



REPORT

Clover Alloys SA
Conceptual and
Numerical Model
GROUNDWATER
IMPACT ASSESSMENT
Rietfontein Plant

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Executive Summary

Hyrogeek Consulting is pleased to provide this hydrogeological assessment and to assess the existing groundwater management, potential impacts and monitoring programme at Rietfontein Plant. A hydrocensus was conducted on the 11th to 13th of February 2024. The hydrocensus involved the measuring of static/dynamic groundwater levels, and sampling of groundwater quality in the vicinity of the Rietfontein Plant. The assessment concluded the following:

- A good correlation between groundwater level and surface elevation at Rietfontein Plant suggests that the groundwater flow in the shallow aquifer is undisturbed and mimics topography.
- The Sandspruit was identified as a potential receptor due to the proximity to the Rietfontein Plant. The Sandspruit is deemed more susceptible to contamination by surface water runoff and seepage from the shallow weathered aquifer.
- There are signs of groundwater contamination down gradient of the Rietfontein Chrome Plant towards the Sandspruit (a tributary of the Hex River). Elevated chrome was observed in borehole FH02 and elevated nitrate and sulphate concentrations observed in monitoring boreholes at RCM which is indicative of contamination caused by mining activities.
- Groundwater monitoring network (drilled four boreholes (RM04, RM05, RM06 and RM07) has been put into place to monitor any possible contamination from stockpiles and PCD's.
- Stormwater management infrastructure will be place through a lined PCD dam will be in place to mitigate the risk to groundwater.

The main constituents of concern identified during the analysis are listed as follows:

- **Rietfontein Chrome Plant** – Electrical Conductivity (EC), TDS and Chrome (Cr)

The numerical modelling results:

- The pollution plume migration of the current and future stockpiles is and will be contained through the current abstraction from boreholes RP01, RP02 and RP03. This needs to be confirmed with future monitoring boreholes of water quality, water quantity and water levels.

The following actions and recommendations are put forward for consideration:

- Monitoring monthly abstraction volumes from production boreholes (RP01-RP03) and water levels from all boreholes that are in use on the Rietfontein Plant (preferably with automated flow meters).
- Boreholes FH01, FH02 and H/BH4 should be added to the monitoring network.
- Aquifer Testing (12 hour) is recommended on the newly drilled monitoring boreholes to determine aquifer parameters
- It is recommended to do a comprehensive quarterly analysis of all boreholes at an accredited laboratory for parameters **Physical and Aesthetic Factors**: pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), and Total Hardness. **Macro Elements**: Total Alkalinity (MAIk), Sulphate (SO₄),

Director: NL van Zyl (MSc. Hydrogeology)

Nitrate (NO₃), Chloride (Cl), Fluoride (F), Calcium (Ca), Magnesium (Mg), Potassium (K), and Sodium (Na). **Micro Elements:** Aluminium (Al), Iron (Fe), Manganese (Mn), Cadmium (Cd), Chromium (Cr), Copper (Cu), Nickel (Ni), Lead (Pb), Cobalt (Co), and Zinc (Zn).

The potential environmental impacts associated with the proposed new infrastructure—such as the pollution control dam (PCD), clean and dirty water separation systems, and related channels—have been reviewed in the context of the existing operations assessed under the Section 24G application. Based on the nature, location, and function of the planned infrastructure, the associated impacts are anticipated to be materially similar in type, extent, and significance to those already identified and assessed.

As such, these impacts are sufficiently addressed by the current impact assessment. Should any deviations or unique site-specific impacts arise during implementation, these will be managed under the existing environmental management framework and mitigation measures already in place

Table of Contents

1	INTRODUCTION.....	5
1.1	Setting the stage	5
1.2	Objectives of the Investigation.....	5
2	REGULATORY FRAMEWORK.....	5
2.1	National water Act	5
2.2	Checklist for Specialist studies	6
2.3	Reviewed Documentation.....	1
2.4	Scope of Work.....	1
3	REGIONAL DESCRIPTION	2
3.1	Locality of the Study Area.....	2
3.2	Regional Drainage and Surface Topography	2
3.3	Rainfall and Cumulative Rainfall Departure (CRD).....	5
3.4	Evaporation	6
4	GEOLOGY OF THE STUDY AREA	6
4.1	Regional Geology.....	6
5	HYDROGEOLOGY OF THE STUDY AREA	9
5.1	Aquifers and Groundwater Occurrence	9
5.1.1	Unsaturated zone – shallow, saprolitic aquifer.....	9
5.1.2	Saturated zone – fractured bedrock aquifer.....	9
5.1.3	Water Strike Depths.....	10
5.2	Monitoring Network	10
6	FIELD INVESTIGATION	10
6.1	Source Pathway Receptor Model.....	10
6.1.1	Rietfontein Plant Operation.....	10
6.2	Hydrocensus	11
6.3	Groundwater Gradient.....	12
6.4	Dewatering and Abstraction	18
6.5	Hydraulic Conductivity and Transmissivity	18

6.6	Recharge.....	19
6.7	Stormwater Management Plan.....	19
6.8	Water Quality.....	20
6.8.1	Rietfontein Plant Operation hydrocensus.....	21
6.8.2	Piper Diagram.....	21
6.9	Geophysical Survey	27
6.10	Earth Resistivity Method	27
6.11	Drilling	32
6.12	Aquifer Testing.....	36
6.12.1	Existing Boreholes	36
7	Conceptual Model of the Aquifer System	39
8	GROUNDWATER FLOW MODEL DEVELOPMENT	41
8.1	Objectives of the Modelling	41
8.2	Modelling Package	41
8.3	Assumptions and limitations.....	41
8.4	Model Area.....	42
8.5	Construction of the Finite Element Grid.....	44
8.6	Boundary Conditions	45
8.7	Model layers	46
8.8	Aquifer Transmissivity (Hydraulic Conductivity).....	47
8.9	Steady State Simulation (Calibration).....	48
8.10	Steady State Groundwater Balance.....	51
9	DEVELOPMENT OF THE CONTAMINANT TRANSPORT MODEL.....	51
9.1	Introduction.....	51
9.2	Processes Controlling Contaminant Transport.....	51
9.2.1	Advection	52
9.2.2	Hydrodynamic Dispersion	52
9.3	Mass Balance Equation.....	52
9.4	Kinematic Porosity Values.....	53

9.5	Longitudinal and Transversal Dispersivities	53
9.6	Source Term.....	53
9.7	Mass Transport Transient Simulations	55
9.7.1	Scenario 1: Current Impact from existing Stockpiles 2023-2025	55
9.7.2	Scenario 2: Future Impact from existing and future Waste Rock Dumps LOM 2025-2036....	55
10	HYDROGEOLOGICAL RISK ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PROGRAMME	58
10.1	Rietfontein Plant Operation	58
10.1.1	Future and current impacts of the Chrome wash plant on the hydrogeological regime.	58
10.1.2	Mitigation and management measures.....	59
10.2	Risk Assessment Criteria	59
10.2.1	Procedure	59
10.2.2	Determination of Significance	59
10.2.3	Impact Prioritization	65
10.2.4	Cumulative impact	67
10.3	EMPR inclusion.....	67
11	Monitoring Plan	72
12	CONCLUSIONS AND RECOMMENDATIONS	74
13	RECOMMENDATIONS	75
13.1	Specialist opinion:	75
14	References	76

List of Tables

Table 1	Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended).	6
Table 2	Reviewed information for groundwater.....	1
Table 3	Average rainfall and evaporation (Minelock, 2022)	5
Table 4	Monitoring boreholes and location monitored.....	10

Table 5 Hydrocensus information for Rietfontein Plant Operation.....	13
Table 6 Section 21 (a) Water Use Activities approved in WUL	18
Table 7 Hydraulic conductivities previously used at RCM	18
Table 8 Transmissivity values tested from existing production boreholes	19
Table 9 Water quality analysis results from the fourth quarter of 2023.....	20
Table 10 Water Quality Analysis results of boreholes tested.	23
Table 11 Proposed Drill Sites.....	28
Table 12 Rietfontein Drilling summary.....	32
Table 13 UOL drilling findings based on water characteristics	32
Table 14 Summarised Aquifer testing programme for existing boreholes.	36
Table 15 Boreholes recommendations.....	37
Table 16 Boundary Conditions	45
Table 17 Calibrated Aquifer parameters.....	47
Table 18 Steady state results.....	48
Table 19 Water Balance for current conditions	51
Table 20 Source terms.....	53
Table 21 Criteria for Determining Impact Consequence.....	60
Table 22: Probability/ Likelihood Scoring	61
Table 23 Determination of Significance.....	62
Table 24 Significance Scores.....	62
Table 25 Risk Assessment Rating Consequence	63
Table 26: Criteria for Determining Prioritisation.....	65
Table 27: Determination of Prioritisation Factor	66
Table 28: Final Environmental Significance Rating	66
Table 29 Risk Assessment Rating Final Environmental Significance.....	68
Table 30 EMPr Inclusion	70
Table 31 Proposed monitoring network.....	72

List of Figures

Figure 1 Location of Rietfontein plant.....	1
Figure 2 Regional topography and drainage	3
Figure 3 Plant infrastructure layout.....	4
Figure 4 Climatic data representation.....	6
Figure 5 Geology groups present.....	7
Figure 6 Regional Geology.....	8
Figure 6.1: Water level statistic graph for Rietfontein Plant Operation hydrocensus.....	11
Figure 6.2: Correlation between groundwater elevation and surface elevation.	12
Figure 3 Hydrocensus survey.....	15
Figure 4 Hydrocensus survey boreholes sampled	16
Figure 5 Groundwater flow contours (mamsl) and directions	17
Figure 6 Stormwater infrastructure Plan.....	20
Figure 7 Piper diagram for Rietfontein Plant	22
Figure 8 Spatial distribution of Sulphate (SO ₄) concentrations for Rietfontein Chrome Plant.....	25
Figure 9 Spatial distribution of Nitrate (NO ₃) concentrations for the Rietfontein Plant Operation	26
Figure 10 Geophysical survey ERT Traverse 1.....	29
Figure 11 Geophysical survey ERT Traverse 2.....	29
Figure 12 Geophysical survey ERT Traverse 3.....	29
Figure 13 Geophysical survey ERT Traverse 5.....	30
Figure 14 Geophysical survey ERT Traverse 5.....	30
Figure 15 geophysical surveys.....	31
Figure 16 Borehole RM05	33
Figure 17 Borehole RM04	33
Figure 18 Borehole RM07	34
Figure 19 Borehole RM06	34
Figure 20 Drilled boreholes	35
Figure 21 Aquifer Tested boreholes	38

Figure 22 Conceptual model 40

Figure 23 Model boundary 43

Figure 24 FEFLOW Mesh 44

Figure 25 FEFLOW boundary conditions in Rietfontein Area..... 46

Figure 26 3D Model looking North with elevation 47

Figure 27 Scatterplot of measured vs simulated heads..... 49

Figure 28 Piezometric surface based on current conditions..... 50

Figure 29 Liner design..... 54

Figure 30 Source term included in model as fluid flux..... 54

Figure 31 Pollution Plume current conditions 56

Figure 32 Pollution Plume at 2036 current LOM 57

Figure 33 Cumulative impacts and sensitive receptors 69

Figure 34 Proposed groundwater monitoring plan 73

Appendices

Appendix 1 DRASTIC

Appendix 2 Lab Quality Results



Distribution history

Name	Company
Andre van Rooyen	Environmental Impact Management Services (Pty) Ltd
Douglas Richards	Minelock Environmental Engineers

Document history

Report	Date	Version	Status
202501-02	February 2025	Conceptual 1.0	DRAFT
202501-02	March 2025	Numerical Model 2.0	DRAFT
202501-02	May 2025	Numerical Model 3.0	FINAL DRAFT
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The findings, results, observations, conclusions, and recommendations presented in this report are based on the author's best scientific and professional knowledge, as well as the available information. The assessment techniques employed are constrained by the information, time, and budgetary limitations relevant to the scope of the investigation. Hydrogeek Consulting reserves the right to modify aspects of the report, including recommendations, should new information emerge from ongoing research, monitoring, or further work in the field.

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This report has been prepared in accordance with the latest requirements for specialist reports set forth by the Department of Environmental Affairs, as outlined in Government Gazette No. 40713 (24 March 2017) and Government Gazette No. 40772 (07 April 2017) under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA).

I, NL van Zyl, hereby declare that:

- I act as the independent specialist for this application.
- I will conduct the work related to this application objectively, even if it leads to findings that are not favorable to the applicant.
- I have no circumstances that could compromise my objectivity in this work.
- I possess the necessary expertise relevant to this application, including knowledge of the Act, Regulations, and relevant guidelines.
- I will comply with all applicable legislation.
- I have not engaged, nor will I engage, in any conflicting interests related to this activity.
- I will disclose to the applicant and the competent authority any material information that could influence decisions regarding the application or the objectivity of any report or document prepared for submission.
- All information I have provided in this declaration is true and correct.

NL VAN ZYL

M.Sc Hydrogeology, Pr.Sci.Nat.

LIST OF ABBREVIATIONS

BHN	Basic Human Needs
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CRD	Cumulative Rainfall Departure
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EARTH	Extended Model for Aquifer Recharge and Soil Moisture Transport through the Saturated Hardrock
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ET	Evapotranspiration
GMU	Groundwater Management Unit
GRDM	Groundwater Resource Directed Measures
GRU	Groundwater Resource Unit
ICM	Integrated Catchment Management
IFR	Instream Flow Requirements
IWRM	Integrated Water Resource Management
K	Hydraulic Conductivity
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
NGDB	National Groundwater Data Base
NWA	National Water Act (Act 36 of 1998)
NWRS	National Water Resource Strategy
RDM	Resource Directed Measures
RQO	Resource Quality Objectives
RU	Resource Unit
S	Storativity
T	Transmissivity
WARMS	Water Use Authorization and Registration Management System
WEM	Water Environment Management
WMA	Water Management Area
WMS	Water Management System

1 INTRODUCTION

Hydrogeek Consulting was contracted by Environmental Impact Management Services (Pty) Ltd to conduct a geohydrological impact study and report as specialist input to the section 24g rectification application and Environmental Management Program (EMP) at the Rietfontein Plant on behalf of Clover Alloys SA.

The focus of this investigation was centered around: -

- Determining a baseline picture of groundwater conditions on and around the Rietfontein Plant
- Determination of the historic groundwater quality and quantity impacts related to the plant activities.
- Determination of the future groundwater quality and quantity impacts related to the proposed activities.

1.1 Setting the stage

Clover Alloys SA (Pty) Ltd's Rietfontein Operation is located in the western area of the Bushveld Complex close to Rustenburg. The Rietfontein Beneficiation Plant (crushing, screening and washing) is located on Portion 23 (Portion 13 – LG 306) of the Farm Rietfontein 338 JQ within the Rustenburg Local Municipality, North West Province. The facility has a three-stage crushing and screening plant that allows it to treat any form of Run of Mine (RoM) feedstock. The washing facility concentrates on the production of specialist high grade products such as foundry and chemical grade concentrates.

Clover Alloys SA owns and operates its' own chrome fines processing and wash plant in the Rietfontein area, South Africa. The Plant supplies Chrome Sands and Concentrates, dried and wet from South Africa for foundry, specialist non-metallurgical and metallurgical applications. The plant also carries out chrome sand recovery from foundry waste from various foundries in the industrial areas, thus saving on waste dumping. The primary focus of Clover Alloys SA in the specialist high grade and nickel chromite sands and concentrates for local and global markets.

1.2 Objectives of the Investigation

The aim of the investigation is to develop a better understanding of the current hydrogeological conditions and to identify any flaws/gaps in the current groundwater management system. This investigation will also outline any potential risks to the receiving environment associated with mining activities.

2 REGULATORY FRAMEWORK

2.1 National water Act

The report is structured according to the requirements of the National Water Act, 1998 Regulations regarding the procedural requirements for water use licence applications and appeals 24 March 2017, Act No. R. 267.

2.2 Checklist for Specialist studies

This checklist is intended to assist in evaluating whether specialist studies conducted as part of an Environmental Impact Assessment (EIA), Basic Assessment, or Environmental Management Programme (EMPr) comply with the requirements of **Appendix 6 of the EIA Regulations, 2014 (as amended)**. It serves as a practical tool for both Environmental Assessment Practitioners (EAPs) and competent authorities to ensure that specialist inputs are complete, transparent, and legally compliant.

Table 1 Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended).

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
1.(1) (a) (i) Details of the specialist who prepared the report	Page 1	
(ii) The expertise of that person to compile a specialist report including a curriculum vita	Appendix 3	
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page 2	
(c) An indication of the scope of, and the purpose for which, the report was prepared	Heading 1	
(cA) An indication of the quality and age of base data used for the specialist report	Heading 2.2	
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Heading 6	
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Heading 6.2	
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Heading 2.3	
(f) details of an assessment of the specifically identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative;	Heading 10.1	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
(g) An identification of any areas to be avoided, including buffers	Heading 6.2	
(h) A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Heading 10.2.4	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Heading 8.3	
(j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Heading 10.1.1 and Heading 10.1.2	
(k) Any mitigation measures for inclusion in the EMPr	Heading 10.1.2	
(l) Any conditions for inclusion in the environmental authorisation	Heading 13	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Heading 13	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Heading 12.1	
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and		
(n)(ii) If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Heading 13	
(o) A description of any consultation process that was undertaken during the course of carrying out the study	Heading 2.3	
(p) A summary and copies of any comments that were received during any consultation process		NA

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
(q) Any other information requested by the competent authority.		NA
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.		NA

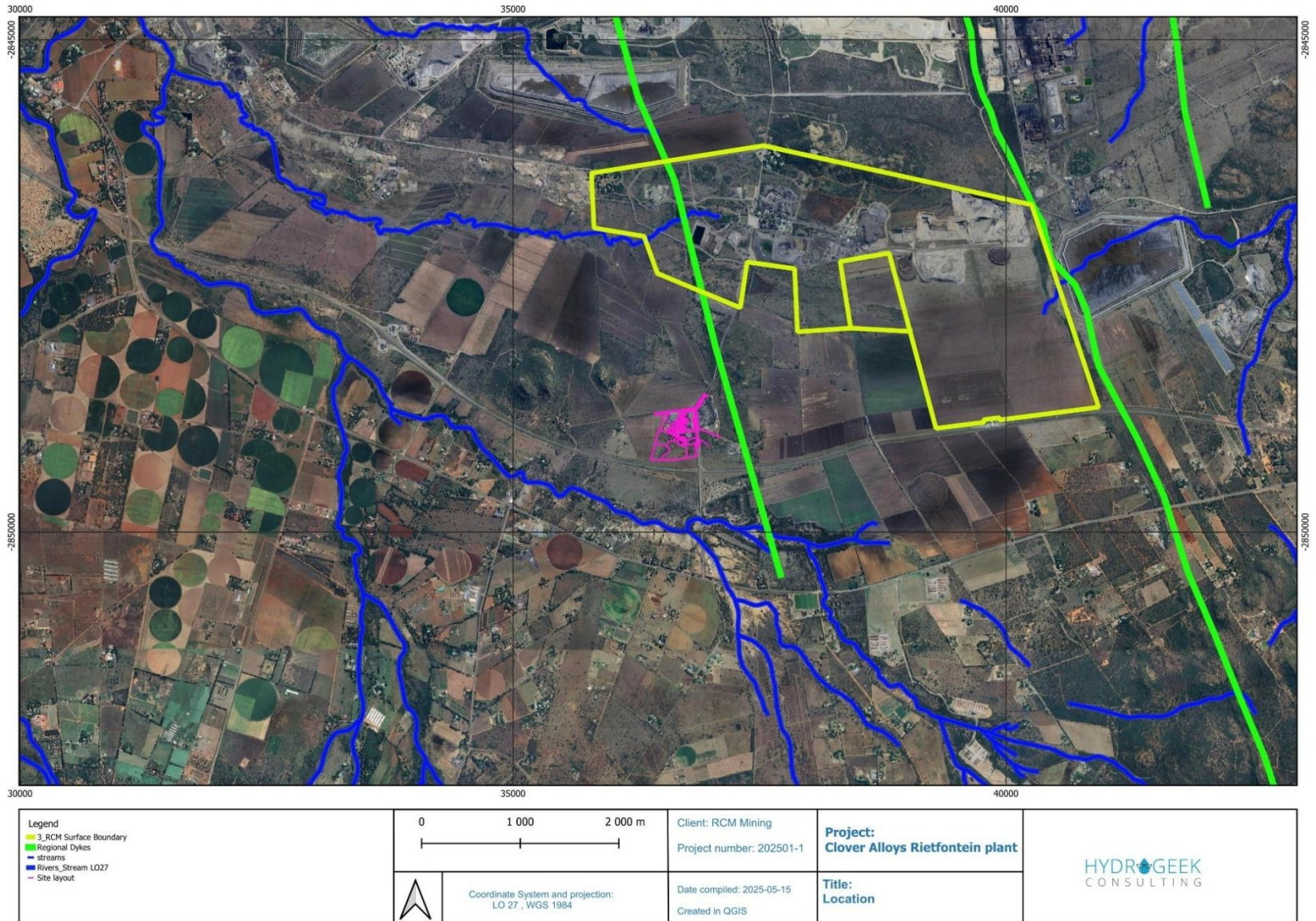


Figure 1 Location of Rietfontein plant

2.3 Reviewed Documentation

The background information used are as follows:

Table 2 Reviewed information for groundwater

Year	Company	Study
2017	GCS	Once off Water Quality Assessment - Rietfontein
2023	HK Geohydrological Services Pty Ltd	GEOHYDROLOGICAL STUDY FOR RIET FONTEIN CHROME PLANT LOCATED ON PORTION 21 OF THE FARM RIET FONTEIN 338 JQ LOCATED IN THE NORTHWEST PROVINCE
2023	MARINE MOUNTAINS ENVIRONMENTAL CONSULTANTS (PTY) LTD	GEOHYDROLOGICAL REPORT FOR CLOVER ALLOYS AT RIET FONTEIN PLANT OPERATION, RUSTENBURG LOCAL MUNICIPALITY, BOJANALA PLATINUM DISTRICT, IN NORTHWEST PROVINCE

2.4 Scope of Work

To address the objective of this assessment the following scope of services was proposed and is further detailed within this report

- 💧 Review and evaluate existing site-related data.
- 💧 Conduct a hydrocensus (1 to 2 km) to record groundwater uses in the area and groundwater levels in private user boreholes and on-site boreholes.
- 💧 Water sampling of groundwater and surface water to determine quality and to highlight any constituents of concern.
- 💧 Conduct a spatial analysis to identify any sensitive receptors in the vicinity of the existing development footprint such as rivers, streams, wetlands etc.
- 💧 Development of the conceptual model into a numerical groundwater model in FEFLOW.
- 💧 Use of a finite element groundwater modelling code, FEFLOW, that represents the hydrogeological conditions and groundwater flow conditions as well as the complexity of the hydrogeological regime.
- 💧 Steady state model calibration to simulate baseline hydrogeological conditions.
- 💧 Development of a transient model to simulate observed long-term monitoring data and increase the level of confidence in the numerical model.
- 💧 Development of a predictive model to simulate groundwater flow and mass migration.

- ◆ Impact Assessment based on existing conditions as well as future infrastructure changes will be addressed.
- ◆ Recommend monitoring and management scenarios and outcomes.

3 REGIONAL DESCRIPTION

3.1 Locality of the Study Area

Clover Alloys SA (Pty) Ltd's Rietfontein Operation is in the western area of the Bushveld Complex close to Rustenburg. The existing chrome washing plant on Portion 23 of the farm Rietfontein 338 JQ is in the North-west Province in quaternary sub-catchment A22H. Refer to Map 1. The plant will be located 14km kilometre south-east of Rustenburg and 6km southeast of Kroondal.

3.2 Regional Drainage and Surface Topography

The project area falls within the Crocodile West and Marico Water Management Area (WMA), quaternary catchment A22H.

The A22H quaternary catchment area is 579 km² and has a MAR of 14.07 million m³. Runoff emanating from this quaternary catchment drains in a north–easterly direction via the Hex River. Elevations in the A22H quaternary range from 1220 meters above mean sea level (mamsl) at the highest point within the catchment and drop to 1112 mamsl at the outlet of the catchment.

The elevation of this area ranges from 1130 mamsl to 1150 mamsl. Surface drainage at the Rietfontein Chrome Plant area occurs mainly towards the South, directly into the Sandspruit as this site is situated approximately 1 km from the Sandspruit.

The main water course in the A22H quaternary catchment is the Hex River found on the western side of the project area; this river joins the Elands River which is a tributary to Crocodile River.

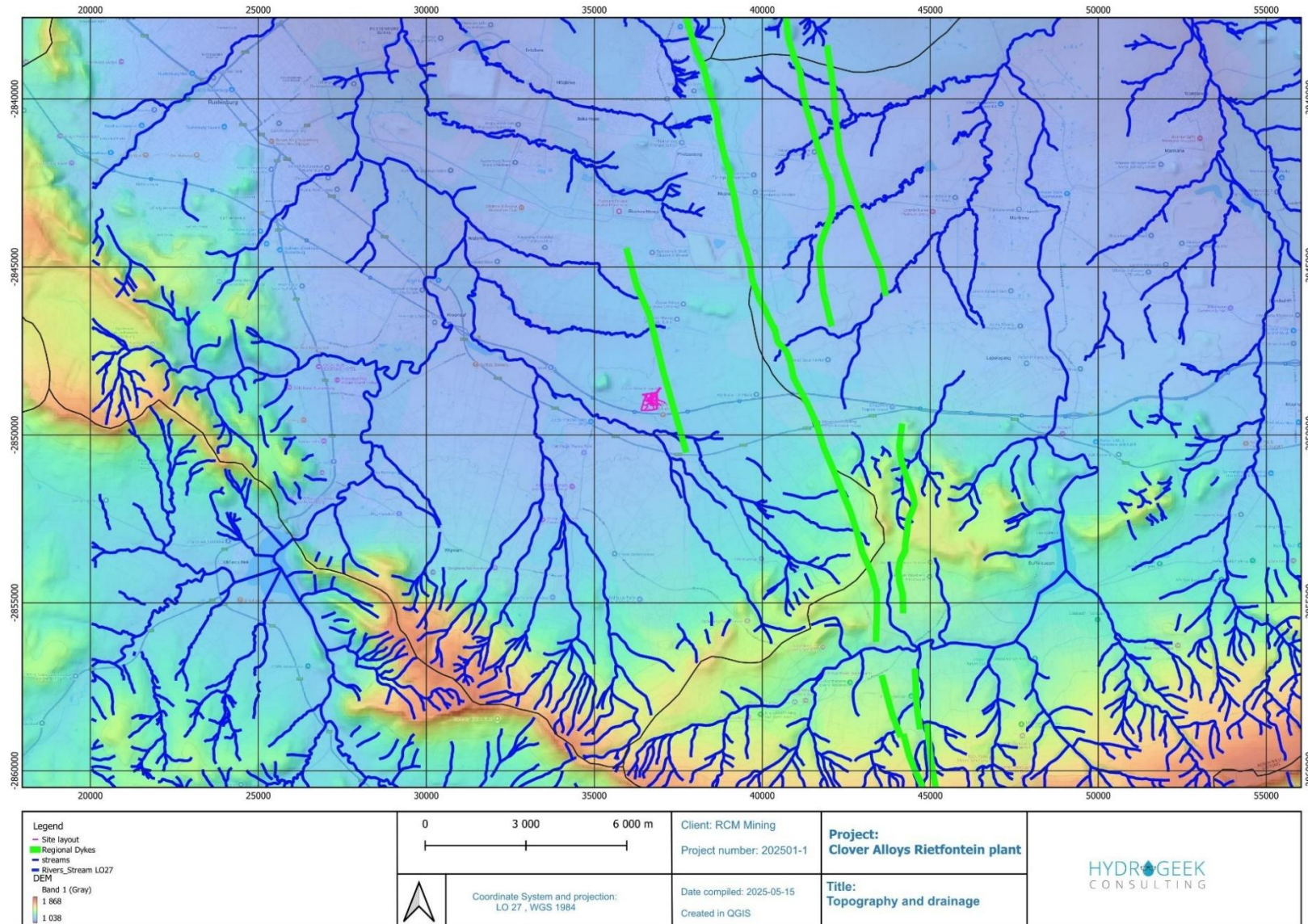


Figure 2 Regional topography and drainage



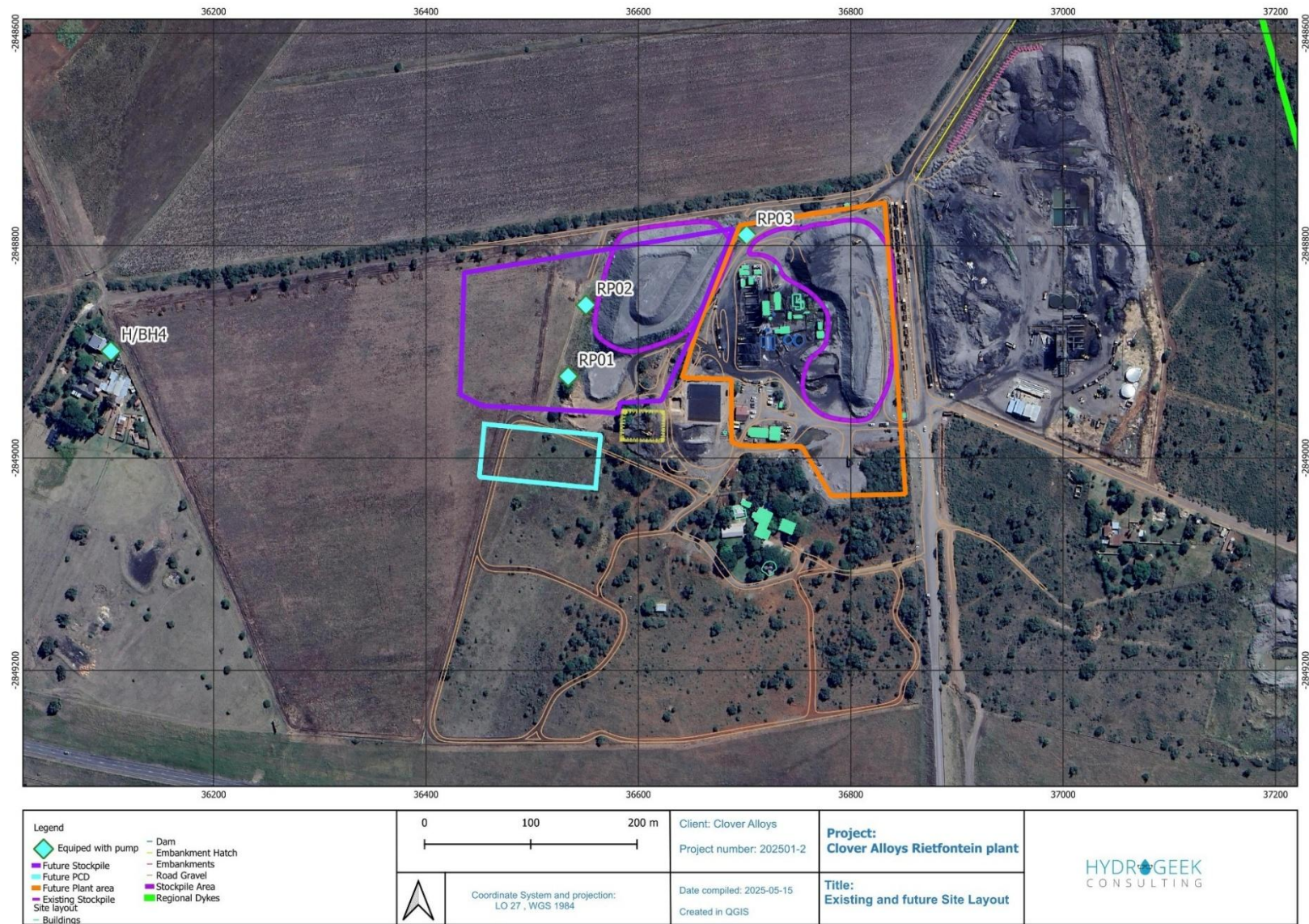


Figure 3 Plant infrastructure layout

3.3 Rainfall and Cumulative Rainfall Departure (CRD)

The area falls within the middle-veld climatic zone with hot summers and mild winters. Regional Mean Annual Precipitation (MAP) varies between 558 mm and 730 mm. Precipitation occurs primarily during the summer months in the form of high intensity, short duration thunderstorms between November and March with the peak rainfall occurring in January.

