundwater abstraction and fissure water. A total of 25 170 m3/m (839 m3/d) is currently available from existing boreholes (DBH04, DBH05, DBH14 and DBH16), and will be licenced in this application as part of the construction phase water supply. The open pits will be dewatered in order for mining activities to continue safely and a maximum of 60 000 m3/m of water will be pumped out of the underground. This water will be re-used in the mining processes.

The availability of water for supply to the proposed Doornhoek Fluorspar Mine was evaluated in terms of the cumulative water resources as well as optimal water reuse at the mine. All the available resources that were identified or mentioned in project meetings were listed. It is important to note that resources for water supply must be verified to ensure that the Doornhoek Fluorspar Mine development will have assurance of supply. Resources are considered verified if legal (e.g. allocations & licences) and/or when monitoring information is available.

7.3 Taking Water

The required make up water demand is 116 654 m3/m (3830 m3/d) for the entire mining operations with an average potable requirement of 810 m3/m at full production. The water supply will be obtained from groundwater abstraction and fissure water. A total of 25 170 m3/m (839 m3/d) is currently available from existing boreholes (DBH04, DBH05, DBH14 and DBH16), and will be licenced in this application as part of the construction phase water supply.

The open pits will be dewatered in order for mining activities to continue safely and a maximum of **60 000 m3/m** of water will be pumped out of the underground. This water will be re-used in the mining processes.

Water supply for the operational phase is subject to further groundwater development which will take place in follow-up phases and be licenced accordingly in a separate IWULA to supply the required make-up water demand. It is suggested that groundwater exploration be focussed on compartment 1 (impacted due to mine dewatering) and compartments 2 and 8 preferentially.

7.4 Storage Volumes

Groundwater will be stored in a raw water reservoir with a capacity of **392** m³.

Potable water will be stored in a clean water reservoir with a capacity of **106 m³.**

A fire water reservoir with a complete fire suppression system of **106 m3**.

Spray water dam of **181 m3**.

Diversion Dam of **5422 m3** at Resource Area A (Diversion Dam A).

Retention Dam of **646 m3** at Resource Area A (Retention Dam A1).

Retention Dam of **396 m3** at Resource Area A (Retention Dam A2).

Retention Dam of **704 m3** at Resource Area A (Retention Dam A3).

Retention Dam of **752 m3** at Resource Area A (Retention Dam A4).

Retention Dam of **33 204 m3** at Resource Area D (Retention Dam D).

Retention dam of **56 900 m3** at Resource Area C. (Retention Dam C).

Process Water Reservoir with a capacity of **1375 m3**.

Storm Water Dam for overburden dump at Resource Area A with a capacity of **1700 m3**. (SWD A)

Storm Water Dam for overburden dump at Resource Area C with a capacity of **19 000 m3**.

Plant Storm Water Dam with a capacity of **70 000 m3**.

TSF Storm Water Dam with a capacity of **10 840 m3** (TSFSWD 1).

TSF Storm Water Dam with a capacity of **52 708 m3** (TSFSWD 2).

TSF Storm Water Dam with a capacity of **15 470 m3** (TSFSWD 3).

7.5 Waste Disposal

An onsite activated sludge treatment facility will be constructed to treat sewage generated during the operational phase. The sludge treatment plant will be designed to process an estimated 40 m³ per day. This would cater for both mining and plant personnel. All sewage drainage, feeding the sludge plant will be gravity fed. The position of the sewage plant is directly next to the water treatment plant and the storm water dam for easy local distribution of treated water.

Sewage reticulation should be handled with 150 ID PVC gravity piping installed subsurface with a minimum cover of 1 m, minimum slope of 1:100 and with 1050 diameter pre-cast manholes at spacing of no more than 90 m and at every change in direction or slope. Sewers should transport sewage to a common manhole at the lowest point from where it will be fed to the treatment facility. Sewage sludge will be stored in tanks (not lagoons) prior to disposal to a registered hazardous waste disposal facility.

Use will be made of temporary chemical sanitary facilities for sewage to be generated by construction workers during the construction phase. Third party waste removal contractors will be responsible for the supplying, servicing, and relocating of temporary chemical sanitary facilities. The contents of the temporary chemical toilets should be disposed of at a registered hazardous waste disposal facility. Sewage sludge generated from the sewage treatment process will be temporarily stored in a sludge tank with a capacity of approximately 10 m^3 before disposal to the Holfontein landfill site.

Water from the sewerage treatment plant will report to the process water dam for re-use in the process. Groundwater and fissure water (dewatering) will report the water treatment plant which will treat approximately 84 m3 of water per day. The water will be treated in two stages.

Stage 1 of the treated water will serve the purpose of the concentrator plant requirements and Stage 2 will be used as make-up for potable water requirements.

Treatment methods for ensuring water meet SANS 241 Class I (potable water) can be categorised as follows:

- Chemical removal by precipitation of insoluble salts by chemical treatment.
- Flocculation, coagulation and settling of insoluble and large contaminates.
- Flocculation, coagulation and filtering of smaller insoluble contaminates.
- Chlorination or other suitable sterilisation.
- Ultra-filtration to remove microscopic contaminates.
- Reverse osmosis to remove remaining undesirable dissolved contaminates.

A workable and effective system would most likely consist of an initial chemical treatment to precipitate out the easily removed ions and flocculate suspended solids.

The prepared water will then enter either circular conical based settlers or lamella plate settlers depending on volumes of treated water and available space on site.

The clarified water is then passed through a bank of multimedia filters that remove any remaining fine particulates. The media used in the filters vary depending on the exact composition of the water. Finally the water would be sterilised and softened depending on the final dissolved solids breakdown.

If the concentration of dissolved solids is still too high after treatment, a reverse Osmosis system would then be required to remove the remaining dissolved solids.

The brine waste water generated by the water treatment process will be temporarily stored in brine evaporation ponds for later disposal at Holfontein landfill site.

7.6 Evaluation of Development Alternatives

Integral to the Environmental process is the consideration and evaluation of alternatives to the proposed development plan In the case of the proposed development, possible alternatives were identified through discussions with authorities, discussions with I&AP's (focus group meetings), reviewing of the existing baseline environmental data which was determined prior to initiating the EIA/MRA, specialist inputs/studies and the design team. Alternatives relevant to this development can be categorized into the following:

- **Site Location alternatives**
    - Location of processing plant and TSF
- **Layout alternatives**
    - Layout of processing plant and TSF
    - Layout of overburden dumps
- **Service alternatives**
    - Water provision;
    - Energy alternatives;
    - Access alternatives; and
    - Waste disposal.
- **Technology alternative**
- **Mining and Deposition Methodology alternatives**
    - Mining Method Alternatives
    - Overburden Deposition Alternatives
- **The "no-go" alternative**
    - Assessed per environmental aspect/area

7.6.1 Site Location Alternatives

Five location alternatives were investigated for the proposed processing plant and TSF. Refer to Section 8.3.1 of the EIA&EMPR.

7.6.2 Layout Alternatives

Four (4) layout alternatives were investigated for the proposed processing plant and TSF. Two location alternatives were investigated for the proposed overburden dump located at resource area A. Refer to Section 8.3.2 and 8.3.3 of the EIA&EMPR.

7.6.3 Service alternatives

The following water supply options were identified and considered:

- Municipal supply – Witkop Mine infrastructure (transfer of Witkop water allocation).

- Grey water discharge from Zeerust sewage treatment plant. Water transferred via Witkop infrastructure or via a new pipeline.
- Expansion and additional development of current groundwater supply for municipal use and utilization of Witkop infrastructure.
- Development of a standalone wellfield, targeting dolomitic formations south and southeast of the project area.
- Transfer of existing irrigation water allocations from the Zeerust dam, use of groundwater from existing boreholes no longer in use by landowners.

It is evident that groundwater will be the economical preferred option of the follow-up water exploration phase. It is proposed that water supply be sourced from groundwater in Compartment 1 and 2, and possibly Compartment 8 if sufficient water does not exist in Compartments 1 and 2.

It is recommended that further groundwater exploration be undertaken in the above compartments as per the recommendations in Hydrogeological Impact Assessment (Appendix 7.8 of the EIA&EMPR).

7.6.4 Mining Method Alternatives

Two alternative mining methods could be implemented at the proposed operation namely, a standard opencast mining method of stripping with LOM placement of the overburden or concurrent partial backfilling. Refer to Section 8.6.1.

7.6.5 No-Go Alternative

The assessment of the “no-go” alternative is a legal requirement according to NEMA and the EIA Regulations. In this scenario no development would take place. The environment would be left as is and the impact on the area and potential benefits would remain unchanged.

It is the opinion of the majority of specialists that in the event that the Doornhoek Fluorspar Mine is not constructed that the status quo will be maintained. The no-go alternative will imply that virtually none of the identified impacts of proceeding with the project will be incurred. The studies to be undertaken during the impact assessment phase will provide reference to the no-go alternative.

In addition to the global socio-economic benefits associated with the mine, the Doornhoek Fluorspar Mine will also provide the local communities with various benefits relating mainly to job creation and skills development. Unemployment in the area is high and mining is seen to hold major possibilities for the area.

Without the implementation of this project, the mentioned benefits would not be realised. The realization of the outcome of the Mining Charter (2004), within the context of the MPRDA (2002), would therefore also not be reached and this has potentially significant negative impacts on national economic growth and social well-being.

8 OPERATIONAL MINE WATER BALANCE

A regional water balance has been conducted (Figure 8-1). The water balance focussed on assessing make-up water requirements during the operational phase of the project taking into account draught and flood scenarios; with recommendations on the optimisation of water uses and scheduling. The simulated draught flood conditions result in the make-up water requirements varying.

The objective of this water balance is to assess make-up water requirements during the operational phase of the project taking into account draught and flood scenarios. The water balance is conceptual and is subject to further feasibility studies and supporting engineering designs.

Water returned from the TSF circuit for re-use in the plant is on average 60087 m3/m and the contribution from rainwater on the TSF is 21560 m3/m.

The flows and return flows are presented in Figure 8-1.

Results are summarised below:

- The average calculated make-up water from the external water source (wellfields) at full production is 116 654 m3/m (3830 m3/d). The average tonnes of ore processed at full production 123 750 tonnes per month. The average water use per tonne of ore processed was calculated at 0.94 m3/tonnes of ore which is within the expected range of between 0.7 m3/t to 1.2m3/t for similar mining developments.
- The average percentage calculated for water returned from the TSF was 40 % with 60 % losses as a result of interstitial lock-up, seepage and evaporation. The seepage component of 23 388 m3/mon must be recaptured and pumped back to the system.
- Fissure water available for make-up water in the concentrator plant is on average 60 000 m3/m.
- A 1:50 year drought and 1:50 flood were also simulated. Make-up water requirements vary between 161,283 m3/m (drought) and 871 m3/m (excessive wet year). Provision needs to be made in the storm water management plan to accommodate extra volumes of storm water during flood scenario's. Since the Water Balance is at pre-feasibility level, a safety factor of 20% was applied to accommodate drought periods where storm water and fissure water may not be adequate to supplement the demand. This equates to a monthly make-up volume of 137 880 m3/m that would need to be secured from external sources.
- Provision needs to be made for construction and ramp-up requirements prior dewatering.

Table 8-1 Input Parameters and Assumptions

	Description	Amount	Comment
Plant	Mine production (t/annum) (ROM) (avg)	6,750,000	Ramp Up Figures Provided by ENRC
	Mine production (t/month) (ROM) (avg)	562500	Calculated
	Plant feed (% of total mined ore only)	22%	Client

	Description	Amount	Comment
	Product (% of plant feed)	16.0%	20 000t/m acid grade filter cake, EMPR, 2016
	Moisture in product (%)	8.0%	EMPR, 2016
	Mining water use (m^3/ton)	0.01	Assumption
	Plant feed (Tailings) post crush dry density (1)	1.8	Client
	Tailings slurry density (1)	1.2	Client
	Balance factor (%)	10%	
	Plant beneficiation process water use ($m^{3/t)}$	0.01	Assumption
	TSF Deposition Rate (% of Plant Feed)	84%	PEA Report, Applied conversion rate
Construction	No People (during construction)	222	EMPR, 2016
	Water used (l/person/day)	120	
Operational People	No People	220	ENRC, SLP
	Water used (M3)	120	
Mining area	Waste as a % of RoM	78%	
	Overburden moisture content (%)	4%	Assumption
	Ore moisture content (%)	8%	Assumption
	Water Returned from rainwater on Open pits (%)	30%	
	Fissure Water (m3/m)	60000	Modeled (Exigo, 2016) Sustainable year 13
Tailings Storage Facility	Water returned from tailings dam (%)	40%	
	Seepage to aquifer (%)	15%	Modelled: 700m3/d
	Evaporation pond (%)	35%	
	Interstitial lock-up (%)	10%	
	Total tailings losses (%)	60%	
		100%	
Overburden dump	Infiltration & seepage to groundwater (% of rain)	0%	
Sewage works	Sewage water to plant	Yes	**Options**
	Sewage water in out ratio (%)	90%	Assumption
	Sewage Outflow to Sewage Works	No	

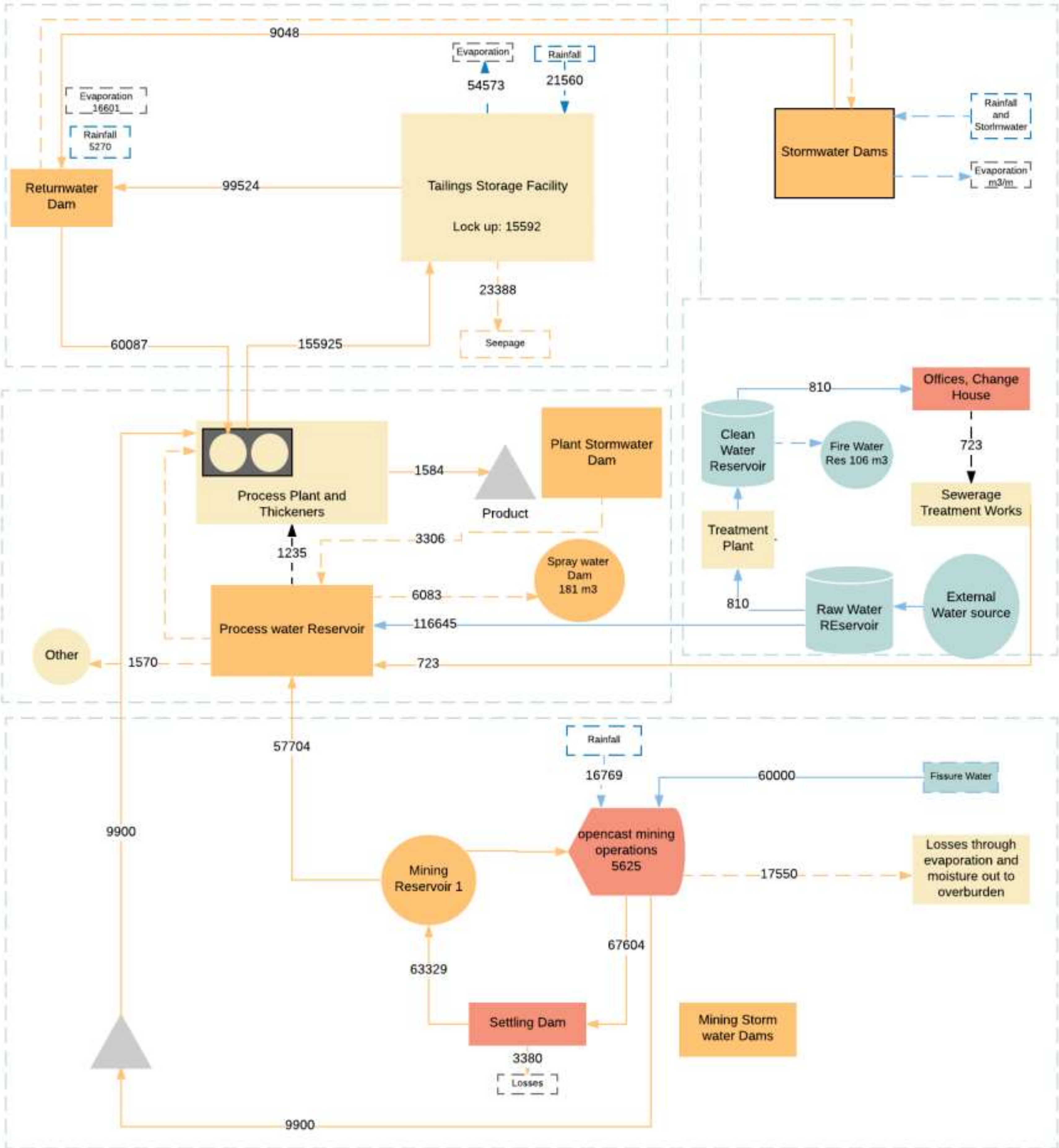

Figure 8-1: Water reticulation and average monthly flow rates

9 MINE DEWATERING AND POST CLOSURE

This section is sourced from the Hydrogeological Impact Assessment Report (Appendix 7.8 of the EIA&EMPR).

9.1 Numerical Groundwater Flow Model

A numerical groundwater flow model has been utilised to aid in decision making, understanding the sensitivity of the system and provide focus to the field work to be conducted in ensuing phases of this project. Previously, limited field work data has been conducted and the historical model was viewed as high level and has been qualified rather than calibrated. The fieldwork component was updated and this data was used in the model reconstruction, recalibration and additional simulations.

In addition, the client supplied updated mining schedules and mine site layouts. This data was used in the update of the numerical model as well as the detailed simulations.

9.1.1 Objectives

The key objectives of this study are listed below:

Determine whether the existing spatial distribution of measured heads adequately describe the heterogeneity within the model domain.

Simulate the proposed mining activities and ascertain the potential impacts on the local groundwater regime.

Assess the possible impact on the local groundwater regime i.e. water levels, availability and quality. Also assess impact on local drainages/rivers with regards to possible surface water flow reduction and water quality impact.

9.1.2 Assumptions and model limitations

As described above, this model is viewed as high level and has been qualified rather than calibrated. Identified data limitations include:

1. Falling head tests as well as aquifer tests were conducted to determine hydraulic conductivity.
    a. The spatial extent of the aquifer tests were enlarged as to obtain more aquifer parameters to use in the model setup and recalibration. Hydraulic conductivity values are available for the dolomite and dolerite dykes. No hydraulic conductivity values are available for the shale and conglomerate units north of the focus area. As such the hydraulic conductivities of the latter units has been assumed from literature and qualified through development of the model.

2. The concept of representative elementary volumes have been applied i.e. a scale has been assumed so that heterogeneity within a system becomes negligible and thus can then be treated as a homogeneous body i.e. the mapped dolomite are treated as a uniform unit.
3. Recharge to the aquifer units is unknown and has been assumed from data collected in similar hydrogeological settings.
4. Groundwater abstraction rates are based on the WARMS database. Additional abstraction rates were assigned based on the aquifer tests concluded (Table 5-10 and Table 6-2).
5. The aquifer is assumed to be compartmentalized by semi-impermeable dyke structures.
6. As the proposed mining depth is expected to terminate at 90 mbgl, the aquifer thickness is assumed at 150 m. This assumption was made as there is no hydrogeological significant unit delineating the aquifer bottom.
7. The rivers in the area have been treated as gaining type streams. As such groundwater is lost from the system via base flow to streams. The aquifer is not however being replenished by losing stream conditions. As the area is characterised by non-perennial rivers this assumption is viewed to be valid.
8. Groundwater divides have been assumed to align with surface water divides. It is assumed that groundwater cannot flow across this type of boundaries.
9. It is assumed that recharge does not vary seasonally with changes in rainfall.

9.1.3 Model set-up

The following sub sections describe the conceptual model and input parameters of the numerical model.

9.1.3.1 Software and mesh

The proposed mine and surrounding groundwater catchment has been described by developing a three dimensional numerical model on the finite element simulation system for subsurface flow and transport process, Feflow®.

The model domain has an aerial extent of 906 km^2 and has been described by a two layer model consisting of triangular mesh comprising 1 171 197 nodes and a corresponding 1 558 478 elements. The mesh was developed to explicitly incorporate hydrogeological boundaries, rivers and known boreholes. Within the focus area the element density has been increased, while a coarser mesh was applied to the elements on the periphery of the model where little data was available. The mesh quality is described below:

- Delaunay violating triangles 2.2%
- Interior holes: 0
- Obtuse angles: 1%> 120^0, $21.2^{\%}$ > 90^0.

9.1.3.2 Boundary conditions

The external boundaries of the model were delineated to coincide with topographical features such as surface water divides, rivers and drainage lines, cognisance of the underlying geology was however also considered in development.

- Hydraulic head boundaries (Blue): The rivers are defined as hydraulic head boundaries where the fixed head is assumed to be equal to topographical elevation. A maximum flow constraint of zero has been applied to the boundary condition in order to simulate gaining type rivers systems i.e. the rivers remove groundwater from the system but do not recharge the aquifer zones. Sensitivity scenarios i.e. possible influence of the Klein Marico River on mine dewatering volumes was simulated.
- No Flow type boundaries (Green): As mentioned, groundwater divides have been assumed to correlate with surface water divides. Thus all water sheds have been defined as no flow type boundaries i.e. boundaries where flow lines are parallel with boundary.

9.1.4 Sources

Recharge is the primary source of inflow to the model domain. Due to a lack of suitable field data for estimating recharge, initial values for model development were derived from literature. The probable recharge values were determined through model qualification; these values are provided in Table 9-1 below.

9.1.5 Sinks

Since the closure of the Witkop mine the primary sink in the catchment is groundwater abstraction for livestock watering and domestic purposes. The volume of water abstracted and the distribution of abstraction boreholes was sourced from the WARMS data base. The distribution of abstraction wells simulated within the flow model is depicted in Figure 9-6.

9.1.5.1 Aquifer parameters

Hydraulic conductivity for model development was obtained from falling head tests, aquifer tests and literature. Through model qualification process hydraulic conductivity values describing the aquifer zones were determined. The hydraulic conductivity values of the calibrated model are provided in Table 9-4.

Storativity values were assumed from literature as no suitable tests have yet been conducted to calibrate the model to obtain storage parameters.

9.1.5.2 Schematic Conceptual model

The components of the conceptual model described in the previous subsections are displayed schematically in Figure 9-1.

