



# 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**

Storm Water Management Plan Report 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	Storm Water Management Plan Report 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	Sbongiseni Christian Mazibuko
Specialist Identity Number	861001 5713 082
Specialist Qualifications:	Masters of Science in Hydrology
Professional affiliation/registration:	SACNASP Pr. Sci. Nat: 011204
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

**SPECIALIST DECLARATION FORM – AUGUST 2023**

---

E-mail

[info@ariys.co.za](mailto:info@ariys.co.za) / [Fhatani@ariys.co.za](mailto:Fhatani@ariys.co.za)

## SPECIALIST DECLARATION FORM – AUGUST 2023

---

### 2. DECLARATION BY THE SPECIALIST

I, Sbongiseni Christian Mazibuko 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 on  here to enter text.

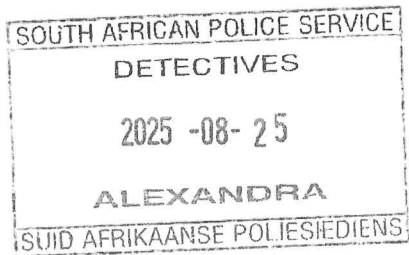
---

Signature of the Commissioner of Oaths

22/08/2025  
Click on  here to enter date.

---

Date





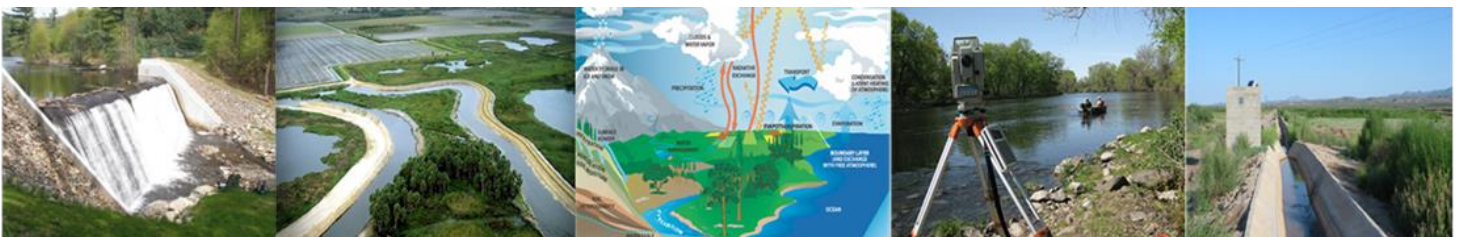
**Storm Water Management Plan for the proposed construction and maintenance of New System 1 at Rand Water Vereeniging Treatment Works, installation of approximately 7 km phase 2 Sludge Pipeline in Vereeniging, 1.5 km sludge line in Panfontein and associated infrastructure within the jurisdiction of Sedibeng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

**Report: Version – 1<sup>st</sup>**

**30 July 2025**




**Client Reference: Rand Water New System 1 and Sludgelines –  
Storm Water Management Plan**



**Storm Water Management Plan 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.**

**Report**

**DOCUMENT VERIFICATION**

<b>TITLE:</b> Rand Water New System 1 and Sludgelines’ – Storm Water Management Plan			
<b>Report Number</b>			
<b>Date</b>		30 July 2025	
<b>Report Version</b>		First	
<b>Verification</b>	<b>Name</b>	<b>Signature</b>	<b>Date</b>
Author	Sbongiseni Mazibuko (Hydrologist) <i>Pr. Sci. Nat: 011204</i>		30 July 2025

**Prepared By:**



Ariys Consultant (Pty) Ltd.  
Block 30, Oxford Office Park,  
3 Bauhinia Street, Highveld Techno Park, Centurion  
0157  
[info@ariys.co.za](mailto:info@ariys.co.za)

**Prepared For:**



Selahle Consultancy and Projects(Pty) Ltd.  
1249 Tamarin Street, Blue Hills  
Midrand  
1685  
[admin@scprojects.co.za](mailto:admin@scprojects.co.za)

*This report is provided solely for the purposes set out in it and may not, in whole or in part, be used for any other purpose without Ariys Consultant’s prior written consent*