Daily rainfall data was obtained from the CCWR (Computing Centre for Water Research, Natal University) database. CCWR gauge 0511672 (Klipfontein) was used. The gauge is located 8km northwest of the plant. The records provided 73 years of recorded and patched daily data that can be representative of the rainfall that occurs on the mine (Minelock, 2022)

Table 3 Average rainfall and evaporation (Minelock, 2022)

Month	Average rainfall (mm)	Average evaporation (mm – S-Pan)
January	117	182
February	91	152
March	80	147
April	46	116
May	16	99
June	8	81
July	4	90
August	5	119
September	16	160
October	52	186
November	82	176
December	116	192
Mean annual	633*	1 700

shows the average amount of rainfall per month in Kroondal (Northwest). The numbers are calculated over a 30-year period to provide a reliable average.

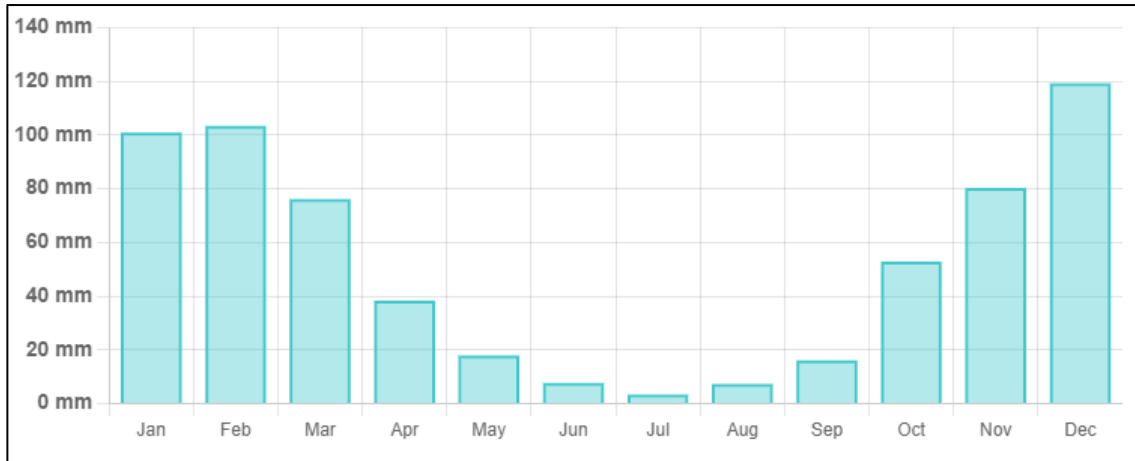


Figure 4 Climatic data representation.

The CRD is a graph that is constructed by accumulating the monthly differences between a specific monthly rainfall and the average monthly rainfall of the rainfall sequence. Increasing CRD trends are therefore indicative of consecutive above average rainfall events (probably causing groundwater recharge and therefore rising water levels) whilst decreasing CRD trends are indicative of consecutive below average rainfall events with no or very little groundwater recharge and therefore declining water levels.

3.4 Evaporation

The proposed development is in Evaporation Zone 3B. The closest Evaporation station A2E008, the Rustenburg station, is located 8km East of the proposed development, and gives a mean annual evaporation (MAE) of 1645mm for the S-Pan value and 2054mm for the A-Pan value. The evaporation measurements cover the years 1957 to 1979.

4 GEOLOGY OF THE STUDY AREA

4.1 Regional Geology

The regional geology of the area is given in Figure 6. The ore body is in the Critical zone of the Rustenburg Layered suite in the Bushveld Ingenious Complex (BIC). The area strikes east-west and dip 10 degrees to the north. The chrome layers are interlayered by pyroxenites, norites and anorthosites. The black turf soil overlays the residual weathered bedrock, approximately up to 6m thick in places. The weathered zone ranges in thickness up to 40m.

The regional area is underlain by the Ruighoek pyroxenite, Mathlagame norite, Mathlagame norite anorthosite and Kroondal Norite of the Rustenburg Layered Suite, Bushveld Complex, Vaalian Era. The soil cover on the site consists of a dark brown to black, firm loamy clay with abundant vegetation roots. This soil is dispersive and expansive and forms large cracks when moisture is driven off. Locally the soil is referred to as black “turf”.

Generally, it should be noted that the geology of site has been artificially modified in areas due to mining activities surrounding the site. This artificial modification of the geology could possibly have an impact on the hydraulic properties of groundwater flow in the subsurface. A simplified description of the units underlying the project area is represented in Figure 5.

SEDIMENTARY AND VOLCANIC ROCKS						INTRUSIVE ROCKS				
Era	Sequence	Group	Formation	Lithology	Colour	Colour	Lithology	Formation	Group	Sequence
QUATERNARY				Surface deposits	Q					
						Vcm	Norite	Mathlagame Norite-anorthosite	RUSTENBURG LAYERED SUITE	RUSTENBURG COMPLEX
VAALIAN					Vcr	Piroxinite	Ruighoek Pyroxenite			
					VI	Piroxinite, dunite, harzburgite	Tweelaagte Bronzitiite			
					Vn	Norite, diabase, epideorite	Norite, hybrid Kolobeng norite rocks			
	TRANSVAAL	PRETORIA	Magaliesburg	Quartzite minor hornfels	Vm					

Figure 5 Geology groups present



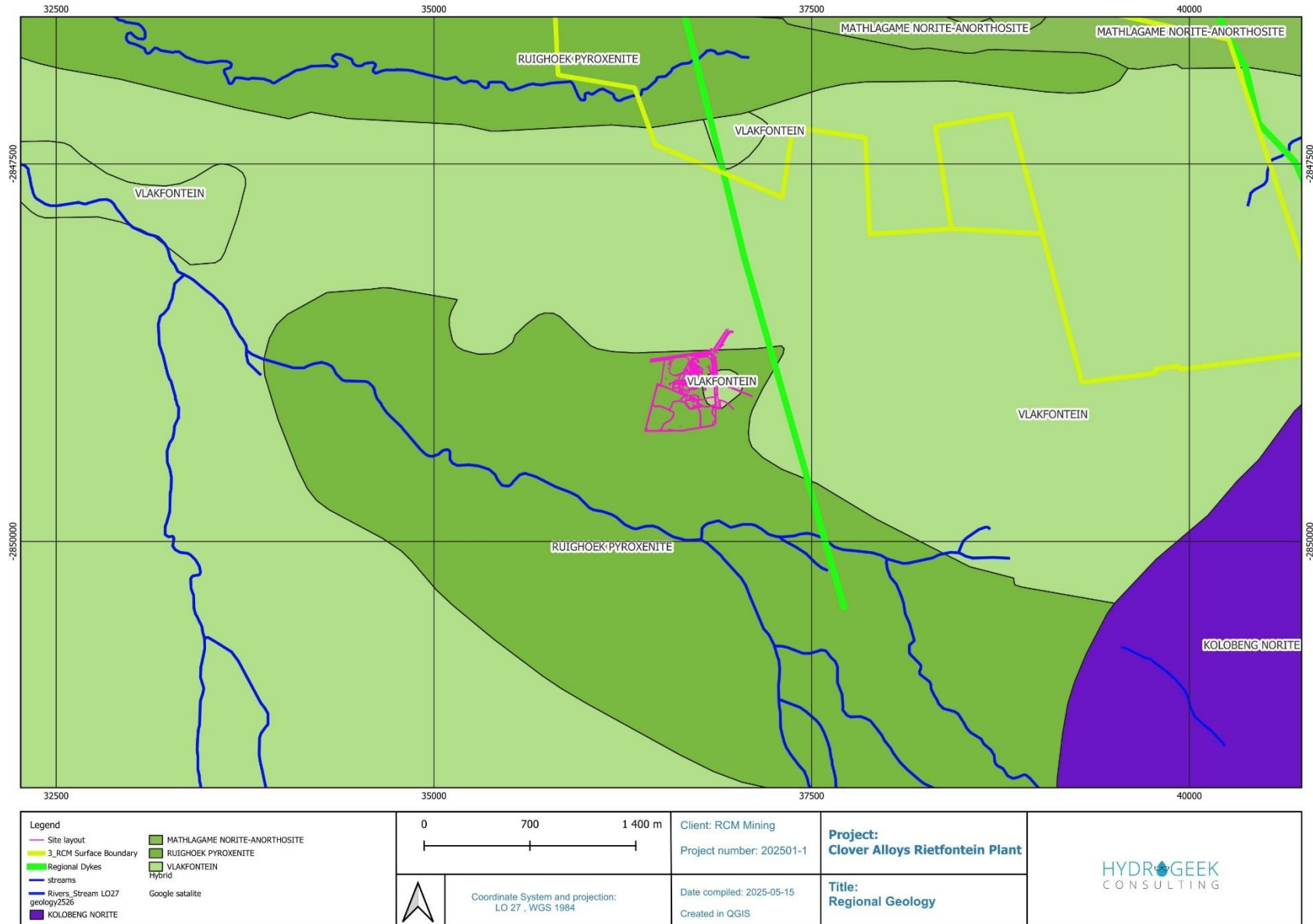


Figure 6 Regional Geology



5 HYDROGEOLOGY OF THE STUDY AREA

5.1 Aquifers and Groundwater Occurrence

The area of interest is located on a fractured and intergranular aquifer, with a successful borehole yield of between 0.5 l/s and 2.0 l/s. According to Barnard (2000), the rocks of the Rustenburg layered suite are characterized by a well-developed igneous layering. The mainly mafic rocks include norite, gabbro, magnetite gabbro anorthosite and pyroxenite. Groundwater occurrence is associated mainly with deeply weathered and fractured mafic rocks. Some of the norite zones weather more easily than other rock types. This characteristic in association with north-south striking dykes that cut through and across the norite, has formed groundwater compartments especially in the area between Rustenburg and Pretoria. The groundwater yield potential is classified as poor as the majority of the boreholes on record produce less than 2l/s. The mafic rocks weather to a clay rich soil that is represented by the well-known black turf. The very low permeability of this soil (in the order of 10⁻³m/d) is considered to reduce recharge to underlying aquifers. In most cases the hydraulic conductivity of the subsurface would be increased due to mining activities and this would in turn mean higher yielding aquifers relating to old and current mine workings.

5.1.1 Unsaturated zone – shallow, saprolitic aquifer

The main source of recharge into the shallow aquifer is rainfall that infiltrates the aquifer through the unsaturated (vadose) zone. Vertical movement of water is faster than lateral movement in this system as water moves predominantly under the influence of gravity. This aquifer may contain coarse, anorthositic sediment or turf clay sediment when underlain by anorthosite or gabbro-norite respectively. The hydraulic conductivity of this aquifer ranges between 10⁻⁸ and 10⁻²m.day⁻¹ and porosity ranges between 0.4 and 0.7 for turf clay sediments. The hydraulic conductivity of the coarse, anorthositic sediment can reach up to 20m/day with porosities ranging between values of 0.25 to 0.5.

5.1.2 Saturated zone – fractured bedrock aquifer

Groundwater movement is predominantly associated with secondary structures in this aquifer (fractures, faults, dykes, etc.). The average water level depth in the area ranges between 5 and 40 mbgl. Borehole yields in the Rustenburg Layered Suite fractured aquifers are generally low and can be expected to be between 0.1 and 2 l/s with regional flow resembling flow in the porous medium (i.e. obeying Darcy's law). These formations contain limited quantities of water resources due to the poor storage capacity of the igneous rock. Groundwater quality in the area is also expected to be intermediate to poor with EC values ranging from 4.4 to 120 mS/m and possibly elevated Ca, Mg, Cl, and SO₄ as well as carbonate alkalinity concentrations. Both the porosity and the hydraulic conductivity of the Rustenburg Layered Suite fractured aquifers are known to be low. The commonly expected values of porosity and permeability for igneous rock types, similar to those present in the Rustenburg Layered Suite, are 0.05 (porosity) and 10⁻⁵ m.d⁻¹ (hydraulic conductivity) respectively (Kruseman & de Ridder, 1994). Movement of groundwater in this aquifer will be preferential in secondary structures such as joints, faults and fractures. Dolerite intrusions in the form of dykes and sills are often encountered in this area. The dykes are found to run in a north-northeast / south-southwest direction and

can serve both as aquifers and aquifuges. Thick, unbroken dykes inhibit the flow of water, while the baked and cracked contact zones can be highly conductive. These structures thus tend to dominate the flow of groundwater. Unfortunately, their location and properties are rather unpredictable. Their influence on the flow of groundwater is incorporated by using higher than usual flow parameters for the rocks of the aquifer. According to the groundwater study done by Future Flow (2010) in the direct vicinity of the dyke the weathering depth tends to be more than that of the general valley area due to the effect of fracturing and subsequent higher groundwater recharge and flows associated with the intrusion of the dolerite dyke.

5.1.3 Water Strike Depths

Three boreholes were drilled as part of a study in 2023. The findings of the study provide some information on the water strikes and yields encountered. The water strikes ranges from 20- 34 mbgl, at blow yields of 0.1 to 1.2 l/s.

5.2 Monitoring Network

The current monitoring network consists of the existing abstraction boreholes RP01 and RP02. Currently limited groundwater monitoring exists upstream and downstream of the operations. Boreholes found in the hydrocensus (Borehole FH01 and FH02) exist down gradient of the plant and should be added to the monitoring network.

It is recommended to drill and site additional monitoring boreholes up and downgradient of the expansion of the Waste Rock Dumps and the Pollution Control Dam.

Table 4 Monitoring boreholes and location monitored.

Boreholes	Purpose
RP01 and RP02	Monitoring
RP01, RP02 and RP03	Water Supply

6 FIELD INVESTIGATION

6.1 Source Pathway Receptor Model

A part of the objective of the baseline groundwater assessment was to assess the potential impacts that the Rietfontein Plant Operation might have on the receiving groundwater environment and the sensitive receptors identified during the hydrocensus. For a risk to exist there must be a source, pathway and a receptor present.

6.1.1 Rietfontein Plant Operation

During the hydrocensus, multiple groundwater users were identified within a 2 km radius of the Rietfontein Plant Operation. The groundwater users are not expected to experience adverse impacts from the Rietfontein

Chrome Plant due to the Sandspruit non-perennial tributary of the Hex River forming a divide between the plant and majority of private groundwater users.

Hydrocensus information proved sufficient to determine groundwater quality and potential pollution down-gradient of the Rietfontein Plant. Borehole FH02 situated down gradient of the Rietfontein plant indicated an elevated Total Chrome concentration which confirms that during high-rainfall contaminated run-off contributes to groundwater contamination. Therefore, the aquifer is considered a receptor.

6.2 Hydrocensus

A hydrocensus was conducted on the 11th, 12th and 13th of February 2025. Boreholes were identified within a radius of 2 km of the Rustenburg Chrome Mine (RCM) site and a radius of 2 km around the Rietfontein Plant Operation. Information collected from the hydrocensus included verification of existing boreholes, location of private boreholes, current use, type of pump, groundwater level and the identification of any sensitive receptors.

During the hydrocensus conducted around the Rietfontein Plant Operation site, a total of 26 boreholes were included which was a combination of open/un-equipped boreholes, on-site production boreholes and privately owned water supply boreholes. The key hydrogeological information is summarised as follows:

- Of the 26 boreholes, the static water levels of 15 boreholes were measured with an average static water level of 17.24 mbgl.
- 14 of the 26 boreholes identified are privately owned water supply boreholes.
- The Rietfontein Plant Operation site is situated approximately 1 km north of the Sandspruit, which acts as a divide between the site and the private users situated to the south of the Sandspruit.

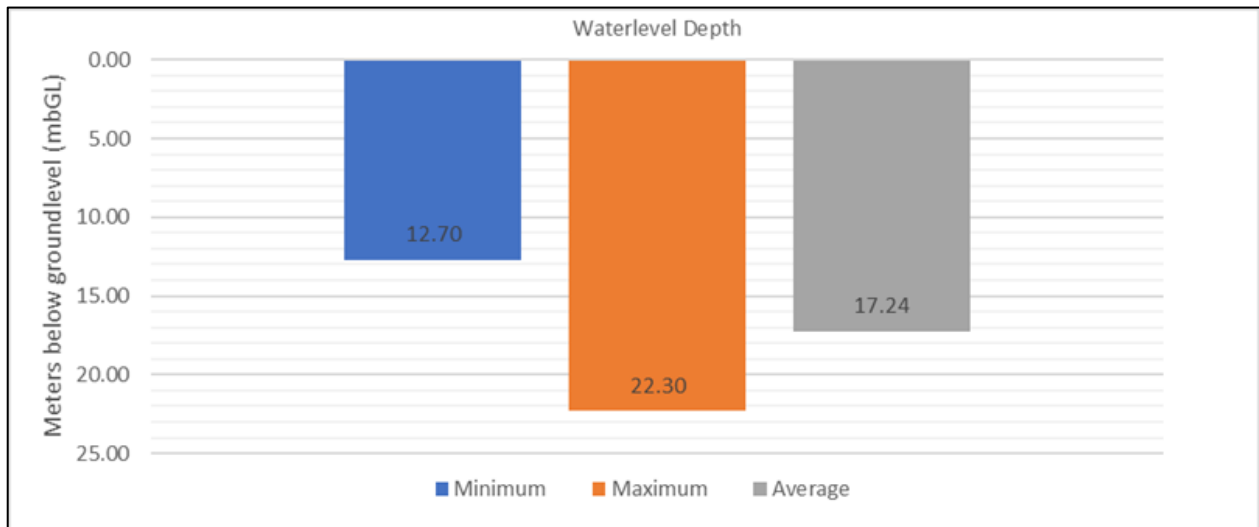


Figure 6.1: Water level statistic graph for Rietfontein Plant Operation hydrocensus

6.3 Groundwater Gradient

Groundwater will flow in response to a hydraulic gradient, typically created by difference in topographic elevation i.e. groundwater will flow from a topographic high to a topographic low. Therefore, a linear correlation generally exists between topography and groundwater level.

The hydrocensus data from the Rietfontein Plant study area is limited in spatial extent but shows a good linear relationship ($R^2 = 89.94\%$). Indicating that undisturbed groundwater mimics surface topography and will flow south/south-east towards the Sandspruit, a non-perennial tributary of the Hex river (Figure 6.2).

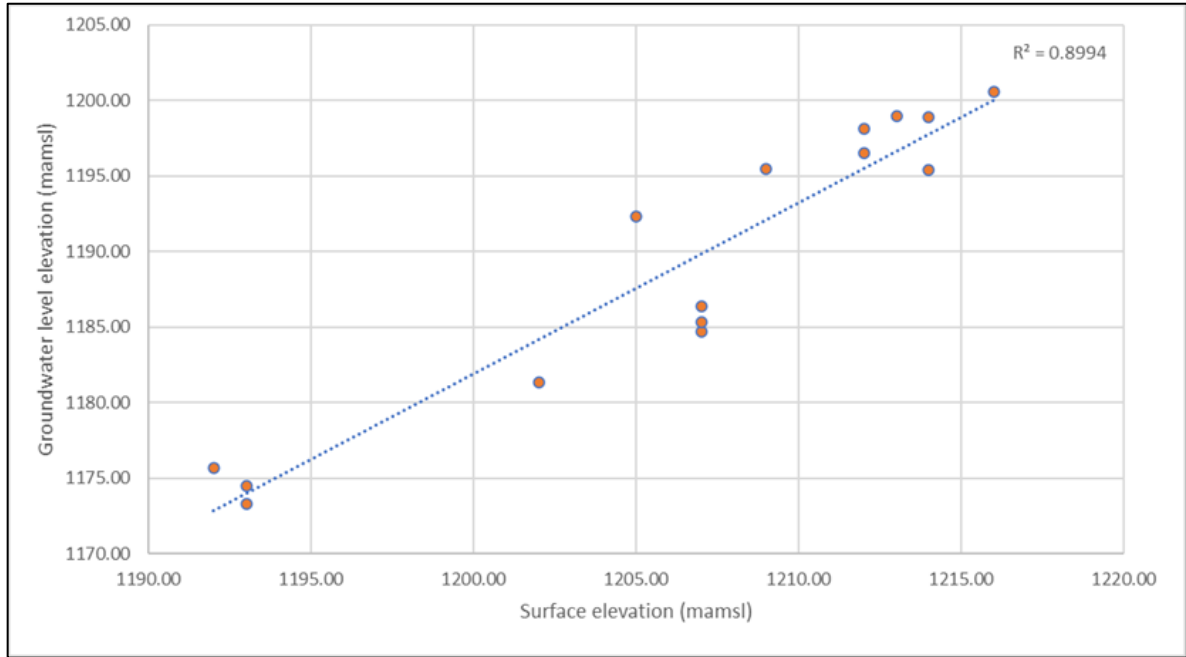


Figure 6.2: Correlation between groundwater elevation and surface elevation.

Table 5 Hydrocensus information for Rietfontein Plant Operation.

Borehole ID	Coordinates		Elevation (maMSL)	BH Type	Casing Material	Borehole Condition	Borehole Depth (mbGL)	Equipment	Static Water Level (mbGL)	Static Water Level (maMSL)	Status		Usage				Comments
	Latitude	Longitude									Operational	Non-operational	Domestic	Livestock	Irrigation	Other	
SC01	-25.7527	27.3721	1212.00	Production	Steel	Good	-	Submersible	13.9	1198.10	x		x		x		Yield - 0.3 l/s
SC02	-25.7529	27.3712	1209.00	Production	Steel	Good	-	Submersible	13.5	1195.50	x			x	x		Yield - 0.3 l/s
SC03	-25.7532	27.3704	1208.00	Production	Steel	Good	-	Submersible	-	-	x		x	x	x		Yield - 0.3 l/s Sealed off
SC04	-25.7531	27.3699	1208.00	Production	Steel	Good	-	Submersible	-	-	x		x	x	x		Yield - 0.3 l/s Sealed off
RN01	-25.7651	27.3651	1207.00	Production	Steel	Good	-	Submersible	22.3	1184.70	x		x		x		Yield - 1.4 l/s
RN02	-25.7654	27.3644	1207.00	Production	Steel	Good	-	Submersible	21.7	1185.30	x			x	x		Yield - 0.8 l/s
RN03	-25.7610	27.3621	1202.00	Production	Steel	Good	41	Submersible	20.7	1181.30	x		x	x	x		Yield - 2 l/s
RN04	-25.7613	27.3622	1202.00	Production	Steel	Good	-	Submersible	-	-	x			x	x		Yield - 0.8 l/s
BS01	-25.7541	27.3481	1185.00	Production	Steel	Good	-	Submersible	-	-	x		x		x		
RN06	-25.7571	27.3558	1192.00	Production	Steel	Good	-	Submersible	16.3	1175.70	x		x		x		
FH01	-25.7492	27.3659	1212.00	Open BH	Steel	Good	-	None	15.5	1196.50	x						
FH02	-25.7504	27.3651	1205.00	Open BH	Steel	Good	-	None	12.7	1192.30	x						
RP01	-25.7476	27.3641	1206.00	Production	Steel	Good	-	Submersible	-	-	x					x	Borehole buried beneath surface Water for wash plant
RP02	-25.7470	27.3643	1207.00	Production	Steel	Good	-	Submersible	20.6	1186.40	x					x	Water for wash plant
RP03	-25.7464	27.3658	1210.00	Production	Steel	Good	-	Submersible	-	-	x					x	Water for wash plant
VM01	-25.7572	27.3501	1193.00	Production	Steel	Good	-	Submersible	18.5	1174.50	x		x		x		
VM02	-25.7568	27.3489	1193.00	Production	Steel	Good	-	None	19.7	1173.30	x	x					Pump removed
BH1	-25.7467	27.3707	1214.00	Production	Steel	Good	32.6	Unkown	18.62	1195.38	x						
BH2	-25.7489	27.3707	1216.00	Production	Steel	Good	46.28	Unkown	15.42	1200.58	x						
BH3	-25.7480	27.3687	1213.00	Production	Steel	Good	30.73	Unkown	14	1199.00	x						
BH4	-25.7473	27.3695	1214.00	Production	Steel	Good	35.83	Unkown	15.11	1198.89	x						
BH5	-25.7441	27.3690	1209.00	Unknown	Steel	Good	60	None	-	-	x						
BH6	-25.7446	27.3695	1211.00	Unknown	Steel	Good	35	None	-	-	x						
BH7	-25.7444	27.3696	1211.00	Unknown	Steel	Good	35	None	-	-	x						
H/BH3	-25.7441	27.3593	1213.00	Production	Steel	Good	-	Submersible	-	-	x						



Borehole ID	Coordinates		Elevation (maMSL)	BH Type	Casing Material	Bore-hole Condition	Borehole Depth (mbGL)	Equipment	Static Water Level (mbGL)	Static Water Level (maMSL)	Status		Usage				Comments
	Latitude	Longitude									Operational	Non-operational	Domestic	Livestock	Irrigation	Other	
H/BH4	-25.7474	27.3598	1204.00	Production	Steel	Good	-	Submersible	-	-	x						
									Minimum	12.70	1173.30						
									Maximum	22.30	1200.58						
									Average	17.24	1189.16						