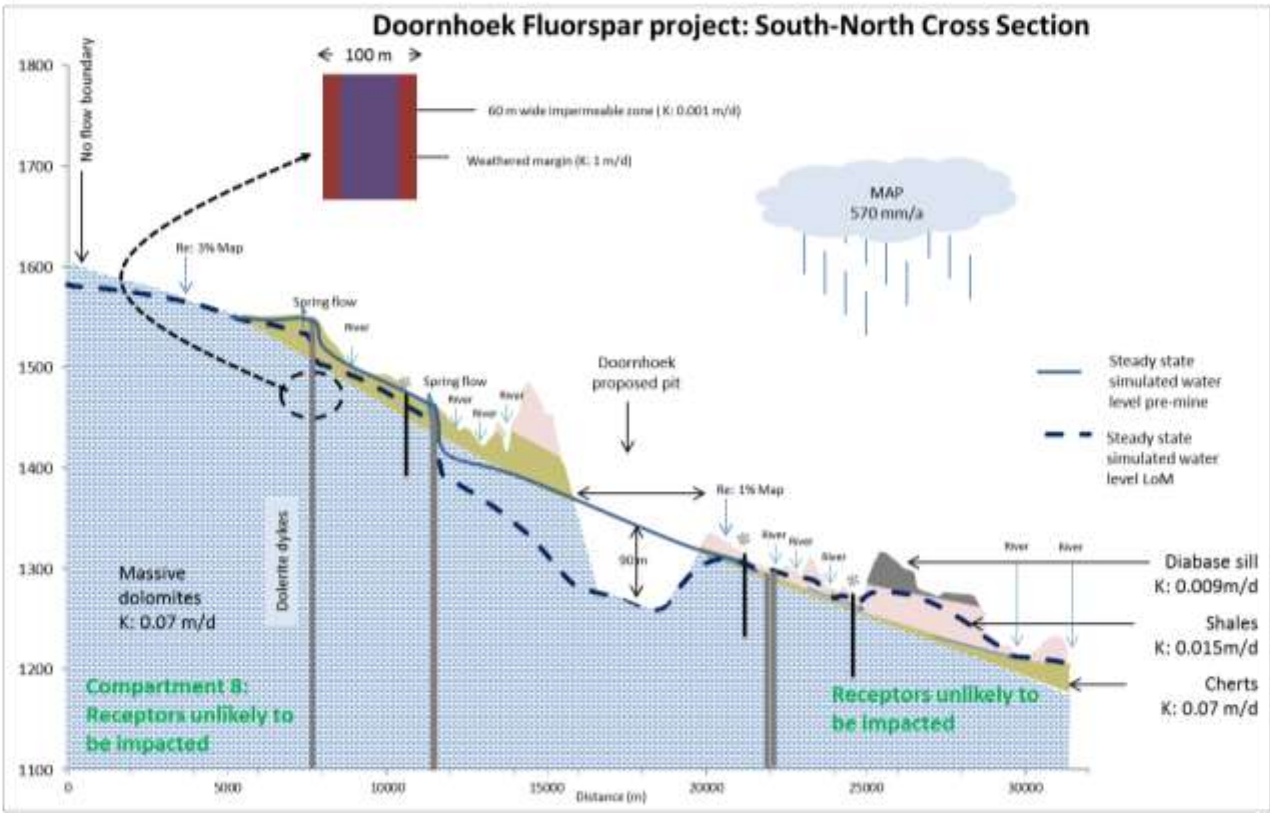

Figure 9-1 Conceptual model

9.1.5.3 Summary of model inputs, data sources and uncertainty

Model input parameters, data sources and data uncertainty are provide in Table 9-1, below

Table 9-1 Model input parameters, data sources and uncertainty

Input parameter	Scale	Source, parameter or assumption description	Data uncertainty
Topography (DEM)		The topographic elevations were interpolated from the 1:50 000 scale 20 m contour intervals as well as the Lidar survey.	Low
Rivers, streams, drainages	1:50 000	Digitised from topographical maps and aerial imagery.	Low
Lithology	1:250 000	GCS geological map sheets - Rustenburg (2526) and Mafikeng (2426) and ENRC detailed mapping	Moderate
Geological structures		High resolution aerial magnetic surveys. While the positions and extent are known the hydraulic characteristics are associated with uncertainty.	Moderate

Input parameter	Scale	Source, parameter or assumption description	Data uncertainty
Mine Layout		A mine layout was supplied by the client	Low
Boreholes and pumping rates		AGES hydrocensus 2013, Exigo Monitoring 2013 -2015, WARMS and aquifer tests conducted during 2016.	Moderate
Rainfall		Collected from rainfall stations within the catchment.	Low-moderate
Steady State Modelling Parameters – Flow Model			
Boundary conditions		Northern model boundary – Fixed hydraulic head boundary with a max flow constraint = 0 m^3/d	Low-moderate
		Eastern, western and southern boundaries are no flow boundaries correlating with surface water divides.	Low-Moderate
		Rivers and drainages within the model domain are described by fixed head boundary conditions and maximum flow constraints of 0 m^3/d. Similarly the dyke structures are assigned as seepage faces so as to simulate spring flows within the model domain.	Low-moderate
Recharge		Recharge could not be estimated from the existing data and was assumed from literature and refined through model qualification.	Moderate
Hydraulic Conductivity		The hydraulic conductivity was estimated from falling head tests literature and aquifer test.	Low
Aquifer thickness		The aquifer thickness is 150 m – the aquifer likely extends deeper than 150 m however no data exists to validate the exact depth.	Moderate
Transient State Modelling Parameters & Mass transport model			
Initial Hydraulic Heads		Simulated heads obtained from simulated steady state conditions as calibrated.	Moderate
Specific Storage		The volume of water that a unit volume of aquifer releases from or takes into storage per unit change in head. $S = S_s \times D$. S_s, refer to Section 4.4.4 of Appendix 7.8 of the EIA&EMPR.	High
Effective Porosity		Porosity is the ratio of the volume of void space to the total volume of the rock of earth material. Assumed conservative porosity of 3% was used in the transient simulations.	High
Longitudinal dispersion coefficient		No field work has been conducted to determine the dispersivity. An approximation of 20 m was used.	High
Transverse dispersion coefficient		Transverse dispersivity was assumed to be 10 x smaller than the longitudinal dispersivity (2 m)	High

9.1.6 Simulation 1: Model qualification and calibration

Based on the conceptual model described above, a numerical model was developed. Under steady state conditions the groundwater flow equation is reduced to exclude storativity and only transmissivity (or hydraulic conductivity) and recharge are considered in the model qualification[1] process. Qualification is the process of adjusting model parameters (hydraulic conductivity and recharge) until a suitable error between simulated and measured hydraulic heads is achieved[2].

Two sets of data points were used in the recalibration of the three dimensional groundwater flow model. A regional set of groundwater data points gathered during the 2016 updated hydrocensus and consists of 78 points, the summary is provided in Table 9-2.

Table 9-2 Summary of regional calibration points

Detail	Mean Absolute Error (m) MAE	Mean Error (m) ME	Root Mean Square Error (m) RMS
Average	14.35	-8.59	330.19
Minimum	0.49	-61.57	0.24
Maximum	61.57	20.23	3791.27
Correlation	Σ = 1061.56	Σ = -635.43	Σ = 24434.37
	1/n = 14.35	1/n = -8.58	1/n = 330.19
			SQRT = 18.17
			RMS% of water level range = 7.08%

The second is focussed group of data points gathered around the proposed site. This set of points consists of 48 points and the summary of the calibration is provided in Table 9-3.

Table 9-3 Summary of focussed calibration points

Detail	Mean Absolute Error (m) MAE	Mean Error (m) ME	Root Mean Square Error (m) RMS
Average	10.03	-9.14	233.06
Minimum	0.34	-70.26	0.12
Maximum	70.26	8.27	4937.10
Correlation	Σ = 481.60	Σ = -438.87	Σ = 11186.84
	1/n = 10.03	1/n = -9.14	1/n = 233.06
			SQRT = 15.27

1The terminology qualification has been used over model calibration due to limited data used for development of this model. Additional field work will be required in or to decrease uncertainty and produce a calibrated model over a qualified model.

2 Spitz and Moreno (1996) specify a normalized root mean square error of less than 5% is deemed suitable for model qualifications

		RMS% of water level range = 6.08%

The steady state model was deemed calibrated based on the acceptable percentages of Root Mean Square Errors obtained for both datasets i.e. <10%.

The calibrated hydraulic parameters are provided in Table 9-4.

Table 9-4 **Calibrated aquifer parameters**

	Lithology	Layer	Thickness	Transmissivity	Kx,y	Kz	Storage Coefficient
1	Chert Poor Dolomite	**1**	10	7	**0.7000**	**7.00E-01**	**5.60E-04**
2	Chert rich Dolomite		10	7	**0.7000**	**7.00E-01**	**5.60E-04**
3	BIF		10	7	**0.7000**	**7.00E-01**	**5.60E-04**
4	Banded Dolomite and Chert		10	14	**1.4000**	**1.40E+00**	**5.60E-04**
5	Chert Free Dolomite		10	7	**0.7000**	**7.00E-01**	**5.60E-04**
6	Dark Chert Free Dolomite		10	7	**0.7000**	**7.00E-01**	**5.60E-04**
7	Dolerite		10	7	**0.7000**	**7.00E-01**	**5.60E-04**
8	Quartzite		10	1.5	**0.1500**	**1.50E-01**	**5.60E-04**
9	Shale		10	1.49	**0.1490**	**1.49E-01**	**2.00E-05**
10	Surface Deposits		10	50	**5.0000**	**5.00E+00**	**4.00E-03**
11	Dyke		10	0.1	**0.0100**	**1.00E-02**	**5.60E-04**
12	Dyke Contact		10	100	**10.0000**	**1.00E+01**	**5.60E-04**
13	Chert Poor Dolomite	**2**	140	21	**0.1500**	**0.15**	**5.60E-04**
14	Chert Rich Dolomite		140	21	**0.1500**	**0.15**	**5.60E-04**
15	BIF		140	21	**0.1500**	**0.15**	**5.60E-04**
16	Banded Dolomite and Chert		140	28	**0.2000**	**0.20**	**5.60E-04**
17	Chert Free Dolomite		140	21	**0.1500**	**0.15**	**5.60E-04**
18	Dark Chert Free Dolomite		140	21	**0.1500**	**0.15**	**5.60E-04**
19	Dolerite		140	21	**0.1500**	**0.15**	**5.60E-04**
20	Dyke		140	0.1	**0.0007**	**0.00**	**5.60E-04**
21	Dyke Contact		140	100	**0.7143**	**0.71**	**5.60E-04**

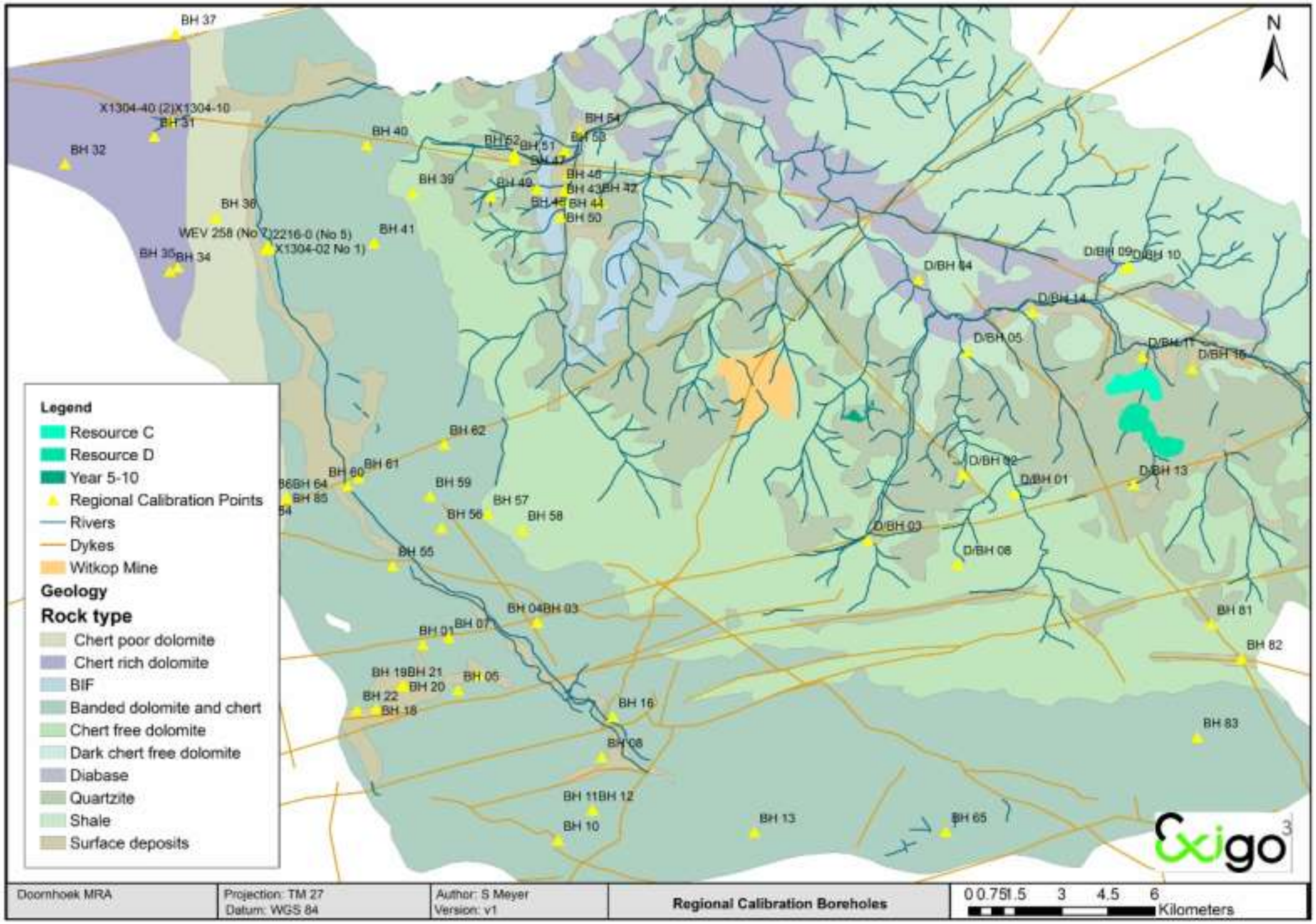

Figure 9-2 **Regional calibration boreholes**

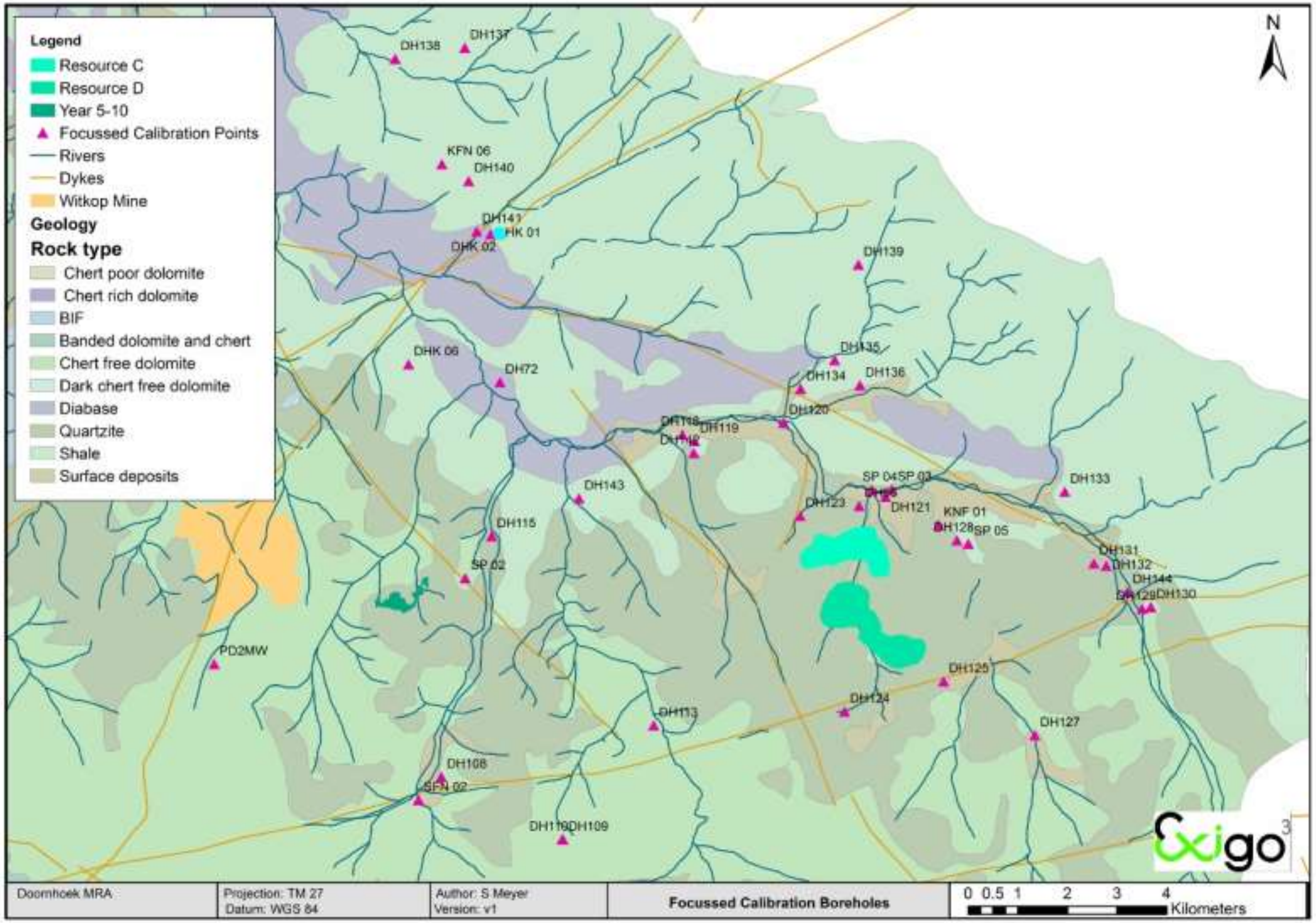

Figure 9-3 **Focussed calibration boreholes**

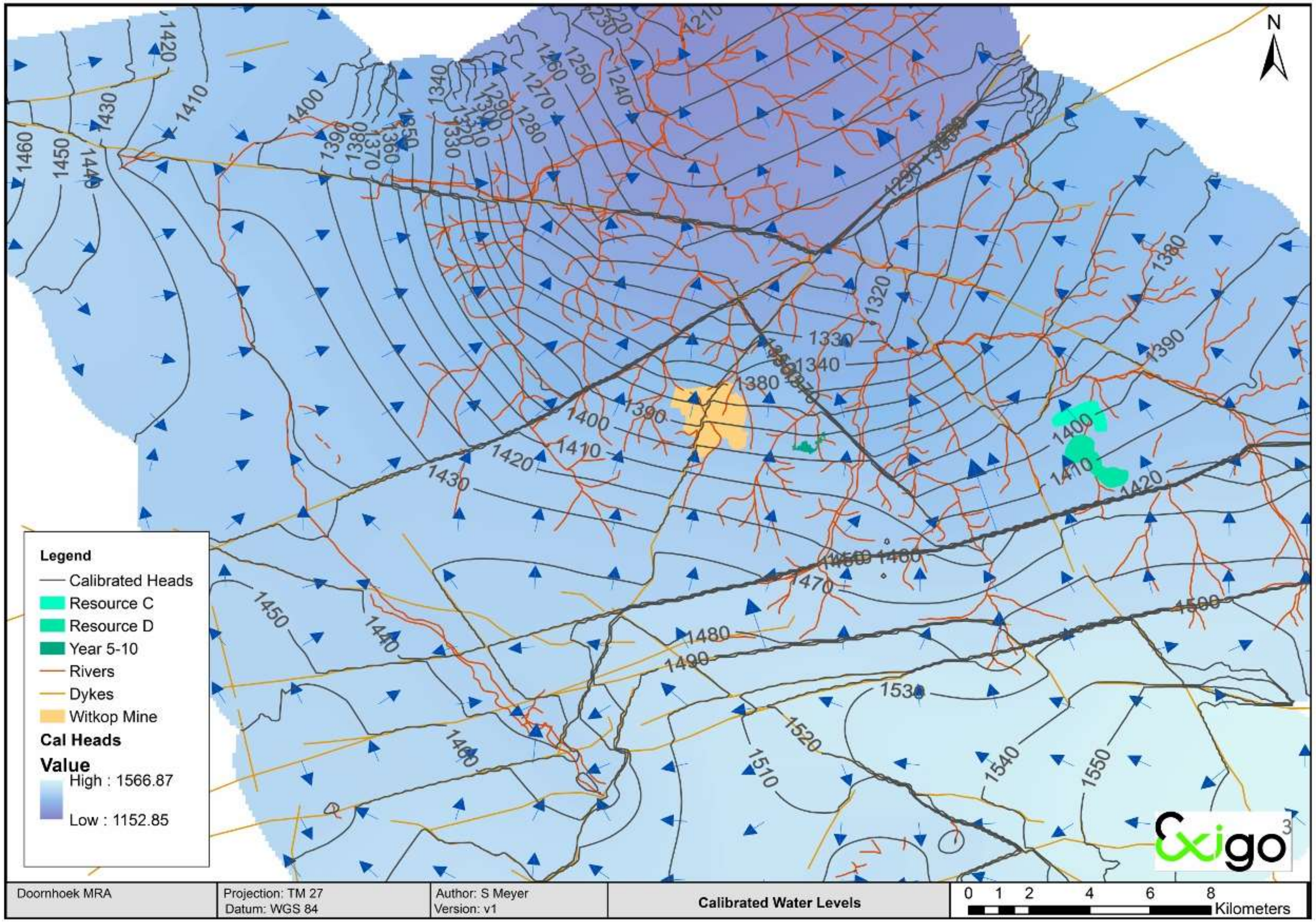

Figure 9-4 **Steady state calibrated heads and flow contours**

9.1.7 Management scenarios

In order to reach the model objectives the following scenarios will be simulated:

1. Review of sensitivity analysis and uncertainty analysis:
2. Determine the area of impact associated with the mine development under steady state conditions
3. Determine area of impact associated with transient dewatering of mine.
4. Determine suitable areas for placement of mine residue facilities so as to reduce the possible impact associated with the facilities.

9.1.8 Summary of model sensitivity

1. The model shows negligible sensitivity to transmissivity in a range ±10% of the base case. Thus limited additional data will be required to constrain the transmissivity of the country rock.
2. The model shows negligible sensitivity to a reduced recharge of 10% relative to base case and marginal sensitivity to increased recharge of 10% relative to base case.

9.1.9 Simulation 2: Transient mine dewatering and water supply simulation

9.1.9.1 Setting the scene on resource management

Impacts are associated with development and the management and mitigation of the possible impacts correlates with sustainable development. The area under investigation needs to be understood before any impacts can be qualified and/or quantified and then only proper management scenarios be implemented.

Registered Water Users

The registered water users located in quaternary catchments A31D and A31C were sourced from the Department of water affairs (DWA) Water use authorisation and registration management system (WARMS). Water users that do not receive their water from a service provider, local authority, water board, irrigation board, government water scheme or other bulk supplier and who are using water for irrigation, mining purposes, industrial use, feedlots, or in terms of a General Authorisation must register on this database.

The registered water users per compartment are provided in Table 9-5. There are 50 registrations in the vicinity of the proposed mine. 12 of these registered users occur within compartment 1 are thus likely to be effected by mine dewatering at the proposed operations. Three recorded springs are also in compartment 1. The largest number of registered users occurs in compartment 19 east of the focus area and across the Klein Marico River.

The compartment with the highest registered water use is compartment 9. These allocations are registered to the Witkop Mine operation. This operation is however no longer active and this allocation is unlikely being utilised annually.

The number of registered water users indicates that the area under investigation and possible influence by the proposed mining activities are very sensitive and proper management scenarios are required. However the proposed water related impacts are constrained to Compartment 4 and 5 to the west, and Compartment 1 and 2 to the north.

Table 9-5 Registered Water Users- Warms database

Compartment	No of registrations	Total of all registered volumes (m^3/a)
Compartment 1	12	194517
Compartment 19	20	234977
Compartment 2	4	59757
Compartment 20	6	257710
Compartment 3	2	96606
Compartment 4	2	86880
Compartment 5	2	116741
Compartment 9	2	2324000
Total	50	3371188

Crocodile (West) Marico Water Management Area Internal Strategic Perspective (ISP)

The National Water Act (NWA, 1998) requires that for each Water Management Area (WMA) a Catchment Management Agency (CMA) be established. The CMA will guide the management of the water resources of the WMA. The Marico, Upper Molopo and Upper Ngotwane catchments are part of the Crocodile (West) and Marico WMA.

Commercial irrigation, urban water use and rural domestic water use forms the three major water user sectors. Irrigation is the major water user in the greater Marico area along the Groot Marico River and the Klein Marico. The major source of supply to the water users and uses are the dolomitic aquifers of the Grootfontein compartments and the Molopo Springs.

The ISP found that the available water resources of the Marico catchments do not meet the water requirements at the appropriate levels of assurance of supply i.e. the catchments are in deficit. The ISP also found that the available water resources of the catchments are not well understood, especially the long term sustainable yield from groundwater resources abstracted from dolomites. Groundwater is widely available in chert horizons and karst zones with borehole yields between 5 and 20 L/s common and feasible. The aquifers in the catchments are important sources of stream base flow for the Groot Marico and the tributaries (DWAF, 2004).

In essence, the ISP concludes that groundwater management in the catchments are of utmost importance. The current water balance indicates a deficit in supply versus demand and little to no possibility of surface water resources being established. Groundwater resources is the only viable option, provided the development is accompanied by a detailed analyses and license application process.

Additionally, certain strategies such as alien vegetation eradication along the Klein Marico riparian zones will increase the water balance and possibly off set negative impacts.

9.1.9.2 Mine sequence and detail

A detailed mine plan and site layout with alternatives was provided by the client. The mine schedule and alternatives was evaluated as part of this study and incorporated into the numerical groundwater flow model (Figure 9-5, Figure 9-6).

The mining sequence was incorporated into the groundwater flow model as shown in Figure 9-5.

