forestry, fisheries
& the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

Private Bag X447, Pretoria, 0001, Environment House, 473 Steve Biko Road, Pretoria, 0002 Tel: +27 12 399 9000, Fax: +27 86 625 1042

SPECIALIST DECLARATION FORM – AUGUST 2023

Specialist Declaration form for assessments undertaken for application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

REPORT TITLE

Hydrogeological Assessment Study for the proposed construction and maintenance of New System 1 at Rand Water Vereeniging Treatment Works, installation of approximately 7 km phase 2 Sludge Pipeline in Vereeniging, 1.5 km sludge line in Panfontein and associated infrastructure within the jurisdiction of Sedibeng District Municipality, Gauteng Province.

Kindly note the following:

1. This form must always be used for assessment that are in support of applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting, where this Department is the Competent Authority.
2. This form is current as of August 2023. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.dffe.gov.za/documents/forms.
3. An electronic copy of the signed declaration form must be appended to all Draft and Final Reports submitted to the department for consideration.
4. The specialist must be aware of and comply with *'the Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the act, when applying for environmental authorisation - GN 320/2020)'*, where applicable.

1. SPECIALIST INFORMATION

Title of Specialist Assessment	Hydrogeological Assessment Study for the proposed construction and maintenance of New System 1 at Rand Water Vereeniging Treatment Works, installation of approximately 7 km phase 2 Sludge Pipeline in Vereeniging, 1.5 km sludge line in Panfontein and associated infrastructure within the jurisdiction of Sedibeng District Municipality, Gauteng Province.
Specialist Company Name	Ariys Consultant
Specialist Name	Fhatani Makhuvha
Specialist Identity Number	9211025759089
Specialist Qualifications:	Bachelor of Earth Sciences in Mining & Environmental Geology
Professional affiliation/registration:	SACNASP Pr. Sci. Nat: 118364
Physical address:	Block 30, Oxford Office Park, 3 Bauhinia Street, Highveld Techno Park, Centurion, 0157
Postal address:	Same as Physical Address
Postal address	Same as Physical Address
Telephone	068 497 6579

Cell phone	068 497 6579
E-mail	info@ariys.co.za / Fhatani@ariys.co.za

2. DECLARATION BY THE SPECIALIST

I, Fhatani Makhuvha declare that –

- I act as the independent specialist in this application;
- I am aware of the procedures and requirements for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (NEMA), 1998, as amended, when applying for environmental authorisation which were promulgated in Government Notice No. 320 of 20 March 2020 (i.e. "the Protocols") and in Government Notice No. 1150 of 30 October 2020.
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing –
  - any decision to be taken with respect to the application by the competent authority; and;
  - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the NEMA Act.

Signature of the Specialist

Ariys Consultant (Pty) Ltd

Name of Company:

22 Aug 2025

Date

SPECIALIST DECLARATION FORM – AUGUST 2023

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, _ Fhatani Makhuvha_____, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

Ariys Consultant (Pty) Ltd

Name of Company

22/08/2025

Date

Click or tap here to enter text.

Signature of the Commissioner of Oaths

Click or tap to enter a date.

Date

SOUTH AFRICAN POLICE SERVICE
DETECTIVES
2025 -08- 25
ALEXANDRA
SUID AFRIKAANSE POLIESIEDIENS

HYDROGEOLOGICAL INVESTIGATION STUDY FOR THE PROPOSED CONSTRUCTION AND MAINTENANCE OF NEW SYSTEM 1 AT RAND WATER VEREENIGING TREATMENT WORKS, INSTALLATION OF APPROXIMATELY 7 KM PHASE 2 SLUDGE PIPELINE IN VEREENIGING AND ASSOCIATED INFRASTRUCTURE WITHIN THE JURISDICTION OF SEDIBENG DISTRICT MUNICIPALITY, GAUTENG PROVINCE.

REPORT STATUS: FINAL REPORT

DATE: JUNE 2025

PREPARED BY:

ARIYS CONSULTING (PTY) LTD

Oxford Office Park, Unit 30 First Floor Right,
3 Bauhina Street, Highveld Techno Park,
Centurion, 0157 | South Africa

PREPARED FOR

SELAHLE CONSULTANCY AND PROJECTS (PTY) LTD

546 16th Road,
Constantia Park Block 2, 1st Floor,
Randjespark, 1682 | South Africa

Title:	**Hydrogeological Investigation Study for the Proposed Construction and maintenance of New System 1 at Rand Water Vereeniging Treatment Works, installation of approximately 7 km phase 2 sludge pipeline in Vereeniging and associated infrastructure within the jurisdiction of Sedibeng District Municipality, Gauteng Province.**
Prepared for:	**Selahle Consultancy and Projects (Pty) Ltd** 546 16th Road, Constantia Park Block 2, 1st Floor, Randjespark, 1682
Contact Person:	**Miss. Sinnah Mhlongo**
Office:	+27 79 614 8298
Prepared by:	**Ariys Consulting (Pty) Ltd** Oxford Office Park, Unit 30 First Floor Right, 3 Bauhina Street, Highveld Techno Park, Centurion, 0157
Contact Person:	**Mr Fhatani Makhuvha**
Mobile:	+27 68 497 6579
Project No.:	AC-HG-01/03
Project Team:	FL Makhuvha, Hydrogeologist (Pri.Nat.Sci./MGSSA/GWD)
Site Coordinates:	Lat: -26.687440°S, Long: 27.919265°E
Location:	Rand Water Vereeniging Treatment Works - New System 1, Vereeniging, Gauteng Province
Date:	25 June 2025

Report Approved:

Fhatani Lenon Makhuvha *Pr.Nat.Sci/GWD*
Hydrogeologist

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

Ariys Consulting (Pty) Ltd has been appointed by Selahle Consultancy and Projects (Pty) Ltd on behalf of Rand Water to conduct a hydrogeological investigation study for the Construction and maintenance of New System 1 at Rand Water Vereeniging Treatment Works, installation of approximately 7 km phase 2 sludge pipeline in Vereeniging and associated infrastructure within the Jurisdiction of Emfuleni Local Municipality forming part of Sedibeng District Municipality in Gauteng Province, South Africa.

The New System 1 Vereeniging water treatment works and Phase 2 Sludge Pipeline with approximately 7 km of 1000mm nominal internal diameter steel sludge pipe with an 8mm wall thickness to be laid from the Vereeniging water treatment works to the Vaal river crossing. The hydrogeological assessment forms part of the requirement of the Basic Assessment (BA), Water Use License Application and A Heritage Permit for the proposed construction and maintenance of New System 1 in Vereeniging water treatment works and the Installation of Sludge Pipelines for Phase 2 for the following:

- New System 1 Vereeniging
  - Construction of a new 250 MLD flocculator and 225 MLD sedimentation tank.
  - Installation of the de-sludge bridge.
  - Construction of access roads.
  - Installation of a raw water pipeline.
  - Installation of a sludge pipeline.
  - Demolition of System 1 tank (90 MLD) to allow for the installation of a new automated
  - system capable of producing 1400 MLD.
  - Construction of a Laboratory and
  - The installation of a new Carbon Dioxide dosing Carbonisation Bay.
- Phase 2 Sludge Pipeline
  - Phase 2 of the sludge pipeline starts from the sludge pumping station inside Vereeniging Water Treatment Works and runs through mostly an established industrial area in the south of Vereeniging. The industrial area is fully serviced with surfaced roads, a stormwater system, a sewer system, water supply, electricity, gas pipelines and communication services. The proposed sludge pipeline runs alongside as well as across some of these services which also include Rand Water Bulk Water Pipelines to the Vaal River Crossing.
  - The installation of a 7 km of 1000mm nominal internal diameter steel sludge pipe with an 8mm wall thickness to be laid from the Vereeniging Pumping Station to the Vaal River Crossing.
  - The total length of the pipeline will be approximately 7000m.

The scope of work for the hydrogeological assessment was to carry out the desktop analyses, review of the existing hydrogeological study reports and a detailed field investigation comprising of a hydrocensus and sampling of monitoring boreholes.

2 METHODOLOGY

2.1 DESKTOP STUDY

Ariys Consulting (Pty)Ltd assessed all available geological and hydrogeological data. All existing groundwater data was reviewed and assessed during the desktop study.

A study of the 1: 250 000 geological maps and satellite images were conducted during the desktop study. All relevant information was sourced from the client as well as from the relevant governmental departments where available. Any existing groundwater data captured in the National Groundwater Archive (NGA), obtained from the Department of Water Affairs was utilised.
The following data sources were used during the study:

- Geological map (1:250 000): 2626 West Rand;
- The groundwater resources of the Republic of South Africa, sheets 1 and 2 (Vegter 1995);
- GRIP(Groundwater Resource Information Programme) data;
- GRDM, Groundwater Resource Directed Measures, GRDM Training Manual; and
- The National Groundwater Archive (NGA), Department of Water Affairs.
- JG Africa, 2016. Sedimentation and Flocculation Plant at Vereeniging Pumping Station Geotechnical Report (P/N: 4256/02).
- GCS Water and Environment (Pty) Ltd, 201. Rand Water Vereeniging Water Treatment Works - System 1: Hydrogeological Investigation Report (18-0660).

2.2 HYDROCENSUS INVESTIGATION

A hydrocensus was conducted within a 5 km radius of the site area. The following information can be captured during the hydrocensus:

- GPS coordinates and elevation of existing boreholes or springs;
- Water levels of the boreholes, where accessible;
- Estimated abstraction volumes, where provided;
- Any other information regarding the water reliability or quality;
- Identifying surface water bodies and usage;
- Determine groundwater usage and identify groundwater users; and
- Selected boreholes identified during the hydrocensus will be incorporated within a monitoring plan to monitor groundwater quality.

2.3 GROUNDWATER SAMPLING

The hydrocensus/monitoring boreholes were sampled. The samples were submitted to Aquatico Scientific a SANAS accredited laboratory based in Irene, Centurion, South Africa. A total of 3 samples were collected.

The hydrochemical sampling was carried out in accordance with the following publications:

- SABSISO5667-11:1993 Guidance on sampling of groundwater
- SABSISO5667-1:1980 Guidance on the design of sampling programs
- SABSISO5667-2:1991 Guidance on sampling techniques
- SABSISO5667-3:1994 Guidance on the preservation and handling of samples

The following parameters were analysed for, viz: anions, cations and selected metals. Water level measurements were recorded in all sampled boreholes to comment on the feasibility of the existing monitoring boreholes in place and to be used as future groundwater monitoring boreholes.

3 SITE DESCRIPTION

3.1 SITE LOCATION

The Rand Water Vereeniging Water Treatment Works is located in Vereeniging Central Business within the Jurisdiction of Emfulani Local Municipality forming part of Sedibeng District Municipality of Gauteng Province in South Africa. The geographical coordinates of the site are -26.687440°S, 27.919265°E. The site can be accessed via Barrage Road (R42) in Vereeniging. Refer to Figure 4-1 for locality map of the project area.

3.2 TOPOGRAPHY AND DRAINAGE

The site is situated at maximum elevation of 1447m, exhibits varied topography in relation to surrounding points. The terrain slopes downward to the east by approximately -5m, rises upward to the west by +2m, and slopes downward to the south by approxiamtely-4m. This suggests an undulating or sloping topography rather than a flat one. Water drainage is likely to occur towards lower elevations, such as south and east, while the western and northern directions may experience water runoff moving away.

3.3 CLIMATE

The climatic conditions prevailing in Vereeniging are characterized by a warm and moderate temperature. In Vereeniging, the level of precipitation during summers surpasses that of winters. The Köppen-Geiger climate classification identifies this particular weather pattern as belonging to the category of Cwb. The average annual temperature is 17.0 °C in Vereeniging. The annual rainfall is 752 mm. In terms of precipitation, the month with the lowest amount of rainfall is July, recording a mere 4 mm in its entirety. This denotes an exceptionally dry period within that particular time frame. The highest amount of precipitation occurs during the month of December, with an average quantity reaching up to 143 mm. The month that experiences the highest temperatures throughout the year is referred to as January, where an average temperature of 21.1 °C prevails. The month of July registers the most frigid temperatures throughout the year, with an average low temperature of 10.2 °C.

4 HYDROGEOLOGICAL DESKTOP STUDY

4.1 GEOLOGY

According to the published 1:250,000 Geological Map 2626 West Rand (Council for Geoscience, 1986), the site is underlain by shale, sandstone and coal seams from the Vryheid Formation of the Ecca Group, Karoo Sequence overlain by soil cover and alluvial quaternary sediments of the Vaal River. The localized geology around the Rand Water Vereeniging Treatment Works and Phase 2 Sludge Pipeline Route is shown in Figure 4.2.

According to the published 1:500,000 Hydrogeological Map Series 2526 Johannesburg (Barnard, 2000), the Vryheid Formation quality is mostly acceptable for any use and yield potential is considered to be low. This is based on approximately 83 % of the boreholes on record produce less than 2 L/s. Groundwater rest levels is generally encountered between 2 and 25 m below ground level (m bgl).

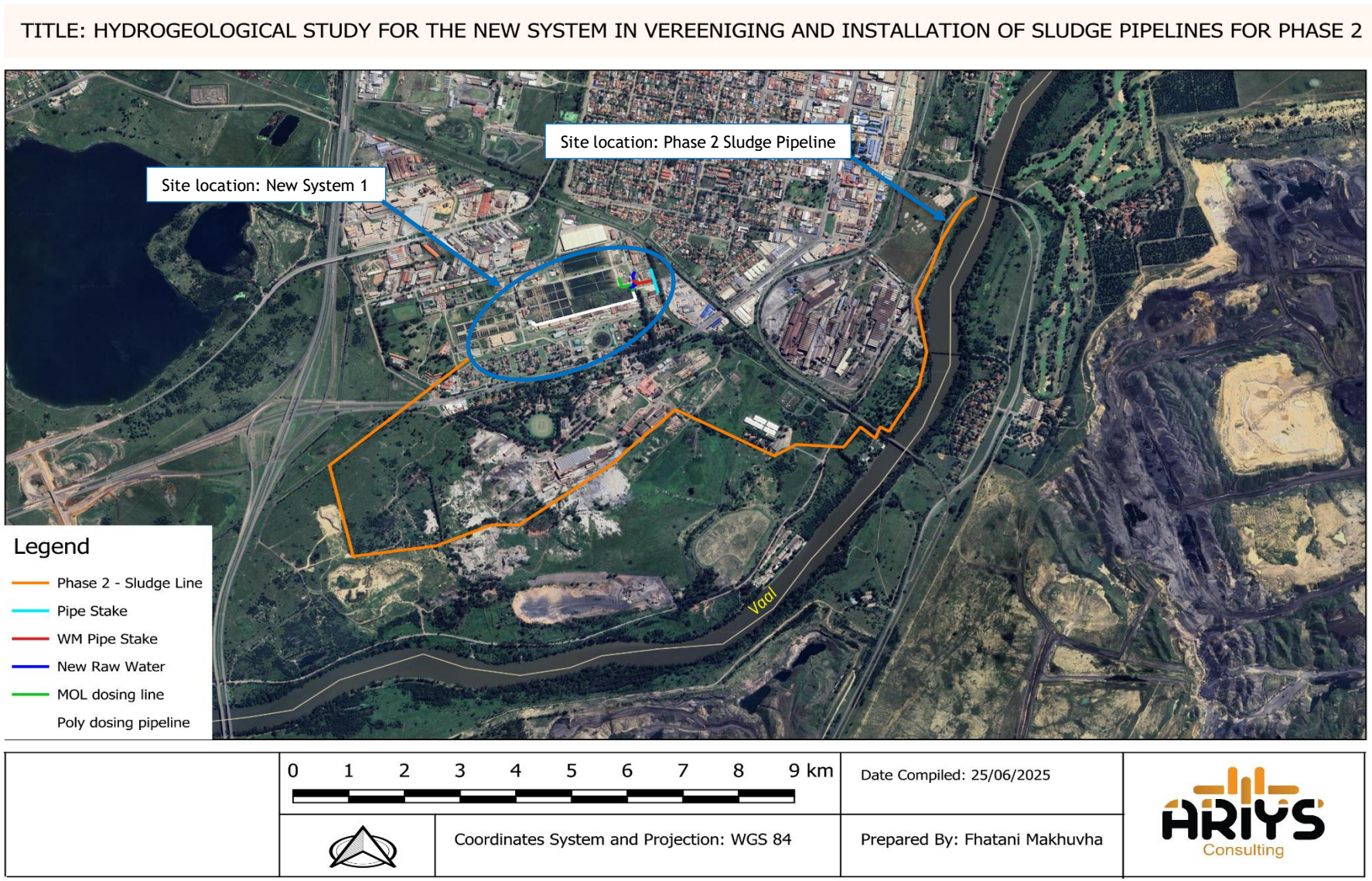


FIGURE 4-1: SITE LOCATION MAP

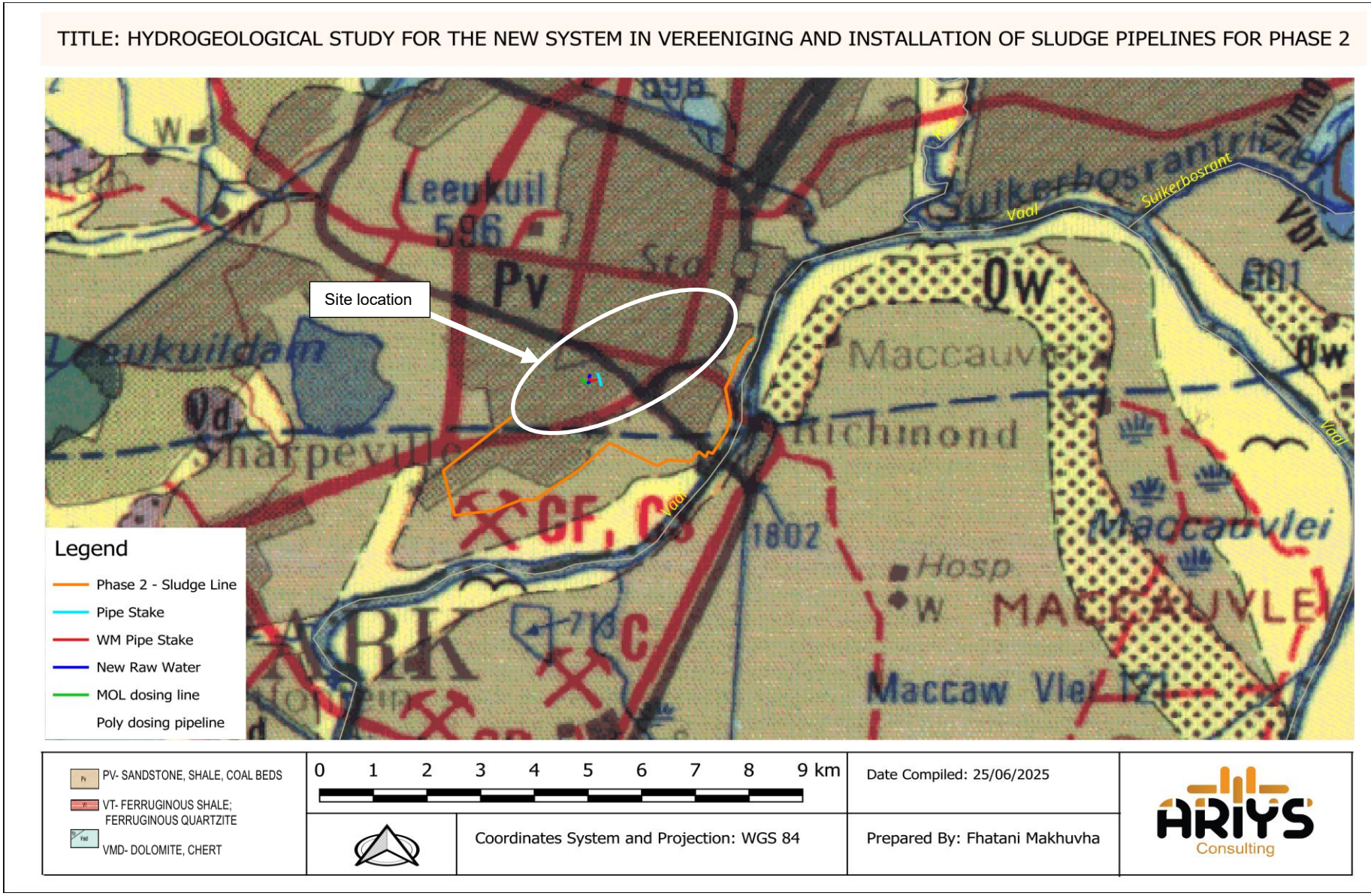


FIGURE 4-2 GEOLOGY MAP

4.2 HYDROGEOLOGY

The study area is situated in the **Vaal** Water Management Area and falls within **C22F** Quaternary catchment. As Per the 1:500 000 **2626 West Rand** Hydrogeological Map Series sheet the underlying geological formations within 'fractured' aquifers. Potential groundwater yields of between **0.5 L/s and 2.0 L/s** are associated with 'fractured' aquifers. The primary porosity of the rocks provides the storage capacity with limited groundwater movement, while secondary features such as fractures, faults, bedding planes and dolerite intrusions enhance the groundwater flow. Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the site is regarded a "**minor aquifer**". Hydrogeological map is seen in Figure 4-3.