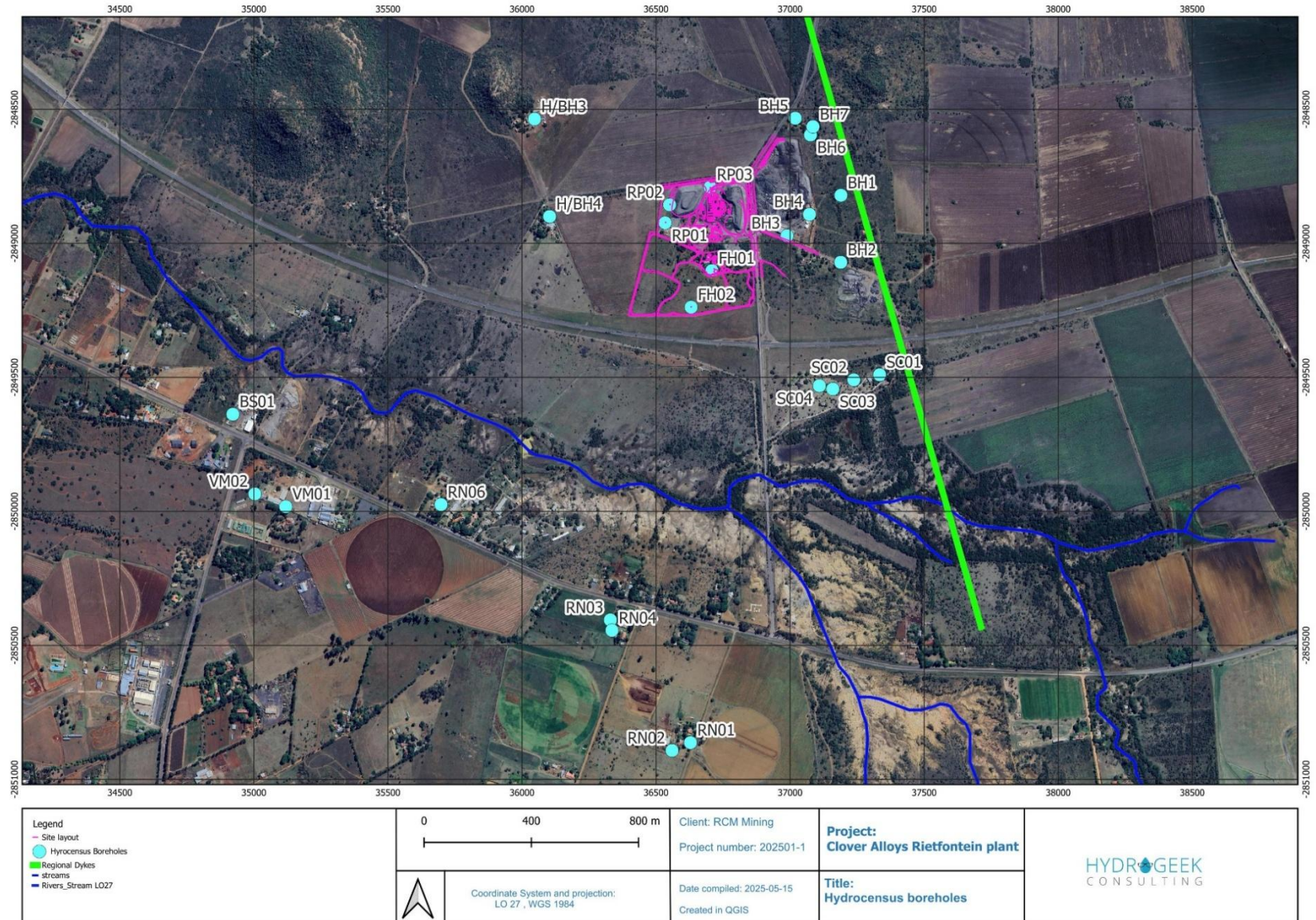


Figure 3 Hydrocensus survey



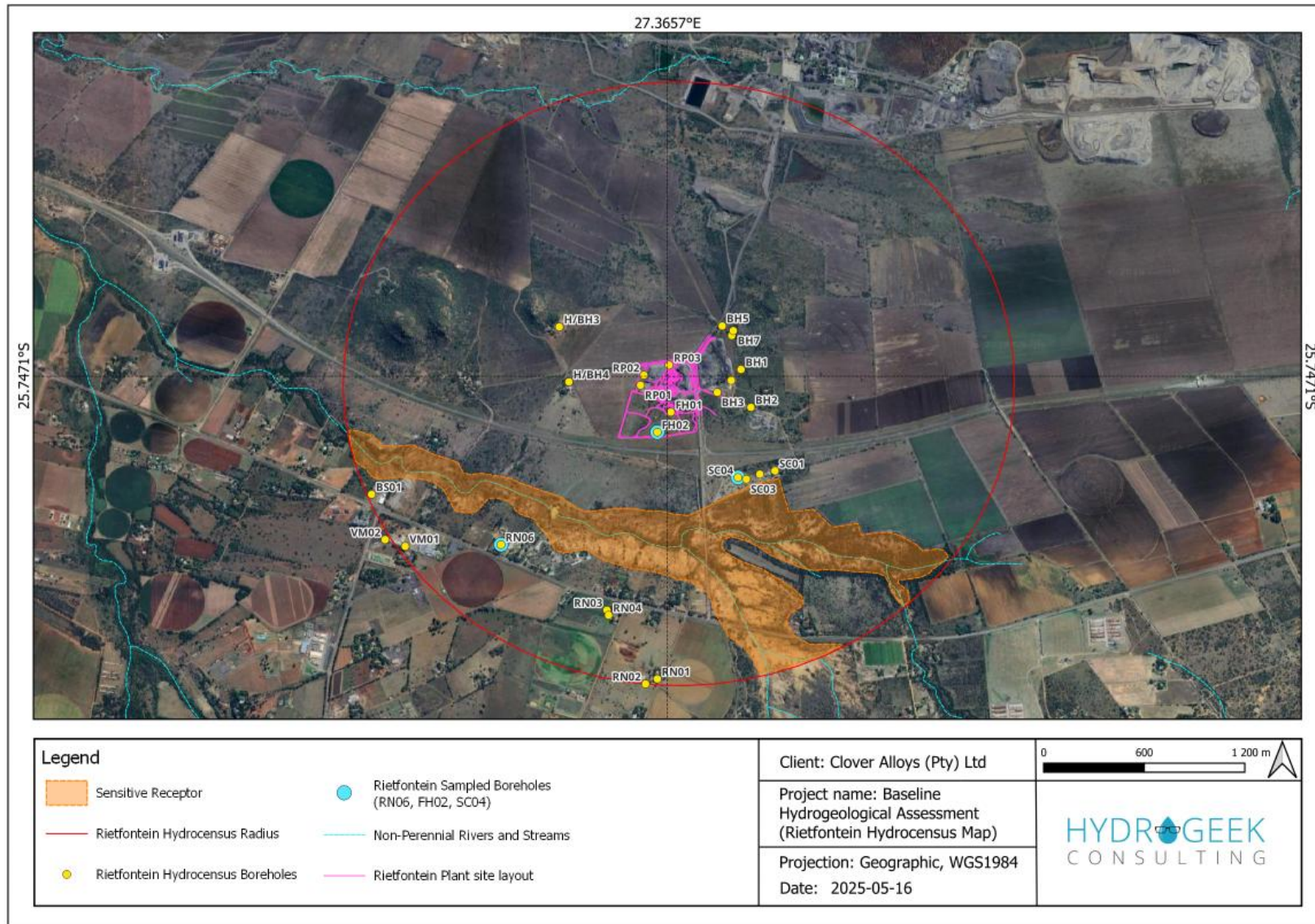


Figure 4 Hydrocensus survey boreholes sampled



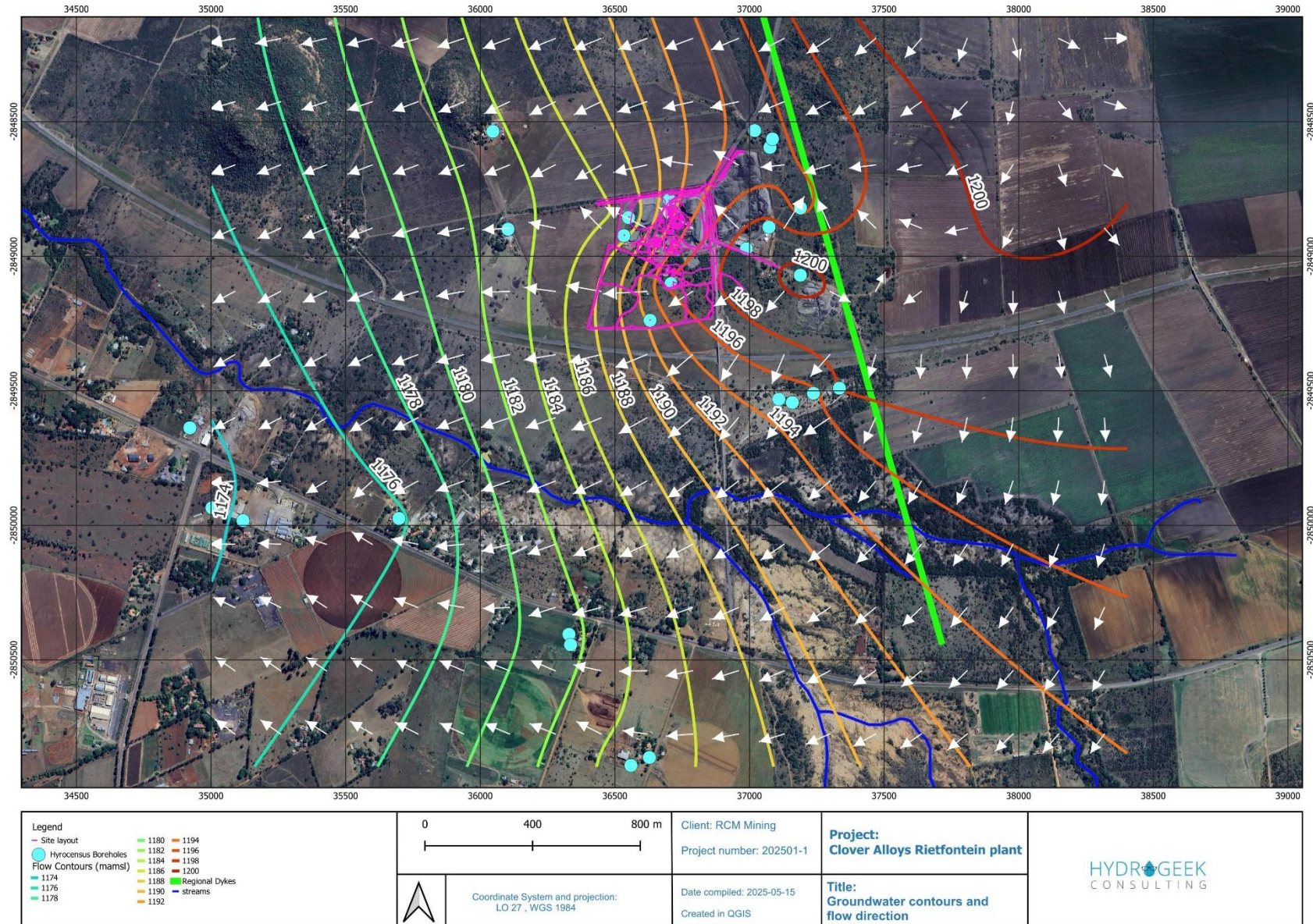


Figure 5 Groundwater flow contours (mamsl) and directions

6.4 Dewatering and Abstraction

An approved usage of 2059 m³/a has been approved from two boreholes. Based in the hydrocensus on site, three boreholes RP01, RP02 and RP03 are used for industrial purposes. The abstraction rates are unknown and no record of monitoring was provided. These abstraction rates need to be verified with flow meters and recorded for monitoring.

Table 6 Section 21 (a) Water Use Activities approved in WUL

Description and Purpose	Volume (m ³ /a)	Property Description	Co-ordinates
Taking water from Borehole 1 for industrial use	1 320	Portion 23 of the Farm Rietfontein 338 JQ	S 25.75046 E 27. 36512
Taking water from borehole 2 for domestic use	739	Portion 23 of the Farm Rietfontein 338 JQ	S 25. 74772 E 27. 38802
Total	2 059		

6.5 Hydraulic Conductivity and Transmissivity

The hydraulic conductivity for the site was not assessed during this study, but previous studies provide values that can be used that were obtained through aquifer testing in the area (Table 7).

Table 7 Hydraulic conductivities previously used at RCM

Study	Area	Transmissivity values (T)	Hydraulic Conductivity (k)
JMA, 2009	Wonderkop Segment		0.45 m/d and 6.7 m/d, geometric mean of 1.5 m/d
Digby Wells, 2014	Dyke that forms the catchment divide east of the project area	6.8 m ² /d and the transmissivity of the aquifer matrix is estimated at 3.5 m ² /d.	
Digby Wells, 2016	Mining area, upper 20-30m	2.41 to 4.82 m ² /d	1.4 x 10 ⁻⁶ to 2.8 x 10 ⁻⁸

Estimated transmissivity values, derived using the Cooper–Jacob method, range from 3.8 m²/day to 9.9 m²/day, indicating low to moderate aquifer productivity and a degree of heterogeneity within the system. These parameters will inform the initial hydraulic conductivity distribution and calibration targets in the numerical model, with further refinement expected during transient calibration as additional monitoring and aquifer test data are incorporated. These values fits well with the expected hydraulic conductivities tested previously.

Table 8 Transmissivity values tested from existing production boreholes

Borehole Information			
Borehole Number	Borehole Depth (m)	Static Water level (mbgl)	Transmissivity (m ² /day) Cooper jacob
RP01	48.43	14.18	4.8
RP02	27.08	15.79	9.9
RP03	75.79	17.93	3.8

6.6 Recharge

Groundwater recharge is the process by which water moves downward from the surface to underground aquifers. It occurs through natural processes like precipitation, infiltration, and percolation, as well as through artificial recharge methods.

Pre mining conditions the Hex River would have acted as the regional drain to remove groundwater as baseflow to the river. A small portion of rainfall (approximately 1-3%) would have recharged groundwater. As mining activities started the disturbed areas have been altered. Recharge rates are expected to be higher up to 15-20% on waste areas and open-cast mining.

6.7 Stormwater Management Plan

It is understood that a stormwater management plan report is in place (Minelock, P284_Rietfontein Plant SWMP Design Report) based on the findings from the specialist studies, the Pollution Control Dam (PCD) and associated infrastructure were sized as an integrated system (.). The PCD was designed according to the Best practise Guidelines and Government notice GN 704 as well as the NEMWA regulations of 2013, 2015 as amended in 2018 as applicable on mine waste.

The PCD will collect dirty water from the site footprint area via various channels as shown in the design drawings. The PCD is designed to size the PCD for a total volume of 8000 m³, which will result in the following approach according to the water balance study.

- Pollution control dam capacity = 8000 m³
- Temporary product stockpile catchment size = 3.19ha
- Dust suppression = 10 m³/d.

This stormwater management infrastructure will assist in mitigating any further contamination based on the associated infrastructure.

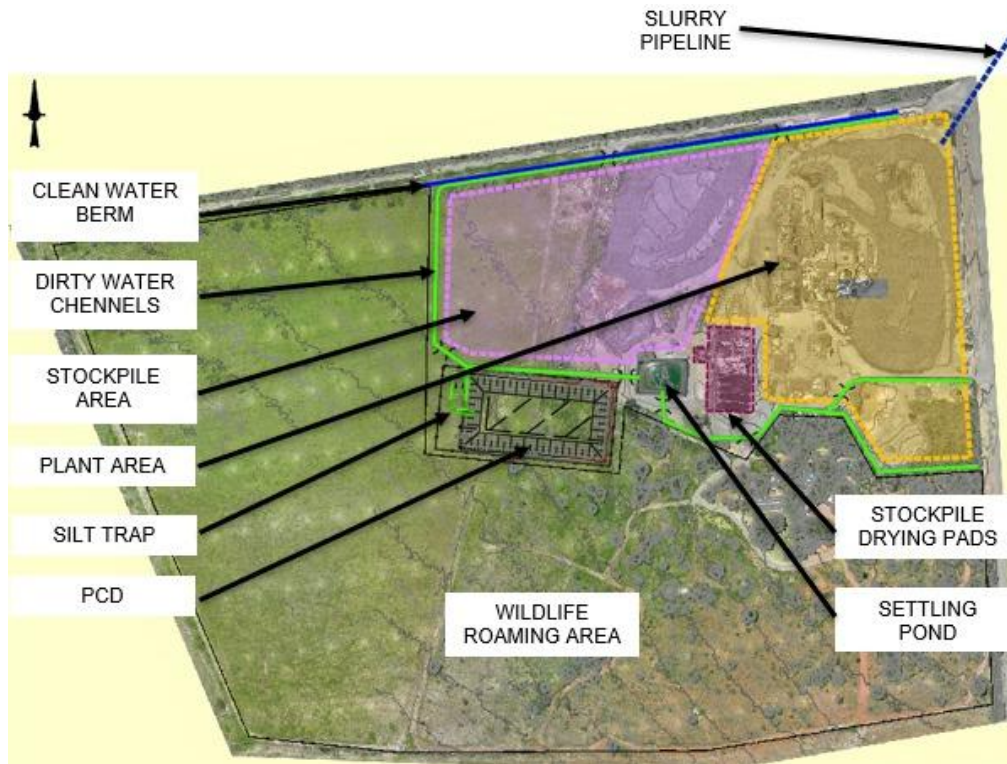


Figure 6 Stormwater infrastructure Plan

6.8 Water Quality

Based on previous work in 2017 by Digby Wells Borehole 1 indicate exceedances for magnesium, sulphate and fluoride concentrations based on the IWUL 2017. Additionally, no exceedances based on the SANS Drinking Water Standards or SAWQG for Industrial Use are seen. Potential impact on the groundwater is attributed to activities at Clover Alloys at Rietfontein. The Borehole 2 indicate exceedances for conductivity, calcium, magnesium, chloride and sulphate concentrations based on the IWUL for 2017. Additionally for conductivity, total dissolved solids, total hardness and nitrate concentrations based on either the SANS 241:2014 Drinking Water Standards or SAWQG for Industrial Use are exceeded. The exceedance indicates potential impacts associated with the activities at Clover Alloys at Rietfontein.

The surface water localities, Sink, Settling and Cement Dam indicate exceedances for conductivity, total dissolved solids, total hardness, ammonium and nitrate concentrations based on either the SANS 241:2014 Drinking Water Standards or SAWQG for Industrial Use. The Settling and Cement Dam shows exceedances for nickel concentrations based on the SANS 241:2014 Drinking Water Standards.

The programme involves monitoring of two abstraction boreholes at the Rietfontein operations for only quality based on this report. The most recent water quality analysis results obtained from Clover Alloys Quarterly Ground Water Monitoring Report (Fourth Quarter of 2023) are summarised in Table 9 below. **No parameters exceeded the SANS guidelines, and the water quality is deemed good.**

Table 9 Water quality analysis results from the fourth quarter of 2023.

Variable	Unit	Limit	Borehole ID's	
			RT01	RT02
pH	pH units	7-9	8.01	7.91
Al	mg/l	<0.15	<0.01	<0.01
Ca	mg/l	40-60	37.4	29.9
Cl	mg/l	100	42.95	35.8502
Fe	mg/l	0.1	<0.005	<0.005
Mg	mg/l	30-40	27.38	24.48
Na	mg/l	<100	18.62	17.21
SO4	mg/l	<200	40.07	34.51
NO3	mg/l	<6	30.4	23.2F
F	mg/l	<1	0.143	0.174

6.8.1 Rietfontein Plant Operation hydrocensus

- **EC** – EC values for the two private water supply boreholes exceeded the Class 4 Limits of the DWS Drinking Water Guideline Limits.
- **Nitrate** – All Nitrate concentrations are below the acute health limit of ≤ 11 mg/L.
- **Chrome** – The Chrome concentration for borehole FH02 (0.4 mg/L) located down gradient of the Rietfontein Chrome Plant, exceeded the SANS 241:2015 Drinking Water Standards acute health limit of 0.05 mg/L. This indicates possible contamination of the groundwater regime, originating from the plant.

6.8.2 Piper Diagram

A Piper plot is a tri-linear plot where the hydro-chemical composition of water samples is evaluated determining the ratios of predominant cations and anions. The plot is divided into water facies depicting the dominant ratios.

- The calcium-magnesium-bicarbonate (left quarter) of the Piper diagram is normally characterized by recently recharged water.
- The sodium-bicarbonate (bottom quarter) is typical of flow within the aquifer, with the sodium replacing the calcium and magnesium in solution.

- The sodium-chloride dominant (right quarter) is associated with stagnant or slow-moving groundwater with little or no recharge.
- The sulphate dominant (top quarter) is typical of water impacted by the oxidation of pyrite, or other sulphate bearing sources.

The following observations are made with reference to the piper diagrams for the Rietfontein Plant study area shown in

- Boreholes FH02, SC04 and RN06 sampled during the Rietfontein Plant hydrocensus plot towards the left-hand side of the diamond which indicates magnesium-bicarbonate type groundwater. This groundwater is typically associated with recently recharged groundwater

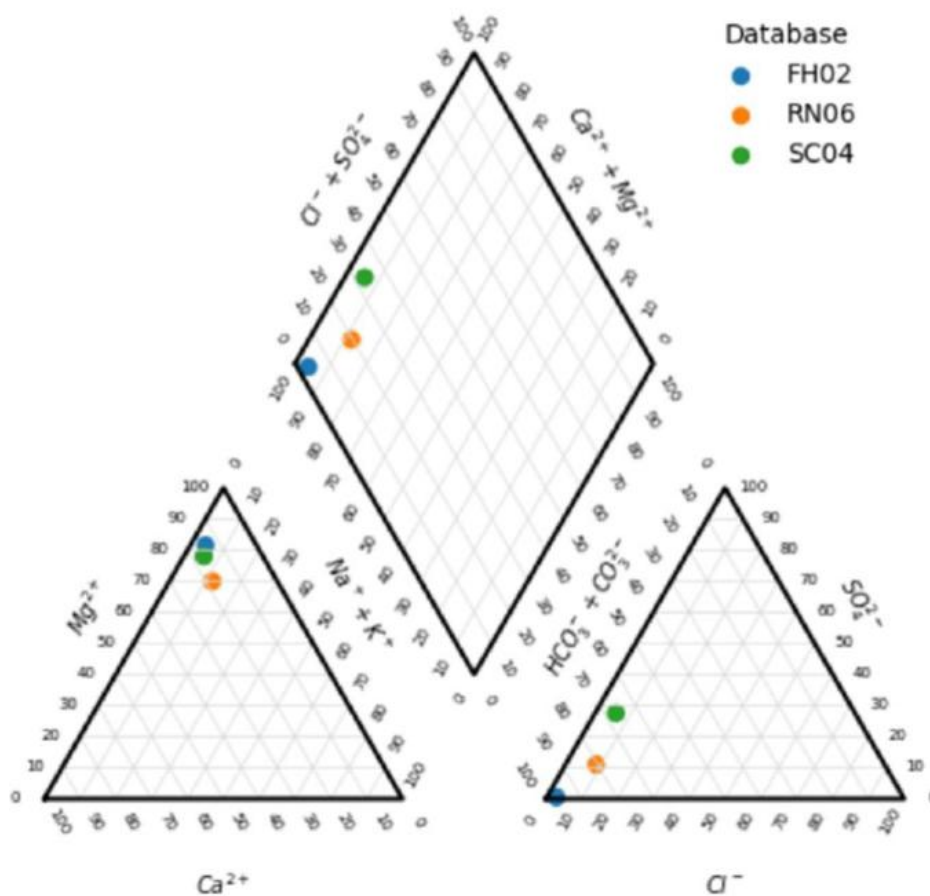


Figure 7 Piper diagram for Rietfontein Plant

Table 10 Water Quality Analysis results of boreholes tested.

	DWS Drinking Water Guideline Limits					SANS241: 2015 Drinking Water Standard Limits			RN06 (Rietfontein)	SC04 (Rietfontein)	FH02 (Rietfontein)
	Class 0	Class 1	Class 2	Class 3	Class 4	Aesthetic limits	Chronic Health Limits				
pH	5-9.5	4.5-5 or 9.5-10	4-4.5 or 10-10.5	3-4 or 10.5-11	<3 or >11	≥5 to ≤9.7			7.92	7.83	7.5
Electrical Conductivity	<70	70-150	150-370	370-520	>520	Aesthetic ≤170			914	1349	958
TDS	<450	450-1000	1000-2400	2400-3400	>3400	Aesthetic ≤1200			611	940	616
Antimony							Chronic health ≤0.02		<0.05	<0.05	<0.05
Arsenic	<0,01	0,01 - 0,05	0,05-0,2	0,2-2	>2		Chronic health ≤0,01		<0.05	<0.05	<0.05
Barium							Chronic health ≤0,7		0.12	0.14	0.07
Beryllium									<0.05	<0.05	<0.05
Boron							Chronic health ≤2,4		<0.5	<0.5	<0.5
Calcium	<80	80-150	150-300	>300					42.28	59.91	34.54
Copper	<1	1-1,3	1,3-2	2 - 15	>15		Chronic health ≤2		0.06	<0.05	0.07
Total Iron	<0,5	0,5-1	1 - 5	5 - 10	>10	Aesthetic ≤0,3	Chronic health ≤2		<0.05	<0.05	0.14
Magnesium	<70	70-100	100-200	200-400	>400				98.67	172	119.7
Manganese	<0,1	0,1-0,4	0,4-4	4 - 10	>10	Aesthetic ≤0,1	Chronic health ≤0,4		<0.05	<0.05	0.31
Molybdenum									<0.01	<0.01	<0.01
Potassium	<25	25-50	50-100	100-500	>500				2.83	3.56	3.12
Sodium	<100	100-200	200-400	400-1000	>1000	Aesthetic ≤200			30.11	21.16	9.97

	DWS Drinking Water Guideline Limits					SANS241: 2015 Drinking Water Standard Limits			RN06 (Rietfontein)	SC04 (Rietfontein)	FH02 (Rietfontein)
	Class 0	Class 1	Class 2	Class 3	Class 4	Aesthetic limits	Chronic Health Limits				
Chloride	<100	100-200	200-600	600-1200	>1200	Aesthetic ≤300			25.5	28.65	8.39
Fluoride	<0,7	0,7-1	1-1,5	1,5-3,5	>3,5		Chronic health ≤1,5		0.18	0.67	0.22
Free & Saline Ammonia	0 - 1	1 - 2	2 - 10	>10		Aesthetic ≤1,5			0.11	0.12	9.44
Nitrate	<6	6 -10	10 - 20	20-40	>40		Acute health ≤11		1.94	6.68	<0.5
Nitrite							Acute health ≤0,9		<0.13	<0.13	<0.13
Ortho Phosphate as P									<0.2	<0.2	0.72
Sulphate	<200	200-400	400-600	600-1000	>1000	Aesthetic ≤250	Acute health ≤500		43.97	185.2	<2
Cadmium							Chronic health ≤0.003		<0.05	<0.05	<0.05
Lead							Chronic health ≤0.01		<0.05	<0.05	<0.05
Cr(VI)*									<0.05	<0.05	<0.05
Total Chrome	0 - 0,05		0,05 - 1	1 - 5	>5		Chronic health ≤0,05		<0.05	<0.05	0.4
Nickel							Chronic health ≤0.07		<0.05	<0.05	<0.05
Cobalt									<0.05	<0.05	<0.05
Selenium							Chronic health ≤0.04		<0.1	<0.1	<0.1
Lithium									<0.05	<0.05	<0.05
Zinc	0 - 5	5 - 10	10 - 50	50 - 700	>700	Aesthetic ≤5			0.08	<0.05	0.21

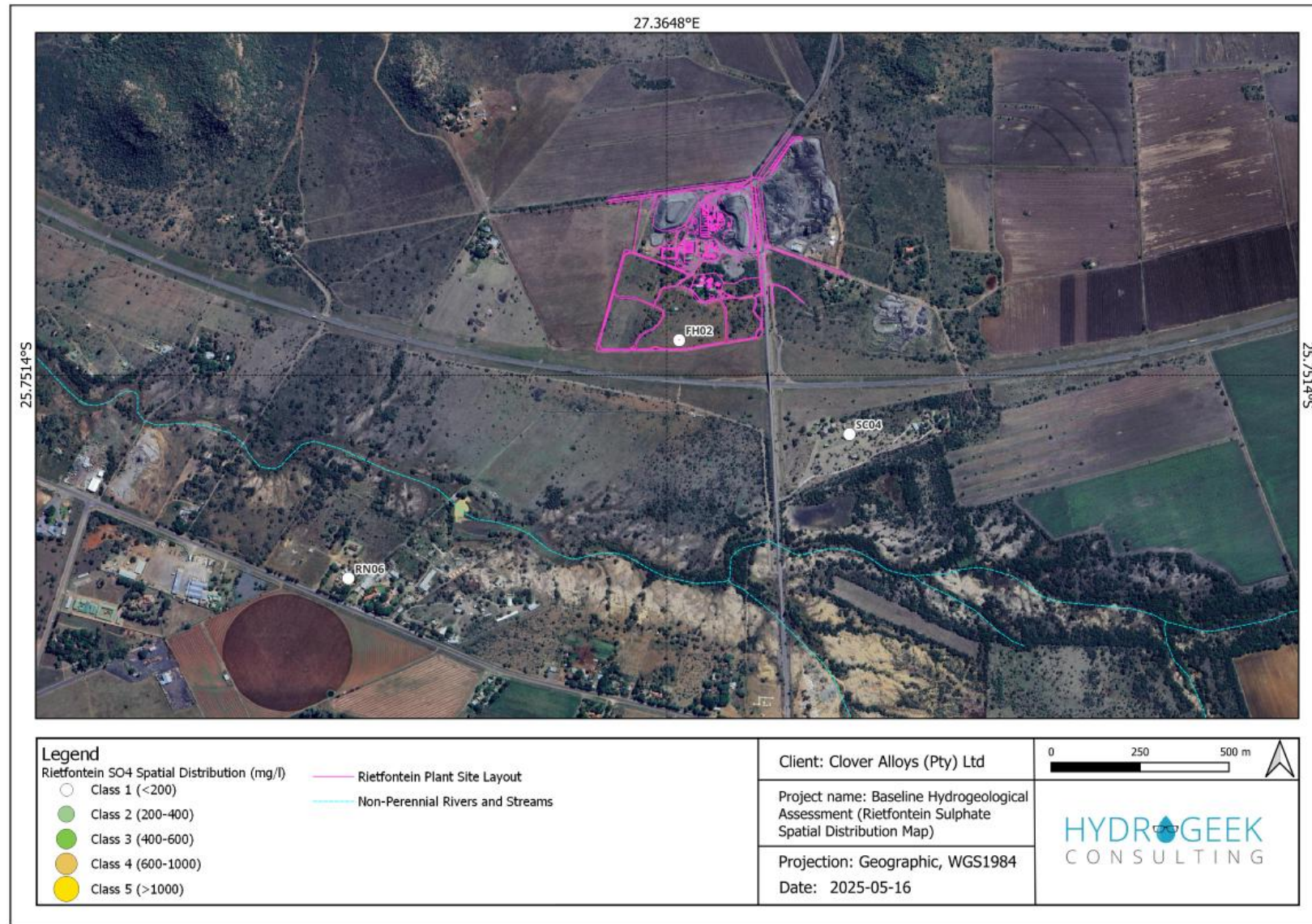


Figure 8 Spatial distribution of Sulphate (SO₄) concentrations for Rietfontein Chrome Plant

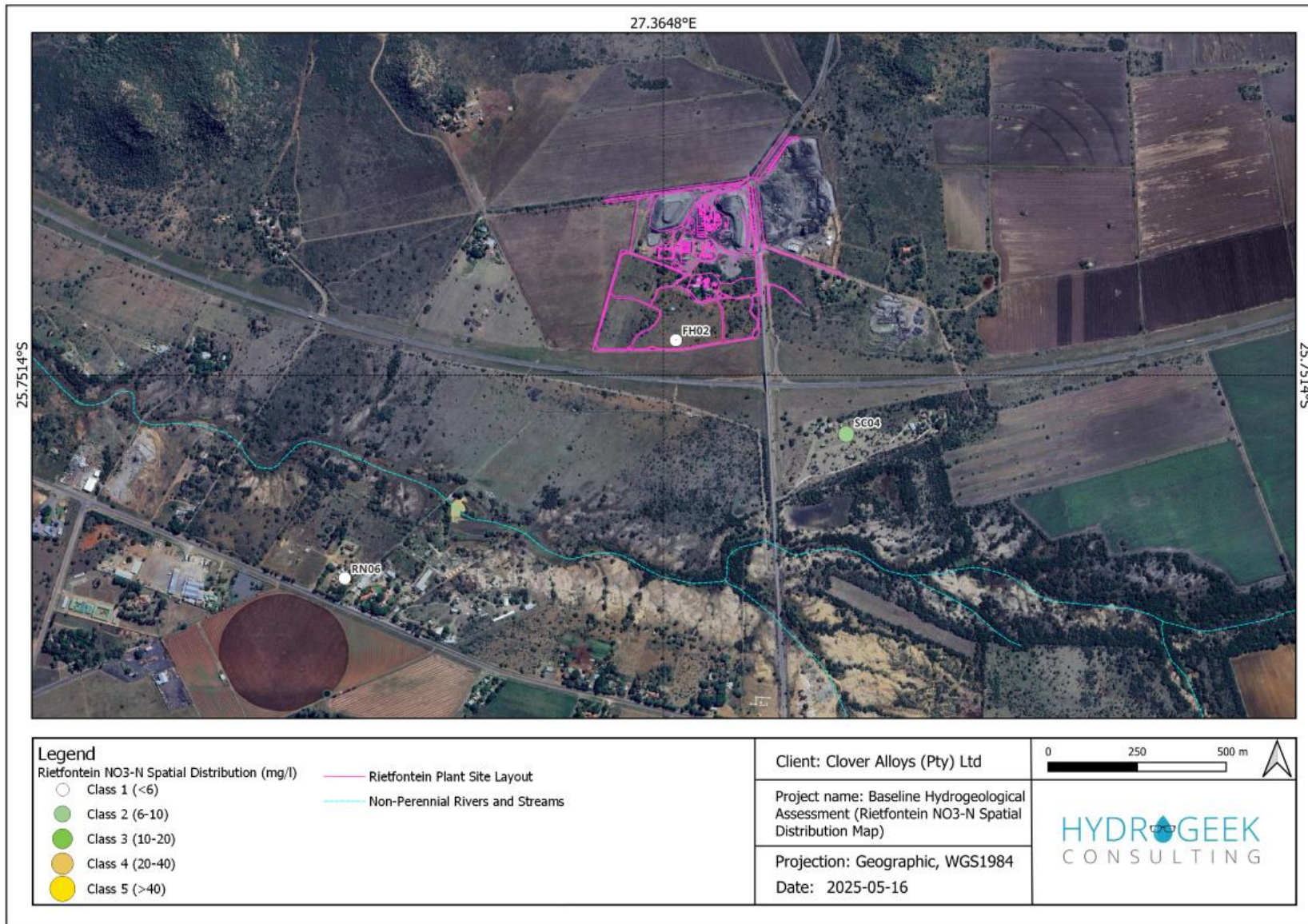


Figure 9 Spatial distribution of Nitrate (NO₃) concentrations for the Rietfontein Plant Operation

6.9 Geophysical Survey

6.10 Earth Resistivity Method

The ERT survey was conducted with the Abem Lund 2D resistivity system. The electrode separation and survey protocol used, determines the depth of investigation. The measuring protocols used were Wenner array with an investigation depth of approximately 60m, using 100-meter cables with 10-meter spacing intervals.