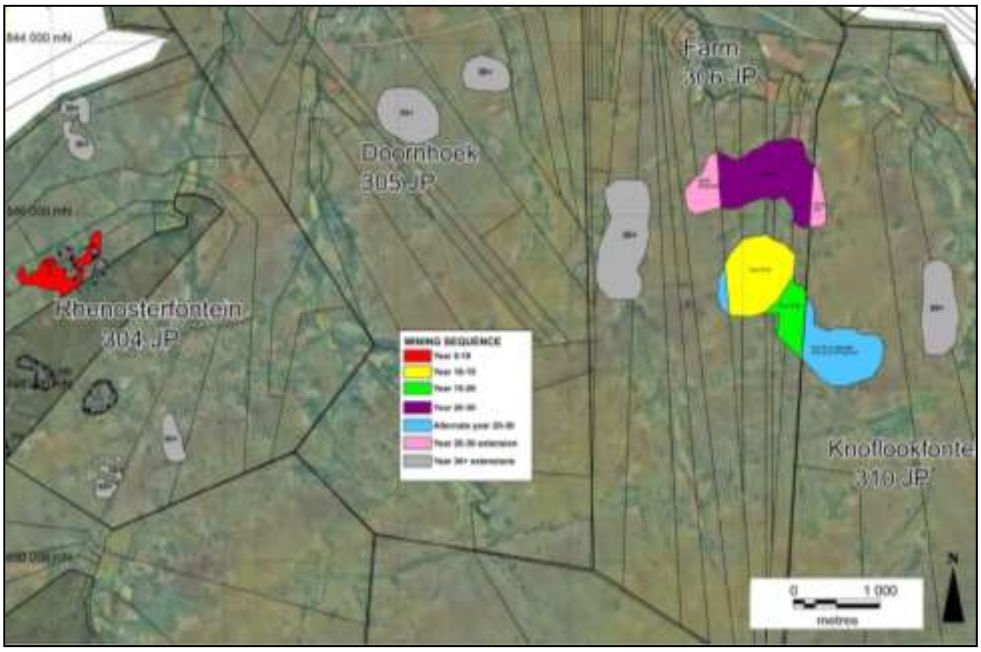

Figure 9-5 Planned mining sequence (Client)

9.1.9.3 Constrained versus Unconstrained flow from the Klein Marico River

Two scenarios for potential mine dewatering rates were simulated i.e. all rivers constrained i.e. the Klein Marico River contributes zero volumes to mine dewatering. Secondly, the Klein Marico River was constrained such that the potential inflows do not exceed the Mean Annual Run-off from the mine area catchment (Figure 9-7). A possible link does exist between the surface water (Klein Marico River) and the groundwater i.e.

currently under pristine conditions the river is classified as a gaining river – groundwater reports as baseflow and contributes to the surface water flow.

Should the hydraulic gradients be reversed due to mine dewatering, possible leaking from the Klein Marico River to the groundwater might be induced. Thus the need to simulate constrained versus unconstrained flow in the Klein Marico River to obtain a sense of possible volumes. The river basin and possible flow is constrained by the lithological type and associated parameters. Also, flow will occur through discrete fractures. The characteristics and presence of these potential fracture zones / hydraulic links between the proposed open pits and Klein Marico River should be investigated in the next phase with the following:

1. Detailed geophysical traverses to map the subsurface geological scene between the Klein Marico River and Recourse C.
2. Drilling of aquifer characterization boreholes on discrete fractures zone and/or zones of preferential flow.
3. Long term aquifer tests of the boreholes (96 hours+). The hydraulic regime should be stressed maximal and samples taken every 4 hours for isotopic analyses and fingerprinting. Samples of the Klein Marico should also be taken and analysed for leakage. The tests will confirm a possible link and mixing ratios between groundwater and surface water.

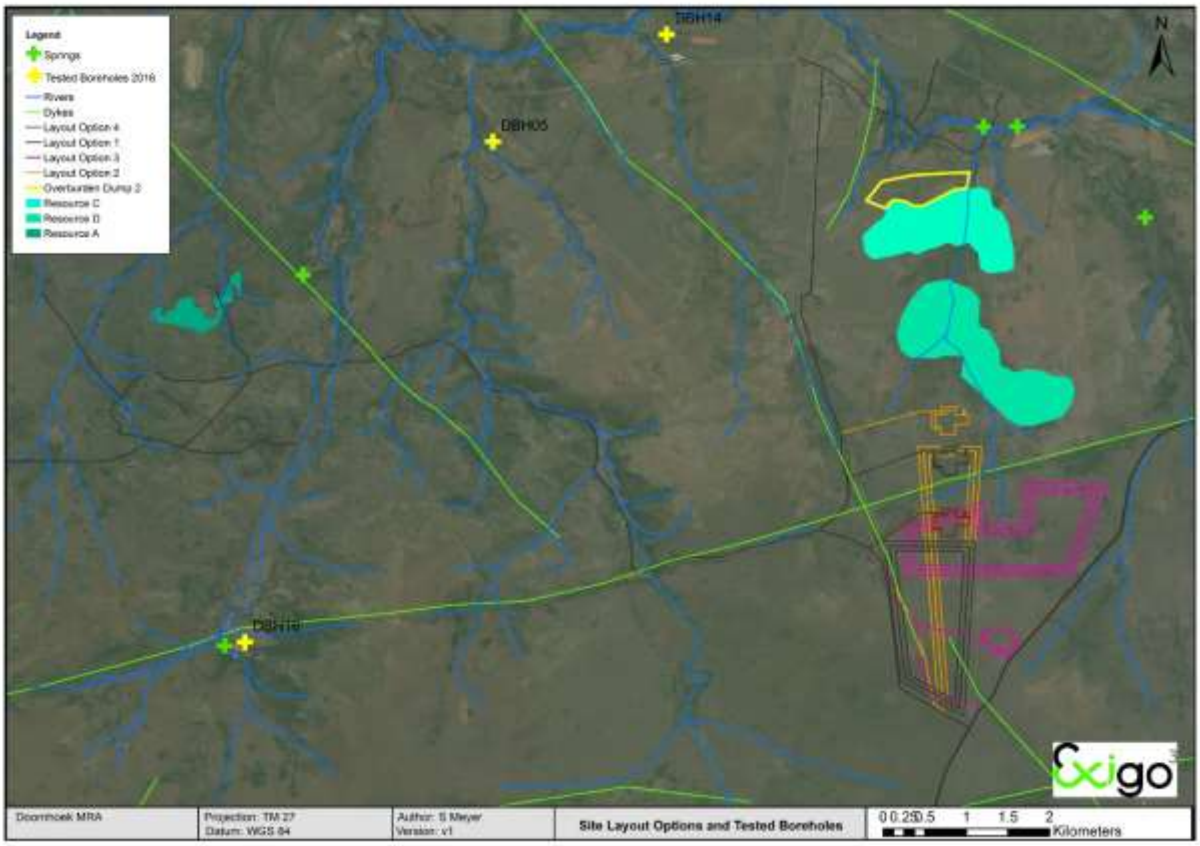

Figure 9-6 Site layout options and alternartives with water supply boreholes

As shown in Table 9-6 and Figure 9-7 the MAR for the mine catchment is approximately 55 L/s (4800 m^3/d) correlating to a runoff coefficient of 2% compared to the 250 L/s for the quaternary catchment A31D. The maximum influence i.e. reduction of flow could be approximately 20% of the runoff in the A31D quaternary catchment.

The constraints on the Klein Marico River north of the proposed open pits were assigned such that a maximum of 4800 m^3/d would be able to potentially flow into the modelled open pit. The actual volume reporting to the open pit is a function of the hydraulic conductivity of the underlying layers i.e. quartzites and shales and the gradient induced by the mine advancement.

In the follow up phase additional analyses should be done to investigate the influence of droughts and floods on the potential inflow volumes and vice versa.

Table 9-6 Mean Annual Runoff (MAR) from mine catchment

		Quad A31D	**Mine catchment**
Catchment area (m^2)		704,014,193.00	155,820,661.00
MAP (mm/a)		566.00	566.00
MAP (m^3/a)		398,472,033.24	88,194,494.13
MAR (m^3/a)		7,910,000.00	1,750,733.78
MAR (L/s)		250.82	**55.52**
MAR % of MAP	1.99		

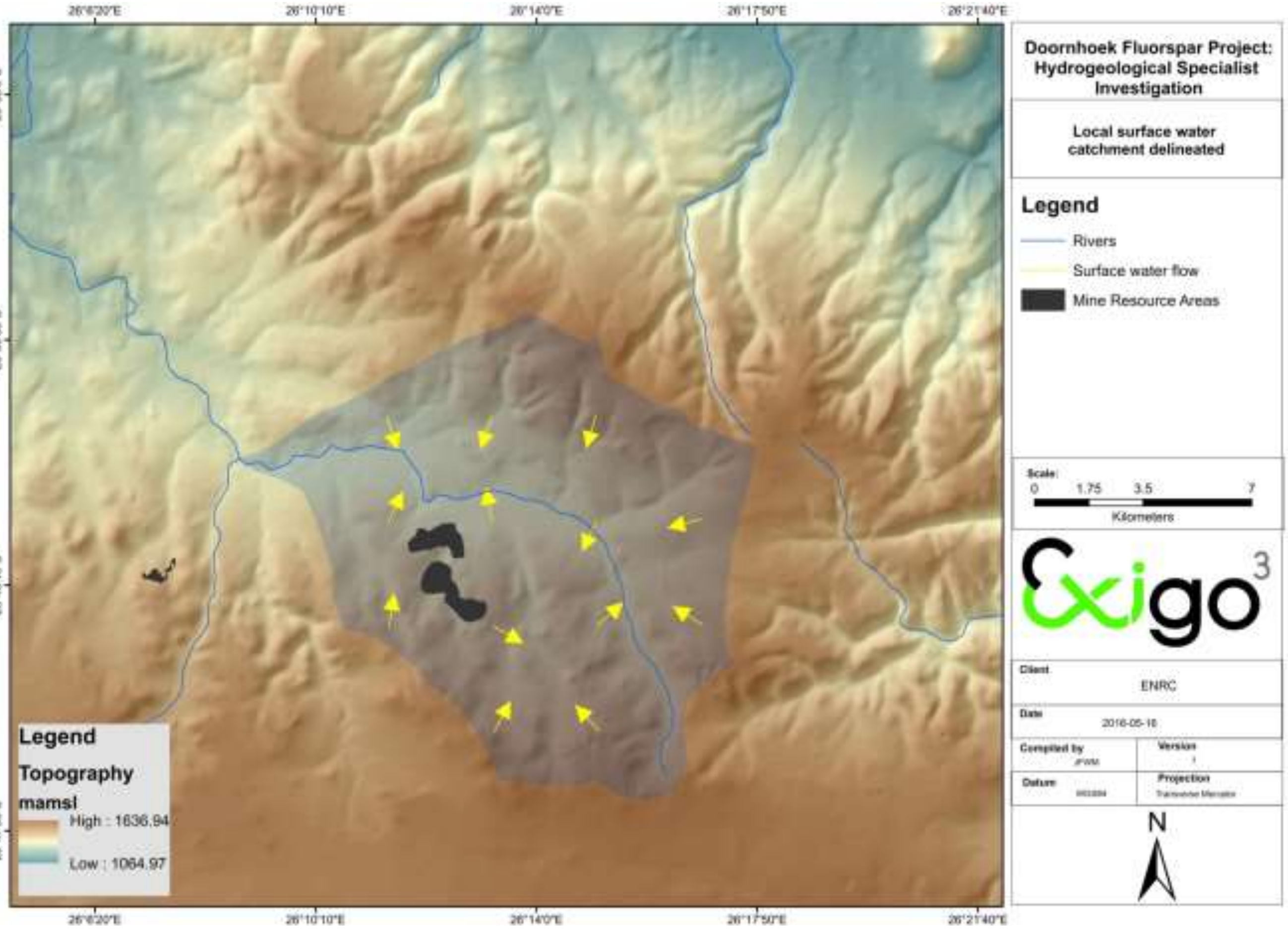

Figure 9-7 **Mine area cathcment for MAR assessment**

The influences of droughts and floods should be included in the updated modelling scenarios for planning purposes. The influence should be studied in the next phases and impacts simulated on the potential dewatering rates.

The mine dewatering model was simulated for a total of 30 years Life of Mine (LoM). Each open pit was simulated discretely and individual dewatering volumes were calculated for each pit.

- The estimated inflows during LoM are expected to initiate between year 9 and year 10 at the Year 5 – 10 open pit (Resource A). This pit was simulated to only reach a maximum depth of 60 mbgl. The maximum depth of 60 m was taken from the highest peak to the lowest part of mineralization and is only a small percentage of the pit. The majority of the pit is not more than 30 m deep. The pit was included in the groundwater flow model as 60 m deep across the entire pit area to simulate maximum impact for the conservative scenario according to the precautionary principle; however, analogue sites indicate no dewatering volumes. Peak dewatering rates at this pit reach approximately 1000 m3/d at the end of year 10. Once mining stops, the steady state dewatering rate potentially associated with this open pit stabilizes at 320 m3/d. This could be regarded as a potential water supply source. However, analogue sites (existing open pits in the area) indicated dry conditions and no dewatering rates – however, the existing pits are shallower than the proposed pits.

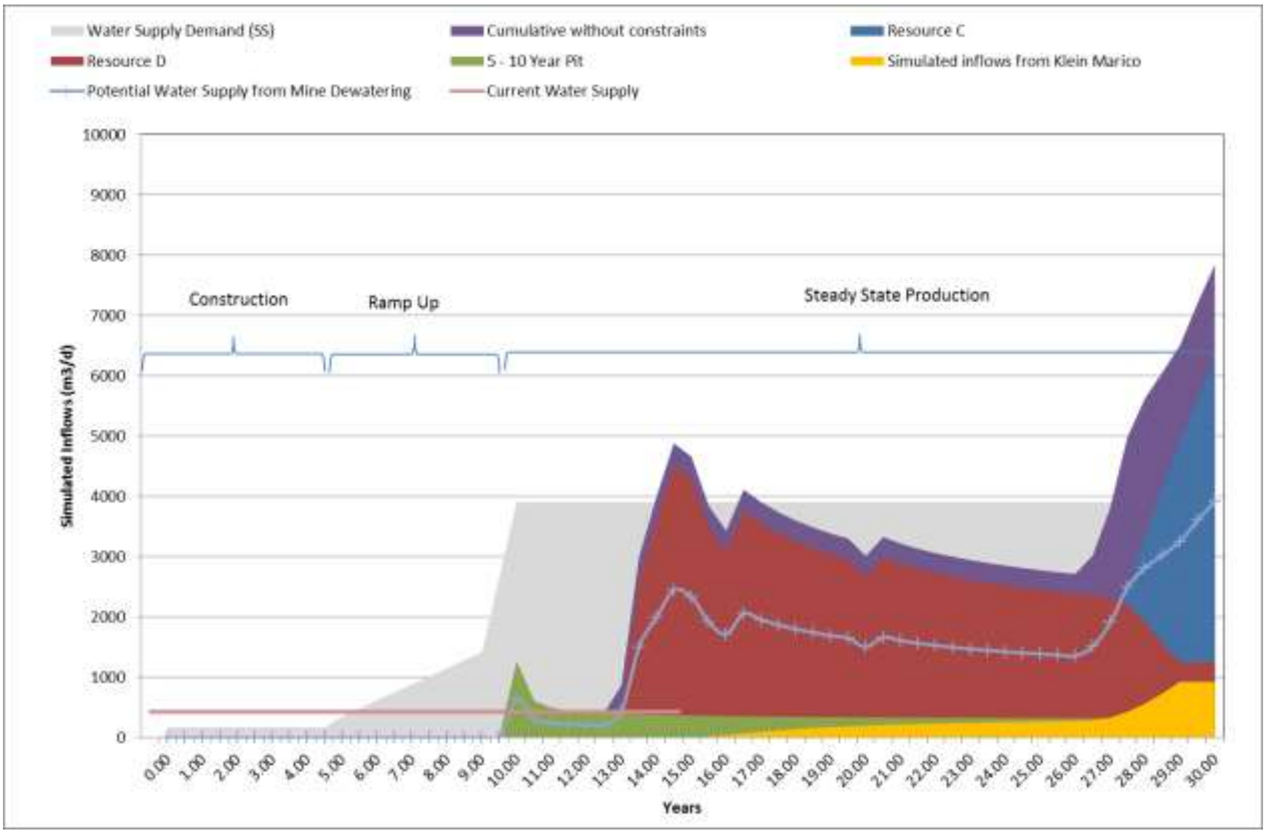

Figure 9-8 Simulated volumes associated with mine dewatering

- **Resource D** is mined from year 10 to year 30 and reaches a maximum depth of 90 mbgl. A pit depth of 90 m was applied on the entire model area to simulate maximum impact i.e. the conservative case according to the precautionary principle. Potential dewatering rates peak at 5000 m3/d at year 14 and steadily declines to a dewatering rate varying between 2000 m3/d and 3000 m3/d. The peak in dewatering rates indicates the volume of storage removed from the aquifer (Compartment 1) and the decline in dewatering rates suggest the steady state rates expected. The effect of evaporation on dewatering rates should be accounted for, and up to 50% of reported dewatering volumes (collected in the open pit) could be lost to evaporation. Should pre-dewatering by means of a curtain of dewatering wells around the open pit be the preferred option, then the dewatering volumes should be closer to the total simulated volumes i.e. not evaporation exposed volumes.

- **Resource C** is mined between year 20 and year 30 and reaches a maximum depth of 90 mbgl. This resource is also located the closest to the Klein Marico River, and should any influence of potential inflow from the river be expected, it will be seen at this resource. Pre-dewatering of the area (and compartment) during mining of Resource D, influence the dewatering rates at Resource C. A steep increase in dewatering rates was simulated between year 26 and year 27 of mining and peak at 8000 m^3/d. This peak in simulated dewatering volumes is only an indication. Once long term monitoring and abstraction data becomes available, then the model should be re-calibrated and the scenarios re-simulated to refine the envelope of uncertainty with regards to dewatering volumes.
- The increase in possible inflow from the Klein Marico River was also simulated and shown in Figure 9-8. The inflows from the Klein Marico River increases as the Zone of Influence (ZOI) increase with time and hence the hydraulic gradient. The volume of flow is a function of the hydraulic parameters of the river base as well as the gradient. With an increase in these parameters an increase in potential flow would occur i.e. open discrete fractures linking the surface water feature with groundwater and/or deeper open pits, closer to the river etc. Maximum simulated inflows reach approximately 900 m^3/d resulting in less than 4% impact on the simulated surface water runoff in the A31D quaternary catchment. Once the possible link between the Klein Marico River and the groundwater has been established, then the simulated inflows should be updated with a detailed assessment on the surface water runoff of the Klein Marico River catchment area as well as the Groot Marico river catchment area.
- Alien vegetation eradication in the riparian zone of the Klein Marico River plays an important role in offsetting the potential impact of seepage from the river towards the open pits. The nett change in flow should be studied and determined based on the volumes of alien vegetation available. The positive offset on the local water balance should be determined and the resultant difference in flow in the river could offset the seepage volumes. A detailed surface water flow model, coupled with a biodiversity study and mapping of the alien vegetation should be conducted in the follow up phase. It is also suggested that local labour should be used for the alien vegetation eradication program.
- Water supply was included in the simulation. Five boreholes were subjected to aquifer tests for the purpose of sustainable water supply to the mine. The boreholes and proposed yields (average sustainable yields) were included in the simulation (Table 9-7, Figure 9-6)

Table 9-7 Water Supply Boreholes (Figure 9-6)

Basic Information			Sustainable yield (ℓ/s)					
Label	Longitude	Latitude	FC Analysis Sustainable yield (ℓ/s)	Sustainability Check - Cooper Jacob (ℓ/s)	Average Sustainable yield (ℓ/s)	Radius of Recharge zone (m)	Abstraction duty cycle (h)	Abstraction per annum (m³/a)
DBH04	-25.685690	26.141840	0.72	0.65	0.69	480.11	12.00	21602.16
DBH05	-25.706600	26.156070	3.66	3.50	3.58	1242.37	12.00	112898.88
DBH09	-25.681480	26.202460	0.14	0.17	0.16	241.57	12.00	4888.08
DBH14	-25.695000	26.174880	2.60	2.75	2.68	914.30	12.00	84358.80
DBH16	-25.760780	26.129220	3.07	2.44	2.76	1322.57	12.00	86881.68
Maximum			**3.66**	**3.50**	**3.58**	**1322.57**	**12.00**	**112898.88**
Minimum			**0.14**	**0.17**	**0.16**	**241.57**	**12.00**	**4888.08**
Average			**2.04**	**1.90**	**1.97**	**840.18**	**12.00**	**62125.92**
Total			**10.19**	**9.51**	**9.85**			**310629.60**

- However subsequent to the hydrogeological assessment and supporting regional water balance it is proposed that water supply be conducted from groundwater resources. Groundwater resources will be developed in Compartment 1 and 2 with the possibility of compartment 8 should sufficient resources not be available in the first two mentioned. The applicant understands that groundwater development may have a negative impact with regards to water supply in terms of water quantity and quality due to mining activities and water supply to the mine, and will implement mitigation measures supported by monitoring to mitigate and limit any impacts in this regard. Any landowners who may be verified to be affected will be subject to compensation and/or purchase agreements.
- From the detailed environmental site water balance the average calculated make-up water from the external water source (wellfields) at full production is 116 654 m^3/month (3830 m^3/day). The average tonnes of ore processed at full production 123 750 tonnes per month. The average water use per tonne of ore processed was calculated at 0.94 m^3/tonnes of ore which is within the expected range of between 0.7 m^3/t to 1.2m^3/t for similar mining developments.
- The sensitivity and influence of the constraints and possible inflows from the Klein Marico River were simulated as well. The aquifer tests indicate a potential connection between the surface water runoff in the Klein Marico River and the groundwater. The difference in simulated inflows due to potential inflows from the Klein Marico River increases to a maximum of 900 m^3/d.
- The proposed development and simulated influence are located a substantial distance away from the Marico eye and no influence is envisaged on the quality and quantity of flow according to the current mine layout, depth and schedule.

The mine numerical groundwater flow modelling follows the precautionary principle. In such a case where assumptions were made due to a gap in data, a conservative approach is taken. The simulated impacts are provided and reported on, however, should the follow up studies be completed and the gaps addressed, the resultant impact on the receiving environment should be less.

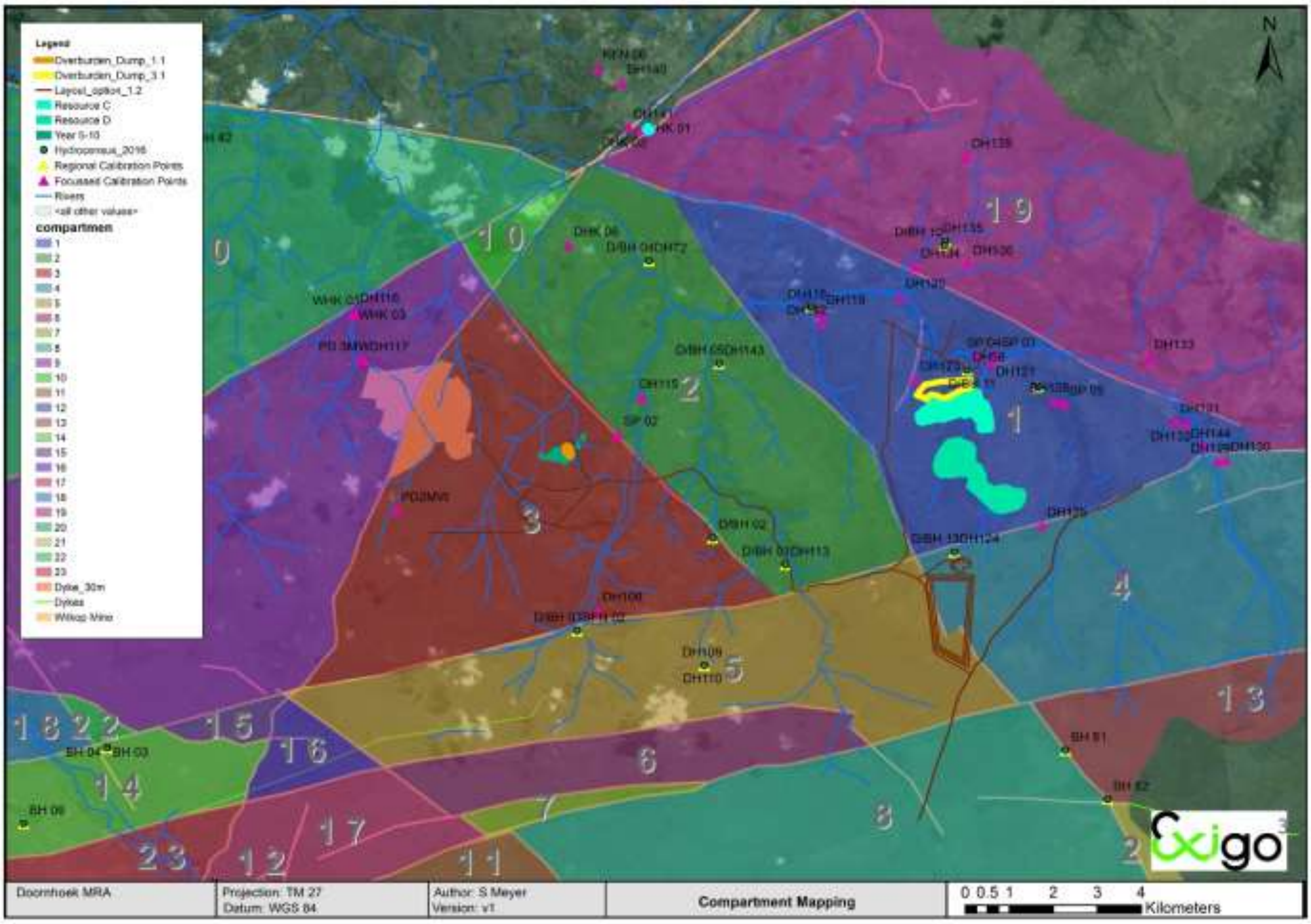

Figure 9-9 Compartment mapping for influence assessment

Through evaluation of the data sources the dykes structures in vicinity of the proposed mine were mapped. The identified dykes were then overlain across a simplified geological map and compartments were mapped according to the intersecting dyke structures (Figure 9-9).