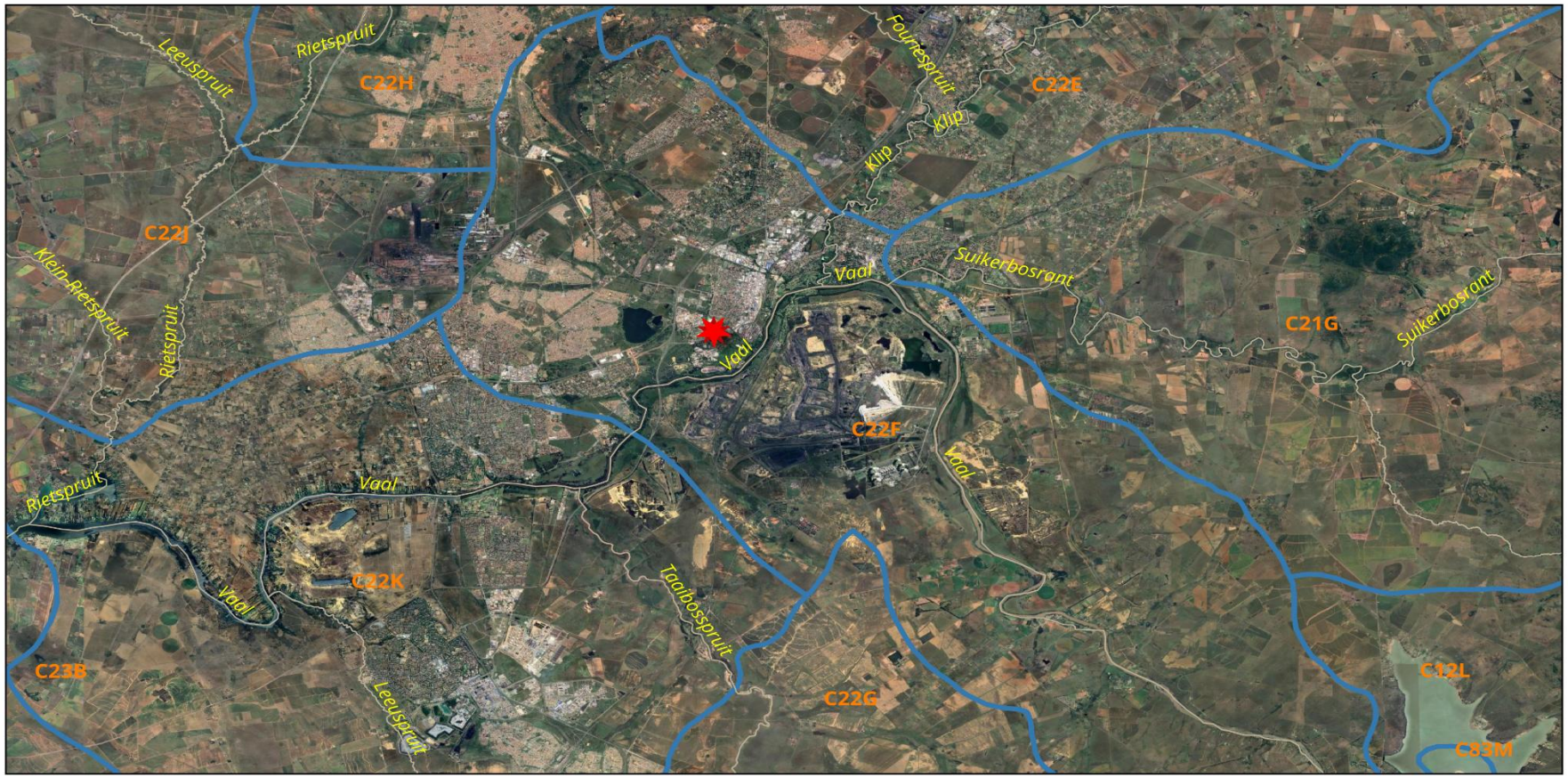
The mine dumps located to the south of the site may serve as artificial sources of water infiltration into the groundwater system. It is expected that the alluvium within the study area will exhibit the highest natural recharge rates, attributed to the coarser texture of the lithological composition.

Any spillage and linkage from the infrastructure at the Rand Water Vereeniging Treatment Works could potentially introduce various constituents into the groundwater environment, particularly due to the use of chemicals such as calcium oxide, silicon dioxide, sodium silicate, and ferric chloride during the coagulation and flocculation processes at the Treatment Works.

Slightly elevated levels of constituents have been observed in the monitoring borehole RW VG-MB2, which include Total Dissolved Solids, calcium, and magnesium.

The use of slaked lime at the site may be contributing calcium and magnesium cations to the groundwater.

TITLE: HYDROGEOLOGICAL STUDY FOR THE NEW SYSTEM 1 IN VEREENIGING AND THE INSTALLATION OF SLUDGE PIPELINES FOR PHASE 2



Legend

Site Location

0 1 2 3 4 5 6 7 8 9 km

Coordinates System and Projection: WGS 84

Date Compiled: 25/06/2025

Prepared By: Fhatani Makhuvha

ARIYS Consulting

FIGURE 4-3 HYDROGEOLOGY MAP

4.2.1 Aquifer Classification

Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the study is regarded a **"minor aquifer"**. A summary of the classification scheme is provided in Table 4-1.

Table 4-1: AQUIFER CLASSIFICATION SCHEME (PARSONS, 1995; PARSONS AND CONRAD, 1998)

Aquifer System	Defined by Parsons (1995)	Defined by DWAF Min Requirements (1998)
Sole Source Aquifer	An aquifer which is used to supply 50% or more of domestic water for a given area, and for which there are no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields, and natural water quality are immaterial.	An aquifer, which is used to supply 50% or more of urban domestic water for a given area for which there are no reasonably available alternative sources should this aquifer be impacted upon or depleted.
Major Aquifer	High permeable formations usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (<150 mS/m).	High yielding aquifer (5-20 L/s) of acceptable water quality.
Minor Aquifer	These can be fractured or potentially fractured rocks, which do not have a high primary permeability or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important both for local supplies and in supplying baseflow for rivers.	Moderately yielding aquifer (1-5 L/s) of acceptable quality or high yielding aquifer (5-20 L/s) of poor-quality water.
Non-Aquifer	These are formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer as unusable. However, groundwater flow through such rocks, although imperceptible, does take place, and need to be considered when assessing the risk associated with persistent pollutants.	Insignificantly yielding aquifer (< 1 L/s) of good quality water or moderately yielding aquifer (1-5 L/s) of poor quality or aquifer which will never be utilised for water supply, and which will not contaminate other aquifers.
Special Aquifer	An aquifer designated as such by the Minister of Water Affairs, after due process.	An aquifer designated as such by the Minister of Water Affairs, after due process.

4.3 AQUIFER VULNERABILITY

Aquifer vulnerability is defined as the intrinsic characteristics that determine the aquifer's sensitivity to the adverse effects resulting from the imposed pollutant (Per Lynch et al). The following factors influence groundwater vulnerability:

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

The Groundwater Decision Tool (GDT) was used to quantify the vulnerability of the aquifer underlying the site. The depth to groundwater below the site was estimated from water levels measured obtained from NGA database inferred to be 13,5 mbgl.

The aquifer system is classified as a minor aquifer. The local population is dependent on groundwater. Furthermore, the area is characterised by several surface water features which can be used if necessary. The aquifer is also important for supplying base flow to the rivers and streams.

To achieve the Aquifer System Management and Second Variable Classifications, as well as the Groundwater Quality Management Index, the waiting and rating approach has been adopted for the site as per South African Aquifer Systems Management Classification (Parson,1995). Variable classification considers the three (3) generic classes (High, Medium, and Low) (**TABLE 4-3**). The aquifer vulnerability is determined using the Aquifer Vulnerability Map of South Africa. The vulnerability map indicates the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. The two ratings (Aquifer System Management and Aquifer Vulnerability) are then multiplied to yield a groundwater management decision index.

TABLE 4-2: RATINGS FOR THE AQUIFER SYSTEM MANAGEMENT AND SECOND VARIABLE CLASSIFICATION (PARSONS, 1995)

Aquifer System Management Classification		Second Variable Classification	
Class	Points	Class	Points
Sole Source Aquifer System	6	High	3
Major Aquifer System	4	Medium	2
Minor Aquifer System	2	Low	1
Non-aquifer system	0		
Special Aquifer System	0-6		

TABLE 4-3: RATINGS FOR THE SITE- AQUIFER CLASSIFCATION AND SECOND VARIABLE CLASSFICATIONS

Aquifer Systems Management		
Class	Points	Site
Sole Source Aquifer System	6	2
Major Aquifer System	4	
Minor Aquifer System	2	
Non-aquifer system	0	
Special Aquifer System	0-6	
Vulnerability Classification (weathering/ fracturing)		
Class	Points	Site
▪ High	3	2
▪ Medium	2	
▪ Low	1	

4.4 GROUNDWATER QUALITY MANAGEMENT

As part of the aquifer classification, a Groundwater Quality Management (GQM) Index is used to define the level of groundwater protection required. The GQM Index is obtained by multiplying the rating of the aquifer system management and the aquifer vulnerability. The GQM index for the site is presented in **TABLE 4-4**.

The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer is classified as **medium** (**TABLE 4-3**). However, it should be noted that due to the near surface perched coupled with shallow groundwater level on site, during heavy rainfall events the site is likely to experience raised water levels that may lead to water pooling on site and increases the likelihood of groundwater contamination onsite. Measures need to be taken to ensure appropriate drainage facilities are constructed to prevent the abovementioned issues. The prevailing in-situ conditions thus render the groundwater system as highly vulnerable to contamination due to anthropogenic activities.

TABLE 4-4: GQM INDEX FOR THE SITE

GQM Index	Level of Protection	Study area
<1	Limited	4
1-3.	Low level	
3-6.	Medium Level	
6-10.	High Level	
>10	Strictly non-degradation	

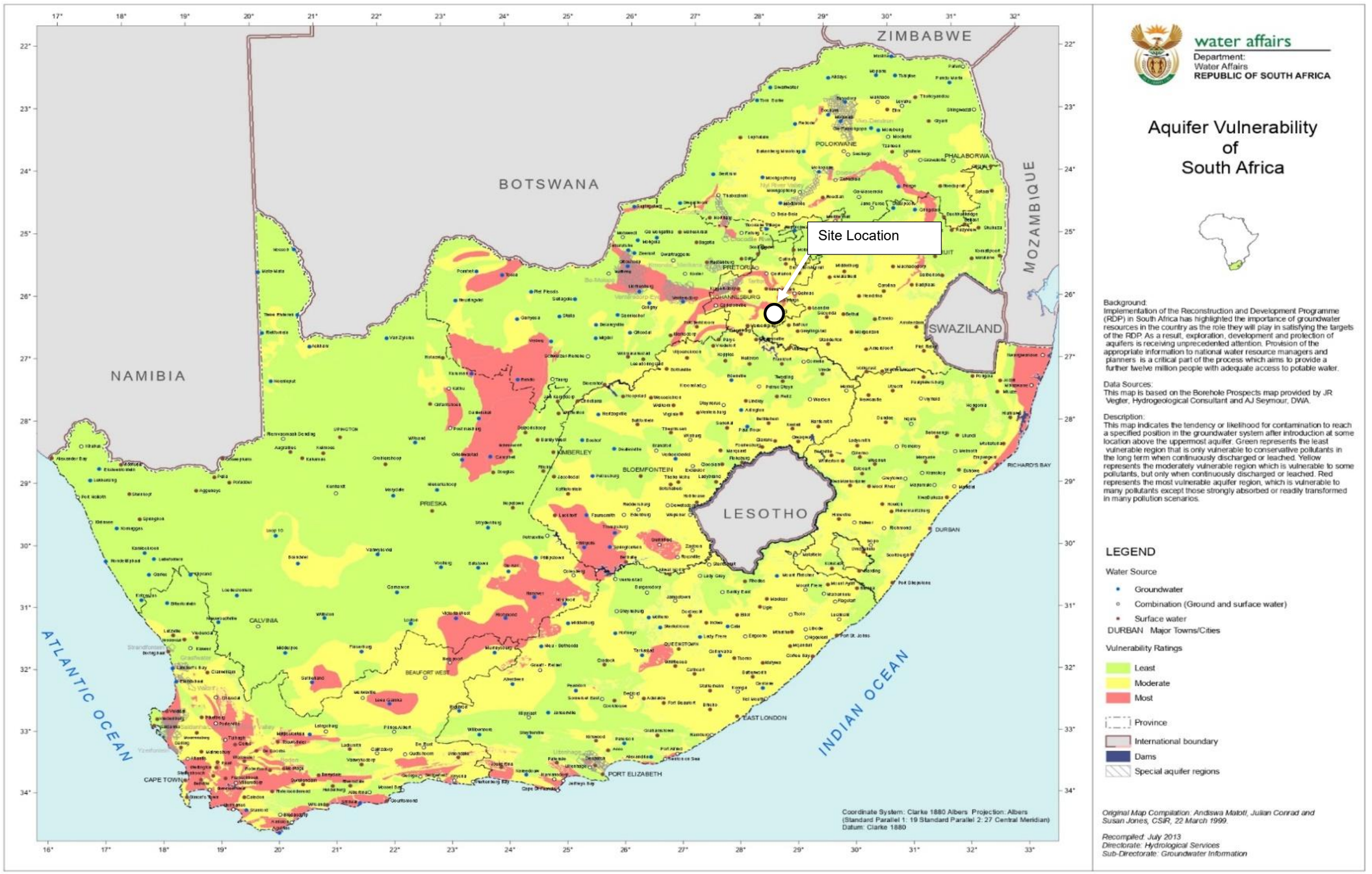


FIGURE 4-4 AQUIFER VULNERABILITY MAP OF SOUTH AFRICA

5 PREVIOUS GROUNDWATER MONITORING FOR RAND WATER VEREENIGING TREATMENT WORKS - SYSTEM 1 SITE AND PROPOSED SITE FOR PHASE 2 SLUDGE PIPELINE

A water quality monitoring programme is currently being undertaken for the Rand Water Vereeniging Treatment Works - System 1 Site, by Rand Water team on site and no previous boreholes located within the Phase 2 Sludge Pipeline site.

The overall objectives of the monitoring programme were to:

- Comply with the conditions of the Environmental Authorisation (EA) issued by the Department of Environmental Affairs (DEA), and the Water Use License (WUL) from the Department of Water Affairs (DWA);
- Determine the quality of water resources in the vicinity of the Rand Water Vereeniging Treatment Works - System 1 Site by:
    - Sampling the surface and groundwater at pre-determined positions on a monthly basis;
    - Recording the physical parameters at each sampling point when samples are taken;
    - Sending the samples to a laboratory for analysis;
    - Reporting the results of the aforementioned in a monthly monitoring report; and
    - Presenting the contents of the monitoring reports.

During this period a total of three (3) water samples were collected, from the borehole used for monitoring.

6 NATIONAL GROUNDWATER ARCHIVE DATA

6.1 NGA DATA

National Groundwater Archives (NGA) is a web enabled database system that allows capturing, viewing, modifying and extraction of groundwater related data by registered users. NGA was used to gather information on existing boreholes within a 5km radius of the site to understand the spatial status of groundwater flow regime. For each borehole identified on NGA, the parameters including location, groundwater level, water strike and elevation where possible were noted.

A total of ten (10) boreholes were identified from the NGA data. The parameters including location, groundwater level, and elevation where possible were noted. The following could be concluded based on the obtained data:

- Groundwater level range is between 1,37mbgl and 24,99mbgl. The water levels were recorded between 1937 and 1992.
- All boreholes identified are located northeast of the site. With three (3) boreholes located within a 2km radius of the site.
- The site is therefore underlain by a very shallow groundwater table.

Data collected from the NGA database can be outdated and some borehole attributes could have changed over the years, or the borehole has since been destroyed. It is important to note that this information only serves as a baseline to understand the groundwater regime. The table below (Table 6-1) summarizes the NGA data obtained within a 5km radius of the site. Figure 6-1 shows the locations of the boreholes with groundwater levels obtained from the NGA data.