The ERT survey is basically an automated Wenner-type sounding. A large number of soundings with different AB (current electrodes) and MN (potential electrodes) are done along a line. Apparent resistivities are calculated, yielding resistivity-depth sections. The depth of exploration is a function of the electrode spacing used, with the maximum depth not exceeding twelve times the electrode spacing used. Depending on the data density, depths can be accurate to within 10%.

The system automatically cycles through electrodes placed into the ground along a 400m cable connection, varying the positions of the potential and current electrodes. By doing this an accurate subsurface picture of the resistivity distribution in the ground is built up.

The most common minerals forming soils and rocks have very high resistivity in dry conditions, and the resistivity of soils and rocks is therefore normally a function of variations in water content and the concentration of dissolved ions in the groundwater.

Resistivity investigations are thus used to identify zones with different electrical properties, which can then be referred to different geological strata.

The geophysical data were evaluated by plotting the data on linear graphs, which permit comparison of data from the different geophysical methods used. Thirteen drill sites and five alternative sites were selected based on the geophysical data. Drill sites are listed in priority but can be adjusted according to drilling results. Geophysical methods target geological structures which are associated with groundwater and therefore water or water strikes in boreholes are not guaranteed.

Four proposed drill sites were selected as listed in Table 11 and indicated on. The eight (8) geophysical traverses indicating drill sites are listed as Appendix A.

The geo-electrical resistivity models acquired across the survey area reveal a range of subsurface conditions, from broadly layered and geotechnically uniform profiles to zones of structural complexity requiring further investigation. The following key features are identified across the traverses and are illustrated on the accompanying figures

- Two zones of anomalously low to very low resistivity ($< 93.5 \Omega \cdot m$) extending to the full depth of investigation are identified along CP ERT1, centred between stations 20 and 50, and again between stations 90 and 115. These are interpreted as structurally controlled weathering zones along fracture, fault, or dyke-related features within the Ruighoek Pyroxenite, and are considered priority targets for monitoring borehole placement.
- Two steeply dipping to near-vertical high resistivity anomalies are identified along CP ERT2, centred between stations 140 and 160, and between stations 285 and 330 respectively. These features are

interpreted as competent structural bodies, most likely dyke intrusions or resistive lithologies such as pegmatoidal pyroxenite or chromitite reef horizons within the Rustenburg Layered Suite.





-  A suspected fault or dyke structure is identified along CP ERT3 at approximately station 80, expressed as a near-vertical low resistivity feature at the contact between the weathered south-southwestern portion of the traverse and the central high resistivity anomaly. This interpretation is supported by anomalously low resistivity values ($< 58.9 \Omega \cdot m$) at surface between stations 80 and 120, which are atypical for the expected weathered pyroxenite profile and may indicate saturated fault gouge or highly altered material associated with a structural discontinuity.
-  A localised zone of anomalously low resistivity ($< 58.9 \Omega \cdot m$) at depth between stations 0 and 40 along CP ERT4 may suggest a structurally controlled zone of enhanced fracturing or moisture retention, possibly associated with a fault or lithological contact within the weathered Ruighoek Formation. The lateral margins of the prominent high resistivity body (374 to 942 $\Omega \cdot m$) identified towards the northern portion of this traverse are considered a primary target for monitoring borehole placement.
-  CP ERT5 presents a broadly uniform, laterally consistent subsurface profile characterised by a gradational weathering sequence from residual soil and colluvium at surface through partially weathered to moderately fractured pyroxenite, deepening to fresh competent bedrock at depth. No discrete high resistivity anomalies characteristic of dyke intrusions are identified. This traverse presents no significant structures or anomalous zones of hydrogeological concern.
-  The contact zone between the weathered south-southwestern portion of CP ERT3 and the central high resistivity anomaly, together with the near-vertical feature at station 80, represent the most structurally complex subsurface conditions recorded across the survey campaign and are identified as primary targets for further investigation and targeted drilling.

Table 11 Proposed Drill Sites

Drill sites	Latitude	Longitude	Traverse	Station (m)	Borehole Name
ERT1_S80	-25.747259	27.367226	1	80	RM04
ERT3_S80	-25.74712	27.36548	3	80	RM07
ERT4_S270	-25.74691	27.36297	4	270	RM05
ERT5_S50	-25.74860	27.36373	5	50	RM06

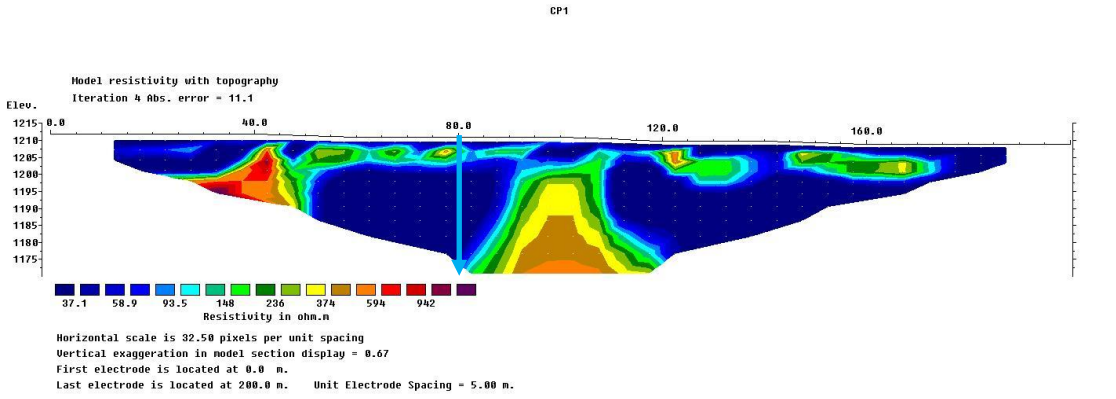


Figure 10 Geophysical survey ERT Traverse 1

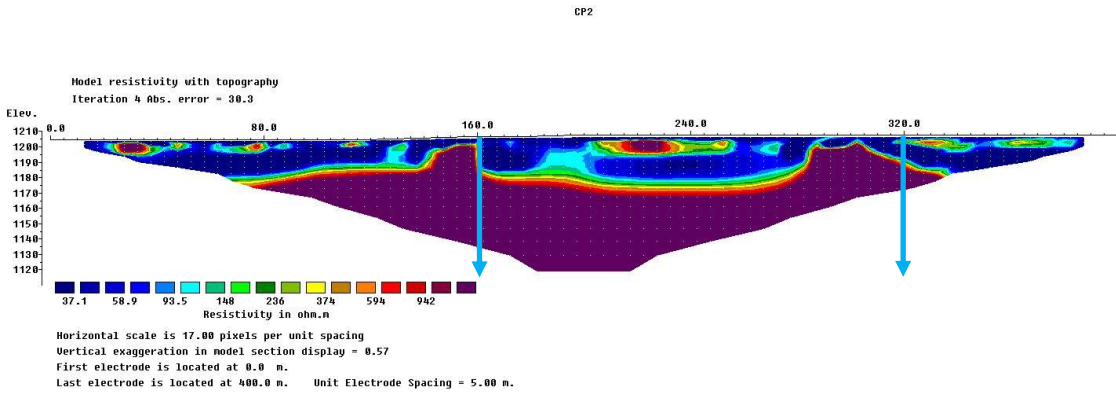


Figure 11 Geophysical survey ERT Traverse 2

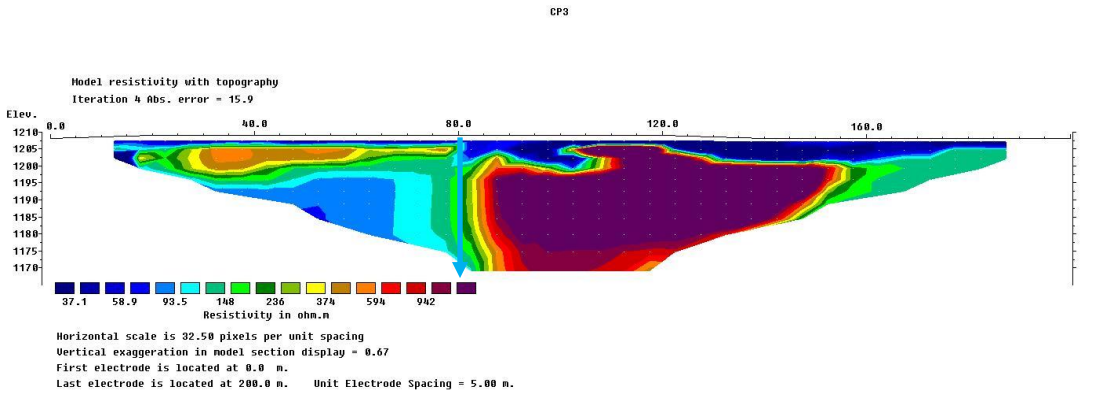


Figure 12 Geophysical survey ERT Traverse 3

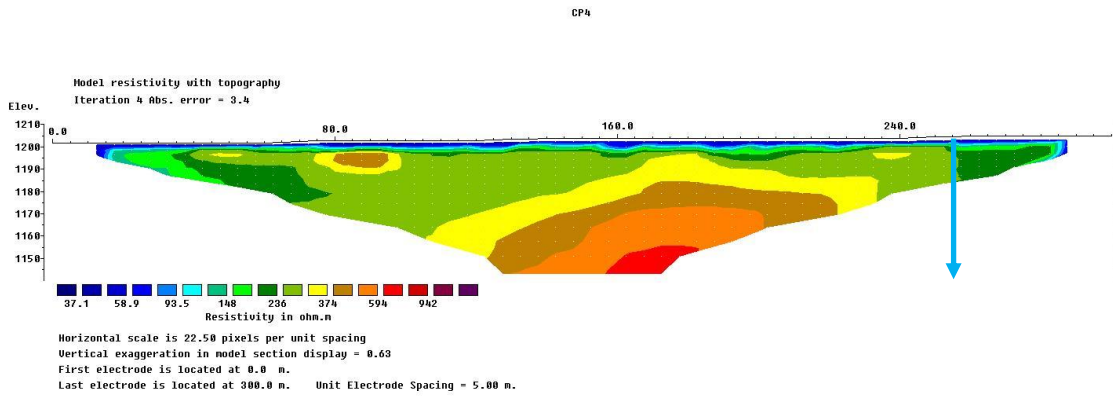


Figure 13 Geophysical survey ERT Traverse 5

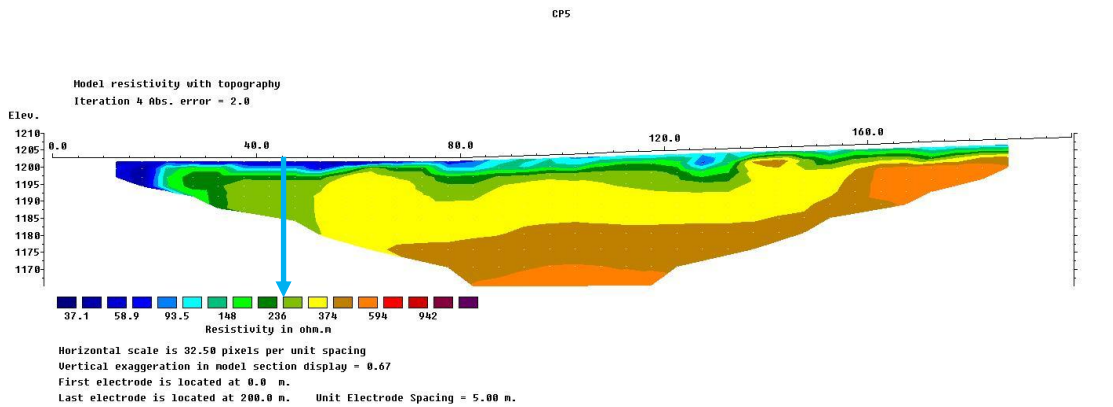


Figure 14 Geophysical survey ERT Traverse 5

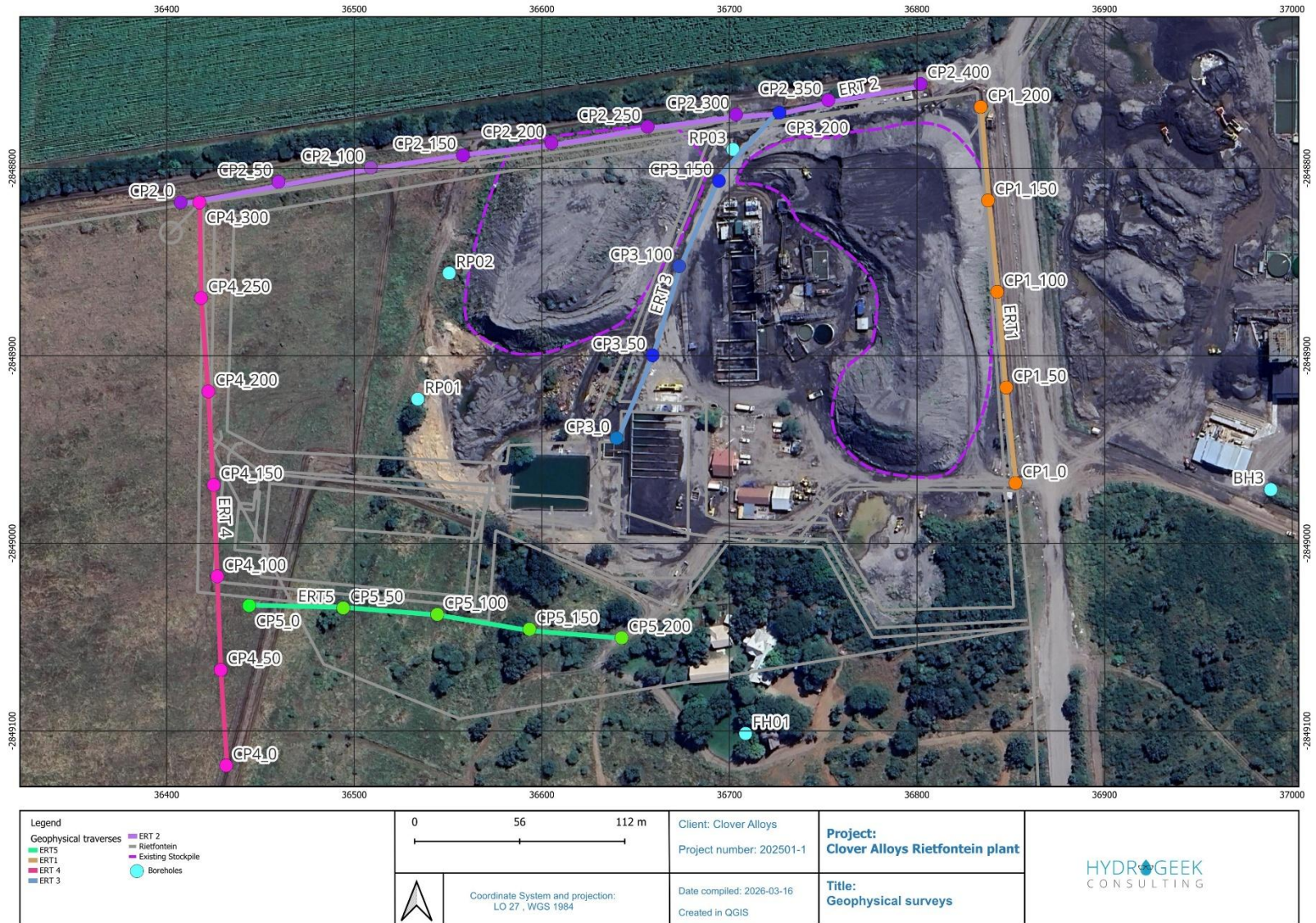


Figure 15 geophysical surveys

6.11 Drilling

Rietfontein Plant conducted a hydrogeological drilling program (6 April to 10 April) based on the results of prior geophysical surveys. The program involved the completion of monitoring boreholes with air percussion methods. Monitoring boreholes were completed with a combination of slotted and solid casing, selected based on the weathering characteristics encountered and the depth at which water strikes occurred. The depth of all the boreholes are 60 meters below ground level (mbgl). This approach will enable the collection of valuable data in the future. A summary of the drilling is given in Table 12.

Table 12 Rietfontein Drilling summary

Borehole No.	Drilling Depth (m)	Casing Depth (m) (Steel) (Solid)	Casing Depth (m) (Steel) (Perf)	Reaming Drilling Diameter (216mm) from (m)	Geological Formation Intersected
RM04	60	0-18	18-27	0-27	Norites
RM05	60	0-18	18-30	0-30	Norites
RM06	60	0-16	16-28	0-28	Norites
RM07	60	0-18	18-30	0-30	Norites

Water strikes were observed at depths ranging from 20-30 meters below ground level (mbgl), primarily weathered and fresh bedrock contact. The blow yield was measured for each borehole.

Table 13 UOL drilling findings based on water characteristics

Borehole No.	Drill site	Water Strike Depth (m)	Final Blow Yield (l/s)	Borehole Status	SWL (mbgl)	Comments	Date completed
RM04		22,30	0.5	Monitoring	To be confirmed	Lockable cap and block	07/04/2026
RM05		21,27	0.5	Monitoring	To be confirmed	Lockable cap and block	07/04/2026
RM06		24	0.3	Monitoring	To be confirmed	Lockable cap and block	07/04/2026
RM07		22	0.5	Monitoring	To be confirmed	Lockable cap and block	07/04/2026

Borehole logs



Figure 16 Borehole RM05



Figure 17 Borehole RM04



Figure 18 Borehole RM07



Figure 19 Borehole RM06



Figure 20 Drilled boreholes

6.12 Aquifer Testing

Aquifer testing was conducted at two existing boreholes

The objective of the aquifer testing was:

- To determine aquifer parameters;
- To determine safe yield of the boreholes.

The pump testing programme consists out of a step drawdown/discharge test (SDT) followed by a constant discharge test (CDT), and a water level recovery test. The SDT tests comprised of four to five 60-minute steps at increasing pumping rates. The aim of the SDT is to assess the performance of the borehole under different pumping yields and determine the pumping rate for the CDT.

The aquifer testing programme is summarised in in Table 14 and the borehole management recommendations in Table 15. Data analysis was conducted with the FC method developed by the Institute for Groundwater Studies at Free State University, Bloemfontein.

6.12.1 Existing Boreholes

The CDT is conducted to determine the hydraulic parameters of the aquifer and to determine the safe yield of the boreholes. The tested boreholes yield ranges from 0.31 to 1.83 l/s. The CDTs were conducted for a period of 1440 minutes, after which the water level recovery was measured. The pumping yields were measured volumetrically during the testing programme

Table 14 Summarised Aquifer testing programme for existing boreholes.

Borehole No.	Borehole Depth (m)	Static Water Level (mbgl)	No of SDT's	Final Yield of SDT (l/s)	Duration of CDT (Min)	Yield of CDT (l/s)	DD of CDT (m)
RP01	48.43	14.18	3	2	2440	0.7	5.82
RP02	27.08	15.79	4	2.2	2440	0.5	2.35
RP03	75.79	17.93	3	1.5	2440	0.5	17.93

Table 15 Boreholes recommendations

Borehole Information				Borehole Management Recommendations						Abstraction Rates		
Borehole Number	Borehole Depth (m)	Static Water level (mbgl)	Transmissivity (m ² /day) Cooper jacob	Yield (l/s)	Duty Cycle (hrs/day)	Pump Inlet (m)	Dynamic Water Level (m)	Critical Water Level (m)	Pump Installation	Yield (l/hour)	Daily Abstraction L/day	Monthly Abstraction L/month
RP01	48.43	14.18	4.8	0.5	12	46	18	26	Mono Electric	1800	21,600	648,000
RP02	27.08	15.79	9.9	0.6	12	24	18	22	Mono Electric	2160	25,920	777,600
RP03	75.79	17.93	3.8	0.4	12	64	28	34	Mono Electric	1440	17,280	518,400
Total				1.5								



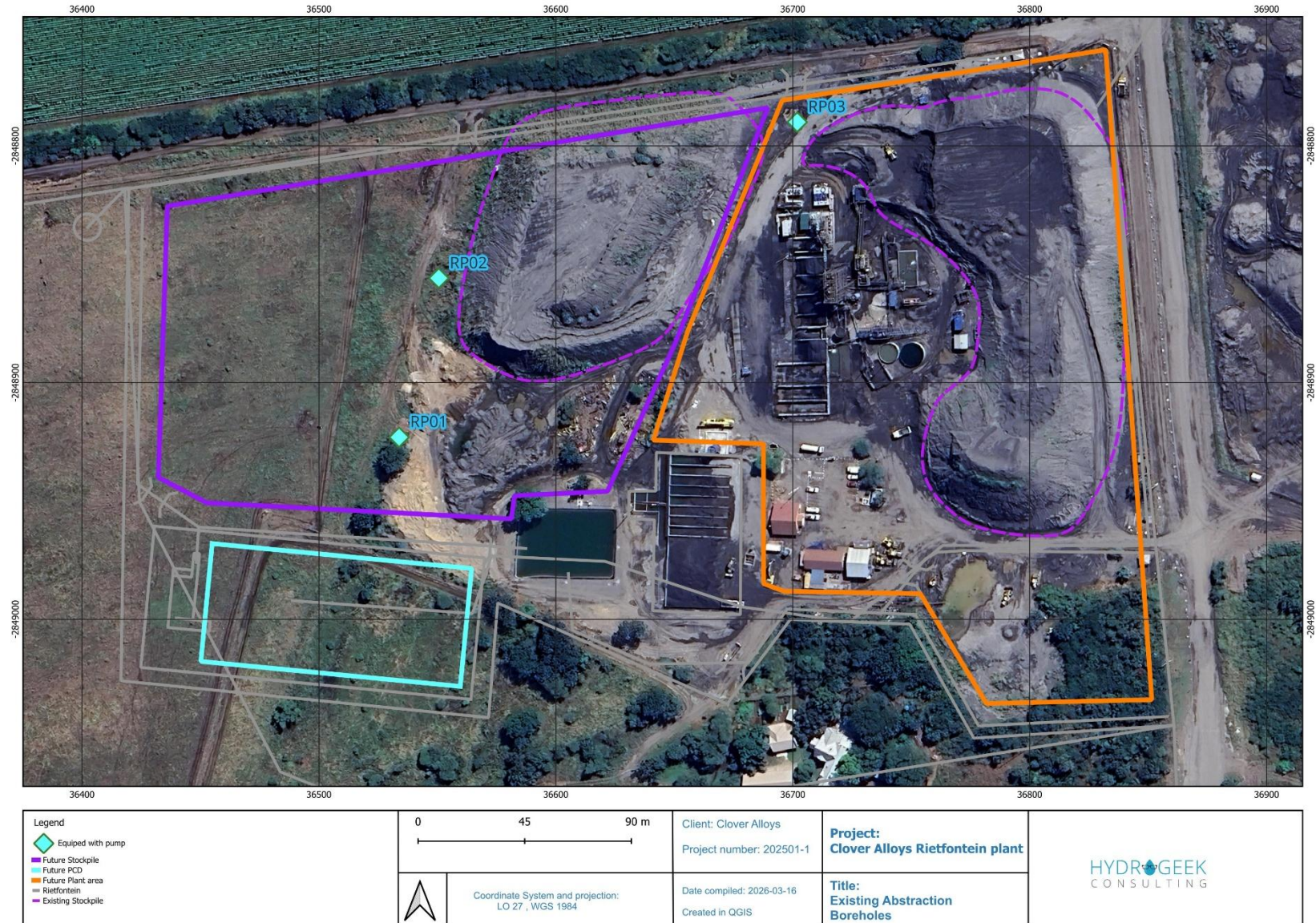


Figure 21 Aquifer Tested boreholes

7 Conceptual Model of the Aquifer System

The geometrical characterization of hydrostratigraphic units was established through past studies and experience in these geological environments. Subsequently, interpretations were extrapolated to cover an approximate area of 10.5 x 12 km, utilizing additional data sources such as rock outcrops and surface formation maps.

- 💧 The Rietfontein area consists of an eastern and western existing Stockpile area (for reference Minelock did a waste classification on these materials), Pollution Control Dam and Plant area.
- 💧 The area exhibits varying levels of conductivity and recharge. Hydraulic conductivity ranges from 1.5 x 10⁻¹ m/d for the Shallow weathered to 1.0 x 10⁻⁵ m/d for the intact bedrock.
- 💧 The hydrostratigraphic units within the region are delineated as follows:
 1. Turf Clay
 2. Shallow weathered zone
 6. Bedrock – Intact
- 💧 Groundwater levels are shallow ranging from 13.5 – 20.6 mbgl. Groundwater levels unaffected by production are below 15 mbgl.
- 💧 The groundwater flow direction is towards the west or south west. Localised drawdown on site is observed with a borehole level at 20.6 mbgl.
- 💧 Three abstraction boreholes (RP01, RP02 and RP03) are being used for abstraction.
- 💧 The Sandspruit was identified as a potential receptor due to the proximity to the Rietfontein Plant. The Sandspruit is deemed more susceptible to contamination by surface water runoff and seepage from the shallow weathered aquifer.
- 💧 There are signs of groundwater contamination down gradient of the Rietfontein Chrome Plant towards the Sandspruit (a tributary of the Hex River).

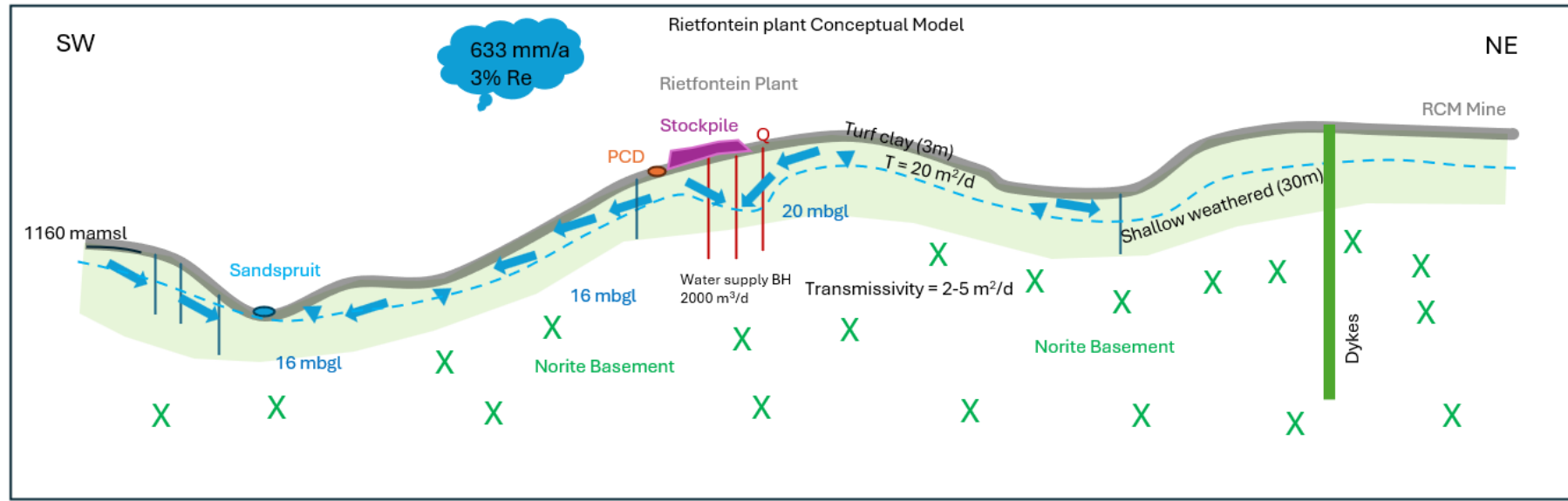


Figure 22 Conceptual model

8 GROUNDWATER FLOW MODEL DEVELOPMENT

8.1 Objectives of the Modelling

- Determination of the future groundwater quality and quantity impacts related to the proposed changes in plan activities will be modelled.

8.2 Modelling Package

FEFLOW is a powerful 3-D finite element groundwater flow and solute transport model. It can solve transient or steady-state flow, saturated and unsaturated flow, multiple free surfaces or perched water tables.

FEFLOW has a comprehensive selection of graphical tools for building the finite element mesh, assigning property zones and setting boundary conditions. The software includes state-of-the-art 3-D visualization of modelling outputs.

The main advantages of FEFLOW are its versatility in solving different flow and transport problems, flexibility in discretizing problems (representing models with elements) due to use of the finite element method, and flexibility in formulating boundary conditions (due to its use of “constrained” boundaries). This flexibility in model discretization and boundary conditions can be very useful when simulating complex flow problems (e.g. mine developments in structurally controlled bedrock and progressive excavation of open pit and underground mine excavations). FEFLOW is recommended for complex natural resource problems in which complex geometries and/or complex boundary conditions will have to be simulated.

The main disadvantage of FEFLOW is that it requires significant modelling expertise, including in-depth understanding of finite-element methods. The software’s flexibility makes it a powerful tool but can also make it difficult to use (for inexperienced users in particular). Setting up FEFLOW may also require more data that may not be readily available.

8.3 Assumptions and limitations

- The activation and concentrations of source terms were based on monitoring data and historic Google Earth images.
- The geology was based on the 1:250 000 published geological maps as well as 1:50 000 topographical maps.
- QGIS online aerial imagery was used in the layout of the various maps compiled for the current report. The imagery may well be dated and has been used for reference only.
- The model is used for decision making and should be applied accordingly. Modelled impacts may vary at any point and on-going monitoring is required to actively manage the proposed mining activities and possible impacts.
- No site characterization boreholes were drilled for this investigation; aquifer parameters and hydrostratigraphic units were assumed based on historical data and similar studies.

- The investigation utilized data from field surveys and existing monitoring as a snapshot, with further trends to be verified through ongoing monitoring as outlined in the monitoring program.
- The numerical groundwater flow model was developed using site-specific information, excluding influences from neighboring mining developments.

8.4 Model Area

The model domain has been revised to encompass the regional extents of the pits, underground workings and waste areas, ensuring a simplified yet comprehensive representation. The current model domain is considered adequate, with boundary adjustments deemed unnecessary as they would have minimal impact on the modelled outcomes. Notably, topographical highs were predominantly selected in the north and south regions. Additionally, in the western and southeastern areas, a river serves as the outer boundary of the model domain. These adjustments were made to maintain model simplicity while adequately capturing the hydrogeological dynamics of the study area.