Twenty-three compartments were identified. The focus area of the proposed mine is situated over three compartments demarcated as compartments 1, 3 and 4. The identification of springs along the dyke separating compartments 1, 2 and from 4 and 5 indicates that the dyke is likely semi-impermeable to impermeable. Therefore water table drawdown associated with a mining operation in compartments 1, 2 and 3 are likely not to extend southerly into compartments 4 and 5 (Figure 9-9).

The peak zone of influence due to mine dewatering is shown in Figure 9-10. Compartmental dewatering is observed and the simulated impact is limited to compartments 1 and 2 for Resource C and Resource D and Compartment 3 for the 5 – 10 Year pit (Resource A). The dykes, assumed to be semi-impermeable/leaky, acts as natural mitigation measures and contain the zone of influence. However, cross compartmental leaking is possible and should form part of the follow up phase of investigations:

1. Detailed geophysics on the dykes separating compartment 1 and 2 as well as compartments 1 and 4. The geophysics should be perpendicular to the dykes as well as along the dykes to site suitable drilling targets. Drilling should take place both sides of the dykes as well as in the most permeable section of the dyke.
2. Drilling and testing to confirm dyke integrity. The dykes could act as natural mitigation measures i.e. to limit and secure possible impacts to certain compartments. The cross-dyke testing in paired boreholes (opposite the dyke from each other) will confirm possible leakage and influence. Testing within the dyke, if possible, will confirm upper permeability value of the dyke material for model update and management scenario measures.

The simulated zone of influence for the Resource A open pit is contained within compartment 3 and the steady state drawdown contours indicated a maximum drawdown potential up to 5 m. The simulation was conducted to formulate management strategies, little to no impact is foreseen and no dewatering influences due to the mining depth being 30 m across the open pit area rather than the maximum depth of 60 m used in the modelling scenarios. Monitoring should be conducted in compartment 3 and across the dyke in compartment 2. The spring SP02 could possibly be influenced by the dewatering and should be part of the monitoring program.

The monitoring program should include boreholes located on both sides of the dykes i.e. west (compartment 1 and 2) and southern compartment boundaries (compartment 1 and 4), to accurately monitor the influence. Discreet fractures might exist which could contribute to influences beyond the compartments. A maximum drawdown of 52 m i.e. change in current calibrated water levels, were simulated within compartment 1. The zone of influence (ZOI) would possibly reach the Klein Marico River, and hence the inflow from the river simulated as part of these scenarios.

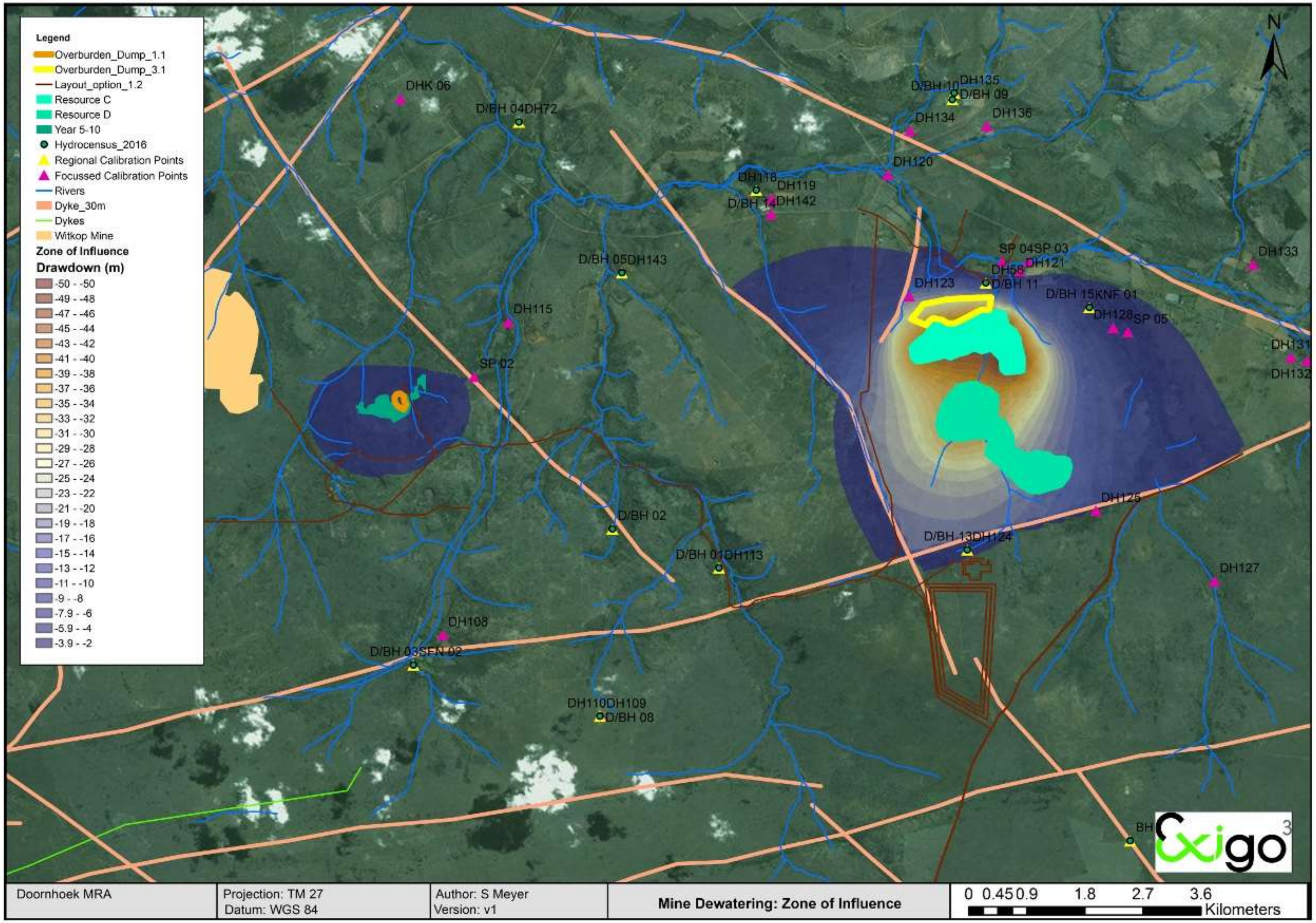

Figure 9-10 Zone of Influence (ZOI) associated with transient mine dewatering

9.1.10 Simulation 3: Mass transport associated with the TSF and overburden dumps

This scenario details the possible contaminant plume which could originate from the TSF and the overburden dumps for the initial 30 years of the LoM. This scenario is only a simulation for management purposes i.e. advective transport was simulated on possible leaching concentrations of sulphates, TDS and fluor to show in which direction a possible plume could migrate. This will enable the client to install adequate monitoring points and mitigation measures to address this possibility.

9.1.10.1 Geochemical background

The detailed geochemical model compiled by Dr. Hansen from Geochemical Dynamic Systems i.e. *Doornhoek Fluorspar Geochemical Risk Assessment – Waste classification and geochemical modelling* was used as reference to obtain the baseline and possible leachate parameters associated with the mining infrastructure, especially the overburden dump and TSF position and alternatives.

For the operational phase, the model results indicated that sulphate values in the tailings pore water exceed regulatory values and groundwater baseline values. Additionally, fluoride values in the tailings will range from 0.9 mg/L to 2.7 mg/L, with the later value the maximum (Hansen, RN 2016). The results associated with the overburden dumps indicated sulphide to be below detection limits and fluoride similar to the baseline values. For the purposes of the mass transport model during the operational phase, TDS was used as a scalar value to indicate potential impacts and propose suitable management measures.

9.1.10.2 Mass transport model input

TDS was used as a parameter associated with the overburden dumps and sulphates and Fluoride with the TSF. The background and possible leachate values used were obtained from the detailed geochemical analyses conducted on the waste material (Hansen, RN 2016).

Analysing the background values of sulphates in the groundwater shows the average concentration for sulphates in the groundwater is 95 mg/ℓ, 1.8 mg/ℓ for F and 501 mg/ℓ for TDS. As detailed in the geochemical assessment a possible 880 mg/ℓ of sulphates and 2.7 mg/ℓ of F could leach from the TSF during the operational phase. For the overburden dumps, a possible 994 mg/ℓ could leach associated with TDS.

A porosity of 5% was assigned for to the dolomitic lithologies and 3% for the remaining units. The scenarios of sulphate leaching from the TSF and overburden dumps were simulated with a linearly increasing trend over the initial 30 years, thus starting at the background values and ending at the simulated leachate concentrations i.e. sourced from the geochemical model results. Fluxes were assigned to the TSF and overburden dumps to simulate the increased recharge on these facilities. A maximum recharge of 30% was assigned to the overburden dumps and a 0.001 m/d flux to the waste material deposited on the TSF. This could influence the water balance and possible dewatering rates due to the close proximity of especially the overburden dump to the open pit. However, due to the small extent of the overburden dumps, this is not foreseen as a major impact.

The TSF positons for site layouts 1 and 4 are the same i.e. only the position of the proposed plant area changes. Hence, for the next simulation reference is made to TSF Option 1 which includes both 1 and 4 (Figure 9-6).

The TSF Option 1 (4) was simulated first. Both sulphate and fluoride was used as sources to simulate the possible migration of salts originating from this facility. The placement of the facility spans over two compartments i.e. 4 and 5. We would suggest that the dyke separating compartment 4 and 5 be used as a natural mitigating measure i.e. the entire TSF position should be located within compartment 4.

The resultant simulated flow associated with the TSF 1 (4) is shown in Figure 9-11 and Figure 9-12. The simulation indicated that a potential larger impact zone is created by the SO_4 simulation if compared to the F simulation due to the difference in potential source and baseline values. Thus, for the TSF alternative simulations (Options 2 and 3) SO_4 was used as potential contaminant source.

Both scenarios indicated that the potential contaminant impacts compartment 4, compartment 5 to the west, compartment 1 and 2 to the north. To mitigate this impact, monitoring and management in all four compartments will be required i.e. monitoring boreholes drilled on either side of the dykes, both shallow and deep paired boreholes to monitor deeper fractured flow and shallower perched groundwater flow. As mentioned, moving the TSF position closer to the open pits and within one compartment (4) or two compartments maximum (1 and 4) would be ideal. The open pits and zone of influence due to mine dewatering will act as a mitigation measure capturing the plume and containing it. The placement of the TSF south of the open pits is ideal with regards to possible impacts on the Klein Marico River – the open pits will intercept any possible contaminant and contain this from a groundwater perspective. Surface water runoff, should be mitigated accordingly. . The post operational plan should be optimised such that the open pits creates a sink and contain any salts originating from the TSF and overburden dumps.

The TDS simulation associated with the overburden dumps are shown in Figure 9-13. The dumps are substantially smaller than the TSF. The placement of the overburden dumps is ideal i.e. close to the open pits. The hydraulic gradient induced by the mine dewatering contains the possible plume originating from the dumps and act as a mitigation measures. A possible change in position of the overburden dump associated with Resource C would be to shift this dump south i.e. away from the Klein Marico River. An optimization exercise should be performed on the position in the follow up phases.

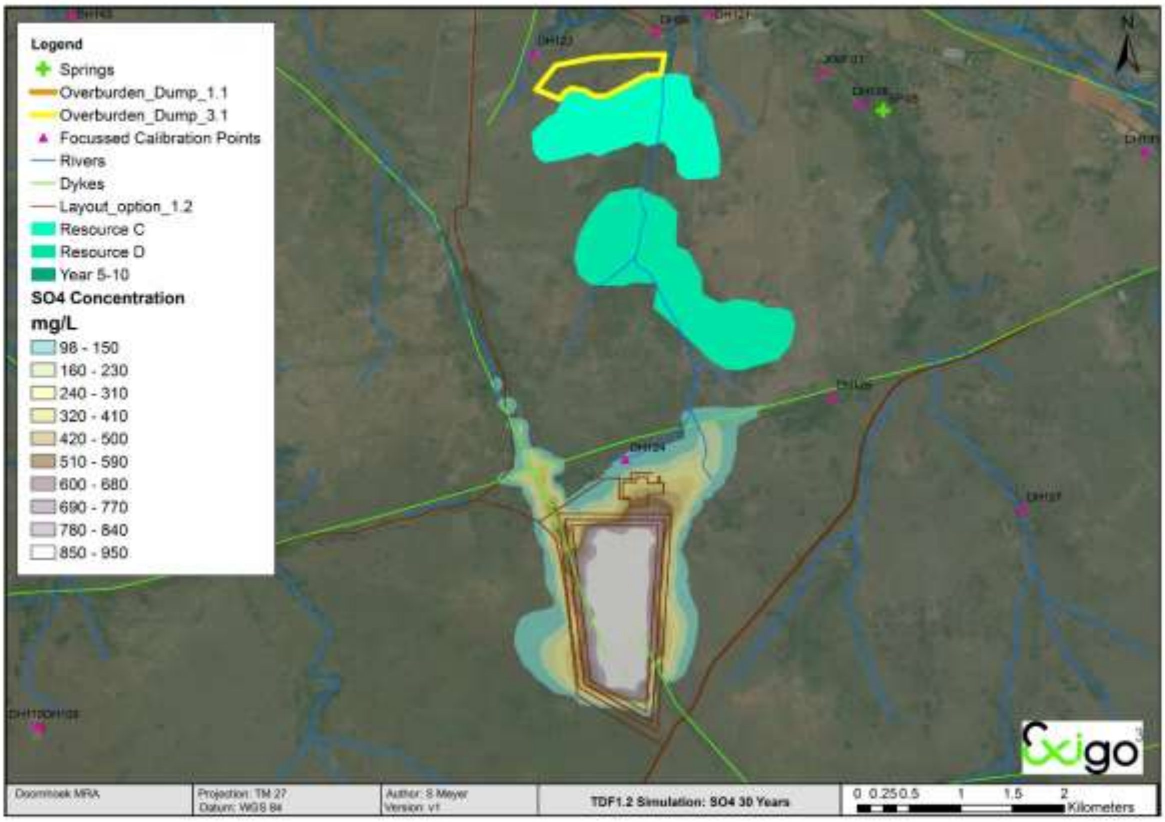

Figure 9-11 **SO4 simulated transport for TSF Option 1 (4)**

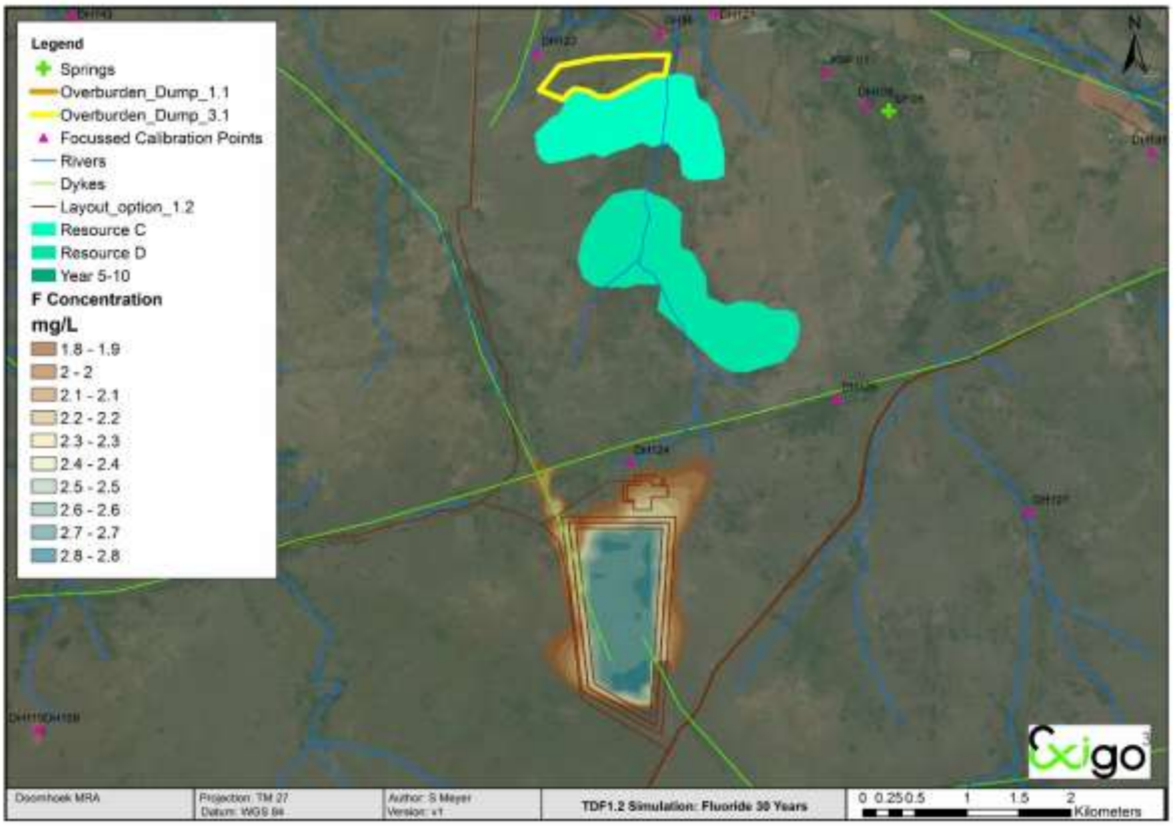

Figure 9-12 **F simulated transport for TSF Option 1 (4)**

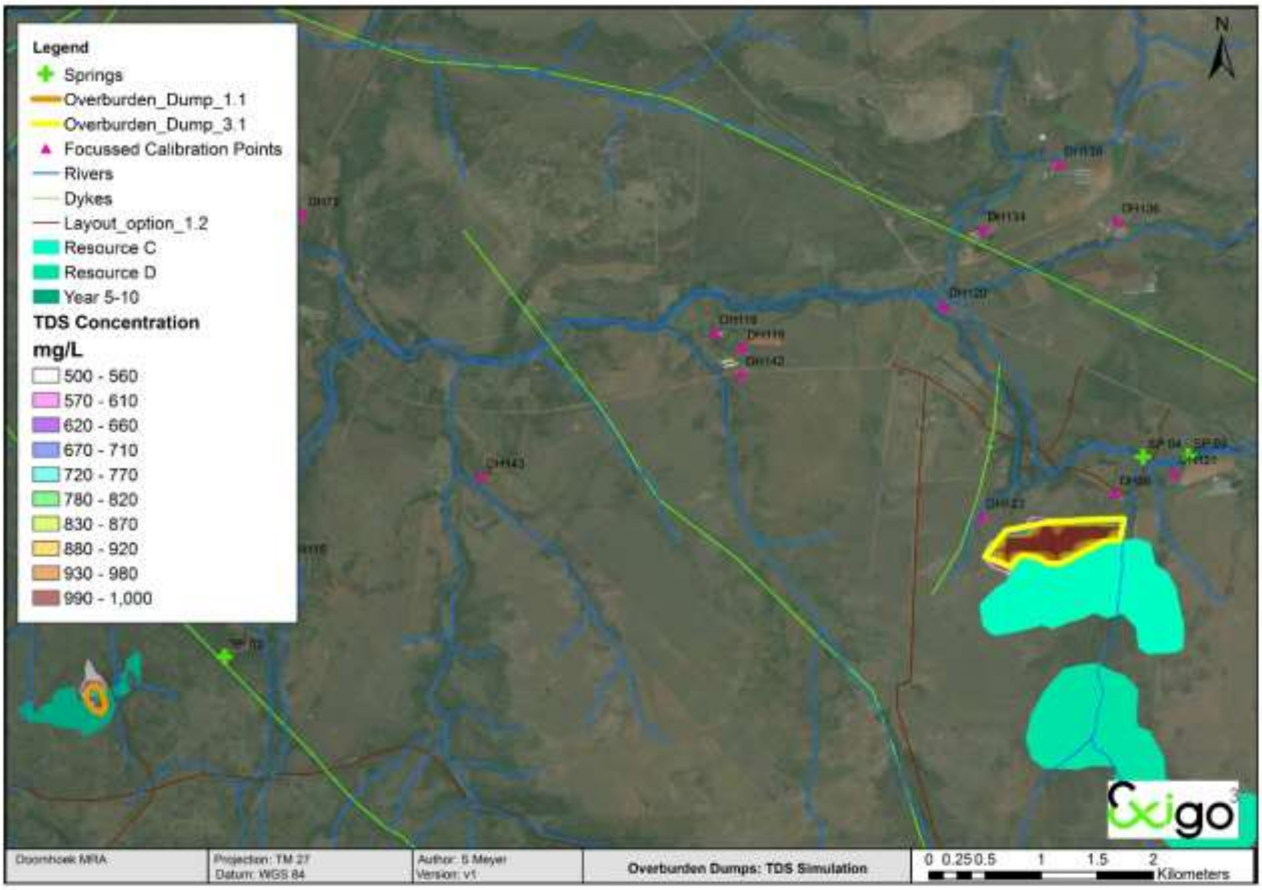

Figure 9-13 TDS simulated transport the overburden dumps

Monitoring points should be installed between the overburden dumps and the closest receptor i.e. the Klein Marico River. Again paired boreholes, both shallow and deep, should be drilled to monitor the perched and fractured aquifer flow.

9.1.10.3 Infrastructure alternatives

As part of the study, various alternatives for the placement of the TSF were supplied as shown in Figure 9-6. The preferred mine site layout and associated TSF position as shown in Layout Option 1 and 4 were analysed in the previous section. The mass transport associated with Option 2 and 3 are shown in Figure 9-14 and Figure 9-15. The migration of Option 2 shows that the ZOI associated with the open pits acts as mitigation to possible flow which is positive. The flow associated with Option 3 migrates to the east along the dyke contact (semi-impermeable) and along the surface water drainage. This is not preferable. A combination of Option 1 (4) and 2 would be preferred without any extension of the TSF into compartment 5.