TITLE: HYDROGEOLOGICAL STUDY FOR THE NEW SYSTEM 1 IN VEREENIGING AND THE INSTALLATION OF SLUDGE PIPELINES FOR PHASE 2

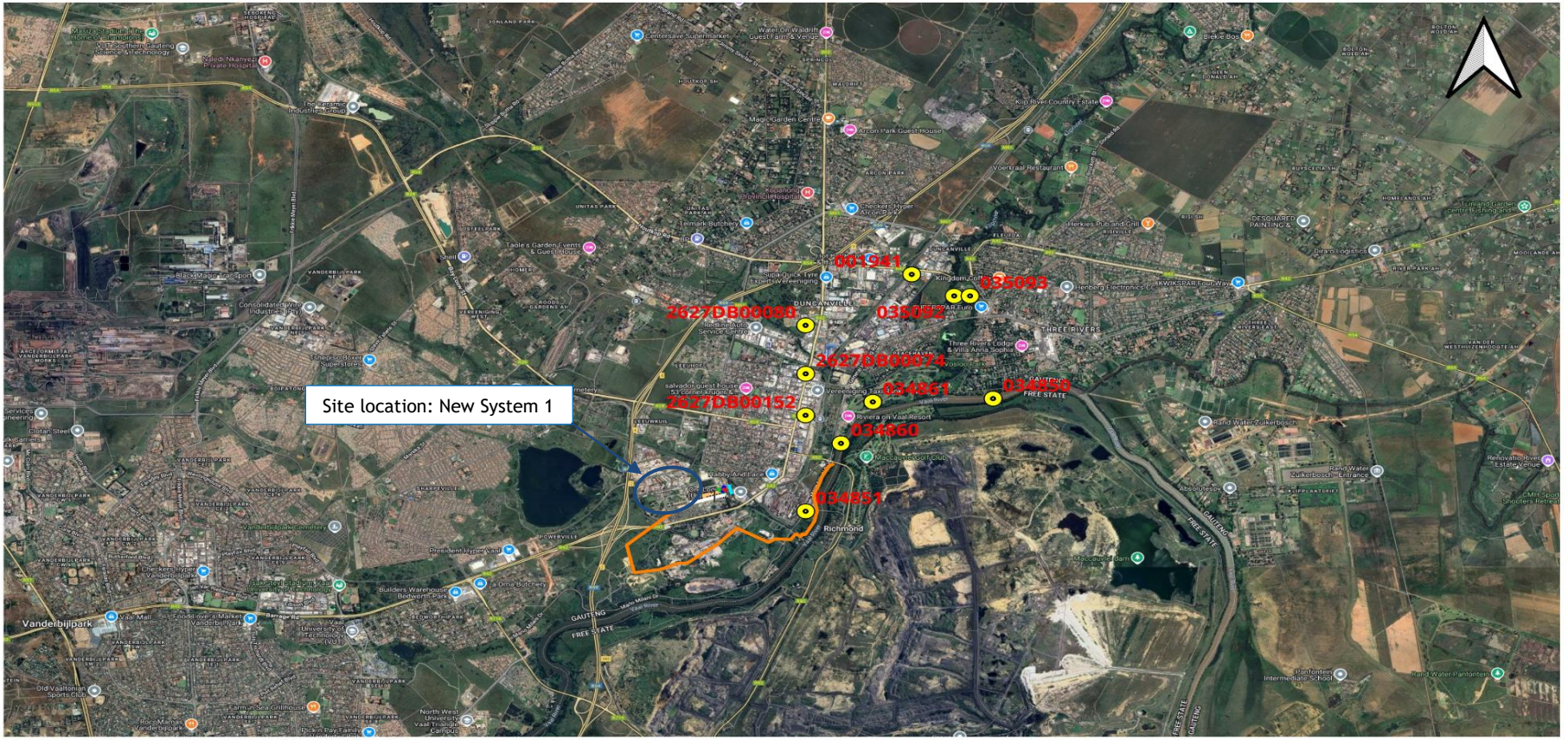


FIGURE 6-1: NGA DATA BOREHOLE LOCATIONS

TABLE 6-1: NGA DATA SUMMARY

BH ID	latitude	Longitude	Farm name	Lithology	Bottom depth (m)	Water strike	Water Level (m)	Elev - mams	WL_mamsl
001941	-26.65054S	27.94967E	VEREENIGING	Tillite, Dolomite	98,76	54,25	24,99	1445	1420,01
034850	-26.67137S	27.96245E	VEREENIGING	Coal, tillite, chert, dolomite	49	28	4,40	1429	1424,6
034851	-26.69026S	27.93301E	VEREENIGING	Dolomite, Alluvium	43	7	12,35	1429	1416,65
034860	-26.67887S	27.93856E	VEREENIGING	Alluvium, mudstone, dolomite	49	22	8,55	1427	1418,45
034861	-26.67192S	27.94356E	VEREENIGING	Coal, tillite, shale, chert, dolomite	45	18	1,37	1429	1427,63
035092	-26.65415S	27.95634E	VEREENIGING	Sandstone, shale, dolomite	56	14	2,53	1429	1426,47
035093	-26.65415S	27.95884E	VEREENIGING	Shale, coal, chert, dolomite	75	12	3,42	1429	1425,58
2627DB00074	-26.66721S	27.93302E	VEREENIGING	Dolomite	120	63	27,4	1440	1412,6
2627DB00080	-26.67693S	27.933E	VEREENIGING	Dolomite	154	144	30	1440	1410
2627DB00152	-26.67417S	27.933E	VEREENIGING	Shale, coal, conglomerate	92,66	78.64	19,81	1440	1420,19
Average							13,5	1433,7	1420,218

6.1 GROUNDWATER FLOW DIRECTION

Groundwater elevation and Flow Regime based on groundwater level measurements obtained from NGA data was used to create groundwater flow directions. In general, the water table mimics the topography, and groundwater flow is from areas of higher lying ground.

A good correlation between the measured head and topography can be seen in Figure 6-2 (R^2 = 0.2992, i.e., approximately 99% of observed groundwater level variations can be explained by variations in land surface elevation and it can be assumed that the water table slightly mimics the surface topography but is somewhat higher or somewhat lower in places.

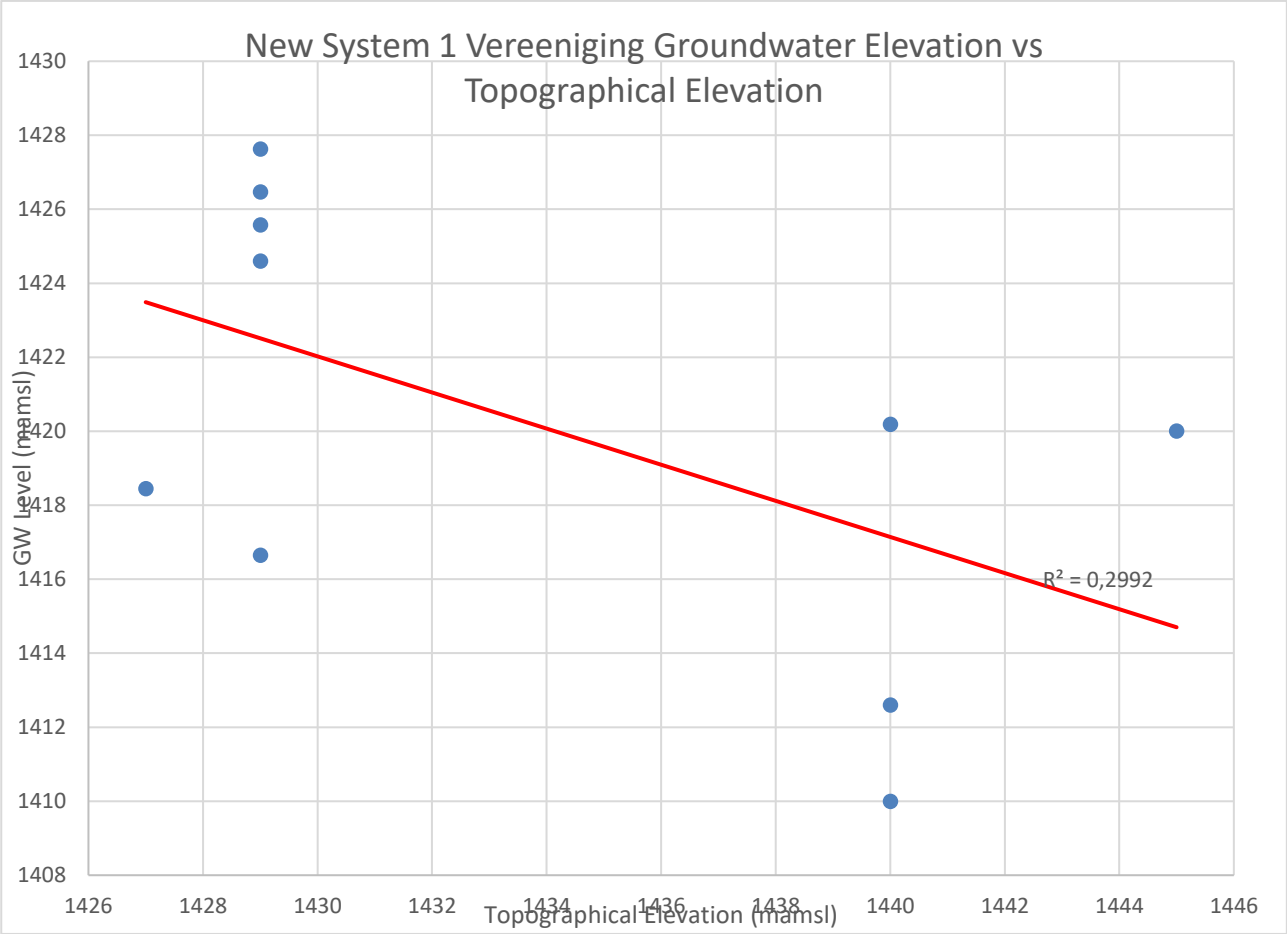


FIGURE 6-2: GW VS TOPOGRAPHICAL ELEVATION

7 HYDROCENSUS

Ariys Consulting undertook the Hydrocensus Investigation on the 26th Of May 2025. A total number of three (3) boreholes were identified during the Hydrocensus Investigation. Details of the boreholes are presented in Table 7-1, and Table 7-2.

For each borehole identified, parameters including the location, elevation, groundwater level and water quality were recorded. Groundwater samples were collected for water quality analyses and submitted to Sanas accredited Laboratory Aquatico Scientific in Irene, Centurion.

Field observations for each sampling point, consisting of the following information, were recorded on field data sheets:

- Boreholes are located within the Rand Water Vereeniging Treatment Works Site adjacent to proposed System 1.
- Groundwater Level were measured in VG-MB1(4,0m), VG-MB2 (3,9m) and VG-MB3 (2,6m).
- Coordinates of each borehole.
- General characteristics of the water samples such as colour and smell as well as visual observations of the sample site.
- Borehole are quipped and used as monitoring boreholes.

TABLE 7-1 HYDROCENSUS BOREHOLES

Borehole ID	Co-ordinates		Elevation (mams)	Water Level(m)	Water Level (mamsl)	Depth	Usage	Colour	Borehole conditions	Water sample collected
	Latitude	Longitude								
VG-MB1	-26.686947°S	27.919558°E	1442	4,0	1438	unknown	Monitoring	Colourless	Good	Yes
VG-MB2	-26.687147°S	27.918647°E	1442	3,9	1438,1	unknown	Monitoring	Colourless	Good	Yes
VG-MB3	-26.687619°S	27.920261°E	1443	2,6	1440,4	unknown	Monitoring	Colourless	Good	Yes

TABLE 7-2 HYDROCENSUS PHOTO LOG

Photo Log		
		
Plate1: VG-MB1	Plate 2: VG-MB2	Plate 3: VG-MB3
		
Plate4: New System 1 Vereeniging Site	Plate 5: New System 1 sludge pipeline Route	Plate 6: New System 1 water pipeline Route

Photo Log		

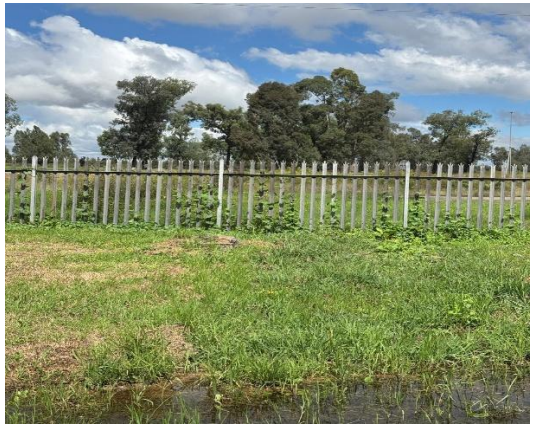



Plate1: Phase 2 Sludge Pipeline Route Start Point	Plate 2: Phase 2 Sludge Pipeline Route	Plate 3: Phase 2 Sludge Pipeline Route
		
Plate4: Phase 2 Sludge Pipeline Route	Plate 5: Phase 2 Sludge Pipeline Route	Plate 6: Phase 2 Sludge Pipeline Route End Point

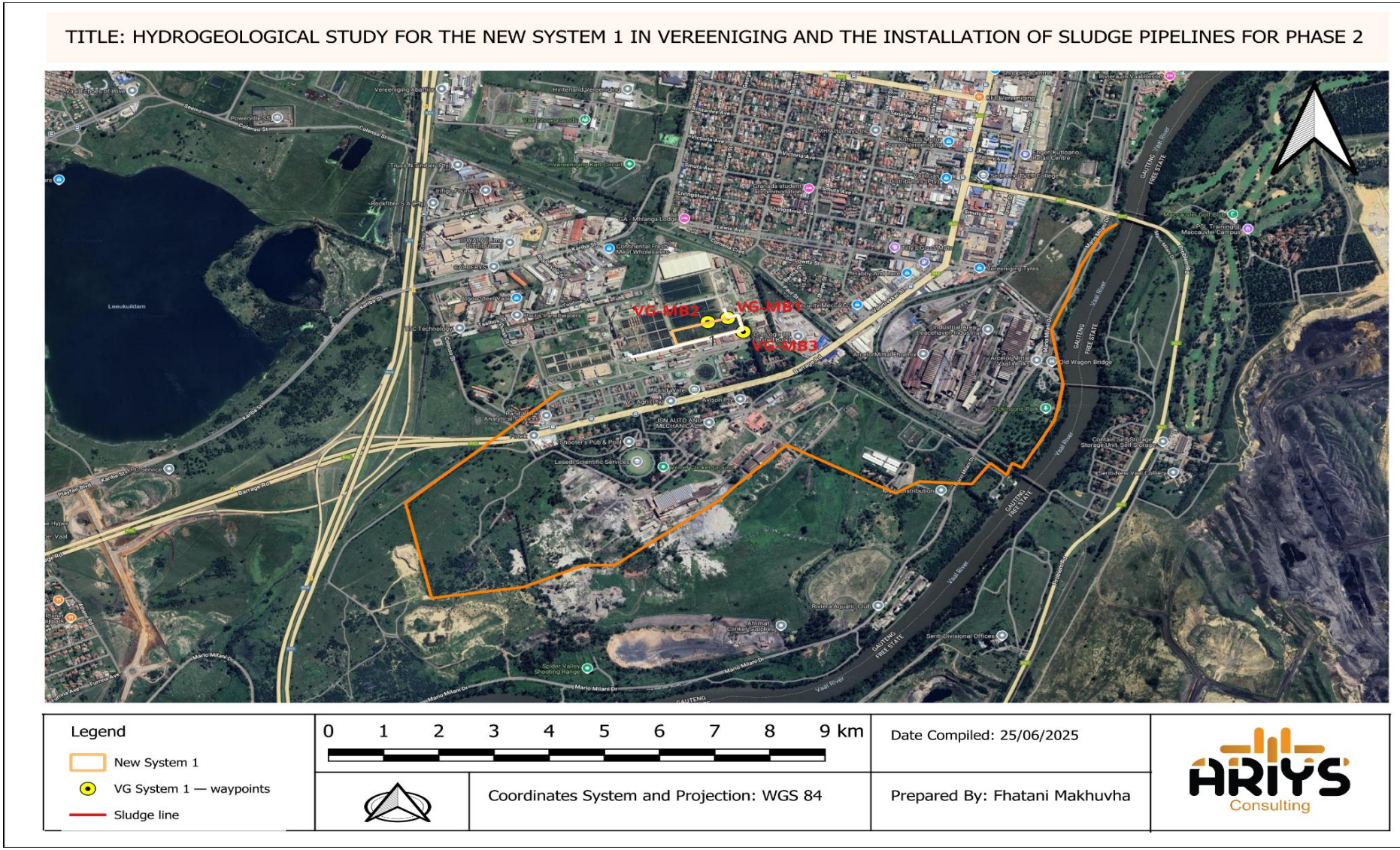


FIGURE 7-1 HYDROCENSUS MAP

8 GROUNDWATER AND SURFACE WATER QUALITY ANALYSIS

The water qualities measured within the boreholes are tabulated in Table 10-3 and were compared to the SANS241-1:2011 drinking water quality standards for domestic use. The chemistry data provides baseline conditions in order to make comparisons too in the Future to determine if the water quality has deteriorated based on the influence of the Water Treatment Works Site.

Groundwater and surface water samples were collected and submitted to an accredited laboratory for water quality analyses. Concentrations have been compared to the following water quality standard:

- **South African National Standards (SANS) 241 (2015)**

The SANS 241: 2015 specifies limits in terms of four categories:

- **Acute Health** – poses an immediate unacceptable health risk if present at concentrations exceeding the numerical limits specified.
- **Aesthetic** – does not pose an unacceptable health risk if present at concentrations exceeding the numerical limits specified, but will taint water with respect to taste, odour, and colour.
- **Chronic Health** – poses an unacceptable health risk if ingested over an extended period if present at concentrations exceeding the numerical limits specified.
- **Operational** – is essential for assessing the efficient operation of treatment systems and risks to infrastructure.

8.1 GROUNDWATER AND SURFACE WATER QUALITY RESULTS

Ground water and surface water quality results indicated that all analysed constituents were recorded below SANS 241:2015 standard limits except for Turbidity (NTU), E coli, T coli, Iron (Fe), Lead (PB) and Manganese (Mn). Refer to Table 8-1 and Appendix A.

- Turbidity (NTU) has been recorded above SANS 241:2015 of 4 NTU for Operational Health in VG-MB1 (12,3 NTU), VG-MB2 (29,7 NTU) and VG-MB3 (41,7 NTU).
- Manganese (Mn) has been recorded below SANS 241:2015 of <0.1 mg/l for Aesthetic Health in VG-MB1 (0.91 mg/l) and VG-MB2 (1,28 mg/l)
- Lead (Pb) has been recorded below SANS 241:2015 of <0.1 mg/l for Aesthetic Health in VG-MB2 (0,26 mg/l)
- Iron (Fe) has been recorded below SANS 241:2015 of 0.3 mg/l for Aesthetic Health in VG-MB3 (0.28 mg/l) and VG-MB4 (0.466 mg/l)
- E coli has been recorded above SANS 241:2015 of 1 CFU/100ml for Acute Health in a VG-MB2 (5 CFU/100ml)
- T coli has been recorded above SANS 241:2015 of 10 CFU/100ml for Operational Health in VG-MB2 (2900 CFU/100ml).

Ground water results indicated that the water from these sources is not suitable for human consumption. Water treatment is recommended before any human consumption.