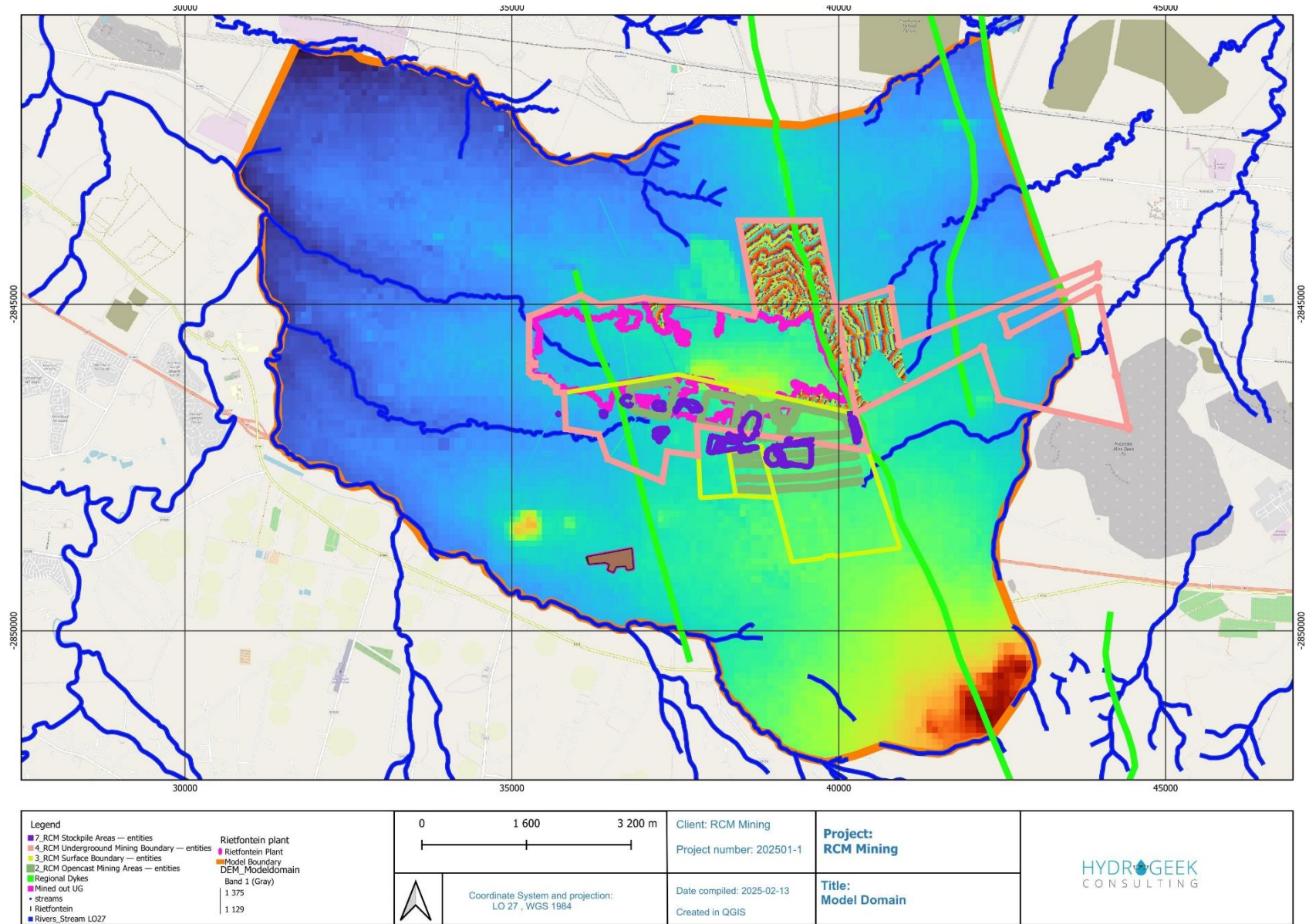


Figure 23 Model boundary

8.5 Construction of the Finite Element Grid

The numerical model encompasses the area of Rietfontein covering a total area of 170 km² (approximately 10 km × 17 km). A finite element network (grid) was designed to provide a high resolution of the numerical solution, while at the same time accommodating the large model area. The super element mesh contains the main important features of the conceptual model, e.g. the surface expression of the main hydro lithological aquifer units, structures, drainages and mine facilities. The finite element grid is based on a super element mesh constructed across the area

The finite element grid was compiled using the FEFLOW pre-processing software, which facilitated the construction of six-noded triangular prism elements over the area of investigation. The triangular grid consists of 81.381 elements and 41,050 nodes per slice.

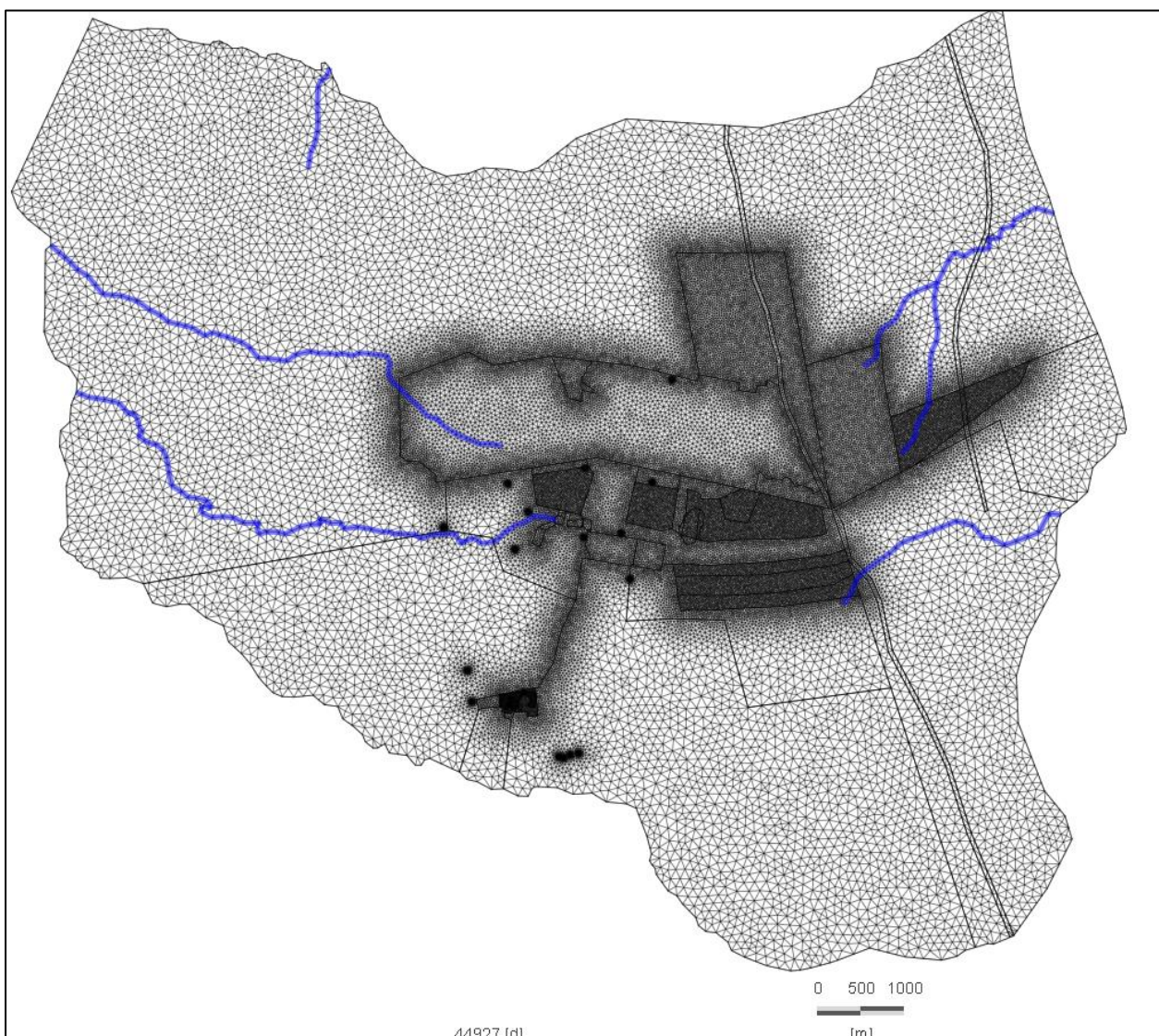


Figure 24 FEFLOW Mesh

8.6 Boundary Conditions

Boundary conditions express the way the considered domain interacts with its environment. In other words, they express the conditions of known water flux, or known variables, such as piezometric head. Different boundary conditions result in different solutions, hence the importance of stating the correct boundary conditions. Boundary conditions in a groundwater flow model can be specified either as:

- Dirichlet Type (or constant head) boundary conditions, or
- Neuman Type (or specified flux, including “no flux”) boundary conditions, or
- A mixture of the above

The model area perimeter coincides with topography as no flow boundaries. At the southern boundary a constrained head (max flow 0 m³/d) is specified equal to the water level elevation (water can only leave the model at this position).

Table 16 Boundary Conditions

Boundary	Topographical Feature	Boundary Condition
Northern Boundary	Catchment Divide	Seepage face hydraulic head
Southern Boundary	Surface Water feature	Seepage face hydraulic head
Western Boundary	Surface Water feature	Seepage face hydraulic head
Eastern Boundary	Geological Dyke	No flow boundary Condition

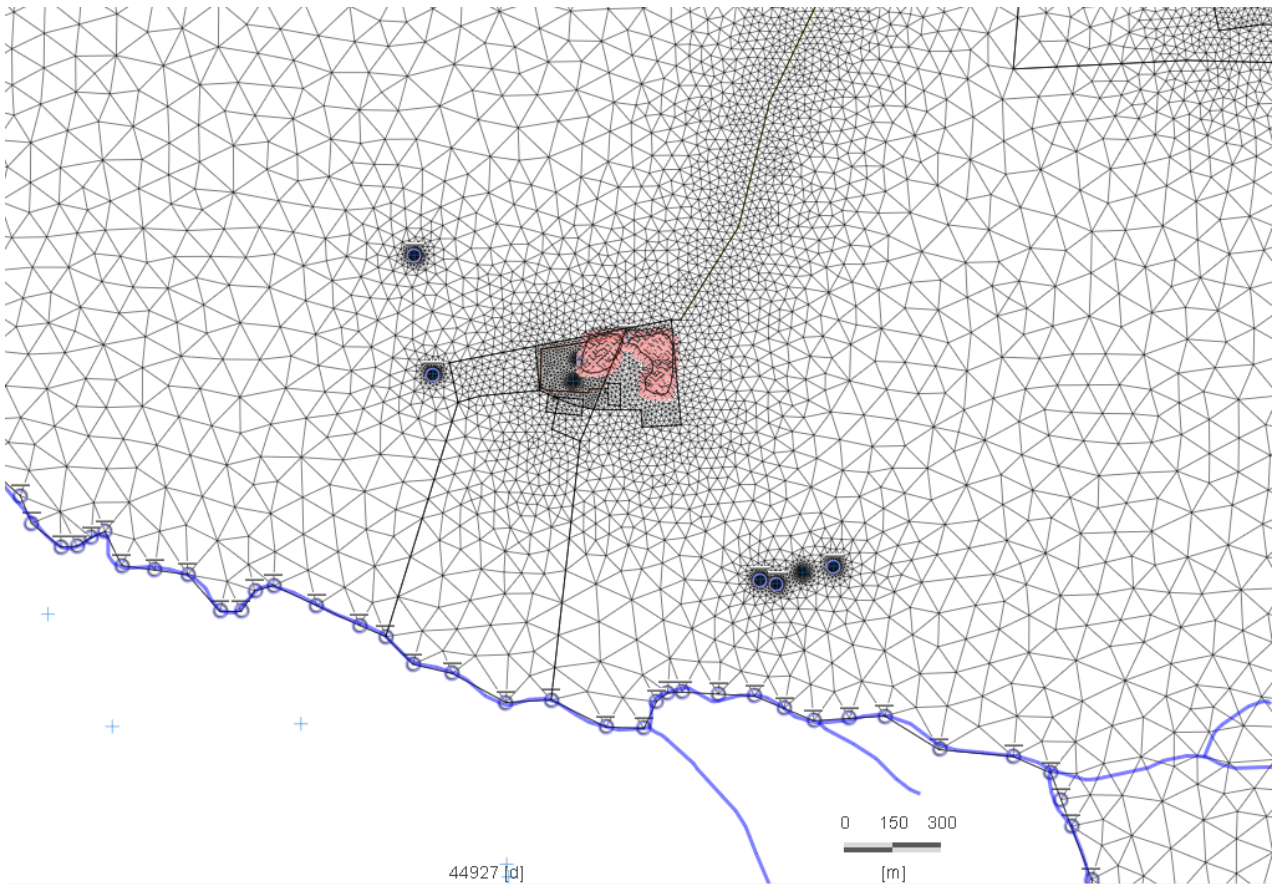


Figure 25 FEFLOW boundary conditions in Rietfontein Area

8.7 Model layers

The hydrostratigraphic units within the region have been discretized into six numerical model layers, providing a structured representation of the subsurface hydrogeological framework:

- Layer 1 Turf clay
- Layer 2: Shallow Weathered
- Layer 3: Basement Bedrock

These model layers serve as the foundation for simulating groundwater flow and transport processes within the study area. Additionally, the top slice of the model corresponds to the topography of the area, ensuring accurate representation of surface features and elevations. Conversely, the bottom of the model extends below the surrounding underground mining activities providing comprehensive coverage of the subsurface environment. No mining is currently taking place at the Rietfontein plant. This vertical arrangement enables the integration of both natural and anthropogenic influences on groundwater dynamics, facilitating robust modelling and analysis.

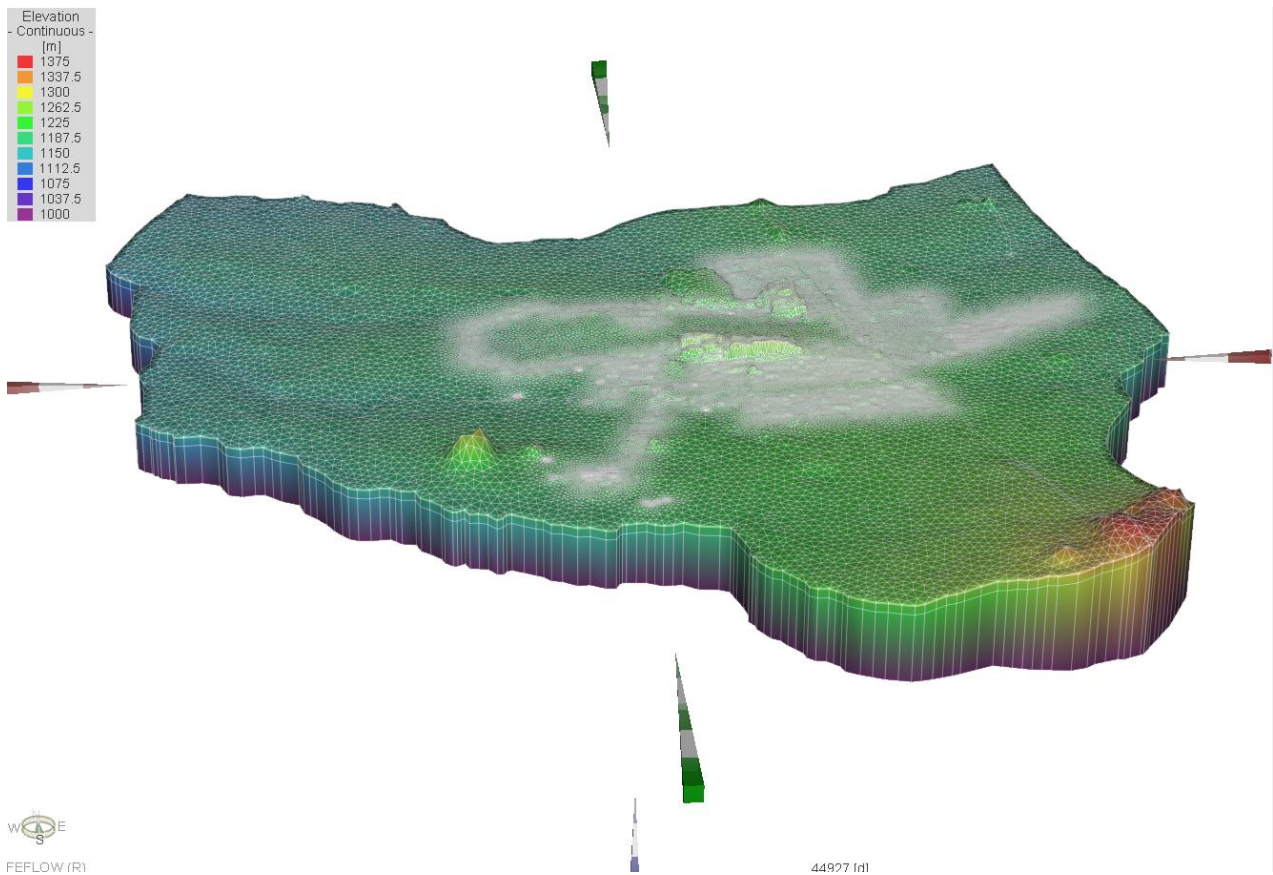


Figure 26 3D Model looking North with elevation

8.8 Aquifer Transmissivity (Hydraulic Conductivity)

The aquifer parameters calibrated in the model is based on the previous aquifer testing in the area. The model calibration refined the parameters as shown in Table 17.

Table 17 Calibrated Aquifer parameters





Hydrostratigraphic Units	Model Layer	Hydraulic Conductivity (m/d)	Anisotropy (Kx/Kz)	Drainage Porosity
Turf Clay	1	3.0×10^{-1}	10	0.15
Shallow Weathered	2	1.5×10^{-1}	10	0.03
Basement bedrock	3	1.0×10^{-5}	10	0.03

8.9 Steady State Simulation (Calibration)

Calibration is the process of identifying a suitable set of hydraulic parameters, boundary conditions, and stresses that best describe the observed hydraulic heads or fluxes within a defined catchment (Anderson and Woessner, 1992). 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 calibration process. The model calibration was carried out by adjusting hydraulic conductivity and aquifer recharge.

During steady-state calibration, parameters defining hydraulic properties described in section 2.5.

The following model metrics are used to judge the calibration performance:

-  Model convergence
-  Water balance error <1%
-  RMS error of < 10m
-  Normalized RMS of < 10%

Simulated potentiometric surface matches the conceptual understanding of groundwater flow. The steady state results are given in Table 18.

Table 18 Steady state results

Calibration Results			
Groundwater level ID	Observed Water Level	Simulated Water Level	Difference
SC01	1198,1	1196,83034	1,270
SC02	1195,5	1194,5599	0,940
FH01	1196,5	1191,04727	5,453
FH02	1192,3	1190,54156	1,758
RP02	1186,4	1187,94105	-1,541
BH1	1195,38	1198,40846	-3,028
BH2	1200,58	1197,56042	3,020
BH3	1199	1195,04082	3,959
BH4	1198,89	1196,48329	2,407
Mean error (m)	ME		1,582
Root Mean Square Error	RMSE		2,502
Normalized Root Mean Square Error	nRMSE		17,65%

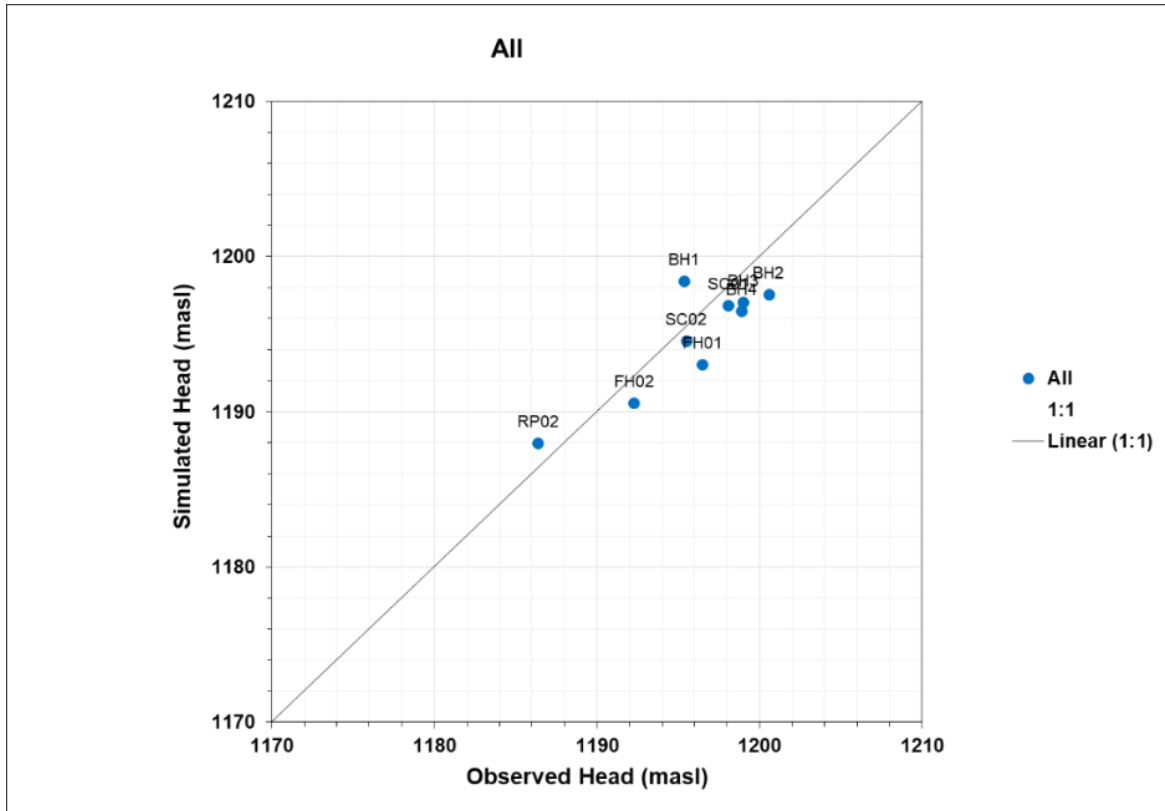


Figure 27 Scatterplot of measured vs simulated heads

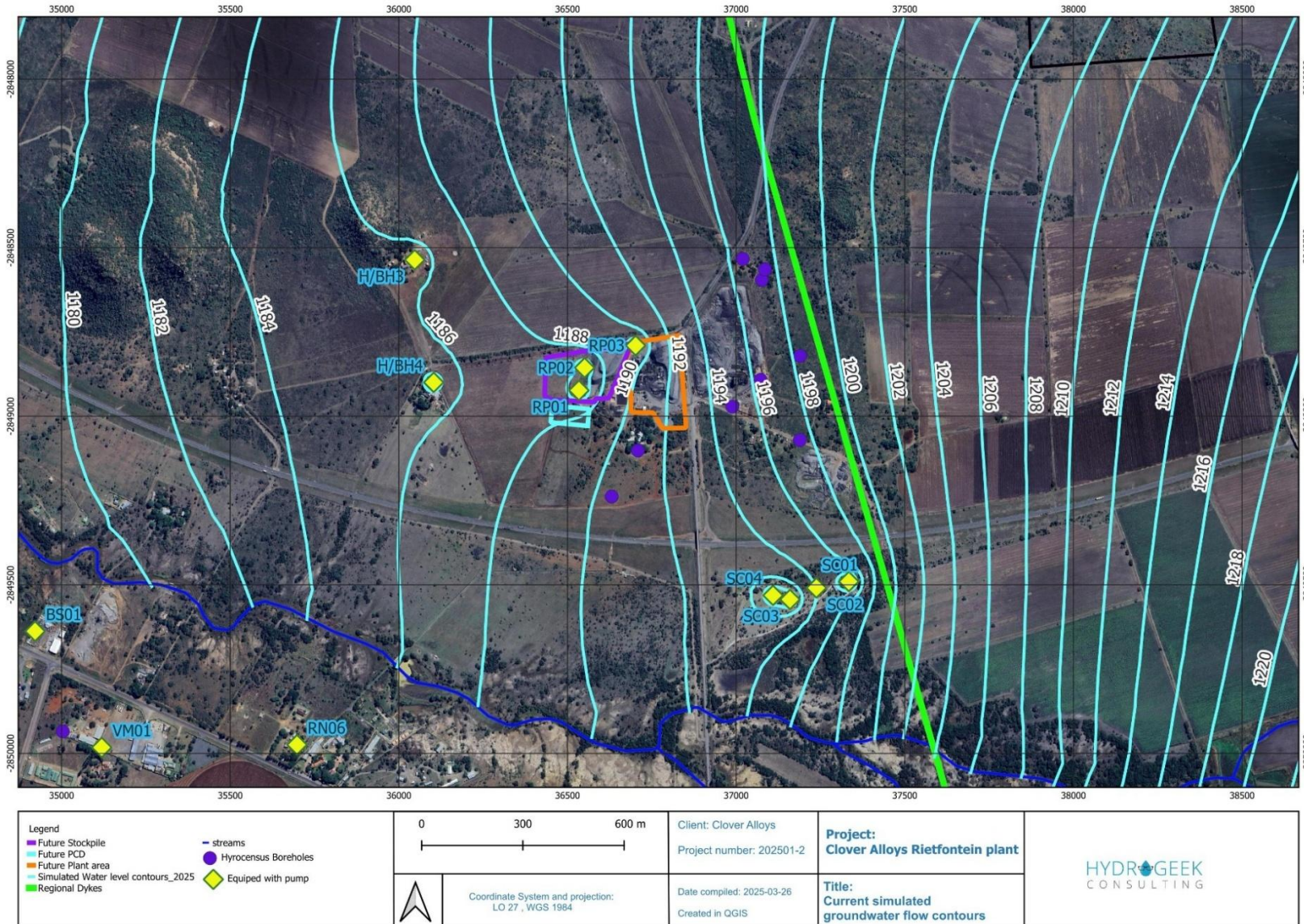


Figure 28 Piezometric surface based on current conditions

8.10 Steady State Groundwater Balance

The calibration simulation conducted represents the current groundwater flow conditions as observed in Feb 2025. Figure 21 depicts the interpreted piezometry of the model, representing shallow weathered zone

It can be observed that the abstraction borehole has impacted the groundwater flow. Continuing with the simulations, the model captures the interactions between the abstraction wells and waste facilities impact on groundwater levels. The results provide insights into the flow dynamics and potential changes induced by the plant operations. It's crucial to interpret these findings in conjunction with the calibrated model and acknowledge the limitations and uncertainties inherent in numerical simulations.

Table 19 Water Balance for current conditions

	Inflow (m ³ /d)	Outflow (m ³ /d)	Balance (m ³ /d)
Effective Recharge	2606	0	2606
Water losses from drainages		2427,96	178,04
Water losses from abstraction boreholes		184,54	-6,5
Seepage losses from facilities	6,5		0
Total	2612,5	2612,5	0
Balance error (%)			0

9 DEVELOPMENT OF THE CONTAMINANT TRANSPORT MODEL

9.1 Introduction

A numerical model of solute transport, coupled with the groundwater flow model, was developed to simulate the effect of the establishment of new location of waste rock piles on groundwater quality. The following paragraphs present the methodology used, the simulations performed, and the results obtained

9.2 Processes Controlling Contaminant Transport

Transport through a porous medium is mainly controlled by the following two processes:

- ◆ Advection; and
- ◆ Hydrodynamic dispersion.

For clarity these processes will be discussed briefly.

9.2.1 Advection

Advection is the component of contaminant movement described by Darcy's Law. If uniform flow at a velocity (V) takes place in the aquifer, Darcy's law calculates the distance (x) over which a labelled water particle migrates over a time period (t) as $x = Vt$.

9.2.2 Hydrodynamic Dispersion

💧 Mechanical dispersion; and

💧 Molecular diffusion.

Mechanical dispersion is the process whereby the initially close group of labelled particles is spread in a longitudinal as well as in a transverse direction. This is caused by the velocity distribution (as a result of varying microscopic streamlines) that develops at the microscopic level of flow around the grain particles of the porous medium. Although this spreading is both in the longitudinal and transversal direction of flow, it is primarily in the former direction. Very little spreading can be caused in the transversal direction by velocity variations alone.

Molecular diffusion mainly causes transversal spreading, by the random movement of the molecules in the fluid from higher contaminant concentrations to lower ones. It is thus clear that if $V = 0$, the contaminant is transported by molecular diffusion only, or in other words the higher the velocity of the groundwater, the less the relative effect of molecular diffusion on the transportation of a labelled particle.

In addition to advection, mechanical dispersion and molecular diffusion, several other phenomena may affect the concentration distribution of a contaminant as it moves through a porous medium. The contaminant may interact with the solid surface of the porous matrix in the form of adsorption of contaminant particles on the solid surface, deposition, solution of the solid matrix and ion exchange. All these phenomena cause changes in the concentration of a contaminant in a flowing fluid.

9.3 Mass Balance Equation

The mass balance equation (Bear and Verruijt, 1992) (equation of hydrodynamic dispersion or the advection-dispersion equation) of a pollutant (contaminant) is expressed as:

$$\frac{\partial n c}{\partial t} = - \Delta \cdot q c, \text{ total} - f + n p \Gamma - P c + R c \quad (3)$$

Where:

$n c$ = mass of pollutant per unit volume of porous medium;

n = porosity of saturated zone;

c = concentration of pollutant (mass of pollutant per unit volume of liquid (water));

$\Delta \cdot q c, \text{ total}$ = excess of inflow of a considered pollutant over outflow, per unit volume of porous medium, per unit time;

f = quantity of pollutant leaving the water (through adsorption, ion exchange etc.);

$n p \Gamma$ = mass of pollutant added to the water (or leaving it) as a result of chemical interactions among species inside the water, or by various decay phenomena;

Γ	=rate at which the mass of a pollutant is added to the water per unit mass of fluid;
ρ	= density of pollutant;
P_c time;	= total quantity of pollutant withdrawn (pumped) per unit volume of porous medium per unit time;
R_c unit time.	= total quantity of pollutant added (artificial recharge) per unit volume of porous medium per unit time.

9.4 Kinematic Porosity Values

Definition of kinematic porosity: “From the point of view of fluid displacement, the adhesive water may be viewed as part of the solid. The empty volume, where the water can circulate, is smaller than the total porosity: it defines the kinematic or effective porosity of a saturated medium”.

A Kinematic porosity of 3% was applied.

9.5 Longitudinal and Transversal Dispersivities

A longitudinal dispersivity value of 10 m was calibrated for the simulations (Spitz and Moreno, 1996). Bear and Verruijt (1992) estimated the average transversal dispersivity to be 10 to 20 times smaller than the longitudinal dispersivity. An average value of 1 m was selected for this parameter during the simulations.

9.6 Source Term

A fluid flux and a mass flux boundary condition were implemented as input parameters into the numerical model. This boundary condition facilitates the introduction of a mass load (expressed in $g/m^2/d$) into the model, derived from the product of the seepage rate (in m/d) and the concentration (in mg/l) of the contaminant. For instance, arsenic concentrations of $0.27 mg/l$ were utilized in the model calculations to determine the corresponding mass load introduced at the specified boundary. The rate modelled for the PCD dam is $172 l/day$.

Table 20 Source terms

Area	Seepage rate mm/a	Seepage rate m/d	TDS mg/l	mass load $g/m^2/d$
Pollution Control Dam (lined)	-10	-0.000026	1000	-0.026
Existing Waste Stockpiles	-90	-0.00024657	1000	-0.24657
Future Waste Stockpiles	-90	-0.00024657	1000	-0.24657

leakage calculations below used by Minelock correlated well with what was used in the plume modelling.