---

**LIST OF ACRONYMS**

ALOS	Advanced Land Observing Satellite
BA	Basic Assessment
BPGs	Best Practice Guidelines
EIA	Environmental Impact Assessment
DEM	Digital Elevation Model
DWS	Department of Water and Sanitation
JAXA	Japanese Aerospace Exploration Agency
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
NEMA	National Environmental Management Act
NWA	National Water Act
NWRS	National Water Resource Strategy
QGIS	Quantum Geographical Information System
SAWS	South African Weather Station
SCS	Soil Conservation Services
SWMP	Storm Water Management Plans
WR2012	2012 South African Water Resources Study
WTW	Water Treatment Works

**CONTENTS PAGE**

**1 INTRODUCTION ..... 1**

    1.1 BACKGROUND..... 1

    1.2 PURPOSE ..... 1

**2 SCOPE OF WORK ..... 5**

    2.1 ASSUMPTIONS AND LIMITATIONS ..... 5

**3 METHODOLOGY ..... 6**

    3.1 DESKTOP STUDY AND SITE VISIT..... 6

    3.2 BASELINE HYDROLOGY..... 6

    3.3 STORM WATER MANAGEMENT PLAN..... 7

**4 DESKTOP ASSESSMENT ..... 8**

    4.1 DATA USED ..... 8

    4.2 LEGISLATION AND GUIDELINES ..... 8

        4.2.1 *National Legislation*..... 8

**5 BASELINE HYDROLOGY..... 10**

    5.1 CLIMATE AND HYDROLOGICAL SETTINGS ..... 10

    5.2 DRAINAGE PATTERNS..... 10

    5.3 RAINFALL AND EVAPORATION..... 13

    5.4 DESIGN RAINFALL ..... 13

**6 CONCEPTUAL STORMWATER MANAGEMENT PLAN..... 16**

    6.1 PRINCIPLES AND LEGISLATIVE FRAMEWORK..... 16

    6.2 EXISTING STORMWATER NETWORK..... 16

    6.3 WATER MANAGEMENT SYSTEM..... 17

    6.4 WATER CLASSIFICATION SYSTEM..... 17

    6.5 CONSTRUCTION SITE ACCESS ROUTES ..... 18

    6.6 MITIGATION MEASURES ..... 18

**7 STORMWATER MANAGEMENT MONITORING AND MAINTENANCE..... 20**

    7.1 MONITORING ..... 20

    7.2 MAINTENANCE ..... 20

**8 RECOMMENDATIONS AND CONCLUSIONS ..... 23**

    8.1 RECOMMENDATIONS ..... 23

    8.2 CONCLUSIONS ..... 24

**9 REFERENCES ..... 25**

**10 APPENDICES..... 26**

    10.1 DETAILED SLOPE PATTERNS FOR THE SITES..... 26

**LIST OF FIGURES**

Figure 1-1: Study locality ..... 2

Figure 1-2: Locality of Rand Water VG New System 1 infrastructure ..... 3

Figure 1-3: Locality of Panfontein Water Treatment Residue site..... 4

Figure 5-1: Average minimum and maximum temperatures for Vereeniging ..... 10

Figure 5-2: Slope analysis across the two project sites ..... 11

Figure 5-3: Sub-drainage areas and flow direction around VG New System 1 infrastructure ..... 12

Figure 5-4: Sub-drainage areas and flow direction surrounding the Panfontein area ..... 12

Figure 5-5: Seasonal distribution of rainfall and evaporation (Bailey and Pitman, 2015) ..... 13

Figure 5-6: Design rainfall depths for Maccauvlei SAWS station..... 15

**LIST OF TABLES**

Table 4-1: NEMA Government Notices that are applicable to this study ..... 9

Table 5-1: Monthly evaporation for the study area..... 13

Table 5-2: Summary of the five closest SAWS rain stations used in the Design Rainfall Estimation ... 14

Table 5-3: Summary of the design rainfall depths for various return periods ..... 14

Table 6-1: Water classification areas for the project ..... 17

Table 7-1: Proposed management plans and actions..... 21

Table 7-2: Proposed mitigation measures for the identified impacts of the three phases ..... 22

---

## **1 INTRODUCTION**

### **1.1 Background**

Ariys Consulting (Pty) Ltd was appointed by Selahle Consultancy and Projects (Pty) Ltd to undertake a conceptual Stormwater Management Plan (SWMP) 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 sludgeline in Panfontein Water Treatment Water Residue Site within the jurisdiction of Sedibeng District Municipality, Gauteng Province of South Africa (Figure 1-1). The construction activities and operation of the proposed system have the potential to impact the water quality of the surrounding area due to improper planning of the stormwater within the project area through increased suspended solids and uncontrolled spillages of chemical elements.