TABLE 8-1: SUMMARY OF WATER QUALITY ANALYSIS

SANS 241-1:2015 Ed. 2 :						
Operational Health						
Aesthetic Health						
Acute Health						
Chronic Health						
Date Sampled:				**VG-MB1**	**VG-MB2**	**VG-MB3**
Physical Determinants	**Unit**	**Risk**	**General / Standard Limit**	**Borehole water**	**Borehole water**	**Borehole water**
pH - Value @ 25 °C	pH Units	Operational	≥ 5 to ≤ 9.7	7,23	7,62	7,28
Electrical Conductivity in mS/m @ 25°C	mS/m	Aesthetic	≤170	128	60,3	152
Total Dissolved Solids @ 180°C	mg/l	Aesthetic	≤1200	688	296	842
Turbidity in N.T.U	mg/l	Operational	≤1	12.3	29,7	41,7
	mg/l	Aesthetic	≤5			
Total Alkalinity as $CaCO_3$	mg/l	---	---	355	201	186
Chloride as Cl	mg/l	Aesthetic	≤300	25,5	24,6	77,5
Sulphate as SO_4	NTU	Acute health	≤500	233	43,4	391
		Aesthetic	≤250			
Fluoride as F	mg/l	Chronic health	≤1.5	<0.263	0,385	<0.263
Nitrate as N	-	Acute health	≤11	0,446	<0,194	
E. coli (MPN/100 mℓ)	mg/l	Acute health	Not detected	<1	5	<1
T. coli (MPN/100 mℓ)	mg/l	Operational health	10	<1	2900	<1
Sodium as Na	mg/l	Aesthetic	≤200	32,0	33,6	69,0
Potassium as K	mg/l	---	---	7,46	3,99	15,9
Calcium as Ca	mg/l	---	---	105	36,4	113
Magnesium as Mg	mg/l	---	---	68,1	26,3	53,1
Aluminium as Al (µg/ℓ)	mg/l	Operational	≤0,3	<0,002	<0.002	<0.002
Cadmium as Cd (µg/ℓ)	mg/l	Chronic health	≤0,03	<0,002	<0,002	<0,002
Total Chromium as Cr (µg/ℓ)	mg/l	Chronic health	≤0,05	<0,003	<0,003	<0,003
Copper as Cu (µg/ℓ)	mg/l	Chronic health	≤2	<0,002	<0,002	<0,002
Iron as Fe (µg/ℓ)		Chronic health	≤ 2	<0,004	0,278	0,465
		Aesthetic	≤0,3			
Lead as Pb (µg/ℓ)	mg/l	Chronic health	≤0,01	<0,004	0,255	<0,004
Manganese as Mn (µg/ℓ)		Chronic health	≤0,4	0,913	1,28	0,003
	mg/l	Aesthetic	≤0,1			
Nickel as Ni (µg/ℓ)	mg/l	Chronic health	≤0,07	0,004	<0,002	<0,002
Zinc as Zn	mg/l	Aesthetic	≤5	0,006	0,004	0,003

9 CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

The main objective of the risk assessment is to identify the negative impacts that can be avoided and/or mitigated and the benefits of the positive impacts during the construction of the New System 1 and Phase 2 Sludge Pipeline on the environment. The hazards identified with the proposed construction and maintenance, and its impact on the groundwater environment are hydrocarbon contamination.

9.1 NEW SYSTEM 1 VEREENIGING WATER TREATMENT WORKS

The site has been zoned as Rand Water Vereeniging Water Treatment Works area. As part of the evaluation of the site, the environmental risk has been assessed using the potential Source – Pathway – Receptor model of potential contamination. The site assessment includes identification of the potential sources, pathways, and receptors within the context of possible contamination, i.e., a situation where the source(s), pathway(s) and receptor(s) are all present at a site and therefore a real (as opposed to a perceived) risk of potential impact exists.

9.2 PHASE 2 SLUDGE PIPELINE

The pipeline is passing through different premises zoned as industrial, mining and farming area. As part of the evaluation of the site, the environmental risk has been assessed using the potential Source – Pathway – Receptor model of potential contamination. The site assessment includes identification of the potential sources, pathways, and receptors within the context of possible contamination, i.e., a situation where the source(s), pathway(s) and receptor(s) are all present at a site and therefore a real (as opposed to a perceived) risk of potential impact exists.

TABLE 9-1 CONCEPTUAL SITE MODEL

<table>
<tr><th colspan="5">CONCEPTUAL SITE MODEL</th></tr>
<tr><td>Overview</td><td colspan="4">The land use is zoned as Water Treatment Works , industrial, mining and farming Site.

The neighbouring properties comprise industrial firms and farms (on phase 2 sludge pipeline).

The groundwater flow direction inferred from the NGA data in a south direction.</td></tr>
<tr><td>Sources</td><td colspan="4">The study area will consist of domestic waste and minor construction waste which is the main source of contamination.

▪ Domestic and Construction waste: Domestic sludge containing organic substances, soaps, hydrocarbons, and high pH maybe found due to the waste on site.

▪ Petrol: MTBE and Benzene concentration may be detected in surface and groundwater due to tracks on site.

▪ Diesel: Hydrocarbons of the paraffinic and naphthenic concentration may be detected in surface and groundwater due to tracks on site.

▪ Dust pollution: Pollution caused by movement of vehicles. The airlifted pollution can infiltrate into the groundwater during rain events.</td></tr>
<tr><td rowspan="4"></td><td>Pathway</td><td colspan="2">Description</td><td>Risk</td></tr>
<tr><td rowspan="2">Groundwater infiltration</td><td>Onsite</td><td>Infiltration of contaminated water into the ground</td><td>Medium</td></tr>
<tr><td>Offsite</td><td>Via shallow groundwater and vertical migration through low to medium permeable shallow soils</td><td>Medium</td></tr>
<tr><td>Vehicle movement</td><td>Surface</td><td>Spillage of oils from heavy vehicles contaminating surface water and soil and creating dust and noise</td><td>Low</td></tr>
<tr><td rowspan="2"></td><td>Receptor</td><td colspan="3">Location</td></tr>
<tr><td>Onsite employees</td><td colspan="3">Workers that are based at Rand Water Vereeniging Water Treatment Works Site.</td></tr>
</table>

CONCEPTUAL SITE MODEL		
	Offsite residents	Relatively industrial firms and farmers properties located 5km around the study area
	Commercial users	Industrial firms and Farmers located in a 5km radium from the site
	Groundwater	Nearest groundwater sources providing water in the area
	Surface waters	The Stream is located 1,74 km south of the Rand Water Vereeniging Water Treatment Works New System 1 site (downstream) and Phase 2 Sludge pipeline have a portion running parallel to the stream (Vaal River) for 1,45 km in extent at a radius on less than 100m.
Pollutant linkages	**Receptor**	**Location**
Groundwater: Source concentration is not likely exceeding impact criteria for the impact to water resources.		
OVERALL ASSESSMENT		**Low to Medium**

10 RISK IMPACT ASSESSMENT

Impacts from the proposed development construction activities on Rand Water Vereeniging Water Treatment Works New System 1 and Phase 2 Sludge Pipeline Site were evaluated and include:

- Impacts on groundwater levels, flow patterns and volumes;
- Impacts on groundwater qualities; and
- Impacts on surface water qualities.

During the risk assessment, the risk to the groundwater levels and quality were evaluated. Each of the identified risks was then rated (Table 10-3).

10.1 RISK RATING CRITERIA

This section contains a summary and a motivation of the potential interactions and impacts which may be associated with the project activities, specifically related to the hydrogeological specialist field. The identified potential impacts are summarised as follows:

- Groundwater level
- Groundwater Quality

10.1.1 RISK RATING CRITERIA

The impacts were rated and ranked based on the system as described below:

- **Magnitude**: is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and was classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely recognized standards were to be used as a measure of the level of impact.
- **Scale/Geographic extent** refers to the area that could be affected by the impact and was classified as site, local, regional, national, or international.
- **Duration**: refers to the length of time over which an environmental impact may occur i.e. transient (less than 1 year), short-term (1 to 5 years), medium term (5 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent.
- **Probability of occurrence** is a description of the probability of the impact occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will occur).

Table 10-1Scaling Risk

Status of Impact	
The impacts are assessed as either having a:	
Negative effect (i.e. at a `cost' to the environment),	
Positive effect (i.e. a `benefit' to the environment),	
Neutral effect on the environment.	
Extent of the impact	Duration of the impact
(1) Site (site only),	1) Immediate (<1 year),
(2) Local (site boundary and immediate surrounds),	(2) Short term (1-5 years),
(3) Regional,	(3) Medium term (5-15 years),
(4) National,	(4) Long term (ceases after the operational life span of the project),
(5) International.	(5) Permanent.
Magnitude of the Impact	Probability of Occurrence
(0) None,	The likelihood of the impact actually occurring is indicated as either:
(2) Minor,	(0) None (the impact will not occur),
(4) Low,	(1) Improbable (probability very low due to design or experience),
(6) Moderate (environmental functions altered but continue),	(2) Low probability (unlikely to occur),
(8) High (environmental functions temporarily cease),	(3) Medium probability (distinct probability that the impact will occur),
(10) Very high / unsure (environmental functions permanently cease.	(4) High probability (most likely to occur),
	(5) Definite.

10.1.2 SIGNIFICANCE OF THE IMPACT

Based on the information contained in the points above, the potential impacts are assigned a significance rating (S). This rating is formulated by adding the sum of the numbers assigned to extent (E), duration (D) and magnitude (M) and multiplying this sum by the probability (P) of the impact.

S= (E+D+M) P

The significance ratings are given below

(<30) low (i.e. where this impact would not have a direct influence on the decision to develop in the area),

(30-60) medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated), (>60) high (i.e. where the impact must have an influence on the decision process to develop in the area).

Table 10-2 Significant colour code

Significance	Environmental Significance Points	Colour Code
High	>60	H
Medium	30 to 60	M
Low	<30	L

TABLE 10-3: RISK RATING

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	AREA APPLICABLE	CORRECTIVE MEASURE	IMPACT RATING CRITERIA						RECOMMENDED MITIGATION MEASURES
				Nature	Extent	Duration	Magnitude	Probability	SIGNIFICANCE	
Pre-Construction										
Hydrological yield	Vegetation removal to clear area for construction	Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during pre-construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.	Yes	Negative	2	1	6	4	36	Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible. ion of water seepage in construction site, drainage system will need to be installed to redirect water away from construction site.
Groundwater quality	Hydrocarbons leakage	Based on NGA and hydrocensus data the site is characterised by shallow groundwater levels, thus hazardous waste such as grease and oil from operational HDV and LDV can impact the groundwater quality in events of spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately the groundwater system especially during rainfall events.	yes	Negative	1	2	5	3	24	Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system. Vehicle found with a leak to be removed from site immediately.

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	AREA APPLICABLE	CORRECTIVE MEASURE	IMPACT RATING CRITERIA						RECOMMENDED MITIGATION MEASURES
				Nature	Extent	Duration	Magnitude	Probability	SIGNIFICANCE	
Construction										
Diversion surface water for dry working conditions on site.	Construction of New System 1	During the construction phase, surface water may be diverted for dry working conditions. The natural surface water flow will be affected.	Yes	Negative	3	1	3	3	21	The design and implementation of the temporary stream diversion should consider the environmental impacts. To reduce the impact on aquatic habitants, various structures must be installed to mimic and protect existing stream environment.
Groundwater quality	Construction of New System 1	Shallow groundwater systems are susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately the groundwater system especially during rainfall events.	Yes	Negative	2	2	6	4	40	Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system. Groundwater Monitoring boreholes should be installed upstream, midpoint and downstream of the site to monitor quality and water level.
Surface water quality	Construction of pipeline	Material from construction flowing into surface water bodies and upstream outbursts and overflow, which may pose a threat and risk to surface water quality.	yes	Negative	2	2	6	4	40	Surface water quality monitoring plan must be implemented to monitor quality and ensure no contamination occurs within the site.
Increase in hydrological yield	Construction of a New System 1	Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.	Yes	Negative	1	2	5	3	24	Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	AREA APPLICABLE	CORRECTIVE MEASURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES
				Nature	Extent	Duration	Magnitude	Probability	SIGNIFICANCE	
OPERATIONAL- PEOPLE RESIDING IN THE HOUSES										
Groundwater quality	Infiltration of domestic wastewater	Domestic wastewater is rich in nitrogen and phosphorus which may pose a threat and risk to groundwater system. The water table in the area is very shallow, this may result in untreated effluent escaping into groundwater	Yes	Negative	1	1	4	3	18	Maintenance plan must include groundwater quality monitoring should be conducted on a quarterly basis to ensure no contamination occurs within the site. Management plan must include inspection of the integrity of the domestic wastewater structures to prevent against infiltration of domestic wastewater into groundwater system.
Hydrological yield	Re-vegetation	Vegetation acts as buffer zones and protect soil surface and limit soil erosion.	Yes	Positive	1	2	3	4	24	re-vegetation activities are encouraged during reduce rainfall impact, reduce surface water velocities, enhance infiltration, trap sediments

11 CONCLUSION

Based on the desktop studies, field investigation and assessment of data collected, the following conclusions are made:

- The site is underlain by the shale, sandstone and coal seams from the Vryheid Formation of the Ecca Group, Karoo Sequence overlain by soil cover and alluvial quaternary sediments of the Vaal River.
- Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the site is regarded a **"minor aquifer"** with regional yields ranging between 0,5-2,0l/s.
- The site is situated in the **Vaal water Management and falls within C22F Quaternary catchment**.
- The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer is classified as low. Measures need to be taken to ensure appropriate drainage facilities are constructed to prevent the abovementioned issues.
- Ten (10) boreholes were identified from the NGA data all within a 5-kilometre radius from the of the investigated site. Groundwater level range is between 1,37 mbgl and 24,99 mbgl. The water levels were recorded between 1937 and 1992.The site is therefore underlain by a very shallow groundwater table.
- During Hydrocensus three (3) boreholes within a 5km radius of the investigated site. Observations regarding the borehole location, construction, water level and status and current usage was noted.
- Ground water and surface water quality results indicated that all analysed constituents were recorded below SANS 241:2015 standard limits except for Turbidity (NTU), E coli, T coli, Iron (Fe) and Manganese (Mn). Ground water and surface water results indicated that the water from these sources is not suitable for human consumption. Filtration method is recommended before any human consumption.
- **Groundwater Risk Assessment:** Groundwater level and quality has a low to medium possible risk impact.
- **Preconstruction:**
  - Based on NGA data the site is characterised by shallow groundwater level that is susceptible to contamination inflow especially in heavy rainfall events. Groundwater Monitoring boreholes should be installed upstream and downstream of the site to monitor groundwater quality.
  - The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system.

- Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
- Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.
- Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.

- **During construction:**
  - During the construction phase, surface water may be diverted for dry working conditions. The natural surface water flow will be affected. The design and implementation of the temporary stream diversion should consider the environmental impacts. To reduce the impact on aquatic habitants, various structures must be installed to mimic and protect existing stream environment.
  - The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system. - Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations and Environmental Management Programme) for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
  - Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during pre-construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff. - Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.
  - Material from construction flowing into surface water bodies and upstream outbursts and overflow, which may pose a threat and risk to surface water quality. - Surface water quality monitoring plan must be implemented to monitor quality and ensure no contamination occurs within the site.
  - Continuous groundwater and surface water monitoring is recommending upstream and downstream of the site to monitor quality and water level.
- **After construction (people, industry firm and farms residing within the investigated site):**

- In the event the residents rely on groundwater for domestic use, unmonitored abstraction of groundwater is likely to impact negatively on the groundwater table- Aquifer testing should be conducted to establish suitable yields on the borehole to prevent excessive pumping and to regulate critical water levels.
- Domestic wastewater is rich in nitrogen and phosphorus which may pose a threat and risk to groundwater system. The water table in the area is very shallow, this may result in untreated effluent escaping into groundwater- Groundwater quality monitoring should be conducted on a quarterly basis to ensure no contamination occurs within the site. The integrity of the domestic wastewater structures must be regularly inspected to prevent against infiltration of domestic wastewater into groundwater system.
- Re-vegetation - re-vegetation activities are encouraged during reduce rainfall impact, reduce surface water velocities, enhance infiltration, trap sediments.

12 RECOMMENDATIONS

The following recommendation are to be considered:

12.1.1 GROUNDWATER MONITORING PROGRAMME

Groundwater level and quality are required to be continuously monitored to be able to trace and measure possible contaminates that may emanate from the proposed activities and rising of the groundwater levels that may emanate due to recharge of the aquifer.

During groundwater monitoring programme the following information must be recorded as per the Standard Operations Procedure (SOP) for sampling and monitoring groundwater:

- Static water level, prior to sampling.
- Site conditions and Pictures
- Purging volumes and purging time
- Borehole conditions
- In-situ field parameters
- Sampling volumes and preservation methods

12.1.2 SAMPLING GUIDELINES

- The sampling and sample preservation will be undertaken according to the following guidelines:
- "Groundwater sampling: a comprehensive guide for sampling methods", compiled by John M Weaver for the Water Research Commission (WRC Report TT 56/92).
- SABS ISO 5667-11: 1993 Guidance on sampling of groundwater
- SABS ISO 5667-1: 1980 Guidance on the design of sampling programs
- SABS ISO 5667-2: 1991 Guidance on sampling techniques
- SABS ISO 5667-3: 1994 Guidance on the preservation and handling of samples

13 REFERENCES

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- JG Africa, 2016. Sedimentation and Flocculation Plant at Vereeniging Pumping Station Geotechnical Report (P/N: 4256/02).
- GCS Water and Environment (Pty) Ltd, 201. Rand Water Vereeniging Pump Station - System 1: Hydrogeological Investigation Report (18-0660).