- Primary Leakage drainage system ALR (1 m depth) 2 847 $l/ha/day$
- Primary Leakage drainage system ALR (2.7 m depth) 4 678 $l/ha/day$

- Primary Leakage drainage system capacity 4 704 ℓ/ha/day
- Primary Leakage drainage system ALR (2.7 m depth) 3 483 ℓ/PCD/day

For the secondary liner, the estimated leakage rate would be **150 ℓ/PCD/day**

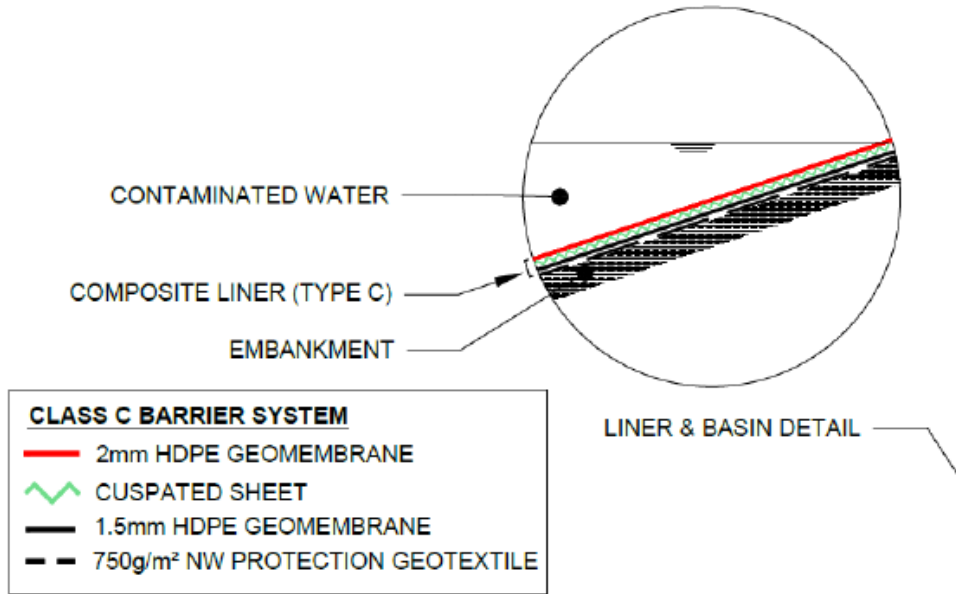


Figure 29 Liner design

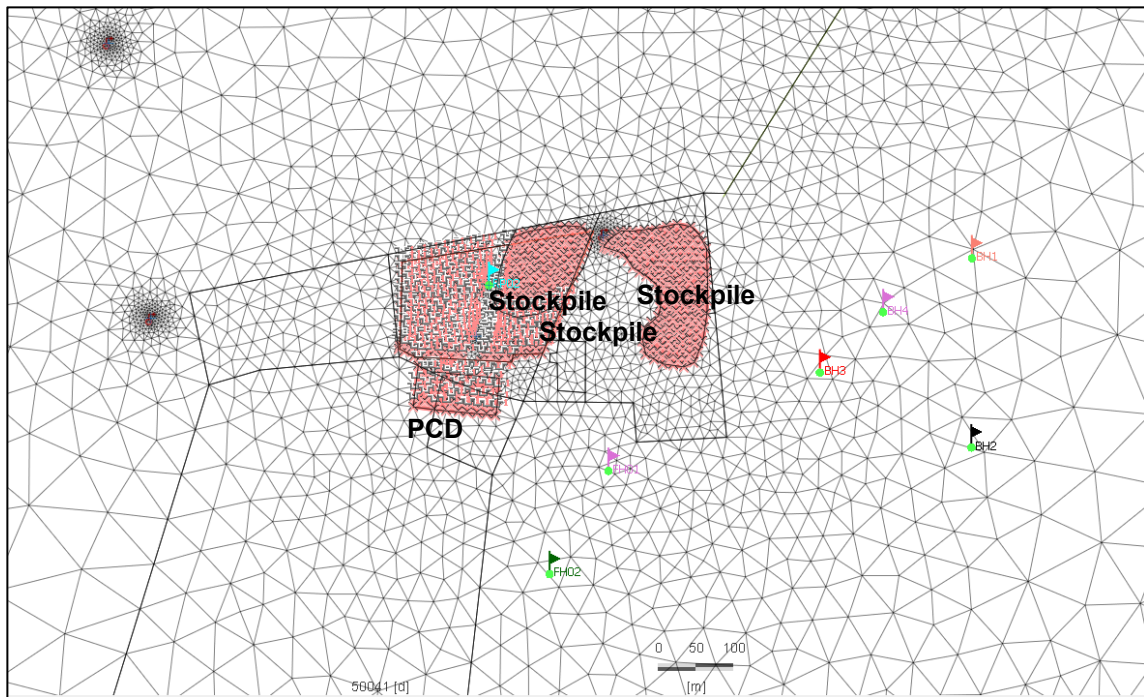


Figure 30 Source term included in model as fluid flux.

9.7 Mass Transport Transient Simulations

9.7.1 Scenario 1: Current Impact from existing Stockpiles 2023-2025

The progression of TDS concentrations in groundwater within the unweathered zone (layer 2 of the model) in the absence of sealing measures. The Stockpiles are situated on site close to the abstraction boreholes and started in 2023 in the model, resulting in a reduced impact, as the cone of depression captures the plume. The findings suggest that a dissolved plume would form and have already reached the abstraction boreholes. The source concentration exceeds the standard criterion of 450 mg/l, with a background value of 100 mg/l. The existing plume spreads towards the east but remains within the boundaries of Rietfontein.

9.7.2 Scenario 2: Future Impact from existing and future Waste Rock Dumps LOM 2025-2036

In this scenario the additional stockpile area started in 2026. The progression of TDS concentrations in groundwater within the unweathered zone (layer 2 of the model) in the absence of sealing measures. The lined PCD was also simulated as part of this study and shows negligible impact in terms of the quality. The Stockpiles are situated on site close to the abstraction boreholes and started in 2023 in the model, resulting in a reduced impact, as the cone of depression captures the plume. The findings suggest that a dissolved plume would form and have already reached the abstraction boreholes. The source concentration exceeds the standard criterion of 450 mg/l, with a background value of 100 mg/l. The existing plume spreads towards the east but remains within the boundaries of Rietfontein.

The future plume spreads over a distance of 100m towards the east but is retarded/captured by the abstraction boreholes.

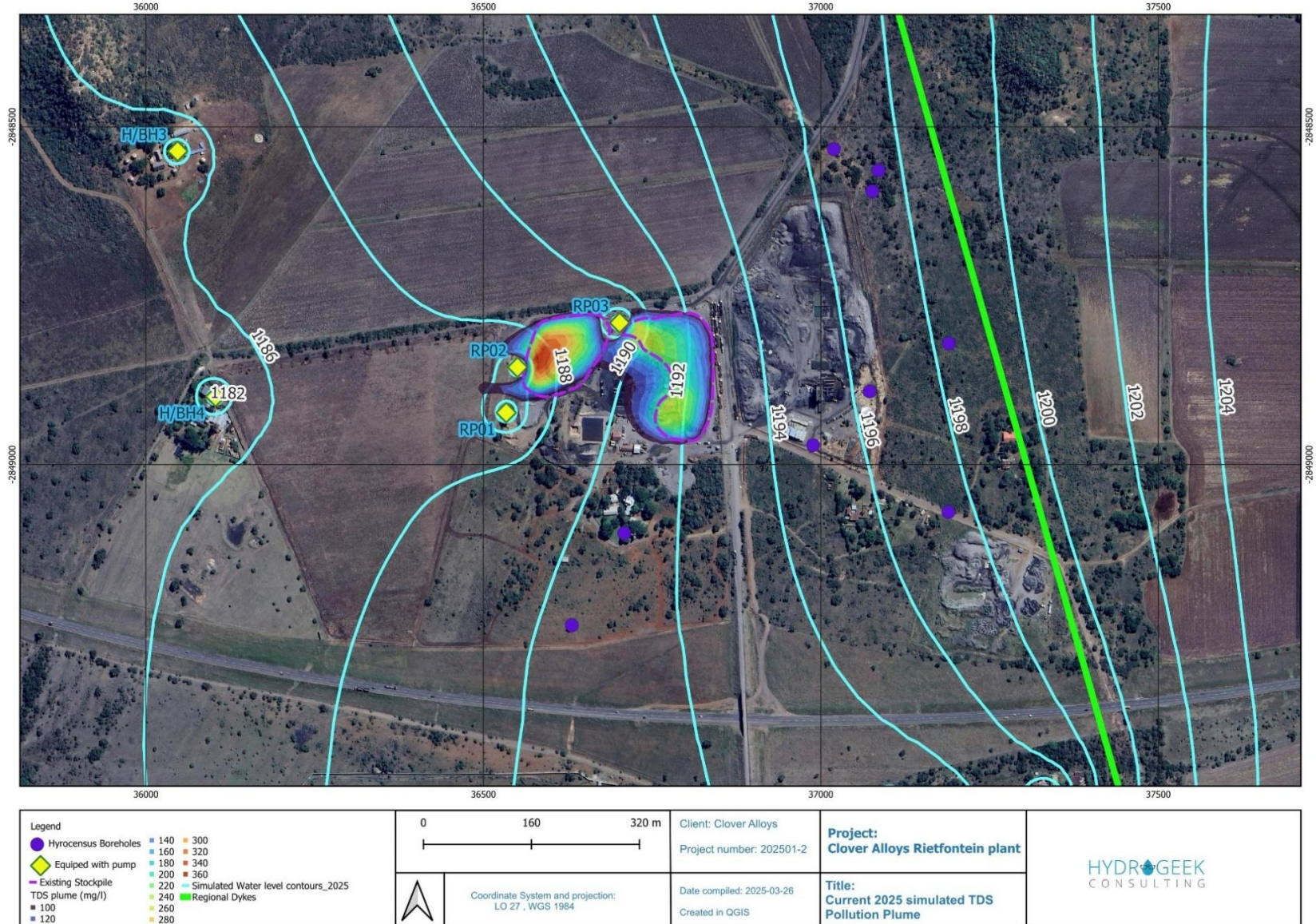


Figure 31 Pollution Plume current conditions



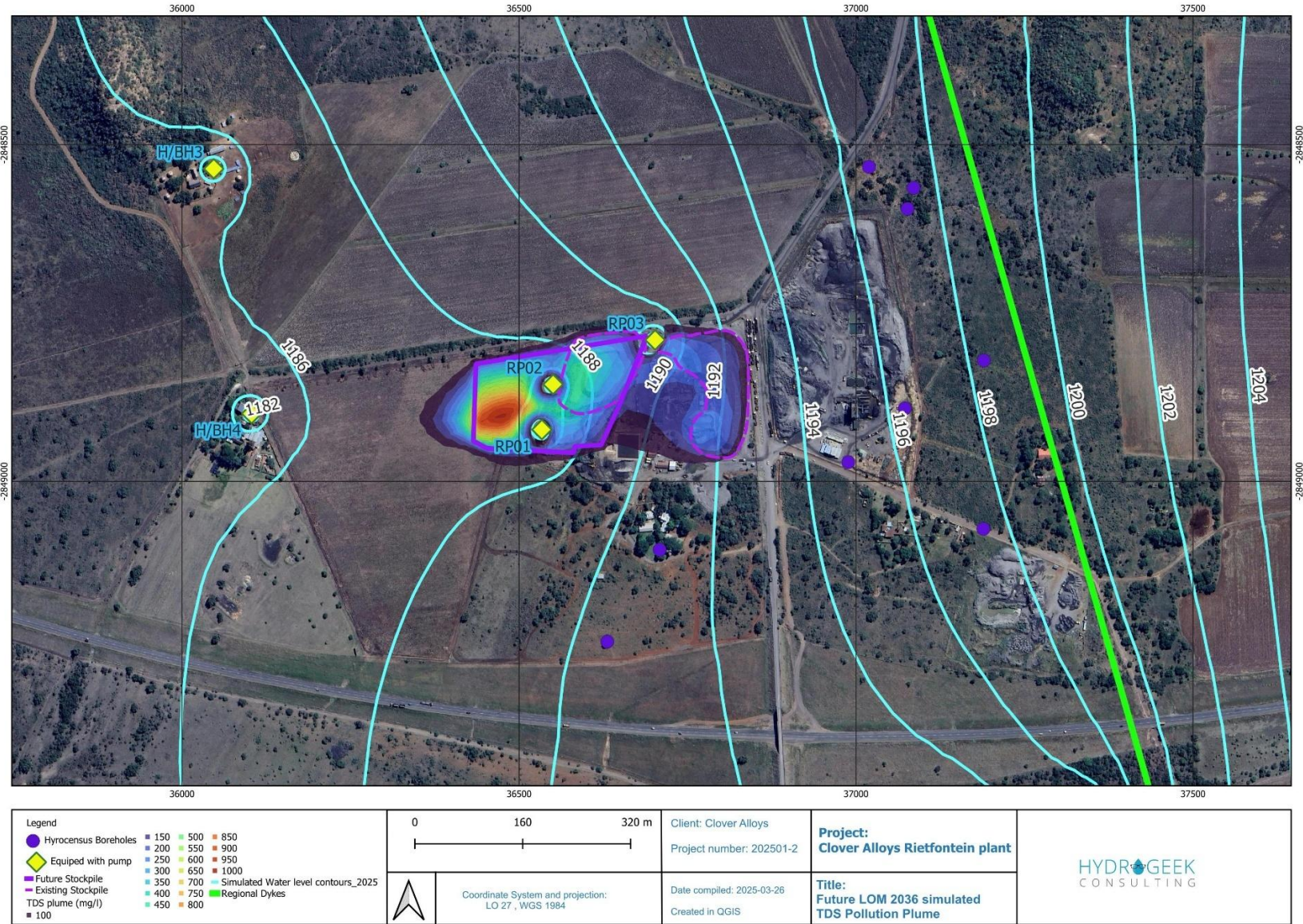


Figure 32 Pollution Plume at 2036 current LOM



10 HYDROGEOLOGICAL RISK ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PROGRAMME

The aim of this section is to assess the likely hydrogeological impacts that the Rietfontein Plant might have on the receiving environment and sensitive receptors. The groundwater risk assessment methodology is based on defining and understanding the three basic components of the risk, i.e. the source of the risk (source term), the pathway along which the risk propagates, and finally the target that experiences the risk (receptor). The risk assessment approach is therefore aimed at describing and defining the relationship between cause and effect. In the absence of any one of the three components, it is possible to conclude that groundwater risk does not exist.

The current impacts from the infrastructure were assessed to have already impacted the groundwater environment in terms of quality and quantity. The additional infrastructure will not have higher impact on the current groundwater environment; therefore the current and future impacts can be contained through the proposed mitigation.

10.1 Rietfontein Plant Operation

Statement on Impact Differentiation

The potential environmental impacts associated with the proposed new infrastructure—such as the pollution control dam (PCD), clean and dirty water separation systems, and related channels—have been reviewed in the context of the existing operations assessed under the Section 24G application. Based on the nature, location, and function of the planned infrastructure, the associated impacts are anticipated to be materially similar in type, extent, and significance to those already identified and assessed.

As such, these impacts are considered to be sufficiently addressed by the current impact assessment. Should any deviations or unique site-specific impacts arise during implementation, these will be managed under the existing environmental management framework and mitigation measures already in place."

10.1.1 Future and current impacts of the Chrome wash plant on the hydrogeological regime.

- There is currently evidence of groundwater contamination as seen by the elevated Chrome concentration in borehole FH02, unlikely from the plant operations.
- Abstraction at water supply boreholes can lead to a decline in the groundwater levels and potentially affect private groundwater users located approximately 400 – 600m to the northwest of the plant.
- Abstraction at water supply boreholes can lead to a decline in groundwater levels and potentially capture contamination from the Stockpiles.
- Poor storm water management in the past and runoff during heavy rains can increase the seepage of Chrome into groundwater
- Storage and handling of hydrocarbons and hydrocarbon spillage at plant and generators.

10.1.2 Mitigation and management measures.

- Currently there are no groundwater monitoring boreholes at the Rietfontein Chrome Plant. Geophysical surveys need to be conducted on site and around the facility to determine the placement of monitoring boreholes in an upgradient position, on-site and down gradient position of the stockpiles, pollution control dam and plant.
- Monitoring of abstraction boreholes water quality to ensure water quality is to standard required by plant.
- 48–72-hour aquifer testing of the three boreholes (RP01, RP02 and RP03) to determine a sustainable yield for the aquifer and the effect on each other.
- Monitoring of abstraction volumes and monitoring boreholes water levels to ensure abstraction rates are sustainable and managed.
- Stormwater management infrastructure through a lined PCD dam will be in place to mitigate the risk to groundwater.

10.2 Risk Assessment Criteria

10.2.1 Procedure

The impact significance rating methodology, as presented herein and utilised for all EIMS Impact Assessment Projects, is guided by the requirements of the NEMA EIA Regulations 2014 (as amended). The approach may be altered or substituted on a case by case basis if the specific aspect being assessed requires such-such instances require prior EIMS Project Manager approval. The broad approach to the significance rating methodology is to determine the significance (S) of an environmental risk or impact by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relating this to the probability/ likelihood (P) of the impact occurring. The S is determined for the pre- and post-mitigation scenario. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the S to determine the overall final significance rating (FS). The impact assessment will be applied to all identified alternatives.

10.2.2 Determination of Significance

The final significance (FS) of an impact or risk is determined by applying a prioritisation factor (PF) to the post-mitigation environmental significance. The significance is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E + D + M + R) * N}{4}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 21 below.

Table 21 Criteria for Determining Impact Consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. Highly localised, limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property or site boundary, or the area within a few hundred meters of the site)
	3	Local (i.e. beyond the site boundary within the Local administrative boundary (e.g. Local Municipality) or within consistent local geographical features, or the area within 5 km of the site)
	4	Regional (i.e. Far beyond the site boundary, beyond the Local administrative boundaries within the Regional administrative boundaries (e.g. District Municipality), or extends into different distinct geographical features, or extends between 5 and 50 km from the site).
	5	Provincial / National / International (i.e. extends into numerous distinct geographical features, or extends beyond 50 km from the site).
Duration	1	Immediate (<1 year, quickly reversible)
	2	Short term (1-5 years, less than project lifespan)
	3	Medium term (6-15 years)
	4	Long term (15-65 years, the impact will cease after the operational life span of the project)
	5	Permanent (>65 years, no mitigation measure of natural process will reduce the impact after construction/ operation/ decommissioning).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected)
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected, or affected environmental components are already degraded)
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; moderate improvement for +ve impacts; or where change affects area of potential conservation or other value, or use of resources).

	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease; high improvement for +ve impacts; or where change affects high conservation value areas or species of conservation concern)
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease, substantial improvement for +ve impacts; or disturbance to pristine areas of critical conservation value or critically endangered species)
Re-versi-bility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring very high time and cost.
	5	Irreversible Impact.

Once the C has been determined, the significance is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/ scored as per Table 22.

It is noted that both environmental risks as well as environmental impacts should be identified and assessed. Environmental Risk can be regarded as the potential for something harmful to happen to the environment, and in many instances is not regarded as something that is expected to occur during normal operations or events (e.g. unplanned fuel or oil spills at a construction site). Probability and likelihood are key determinants or variables of environmental risk. Environmental Impact can be regarded as the actual effect or change that happens to the environment because of an activity and is typically an effect that is expected from normal operations or events (e.g. vegetation clearance from site development results in loss of species of concern). Typically the probability of an unmitigated environmental impact is regarded as highly likely or certain (management and mitigation measures would ideally aim to reduce this likelihood where possible). In summary, environmental risk is about what could happen, while environmental impact is about what does happen.

Table 22: Probability/ Likelihood Scoring

Probability	1	Improbable (Rare, the event may occur only in exceptional circumstances, the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <5% chance).
	2	Low probability (Unlikely, impact could occur but not realistically expected; >5% and <20% chance).
	3	Medium probability (Possible, the impact may occur; >20% and <50% chance).
	4	High probability (Likely, it is most probable that the impact will occur- > 50 and <90% chance).
	5	Definite (Almost certain, the impact is expected to, or will, occur, >90% chance).

The result is a qualitative representation of relative significance associated with the impact. Significance is therefore calculated as follows:

$$S = C \times P$$

Table 23 Determination of Significance

Consequence	5- Very High	5	10	15	20	25
	4- High	4	8	12	16	20
	3- Medium	3	6	9	12	15
	2- Low	2	4	6	8	10
	1- Very low	1	2	3	4	5
		1- Improbable	2- Low	3- Medium/Possible	4- High/Probable	5- Highly likely/Definite
Probability						

The outcome of the significance assessment will result in a range of scores, ranging from 1 through to 25. These significance scores are then grouped into respective classes as described in Table 24

Table 24 Significance Scores

S Score	Description
≤4.25	Low (i.e. where this impact is unlikely to be a significant environmental risk/ reward).
>4.25, ≤8.5	Low-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>8.5, ≤13.75	High-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>13.75	High (i.e. where the impact will have a significant environmental risk/ reward).

The impact significance will be determined for each impact without relevant management and mitigation measures (pre-mitigation significance), as well as post implementation of relevant management and mitigation measures (post-mitigation significance). This allows for a prediction in the degree to which the impact can be managed/mitigated.



Table 25 Risk Assessment Rating Consequence

Impacts without Mitigation	Phase	Extent	Duration	Magnitude	Reversibility	Nature	Consequence	Probability	Significance		Mitigation measure
Impacts on water quality by plant operations (Current and future Waste rock dumps)	Construction and operational	2	4	3	3	-1	-3	3	-9	High-Medium	
Impacts on water quantity by abstraction boreholes. (Pumping from production boreholes)	Construction and operational	2	4	3	3	-1	-3	3	-9	High-Medium	
Impacts with Mitigation	Phase	Extent	Duration	Magnitude	Reversibility	Nature	Consequence	Probability	Significance		
Impacts on water quality by plant operations (Waste rock dumps seepage and spills from plant operations)	Construction and operational	1	4	2	3	-1	-2.5	2	-5	Low-Medium	<p>Currently there are no groundwater monitoring boreholes at the Rietfontein Chrome Plant. Geophysical surveys need to be conducted on site and around the facility to determine the placement of monitoring boreholes in an upgradient position, on-site and down gradient position of the stockpiles, pollution control dam and plant.</p> <p>Monitoring of abstraction boreholes water quality to ensure</p>



											<p>water quality is to standard required by plant.</p> <p>Stormwater management infrastructure through a lined PCD dam will be in place to mitigate the risk to groundwater.</p>
<p>Impacts on water quantity by abstraction boreholes. (Pumping from production boreholes)</p>	<p>Construction and operational</p>	1	4	2	3	-1	-2.5	2	-5	<p>Low-Medium</p>	<p>48-72-hour aquifer testing of the three boreholes (RP01, RP02 and RP03) to determine a sustainable yield for the aquifer and the effect on each other.</p> <p>Monitoring of abstraction volumes and monitoring boreholes water levels to ensure abstraction rates are sustainable and managed.</p> <p>Stormwater management infrastructure through a lined PCD dam will be in place to mitigate the risk to groundwater.</p>



10.2.3 Impact Prioritization

Further to the assessment criteria presented in the section above, it is necessary to consider each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impacts' post-mitigation significance (post-mitigation). This prioritisation factor does not aim to detract from the significance ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the post-mitigation significance based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 26: Criteria for Determining Prioritisation

Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/ definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable Loss of Resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 26. The impact priority is therefore determined as follows:

$$Priority = CI + LR$$

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (Refer to Table 27).

Table 27: Determination of Prioritisation Factor

Priority	Prioritisation Factor
2	1
3	1.125
4	1.25
5	1.375
6	1.5

In order to determine the final impact significance (FS), the PF is multiplied by the post-mitigation significance scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e. if an impact comes out with a high medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a higher significance).

Table 28: Final Environmental Significance Rating

Significance Rating	Description
<-25	Very High (Impacts in this class are extremely significant and pose a very high environmental risk. In certain instances these may represent a fatal flaw. They are likely to have a major influence on the decision and may be difficult or impossible to mitigate. Offset's may be necessary.
<-13.75 to -25	High negative (These impacts are significant and must be carefully considered in the decision-making process. They have a high environmental risk or impact and require extensive mitigation measures).
-8.5 to -13.75	Medium-High negative (i.e. Impacts in this class are more substantial and could have a significant environmental risk. They may influence the decision to develop in the area and require more robust mitigation measures).
<-4.25 to <-8.5	Medium- Low negative (i.e. These impacts are slightly more significant than low impacts but still do not pose a major environmental risk. They might require some mitigation measures but are generally manageable).
-1 to -4.25	Low negative (i.e. Impacts in this class are minor and unlikely to have a significant environmental risk. They do not influence the decision to develop in the area and are typically easily mitigated.
0	No impact

Significance Rating	Description
1 to 4.25	Low positive
>4.25 to <8.5	Medium-Low positive
8.5 to 13.75	Medium-High positive
>13.75	High positive

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

10.2.4 Cumulative impact

The cumulative impact on both the water levels and quality, with the infrastructure is plotted on Figure 33. The impacts can be seen based on the plant activities with the sensitive receptor the Sandpruit. The activities include the abstraction of production boreholes and the seepage of the two existing and future waste rock Dumps.

10.3 EMPR inclusion

See attached Table 30

Table 29 Risk Assessment Rating Final Environmental Significance

Impacts	Cumulative Impact (CI)	Loss of Resources (LR)	Priority (P)	Priority factor (PF)	Post mitigation Significance	Final Significance (FS)		Mitigation measure
Impacts on water quality by plant operations (Current and Future Waste rock dumps seepage)	2	2	4	1.25	-5	-6.25	Medium-Low negative	<p>Currently there are no groundwater monitoring boreholes at the Rietfontein Chrome Plant. Geophysical surveys need to be conducted on site and around the facility to determine the placement of monitoring boreholes in an upgradient position, on-site and down gradient position of the stockpiles, pollution control dam and plant.</p> <p>Monitoring of abstraction boreholes water quality to ensure water quality is to standard required by plant.</p> <p>Stormwater management infrastructure through a lined PCD dam will be in place to mitigate the risk to groundwater.</p>
Impacts on water quantity by abstraction boreholes. (Pumping from production boreholes)	2	2	4	1.25	-5	-6.25	Medium-Low negative	<p>48–72-hour aquifer testing of the three boreholes (RP01, RP02 and RP03) to determine a sustainable yield for the aquifer and the effect on each other.</p> <p>Monitoring of abstraction volumes and monitoring boreholes water levels to ensure abstraction rates are sustainable and managed.</p> <p>Stormwater management infrastructure through a lined PCD dam will be in place to mitigate the risk to groundwater.</p>



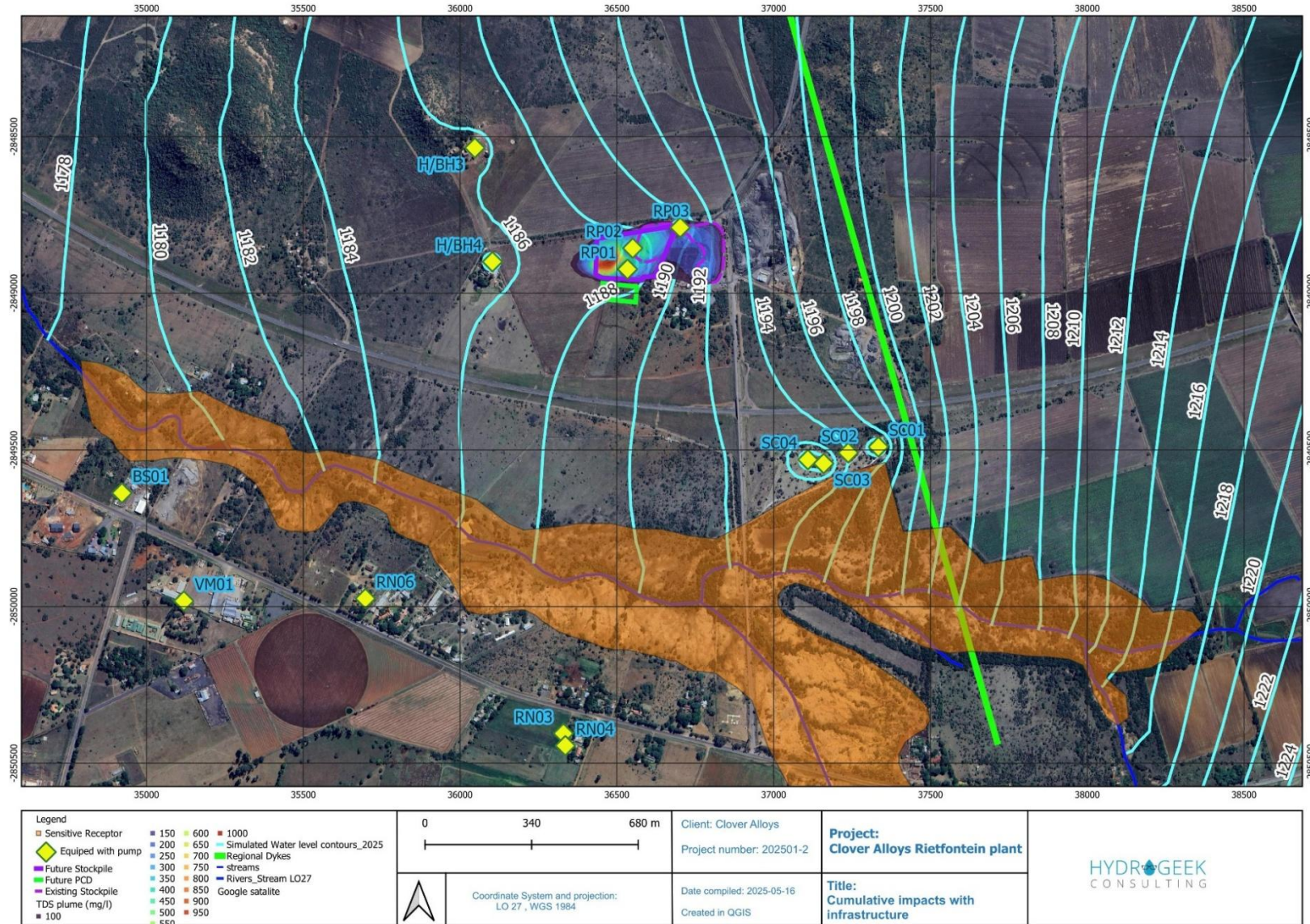


Figure 33 Cumulative impacts and sensitive receptors

Table 30 EMPr Inclusion

Mitigation Measures	Phase	Timeframe	Responsible Party for Implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Monitoring Tool)
Currently there are no groundwater monitoring boreholes at the Rietfontein Chrome Plant. Geophysical surveys need to be conducted on site and around the facility to determine the placement of monitoring boreholes in an upgradient position, on-site and down gradient position of the stockpiles, pollution control dam and plant.	Construction Operation	Prior to construction and ongoing throughout lifespan of mine	Applicant	Monthly water levels and quarterly groundwater quality samples	Ensure compliance with relevant legislation	No legal directives Legal compliance audit scores
Monitoring of abstraction boreholes water quality to ensure water quality is to standard required by plant.	Construction Operation	Prior to construction and ongoing throughout lifespan of mine	Applicant	Monthly water levels and quarterly groundwater quality samples	Ensure compliance with relevant legislation	No legal directives Legal compliance audit scores
48–72-hour aquifer testing of the three boreholes (RP01, RP02 and RP03) to determine a sustainable yield for the aquifer and the effect on each other.	Construction Operation	Prior to construction and ongoing	Applicant	One off	Ensure compliance with relevant legislation	No legal directives Legal compliance audit scores



		throughout lifespan of mine				
Monitoring of abstraction volumes and monitoring boreholes water levels to ensure abstraction rates are sustainable and managed.	Construction Operation	Prior to construction and ongoing throughout lifespan of mine	Applicant	Daily measurement of abstractions rates through flow meter on abstraction boreholes	Ensure compliance with relevant legislation	No legal directives Legal compliance audit scores
Stormwater management infrastructure through a lined PCD dam will be in place to mitigate the risk to groundwater.	Construction Operation	Prior to construction and ongoing throughout lifespan of mine	Applicant	One off	Ensure compliance with relevant legislation	



11 Monitoring Plan

Groundwater monitoring boreholes must be evaluated for various chemical constituents, including:

- **Physical and Aesthetic Factors:** pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), and Total Hardness.
- **Macro Elements:** Total Alkalinity (MAIk), Sulphate (SO₄), Nitrate (NO₃), Chloride (Cl), Fluoride (F), Calcium (Ca), Magnesium (Mg), Potassium (K), and Sodium (Na).
- **Micro Elements:** Aluminium (Al), Iron (Fe), Manganese (Mn), Cadmium (Cd), Chromium (Cr), Copper (Cu), Nickel (Ni), Lead (Pb), Cobalt (Co), and Zinc (Zn).
- Monthly assessments of water levels are required, with water quality monitoring conducted quarterly. Detailed reports summarizing the monitoring outcomes must be submitted to the Regional Head of the Department within the timelines set forth in the Water Use License (WUL) conditions. Existing Boreholes FH01, FH02 and H/BH4 should be added to the monitoring network.
- Monitor boreholes RP01, RP02, RP03, RM04, RM05, RM06, RM07, , FH01, FH02 and H/BH4
- Monthly water levels for all boreholes.