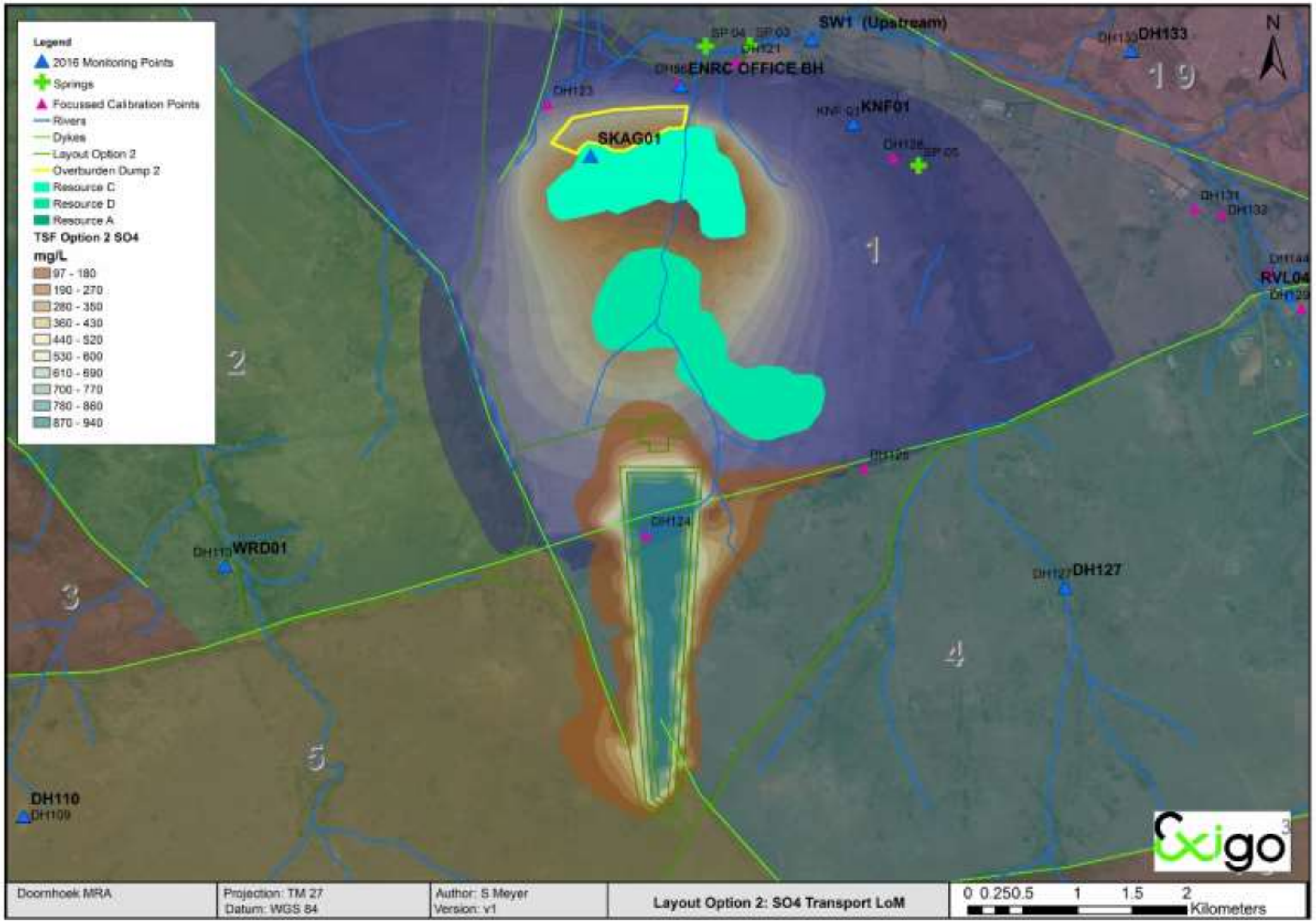

Figure 9-14 **SO4 simulated transport for TSF Option 2**

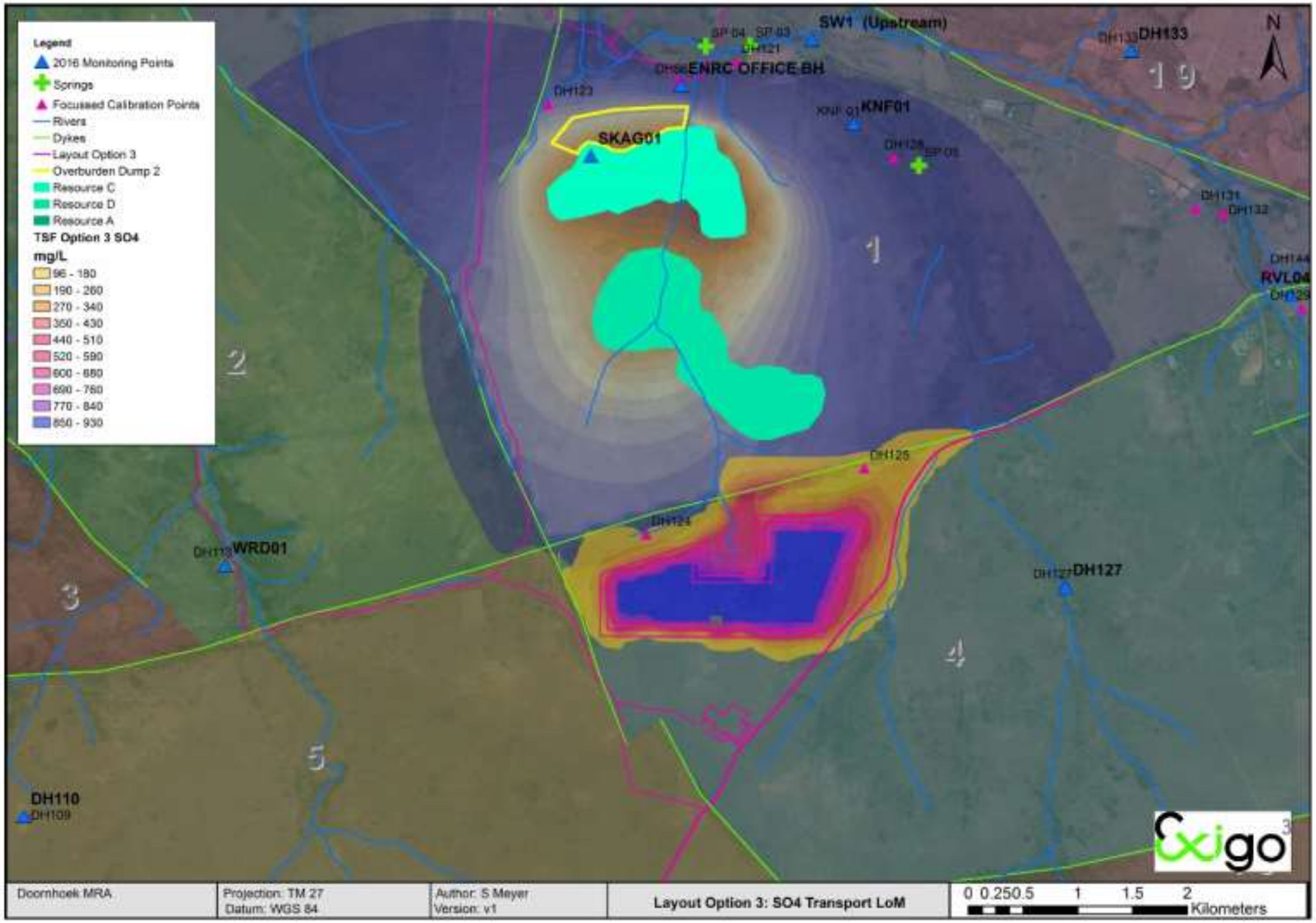

Figure 9-15 SO4 simulated transport for TSF Option 3

9.1.11 Surface water and groundwater balance: Summary and impacts

The steady state calibrated model indicated that 33 856 m³/d of recharge water flows into the groundwater catchment area due to infiltrating from precipitation. This annual recharge is averaged per day. This resultant flow is produced from a combination of recharge inflow; outflow as groundwater base flow, and from losses, such as evapotranspiration. The groundwater balance shown in Table 9-8 is derived from the total inflows (recharge) and the total outflows (base flow and losses).

Additionally, for Compartment 1 and 2 combined, the total volume of groundwater reporting as base flow to the Klein Marico River is approximately 527 m^3/d and the recharge is on these compartment correlate to 920 m^3/d.

For the steady state calibration, community abstraction from boreholes was included. The volumes are assumptions based on the application and should be verified, especially any water users in compartment 1 and 2.

The transients simulations indicated that mine dewatering, flow from the TSF and overburden dumps contribute -4190 m^3/d, 770 m^3/d and 150 m^3/d to the water balance respectively. Additional water supply removes 432 m^3/d from the water balance.

For compartment 1 and 2, the base flow to the Klein Marico River during the operational phase of the mining activities decreased to 327 m^3/d i.e. a difference of 200 m^3/d. Maximum simulated losses or leakage from the river to the proposed open pit equated to 877 m^3/d.

It is important to understand the possible link between the Klein Marico River and the local aquifer, the extent and the characteristics. Follow up studies should be conducted to refine the volumes possibly leaked from the Klein Marico River and quantify the loss in baseflow from compartment 1 to the Klein Marico River.

Table 9-8 Water balance evaluation for steady state calibration

Scenario 1: Pre-development steady state calibrated model				
	Component	**Inflow (m^3/d)**	**Outflow (m^3/d)**	**Balance (m^3/d)**
1	Recharge from precipitation:	33856	0	**33856**
2	Mine Dewatering	0	0	**0**
3	Abstraction: Community Boreholes	0	-2355	**-2355**
4	Abstraction: Possible Mine Supply	0	0	**0**
5	Recharge from TSF	0	0	**0**
6	Recharge from Overburden Dumps	0	0	**0**
7	Base flow and losses	0	-31502	**-31502**
8	Storage	0	0	**0**

Scenario 1: Pre-development steady state calibrated model				
	Component	**Inflow (m^3/d)**	**Outflow (m^3/d)**	**Balance (m^3/d)**
	Total	**33856**	**-33857**	**-1**
Balance Error (%)				**0.00%**

Table 9-9 Water balance evaluation for mine dewatering, water supply and mass transport

Scenario 2: Transient state mine dewatering, water supply and mass transport				
	Component	**Inflow (m^3/d)**	**Outflow (m^3/d)**	**Balance (m^3/d)**
1	Recharge from precipitation:	33856	0	**33856**
2	Mine Dewatering	0	-4190	**-4190**
3	Abstraction: Community Boreholes	0	-2355	**-2355**
4	Abstraction: Possible Mine Supply	0	-432	**-432**
5	Recharge from TDF	770	0	**770**
6	Recharge from Overburden Dumps	150	0	**150**
7	Base flow and losses	0	-30556	**-30556**
8	Storage	2450	0	**2450**
	Total	**37226**	**-37533**	**-307**
Balance Error (%)				**-0.82%**

9.1.12 Additional simulations required in follow up phases for impact assessment and mitigation measures

The closure impacts associated with the mine dewatering and infrastructure rehabilitation should be updated with detailed modelling once the closure plan has been finalised. The detailed modelling is dependent on the following:

1. Will the TSF and overburden dumps be reworked and/or rehabilitated to minimise the water balance.
2. The open pits will be partially backfilled. The closure plan should be optimised such that the open pits minimise the potential impact on the Klein Marico River (decreased ZOI) while still capturing and containing any possible migration of salts from the TSF and overburden dumps. Post closure pit flooding simulations should be conducted and included in the closure plan.
3. A dynamic integrated environmental water balance and salt balance to determine the impacts of the mine on the groundwater and surface water during the operational and post operational phases.
4. Detailed sustainability modelling, both analytical and numerical should be conducted once the water supply resources have been identified and developed.

5. The impact of alien vegetation eradication on the riparian zone along the Klein Marico River should be investigated. Detailed offset volumes should be determined and included in the Integrated Water Use License Application process.
6. Mine dewatering optimisation. Compartment 1 will be affected by mine dewatering caused by mining of the Recourse C and D open pits. Collecting the groundwater within the open pits with traditional sumps will expose the resource to evaporation losses and ultimately decrease the water available for affected IAPs and possible surplus water supply to the mining operations. Also, any water in contact with mining operations is classified as dirty or grey water and should be treated before discharging can take place. Installing a curtain of dewatering boreholes around the open pits would be the preferred option. The compartment will be pre-dewatered and the mining conditions will be dry i.e. a safer working environment. The water is classified as non-contact water and could be directly discharged back in the Klein Marico River (offset of possible impact by mine dewatering ZOI), supplied to IAPs or used in the mining process. These scenarios of sump collection and pre-dewatering should be assessed in detail in the follow-up phase of the hydrogeological study.
7. The possibility of sinkhole formation due to mine dewatering and reduction in pressure head in the dolomitic aquifer should be addressed. The hydrogeological investigation will form part of a detailed geotechnical investigation addressing this risk.

10 PUBLIC PARTICIPATION

The following process was undertaken to facilitate the public participation for the proposed project:

10.1 Newspaper Advertisement

An Advertisement, notifying the public of the submission of the Environmental Authorisation Application and the Mining Right Application (MRA) as well as the process to be followed; and requesting I&AP’s to register their comments with Exigo, was placed in both English and Afrikaans in a local newspaper (the Mahikeng Mail Newspaper was used due to the Zeerust News only being published monthly by the 29th which would not have allowed sufficient time for the 30 day commenting period on the Draft SR prior to the legally required submission of the Final SR) on the 15th of July 2016 in accordance with regulation 41(2)(c) and (d) of the EIA Regulations of 2014.

In addition the availability of the Draft Scoping Report (DSR) for public review as well as the Public Meeting held on the 28th of July 2015 was also advertised in the above advert.

10.2 Site notices

In order to inform surrounding communities and adjacent landowners of the proposed development, notice boards (in accordance with regulation 41(2)(a) of the EIA Regulations) was erected at key locations surrounding the project site and within the project area on the 15th of July 2016.

10.3 Direct Notification of Identified I&AP's

Identified stakeholders, who included the following sectors, were directly informed by post, email, fax or sms of the proposed development on the 8th of June 2016:

- The owners and occupiers of the site where the activity is or is to be undertaken or to any alternative site;
- The owners and occupiers of land adjacent to the site where the activity is or is to be undertaken or to any alternative site;
- Municipal Manager of the Ngaka Modiri Molema District Municipality (NMMDM);
- Municipal Manager of the Ramotshere Moiloa Local Municipality (RMLM);
- Municipal Manager of the Ditsobotla Local Municipality (DLM);
- Department of Rural, Environment and Agricultural Development, North West Province;
- Department of Water and Sanitation (DWS) Limpopo - North West Proto CMA;
- Department of Public Works and Roads North West;
- Department of Community Safety & Transport Management North West;
- Department of Finance, Economic & Enterprise Development North West;
- Department of Agriculture – North-West;
- Department of Rural Development and Land Reform (DRDLR);
- SANRAL (Northern region);
- South African Heritage Resources Agency (SAHRA) (North West);
- Regional Manager of Land Development and Environmental Management for ESKOM;
- AGRI North West;
- Afriforum;
- North West Farmers Union;
- Molemane Eye Nature Reserve;
- Witkop Fluorspar Mine;
- Mmutlwa Wa Noko Committee.

A notification with regards to the availability of the Draft Scoping Report (DSR) for public review as well as the Public Meeting held on the 28th of July 2016 was also sent to stakeholders on the 15th of July 2016.

10.4 Public Meetings

A Scoping Phase public meeting was held on the 28th of July 2016; to provide I&APs with the opportunity to raise issues and comments and ask specific questions in the presence of the relevant consultants on the project as well as explain the authorisation process and associated timelines. The public meeting was advertised in a local newspaper on the 15th of July 2016. An EIA Phase public meeting was held on 12 January 2017. All issues raised by the I&APs during the public meetings are included in Appendix 8.4: Public Meeting and Focus Group Meeting Minutes and Attendance

Registers.

10.5 Focus Group Meetings

Focus Group meetings (one on one consultation meetings and telephonic consultation) were held with specific landowners, as well as the relevant Government Departments in order to further ongoing consultations, as follows:

- Landowners who are directly affected by the activity (refer to Table 6 of the EIA&EMPR);
- Landowners directly adjacent to activity (refer to Table 6 of the EIA&EMPR);
- Ngaka Modiri Molema District Municipality (NMMDM);
- Ramotshere Moiloa Local Municipality (RMLM);
- Department of Mineral Resources (DMR);
- Department of Water and Sanitation (DWS);
- Mmutlwa Wa Noko Committee.

Please refer to the meeting minutes of the above focus group meetings as well as Table 6 of the EIA&EMPR for more details of the key issues discussed (refer to Appendix 8.4 of the EIA&EMPR).

10.6 Draft Scoping Report

The EIA Regulations specify that the Draft Scoping Report (DSR) must be subjected to a public participation process of at least 30 days. A period of 30 days (15 July till 15 August 2016) was made available for public comment on the DSR as part of the environmental impact assessment process. The availability of the DSR was announced via advert, site notices and notification letters as specified above to all the identified potential I&AP's.

In addition, the DSR was distributed for comment as follows:

- Electronic copies were made available on dropbox;
- Hard copies were made available at the relevant local municipalities (RMLM and DLM) as well as the public libraries in Zeerust and Lichtenburg; and
- Hard copies and electronic copies were made available upon request.

10.7 Final Scoping Report

The Draft Scoping Report (DSR) was updated after the draft review to incorporate the comments received and issues raised by I&APs. The Final Scoping Report (FSR) was submitted to the DMR on the 25th of August 2016.

10.8 Draft EIA&EMPR

This Draft EIA&EMPR was subjected to a public participation process of at least 30 days. A period of 30 days (5 December 2016 till 26 January 2017) was made available for public comment on the Draft EIA&EMPR as part of the environmental impact assessment process. The availability of the Draft EIA&EMPR was announced via notification letters as specified above to all the identified potential and registered I&APs.

In addition, the Draft EIA&EMPR was distributed for comment as follows:

- Electronic copies were made available on dropbox;
- Hard copies were made available at the relevant local municipalities (RMLM and DLM) as well as the public libraries in Zeerust and Lichtenburg; and
- Hard copies and electronic copies were made available upon request.

10.9 Final EIA&EMPR

The Final EIA&EMPR will be updated following the review of the Draft EIA&EMPR, to incorporate the comments received and issues raised by I&APs. The Final EIA&EMPR was submitted to the DMR on 6 February 2017.

11 INTEGRATED WATER AND WASTE MANAGEMENT PLAN (IWWMP)

11.1 Environmental objectives and goals

This Environmental Management system is based on the "best practicable environmental option (BPEO)" principle. Long term sustainability can only be achieved when taking into consideration the following essential principles, which have been taken into account in the drafting of the EMPR (Appendix C: Environmental Impact assessment and Environmental Management Programme Report (EIA&EMPR)):

- Compliance with environmental legislation
- Life-cycle approach
- Continual improvement
- Precautionary principle
- Site-specific considerations
- Consideration of temporal variability
- Risk based approach
- Public participation
- Management commitment

Within the context of the principles listed above, the long term sustainability objectives are:

- To avoid impacts by effective planning in order to prevent of limit possible impacts.
- To minimize impacts by implementing decisions or activities that are designed to reduce the undesirable impact on the physical, bio-physical and social aspects detailed in the previous chapters.
- Rectifying impacts by rehabilitating or restoring the affected environment.

11.2 Purpose and scope of the Environmental Management Program

To ensure a holistic framework for the management of the environmental impacts during the planning, construction, operation, decommissioning and closure of the mining development, the EMPR sets out general environmental requirements which are applicable to these phases of the project. The EMPR also contains a series of environmental specifications designed to avoid, minimise and ultimately manage the impacts of the project during all phases.

It must be noted that the EMPR is a working document that needs to be updated on a regular basis.

11.3 General Environmental Specifications

The environmental specifications following below are applicable to the design, construction and operational phases of the mining development.

11.4 Targets and objectives

The applicant shall establish detailed environmental objectives and targets during the planning phase to meet the commitments included in its environmental policy, the environmental specifications included in the planning, construction, operation, decommissioning and closure phases of the project and all legislative obligations and requirements included in the EA.

11.5 Auditing requirements

All environmental auditing and inspections required to monitor compliance with its obligations in terms of the EMPR, must be conducted at the different stages of the project.

Refer to section 37.11.6 of the EIA&EMPR for the auditing protocol.

11.6 Management review

Management is required to ensure management review of the EMPR during the operational phase to ensure its continuing suitability, adequacy and effectiveness. Management shall consider and review auditing reports and monitoring reports at reasonable intervals throughout the construction and operational phases. Management shall after reviewing the audit results, address the need for possible changes to policy, objectives and other elements of the EMPR and make recommendations for implementation, which should lead to continual improvement.

11.7 Emergency preparedness and response

The SHE (Safety, Health & Environment) representative shall compile and maintain environmental emergency procedures to deal with incidents and accidents, together with the appropriate response procedures, for application throughout the life cycle of the project. The emergency response procedures shall be drafted in accordance with international and national specifications for emergency preparedness and response and shall include but not be limited to accidents, fires, flooding, spillages etc.

The mine shall comply with the emergency preparedness and incident and accident reporting requirements of the Occupational Health and Safety Act 85 of 1993, the National Environmental Management Act, Act 107 of 1998, the National Water Act, Act 36 of 1998 and the National Veld and Forest Fire Act 101 of 1998 as amended and/or any other legislations relevant to the proposed project.

The mine shall be responsible for the implementation of the emergency preparedness and response procedure and shall ensure that all incidents and accident are recorded in an Environmental Incident Log. The log should be completed and all reports should be kept on file by the Environmental Manager as set out in the EMPR (Section 37.11.7 of the EIA&EMPR).

11.8 Incident (non-conformances) reporting and mitigating procedures

A procedure shall be compiled to deal with Incidents (non-conformances). The purpose of this procedure shall be to provide guidance to all employees and contractors as to their responsibilities to fellow employees and colleagues in terms of the identification and reporting of environmental non-conformances and incidents at the mine operations.

A "non-conformance" is interpreted to include legal non-compliance, deviations from policy, objectives and targets not achieved accidents, ineffective procedures, and deviations from specified conditions and from other requirements of the environmental management system.

This procedure shall be developed so as to provide guidance to ensure that:

- Danger to the environment, personnel, contractors and the non-employees is minimized.
- Legal liability is managed and minimized.
- Public relations are effectively managed during and following a non-conformance.
- Reporting is effective and corrective / follow-up actions are implemented.

Non-conformances are listed in four categories, as indicated below:

- Policy and Legal
  - environmental policy commitments not addressed or fulfilled
  - environmental policy not communicated to employees
  - environmental policy statement not available to the public
  - relevant environmental laws not identified, understood or complied with
  - pollution discharges that are prohibited or exceed permitted legal limits
- People and Communication
  - environmental responsibilities not defined, understood or exercised
  - inadequate authority delegated for effective control
  - environmental training needs not identified or planned
  - training not carried out or not effective

  - employees unaware of the environmental impacts and risks of their work
  - new employees ignored by the system.
- Systems and Documentation
  - no co-ordination - environmental objectives not reflecting policy commitments
  - no co-ordination - environmental actions not reflecting objectives
  - management programs not being reviewed to schedule
  - key documents unavailable, for example Operational Procedures
  - unauthorised amendments in controlled documents
  - obsolete documents available in operational areas
  - emergency plans not tested or reviewed
  - corrective actions signed-off, but found to be ineffective in practice
  - environmental records not maintained up-to-date
  - retention times of environmental records not recorded
  - internal auditing running behind schedule
  - managers unaware of internal audit findings
  - decisions of the Management Review not carried out
- Materials and Processes
  - major pollution event or pollution risk not identified or controlled
  - waste not controlled or segregated
  - major resource-use not identified or controlled
  - significance assessment of environmental aspects not based on risk factors
  - information on significant impacts or risks not kept up to date
  - environmental impact due to subcontractors not identified or controlled

Any non-conformance can be reported in the EMS database (Under Non-conformance and Incidents) or directly to the Environmental Department.

11.9 Typical environmental incidents

The following occurrences are classed as environmental incidents, amongst other:

- Spillages;

- Soil and water pollution.

Significant incidents (Level 4 or 5 Incidents: Table 11-1) must be reported within 24 hours of taking place to the responsible person (SHE manager). The SHE manager will then forward the incident on to the Environmental Manager (EM). The incident must be reported in the format stipulated in the SHE Manual.

An emergency incident must be reported within 24 hours by telephone or fax to the relevant government authorities.

11.10 Environmental awareness training

Management shall ensure that employees are adequately trained with regard to the implementation of the EMPR and environmental legal requirements and obligations. It is recommended that a training need analysis be conducted by a competent environmental training consultant to identify the appropriate environmental training programmes, and the appropriate target groups. Environmental training programmes shall be targeted at three distinct levels of employment i.e. the executive, middle management and labour. The training programmes shall contain the following information:

- The names, positions and responsibilities of the personnel to be trained
- The framework for appropriate training programmes
- The summarized content of each training course
- A schedule for the presentation of the training courses

Table 11-1 Classification of environmental incidents

Levels	Classifications	Comments
1	An incident that has caused negligible, reversible environmental impact, requiring very minor or no remediation.	Is an incident that has resulted in the breach of any environmental operational procedure or standard that may have a minor impact on the environmental eco system and has raised no concern from local stakeholders. (e.g. clean up can been rectified immediately)
2	An incident that has caused minor, reversible environmental impact, requiring minor remediation.	Is an incident that has resulted in the breach of any environmental operational procedure or standard that has a low impact on the environmental eco system and has raised concerns from local stakeholders. (e.g. clean up can been done in one day - i.e. 24 hours)

Levels	Classifications	Comments
3	An incident that has caused moderate, reversible environmental impact with short-term effect, requiring moderate remediation.	Is any incident that resulted in a breach of legal environmental requirements (legislation- non reportable) and/or operational procedures that has a medium impact on the eco system and/or that has caused attention, complaints by local or external stakeholders. (e.g. short term pollution - clean up can done within seven [7] days)
4	An incident that has caused serious environmental impact, with medium-term effect, requiring significant remediation.	Has the potential to become significant (Take National Environmental Management Act into consideration, section 28 to 30) Is any incident that resulted in a breach of legal environmental requirements (legislation - reportable) and/or operational procedures that has a high impact on the eco system and/or that has caused attention, complaints by local or national stakeholders. (e.g. short term pollution levels - where clean up may take up to one month)
5	An incident that has caused disastrous environmental impact, with long-term effect, requiring major remediation.	Significant Incident reports required. (Take National Environmental Management Act into consideration, section 28 to 30). Is any incident that resulted in a breach of legal environmental requirements (legislation - reportable) and/or operational procedures that has a significant impact on the eco system and/or that caused attention or complaints by local, national or international stakeholders and / or the press. (e.g. long term pollution - clean-up will take more than a month)

11.11 Record Keeping and Document Control

The mine shall be responsible to establish a procedure for document control in relation to its obligations towards compliance with Environmental Requirements. The document control procedure shall comply with the following requirements:

- Documents must be identifiable by division, function, activity and contact person
- Every document shall identify the personnel and their positions, who drafted and compiled the document, reviewed and recommended approval, and finally approved and signed off the document for distribution
- All documents shall be dated, provided with a revision number and reference number, organized and retained for a specific period
- The documents shall be reviewed periodically and revised where necessary

11.12 IWWMP Action Plan (Priority Actions and other short, medium and long term actions)

Environmental management priorities are based on addressing the most high-risk aspects first to reduce environmental risk. Once all aspects have been addressed to an acceptable risk level, optimization strategies can be investigated.