This study, therefore, aims to conceptualise and draft an efficient SWMP that will ensure that there is no increased overland runoff, erosion and contamination of the surrounding surface water receptors of the proposed infrastructure by the Vaal River. This SWMP was drafted in accordance with Best Practice Guidelines: G1 for Storm Water Plan (DWAF, 2006). Results from this study will provide specialist inputs in support of the Basic Assessment (BA) requirements for the 2014 (as amended) Environmental Impact Assessment (EIA) Regulations in terms of the National Environmental Management Act (NEMA Act 103 of 1998 - as amended) as well as to support Water Use Licence Application (WULA) required in terms of the National Water Act (NWA) (Act No. 107 of 1998). These listed compliance requirements are agreed upon based on the study's scope and terms of reference.

### **1.2 Purpose**

This SWMP contributes towards Rand Water's New System 1 upgrades in Vereeniging (Figure 1-2) and Panfontein Water Treatment Residue site (Figure 1-3), comprising a bulk sludge pipeline that consists predominantly of concrete pipes. This study, therefore, aims to develop a conceptual SWMP for the construction phase, covering all aspects from commencement until operation. The ultimate objectives are the control of stormflow on the Water Treatment Works (WTW) site and the prevention of erosion and sediment deposition into the project's surrounding water systems. The methodology adopted for this SWMP was to specify objectives, potential problems and mitigation measures that the contractor would have to implement during construction.