Table 31 Proposed monitoring network

Borehole	Area monitored	Use	Status
RP01	Existing Stockpile	Abstraction borehole	Current
RP02	Existing Stockpile	Abstraction borehole	Current
RP03	North of Plant	Abstraction borehole	Current
RP04	East Background	Monitoring	Drilled
RP05	West of Stockpiles	Monitoring	Drilled
RP06	South of PCD	Monitoring	Drilled
RP07	Middel of Stockpiles	Monitoring	Drilled
FH01	South of Plant	Monitoring	Existing not used
FH02	South of Plant	Monitoring	Existing not used
H/BH4	Far West	Monitoring	Existing not used

Additionally, calibrated mechanical or electronic flow meters should be installed at all abstraction points to accurately measure and record water abstraction volumes. These figures must be included in the monitoring reports and utilized for updates to the groundwater flow model.

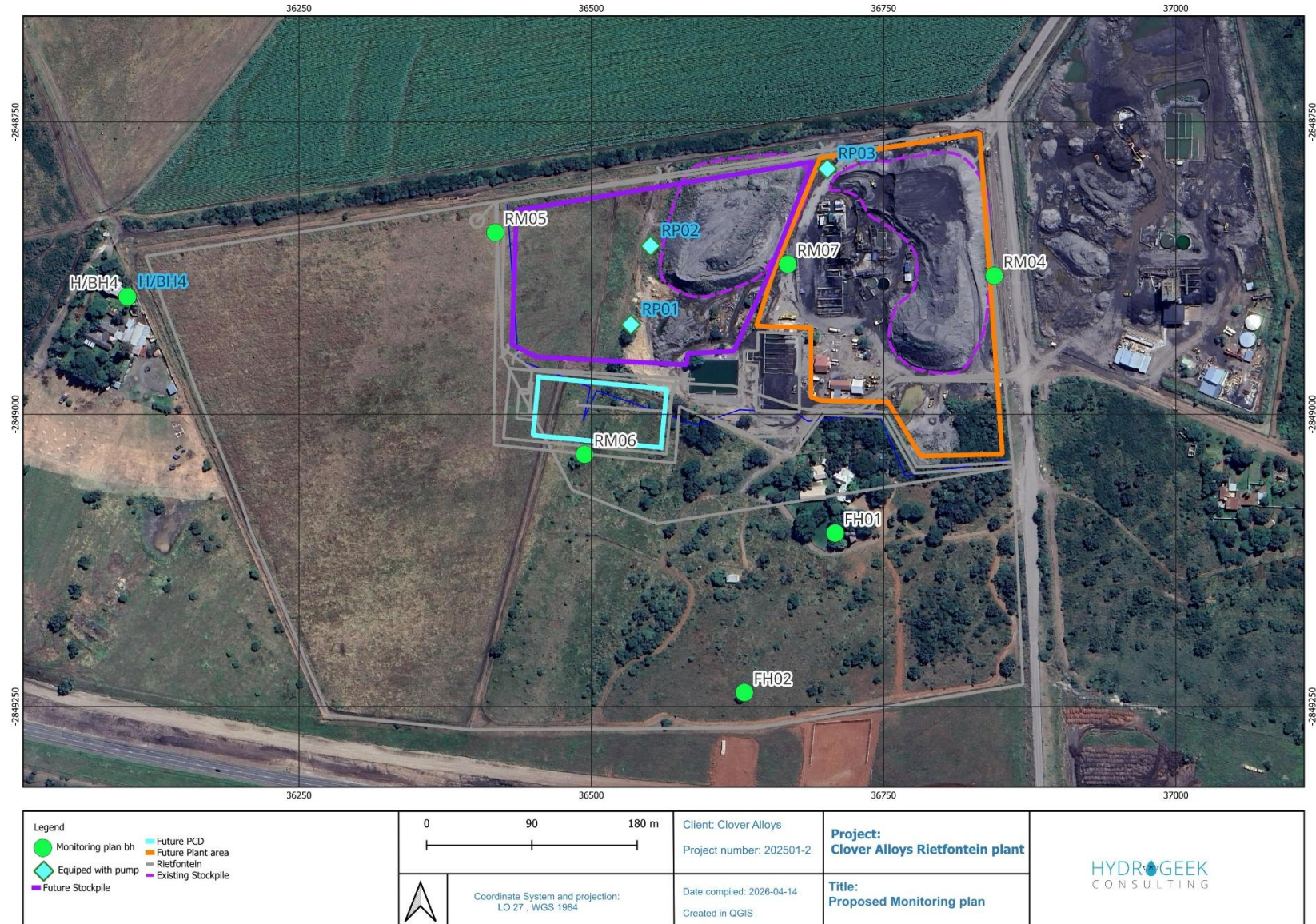


Figure 34 Proposed groundwater monitoring plan



12 CONCLUSIONS AND RECOMMENDATIONS

- A hydrocensus was conducted on the 11th, 12th and 13th of February 2025 to obtain the latest hydrogeological data of the surrounding area, location of sensitive receptors relative to the study areas, current state of private user and on-site monitoring boreholes. The groundwater levels varied between a minimum of 12.7 mbgl and a maximum of 22.3 mbgl for the Rietfontein Chrome Plant study area
- Also based on the hydrocensus, it can be concluded that the Sandspruit is a sensitive receptor due to the proximity of the wetland/spruit to the Rietfontein Plant Operation. The Sandspruit is more susceptible to contamination by surface water runoff and seepage from the shallow weathered aquifer.
- A total of 13 boreholes were sampled of which 8 were submitted (2 private water supply boreholes, 1 unequipped borehole, and 5 monitoring boreholes) for analysis of basic inorganic parameters and the results were compared to the 241:2015 'Drinking Water Standards' (SANS, 2015), as well as the DWS South African Water Quality Guidelines - Domestic Use (DWS and WRC, 2000). The main constituents of concern identified during the analysis are listed as follows:
 - Rietfontein Chrome Plant – Electrical Conductivity (EC) and Chrome
 - There are signs of groundwater contamination down gradient of the Rietfontein Chrome Plant towards the Sandspruit (a tributary of the Hex river). This is indicated by the elevated Chrome concentration measured in borehole FH02.
 - The weak correlation between groundwater elevation and surface elevation observed at Rietfontein suggests localised dewatering of the aquifer either due to abstraction by dewatering and water supply boreholes or due to open cast mining.
 - The application of the DRASTIC method resulted in a vulnerability rating of 114, which classified the aquifer as having **a medium vulnerability**. Based on geological analysis and hydrocensus data it can be concluded that the aquifer system in the study area can be classified as a **Minor Aquifer System**.
 - The CDT was conducted to determine the hydraulic parameters of the aquifer and to determine the safe yield of the boreholes. The tested boreholes yield ranges from 0.31 to 1.83 l/s. The CDTs were conducted for a period of 1440 minutes, after which the water level recovery was measured. The pumping yields were measured volumetrically during the testing programme.
 - Rietfontein Plant conducted a hydrogeological drilling program (6 April to 10 April) based on the results of prior geophysical surveys. The program involved the completion of monitoring boreholes with air percussion methods. Monitoring boreholes were completed with a combination of slotted and solid casing, selected based on the weathering characteristics encountered and the depth at which water strikes occurred. The depth of wash of the boreholes are 60 meters below ground level (mbgl).
 - There is a major shortfall in up-gradient, on site and down gradient monitoring borehole reference points to measure the extent and intensity of contaminant migration through the groundwater.. The temporal groundwater level drawdown should also be measured monthly.

- The modelling results indicate contamination is contained within the plant site. Abstraction boreholes causes a decline in groundwater levels and captures and contains the migration of the plume towards the west.
- Stormwater management infrastructure will be place through a lined PCD dam will be in place to mitigate the risk to groundwater.

13 RECOMMENDATIONS

The following recommendations are put forward for consideration:

- Monitoring monthly abstraction volumes from production boreholes (RP01-RP03) and water levels from all boreholes that are in use on the Rietfontein Plant (preferably with automated flow meters).
- Boreholes FH01, FH02 and H/BH4 should be added to the monitoring network.
- Aquifer Testing (12 hour) is recommended on the newly drilled monitoring boreholes to determine aquifer parameters
- It is recommended to do a comprehensive quarterly analysis of all boreholes at an accredited laboratory for parameters **Physical and Aesthetic Factors**: pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), and Total Hardness. **Macro Elements**: Total Alkalinity (MAIk), Sulphate (SO₄), Nitrate (NO₃), Chloride (Cl), Fluoride (F), Calcium (Ca), Magnesium (Mg), Potassium (K), and Sodium (Na). **Micro Elements**: Aluminium (Al), Iron (Fe), Manganese (Mn), Cadmium (Cd), Chromium (Cr), Copper (Cu), Nickel (Ni), Lead (Pb), Cobalt (Co), and Zinc (Zn).

13.1 Specialist opinion:

The potential environmental impacts associated with the proposed new infrastructure—such as the pollution control dam (PCD), clean and dirty water separation systems, and related channels—have been reviewed in the context of the existing operations assessed under the Section 24G application. Based on the nature, location, and function of the planned infrastructure, the associated impacts are anticipated to be materially similar in type, extent, and significance to those already identified and assessed.

As such, these impacts are considered to be sufficiently addressed by the current impact assessment. Should any deviations or unique site-specific impacts arise during implementation, these will be managed under the existing environmental management framework and mitigation measures already in place.

The project is considered viable from a groundwater perspective, provided that the recommended mitigation measures and supporting studies are implemented to better define water availability and quality on site. The associated risks can be effectively managed through regular monitoring of groundwater quality, water levels, and abstraction volumes from the aquifer.

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Signature Page

Hydrogeek Consulting PTY Ltd

Authorization		
Name	Signature	Date
NL van Zyl Hydrogeologist		April 2026

Reg.No. 2019/327216/07

Directors: NL van Zyl

Appendix 1 DRASTIC

DRASTIC parameters		Range	Rating (<i>r</i>)	Weight (<i>w</i>)
Water table depth (m)		0.0–1.5	10	5
		1.5–4.6	9	
		4.6–9.1	7	
		9.1–15.2	5	
		15.2–22.9	3	
		22.9–30.5	2	
		> 30.5	1	
Net recharge		11–13	10	4
		9–11	8	
		7–9	5	
		5–7	3	
		3–5	1	
Aquifer media		Rubble and sand	0	3
		Gravel and sand	7	
		Gravel, sand, clay, and silt	5	
		Sand and clay	4	
		Sand, clay, and silt	3	
Soil media		Rubble, sand, clay, and silt	9	2
		Gravel and sand	7	
		Gravel, sand, clay, and silt	6	
		Sand	5	
		Sand, clay, and silt	3	
		Clay and silt	2	
Topography or slope (%)		0–2	10	1
		2–6	9	
		6–12	5	
		12–18	3	
		> 18	1	
The impact of the vadose zone		Rubble, sand, clay, and silt	9	5
		Gravel and sand	7	
		Gravel, sand, clay, and silt	5	
		Sand, clay, and silt	3	
Hydraulic conductivity (m d^{-1})		0–4.1	1	3
		4.1–12.2	2	
		12.2–28.5	4	
		28.5–40.7	6	
		40.7–81.5	8	

Appendix 2 Water Quality Lab Results



TEST REPORT
56313A

Client and Project Information

Client: NOA8 (Pty) Ltd
Address: Oberon Avenue
Gauteng
0081

Attention: Stephan Botha
Tel: (084) 625-5483
Email: stephan.botha@noa8.co.za

Project number: N/A
Project name: N/A

Sample Information

Sample ID: BH16A
Units: mg/l [ppm] (unless stated elsewhere)

Matrix: Water
Container: Plastic

Date Received: 2025/02/14
Date Analysed: 2025/02/17
Date Issued: 2025/02/24

Cations and Metals

As	<0.05	Cd	<0.05	K	3.91	Na	38.22	Zn	<0.05
B	<0.5	Co	<0.05	Li*	<0.05	Ni	<0.05		
Ba	0.09	Cr	<0.05	Mn	0.48	Pb	<0.05		
Be	<0.05	Cu	<0.05	Mg	65.02	Sb	<0.05		
Ca	31.15	Fe	3.50	Mo	<0.1	Se	<0.1		

Anions (Discrete Analyser)

Cl	45.42	NO2 as N	<0.13	SO4	128.50
F	0.26	NO3 as N	<0.5	PO4 as P	0.41

Other Parameters

pH	7.49
EC (µs/cm)	730
NH4*	0.21
TDS	570
Cr(VI)*	<0.05

Disclaimers

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- 5) Methods: EPL-WL-001 (Conductivity), EPL-WL-002 (Alkalinity), EPL-WL-003 (pH), EPL-WL-004 (TDS), EPL-WL-005 (Anions by IC), EPL-WL-006 (Cations by IC), EPL-WL-007 (Metals), EPL-WL-008 (Cr(VI)), EPL-WL-009 (TOC), EPL-WL-010 (Hg by DMA), EPL-WL-011 (Anions by Discrete Analyser), EPL-HPLC-001 (Formaldehyde), EPL-ML-001 (Micro).
- 6) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.
- 7) Cr(III) and Cr(VI) are assumed to be the two major oxidative states of Chromium.

Miche Kannemeyer
Authorised Signatory





TEST REPORT 56313A

Client and Project Information

Client: NOAB (Pty) Ltd
Address: Oberon Avenue
Gauteng
0081

Attention: Stephan Botha
Tel: (084) 625-5483
Email: stephan.botha@noa8.co.za

Project number: N/A
Project name: N/A

Sample Information

Sample ID: BH17
Units: mg/l [ppm] (unless stated elsewhere)

Matrix: Water
Container: Plastic

Date Received: 2025/02/14
Date Analysed: 2025/02/17
Date Issued: 2025/02/24

Cations and Metals

As	<0.05	Cd	<0.05	K	0.85	Na	18.80	Zn	1.09
B	<0.5	Co	<0.05	Li*	<0.05	Ni	<0.05		
Ba	0.07	Cr	<0.05	Mn	<0.05	Pb	<0.05		
Be	<0.05	Cu	<0.05	Mg	145.00	Sb	<0.05		
Ca	72.00	Fe	0.08	Mo	<0.1	Se	<0.1		

Anions (Discrete Analyser)

Cl	14.04	NO ₂ as N	<0.13	SO ₄	232.50
F	0.22	NO ₃ as N	29.91	PO ₄ as P	0.22

Other Parameters

pH	7.57
EC (µs/cm)	1278
NH ₄ ⁺	0.11
TDS	997
Cr(VI)*	<0.05

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- Cr(III) and Cr(VI) are assumed to be the two major oxidative states of Chromium.

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Page 2 of 8





TEST REPORT
56313A

Client and Project Information

Client: NOAB (Pty) Ltd	Attention: Stephan Botha	Project number: N/A
Address: Oberon Avenue Gauteng 0081	Tel: (084) 625-5483	Project name: N/A
	Email: stephan.botha@noa8.co.za	

Sample Information

Sample ID: FH02	Matrix: Water	Date Received: 2025/02/14
Units: mg/l [ppm] (unless stated elsewhere)	Container: Plastic	Date Analysed: 2025/02/17
		Date Issued: 2025/02/24

Cations and Metals

As	<0.05	Cd	<0.05	K	3.12	Na	9.97	Zn	0.21
B	<0.5	Co	<0.05	Li*	<0.05	Ni	<0.05		
Ba	0.07	Cr	0.40	Mn	0.31	Pb	<0.05		
Be	<0.05	Cu	0.07	Mg	119.70	Sb	<0.05		
Ca	34.54	Fe	0.14	Mo	<0.1	Se	<0.1		

Anions (Discrete Analyser)

Cl	8.39	NO2 as N	<0.13	SO4	<2
F	0.22	NO3 as N	<0.5	PO4 as P	0.72

Other Parameters

pH	7.50
EC (µs/cm)	958
NH4*	9.44
TDS	616
Cr(VI)*	<0.05

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Authorised Signatory





TEST REPORT
56313A

Client and Project Information

Client: NOAB (Pty) Ltd	Attention: Stephan Botha	Project number: N/A
Address: Oberon Avenue Gauteng 0081	Tel: (084) 625-5483	Project name: N/A
	Email: stephan.botha@noa8.co.za	

Sample Information

Sample ID: LANBH13	Matrix: Water	Date Received: 2025/02/14
Units: mg/l [ppm] (unless stated elsewhere)	Container: Plastic	Date Analysed: 2025/02/17
		Date Issued: 2025/02/24

Cations and Metals

As <0.05	Cd <0.05	K 1.54	Na 30.23	Zn 0.08
B <0.5	Co <0.05	Li* <0.05	Ni <0.05	
Ba 0.14	Cr <0.05	Mn <0.05	Pb <0.05	
Be <0.05	Cu 0.11	Mg 175.20	Sb <0.05	
Ca 50.18	Fe 0.55	Mo <0.1	Se <0.1	

Anions (Discrete Analyser)

Cl 73.21	NO2 as N <0.13	SO4 305.20
F 0.24	NO3 as N 29.63	PO4 as P <0.2

Other Parameters

pH	7.70
EC (µs/cm)	1441
NH4*	0.07
TDS	1233
Cr(VI)*	<0.05

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Miche Kannemeyer
Authorised Signatory





TEST REPORT
56313A

Client and Project Information

Client: NOAB (Pty) Ltd	Attention: Stephan Botha	Project number: N/A
Address: Oberon Avenue Gauteng 0081	Tel: (084) 625-5483	Project name: N/A
	Email: stephan.botha@noab.co.za	

Sample Information

Sample ID: LANBH6	Matrix: Water	Date Received: 2025/02/14
Units: mg/l [ppm] (unless stated elsewhere)	Container: Plastic	Date Analysed: 2025/02/17
		Date Issued: 2025/02/24

Cations and Metals

As <0.05	Cd <0.05	K 1.28	Na 78.78	Zn 0.44
B <0.5	Co <0.05	Li* <0.05	Ni <0.05	
Ba 0.15	Cr <0.05	Mn 0.06	Pb <0.05	
Be <0.05	Cu 0.29	Mg 160.90	Sb <0.05	
Ca 43.02	Fe 32.99	Mo <0.1	Se <0.1	

Anions (Discrete Analyser)

Cl 217.90	NO2 as N <0.13	SO4 358.30
F 0.16	NO3 as N 19.80	PO4 as P <0.2

Other Parameters

pH	7.57
EC (µs/cm)	1514
NH4*	0.11
TDS	1124
Cr(VI)*	<0.05

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Authorised Signatory





TEST REPORT
56313A

Client and Project Information

Client: NOAB (Pty) Ltd	Attention: Stephan Botha	Project number: N/A
Address: Oberon Avenue Gauteng 0081	Tel: (084) 625-5483	Project name: N/A
	Email: stephan.botha@noa8.co.za	

Sample Information

Sample ID: LANBH9	Matrix: Water	Date Received: 2025/02/14
Units: mg/l [ppm] (unless stated elsewhere)	Container: Plastic	Date Analysed: 2025/02/17
		Date Issued: 2025/02/24

Cations and Metals

As <0.05	Cd <0.05	K 2.90	Na 121.70	Zn 0.59
B <0.5	Co <0.05	Li* <0.05	Ni <0.05	
Ba 0.11	Cr <0.05	Mn <0.05	Pb <0.05	
Be <0.05	Cu 0.05	Mg 124.20	Sb <0.05	
Ca 37.48	Fe <0.05	Mo <0.1	Se <0.1	

Anions (Discrete Analyser)

Cl 98.72	NO2 as N <0.13	SO4 294.30
F 0.11	NO3 as N 10.85	PO4 as P 0.51

Other Parameters

pH	7.57
EC (µs/cm)	1450
NH4*	0.08
TDS	1045
Cr(VI)*	<0.05

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Authorised Signatory





TEST REPORT
56313A

Client and Project Information

Client: NOA8 (Pty) Ltd
Address: Oberon Avenue
Gauteng
0081

Attention: Stephan Botha
Tel: (084) 625-5483
Email: stephan.botha@noa8.co.za

Project number: N/A
Project name: N/A

Sample Information

Sample ID: RN06
Units: mg/l [ppm] (unless stated elsewhere)

Matrix: Water
Container: Plastic

Date Received: 2025/02/14
Date Analysed: 2025/02/17
Date Issued: 2025/02/24

Cations and Metals

As	<0.05	Cd	<0.05	K	2.83	Na	30.11	Zn	0.08
B	<0.5	Co	<0.05	Li*	<0.05	Ni	<0.05		
Ba	0.12	Cr	<0.05	Mn	<0.05	Pb	<0.05		
Be	<0.05	Cu	0.06	Mg	98.67	Sb	<0.05		
Ca	42.28	Fe	<0.05	Mo	<0.1	Se	<0.1		

Anions (Discrete Analyser)

Cl	25.25	NO2 as N	<0.13	SO4	43.97
F	0.18	NO3 as N	1.94	PO4 as P	<0.2

Other Parameters

pH	7.92
EC (µs/cm)	914
NH4*	0.11
TDS	611
Cr(VI)*	<0.05

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Miche Kannemeyer
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TEST REPORT 56313A

Client and Project Information

Client: NOAB (Pty) Ltd
Address: Oberon Avenue
Gauteng
0081

Attention: Stephan Botha
Tel: (084) 625-5483
Email: stephan.botha@noa8.co.za

Project number: N/A
Project name: N/A

Sample Information

Sample ID: SC04
Units: mg/l [ppm] (unless stated elsewhere)

Matrix: Water
Container: Plastic

Date Received: 2025/02/14
Date Analysed: 2025/02/17
Date Issued: 2025/02/24

Cations and Metals

As	<0.05	Cd	<0.05	K	3.56	Na	21.16	Zn	<0.05
B	<0.5	Co	<0.05	Li*	<0.05	Ni	<0.05		
Ba	0.14	Cr	<0.05	Mn	<0.05	Pb	<0.05		
Be	<0.05	Cu	<0.05	Mg	172.00	Sb	<0.05		
Ca	59.91	Fe	<0.05	Mo	<0.1	Se	<0.1		

Anions (Discrete Analyser)

Cl	26.65	NO ₂ as N	<0.13	SO ₄	185.20
F	0.67	NO ₃ as N	6.68	PO ₄ as P	<0.2

Other Parameters

pH	7.83
EC (µs/cm)	1349
NH ₄ ⁺	0.12
TDS	940
Cr(VI)*	<0.05

Disclaimers

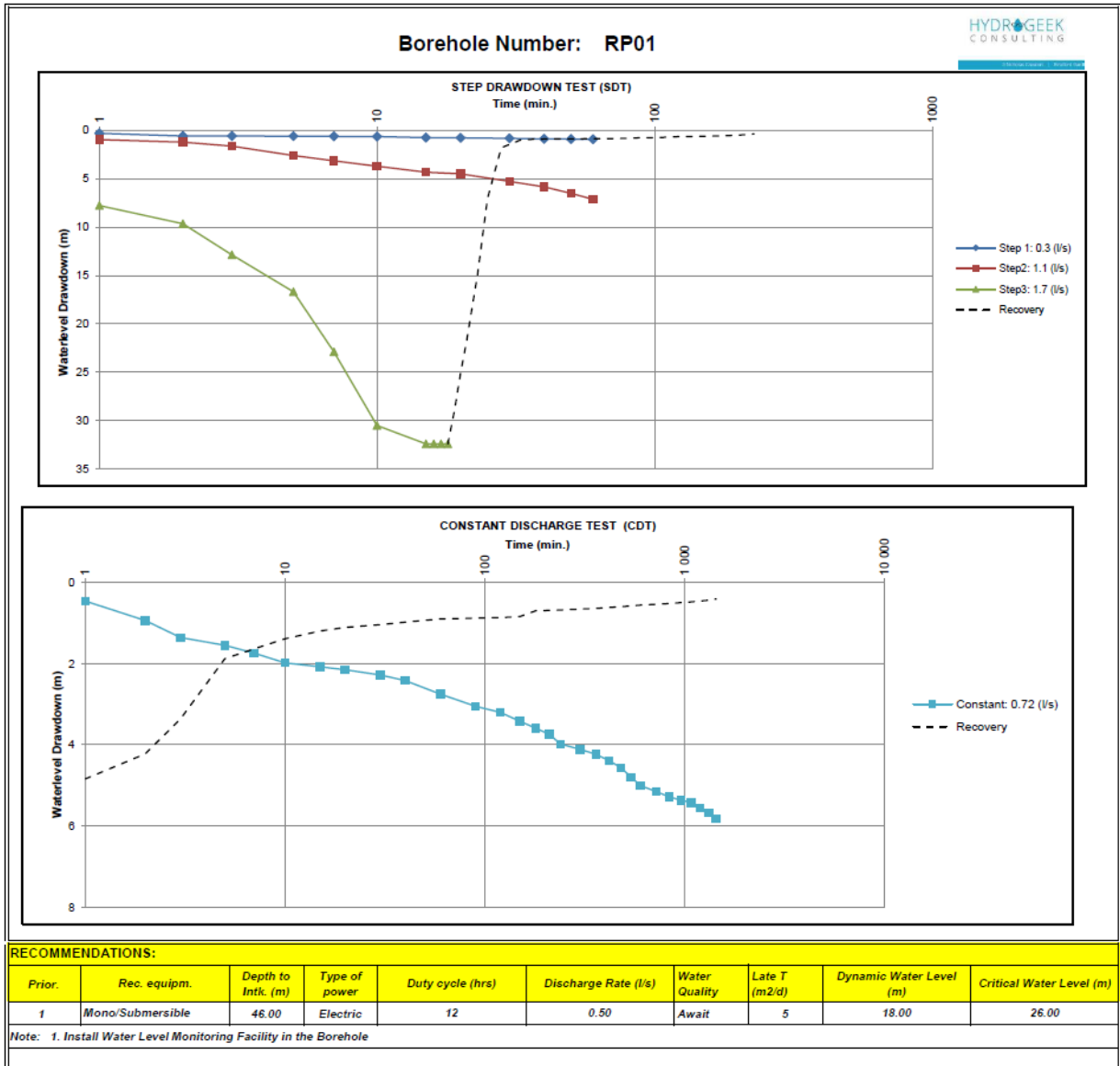
- The results only relate to the test items provided, in the condition as received.
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Page 8 of 8

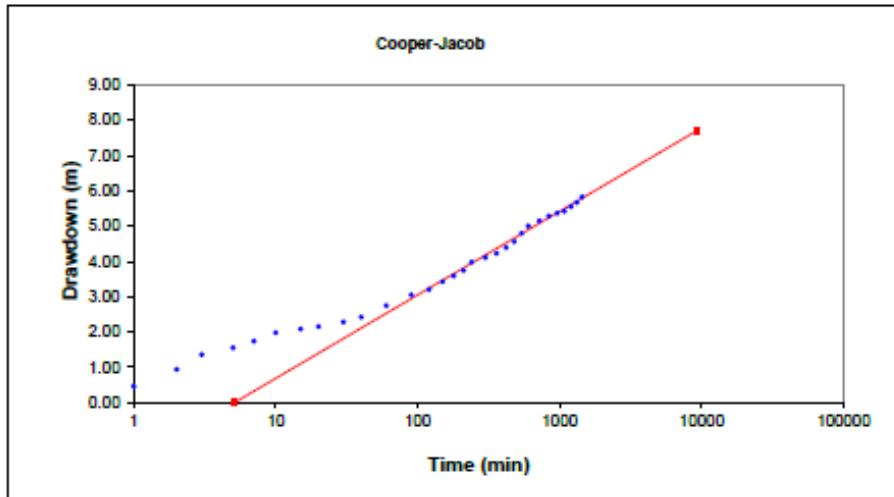


Appendix 3 Aquifer Testing



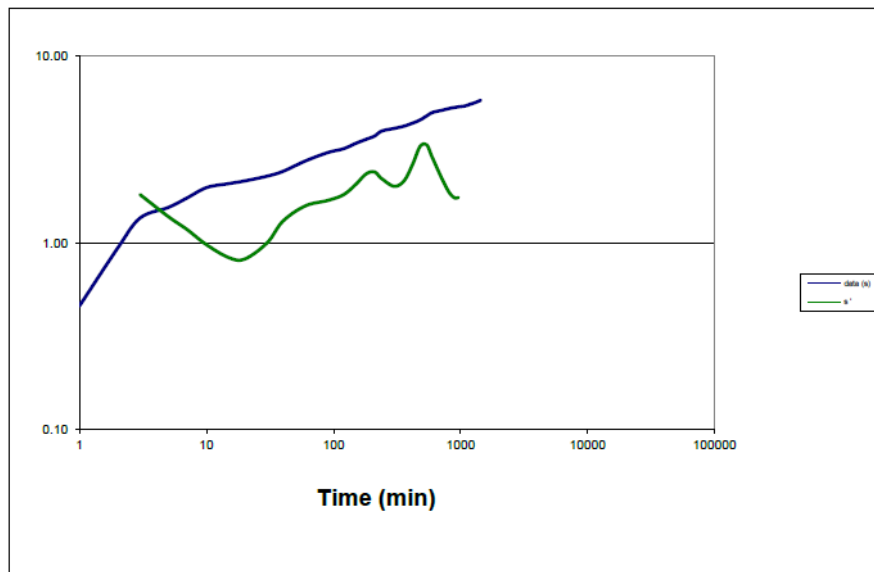
Cooper-Jacob method			
RP01			
$T(m^2/d) =$	4.8	$r_e (m) =$	1.27
$s =$	2.38E-02	$Q (l/s) =$	0.72