Table 11-2 IWWMP Action Plan

Objective	Target/actions	Responsibility	Timeframe	Monitoring
Comply with regulatory requirements	Receive all environmental authorisations and Water use licences prior to implementation	Environmental manager	2017 but dependant on DWS approval	IWUL audit
Comply with water quality variable	Monitor water up and downstream Avoid discharges into watercourses Minimise movement of possible contamination plumes by implementing monitoring boreholes Clean spillages up as soon as possible.	Environmental manager	Continual as per the monitoring commitments	Continual water quality monitoring
Monitor and determine amount of dewatering	Implement appropriate measuring devices to measure the amount of water abstracted, received and/or consumed	Environmental manager and Engineering department	To be determined during mining phase	Continually
Stormwater management (separating clean and dirty water)	Ensure (unless exemption is approved for certain aspects) compliance with GN704. Implement engineering designs in stormwater management reports Inspect stormwater channels and berms on a regular basis.	Engineering and Environmental department	Continually and prior to implementation of construction	Continue monthly inspections Plans to be audited every two years for GN704 compliance
Optimise water usage	Continually review and implement further options for water usage optimisation by means of regular water balance updates	Environmental manager and Engineering department	Continual	Continual water quantity monitoring

11.13 Management measures related to the EIR&EMPR

The management measures related to the EIR&EMPR are detailed in Table 24 and 24 in Appendix C: Environmental Impact assessment and Environmental Management Programme Report (EIA&EMPR) including specialist reports.

11.13.1 Assessment Methodology

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need. Assessment of impacts will be based on the Department of Environmental Affairs Guideline Document: EIA Regulations 2010. The significance of the aspects/impacts of the process will be rated by using a matrix derived from Plomp (2004) and adapted to some extent to fit this process. These matrixes use the consequence and the likelihood of the different aspects and associated impacts to determine the significance of the impacts.

The significance of the impacts will be determined through a synthesis of the criteria below:

Probability. This describes the likelihood of the impact actually occurring.

Improbable:	The possibility of the impact occurring is very low, due to the circumstances, design or experience.
Probable:	There is a probability that the impact will occur to the extent that provision must be made therefore.
Highly Probable:	It is most likely that the impact will occur at some stage of the development.
Definite:	The impact will take place regardless of any prevention plans, and there can only be relied on mitigatory actions or contingency plans to contain the effect.

Duration. The lifetime of the impact

Short term:	The impact will either disappear with mitigation or will be mitigated through natural processes in a time span shorter than any of the phases.
Medium term:	The impact will last up to the end of the phases, where after it will be negated.
Long term:	The impact will last for the entire operational phase of the project but will be mitigated by direct human action or by natural processes thereafter.
Permanent:	Impact that will be non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.

Scale. The physical and spatial size of the impact

Local:	The impacted area extends only as far as the activity, e.g. footprint

Site: The impact could affect the whole, or a measurable portion of the above mentioned properties.

Regional: The impact could affect the area including the neighbouring residential areas.

Magnitude/ Severity. Does the impact destroy the environment, or alter its function.

Low: The impact alters the affected environment in such a way that natural processes are not affected.

Medium: The affected environment is altered, but functions and processes continue in a modified way.

High: Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.

Significance. This is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required.

Negligible: The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.

Low: The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.

Moderate: The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision, and management intervention will be required.

High: The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation.

The following weights will be assigned to each attribute:

Aspect	Description	Weight
Probability	Improbable	1
	Probable	2
	Highly Probable	4
	Definite	5
Duration	Short term	1
	Medium term	3

	Long term	4
	Permanent	5
Scale	Local	1
	Site	2
	Regional	3
Magnitude/Severity	Low	2
	Medium	6
	High	8
Significance	Sum (Duration, Scale, Magnitude) x Probability	
	Negligible	<20
	Low	<40
	Moderate	<60
	High	>60

The significance of each activity will be rated without mitigation measures and with mitigation measures for both construction, operational and closure phases of the fluorspar mine development.

The mitigation effect of each impact will be indicated without and with mitigation measures as follows:

- can be reversed
- can be avoided, managed or mitigated
- may cause irreplaceable loss of resources

11.13.2 Impact Identification and significance rating

Construction is associated with the Construction Phase as well as the Operational Phase:

1. Construction Phase: All activities on site up to the start of operation, including initial site preparations.
2. Operational Phase: All activities including the operational and maintenance of the proposed development.

11.13.2.1 Planning Phase

a) Planning Phase Activities

1. Stakeholder engagement: aquifer testing arrangements.
2. Establishment and operation of construction camp.
3. Anthropogenic activities on site.

4. Fuelling and movement of construction vehicles.

b) Mitigation Measures

1. Monitor borehole yield and water level during pump test to prevent over-abstraction.
2. Chemical sanitary facilities to be used and situated down gradient from local drainage systems.
3. Best practise camp management and house-keeping principles to be implemented.
4. Fuelling of vehicles at earmarked concrete-lined areas. Fuel storage in bunded areas. Spill trays to be utilized where necessary. Include spectrum of hydrocarbon elements in monitoring program.

11.13.2.2 Construction Phase

The infrastructure proposed for the planned Doornhoek Fluorspar Mine during construction is:

- Access roads
- Processing Plant
- Supporting buildings
- Temporary construction camp
- Ablution facilities

a) Construction Phase Activities

1. Inadequate sanitary facilities and ablutions facilities can result in health risks and groundwater / surface water contamination.
2. Explosives will be used in the open pit clearing and development; this may contribute nitrates to the groundwater. Monitoring will confirm and quantify concentration and should be included in the monitoring protocol.
3. Activities during the construction phase can significantly increase the risk of surface water pollution. The areas cleared of vegetation and impacted on by excavation must be managed to prevent sedimentation of storm water channels. The location of stockpiled or excavated soil material must be done in such a way as to prevent siltation of drainage systems.
4. The construction camp must be adequately managed to avoid surface water contamination, which could result from littering or inadequate sanitation facilities.

Without mitigation measures the impact of construction related activities can be moderate to low without mitigation measures and negligible to low with mitigation measures.

b) Mitigation Measures

The following mitigation measures are recommended:

1. Construction should preferably take place during the dry season.
2. Adequate fuel containment facilities to be used during construction phase.
3. The use of all materials, fuels and chemicals which could potentially leach into underground water must be controlled.
4. All materials, fuels and chemicals must be stored in a specific and secured area to prevent pollution from spillages and leakages.
5. Construction vehicles and machines must be maintained properly to ensure that oil spillages are kept at a minimum.
6. Spill trays must be provided if refuelling of construction vehicles are done on site.
7. Chemical sanitary facilities must be provided for construction workers. Construction workers should only be allowed to use temporary chemical/ permanent toilets on the site. Chemical toilets shall not be within close proximity of the drainage system. Frequent maintenance should include removal without spillages.
8. No uncontrolled discharges from the construction camp shall be permitted.
9. Chemical storage areas should be sufficiently contained, and the use of chemical should be controlled.
10. The removed soil and vegetation should be replaced once construction is complete and the pipeline cavities filled in and re-vegetated where possible.
11. Real time monitoring should be installed in equipped boreholes and monthly monitoring should be conducted on water levels measurements, groundwater quality and isotope and hydro chemical fingerprinting to establish origin of groundwater if abstracted close to Klein Marico River.

11.13.2.3 Operational Phase

a) Mine dewatering, water supply and mass transport

The simulated drawdown due to mine dewatering is shown in Figure 9-10 and the potential migration of salts associated with the TSF and overburden dumps are shown in Figure 9-11, Figure 9-12 and Figure 9-13.

1. A radius of influence is associated with the mine dewatering during LoM which could impact neighbouring groundwater users and sensitive receptors i.e. springs and the Klein Marico River. Mine dewatering is a function of time and hydraulic parameters, and thus the numerical flow modelling is a management tool that should be used for decision making.

2. The simulation showed that the average dewatering rates are approximately 4000 m^3/d with possible peak inflows to the end of the 30 year Life of Mine of above 7000 m^3/d for Resource C & D. Depending on the method of abstraction i.e. sumps versus pre-dewatering, the mine dewatering volumes could be as much as 50% less due to evaporation losses.
3. The overburden dumps plumes shows little migration due to the position of these facilities with regards to the zone of influence and position relative to the open pits i.e. the facility is located within the ZOI and hence shows little migration. Adequate monitoring should be conducted around the overburden dumps to assess possible flow in the unsaturated zone beneath the dumps.
4. The migration of salts form the TSF should be monitored. Plume migration might flow across compartment boundaries and adequate monitoring should be installed to detect and manage.
5. Depletion of the groundwater in the aquifer and related compartment due to the proposed open pit mining dewatering.
6. Possible inflow from the Klein Marico River into the open pit mine. Water collected in the open pit mine (or dewatering wells) should be sampled and tested with hydrochemical and isotope finger printing monthly to verify the origin. If the origin is established to be from the Klein Marico River, the water should be treated to an acceptable quality and discharged back into the Klein Marico River. If it is confirmed that the water seepage into the open pit mine is a diluted combination between surface water from the Klein Marico River and groundwater, then the dilution ratios should be calculated and the surface water quantities should be released back into the river. The groundwater component should be licensed and could be used in the mine circuit if the license is granted.
7. Contamination of surface and groundwater quality due to contaminated storm water run-off which originates from the proposed TSF and overburden dumps as well as the process plant site.
8. Increased erosion and silt loading of surface water bodies
9. Contamination of groundwater sources due to dewatering by the open pit mines.
10. Change in local drainage patterns and hence flow regimes.
11. Possible groundwater seepage from the TSF and overburden dumps along the hydraulic head gradient of the groundwater regime below this facility.
12. Depletion of groundwater levels due to over abstraction from water supply boreholes

identified as sustainable water supply boreholes.

13. In-adequate groundwater and water supply management i.e. failure to comply with monitoring protocol and not adhering to sustainable abstraction from water supply boreholes.
14. Additional water supply boreholes should be drilled to supplement the current wellfield to supply in the majority of mines water demand. Additional sources of groundwater should be identified and explored in the future to supply the required make up water demand.
15. Vandalism of water supply infrastructure due to inadequate protection.

b) Mitigation Measures

1. The radius of influence should be monitored with local and regional water level measurements monthly. Substitute water should be supplied if it's found and proven that neighbouring water levels and yields are affected.
2. Detailed geophysics between the open pits and the Klein Marico River should be conducted to map possible preferential flow paths connecting the open pit and the river. Drilling and long term aquifer testing should be conducted as well as ongoing monitoring with isotope analyses and finger printing to establish the source of the dewatered volumes.
3. Inclined packer testing could be conducted below the Klein Marico River to assess the possible inflows into the open pit mine associated with a possible structure along the Klein Marico River. The groundwater flow model should be updated accordingly.
4. Long duration aquifer tests should be conducted on any newly drilled water supply, monitoring and/or seepage capturing boreholes drilled during the LoM.
5. On-going monthly isotope analyses should be conducted on the water supply boreholes as well as the water captured in the open pit mine to confirm the origin of the water in comparison to the surface water from the Klein Marico River.
6. The groundwater flow model should be updated every two years or as soon as additional groundwater exploration and/or monitoring data becomes available.
7. Water seeping into the open pit mine should be directed into a sump and pumped to surface. Real time monitoring should be implemented to record the volumes pumped from the open pit mine.
8. Water pumped from the open pit mine should be pumped into a dirty water system and should not be allowed to enter any clean water system, natural drainage line, or

the aquifer.

9. Storm water from the TSF and overburden dumps should be contained in a process water dam and included in a closed dirty water system
10. The pipeline should be properly maintained and inspected at regular intervals for the early detection of leakages, malfunctioning and acts of vandalism.
11. Pipeline construction at river crossings and in flood lines should be adequate to withstand flood conditions.
12. The pipeline should be visible and/ or marked to prevent damage to pipeline.
13. The pipeline and related infrastructure should be designed to minimise evaporation and transmission losses.
14. Pressure gauges should be installed at the pipeline for the early detection of pressure loss that may indicate leakages.
15. Monthly visual checks for damp areas around borehole equipment and pipeline.
16. Communities and IAPs should be consulted before construction of the pipeline. Significant issues would be permission to build the pipeline and education about the pipeline.
17. Boreholes and related equipment should be in a fenced in area in a locked pump house for protection against theft and vandalism.
18. Communities should be consulted in advance about the potential lowering of water levels in their boreholes.
19. Groundwater levels should be monitored in all pumping wells throughout.
20. Groundwater levels should be monitored at all monitoring boreholes.
21. A monitoring program must be implemented and honoured.
22. All water retention structures, including process water dams; dirty water dams, etc. should be constructed to have adequate freeboard to be able to contain water from 1:50 year rain events.
23. Monitoring points of surface water features should be identified and monitored.
24. Groundwater and surface water quality information should be determined by sampling the surface water containment water (from the GN704 storm water management system) and monitoring boreholes located upstream and downstream of the mining and infrastructure.
25. Flow measurements in the Klein Marico River should be taken upstream and

downstream of the mine site. The flow measures should be recorded on ongoing basis to monitor possible impacts and flow reductions caused by the mine dewatering. Alien vegetation eradication should be implemented to off-set the possible flow reduction and increase the water balance of the local catchment.

11.13.2.4 Post Operational Phase

a) Mine re-watering, radius of influence and seepage from the TSF

1. Increased groundwater ingress at disturbed/rehabilitated areas.
2. Migration of contamination plume from mine contamination sources.
3. Post-closure pit flooding and acidification.
4. Permanent radius of influence due to mine dewatering
5. Sulphate and Fluoride leaching from the TDF
6. Increased TDS / Nitrate leaching from the overburden dumps

The groundwater levels could take a substantial time to recover post operations and this should be confirmed with monitoring for at least 12 months post closure.

b) Mitigation Measures

1. Rehabilitate the TSF to limit ingress and recharge to these facilities and minimise potential leaching into the groundwater
2. Monitoring of water quality in the neighbouring boreholes and monitoring boreholes drilled for that purpose should continue quarterly post closure for at least 12 months.
3. The radius of influence due to mining will decrease; however, a permanent radius of influence could exist. Affected groundwater users should be compensated.
4. Simulate post closure geochemical leaching
5. Monitoring of groundwater upstream and downstream of the mine overburden dump facilities should be continued. Provision for this should be made in the rehabilitation budget.
6. Monitoring of surface water features upstream and downstream of the mine should be continued. Provision for this should be made in the rehabilitation budget.

11.13.2.5 General Mitigation measures

A management plan should be compiled and implemented at the mine. A monitoring protocol is included in section 37.11 and Table 27 of the EIA&EMPR.

11.13.3 Impact Assessment Ratings

Below are the impact assessment ratings for the proposed Doornhoek Fluorspar Mine development, refer to Table 11-3

Table 11-3 Impact Assessment Matrix

No	Activity	Impact	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude	
	Ecology														
Planning Phase															
1	Eradication of protected trees / flora through permit applications	Eradication of protected trees	WOM	Negative	Definite	5	Short term	1	Local	1	Low	2	20	Negligible	Can be avoided, managed or mitigated
			WM	Negative	Highly Probable	4	Short term	1	Local	1	Low	2	16	Negligible	Can be reversed
Construction Phase															
2	Clearing of vegetation for open pit, construction of infrastructure, access roads etc. causing direct habitat destruction / fragmentation	Habitat destruction / fragmentation of fauna habitats (Refer to Figure 67 to Figure 68 of the EIA&EMPR).	WOM	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Local	1	High	8	65	High	Can be avoided, managed or mitigated
3	Topsoil & subsoil stripping, exposure of soils, ore and rock to wind and rain during	Soil erosion and sedimentation	WOM	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Local	1	Medium	6	44	Moderate	Can be avoided, managed or mitigated

	construction causing erosion and sedimentation														
4	Vegetation clearing / vehicle movement	Spreading and establishment of alien invasive species	WOM	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low	Can be reversed
5	Vegetation clearing / vehicle movement	Habitat degradation due to dust	WOM	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Site	2	Medium	6	60	Moderate	Can be reversed
6	Heavy machinery and vehicle movement on site	Spillages of harmful substances	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be reversed
7	Heavy machinery and vehicle movement on site; construction of infrastructure, roads etc.	Road mortalities of fauna / impact of human activities on site	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be avoided, managed or mitigated
Operational Phase															
8	Storage of tailings, laydown areas of overburden dumps and stockpiles	Habitat destruction / fragmentation of fauna habitats (Refer to Figure 67 to 68 of the EIA&EMPR).	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Site	2	High	8	70	High	Can be avoided, managed or mitigated
9	Increased hardened surfaces around infrastructure and exposed areas	Soil erosion and sedimentation	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Can be avoided, managed or mitigated

	around open pits, laydown areas of overburden dumps and stockpiles as well as TSF														
10	Heavy machinery and vehicle movement on site	Spreading and establishment of alien invasive species	WOM	Negative	Highly Probable	4	Permanent	5	Site	2	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low	Can be reversed
11	Heavy machinery and vehicle movement on site	Habitat degradation due to dust	WOM	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Medium term	3	Site	2	Medium	6	55	Moderate	Can be reversed
12	Heavy machinery and vehicle movement on site	Spillages of harmful substances	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be reversed
13	Heavy machinery and vehicle movement on site; workers accommodated on site causing poaching, wood collection, fires etc.	Road mortalities of fauna / impact of human activities on site	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be avoided, managed or mitigated
Closure and Decommissioning Phase															
14	Rehabilitation of mining site	Improvement of habitat through revegetation / succession over time	WOM	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low	Can be avoided, managed or mitigated
			WM	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate	Can be reversed
15	Demolition of mining	Soil erosion and	WOM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	May cause irreplaceable loss of resources

	infrastructure / Cessation of mining / rehabilitation of mining site	sedimentation	WM	Negative	Probable	2	Medium term	3	Local	1	Low	2	12	Negligible	Can be avoided, managed or mitigated
16	Demolition of mining infrastructure / Cessation of mining / rehabilitation of mining site	Spreading and establishment of alien invasive species	WOM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be reversed
17	Demolition of mining infrastructure / Cessation of mining / rehabilitation of mining site / vehicle movement on site	Habitat degradation due to dust	WOM	Negative	Highly Probable	4	Long term	4	Site	2	High	8	56	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	Can be reversed
18	Heavy machinery and vehicle movement on site	Spillages of harmful substances	WOM	Negative	Highly Probable	4	Medium term	3	Regional	3	Medium	6	48	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Site	2	Low	2	10	Negligible	Can be avoided, managed or mitigated
19	Heavy machinery and vehicle movement on site	Road mortalities of fauna / impact of human activities on site	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be avoided, managed or mitigated
Post-Closure Phase															
20	Natural Successional processes	Improvement of habitat through revegetation / succession	WOM	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low	Can be avoided, managed or mitigated
			WM	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate	Can be reversed

		over time												
21	Exposed surfaces / unrehabilitated areas on site post closure / poor monitoring during LoM	Soil erosion and sedimentation	WOM	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated
22	Exposed surfaces / poor monitoring of revegetation on site	Spreading and establishment of alien invasive species	WOM	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated
Wetlands															
Planning Phase															
23	Obtaining of IWUL for crossings and mining through water courses / wetlands	Delay of mining onset	WOM	Negative	Definite	5	Short term	1	Local	1	High	8	50	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Highly Probable	4	Short term	1	Local	1	Medium	6	32	Low	Can be reversed
Construction Phase															
24	Clearing of vegetation for open pit through wetlands and water courses as well as road crossings	Wetland and watercourse destruction / fragmentation of wetland habitats (refer to Figure 69 to 70 of the EIA&EMPR)	WOM	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Local	1	High	8	65	High	Can be avoided, managed or mitigated
25	Clearing of vegetation for open pit through wetlands and	Impediment of flow patterns	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Site	2	High	8	70	High	Can be avoided, managed or

	water courses as well as road crossings														mitigated
26	Topsoil & subsoil stripping, exposure of soils, ore and rock to wind and rain during construction causing erosion and sedimentation in wetlands	Soil erosion and sedimentation	WOM	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Local	1	Medium	6	44	Moderate	Can be avoided, managed or mitigated
27	Vegetation clearing / vehicle movement	Spreading and establishment of alien invasive species in wetlands	WOM	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low	Can be reversed
28	Heavy machinery and vehicle movement on site	Spillages of harmful substances	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be reversed
Operational Phase															
29	Opencast mining	Dewatering of wetlands causing direct habitat loss / destruction	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Site	2	High	8	70	High	Can be avoided, managed or mitigated
30	Increased hardened surfaces around infrastructure and exposed areas around open pits, laydown areas of overburden dumps and stockpiles as	Soil erosion and sedimentation in wetland / water courses	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Can be avoided, managed or mitigated

	well as TSF, road crossings														
31	Heavy machinery and vehicle movement on site	Spreading and establishment of alien invasive species in wetlands	WOM	Negative	Highly Probable	4	Permanent	5	Site	2	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low	Can be reversed
32	Heavy machinery and vehicle movement on site	Spillages of harmful substances leading to water pollution in wetlands	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be reversed
Closure and Decommissioning Phase															
33	Rehabilitation of mining site	Improvement of wetland habitat through revegetation / succession over time	WOM	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low	Can be avoided, managed or mitigated
			WM	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate	Can be reversed
34	Demolition of mining infrastructure / cessation of mining / rehabilitation of mining site	Soil erosion and sedimentation in wetlands	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be avoided, managed or mitigated
35	Demolition of mining infrastructure / cessation of mining / rehabilitation of mining site	Spreading and establishment of alien invasive species in wetlands	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be reversed

36	Heavy machinery and vehicle movement on site	Spillages of harmful substances	WOM	Negative	Highly Probable	4	Medium term	3	Regional	3	Medium	6	48	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Site	2	Low	2	10	Negligible	Can be avoided, managed or mitigated
Post-Closure Phase															
37	Natural Successional processes	Improvement of wetland habitat at crossings through revegetation / succession over time	WOM	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low	Can be avoided, managed or mitigated
			WM	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate	Can be reversed
38	Exposed surfaces / unrehabilitated areas on site post closure / poor monitoring during LoM	Soil erosion and sedimentation	WOM	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated
39	Exposed surfaces / poor monitoring of revegetation on site	Spreading and establishment of alien invasive species	WOM	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated
Geochemical / Waste Classification															
Operational Phase															
70	Disposal of tailings on tailings facility	Development of acid mine drainage conditions	WOM	Negative	Improbable	1	Long term	4	Regional	3	High	8	15	Negligible	
			WM	Negative	Improbable	1	Long term	4	Site	2	High	8	14	Negligible	
71	Disposal of tailings on tailings facility	Contamination of	WOM	Negative	Improbable	1	Long term	4	Regional	3	High	8	15	Negligible	

		groundwater, surface water and soil by metals and metalloids	WM	Negative	Improbable	1	Long term	4	Site	2	High	8	14	Negligible	
72	Disposal of tailings on tailings facility	Contamination of groundwater, surface water and soil by sulphate and fluoride	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Long term	4	Site	2	Medium	6	12	Negligible	
73	Disposal of tailings on tailings facility	Contamination of groundwater, surface water and soil by nitrate	WOM	Negative	Highly Probable	4	Short term	1	Site	2	Medium	6	36	Low	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Short term	1	Site	2	Low	2	5	Negligible	
74	Disposal of overburden onto overburden dump facility	Contamination of groundwater, surface water and soil by metals and metalloids	WOM	Negative	Improbable	1	Long term	4	Regional	3	High	8	15	Negligible	
			WM	Negative	Improbable	1	Long term	4	Site	2	High	8	14	Negligible	
75	Disposal of overburden onto overburden dump facility	Contamination of groundwater, surface water and soil by sulphate and fluoride	WOM	Negative	Improbable	1	Long term	4	Regional	3	High	8	15	Negligible	
			WM	Negative	Improbable	1	Long term	4	Site	2	High	8	14	Negligible	
76	Disposal of overburden onto overburden dump facility	Contamination of groundwater, surface water and soil by nitrate	WOM	Negative	Highly Probable	4	Short term	1	Regional	3	Medium	6	40	Low	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Short term	1	Site	2	Medium	6	9	Negligible	