APPENDICES

APPENDIX A: LABORATORY RESULTS

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0685

Test Report

Client: ARIYS CONSULTING
Address: Oxford Office Park, 30 Bauhinia Street, Highveld Techno Park , Centurion, 016
Report no: 223278
Project: Vereeniging Rand Water

Date of report: 06 June 2025
Date accepted: 30 May 2025
Date completed: 05 June 2025
Date received: 30 May 2025

Lab no:					259134	259135	259136
Date sampled:					26-May-25	26-May-25	26-May-25
Aquatico sampled:					No	No	No
Sample type:					Water	Water	Water
Locality description:					VGMB 1	VGMB 2	VGMB 3
		Analyses	Unit	Method			
A	AQL	pH @ 25°C	pH	ALM 20	7.23	7.62	7.28
A	AQL	Electrical conductivity (EC) @ 25°C	mS/m	ALM 20	128	60.3	152
A	AQL	Total dissolved solids (TDS)	mg/l	ALM 26	688	296	842
A	AQL	Total Alkalinity	mg $CaCO_3$/l	ALM 01	355	201	186
A	AQL	Chloride (Cl)	mg/l	ALM 02	25.5	24.6	77.5
A	AQL	Sulphate (SO_4)	mg/l	ALM 03	233	43.4	391
A	AQL	Nitrate (NO_3) as N	mg/l	ALM 06	<0.194	<0.194	2.27
A	AQL	Total oxidised nitrogen as N	mg/l	ALM 06	<0.194	<0.194	2.27
A	AQL	Ammonium (NH_4) as N	mg/l	ALM 05	0.055	3.13	0.056
A	AQL	Fluoride (F)	mg/l	ALM 08	<0.263	0.385	<0.263
A	AQL	Acid Soluble Calcium (Ca)	mg/l	ALMA 30	105	36.4	113
A	AQL	Acid Soluble Magnesium (Mg)	mg/l	ALMA 30	68.1	26.3	53.1
A	AQL	Acid Soluble Sodium (Na)	mg/l	ALMA 30	32.0	33.6	69.0
A	AQL	Acid Soluble Potassium (K)	mg/l	ALMA 30	7.46	3.99	15.9
A	AQL	Acid Soluble Aluminium (Al)	mg/l	ALMA 31	<0.002	<0.002	<0.002
A	AQL	Acid Soluble Iron (Fe)	mg/l	ALMA 31	<0.004	0.255	<0.004
A	AQL	Acid Soluble Manganese (Mn)	mg/l	ALMA 31	0.913	1.28	0.003
A	AQL	Acid Soluble Chromium (Cr)	mg/l	ALMA 31	<0.003	<0.003	<0.003
A	AQL	Acid Soluble Copper (Cu)	mg/l	ALMA 31	<0.002	<0.002	<0.002
A	AQL	Acid Soluble Nickel (Ni)	mg/l	ALMA 31	0.004	<0.002	<0.002
A	AQL	Acid Soluble Zinc (Zn)	mg/l	ALMA 31	0.006	0.004	0.003
A	AQL	Acid Soluble Cadmium (Cd)	mg/l	ALMA 31	<0.002	<0.002	<0.002
A	AQL	Acid Soluble Lead (Pb)	mg/l	ALMA 31	<0.004	<0.004	<0.004
A	AQL	E.coli	CFU/100ml	ALM 40	<1	5	<1
A	AQL	Total coliform	CFU/100ml	ALM 40	<1	2900	<1

A = Accredited N = Not accredited Sub = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report ; Results relate only to the items received and tested ; Results reported against the limit of detection; Results marked "Not SANAS Accredited" in this report are not covered by the Scope of Accreditation for this laboratory; Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation; The report shall not be reproduced except in full without approval of the laboratory

M. Swanepoel
Technical Signatory

AQL 89 Regency Drive, R21 Corporate Park, Centurion, South Africa Tel: +27 12 450 3800 www.aquatico.co.za
AQK 28 Karee ave, Kathu, Northern Cape, South Africa Tel: +27 53 880 0208 www.aquatico.co.za

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0685

Test Report

Client: ARIYS CONSULTING
Address: Oxford Office Park, 30 Bauhinia Street, Highveld Techno Park , Centurion, 016
Report no: 223278
Project: Vereeniging Rand Water

Date of report: 06 June 2025
Date accepted: 30 May 2025
Date completed: 05 June 2025
Date received: 30 May 2025

Lab no:					259134	259135	259136
Date sampled:					26-May-25	26-May-25	26-May-25
Aquatico sampled:					No	No	No
Sample type:					Water	Water	Water
Locality description:					VGMB 1	VGMB 2	VGMB 3
		Analyses	**Unit**	**Method**			
A	AQL	Turbidity	NTU	ALM 21	12.3	29.7	41.7
A	AQL	Total hardness	mg $CaCO_3$/l	ALM 26	542	199	499
A	AQL	Total organic carbon (TOC)	mg/l	ALM 63	2.09	2.51	2.69
A	AQL	Langelier Saturation Index	LSI	ALM 26	-0.36	-0.64	-0.57

A = Accredited N = Not accredited Sub = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report ; Results relate only to the items received and tested ; Results reported against the limit of detection; Results marked "Not SANAS Accredited" in this report are not covered by the Scope of Accreditation for this laboratory; Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation; The report shall not be reproduced except in full without approval of the laboratory

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HYDROGEOLOGICAL INVESTIGATION STUDY FOR THE INSTALLATION OF AN INTERCONNECTION NEW SLUDGE PIPELINE AT RAND WATER'S PANFONTEIN RAW WATER RESIDUE SITE IN PANFONTEIN WITHIN THE JURISDICTION OF MIDVAAL LOCAL MUNICIPALITY FORMING PART OF SEDIBENG DISTRICT MUNICIPALITY IN GAUTENG PROVINCE, SOUTH AFRICA.

REPORT STATUS: FINAL REPORT

DATE: JUNE 2025

PREPARED BY:

ARIYS CONSULTING (PTY) LTD

Oxford Office Park, Unit 30 First Floor Right,
3 Bauhina Street, Highveld Techno Park,
Centurion, 0157 | South Africa

PREPARED FOR

SELAHLE CONSULTANCY AND PROJECTS (PTY) LTD

546 16th Road,
Constantia Park Block 2, 1st Floor,
Randjespark, 1682 | South Africa

Title:	**Hydrogeological Investigation Study for the Installation of an Interconnection New Sludge Pipeline at Rand Water's Panfontein Raw Water Residue Site in Panfontein within the Jurisdiction of Midvaal Local Municipality Forming Part of Sedibeng District Municipality in Gauteng Province, South Africa.**
Prepared for:	**Selahle Consultancy and Projects (Pty) Ltd** 546 16th Road, Constantia Park Block 2, 1st Floor, Randjespark, 1682
Contact Person:	**Miss. Sinnah Mhlongo**
Office:	+27 79 614 8298
Prepared by:	**Ariys Consulting (Pty) Ltd** Oxford Office Park, Unit 30 First Floor Right, 3 Bauhina Street, Highveld Techno Park, Centurion, 0157
Contact Person:	**Mr Fhatani Makhuvha**
Mobile:	+27 68 497 6579
Project No.:	AC-HG-01/02
Project Team:	FL Makhuvha, Hydrogeologist (Pri.Nat.Sci./MGSSA/GWD)
Site Coordinates:	Lat: -25.958655°S, Long: 28.090008°E
Location:	Rand Water's Panfontein Raw Water Residue Site, Gauteng Province
Date:	25 June 2025

Report Approved:

Fhatani Lenon Makhuvha *Pr.Nat.Sci/GWD*
Hydrogeologist

EXECUTIVE SUMMARY

Ariys Consulting (Pty) Ltd has been appointed by Selahle Consultancy and Projects (Pty) Ltd on behalf of Rand Water to conduct a hydrogeological investigation study for the installation of an interconnection New Sludge Pipeline at Rand Water's Panfontein Raw Water Residue Site in Panfontein within the Jurisdiction of Midvaal Local Municipality Forming Part of Sedibeng District Municipality in Gauteng Province, South Africa.

The report is a requirement of the Environmental Impact Assessment (EIA) s, Water Use License Application and the Heritage Permit for development of New Sludge Pipeline at Rand Water's Panfontein Raw Water Residue Site in Panfontein.

The field investigation was conducted on the 26th of May 2025.

The site is underlain by the Aeolian Sand (Qw) – Deposition of sediment by wind. The site is underlain by Aeolian Sand (Qw) in places.

Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the site is regarded a **"minor aquifer"** with regional yields ranging between 0,5-2,0l/s.

The site is situated in the **Vaal water Management and falls within C22F** Quaternary catchment.

The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer is classified as low. Measures need to be taken to ensure appropriate drainage facilities are constructed to prevent the abovementioned issues.

Seven (7) boreholes were identified from the NGA data all within a 5-kilometre radius from the site investigated. Groundwater level range is between 2,31 mbgl and 16,75 mbgl. The water levels were recorded between 1930 and 1969.The site is therefore underlain by a very shallow groundwater table.

During Hydrocensus three (3) boreholes and canal were visited within a 5km radius of the investigated site. Observations regarding the borehole location, construction, water level and status was noted.

Ground water and surface water quality results indicated that all analysed constituents were below SANS 241:2015 standard limits and DWAF Water Quality Guidelines (Livestock Watering) Target Quality Range except for Turbidity (NTU), E coli and T coli.

Ground water and surface water results indicated that the water from these sources is not suitable for human consumption. Water treatment is recommended before any human consumption.

Groundwater Risk Assessment: Groundwater level and quality has a low to medium possible risk impact.

- **Preconstruction:**
- Based on NGA data the site is characterised by shallow groundwater level and wetland that is susceptible to contamination inflow especially in heavy rainfall events. Groundwater Monitoring boreholes are installed upstream and downstream of the site to monitor groundwater quality.

- The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system.

  - Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
- Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.

  - Vegetation removal must be as minimal as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.
- **During construction:**

  - During the construction phase, surface water may be diverted for dry working conditions. The natural surface water flow will be affected. To reduce the impact on aquatic habitants, various structures must be installed to mimic and protect existing stream environment.
- The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system.

  - Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations and Environmental Management Programme) for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
- Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during pre-construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.

  - Vegetation removal must be as minimal as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.
- Material from construction flowing into surface water bodies and upstream outbursts and overflow, which may pose a threat and risk to surface water quality.

  - Surface water quality monitoring plan must be implemented to monitor quality and ensure no contamination occurs within the site.
- Continuous groundwater and surface water monitoring is recommending upstream and downstream of the site to monitor quality and water level.
- **After construction:**

  - Aquifer testing should be conducted to establish suitable yields on the borehole to prevent excessive pumping and to regulate critical water levels.

- Domestic wastewater is rich in nitrogen and phosphorus which may pose a threat and risk to groundwater system. The water table in the area is very shallow, this may result in untreated effluent escaping into groundwater

- Groundwater quality monitoring should be conducted on a quarterly basis to ensure no contamination occurs within the site. The integrity of the domestic wastewater structures must be regularly inspected to prevent against infiltration of domestic wastewater into groundwater system.

- Re-vegetation

- re-vegetation activities are encouraged during reduce rainfall impact, reduce surface water velocities, enhance infiltration, trap sediments.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

Ariys Consulting (Pty) Ltd has been appointed by Selahle Consultancy and Projects (Pty) Ltd on behalf of Rand Water to conduct a hydrogeological investigation study for the installation of an interconnection New Sludge Pipeline at Rand Water's Panfontein Raw Water Residue Site in Panfontein within the Jurisdiction of Midvaal Local Municipality Forming Part of Sedibeng District Municipality in Gauteng Province, South Africa. The New Sludge Pipeline with approximately 1,5km in length and 800mm in diameter and is located on the Rand Water's Panfontein Raw Water Residue Site and along the access road to the Panfontein Raw Water Residue Site. The hydrogeological assessment forms part of the requirement of Basic Assessment process, Water Use License Application and the Heritage Permit for the proposed construction of new sludge pipeline for the following:

- 1,5km Panfontein Sludge Pipeline - The installation of an interconnection new sludge pipeline with approximately 1,5km in length and 800mm in diameter.

The scope of work for the hydrogeological assessment was to carry out which included a desktop analyses, review of the existing hydrogeological reports and a detailed field investigation comprising of a hydrocensus and sampling of monitoring boreholes.

2 METHODOLOGY

2.1 DESKTOP STUDY

Ariys Consulting (Pty)Ltd assessed all available geological and hydrogeological data. All existing groundwater data was reviewed and assessed during the desktop study.

A study of the 1: 250 000 geological maps and satellite images were conducted during the desktop study. All relevant information was sourced from the client as well as from the relevant governmental departments where available. Any existing groundwater data captured in the National Groundwater Archive (NGA), obtained from the Department of Water Affairs was utilised.

The following data sources were used during the study:

- Geological map (1:250 000): 2628 East Rand;
- The groundwater resources of the Republic of South Africa, sheets 1 and 2 (Vegter 1995);
- GRIP(Groundwater Resource Information Programme) data;
- GRDM, Groundwater Resource Directed Measures, GRDM Training Manual; and
- The National Groundwater Archive (NGA), Department of Water Affairs.
- Aquatico Scientific, 2022. Rand Water Panfontein Raw Water Residue Site Groundwater Impact Assessment Report.

2.2 HYDROCENSUS INVESTIGATION

A hydrocensus was conducted within a 5 km radius of the site area. The following information can be captured during the hydrocensus:

- GPS coordinates and elevation of existing boreholes or springs;
- Water levels of the boreholes, where accessible;
- Estimated abstraction volumes, where provided;
- Any other information regarding the water reliability or quality;
- Identifying surface water bodies and usage;
- Determine groundwater usage and identify groundwater users; and
- Selected boreholes identified during the hydrocensus will be incorporated within a monitoring plan to monitor groundwater quality.

2.3 GROUNDWATER SAMPLING

The hydrocensus/monitoring boreholes were sampled. The samples were submitted to Aquatico Scientific a SANAS accredited laboratory based in Irene, Centurion, South Africa. A total of 4 samples were collected.

The hydrochemical sampling was carried out in accordance with the following publications:

- SABSISO5667-11:1993 Guidance on sampling of groundwater
- SABSISO5667-1:1980 Guidance on the design of sampling programs
- SABSISO5667-2:1991 Guidance on sampling techniques
- SABSISO5667-3:1994 Guidance on the preservation and handling of samples

The following parameters were analysed for, viz: anions, cations and selected metals. Water level measurements were recorded in all sampled boreholes to comment on the feasibility of the existing monitoring boreholes in place and to be used as future groundwater monitoring boreholes.

3 SITE DESCRIPTION

3.1 SITE LOCATION

The site is located within the Jurisdiction of Midvaal Local Municipality forming part of Sedibeng District Municipality of Gauteng Province in South Africa. The geographical coordinates of the site are -26°43'6.46"S, 28° 2'29.56"E. It is situated approximately 15km east of Vereeniging Central Business. The site can be accessed via Pretorius Street in Meyerton. Refer to Figure 4-1 for locality map of the project area.

3.2 Topography and Drainage

The site is situated at maximum elevation of 1476m, exhibits varied topography in relation to surrounding points. The terrain slopes downward to the west by approximately -23m, rises upward to the east by +5m, and slopes downward to the west by approxiamtely-8m. This suggests an undulating or sloping topography rather than a flat one. Water drainage is likely to occur towards lower elevations, such as south and east, while the western and northern directions may experience water runoff moving away.

3.3 Climate

The climatic conditions prevailing in Meyerton are characterized by a warm and moderate temperature. In Meyerton, the level of precipitation during summers surpasses that of winters. The Köppen-Geiger climate classification identifies this particular weather pattern as belonging to the category of Cwb. The average annual temperature is 17.0 °C in Meyerton. The annual rainfall is 752 mm. In terms of precipitation, the month with the lowest amount of rainfall is July, recording a mere 4 mm in its entirety. This denotes an exceptionally dry period within that particular time frame. The highest amount of precipitation occurs during the month of December, with an average quantity reaching up to 143 mm. The month that experiences the highest temperatures throughout the year is referred to as January, where an average temperature of 21.1 °C prevails. The month of July registers the most frigid temperatures throughout the year, with an average low temperature of 10.2 °C.

4 HYDROGEOLOGICAL DESKTOP STUDY

4.1 Geology

According to 1:250 000 2628 East Rand Geological Map, the site is underlain by the following lithologies: Aeolian Sand (Qw) – Deposition of sediment by wind.

The Quaternary Sediments - This layer consists mostly of aeolian sands (wind transported) that has not been cemented and has high permeability and conductivity. The Quaternary Sediments are some of the youngest geological layers in southern Africa.

Aeolian sand or wind transported sands generally form excellent primary aquifers due to its inert nature and high permeability. It often has a very shallow, flat-water table which can lead to a swampy or marshy environment.

The geological strata a beneath the Panfontein site are partially weathered for the first few meters below surface. The weathered zone allows for somewhat higher recharge and primary porosity and permeability. Figure 4-2. The site is underlain by aeolian sand in places.