	No boundaries	1 no-flow	2 no-flow	Closed	
Q_{sust}	0.57	0.29	0.19	0.14	including influence of bh's
Avg. $Q_{sust} =$	0.30	std. dev = 0.19			



DERIVATIVE PLOTS AND T- AND S- VALUES

RP01



log derivative = 0.15 → good fracture network



Summary RP01

Applicable	Method	Sustainable yield (l/s)	Std. Dev	Early T (m ² /d)	Late T (m ² /d)	S	AD used
<input checked="" type="checkbox"/>	Basic FC	0.31	0.18	8	3.4	5.50E-04	10.0
<input type="checkbox"/>	Advanced FC			8	3.4	1.00E-03	10.0
<input type="checkbox"/>	FC inflection point	#NUM!	#NUM!				41.6
<input checked="" type="checkbox"/>	Cooper-Jacob	0.30	0.19		4.8	4.00E-02	10.0
<input type="checkbox"/>	FC Non-Linear						10.0
<input checked="" type="checkbox"/>	Barker	0.29	0.16	K _t = 111	S _s =	1.64E-04	10.0
	Average Q _{sust} (l/s)	0.30	0.01	b = 0.24	Fractal dimension n =	1.83	

Recommended abstraction rate (L/s)	0.30	for 24 hours per day
Hours per day of pumping	12	0.42 L/s for 12 hours per day

Amount of water allowed to be abstracted per month	776.2825	m ³
Borehole could satisfy the basic human need of	1035	persons
Is the water suitable for domestic use (Yes/No)	Y	

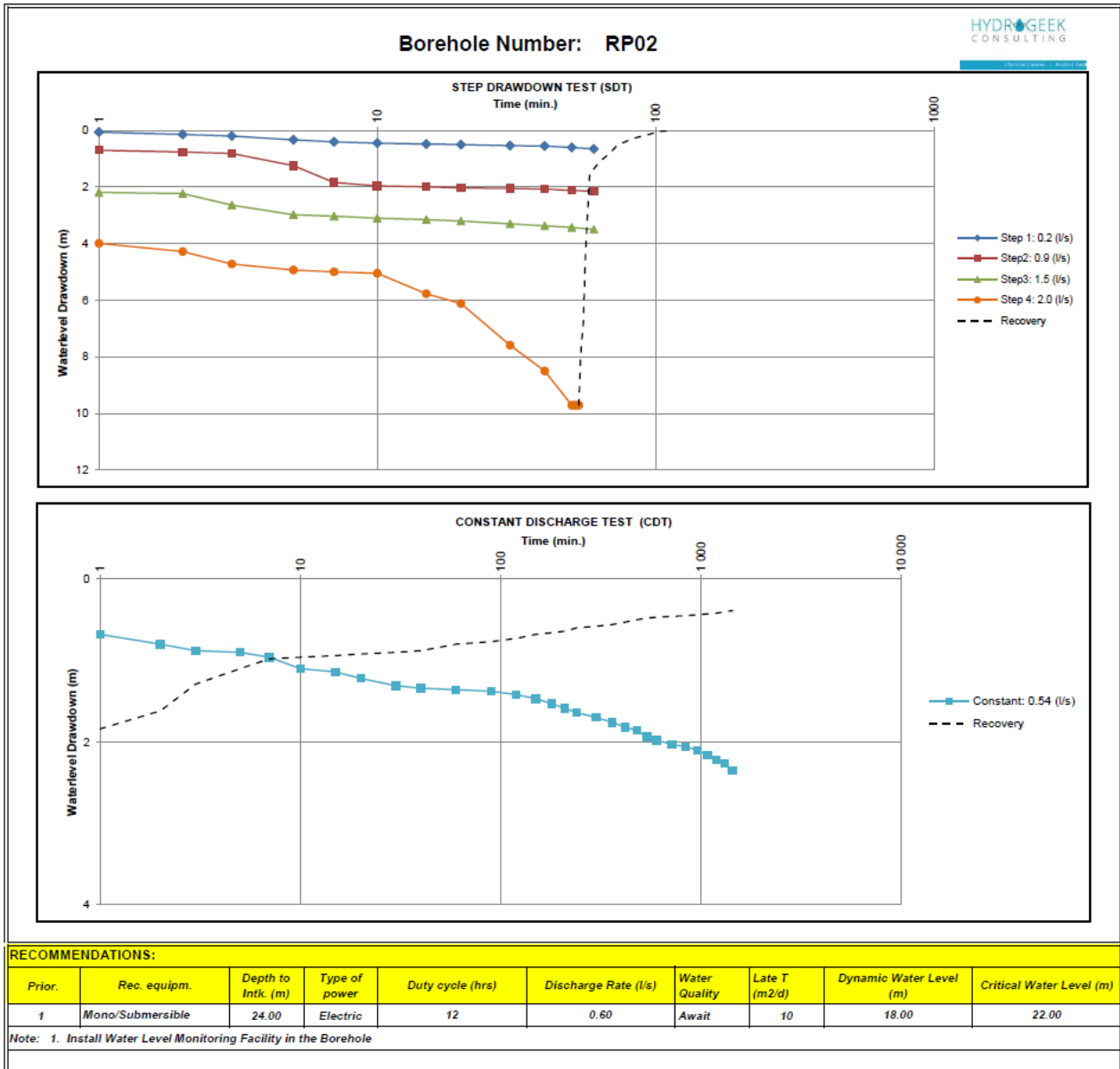
Q = 0.5 l/s 12h/Day
 PI = 46m
 Mono/Submersible Electric
 Dynamic WL= 18m
 Critical WL= 26m
 T = 5 (m²/day)

Recommended pump depth below surface (m)	46
Total Casing length	
Blow yield (l/s)	
Critical depth that water level must not exceeded	26
Depth of bh	48.43
static water level	14.1

Management recommendations

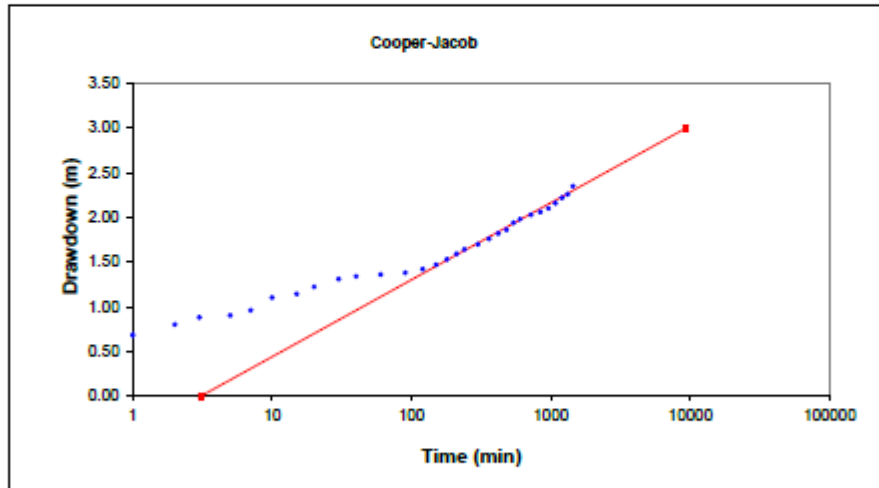
Q = 0.5 l/s 12h/Day
 PI = 46m
 Mono/Submersible Electric
 Dynamic WL = 18m
 Critical WL = 26m
 SWL Difference at end of CDT = 0.41m





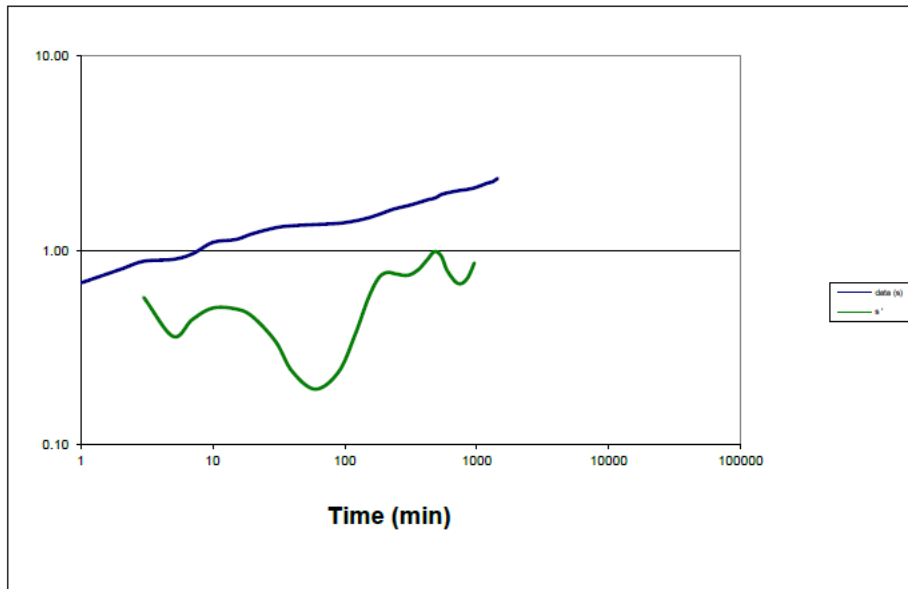
RP02				
$T(m^2/d) =$	9.9	$r_e (m) =$	0.98	0.98
$s =$	4.99E-02	$Q (l/s) =$	0.54	

	No boundaries	1 no-flow	2 no-flow	Closed	
Q_{sust}	0.79	0.40	0.26	0.20	including influence of bh's
Avg. $Q_{sust} =$		0.41	std. dev =	0.27	



DERIVATIVE PLOTS AND T- AND S - VALUES

RP02



log derivative = 0.10 → good fracture network



Summary **RP02**

Applicable	Method	Sustainable yield (l/s)	Std. Dev	Early T (m ² /d)	Late T (m ² /d)	S	AD used
<input checked="" type="checkbox"/>	Basic FC	0.46	0.24	22	7.8	3.85E-04	7.0
<input type="checkbox"/>	Advanced FC			22	7.8	1.00E-03	7.0
<input type="checkbox"/>	FC inflection point	0.00	0.00				2.3
<input checked="" type="checkbox"/>	Cooper-Jacob	0.41	0.27		9.9	4.99E-02	7.0
<input type="checkbox"/>	FC Non-Linear						7.0
<input checked="" type="checkbox"/>	Barker	0.48	0.26	K _f = 111		S _s = 1.64E-04	7.0
	Average Q _{sust} (l/s)	0.45	0.03	b = 0.24	Fractal dimension n =	1.92	

Recommended abstraction rate (L/s) 0.45 for 24 hours per day
Hours per day of pumping 12 0.64 L/s for 12 hours per day

Amount of water allowed to be abstracted per month 1167.915 m³
 Borehole could satisfy the basic human need of 1557 persons
 Is the water suitable for domestic use (Yes/No) Y

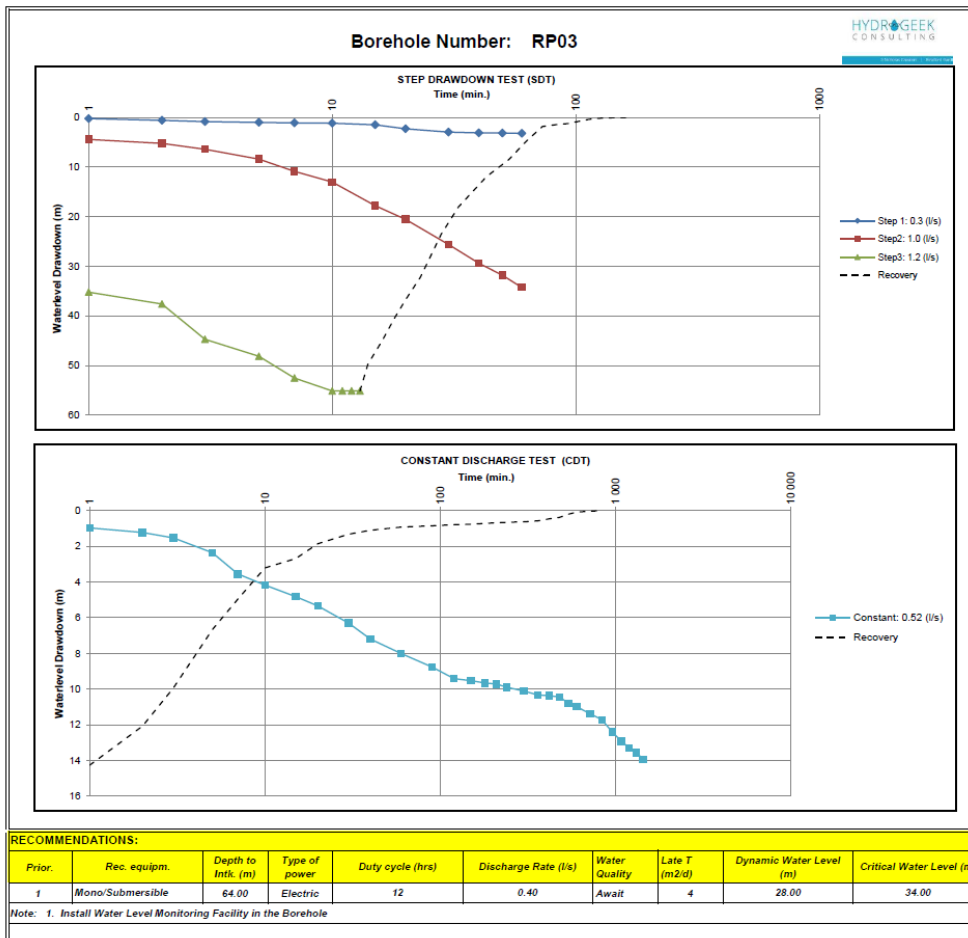
Q = 0.6 l/s/12h/Day
 PI = 24m

Recommended pump depth below surface (m)	46
Total Casing length	
Blow yield (l/s)	
Critical depth that water level must not exceeded	26
Depth of bh static water level	48.43
static water level	14.1

Mono/Submersible Electric
 Dynamic WL= 18m
 Critical WL= 22m
 T = 10 (m²/day)

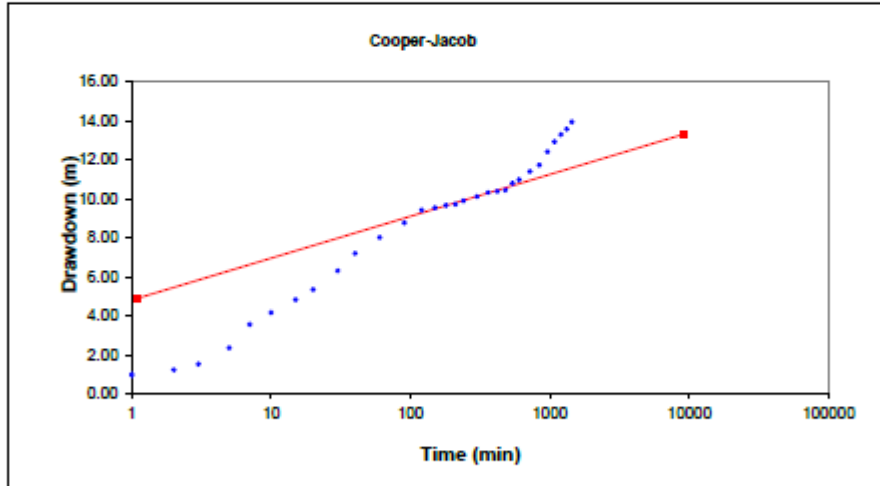
Management recommendations

Q = 0.6 l/s 12h/Day
 PI =24m
 Mono/Submersible Electric
 Dynamic WL = 18m
 Critical WL= 22m
 SWL Difference at end of CDT = 0.39m

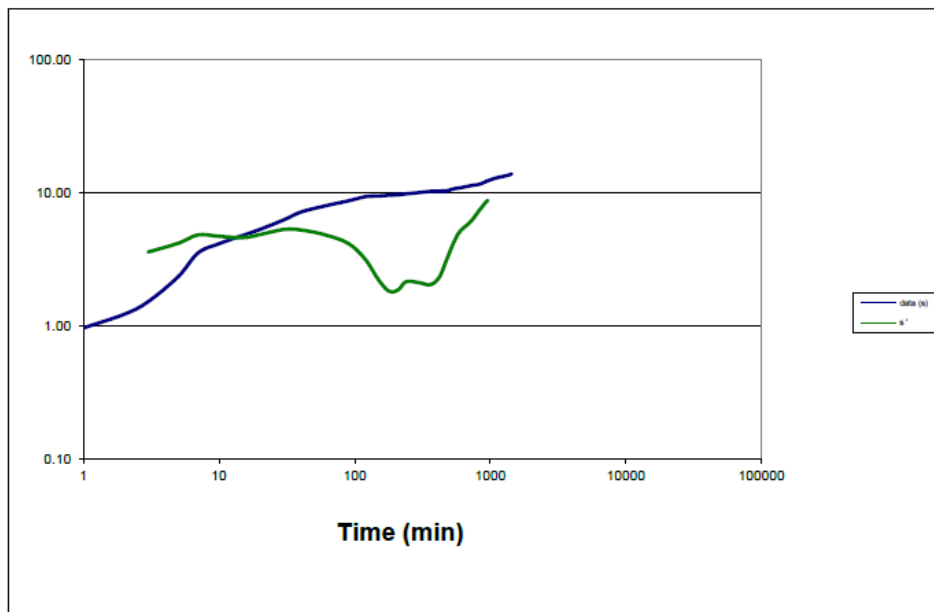


RP03			
$T(m^2/d) =$	3.8	$r_e (m) =$	0.98
$S =$	3.56E-05	$Q (l/s) =$	0.52
			0.98

	No boundaries	1 no-flow	2 no-flow	Closed	
Q_{sust}	0.35	0.18	0.12	0.09	including influence of bh's
Avg. $Q_{sust} =$		0.18	std. dev = 0.12		



DERIVATIVE PLOTS AND T- AND S- VALUES
RP03



log derivative = 0.17 → good fracture network



Summary **RP03**

Applicable	Method	Sustainable yield (l/s)	Std. Dev	Early T (m ² /d)	Late T (m ² /d)	S	AD used
<input checked="" type="checkbox"/>	Basic FC	0.10	0.06	2	0.9	5.50E-04	12.0
<input type="checkbox"/>	Advanced FC			2	0.9	1.00E-03	12.0
<input checked="" type="checkbox"/>	FC inflection point	0.10	0.06				11.5
<input checked="" type="checkbox"/>	Cooper-Jacob	0.18	0.12		3.8	3.56E-05	12.0
<input type="checkbox"/>	FC Non-Linear						12.0
<input checked="" type="checkbox"/>	Barker	0.08	0.03	K _r = 111		S _s =	1.64E-04
	Average Q _{sust} (l/s)	0.12	0.05	b = 0.24	Fractal dimension n =		1.67

Recommended abstraction rate (L/s)	0.12	for 24 hours per day
Hours per day of pumping	12	L/s for 12 hours per day

Amount of water allowed to be abstracted per month	300.0472	m ³
Borehole could satisfy the basic human need of	400	persons
Is the water suitable for domestic use (Yes/No)	Y	

Q = 0.4 l/s 12h/Day
PI = 64m

Recommended pump depth below surface (m)	64
Total Casing length	
Blow yield (l/s)	
Critical depth that water level must not exceeded	34
Depth of bh	48.43
static water level	17.36

Mono/Submersible Electric
Dynamic WL= 28m
Critical WL= 34m
T = 4 (m²/day)

Management recommendations

Q = 0.4 l/s 12h/Day
PI = 64m
Mono/Submersible Electric
Dynamic WL = 28m
Critical WL = 32m



Appendix 1 Boreholes Logs (To b added)

Appendix 3 Curriculum Vita

**Curriculum vitae****NICO VAN ZYL**

Contact Details: nico@hydrogeekconsulting.com
 +27718773744 (Mobile)
 www.linkedin.com/in/nico-van-zyl-00b33a51 (LinkedIn)
 hydrogeekconsulting.com (Company)

Education

M.Sc. Hydrogeology, University of the Free State, Bloemfontein, SA, 2011

Honours. Hydrogeology, University of the Free State, Bloemfontein, SA, 2009

B.Sc. Geology, University of the Free State, Bloemfontein, SA, 2009

Certifications

Collaboration for Success BHP Billiton - Bayside Aluminium, 5 December 2014

Languages

Afrikaans – Fluent

English – Fluent

Hydrogeek Consulting (Pty.) Ltd. – Johannesburg

Hydrogeologist/Groundwater Modeller

Nico is passionate about the field of Hydrogeology and have a special interest in Groundwater modelling (FEFLOW) as a tool to provide cost effective solutions to clients. We are moving more to decision support modelling , through uncertainty analysis using programs that PEST tools. There is so much uncertainty to groundwater modelling it is time we accept it and let allow the flow of information to reach the right places. We are committed to the Bayesian way of thinking, that we start with uncertainty and end with uncertainty. Information reduces uncertainty.

Our experience ranges from Interpretation of groundwater data to form Conceptual Hydrogeological Models and Numerical Groundwater Models for underground and open pit mines. In the past few years we have been busy in different regions around the world, developing Numerical Groundwater Models. Regions and countries include , USA, Australia (Pilbara region), Argentina, UAE, Germany, Peru, South Africa , African countries Zambia, DRC, Mozambique, Ghana and Guinea. The focus is on helping clients with planning and management decisions in terms of groundwater solutions (pore pressures, water supply, dewatering , cone of depressions and quality impacts from mining activities). Sectors we have worked in include mining (gold, platinum, coal and diamond) , manufacturing and government.

HG aim to solve complex issues by being well-informed on what the data is telling us. Our service will provide you with interpreted data to inform your Conceptual model and Uncertainty associated. HG consulting will always be based on cost effective solutions for your Groundwater models. HG believe in under promising and over delivering as we hold our client's long-term satisfaction in the highest regards.

*Why us?
With good experience in FEFLOW a modelling software package, we are confident we can provide a service that yields trustworthy and professional results*

Employment History

Hydrogeek Consulting (Pty) Ltd – Johannesburg

Director – (2019 to Present)

Golder Associates – Johannesburg

Hydrogeologist/Groundwater Modeller and Modelling team leader (2014 to 2019)

AGES – Potchefstroom

Hydrogeologist (2012 to 2014)

University of the Free State

Researcher (2011)

PROJECT EXPERIENCE – HYDROGEOLOGY

South32: Bayside Groundwater Management Plan

Kwa-Zulu Natal, South Africa

This Groundwater Management Plan for Bayside was developed using a detailed Source-Pathway-Receptor (SPR) assessment and simulations to assess the effectiveness of the different scenarios that Bayside are considering.

Development of a post closure Water Management Plan -Phase 2 Decant Study

Gauteng, South Africa

The decant study needed to investigate the potential for the South Deep underground workings to decant on surface based on conservative assumptions. In this report the available hydrogeological data is assessed in more detail as the results and findings are critical to the understanding of the post closure flow system at South Deep.

Western Hub Dewatering and Water Supply Project

Pilbara, Australia

Groundwater Model developed in FEFLOW package. The simulations of dewatering boreholes together with water supply scenarios to meet the demand of the mine. The mine dewatering was done with de-

watering boreholes. The project also involved the impact assessment and the recovery of pit water levels post closure.

Middelburg Ferrochrome – Groundwater Modelling as part of the Contaminated Land team, Middelburg, South Africa.

Mpumalanga, South Africa

This task involved numerical flow and solute transport modelling, developing a new groundwater model using, a highly sophisticated and powerful 3D finite element modelling package (FEFLOW). Data was interpreted and used to update the conceptual model of the site. Remediation scenarios was simulated from trenches to capture contamination downstream.

Amandelbult Groundwater Model for dewatering of the underground, Thabazimbi, South Africa.

Limpopo, South Africa

This task involved numerical flow and solute transport modelling, developing a new groundwater model using, a highly sophisticated and powerful 3D finite element modelling package (FEFLOW) designed to cope with complex hydrogeological situations was used. Dewatering of two underground mines was simulated and the post closure water management scenarios were also done as part of closure, different scenarios was simulated for the TSF's.

Platreef DFS Groundwater Model, Mokopane, Limpopo Province, South Africa.

Limpopo, South Africa

This task involved numerical flow and solute transport modelling, developing a new groundwater model using, a highly sophisticated and powerful 3D finite element modelling package (FEFLOW) for EIA purposes.

Jindal Groundwater Modelling Open Pit dewatering- KwaZulu-Natal, South Africa

Kwa-Zulu Natal, South Africa

This task involved numerical flow and solute transport modelling, developing a new groundwater model using, a highly sophisticated and powerful 3D finite element modelling package (FEFLOW) designed to cope with complex hydrogeological situations will be used.

KCC Hydrogeological Services

Kolwezi, DRC

This task involved numerical flow and solute transport modelling, developing a new groundwater model using a highly sophisticated and powerful 3D finite element modelling package (FEFLOW) designed to cope with complex hydrogeological situations in a Dolomitic karst environment.

Lonmin Marikana Groundwater Model

Marikana, South Africa

Developing of a Groundwater Flow Model with Contaminant Transport.

UMK Mine Groundwater Model

Hotazel, South Africa

Developing of a Groundwater Flow Model with Contaminant Transport. For closure purposes

Maamba Colliery HSESMP Hydrogeological Baseline and Groundwater Model Study

Maamba, Zambia

This task involved numerical flow and solute transport modelling, developing a new groundwater model using a highly sophisticated and powerful 3D finite element modelling package (FEFLOW) designed to cope with complex hydrogeological situations will be used.

WASSA Golden Star Dewatering Model underground and opencast mine

WASSA, Ghana

The groundwater specialist study was completed to fulfil the objectives as required by the EIA, WUL and rehabilitation and closure strategy. Works included construction of a conceptual hydrogeological model and numerical groundwater model to assess the potential impacts on groundwater quantity and quality.

Klipspruit Colliery

Mpumalanga, South Africa

This task involved numerical flow and solute transport modelling, developing a new groundwater model using a highly sophisticated and powerful 3D finite element modelling package (FEFLOW) designed to cope with complex hydrogeological situations will be used.

Khutala Colliery

Mpumalanga, South Africa

This task involved numerical flow and solute transport modelling, developing a new groundwater model using a highly sophisticated and powerful 3D finite element modelling package (FEFLOW) designed to cope with complex hydrogeological situations will be used.

Two Rivers Mine South Opencast Pit

Steelpoort, South Africa

Groundwater inputs to the overall EIA and EMPR, including, geophysical surveying, drilling, testing, groundwater quantity and quality impacts, modelling, reporting of the Two Rivers Mine South Opencast Pit.

Majuba Underground Coal Gasification

Amersfoort, South Africa

Project focussed on characterizing the hydrogeology and groundwater, including pore water pressure monitoring. The development of a conceptual hydrogeological model and numerical model to identify potential impacts on the groundwater system as result of UCG operations.

Townlands Underground Mine Project

North-West, South Africa

The groundwater specialist study was completed to fulfil the objectives as required by the water management strategy, EIA, WUL and rehabilitation and closure strategy. Works included construction of a conceptual hydrogeological model and numerical groundwater model to assess the potential impacts on groundwater quantity and quality.

Bayside Aluminium

Kwazulu-Natal, South Africa

The potential impacts from these identified sources on the groundwater system and migration of contaminant plumes from these sources were evaluated through the groundwater modelling.

KCM Nchanga SPR Model Study Groundwater Flow and Contaminat Transport Modelling

Developing of a Groundwater Flow Model with Contaminant Transport.

Nchanga, Zambia

Mopani Nkana Mine Dewatering Groundwater Model

Developing of a Groundwater Flow Model to determine dewatering rates and pore pressures.

Ndola, Zambia

Mopani Mufulira Mine Dewatering Groundwater Model

Developing of a Groundwater Flow Model to determine dewatering rates and pore pressures.

Mufulira, Zambia

Kinsevere Mine Dewatering and Post Closure Groundwater Model

Developing of a Groundwater Flow Model to determine dewatering rates and impact. Post closure study to determine Pit Lake conditions.

Lubumbashi, DRC

Reminex Mines TriK Dewatering Modelling Study, Guinea 2023

Details to follow

Waterval Smelter Numerical Model , Rustenburg, North Wes 2022

Details to follow

Talon Metals Hydrogeology and Modelling Review, Minnesota, US 2022

Details to follow

Bel Air Alufer Well field design DFS Groundwater Model, Bel Air, Guinea 2022

Numerical Modelling EÜ Magdeburg Concepts for dewatering of systems, Magdeburg, Germany

Details to follow

**Modelo 3D Waste Dump Las Bambas, Peru ,
South America** Details to follow

**Barberton Mines Geohydrological Study and
Groundwater Model, Barberton, South Africa** Details to follow

**Bunker Hill Mine Conceptual Understanding ,
Kellogg, IDAHO, USA** Details to follow

**Groundwater flow and solute transport model,
San Lorenzo, Argentina** Details to follow

**Ardmore Graphite Open Pit Stage 3 Dewatering
Model, Queensland, Australia** Details to follow

**Casa Berardi Mine Principle Open Pit dewater-
ing, Quebec, Canada** Details to follow

**Sunnyside Diamonds Hydrogeological Concep-
tual Model, Northern Cape, South Africa** Details to follow

Training

FEFLOW 7 Groundwater Modelling for Mine Sites

DHI WASY, 21-23 September 2016

FEFLOW Groundwater Modelling for Mine Sites

DHI WASY, 24 August - 26 August 2015

Advanced FEFLOW Groundwater modelling

DHI WASY, 30 October 2012- 2 November 2012

Symple School of Hydrogeological Modelling ,

Milan Italy (18 months)

SUPPLEMENTAL SKILLS

Leapfrog Hydro

Hydrogeological Modelling

Data interpretation

Surfer, GRAPHER

Maps

QGIS, Global Mapper

Groundwater Modelling

FEFLOW 8.0 and FEPEST

Python Coding

Past Statistics

PROFESSIONAL AFFILIATIONS

Pr.Sci.Nat 400165/14

PUBLICATIONS**Conference Proceedings**

Love*, David, Vanessa Aphane, Gerhard van der Linde and Nico van Zyl. 2015. *Innovative approaches to predicting, mitigating and remediating groundwater pollution in UCG*. SAUCGA Workshop, September. Muldersdrift, South Africa.