Post-Closure Phase															
77	Disposal of tailings on tailings facility	Development of acid mine drainage conditions	WOM	Negative	Improbable	1	Long term	4	Regional	3	High	8	15	Negligible	
			WM	Negative	Improbable	1	Long term	4	Site	2	High	8	14	Negligible	
78	Disposal of tailings on tailings facility	Contamination of groundwater, surface water and soil by metals and metalloids	WOM	Negative	Improbable	1	Long term	4	Regional	3	High	8	15	Negligible	
			WM	Negative	Improbable	1	Long term	4	Site	2	High	8	14	Negligible	
79	Disposal of tailings on tailings facility	Contamination of groundwater, surface water and soil by sulphate and fluoride	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Long term	4	Site	2	Medium	6	12	Negligible	
80	Disposal of tailings on tailings facility	Contamination of groundwater, surface water and soil by nitrate	WOM	Negative	Highly Probable	4	Short term	1	Site	2	Medium	6	36	Low	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Short term	1	Site	2	Low	2	5	Negligible	
81	Disposal of overburden onto overburden dump facility	Contamination of groundwater, surface water and soil by metals and metalloids	WOM	Negative	Improbable	1	Long term	4	Regional	3	High	8	15	Negligible	
			WM	Negative	Improbable	1	Long term	4	Site	2	High	8	14	Negligible	
82	Disposal of overburden onto overburden dump facility	Contamination of groundwater, surface water and soil by sulphate and	WOM	Negative	Improbable	1	Long term	4	Regional	3	High	8	15	Negligible	
			WM	Negative	Improbable	1	Long term	4	Site	2	High	8	14	Negligible	

		fluoride													
83	Disposal of overburden onto overburden dump facility	Contamination of groundwater, surface water and soil by nitrate	WOM	Negative	Highly Probable	4	Short term	1	Regional	3	Medium	6	40	Low	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Short term	1	Site	2	Medium	6	9	Negligible	
	Hydrogeology														
Planning Phase															
166	Stakeholder engagement: aquifer testing arrangements.	Lowering of local water levels caused by pump testing	**WOM**	Negative	Highly Probable	4	Short term	1	Local	1	Medium	6	32	Low	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	
167	Establishment and operation of construction camp.	Groundwater and surface water contamination	**WOM**	Negative	Highly Probable	4	Short term	1	Site	2	Medium	6	36	Low	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Short term	1	Site	2	Low	2	10	Negligible	
168	Anthropogenic activities on site.	Contamination risk	**WOM**	Negative	Highly Probable	4	Short term	1	Site	2	Medium	6	36	Low	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Short term	1	Site	2	Low	2	10	Negligible	
169	Fuelling and movement of construction vehicles.	Risk of hydrocarbon spillage and contamination	**WOM**	Negative	Highly Probable	4	Long term	4	Site	2	High	8	56	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	
Construction Phase															
170	Oil, grease and diesel spillages from construction vehicles	Contamination risk	**WOM**	Negative	Highly Probable	4	Short term	1	Site	2	Medium	6	36	Low	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	
171	Pollution of groundwater due	Deterioration of	**WOM**	Negative	Highly Probable	4	Short term	1	Site	2	Medium	6	36	Low	Can be avoided, managed or mitigated

	to sanitation facilities	groundwater quality	**WM**	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	
172	Ground and surface water pollution due to storage of chemicals and building materials	Deterioration of groundwater and surface quality	**WOM**	Negative	Highly Probable	4	Short term	1	Site	2	Medium	6	36	Low	
			WM	Negative	Improbable	1	Short term	1	Local	1	Medium	6	8	Negligible	Can be avoided, managed or mitigated
173	Spillages from diesel (fuel storage) facilities	Deterioration of groundwater and surface quality	**WOM**	Negative	Highly Probable	4	Short term	1	Site	2	Medium	6	36	Low	
			WM	Negative	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	Can be avoided, managed or mitigated
Operational Phase															
174	Dewatering zone of influence.	Lowering of regional groundwater levels (refer to Figure 88 of the EIA&EMPR)	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	
			WM	Negative	Probable	2	Long term	4	Regional	3	High	8	30	Low	Can be avoided, managed or mitigated
175	Contaminant leaching from mine waste facilities.	Groundwater and surface water contamination (Figure 91 of the EIA&EMPR)	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	
			WM	Negative	Probable	2	Medium term	3	Regional	3	Medium	6	24	Low	Can be avoided, managed or mitigated
176	Use of explosives for mine pit development.	Contribution to nitrate over-load in groundwater and surface water resources	**WOM**	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	
			WM	Negative	Highly Probable	4	Medium term	3	Site	2	Low	2	28	Low	Can be avoided, managed or mitigated
177	Hydrocarbon spillages from fuel	Hydrocarbon contamination	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	High	8	60	Moderate	Can be avoided, managed or mitigated

	storage facilities, fuelling and wash-bays.	of groundwater and surface water resources	**WM**	Negative	Probable	2	Long term	4	Site	2	Medium	6	24	Low	
178	Flooding of the open pit	Unsafe working conditions	**WOM**	Negative	Improbable	1	Long term	4	Site	2	Medium	6	12	Negligible	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Short term	1	Site	2	Low	2	5	Negligible	
179	Pollution of groundwater due to sanitation facilities	Deterioration of groundwater quality	**WOM**	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Short term	1	Site	2	Low	2	5	Negligible	
180	Seepage from overburden dumps	Deterioration of groundwater quality (Figure 91 of the EIA&EMPR)	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	High	8	60	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	
181	Sulphate and Fluoride leaching from the TSF	Deterioration of groundwater quality (Figure 89 to 90 of the EIA&EMPR)	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	High	8	60	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	
182	Increased TDS / Nitrate leaching from the overburden dumps	Deterioration of groundwater quality (Figure 91 of the EIA&EMPR)	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	High	8	60	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	
183	Dewatering: Water from the Klein Marico into the	Depletion of surface water resource	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	High	8	60	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Medium	3	Regional	3	Medium	6	24	Low	

	open pit	(Figure 88 of the EIA&EMPR)					term								
184	Dewatering: Spring flow affected	Deterioration of spring flow quantity (Figure 88 of the EIA&EMPR)	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Regional	3	High	8	30	Low	
185	Water losses: leaking pipes	Insufficient maintenance and increase in water use	**WOM**	Negative	Probable	2	Medium term	3	Site	2	High	8	26	Low	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	
186	Water Losses: Transmission losses and evaporation	Insufficient maintenance and increase in water use	**WOM**	Negative	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	Can be avoided, managed or mitigated
			WM	Negative	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	
187	Dewatering: Depletion of water levels in boreholes due to over pumping - Higher than recommended yield	Depletion of groundwater resource, impact on neighbouring users (Figure 88 of the EIA&EMPR)	**WOM**	Negative	Probable	2	Long term	4	Regional	3	High	8	30	Low	Can be reversed
			WM	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	
188	Dewatering: Depletion of water levels in boreholes due to over pumping - Longer than recommended pumping time	Depletion of groundwater resource, impact on neighbouring users (Figure 88 of the EIA&EMPR)	**WOM**	Negative	Probable	2	Long term	4	Regional	3	High	8	30	Low	Can be reversed
			WM	Negative	Improbable	1	Medium term	3	Site	2	Medium	6	11	Negligible	
189	Dewatering: Depletion of community water supply boreholes	Depletion of groundwater resource, impact on	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	Can be reversed
			WM	Negative	Highly Probable	4	Medium term	3	Regional	3	Medium	6	48	Moderate	

	due to dewatering	neighbouring users (Figure 88 of the EIA&EMPR)													
Post-Closure Phase															
190	Increased groundwater ingress at disturbed/rehabilitated areas	Potential decanting of groundwater at low elevation areas.	**WOM**	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	
191	Migration of contamination plume from mine contamination sources	Contamination of regional groundwater and surface water resources.	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Long term	4	Regional	3	Low	2	18	Negligible	
192	Post-closure pit flooding and acidification	Negative impact on regional groundwater resources.	**WOM**	Negative	Probable	2	Long term	4	Local	1	Medium	6	22	Low	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	
193	Permanent radius of influence due to mine dewatering	Depletion of groundwater resource, impact on neighbouring users (Figure 88 of the EIA&EMPR)	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Regional	3	Medium	6	24	Low	
194	Sulphate and Fluoride leaching from the TSF	Deterioration of groundwater quality (Figure 89 to 90 of the EIA&EMPR)	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	
19	Increased TDS /	Deterioration	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Can be avoided, managed or

5	Nitrate leaching from the overburden dumps	of groundwater quality (Figure 91 of the EIA&EMPR)	**WM**	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	mitigated
Aquatic															
Planning Phase															
196	Potentially poor planning leading to extensive dirty water areas which need to be managed which may reduce the mean annual run-off (MAR) to the non-perennial drainage systems in the area.	Loss of instream flow	**WOM**	Negative	Probable	2	Permanent	5	Regional	3	High	8	32	Low	May cause irreplaceable loss of resources
			WM	Positive	Improbable	1	Long term	4	Site	2	Medium	6	12	Negligible	Can be avoided, managed or mitigated
197	Stormwater designs leading to rapid release of water which in turn may lead to a loss of streamflow regulation capabilities in the area	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	Medium	6	52	Moderate	Can be reversed
			WM	Negative	Probable	2	Long term	4	Local	1	Medium	6	22	Low	Can be avoided, managed or mitigated
198	Use of surface runoff and groundwater sources for the supply of production water for the mining	Loss of instream flow	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Medium	6	24	Low	Can be avoided, managed or mitigated

	project may alter the flow in the receiving systems														
199	Use of layout option 2 may impact on the instream flow of the receiving systems.	Loss of instream flow	**WOM**	Negative	Definite	5	Long term	4	Site	2	High	8	70	High	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Short term	1	Local	1	Low	2	4	Negligible	Can be avoided, managed or mitigated
200	Potentially poor planning leading to extensive and complex dirty water areas which need to be managed may impact on water quality.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Permanent	5	Regional	3	Medium	6	28	Low	Can be avoided, managed or mitigated
201	Potentially poor planning leading to placement of polluting structures in non-perennial drainage lines which would increase mobility of pollutants and may impact on water quality.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	Can be reversed
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
202	Potentially inadequate separation of clean and dirty water areas leading to contaminated water leaving the defined dirty water area may impact	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Medium	6	24	Low	Can be avoided, managed or mitigated

	in water quality.														
203	Clean and dirty water systems not being designed adequately to ensure protection of the water resources.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
204	Potentially poor planning leading to the placement of infrastructure within non-perennial drainage lines, with special mention of the waste stockpile areas as well as roads, road crossings and bridges all may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	Can be reversed
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
205	Potentially inadequate design of infrastructure leading to changes to instream habitat.	Loss of aquatic habitat	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
206	Potentially inadequate design of infrastructure leading to changes to system hydrology may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
207	Potentially inadequate	Loss of aquatic	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources

	separation of clean and dirty water areas and the prevention of the release of sediment rich water may alter the aquatic habitat within the receiving environment.	habitat	**WM**	Negative	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	Can be avoided, managed or mitigated
208	Potentially poor planning leading to the placement of infrastructure within non-perennial drainage lines with special mention of the overburden stockpile areas, road crossings and bridges may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	May cause irreplaceable loss of resources
209	Potentially inadequate design of infrastructure leading to changes to instream habitat may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	May cause irreplaceable loss of resources
210	Potentially inadequate design of infrastructure leading to changes to system	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	May cause irreplaceable loss of resources

	hydrology may lead to a loss in aquatic biodiversity.														
211	Potentially inadequate design of infrastructure leading to contamination of water and sediments in the streams may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	Can be avoided, managed or mitigated
Construction Phase															
212	Disturbance of soils during the construction phase could lead to erosion and sedimentation of the aquatic resources present, thus resulting in a loss of instream flow.	Loss of instream flow	**WOM**	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
213	Construction of clean and dirty water separation structures for dirty water management purposes may lead to altered flow levels.	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	Medium	6	52	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
214	Change in surface coverage. Development of the mining rights	Loss of instream flow	**WOM**	Negative	Definite	5	Long term	4	Site	2	High	8	70	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Local	1	Medium	6	22	Low	Can be avoided, managed or

	area will change the surface coverage in some areas from vegetated soil to buildings, hardened gravel roads, paved areas (parking) and compacted earth.														mitigated
215	Clean and dirty water systems not being constructed to the required specifications to prevent contamination of clean water areas may impact on water quality.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Medium	6	24	Low	Can be avoided, managed or mitigated
216	Major earthworks and construction activities may lead to impacts on water quality as a result of erosion and sedimentation as well as resulting in the oxidation of pyrites. In addition, there is a risk of the release of metals to the surface and groundwater resources as a result of tillage and blasting.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated

217	Poor housekeeping and management may lead to impacts on water quality.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Site	2	Medium	6	24	Low	Can be avoided, managed or mitigated
218	Spills and other unplanned events may impact on water quality.	Impacts on water quality	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Can be reversed
			WM	Negative	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	Can be avoided, managed or mitigated
219	Site clearing and the removal of vegetation leading to increased runoff and erosion may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Site	2	Medium	6	65	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	Can be avoided, managed or mitigated
220	Site clearing and road construction and the disturbance of soils leading to increased erosion may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	Medium	6	52	Moderate	Can be reversed
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	Can be avoided, managed or mitigated
221	Earthworks in the vicinity of drainage systems leading to increased runoff and erosion and altered runoff patterns may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	Can be avoided, managed or mitigated
222	Alien vegetation encroachment will impact on and alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	Can be avoided, managed or mitigated

223	Site clearing and the removal of vegetation may lead to a loss in aquatic biodiversity. Site clearing and road construction may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Site	2	Medium	6	65	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	Can be avoided, managed or mitigated
224	Earthworks and other mining construction activities in the vicinity of wetland and riparian areas may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	Can be avoided, managed or mitigated
225	Placement of infrastructure within non-perennial drainage lines with special mention of the overburden stockpile areas, road crossings and bridges may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
226	Inadequate separation of clean and dirty water areas may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Permanent	5	Site	2	Medium	6	26	Low	Can be avoided, managed or mitigated

Operational Phase																
227	Loss of MAR from dirty water areas may impact on the instream flow of the receiving systems.	Loss of instream flow	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Site	2	Medium	6	24	Low	Can be avoided, managed or mitigated
228	Loss of water through clean and dirty water separation may alter instream flow on the receiving systems.	Loss of instream flow	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be avoided, managed or mitigated
229	Impact on natural streamflow regulation and stream recharge due to altered hydrology in the area, with special mention of the formation of an ever increasing cone of depression over the life of the proposed mining project as a result of open cast mining activities and water abstraction, may lead to altered instream flow	Loss of instream flow	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	High	8	56	Moderate	May cause irreplaceable loss of resources
230	Intercepting run-off around mining activities and infrastructure	Loss of instream flow	WOM	Negative	Probable	2	Long term	4	Site	2	High	8	28	Low	Can be reversed
			WM	Negative	Improbable	1	Medium term	3	Local	1	Low	2	6	Negligible	Can be avoided, managed or mitigated

	could reduce the amount of time that water would take to reach the Klein Marico River and its associated tributaries and may lead to "flash flood" events on varying scales.														
231	Capture of run-off and capture of rainfall (inundation) in the 'dirty'/impacted areas would lower instream flow in the receiving environment.	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	Can be avoided, managed or mitigated
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be avoided, managed or mitigated
232	Mining activities and the establishment of mining waste may impact on water quality and thus needs to be managed to prevent pollution.	Impacts on water quality	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be avoided, managed or mitigated
233	Clean and dirty water systems not being maintained and operated to the required specifications to prevent contamination of clean water areas may impact on water quality.	Impacts on water quality	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be avoided, managed or mitigated

234	Poor housekeeping and management during operational phase may lead to impacts on water quality.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be avoided, managed or mitigated
235	Major earthworks and operational activities may lead to impacts on water quality as a result of erosion and sedimentation as well as resulting in the oxidation of pyrites. In addition, there is a risk of the release of metals to the surface and groundwater resources as a result of tillage and blasting.	Impacts on water quality	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated
236	Spills and other unplanned events during operational phase may impact on water quality.	Impacts on water quality	**WOM**	Negative	Definite	5	Medium term	3	Regional	3	High	8	70	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated
237	Ongoing disturbance of soils during general operational activities may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	Can be avoided, managed or mitigated

238	Inadequate separation of clean and dirty water areas may alter the aquatic habitat during the operational phase.	Loss of aquatic habitat	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Local	1	Medium	6	22	Low	Can be avoided, managed or mitigated
239	Mining related activities leading to increased disturbance of soils and drainage lines may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	Can be reversed
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
240	Any activities which lead to the reduction of flow in the system with special mention of the use of surface and groundwater sources for production water may alter the aquatic habitat. It is considered likely that the operational activities will result in a cone of depression in the groundwater aquifers, which will spread outwards as dewatering occurs over the life of the project, thereby resulting in moisture stress and a loss of	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Regional	3	High	8	60	Moderate	May cause irreplaceable loss of resources

	aquatic habitat.															
241	Alien vegetation encroachment will impact on and alter the aquatic habitat.	Loss of aquatic habitat	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Site	2	Medium	6	24	Low	Can be avoided, managed or mitigated
242	Ongoing disturbance of soils with general operational activities may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	WOM	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	Can be avoided, managed or mitigated
243	Inadequate separation of clean and dirty water areas may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	WOM	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Local	1	Medium	6	22	Low	Can be avoided, managed or mitigated
244	Loss of instream flow due to abstraction for water for production may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	WOM	Negative	Highly Probable	4	Long term	4	Site	2	High	8	56	Moderate	Can be reversed
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be avoided, managed or mitigated
245	Seepage from the discard dumps and overburden stockpiles may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	WOM	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Permanent	5	Regional	3	Medium	6	56	Moderate	May cause irreplaceable loss of resources
246	Potential discharge from the mine process	Loss of aquatic biodiversity	WOM	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Regional	3	Medium	6	26	Low	Can be avoided, managed or

	water system with special mention of RWD and any PCD's may lead to a loss in aquatic biodiversity.	and sensitive taxa													mitigated
247	Sewage discharge from mine offices and camps may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Probable	2	Permanent	5	Regional	3	Medium	6	28	Low	Can be reversed
			WM	Negative	Probable	2	Short term	1	Site	2	Medium	6	18	Negligible	Can be avoided, managed or mitigated
248	It is considered likely that the operational activities, with special mention of the open cast mining activities, will result in a cone of depression in the groundwater aquifers, which will spread outwards as dewatering occurs over the life of the project, thereby resulting in moisture stress and a loss of aquatic habitat as well as a loss of surface water recharge to the wetlands and springs which occur in the vicinity of the proposed mining	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	May cause irreplaceable loss of resources

	project.														
249	Acidification as a result of pyrite oxidation and the release of metals due to tillage and blasting may lead to a loss in aquatic biodiversity	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	May cause irreplaceable loss of resources
Closure and Decommissioning Phase															
250	Loss of MAR from latent dirty water areas may still impact on the flow even after operational phase.	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be avoided, managed or mitigated
251	Loss of water to inadequately rehabilitated areas may still have an impact on the flow post operational phase.	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	Can be reversed
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be avoided, managed or mitigated
252	Impact on natural streamflow regulation and stream recharge due to altered hydrology in the area may impact on the flow post operational phase	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	Medium	6	56	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Medium term	3	Local	1	Low	2	6	Negligible	Can be avoided, managed or mitigated
253	Inadequate closure and rehabilitation leading to ongoing pollution from contaminating	Impacts on water quality	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be avoided, managed or mitigated

	sources such as discard dumps and latent dirty water areas may impact on water quality.														
254	Clean and dirty water systems not being maintained or decommissioned properly to the required specifications to prevent contamination of clean water areas may impact on water quality.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be avoided, managed or mitigated
255	Poor housekeeping and management during decommissioning phase may lead to impacts on water quality.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Can be avoided, managed or mitigated
256	Spills and other unplanned events during decommissioning phase may impact on water quality.	Impacts on water quality	**WOM**	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Can be reversed
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated
257	Disturbance of soils as part of demolition activities may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Probable	2	Permanent	5	Site	2	High	8	30	Low	Can be reversed
			WM	Negative	Improbable	1	Short term	1	Local	1	Medium	6	8	Negligible	Can be avoided, managed or mitigated

258	Inadequate separation of clean and dirty water areas may alter the aquatic habitat during the decommissioning phase.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Regional	3	Medium	6	26	Low	Can be avoided, managed or mitigated
259	Ongoing pollution from inappropriately decommissioned structures may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Long term	4	Site	2	Medium	6	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Long term	4	Local	1	Low	2	7	Negligible	Can be avoided, managed or mitigated
260	Alien vegetation encroachment will impact on and alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Can be reversed
			WM	Negative	Probable	2	Long term	4	Local	1	Medium	6	22	Low	Can be avoided, managed or mitigated
261	Disturbance of soils as part of demolition activities may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Probable	2	Permanent	5	Site	2	High	8	30	Low	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Short term	1	Local	1	Medium	6	8	Negligible	Can be reversed
262	Inadequate separation of clean and dirty water areas may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Regional	3	Medium	6	26	Low	Can be avoided, managed or mitigated
263	Seepage from any latent discard dumps and dirty water areas may lead to a loss in aquatic	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Permanent	5	Regional	3	Medium	6	56	Moderate	May cause irreplaceable loss of resources

	biodiversity.														
264	Inadequate closure leading to post closure impacts on water quality may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Permanent	5	Regional	3	Medium	6	14	Negligible	Can be avoided, managed or mitigated
265	Ongoing erosion of disturbed areas that have not been adequately rehabilitated may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Permanent	5	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated
Post-Closure Phase															
266	Loss of MAR from latent dirty water areas may still impact on the flow even after decommissioning phase.	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible	Can be avoided, managed or mitigated
267	Loss of water to inadequately rehabilitated areas may still have an impact on the flow post decommissioning phase.	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	Medium	6	56	Moderate	Can be reversed
			WM	Negative	Probable	2	Long term	4	Local	1	Low	2	14	Negligible	Can be avoided, managed or mitigated
268	Impact on natural streamflow regulation and stream recharge due to altered hydrology in the	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Regional	3	High	8	64	High	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Medium term	3	Local	1	Low	2	6	Negligible	Can be avoided, managed or mitigated

	area may impact on the flow post decommissioning phase														
269	Ongoing erosion and sedimentation of the aquatic resources, which will result in a loss of instream flow due to inadequate rehabilitation of affected areas.	Loss of instream flow	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Medium term	3	Local	1	Low	2	6	Negligible	Can be avoided, managed or mitigated
270	Inadequate closure and rehabilitation leading to ongoing pollution from contaminating sources such as discard dumps and latent dirty water areas may impact on water quality, with special mention of contaminated dirty water decant degenerated from in-filled opencast pits	Impacts on water quality	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Local	1	Low	2	12	Negligible	Can be avoided, managed or mitigated
271	Clean and dirty water systems not being maintained or decommissioned properly to the required specifications to prevent	Impacts on water quality	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Can be avoided, managed or mitigated

	contamination of clean water areas may impact on water quality.														
272	Inadequate rehabilitation of mining areas leading to erosion and sedimentation of the aquatic resources present.	Impacts on water quality	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	Medium	6	70	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Local	1	Low	2	12	Negligible	Can be avoided, managed or mitigated
273	Inadequate separation of clean and dirty water areas may alter the aquatic habitat during the decommissioning phase.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Permanent	5	Regional	3	Medium	6	28	Low	Can be avoided, managed or mitigated
274	Ongoing pollution from inappropriately decommissioned structures may alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Permanent	5	Regional	3	Medium	6	28	Low	Can be avoided, managed or mitigated
275	Alien vegetation encroachment will impact on and alter the aquatic habitat.	Loss of aquatic habitat	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Permanent	5	Local	1	Low	2	16	Negligible	Can be avoided, managed or mitigated
276	Ongoing erosion of disturbed areas that have not been adequately rehabilitated may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	May cause irreplaceable loss of resources
			WM	Negative	Improbable	1	Medium term	3	Local	1	Low	2	6	Negligible	Can be avoided, managed or mitigated

277	Inadequate separation of clean and dirty water areas may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Permanent	5	Regional	3	Medium	6	28	Low	Can be avoided, managed or mitigated
278	Seepage from any latent discard dumps and dirty water areas may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Permanent	5	Regional	3	Medium	6	56	Moderate	May cause irreplaceable loss of resources
279	Potential post closure impacts on water quality may lead to a loss in aquatic biodiversity.	Loss of aquatic biodiversity and sensitive taxa	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Permanent	5	Regional	3	Medium	6	56	Moderate	May cause irreplaceable loss of resources
			WM	Positive	Definite	5	Short term	1	Regional	3	Low	2	30	Low	

Refer to Table 24 of the EIA&EMPR for the relevant mitigation measures.