TITLE: HYDROGEOLOGICAL STUDY FOR THE NEW SLUDGE PIPELINE AT RAND WATER'S PANFONTEIN SLUDGE DISPOSAL SITE

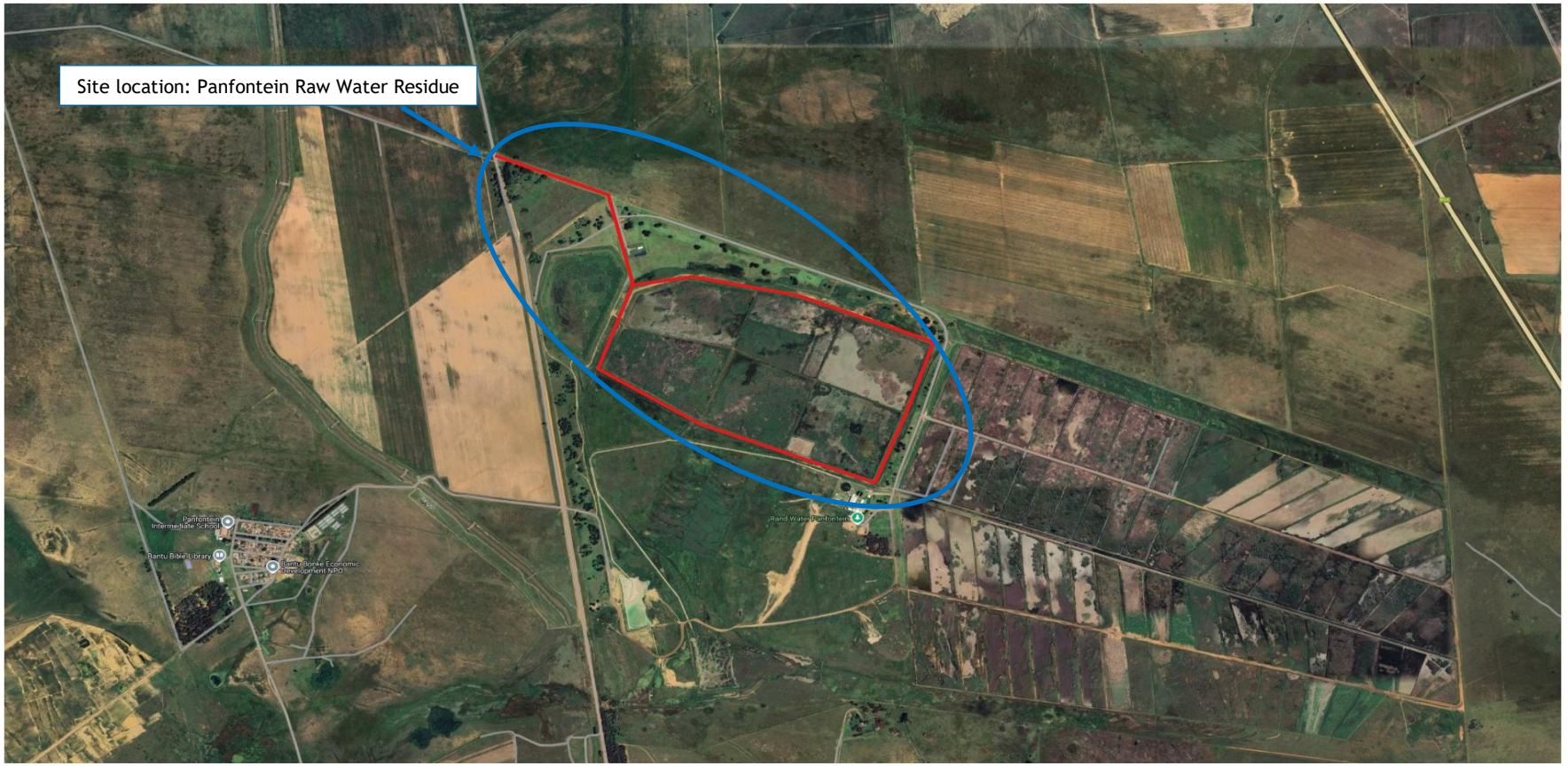

FIGURE 4-1: SITE LOCATION MAP

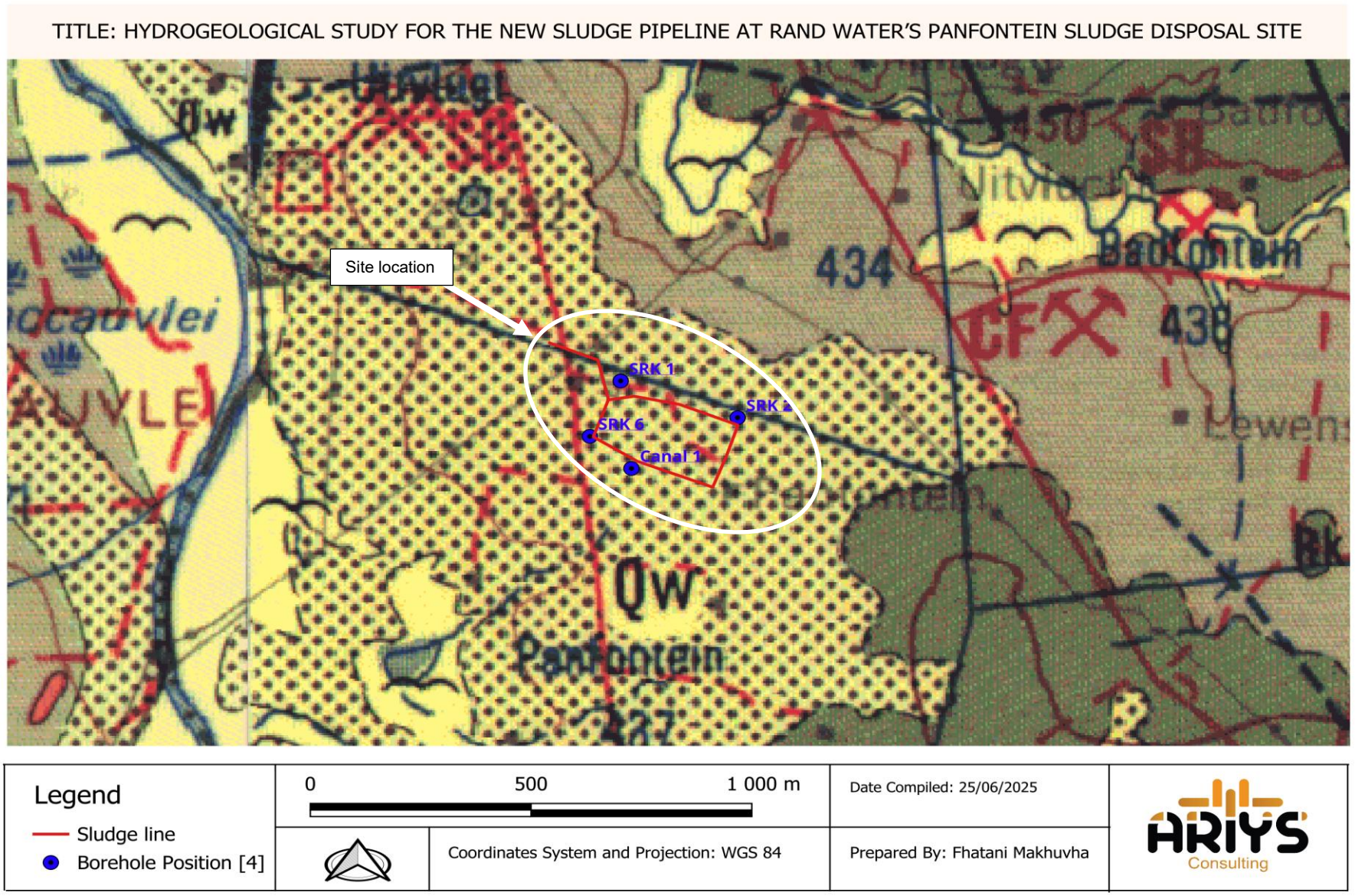

FIGURE 4-2 GEOLOGY MAP

4.2 HYDROGEOLOGY

The study area is situated in the **Vaal** Water Management Area and falls within **C22F** Quaternary catchment. As Per the 1:500 000 **2628 East Rand** Hydrogeological Map Series sheet the underlying geological formations within 'fractured' aquifers. Potential groundwater yields of between **0,5 L/s and 2,0 L/s** are associated with 'fractured' aquifers. The primary porosity of the rocks provides the storage capacity with limited groundwater movement, while secondary features such as fractures, faults, bedding planes and dolerite intrusions enhance the groundwater flow. Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the site is regarded a "**minor aquifer**". Hydrogeological map is seen in Figure 4-3.

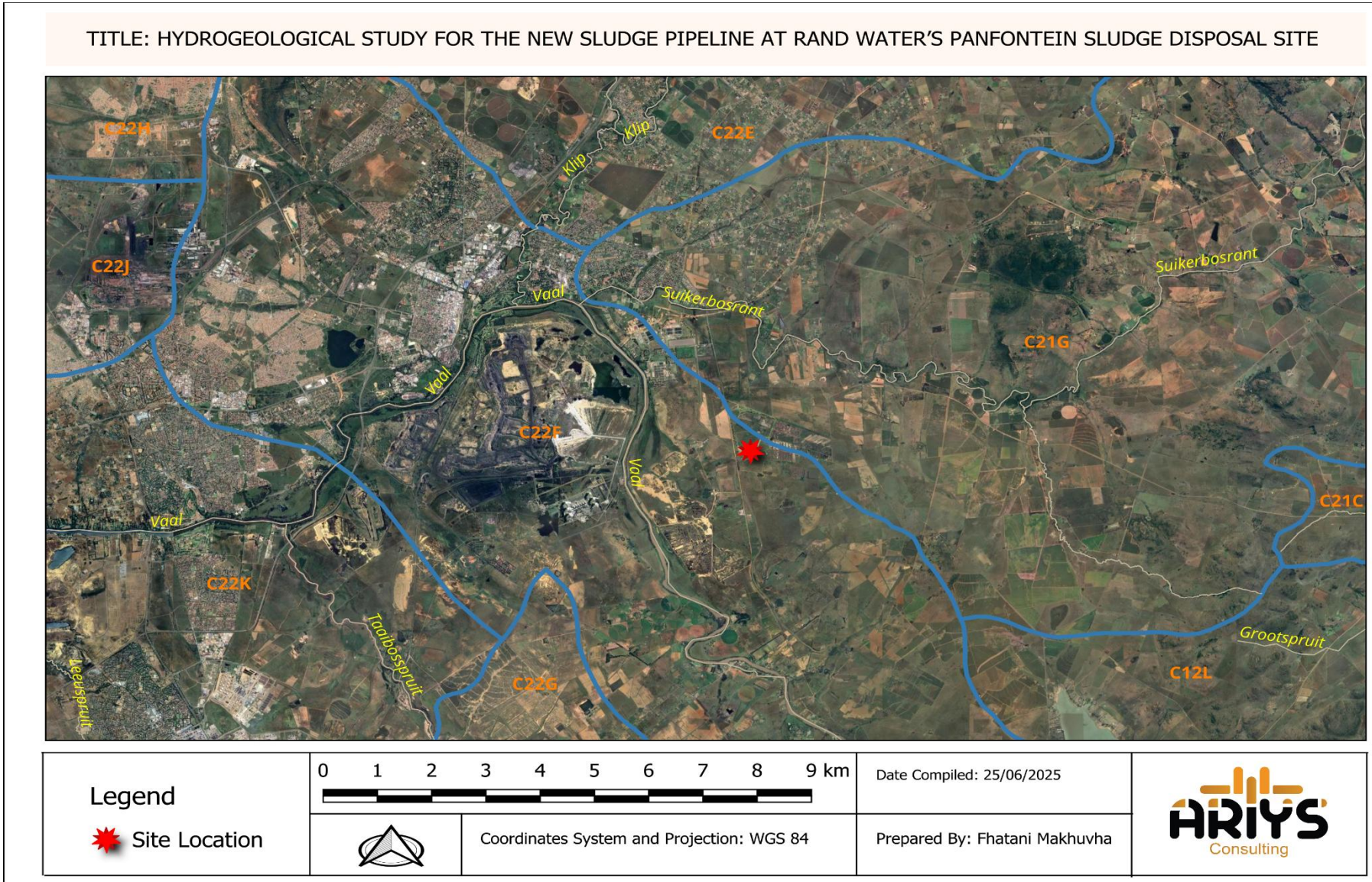

FIGURE 4-3 HYDROGEOLOGY MAP

4.2.1 Aquifer Classification

Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the study is regarded a **"minor aquifer"**. A summary of the classification scheme is provided in Table 4-1.

Table 4-1: AQUIFER CLASSIFICATION SCHEME (PARSONS, 1995; PARSONS AND CONRAD, 1998)

Aquifer System	Defined by Parsons (1995)	Defined by DWAF Min Requirements (1998)
Sole Source Aquifer	An aquifer which is used to supply 50% or more of domestic water for a given area, and for which there are no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields, and natural water quality are immaterial.	An aquifer, which is used to supply 50% or more of urban domestic water for a given area for which there are no reasonably available alternative sources should this aquifer be impacted upon or depleted.
Major Aquifer	High permeable formations usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (<150 mS/m).	High yielding aquifer (5-20 L/s) of acceptable water quality.
Minor Aquifer	These can be fractured or potentially fractured rocks, which do not have a high primary permeability or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important both for local supplies and in supplying baseflow for rivers.	Moderately yielding aquifer (1-5 L/s) of acceptable quality or high yielding aquifer (5-20 L/s) of poor-quality water.
Non-Aquifer	These are formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer as unusable. However, groundwater flow through such rocks, although imperceptible, does take place, and need to be considered when assessing the risk associated with persistent pollutants.	Insignificantly yielding aquifer (< 1 L/s) of good quality water or moderately yielding aquifer (1-5 L/s) of poor quality or aquifer which will never be utilised for water supply, and which will not contaminate other aquifers.
Special Aquifer	An aquifer designated as such by the Minister of Water Affairs, after due process.	An aquifer designated as such by the Minister of Water Affairs, after due process.

4.3 AQUIFER VULNERABILITY

Aquifer vulnerability is defined as the intrinsic characteristics that determine the aquifer's sensitivity to the adverse effects resulting from the imposed pollutant (Per Lynch et al). The following factors influence groundwater vulnerability:

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

The Groundwater Decision Tool (GDT) was used to quantify the vulnerability of the aquifer underlying the site. The depth to groundwater below the site was estimated from water levels measured obtained from NGA database inferred to be 7,72 mbgl.

The aquifer system is classified as a minor aquifer. The local population is dependent on groundwater. Furthermore, the area is characterised by several surface water features which can be used if necessary. The aquifer is also important for supplying base flow to the rivers and streams.

To achieve the Aquifer System Management and Second Variable Classifications, as well as the Groundwater Quality Management Index, the waiting and rating approach has been adopted for the site as per South African Aquifer Systems Management Classification (Parson,1995). Variable classification considers the three (3) generic classes (High, Medium, and Low) (**TABLE 4-3**). The aquifer vulnerability is determined using the Aquifer Vulnerability Map of South Africa. The vulnerability map indicates the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. The two ratings (Aquifer System Management and Aquifer Vulnerability) are then multiplied to yield a groundwater management decision index.

TABLE 4-2: RATINGS FOR THE AQUIFER SYSTEM MANAGEMENT AND SECOND VARIABLE CLASSIFICATION (PARSONS, 1995)

Aquifer System Management Classification		Second Variable Classification	
Class	Points	Class	Points
Sole Source Aquifer System	6	High	3
Major Aquifer System	4	Medium	2
Minor Aquifer System	2	Low	1
Non-aquifer system	0		
Special Aquifer System	0-6		

TABLE 4-3: RATINGS FOR THE SITE- AQUIFER CLASSIFCATION AND SECOND VARIABLE CLASSFICATIONS

Aquifer Systems Management		
Class	Points	Site
Sole Source Aquifer System	6	2
Major Aquifer System	4	
Minor Aquifer System	2	
Non-aquifer system	0	
Special Aquifer System	0-6	
Vulnerability Classification (weathering/ fracturing)		
Class	Points	Site
▪ High	3	2
▪ Medium	2	
▪ Low	1	

4.4 GROUNDWATER QUALITY MANAGEMENT

As part of the aquifer classification, a Groundwater Quality Management (GQM) Index is used to define the level of groundwater protection required. The GQM Index is obtained by multiplying the rating of the aquifer system management and the aquifer vulnerability. The GQM index for the site is presented in **TABLE 4-4**.

The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer is classified as **medium** (**TABLE 4-3**). However, it should be noted that due to the near surface perched coupled with shallow groundwater level on site, during heavy rainfall events the site is likely to experience raised water levels that may lead to water pooling on site and increases the likelihood of groundwater contamination onsite. Measures need to be taken to ensure appropriate drainage facilities are constructed to prevent the abovementioned issues. The prevailing in-situ conditions thus render the groundwater system as highly vulnerable to contamination due to anthropogenic activities.

TABLE 4-4: GQM INDEX FOR THE SITE

GQM Index	Level of Protection	Study area
<1	Limited	4
1-3.	Low level	
3-6.	Medium Level	
6-10.	High Level	
>10	Strictly non-degradation	

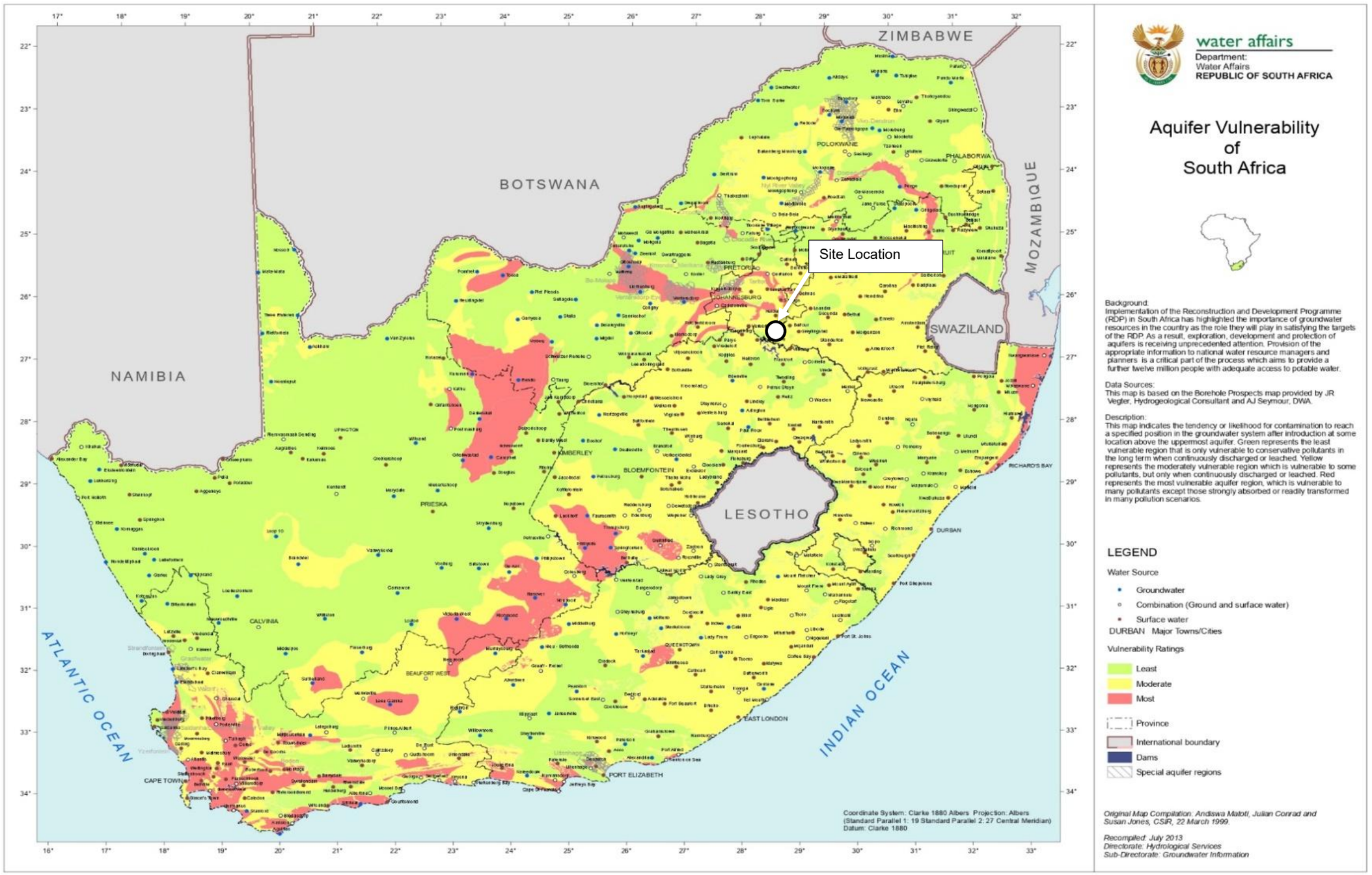

FIGURE 4-4 AQUIFER VULNERABILITY MAP OF SOUTH AFRICA

5 PREVIOUS GROUNDWATER MONITORING FOR RAND WATER'S PANFONTEIN RAW WATER RESIDUE SITE

A water quality monitoring programme is currently being undertaken for the Rand Water's Panfontein Raw Water Residue Site, by Rand Water team on site.

The overall objectives of the monitoring programme were to:

- Comply with the conditions of the Environmental Authorisation (EA) issued by the Department of Environmental Affairs (DEA), and the Water Use License (WUL) from the Department of Water Affairs (DWA);
- Determine the quality of water resources in the vicinity of the Rand Water's Panfontein Raw Water Residue Site by:
- Sampling the surface and groundwater at pre-determined positions on a monthly basis;
- Recording the physical parameters at each sampling point when samples are taken;
- Sending the samples to a laboratory for analysis;
- Reporting the results of the aforementioned in a monthly monitoring report; and
- Presenting the contents of the monitoring reports.

During this period a total of four (4) water samples were collected, which includes three (3) boreholes and one (1) stream.

6 NATIONAL GROUNDWATER ARCHIVE DATA

6.1 NGA DATA

National Groundwater Archives (NGA) is a web enabled database system that allows capturing, viewing, modifying and extraction of groundwater related data by registered users. NGA was used to gather information on existing boreholes within a 5km radius of the site to understand the spatial status of groundwater flow regime. For each borehole identified on NGA, the parameters including location, groundwater level, water strike and elevation where possible were noted.

A total of Seven (7) boreholes were identified from the NGA data. The parameters including location, groundwater level, and elevation where possible were noted. The following could be concluded based on the obtained data:

- Groundwater level range is between 2,31mbgl and 16,75mbgl. The water levels were recorded between 1930 and 1969.
- All boreholes identified are located west, north and northeast of the site. With no boreholes located within a 2km radius of the site.
- The site is therefore underlain by a very shallow groundwater table.

Data collected from the NGA database can be outdated and some borehole attributes could have changed over the years, or the borehole has since been destroyed. It is important to note that this information only serves as a baseline to understand the groundwater regime. The table below (Table 6-1) summarizes the NGA data obtained within a 5km radius of the site. Figure 6-1 shows the locations of the boreholes with groundwater levels obtained from the NGA data.