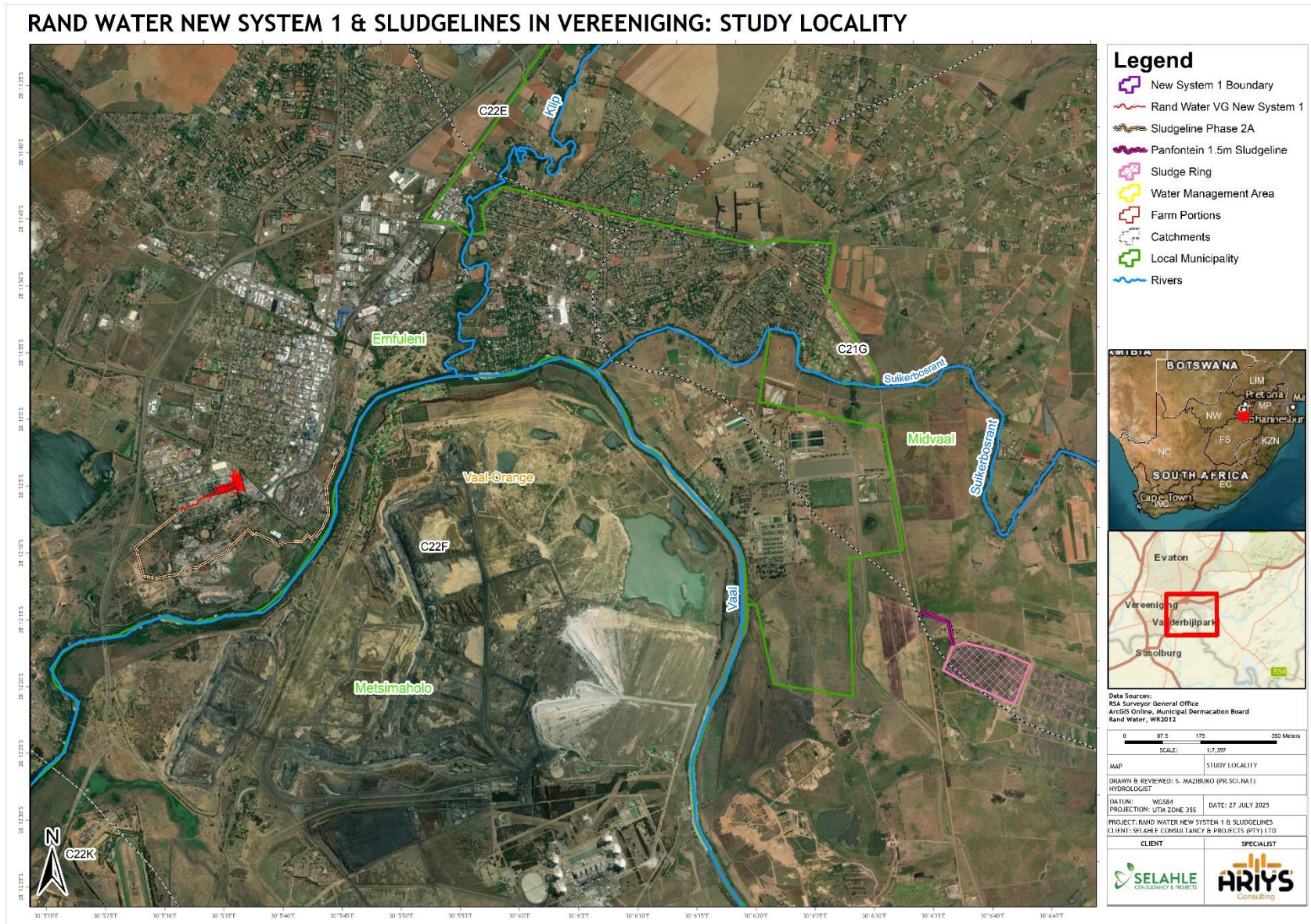


Figure 1-1: Study locality

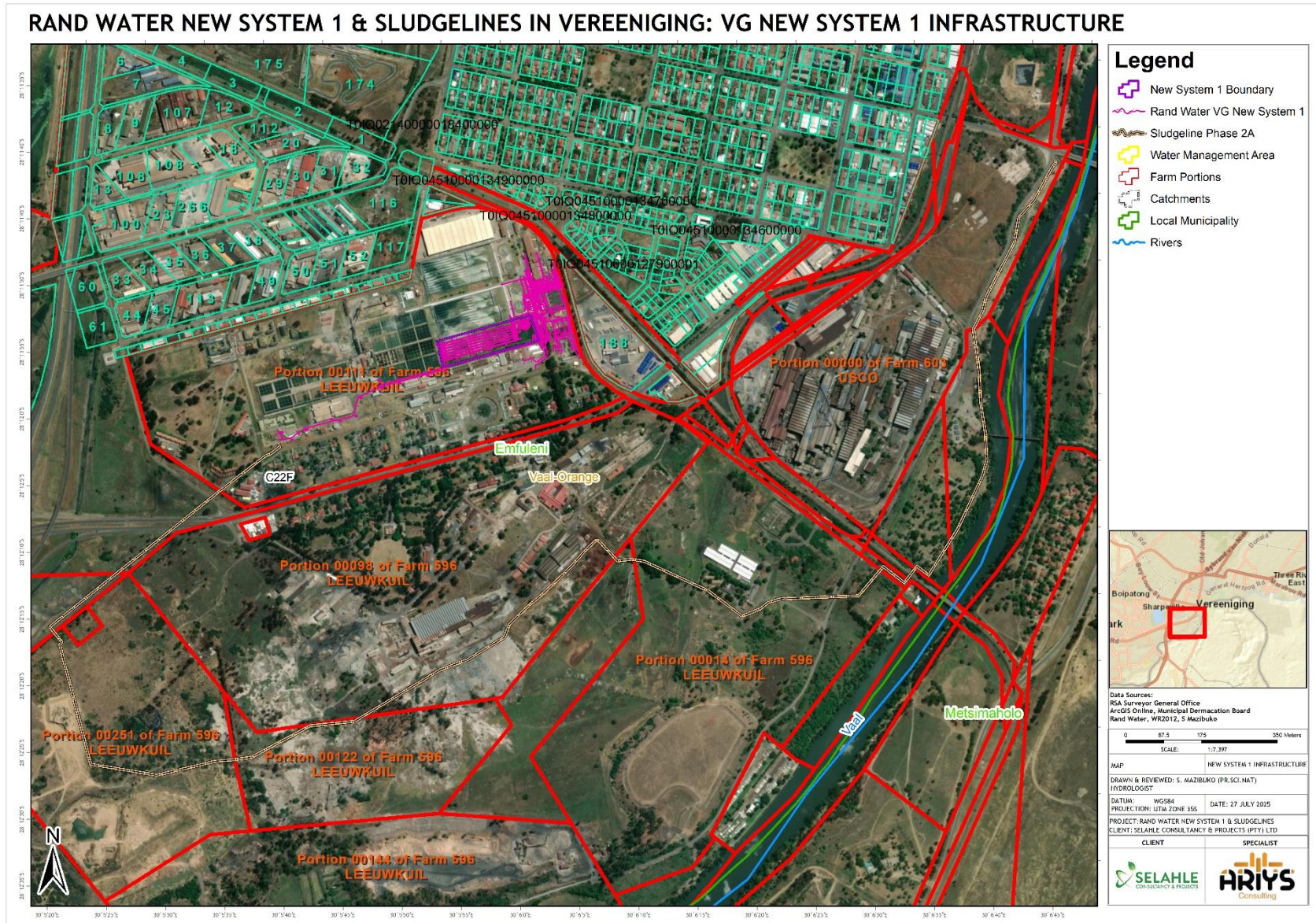


Figure 1-2: Locality of Rand Water VG New System 1 infrastructure

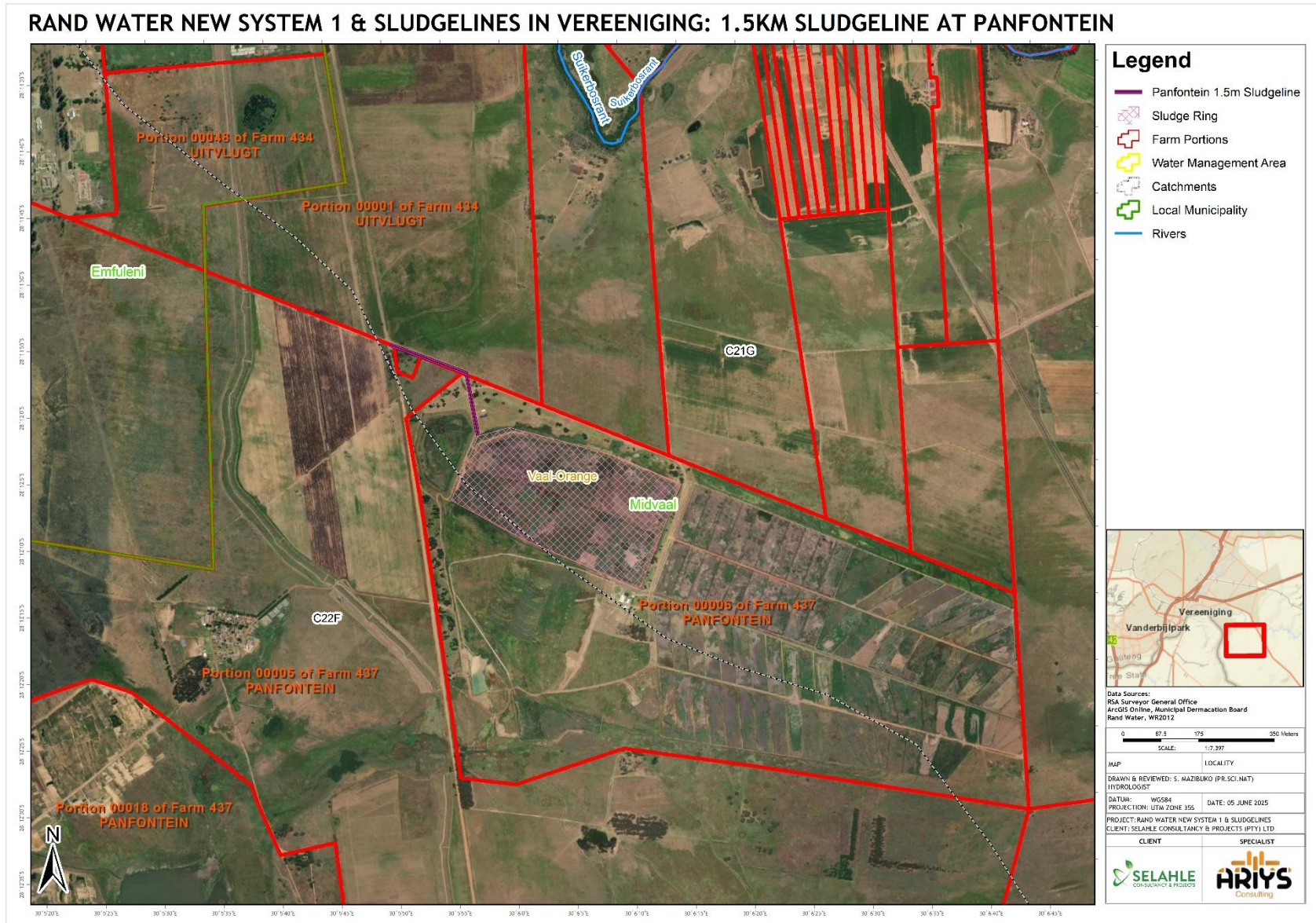


Figure 1-3: Locality of Panfontein Water Treatment Residue site

## 2 SCOPE OF WORK

The scope of work for the water balance study is defined as follows:

1. Baseline Hydrology and Drainage Characterisation:
  - Hydroclimatic characterisation, sub-catchment delineation, and the design rainfall.
2. Conceptual Storm Water Management Plan:
  - Identification of clean water areas;
  - Sizing and conceptual design of the stormwater management system, and
  - Draft stormwater management plan.
3. Reporting:
  - A report deliverable that presents the detailed results of the activities mentioned above and the recommendations will be made based on the study's findings.

### 2.1 Assumptions and Limitations

The following constraints may have affected this hydrological assessment:

- The 30 m ALOS DEM and 5 m contour data combination delineated the sub-catchments likely to generate runoff across the project area. Limitations of high-resolution survey data can directly affect the sizes of the delineated sub-catchment areas as well as the resulting peak runoff volumes.