12 MONITORING REQUIREMENTS

12.1 Environmental Monitoring and Auditing

DEAT (2004) defines environmental auditing as "a process whereby an organisation's environmental performance is tested against its environmental policies and objectives." Monitoring and auditing is an essential environmental management tool which is used to assess, evaluate and manage environmental and sustainability issues:

In order to ensure that the objectives of sustainable development and integrated environmental management are met and in order to obtain data which can inform continuous improvement of environmental practices at the site (adaptive management), monitoring and reporting will be an essential component of the proposed operations.

Monitoring and management actions associated with the project are contained in Table 27 of the EIA&EMPR as well as in the various specialist reports associated with this project. This section provides a summary of the critical monitoring aspects per specific environmental field.

12.2 General Monitoring and Management

The appointment of a suitably qualified on-site Environmental Control Officer (ECO) is essential to the successful implementation of this project, although this role can be fulfilled by the SHE Representative. The ECO will be responsible for the implementation of the EMP, applicable environmental legislation and any stipulations/conditions set by the relevant competent authorities (including but not limited to the DMR and DWS). The Environmental officer will conduct formal monthly site inspections and conduct an internal annual audit during the construction and operational phase.

An independent Environmental Control Officer (ECO) should also be appointed to conduct bi-annual (6 monthly) audits for the duration of the construction and operational phase. The Independent ECO should monitor the success and effective implementation of the environmental management measures stipulated by applicable legislation, the EIA&EMPR, and any conditions set by the competent authorities. Following each site visit, the ECO should submit a report to the DMR documenting the success/failure of the implementation of the management measures at the operations.

12.3 Specific Monitoring Requirements

Monitoring of the proposed development (both on site and where appropriate in the surrounding environments) should be considered a high priority and should be conducted in accordance with the relevant specialist recommendations as summarized below:

12.4 Monitoring Protocol

It is essential that during the construction and operational phase of the proposed development that the monitoring of certain elements is carried out to ensure compliance with regulatory bodies. A monitoring protocol for both the construction phase and the operational phase will be required. The monitoring only includes those activities identified in the EMPR and excludes any monitoring that should take place according to the water use license if and when it will be authorized.

12.5 Monitoring Requirements and Record Keeping

To ensure that the procedures outlined throughout the EMPR are implemented effectively it will be necessary to monitor the implementation of the EMPR and evaluate the success of achieving the objectives listed in the EMPR. To ensure that all personnel on site are aware of their obligation to protect the environment, induction training will also include environmental awareness.

The audit procedure will include a Compliance audit, conducted by the Environmental Control Officer. Where the objectives of the EMPR are not being met the reasons will be determined and remedial action or variation to the tasks will be recommended. Major residual effects shall be documented in a Non-Conformance Report, during the construction and operational phases. Follow-up audits will be conducted as per the audit protocol in the EMPR.

12.5.1 Construction phase

The following monitoring needs to be conducted:

Refer to Table 27 of the EIA&EMPR.

Monitoring must continue from the baseline monitoring already conducted, at least one year prior to construction so that seasonal variations are further accounted for over and above what is already known for the site.

12.5.2 Operational Phase

The following monitoring must be conducted:

Refer to Table 27 of the EIA&EMPR.

12.6 Audit Protocol

It is essential that during the construction and operational phases of the proposed development, the monitoring and auditing of certain elements are carried out to ensure compliance with regulatory bodies. An Audit Protocol for both the construction phase and the actual operational phase will be required. The auditing only includes those activities identified in the EIA&EMPR and excludes any auditing that should take place according to the water use license or any other legislative authorization process if and when they will be authorized.

12.6.1 Construction phase

The following audits need to be completed:

- EMPR compliance (on a daily basis): to be checked by an on-site ECO, SHE representative or Environmental manager (EM).
- EMPR compliance (on a bi-annual basis – 6 monthly): to be checked by an independent ECO.

12.6.2 Operational Phase

The following audits must be completed:

- External environmental compliance audits (EA and EMPR every 6 months during operations).

12.7 Environmental incidents

An environmental incident is defined as any unplanned event that results in actual or potential damage to the environment, whether of a serious or non-serious nature. An incident may involve non-conformance with environmental legal requirements, the requirements of the EMPR, or contravention of written or verbal orders given by the ECO or relevant authority.

In the event of any incident, an Environmental Incident Log should be completed and these reports should be kept on file by the Environmental Manager. Such reports should provide the following details:

- Date of the Incident (and time if relevant)
- Description of the nature of the incident (what happened)
- Explanation for current conditions (why it happened), responsible person, supporting photographs etc.
- Description of corrective actions taken

Corrective action to mitigate the impact (appropriate to the nature and scale of the incident) should be conducted immediately and affected parties notified.

In the case of serious incidents or emergencies, the incident report should be sent to the relevant authority as soon as possible after the incident has been recorded.

12.8 Penalties and Fines for Non-Compliance or Misconduct

This EMPR forms part of the contract agreement between the Client and the Principal contractor. As such, non-compliance with conditions of the EMPR will amount to a breach of contract. Penalties will be issued directly to the contractor by the applicant in the event of non-compliance to the EMPR specifications. The issuing of a penalty will be preceded by a verbal warning by the applicant, as well as strict instruction in at least one monthly ECO report to rectify the situation. The ECO and applicant will communicate with regards to realistic time-frames for possible rectification of the contravention, and possible consequences of continued non-compliance to the EMPR.

Penalties incurred do not preclude prosecution under any other law. Cost of rehabilitation and/or repair of environmental resources that were harmed by the actions of the contractor if such actions were in contravention of the specifications of the EMPR will be borne by the contractor himself. Penalties may be issued over and above such costs. The repair or rehabilitation of any environmental damage caused by non-compliance with the EMPR cannot be claimed in the Contract Bill, nor can any extension of time be claimed for such works. Penalty amounts shall be deducted from Certificate payments made to the Contractor.

The following categories of non-compliance are an indication of the severity of the contravention, and the fine or penalty amounts may be adjusted depending on the seriousness of the infringement.

- Category One – Acts of non-compliance that are unsightly, a nuisance or disruptive to adjacent landowners, existing communities, tourists or persons passing through the area.
- Category Two – Acts of non-compliance that cause minor environmental impact or localised disturbance.
- Category Three – Acts of non-compliance that affect significant environmental impact extending beyond point source.
- Category Four – Acts of non-compliance that result in major environmental impact affecting large areas, site character, protected species or conservation areas.

12.9 Environmental awareness plan

Environmental awareness training is critical for two primary reasons:

a) The workforce must understand how they can play a role in achieving the objectives specified in the EMPR; and

b) The workforce must understand their obligations in terms of the implementation of the EMPR and adherence to environmental-legislative requirements.

This environmental awareness plan is aimed at ensuring that employees, contractors, subcontractors and other relevant parties are aware of and able to meet their environmental commitments. This plan is to be updated on a yearly basis during the construction and operational phases of the project in light of operational changes, learning experiences and identified training needs.

All full time staff and contractors are required to attend an induction session when they start, which session should include environmental aspects.

It is therefore recommended that the ECO/Environmental Manager be involved in induction training. The induction sessions may be modified / adapted based on the audience attending the specific session, but it should ensure that all employees gain a suitable understanding of:

- Environmental requirements of the project, and how these will be implemented and monitored, including each employee's responsibilities with respect to environmental issues;
- Contents and commitments of the EMPR, including no-go areas, employee conduct, pollution prevention (prohibitions against littering, unauthorized fires, loud music, entry to adjacent properties, road conduct etc.);
- Environmentally sensitive areas on and around the proposed development sites, including why these are deemed important and how these are to be managed. Employees will also be made aware of protected species found on the site and how these are to be conserved, as well as alien invasive species potentially found on the site and how these should be managed; and
- Incident identification, remediation and reporting requirements: what constitutes an environmental incident (spillages, fire etc.) and how to react when such an incident occurs.

Environmental training will not be restricted to induction training sessions alone, but will be conducted on an on-going basis throughout the lifecycle of the project as and when required. Records are to be kept of the type of training given (matters discussed and by whom), date on which training was given and the attendees of each training session.

13 SECTION 27 MOTIVATION

The purpose of the Section 27 motivation is to provide assessment information with regards to equity as well as redress and economic empowerment of historically disadvantaged individuals. Considerations as per section 27 of the national water act (act 36 of 1998) follows:

13.1 (a) Existing lawful water uses in terms of section 35

This integrated water use license application is a new water use application; no existing lawful use is taking place on the proposed mining site, for the purpose of mining.

13.2 (b) The need to redress the result of the past racial and gender discrimination

Please refer to the attached Social and Labour Plan submitted to the DMR on 5 December 2016 (Appendix 7.18 of the EIA&EMPR).

13.3 (c) Efficient and beneficial use of water in the public interest

All water will be used as described by DWS's Best Practice Guidelines. Thus water would be treated and re-used as far as possible and by doing so the efficient and sustainable use of water will be at a maximum. The water use(s) would also be in the public interest as the proposed development will improve and uplift the socio-economic circumstances of the surrounding environment. Please refer to Section 11 for management measures.

13.4 (d) The socio-economic impact of the water use or uses if authorised or of the failure to authorise the water use or uses

The mine will create at least 222 sustainable employment opportunities on site that will be filled largely by people coming from the local communities during the operational phase. Forty to sixty percent of employment during the construction phase is envisaged to be recruited locally. Therefore, between approximately 88 and 133 jobs during the first two-year period will be occupied by locals as far as possible; thus allowing the local municipality to decrease their unemployment figures by between 0.3% and 0.6%.

Mining will also contribute to the socio-economic development of the communities in the area, especially through local enterprise development and local procurement. Overall, R1 513.5 million of GDP during construction and R22 564 million of GDP during the operational phase will be created in the South African economy because of the proposed mine's operations. A total of 4 397 FTE person-years will be created during construction in the entire national economy and an additional 1 222 FTE jobs will be supported on an annual basis for the entire mine's operations of 25 years examined in this study. The salaries paid out to local employees will result in an increase in the average household income. Given that both municipalities are relatively poor, an elevated household income will improve their standard of living and reduce poverty. In addition, as income increases, the consumption levels increase will consequently boost the local economy.

Should the water use license be refused, the proposed mining development will not take place and the possible social upliftment related to the mining activities will not be realised.

13.5 (e) Any catchment management strategy applicable to the relevant water resource

The Internal Strategic Perspective for the Crocodile West Marico Water Management Area (WMA) states that the available water resources of the Marico, Upper Molopo and Upper Ngotwane catchments do not meet the current level of water requirements at the appropriate levels of assurance of supply. Due to the semi-arid nature of the catchments and the low mean annual precipitation, there is very to no potential for surface water resource development to meet future water requirements. The available water resources of the catchments are however not well understood, particularly with regards to the long-term sustainable amount of groundwater that can be abstracted from the dolomites that traverse the catchments. One of the strategies identified in the ISP is the understanding of areas and sectors for effluent re-use as well as the groundwater resources strategies for the dolomites. One of the water supply options for the proposed Doornhoek Fluorspar Mine includes the re-use of grey water discharge from the Zeerust sewage treatment plant. This option will be further investigated in follow-up studies and as part of additional water supply development. Currently the focus is on the sustainable development of groundwater resources for water supply.

Another strategy focuses on the clearing of Invasive Alien Plants. The eradication of alien invasive species has been identified in the Hydrogeological Study as a possible offset for the potential dewatering impact of the mine. In addition, all water studies conducted for the proposed mining development have taken a conservative approach as per the precautionary principle in the NEMA.

13.6 (f) The likely effect of the water use to be authorised on the water resource and on other uses

The impact of development on water quantity and quality should be minimised due to the proposed water management measures on the BPEO principle with responsible use and best practices. Clean and dirty water should be separated and process water recycled and re-used. The dirty water should be kept in a closed circuit and spillages minimised.

The following water management aspects are proposed in the design of the mine infra-structure and waste facilities:

- Clean stormwater should be diverted around the mine areas so that dirty and clean water are separated as per GN704.
- The requirement of DWS regulation GN704 should be adhered to, especially the requirement for the stormwater retention dams which should be designed to spill not

more than once in fifty years.

- No infrastructure should be located within the 1:100 year flood line.
- Dirty water should be kept in closed circuit and be re-used in the mining processes.
- The mine residue facilities should be sited within the zone of influence of mine dewatering.
- Evaporation losses should be minimised, unless there is surplus water in the system (e.g. during storm events, the stormwater dams could be used to evaporate surplus water).

Please refer to Table 11-3 for the impact of the activities on groundwater and surface water resources.

13.7 (g) The class and resource quality objectives of the water resource

According to the hydrogeological study the development will result in a maximum simulated inflow of approximately 900 m³/d resulting in less than a 4% impact on the simulated surface water runoff in the A31D quaternary catchment. The dewatering impact on the Klein Marico River could be mitigated by directly discharging the treated dewatered water back into the Klein Marico River. Alternatively offsets such as the purchase of existing irrigation rights or the removal of alien invasive species has also been identified to mitigate the possible impact. The effect on the water reserve is therefore minimal and mitigation measures have been put into place to ensure that the reserve is managed responsibly. More information with regards to the resource quality objectives to be provided by the Department.

13.8 (h) Investments already made and to be made by the water user in respect of the water use in question

Investments with regards to time and money spend on the project includes the compilation of the pre-feasibility study, scoping and EIA study in support of the Mining Right and Environmental Authorisation Applications as well as the specialists studies. Specialist Studies conducted for the development include:

- Socio-economic Impact Assessment
- Archaeological Impact Assessment
- Palaeontological Impact Assessment
- Ecological Impact Assessment
- Soils, Agricultural Potential and Land Capability Assessment
- Wetland Impact Assessment
- Aquatic Impact Assessment
- Hydrogeological Impact Assessment

- Regional Water Balance
- Geochemical Risk Assessment
- Floodline Study and SWMP
- Air Quality Impact Assessment
- Noise Impact Assessment
- Traffic Impact Assessment
- Visual Impact Assessment
- Blasting and Vibration Study
- Rehabilitation, Decommissioning and Mine Closure Plan
- Social and Labour Plan

The approximate investments in monetary value up to date and to be invested in the near future are outlined in Table 13-1 and Table 13-2.

Table 13-1 Approximate monetary investments of the proposed mining development to date

Discipline	Actual (ZAR)
Cost of rights and maintenance	R 2,000,000.00
Exploration drilling	R 42,000,000.00
Assay	R 20,350,000.00
Geo Services	R 12,500,000.00
Vehicle running	R 1,546,000.00
Airborne magnetic surveys	R 2,600,000.00
Lidar surveys	R 2,100,000.00
Mapping	R 850,000.00
License fees	R 300,000.00
Surface access	R 520,860.00
Field Equipment	R 760,000.00
Geotechnical studies	R 250,300.00
Mining Right Application	R 600,000.00
Resource estimates	R 1,500,000.00
Preliminary economic assessment	R 2,850,000.00
Metallurgical Testwork	R 3,100,000.00
Hydrology (water)	R 1,200,000.00
EIA (Including specialists studies)	R 5,500,000.00
Geological and Resource modelling	R 1,550,000.00
Consumables	R 1,670,000.00
Marketing study	R 780,000.00
Contingency	R 1,500,000.00
Total Costs	**R 106,027,160.00**

Table 13-2 Monetary investments to be made for the proposed mining development in the near future

Capex Summary	Approximate Value (ZAR)
Surface rights	R 20,000,000.00
Vehicles	R 3,500,000.00
Field equipment	R 1,800,000.00
Road infrastructure	R 2,500,000.00
Water drilling	R 5,000,000.00
Power	R 3,000,000.00
Pilot plant	R 5,000,000.00
Total Costs	**R 40,800,000.00**

13.9 (i) The strategic importance of the water use to be authorised

This water use is not identified as a strategic water use as described by the Department.

13.10 (j) The quality of water in the water resource which may be required for the reserve and for meeting international obligations

During the hydrocensus conducted in the study area, it was found that the groundwater quality of the selected sampling sites during 2016 is in accordance with most constituent concentration limits specified in SANS 241:2011. Exceptions include elevated fluoride which is a consequence of the fluorspar deposits in the study area, manganese which is commonly associated with dolomite aquifers and elevated selenium. It is inferred that there is a possible direct hydraulic link between the local groundwater system and the surface water feature i.e. Klein Marico River, and therefore the Klein Marico River shows elevated levels of fluoride and manganese.

No water will be directly abstracted from the Klein Marico River; however as a possible link does exist between the surface water (Klein Marico River) and the groundwater, should the hydraulic gradients be reversed due to mine dewatering, possible leaking from the Klein Marico River to the groundwater might be induced. Maximum simulated inflows reach approximately 900 m^3/d resulting in less than 4% impact on the simulated surface water runoff in the A31D quaternary catchment. Once the possible link between the Klein Marico River and the groundwater has been established, then the possible inflows should be updated with a detailed assessment on the surface water runoff of the Klein Marico River catchment area as well as the Groot Marico river catchment area. Offsets in the form of discharging clean water back into the Klein Marico River, alien vegetation eradication and the purchasing of existing irrigation rights has been identified to limit the possible dewatering impact.

There will therefore be no influence on the volumes that need to be reserved for international obligations (e.g. the TSWASA Agreement).

13.11 (k) The probable duration of any undertaking for which a water use is to be authorised

The licence period for the above mentioned water uses would be required for the LOM, which is 30 years.

14 PROPOSED LICENCE CONDITIONS

The standard licence conditions and the uses as described in the IWULA forms in Appendix A: Application Forms should be included in the licence. Various recommendations were made as part of the specialist studies that also needs to be included. Refer to Table 23 of the EIA&EMPR (Appendix C: Environmental Impact assessment and Environmental Management Programme Report (EIA&EMPR) including specialist reports).

15 REPORTS UTILIZED IN COMPILING THE IWULA

Key reports used in compiling the IWULA are as follows:

- Draft EIA&EMPR (Grobler & Uys, 2016)
- Hydrogeological Impact Assessment (Meyer, 2016)
- Aquatic Impact Assessment (Van Staden, 2016)
- Wetland Impact Assessment (Henning, 2016)
- Geochemical Risk Assessment (Hansen, 2016)
- Regional Water Balance Report (Vivier, 2016)
- Floodline Study & SWMP (Coetzer, 2016)
- Social and Labour Plan (Beulah Africa, 2016)
- Socio-economic Impact Assessment (Broughton, 2016)

16 CONCLUSION AND RECOMMENDATION

Exigo was appointed by SA Fluorite (Pty) Limited & Southern Palace 398 (Pty) Limited to facilitate the Integrated Water Use Licence Application (IWULA). The proposed project is a fluorspar mining development and will involve the construction and operation of an opencast mining development as well as associated infrastructure. The following water uses will take place on the farms: Farm 306 (Portion 1, 5, 10, 24, 25, 26, 27, 29, 30), Rhenosterfontein 304 (Portion 9, 10), with possible extension to Knoflookfontein 310 (Portion 1 & 7).

Table 16-1 Water use per property

Water use	Description	Property
21a	Abstracting ground/dewatering water	Rhenosterfontein 304 (Portion 9 & 10) Farm 306 (Portion 1, 24, 25, 26, 27, 29, &30) Knoflookfontein 310 (Portion 1)
21b	Potable Water Reservoir	Farm 306 (Portion 24, 25, 27 & 30)
21b	Fire Water Reservoir	Farm 306 (Portion 24, 25, 27 & 30)
21b	Spray Water Dam	Farm 306 (Portion 24, 25, 27 & 30)
21b	Raw Water Dam	Farm 306 (Portion 24, 25, 27 & 30)
21b	Various Storm Water Dams as part of Stream/drainage diversions	Rhenosterfontein 304 (Portion 6, 9 & 10) Farm 306 (25 & 30) Knoflookfontein 310 (Portion 1)
21c	Infrastructure within 500m of wetland/watercourse	Farm 306 (Portion 24, 25 & 30) Knoflookfontein 310 (Portion 1)
21c	Stream/drainage diversions - Diverting	Rhenosterfontein 304 (Portion 6, 9 & 10) Farm 306 (Portion 4, 10, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)
21g	Tailings Storage Facility	Farm 306 (Portion 5, 24, 25, 26, 27, 29 & 30)
21g	Return Water Dam	Farm 306 (Portion 5, 24, 25, 26, 27, 29 & 30)
21g	Storm Water Dam (Overburden dump at Resource A)	Rhenosterfontein 304 (Portion 9)
21g	Storm Water Dam (Overburden dump at Resource C)	Farm 306 (Portion 26)
21g	Storm Water Dams (plant and TSF)	Farm 306 (Potion 5, 10, 24, 27 & 29) Knoflookfontein (Portion 1 & 7)
21g	Process Water Dam	Farm 306 (Portion 24, 25, 27 & 30)
21g	Sewerage Treatment Plant & Sewerage Sludge Tank	Farm 306 (Portion 24, 25, 27 & 30)
21g	Water Treatment Plant & Brine Evaporation Pond	Farm 306 (Portion 24, 25, 27 & 30)
21g	Dust Suppression	Rhenosterfontein 304 (Portion 9 & 10) Farm 306 (Portion 1, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)
21g	Partial backfilling of open pits	Rhenosterfontein 304 (Portion 9 & 10) Farm 306 (Portion 1, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)
21i	Infrastructure within 500m of wetland/watercourse	Farm 306 (Portion 24, 25 & 30) Knoflookfontein 310 (Portion 1)
21i	Stream/drainage diversions – Diverting tributary of the Klein Marico River around open pits (Resource A, C & D)	Rhenosterfontein 304 (Portion 6, 9 & 10) Farm 306 (Portion 4, 10, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)

21j	Dewatering of mine	Rhenosterfontein 304 (Portion 9 & 10) Farm 306 (Portion 1, 24, 25, 26, 27, 29 & 30) Knoflookfontein 310 (Portion 1)

Specialist studies conducted for the project include a Hydrogeological Impact Assessment, Aquatic Impact Assessment, Wetland Impact Assessment, Geochemical Risk Assessment, Regional Water Balance Report, Floodline Study & SWMP, Social and Labour Plan and Socio-economic Impact Assessment, amongst others.

An assessment of potential impacts identified for the mining development was undertaken. The impacts identified for assessment were assessed within numerous specialist studies. The specialist studies recommended mitigation measures in order to reduce or eliminate any impacts which were identified.

The study concluded that most of the impacts associated with the development can be mitigated to negligible, low or moderate levels of significance. The impacts of high significance after mitigation are as follows:

- Ecology:
  - Habitat destruction / fragmentation of fauna habitats
- Wetlands
  - Wetland and watercourse destruction / fragmentation of wetland habitats
  - Impediment of flow patterns
  - Dewatering of wetlands causing direct habitat loss / destruction
- Soils
  - Soil destruction and sterilization
  - Soil compaction
- Traffic
  - **Positive** Improved access points resulting in increased safety for all road users
  - **Positive** Upgrades to roads benefitting all road users
- Socio-economic
  - **Positive** Stimulation of production and GDP due to operations
  - **Positive** Stimulation of employment creation due to operations
  - **Positive** Skills development
  - **Positive** Improved standard of living due to creation of employment

- **Positive** Increase in government revenue and its ability to deliver services

The findings of the specialist studies undertaken provide an assessment of both the benefits and potential negative impacts anticipated as a result of the proposed project. The findings conclude that provided that the recommended mitigation and management measures are implemented there are no environmental fatal flaws that should prevent the proposed project from proceeding.

In order to achieve appropriate environmental management standards and ensure that the findings of the environmental studies are implemented through practical measures, the recommendations from the EIA&EMPR will form part of the contract with the contractors appointed to construct and maintain the proposed mine and associated infrastructure. The EIA&EMPR would be used to ensure compliance with environmental specifications and management measures. The implementation of the EIA&EMPR for key cycle phases (i.e. construction, operations, decommissioning and closure) of the proposed project is considered to be fundamental in achieving the appropriate environmental management standards as detailed for this project.

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18 APPENDIX A: APPLICATION FORMS

19 APPENDIX B: PROOF OF PAYMENT

20 APPENDIX C: ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PROGRAMME REPORT (EIA&EMPR) INCLUDING SPECIALIST REPORTS

21 APPENDIX D: SURFACE WATER PLANNING AND DESIGNS

22 APPENDIX E: TITLE DEEDS

23 APPENDIX F: CERTIFIED ID COPY

24 APPENDIX G: BUSINESS REGISTRATION CERTIFICATE