TITLE: HYDROGEOLOGICAL STUDY FOR THE NEW SLUDGE PIPELINE AT RAND WATER'S PANFONTEIN SLUDGE DISPOSAL SITE

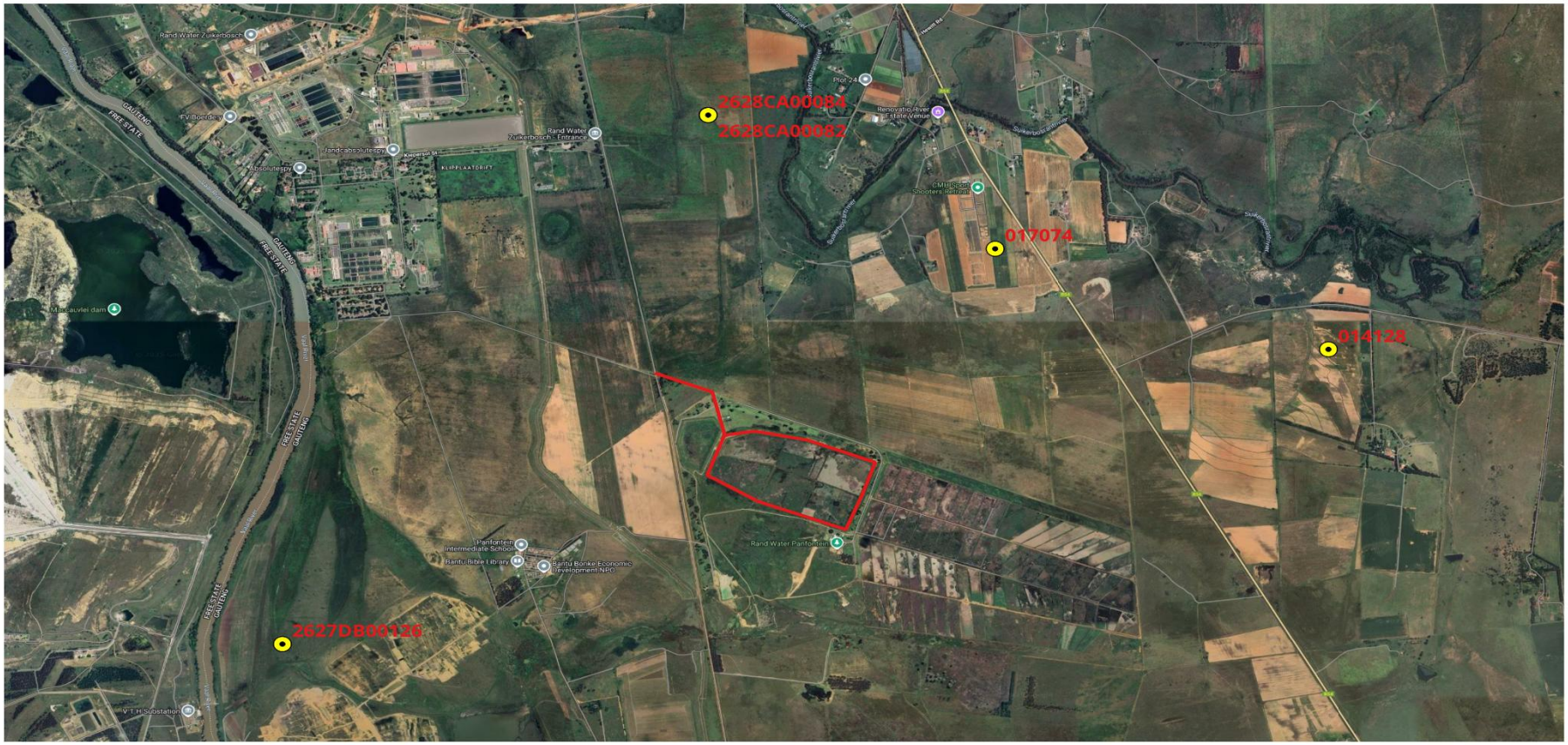

FIGURE 6-1: NGA DATA BOREHOLE LOCATIONS

TABLE 6-1: NGA DATA SUMMARY

BH ID	latitude	Longitude	Farm name	Lithology	Water strike	Water Level (m)	Elev - mams	WL_mamsl
2627DB00126	-26.72638S	27.99828E	PANFONTEIN	Sandstone, Shale	54.86	2.13	1440	1437.87
014128	-26.70194S	28.08026E	BADFONTEIN	Igneous (Lava)	21.34	16.76	1460	1443.24
2628CA00083	-26.6825S	28.03164E	UITGEVLUGT	Dolerite	19.20	15.24	1440	1424.76
017074	-26.6936S	28.05414E	UITVLUGT	Sandstone, Shale, Coal	24.38	3.05	1460	1456.95
2628CA00080	-26.6825S	28.03165E	UITVLUGT	Sandstone, Shale, Coal			1440	
2628CA00082	-26.68249S	28.03165E	UITVLUGT	Sandstone, Shale, Coal	22.86	3.05	1440	1436.95
2628CA00084	-26.68251S	28.03165E	UITVLUGT	Dolerite	17.37	6.10	1440	1433.90
Average						7.72	1446	1438.95

6.1 GROUNDWATER FLOW DIRECTION

Groundwater elevation and Flow Regime based on groundwater level measurements obtained from NGA data was used to create groundwater flow directions. In general, the water table mimics the topography, and groundwater flow is from areas of higher lying ground.

A moderate correlation between the measured head and topography can be seen in Figure 6-2 (R^2 = 0.6483, i.e., approximately 99% of observed groundwater level variations can be explained by variations in land surface elevation and it can be assumed that the water table slightly mimics the surface topography but is somewhat higher or somewhat lower in places.

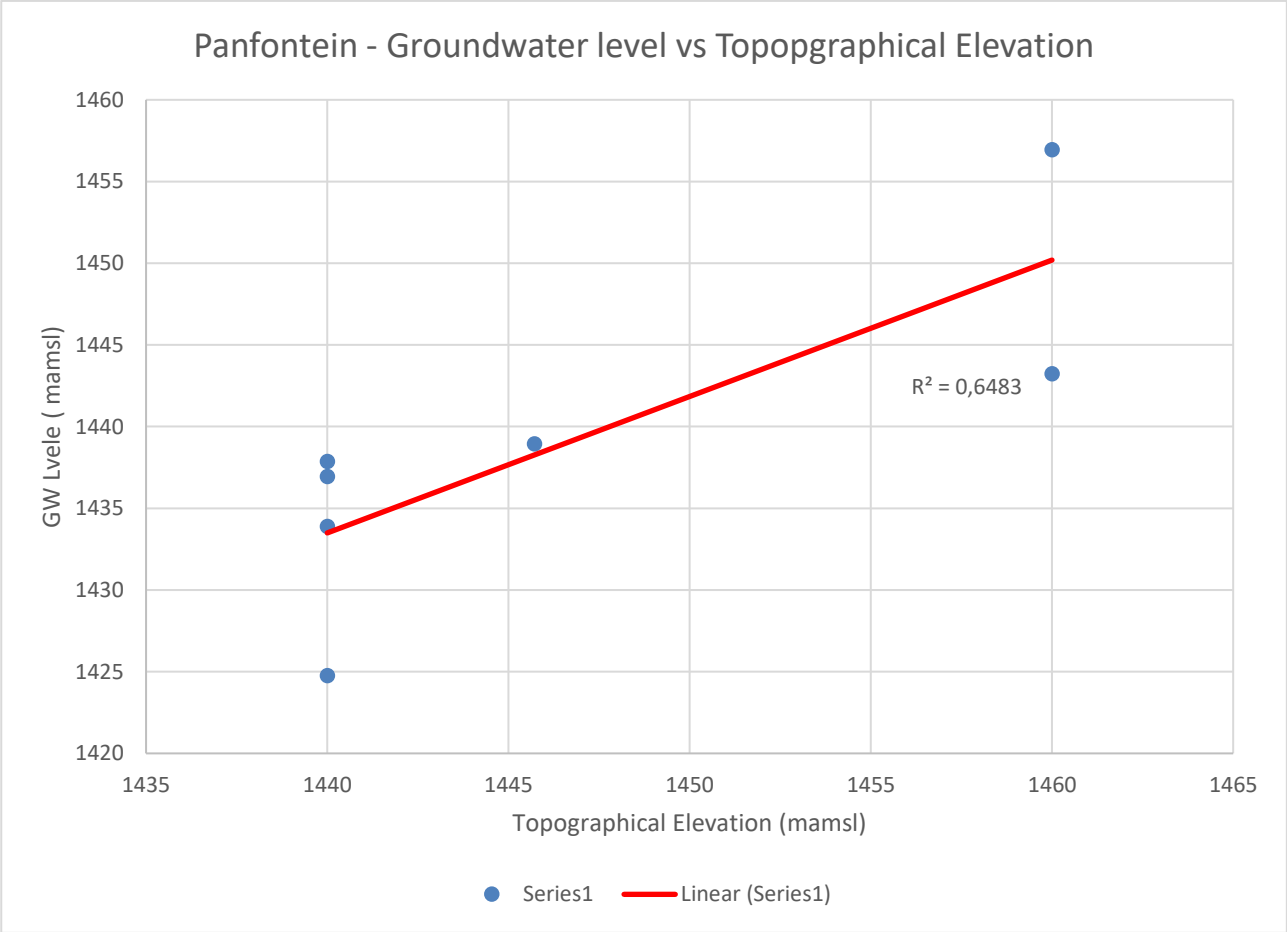

FIGURE 6-2: GW VS TOPOGRAPHICAL ELEVATION

7 HYDROCENSUS

Ariys Consulting undertook the hydrocensus investigation on the 26th of May 2025. A total number of three (3) boreholes and one (1) stream were identified during the hydrocensus investigation. Details of the boreholes and stream are presented in Table 7-1, Table 7-2 and Figure 7-1.

For each borehole identified, parameters including the location, elevation, groundwater level and water quality were recorded. Groundwater samples were collected for water quality analyses and submitted to Sanas accredited Laboratory Aquatico Scientific in Irene, Centurion.

Field observations for each sampling point, consisting of the following information, were recorded on field data sheets:

- Boreholes are located within the Rand Water's Panfontein Raw Water Residue Site along the proposed site.
- Groundwater Level were measured between SRK1 (2,2), SRK 2 (2,5) and SRK (1,8).
- Coordinates of each borehole;
- Depth of water level;
- General characteristics of the water samples such as colour and smell as well as visual observations of the sample site.
- Borehole are quipped and used as monitoring boreholes.

TABLE 7-1 HYDROCENSUS BOREHOLES

Borehole ID	Co-ordinates		Elevation (mams)	Water Level(m)	Water Level (mamsl)	Depth	Usage	Colour	Borehole conditions	Water sample collected
	Latitude	Longitude								
SRK 1	-26.707361°	28.034017°	1484	2,2	1481,8	Unknown	Monitoring	Colourless	Good	Yes
SRK 2	-26.710647°	28.044708°	1480	2,5	1477,5	Unknown	Monitoring	Colourless	Good	Yes
SRK 6	-26.712322°	28.031247°	1477	1,8	1475,2	Unknown	Monitoring	Colourless	Good	Yes
Canal 01	-26.715197°	28.035033°	1475	-	-	-	-	Colourless	-	Yes

TABLE 7-2 HYDROCENSUS PHOTO LOG

Photo Log		
		
Plate1: SRK 1	Plate 2: SRK 2	Plate 3: SRK 6
		
Plate4: Sampled Canal 01	Plate 5: Up Stream Canal 01	Plate 6: Sampling

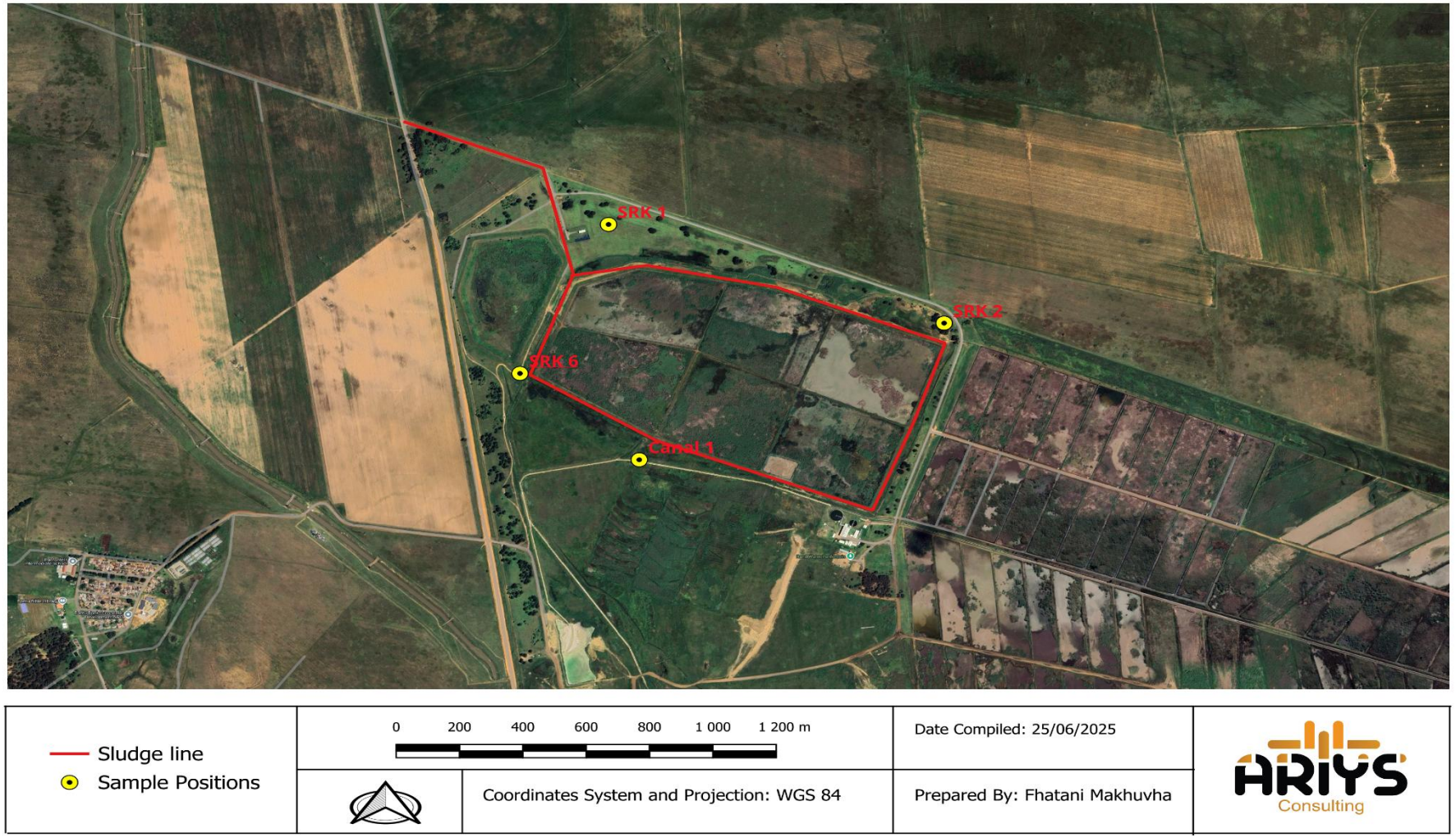

FIGURE 7-1 HYDROCENSUS MAP

8 GROUNDWATER AND SURFACE WATER QUALITY ANALYSIS

The water qualities measured within the boreholes are tabulated in Table 10-3 and were compared to the SANS241-1:2011 drinking water quality standards for domestic use. The chemistry data provides baseline conditions in order to make comparisons too in the Future to determine if the water quality has deteriorated based on the influence of the Sludge Disposal Site.

Groundwater and surface water samples were collected and submitted to an accredited laboratory for water quality analyses. Concentrations have been compared to the following water quality standard:

- **South African National Standards (SANS) 241 (2015)**

The SANS 241: 2015 specifies limits in terms of four categories:

- **Acute Health** – poses an immediate unacceptable health risk if present at concentrations exceeding the numerical limits specified.
- **Aesthetic** – does not pose an unacceptable health risk if present at concentrations exceeding the numerical limits specified, but will taint water with respect to taste, odour, and colour.
- **Chronic Health** – poses an unacceptable health risk if ingested over an extended period if present at concentrations exceeding the numerical limits specified.
- **Operational** – is essential for assessing the efficient operation of treatment systems and risks to infrastructure.

8.1 GROUNDWATER AND SURFACE WATER QUALITY RESULTS

Ground water and surface water quality results indicated that all analysed constituents were recorded below SANS 241:2015 standard limits except for Turbidity (NTU), E coli and T coli. Refer to Table 8-1 and Appendix A.

- Turbidity (NTU) has been recorded above SANS 241:2015 of 4 NTU for Operational Health in SRK 1 (53.7 NTU), SRK 2 (85,2 NTU), SRK 6 (926 NTU) and Canal 01 (10,6 NTU).
- E coli has been recorded above SANS 241:2015 of 1 CFU/100ml for Acute Health in a Canal 01 (1 CFU/100ml)
- T coli has been recorded above SANS 241:2015 of 10 CFU/100ml for Operational Health in Canal 01 (18 CFU/100ml).

Ground water and surface water results indicated that the water from these sources is not suitable for human consumption. Water treatment is recommended before any human consumption.

TABLE 8-1: SUMMARY OF WATER QUALITY ANALYSIS

SANS 241-1:2015 Ed. 2 :							
Operational Health							
Aesthetic Health							
Acute Health							
Chronic Health							
Date Sampled:				**SRK 1**	**SRK 2**	**SRK 6**	**Canal 01**
Physical Determinants	**Unit**	**Risk**	**General / Standard Limit**	**Borehole water**	**Borehole water**	**Borehole water**	**Canal**
pH - Value @ 25 °C	pH Units	Operational	≥ 5 to ≤ 9.7	7,46	7,11	6,86	8,93
Electrical Conductivity in mS/m @ 25°C	mS/m	Aesthetic	≤170	63,4	23,2	27,9	22,5
Total Dissolved Solids @ 180°C	mg/l	Aesthetic	≤1200	415	128	163	129
Turbidity in N.T.U	mg/l	Operational	≤1	53,7	85,2	926	10,6
	mg/l	Aesthetic	≤5				
Total Alkalinity as $CaCO_3$	mg/l	---	---	322	99,2	146	72,2
Chloride as Cl	mg/l	Aesthetic	≤300	9,61	6,29	0,728	10,1
Sulphate as SO_4	NTU	Acute health	≤500	60,4	13,6	9,02	27,1
		Aesthetic	≤250				
Fluoride as F	mg/l	Chronic health	≤1.5	<0.263	<0,263	<0,263	<0,263
Nitrate as N	-	Acute health	≤11	0,446	<0,194		
E. coli (MPN/100 mℓ)	mg/l	Acute health	Not detected	<1	<1	<1	1
T. coli (MPN/100 mℓ)	mg/l	Operational health	10	<1	<1	<1	18
Sodium as Na	mg/l	Aesthetic	≤200	17,1	8,67	8,09	5,85
Potassium as K	mg/l	---	---	5,42	4,20	8,21	4,61
Calcium as Ca	mg/l	---	---	75,7	19,4	30,0	24,6
Magnesium as Mg	mg/l	---	---	48,1	9,12	8,89	11,1
Aluminium as Al (µg/ℓ)	mg/l	Operational	≤0,3	<0,002	0,012	0,129	0,025
Cadmium as Cd (µg/ℓ)	mg/l	Chronic health	≤0,03	<0,002	<0,002	<0,002	<0,002
Total Chromium as Cr (µg/ℓ)	mg/l	Chronic health	≤0,05	<0,003	<0,003	<0,003	<0,003
Copper as Cu (µg/ℓ)	mg/l	Chronic health	≤2	<0,002	<0,002	<0,002	<0,002
Iron as Fe (µg/ℓ)		Chronic health	≤ 2	<0,004	0,278	0,465	0,006
		Aesthetic	≤0,3				
Lead as Pb (µg/ℓ)	mg/l	Chronic health	≤0,01	<0,004	<0,004	<0,004	<0,004
Manganese as Mn (µg/ℓ)		Chronic health	≤0,4	<0.001	0,305	0,095	0,039
	mg/l	Aesthetic	≤0,1				
Nickel as Ni (µg/ℓ)	mg/l	Chronic health	≤0,07	<0,002	<0,002	<0,002	<0,002
Zinc as Zn	mg/l	Aesthetic	≤5	0,005	0,006	0,013	0,005

9 CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

The site has been zoned as Sludge Disposal area. As part of the evaluation of the site, the environmental risk has been assessed using the potential Source – Pathway – Receptor model of potential contamination. The site assessment includes identification of the potential sources, pathways, and receptors within the context of possible contamination, i.e., a situation where the source(s), pathway(s) and receptor(s) are all present at a site and therefore a real (as opposed to a perceived) risk of potential impact exists.