- The stormwater management plan presented in this study is considered conceptual, and detailed civil engineering designs should be conducted before any construction activities for the proposed measures commence.
- Visual assessment of the project site during the site visit, aerial survey data provided as part of the project, and satellite imagery retrieved through Google Earth Pro were used to establish an understanding of drainage patterns and features that are likely to affect storm water generation, movement and elements that might be affected by the proposed development.
- The results of this study are for the purposes of planning, construction activities, Basic Assessment and Environmental Impact Assessment.

---

### **3 METHODOLOGY**

#### **3.1 Desktop Study and Site Visit**

A site walkover was conducted on the 26<sup>th</sup> of May 2025 to identify elements that might be affected due to the proposed activities associated with the construction of the 7 km long sludge pipeline phase 2A, and sludge ring and 1.5 km sludgeline at Panfontein. During this site visit, the existing plant, canals, and land cover were assessed to establish the essential stormwater-related factors for this study. This included the sludge line and the Vaal and Suikerbosrant's riparian reaches, which were also evaluated to identify features that may be affected by construction activities.

Applicable local, regional and national regulations and best practice guidelines relating to the construction of Rand Water's WTW facilities were reviewed. This review aimed to ensure that the proposed developmental activities comply with relevant and up-to-date laws and that plans such as the SWMP are derived in a manner that aligns with the best practices set by the Department of Water and Sanitation (DWS). As part of environmental protection and sustainably conducting infrastructure development, relevant legislation and guidelines for evaluating the identified impacts on the surrounding environment were developed so that they comply with regulations enacted to protect the environment.

Hydrometeorological data used to define the expected hydrological regimes of the development site were collected and analysed to formulate a baseline understanding of local drivers of hydrological processes. Satellite imagery retrieved via Google Earth Pro was used to derive land catchment characteristics that describe the existing conditions, which could affect the calculation of the peak flow volumes and elements that could be affected.