TABLE 9-1 CONCEPTUAL SITE MODEL

<table>
<tr><th colspan="5">CONCEPTUAL SITE MODEL</th></tr>
<tr><td>Overview</td><td colspan="4">The land use is zoned as Sludge Disposal Site. The neighbouring properties comprise farmers.

The groundwater flow direction inferred from the NGA data in a westerly direction.</td></tr>
<tr><td>Sources</td><td colspan="4">The study area will consist of domestic waste and minor construction waste which is the main source of contamination.

▪ Domestic and Construction waste: Domestic sludge containing organic substances, soaps, hydrocarbons, and high pH maybe found due to the waste on site.

▪ Petrol: MTBE and Benzene concentration may be detected in surface and groundwater due to tracks on site.

▪ Diesel: Hydrocarbons of the paraffinic and naphthenic concentration may be detected in surface and groundwater due to tracks on site.

▪ Dust pollution: Pollution caused by movement of vehicles. The airlifted pollution can infiltrate into the groundwater during rain events.</td></tr>
<tr><td rowspan="4"></td><td>Pathway</td><td colspan="2">Description</td><td>Risk</td></tr>
<tr><td rowspan="2">Groundwater infiltration</td><td>Onsite</td><td>Infiltration of contaminated water into the ground</td><td>Medium</td></tr>
<tr><td>Offsite</td><td>Via shallow groundwater and vertical migration through low to medium permeable shallow soils</td><td>Medium</td></tr>
<tr><td>Vehicle movement</td><td>Surface</td><td>Spillage of oils from heavy vehicles contaminating surface water and soil and creating dust and noise</td><td>Low</td></tr>
<tr><td rowspan="2"></td><td>Receptor</td><td colspan="3">Location</td></tr>
<tr><td>Onsite employees</td><td colspan="3">Workers that are based at Rand Water’s Panfontein Raw Water Residue Site.</td></tr>
</table>

CONCEPTUAL SITE MODEL		
	Offsite residents	Relatively farmers properties located 5km around the study area
	Commercial users	Farmers located in a 5km radium from the site
	Groundwater	Nearest groundwater sources providing water to the farmers area
	Surface waters	The Stream is located 1,7 km north of the site (downstream) and 3,12 km west of the site (downstream)
Pollutant linkages	**Receptor**	**Location**
Groundwater: Source concentration is not likely exceeding impact criteria for the impact to water resources.		
OVERALL ASSESSMENT		**Low to Medium**

10 RISK IMPACT ASSESSMENT

Impacts from the proposed development construction activities on Rand Water's Panfontein Raw Water Residue Site, Panfontein were evaluated and include:

- Impacts on groundwater levels, flow patterns and volumes;
- Impacts on groundwater qualities; and
- Impacts on surface water qualities.

During the risk assessment, the risk to the groundwater levels and quality were evaluated. Each of the identified risks was then rated (Table 10-3).

10.1 Risk Rating Criteria

This section contains a summary and a motivation of the potential interactions and impacts which may be associated with the project activities, specifically related to the hydrogeological specialist field. The identified potential impacts are summarised as follows:

- Groundwater level
- Groundwater Quality

10.1.1 Risk rating criteria

The impacts were rated and ranked based on the system as described below:

- **Magnitude**: is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and was classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely recognized standards were to be used as a measure of the level of impact.
- **Scale/Geographic extent** refers to the area that could be affected by the impact and was classified as site, local, regional, national, or international.
- **Duration**: refers to the length of time over which an environmental impact may occur i.e. transient (less than 1 year), short-term (1 to 5 years), medium term (5 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent.
- **Probability of occurrence** is a description of the probability of the impact occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will occur).

Table 10-1Scaling Risk

Status of Impact	
The impacts are assessed as either having a:	
Negative effect (i.e. at a `cost' to the environment),	
Positive effect (i.e. a `benefit' to the environment),	
Neutral effect on the environment.	
Extent of the impact	Duration of the impact
(1) Site (site only),	1) Immediate (<1 year),
(2) Local (site boundary and immediate surrounds),	(2) Short term (1-5 years),
(3) Regional,	(3) Medium term (5-15 years),
(4) National,	(4) Long term (ceases after the operational life span of the project),
(5) International.	(5) Permanent.
Magnitude of the Impact	Probability of Occurrence
(0) None,	The likelihood of the impact actually occurring is indicated as either:
(2) Minor,	(0) None (the impact will not occur),
(4) Low,	(1) Improbable (probability very low due to design or experience),
(6) Moderate (environmental functions altered but continue),	(2) Low probability (unlikely to occur),
(8) High (environmental functions temporarily cease),	(3) Medium probability (distinct probability that the impact will occur),
(10) Very high / unsure (environmental functions permanently cease.	(4) High probability (most likely to occur),
	(5) Definite.

10.1.2 SIGNIFICANCE OF THE IMPACT

Based on the information contained in the points above, the potential impacts are assigned a significance rating (S). This rating is formulated by adding the sum of the numbers assigned to extent (E), duration (D) and magnitude (M) and multiplying this sum by the probability (P) of the impact.

S= (E+D+M) P

The significance ratings are given below

(<30) low (i.e. where this impact would not have a direct influence on the decision to develop in the area),

(30-60) medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated), (>60) high (i.e. where the impact must have an influence on the decision process to develop in the area).

Table 10-2 Significant colour code

Significance	Environmental Significance Points	Colour Code
High	>60	H
Medium	30 to 60	M
Low	<30	L

TABLE 10-3: RISK RATING

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	AREA APPLICABLE	CORRECTIVE MEASURE	IMPACT RATING CRITERIA						RECOMMENDED MITIGATION MEASURES
				Nature	Extent	Duration	Magnitude	Probability	SIGNIFICANCE	
Pre-Construction										
Hydrological yield	Vegetation removal to clear area for construction	Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during pre-construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.	Yes	Negative	2	1	6	4	36	Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible. ion of water seepage in construction site, drainage system will need to be installed to redirect water away from construction site.
Groundwater quality	Hydrocarbons leakage	Based on NGA and hydrocensus data the site is characterised by shallow groundwater levels, thus hazardous waste such as grease and oil from operational HDV and LDV can impact the groundwater quality in events of spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately the groundwater system especially during rainfall events.	yes	Negative	1	2	5	3	24	Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system. Vehicle found with a leak to be removed from site immediately.

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	AREA APPLICABLE	CORRECTIVE MEASURE	IMPACT RATING CRITERIA						RECOMMENDED MITIGATION MEASURES
				Nature	Extent	Duration	Magnitude	Probability	SIGNIFICANCE	
Construction										
Diversion surface water for dry working conditions on site.	Construction of pipeline	During the construction phase, surface water may be diverted for dry working conditions. The natural surface water flow will be affected.	Yes	Negative	3	1	3	3	21	The design and implementation of the temporary stream diversion should consider the environmental impacts. To reduce the impact on aquatic habitants, various structures must be installed to mimic and protect existing stream environment.
Groundwater quality	Construction of pipeline	Shallow groundwater systems are susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately the groundwater system especially during rainfall events.	Yes	Negative	2	2	6	4	40	Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system. Groundwater Monitoring boreholes should be installed upstream, midpoint and downstream of the site to monitor quality and water level.
Surface water quality	Construction of pipeline	Material from construction flowing into surface water bodies and upstream outbursts and overflow, which may pose a threat and risk to surface water quality.	yes	Negative	2	2	6	4	40	Surface water quality monitoring plan must be implemented to monitor quality and ensure no contamination occurs within the site.
Increase in hydrological yield	Construction of a pipeline	Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.	Yes	Negative	1	2	5	3	24	Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	AREA APPLICABLE	CORRECTIVE MEASURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES
				Nature	Extent	Duration	Magnitude	Probability	SIGNIFICANCE	
OPERATIONAL- PEOPLE RESIDING IN THE HOUSES										
Hydrological yield	Re-vegetation	Vegetation acts as buffer zones and protect soil surface and limit soil erosion.	Yes	Positive	1	2	3	4	24	re-vegetation activities are encouraged during reduce rainfall impact, reduce surface water velocities, enhance infiltration, trap sediments

11 CONCLUSION

Based on the desktop studies, field investigation and assessment of data collected, the following conclusions are made:

- The site is underlain by the Aeolian Sand (Qw) – Deposition of sediment by wind. The site is underlain by Aeolian Sand (Qw) in places.
- Based on the aquifer classification map (Parsons and Conrad, 1998) the aquifer underlying the site is regarded a **"minor aquifer"** with regional yields ranging between 0,5-2,0l/s.
- The site is situated in the **Upper Vaal water Management and falls within C22F Quaternary catchment**.
- The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer is classified as low. Measures need to be taken to ensure appropriate drainage facilities are constructed to prevent the abovementioned issues.
- Seven (7) boreholes were identified from the NGA data all within a 5-kilometre radius from the of the investigated site. Groundwater level range is between 2,31 mbgl and 16,75 mbgl. The water levels were recorded between 1930 and 1969.The site is therefore underlain by a very shallow groundwater table.
- During Hydrocensus three (3) boreholes and canal were visited within a 5km radius of the investigated site. Observations regarding the borehole location, construction, water level and status and current usage was noted.
- Ground water and surface water quality results indicated that all analysed constituents were below SANS 241:2015 standard limits and DWAF Water Quality Guidelines (Livestock Watering) Target Quality Range except for Turbidity (NTU), E coli and T coli.
- Ground water and surface water results indicated that the water from these sources is not suitable for human consumption. Water treatment is recommended before any human consumption.
- **Groundwater Risk Assessment:** Groundwater level and quality has a low to medium possible risk impact.
- **Preconstruction:**
  - Based on NGA data the site is characterised by shallow groundwater level that is susceptible to contamination inflow especially in heavy rainfall events. Groundwater Monitoring boreholes should be installed upstream and downstream of the site to monitor groundwater quality.
  - The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system.

- Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
- Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff.
- Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.

- **During construction:**
  - During the construction phase, surface water may be diverted for dry working conditions. The natural surface water flow will be affected. The design and implementation of the temporary stream diversion should consider the environmental impacts. To reduce the impact on aquatic habitants, various structures must be installed to mimic and protect existing stream environment.
  - The shallow groundwater system more susceptible to contamination inflow during construction. Spillages of diesel from earthmoving machinery or construction material is likely to infiltrate the ground and ultimately enter the groundwater system. - Ensure regular inspection of earthmoving vehicles to prevent fuel spillages. Storage of construction material should comply with required regulations and Environmental Management Programme) for storage of construction material to prevent any infiltration of contaminated waste into groundwater system.
  - Vegetation cover impedes the flow of water reducing the rate of surface runoff and more water infiltrating into the ground. Vegetation cover which will be removed during pre-construction therefore altering the natural flow of water. Due to an increased percentage of bare surfaces, there is a higher potential for hydrological yield thus resulting in more surface runoff. - Vegetation removal must be as minimum as possible. All bare surface areas must be re-vegetated in order to mimic the natural hydrological Yield as much as possible.
  - Material from construction flowing into surface water bodies and upstream outbursts and overflow, which may pose a threat and risk to surface water quality. - Surface water quality monitoring plan must be implemented to monitor quality and ensure no contamination occurs within the site.
  - Continuous groundwater and surface water monitoring is recommending upstream and downstream of the site to monitor quality and water level.
- **After construction:**
  - Re-vegetation - re-vegetation activities are encouraged during reduce rainfall impact, reduce surface water velocities, enhance infiltration, trap sediments.

12 RECOMMENDATIONS

The following recommendation are to be considered:

12.1.1 GROUNDWATER MONITORING PROGRAMME

Groundwater level and quality are required to be continuously monitored to be able to trace and measure possible contaminates that may emanate from the proposed activities and rising of the groundwater levels that may emanate due to recharge of the aquifer.

During groundwater monitoring programme the following information must be recorded as per the Standard Operations Procedure (SOP) for sampling and monitoring groundwater:

- Static water level, prior to sampling.
- Site conditions and Pictures
- Purging volumes and purging time
- Borehole conditions
- In-situ field parameters
- Sampling volumes and preservation methods

12.1.2 SAMPLING GUIDELINES

- The sampling and sample preservation will be undertaken according to the following guidelines:
- "Groundwater sampling: a comprehensive guide for sampling methods", compiled by John M Weaver for the Water Research Commission (WRC Report TT 56/92).
- SABS ISO 5667-11: 1993 Guidance on sampling of groundwater
- SABS ISO 5667-1: 1980 Guidance on the design of sampling programs
- SABS ISO 5667-2: 1991 Guidance on sampling techniques
- SABS ISO 5667-3: 1994 Guidance on the preservation and handling of samples

13 REFERENCES

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- The Hydrogeological Map Series of the Republic of South Africa.
- The 1:250 000,2628 East Rand Geological Map-sheet.
- Satellite images, provided by Google Earth.
- Parsons, RP and Conrad, J. (1998). Explanatory Notes for the Aquifer Classification Map of South Africa. Water Research Commission Report No KV 116/98.
- Aquifer Classification Map of South Africa, Department of Water Affairs, 2012.
- GRDM, Groundwater Resource Directed Measures, GRDM Training Manual, 2010.
- Aquatico Scientific, 2022. Rand Water Panfontein Raw Water Residue Site Groundwater Impact Assessment Report.

APPENDICES

APPENDIX A: LABORATORY RESULTS

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0685

Test Report

Client: ARIYS CONSULTING
Address: Oxford Office Park, 30 Bauhinia Street, Highveld Techno Park , Centurion, 016
Report no: 223275
Project: Panfontein

Date of report: 06 June 2025
Date accepted: 30 May 2025
Date completed: 05 June 2025
Date received: 30 May 2025

Lab no:					259125	259126	259127	259128
Date sampled:					26-May-25	26-May-25	26-May-25	26-May-25
Aquatico sampled:					No	No	No	No
Sample type:					Water	Water	Water	Water
Locality description:					SRK 1	SRK 2	SRK 6	Canal 01
		Analyses	Unit	Method				
A	AQL	pH @ 25°C	pH	ALM 20	7.46	7.11	6.86	8.93
A	AQL	Electrical conductivity (EC) @ 25°C	mS/m	ALM 20	63.4	23.2	27.9	22.5
A	AQL	Total dissolved solids (TDS)	mg/l	ALM 26	415	128	163	129
A	AQL	Total Alkalinity	mg $CaCO_3$/l	ALM 01	322	99.2	146	72.2
A	AQL	Chloride (Cl)	mg/l	ALM 02	9.61	6.29	0.728	10.1
A	AQL	Sulphate (SO_4)	mg/l	ALM 03	60.4	13.6	9.02	27.1
A	AQL	Nitrate (NO_3) as N	mg/l	ALM 06	0.446	<0.194	0.249	0.323
A	AQL	Total oxidised nitrogen as N	mg/l	ALM 06	0.446	<0.194	0.249	0.323
A	AQL	Ammonium (NH_4) as N	mg/l	ALM 05	0.059	5.03	6.07	0.011
A	AQL	Fluoride (F)	mg/l	ALM 08	<0.263	<0.263	<0.263	<0.263
A	AQL	Acid Soluble Calcium (Ca)	mg/l	ALMA 30	75.7	19.4	30.0	24.6
A	AQL	Acid Soluble Magnesium (Mg)	mg/l	ALMA 30	48.1	9.12	8.89	11.1
A	AQL	Acid Soluble Sodium (Na)	mg/l	ALMA 30	17.1	8.67	8.09	5.85
A	AQL	Acid Soluble Potassium (K)	mg/l	ALMA 30	5.42	4.20	8.21	4.61
A	AQL	Acid Soluble Aluminium (Al)	mg/l	ALMA 31	<0.002	0.012	0.129	0.025
A	AQL	Acid Soluble Iron (Fe)	mg/l	ALMA 31	<0.004	0.278	0.465	0.006
A	AQL	Acid Soluble Manganese (Mn)	mg/l	ALMA 31	<0.001	0.305	0.095	0.039
A	AQL	Acid Soluble Chromium (Cr)	mg/l	ALMA 31	<0.003	<0.003	<0.003	<0.003
A	AQL	Acid Soluble Copper (Cu)	mg/l	ALMA 31	<0.002	<0.002	<0.002	<0.002
A	AQL	Acid Soluble Nickel (Ni)	mg/l	ALMA 31	<0.002	<0.002	<0.002	<0.002
A	AQL	Acid Soluble Zinc (Zn)	mg/l	ALMA 31	0.005	0.006	0.013	0.005
A	AQL	Acid Soluble Cadmium (Cd)	mg/l	ALMA 31	<0.002	<0.002	<0.002	<0.002
A	AQL	Acid Soluble Lead (Pb)	mg/l	ALMA 31	<0.004	<0.004	<0.004	<0.004
A	AQL	E.coli	CFU/100ml	ALM 40	<1	<1	<1	1
A	AQL	Total coliform	CFU/100ml	ALM 40	<1	<1	<1	18

A = Accredited N = Not accredited Sub = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report ; Results relate only to the items received and tested ; Results reported against the limit of detection; Results marked "Not SANAS Accredited" in this report are not covered by the Scope of Accreditation for this laboratory; Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation; The report shall not be reproduced except in full without approval of the laboratory

M. Swanepoel
Technical Signatory

AQL 89 Regency Drive, R21 Corporate Park, Centurion, South Africa Tel: +27 12 450 3800 www.aquatico.co.za
AQK 28 Karee ave, Kathu, Northern Cape, South Africa Tel: +27 53 880 0208 www.aquatico.co.za

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas testing Laboratory T0685

Test Report

Client:	ARIYS CONSULTING	**Date of report:**	06 June 2025
Address:	Oxford Office Park, 30 Bauhinia Street, Highveld Techno Park , Centurion, 016	**Date accepted:**	30 May 2025
Report no:	223275	**Date completed:**	05 June 2025
Project:	Panfontein	**Date received:**	30 May 2025

Lab no:					259125	259126	259127	259128
Date sampled:					26-May-25	26-May-25	26-May-25	26-May-25
Aquatico sampled:					No	No	No	No
Sample type:					Water	Water	Water	Water
Locality description:					SRK 1	SRK 2	SRK 6	Canal 01
		Analyses	**Unit**	**Method**				
A	AQL	Turbidity	NTU	ALM 21	53.7	85.2	926	10.6
A	AQL	Total hardness	mg $CaCO_3$/l	ALM 26	387	86	112	107
A	AQL	Total organic carbon (TOC)	mg/l	ALM 63	2.40	2.49	13.3	13.3
A	AQL	Langelier Saturation Index	LSI	ALM 26	-0.20	-1.60	-1.50	0.19

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