#### **3.2 Baseline Hydrology**

Baseline hydrometeorological data describing the regimes for the area were obtained from the South African Water Resources Study WR2012 database (Bailey and Pitman, 2015). The Daily Rainfall Data Extraction Utility (Lynch, 2004) was used to extract the design rainfall depth expected for the area with varying return period events. These range from 1:2 to 1:50-yr return periods. The combination of these data provided means to estimate the study site's long-term Mean Annual Precipitation (MAP) and the expected design rainfall depth for the project site. The 5 m contour data were used to delineate sub-catchment areas draining the stormwater runoff and its corresponding flow direction. This was aimed at conceptually developing an understanding of the expected overland runoff patterns after heavy storm events. This is vital in ensuring that slope aspects of the project area and their relative effects are adequately understood in relation to the stormwater plan and management.

### **3.3 Storm Water Management Plan**

The conceptual stormwater management plan for the proposed construction activities seeks to achieve certain objectives based on a philosophy of protecting the environment from potential impacts that might arise on the surrounding surface water resources. This can be achieved using the following general guidelines:

- Illustrate all sub-catchment areas that generate stormwater and their relative preferential overland runoff flow paths,
- Attenuate stormwater back to the natural environment, and
- Maintain the downstream water quality and quantity requirements.

---

## 4 DESKTOP ASSESSMENT

The following sub-sections present the dataset and information obtained during the desktop phase of the hydrological assessment study.

### 4.1 Data Used

The following dataset and tools were used to derive the results of the study:

- **5 m contour data** – for defining the topography of the project area,
- **KMZ files** – for the location and placement of the proposed infrastructure development,
- **DWG files** - for the retrieval of system design drawings for the infrastructure,
- **WR2012 dataset** – defining hydrological regimes of the study site,
- **QGIS** – Editing spatial data and mapping, and
- **Google Earth Pro** – for retrieving satellite imagery dated January 2023.

### 4.2 Legislation and Guidelines

#### 4.2.1 National Legislation

##### 4.2.1.1 Constitution of the Republic of South Africa

Constitution of the Republic of South Africa, 1996 (Act 108 of 1996) – The Bill of Rights states that everyone has the right to an environment that is not harmful to their health or well-being. As such, the State must respect, protect, promote and fulfil everyone's social, economic and environmental rights.

##### 4.2.1.2 The National Water Act

The National Water Act (NWA) requires that the quality of water resources be protected, as well as the integrated management of water resources. The purpose of the Act is to ensure that the nation's water resources are protected, used, developed, conserved and managed in ways which take into account (relevant to this study):

- Protecting aquatic and associated ecosystems and their biological diversity, and
- Reducing and preventing pollution and degradation of water resources.

Section 19 of the National Water Act (Act No. 36 of 1998) (NWA) sets out the principles for “an owner of the land, a person in control of the land or a person who occupies or uses land” to:

- Cease, modify or control any act or process causing pollution,
- Comply with any prescribed waste standard or management practice,
- Contain or prevent the movement of pollutants,

- Eliminate any source of pollution,
- Remedy the effects of the pollution, and
- Remedy the effects of any disturbance to the bed and banks of a watercourse.

Section 26 (1) of the NWA provides for the development of regulations that:

- Regulate or prohibit any activity to protect a water resource or in-stream or riparian habitat, and

#### 4.2.1.3 National Environmental Management Act

The National Environmental Management Act (Act 107 of 1998 (NEMA) sets out the duty of care principle, which applies to all types of pollution that might arise as a result of the proposed developments and must be considered in considering any aspects of potential environmental degradation. Every person who causes has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise the negative impacts and rectify such pollution or degradation of the environment. Appendix 6 of the Government Notice (GN 326) of EIA Regulations 2017 (given in Table 4-1) governs hydrological impact assessments, to which this study conforms.

**Table 4-1: NEMA Government Notices that are applicable to this study**

<b>Listing Notice 1, GNR 983 of 4 December 2014 (as amended GN517, 11 June 2021)</b>		
<b>Activity</b>	<b>Description</b>	<b>Applicability</b>
9	The development of infrastructure exceeding 1 000 metres in length for the bulk transportation of water or stormwater – (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more	The sludge line pipe length will exceed the stipulated threshold.
<b>Listing Notice 3 (GNR 985 of 4 December 2014 (as amended GN517, 11 June 2021)</b>		
<b>Activity</b>	<b>Description</b>	<b>Applicability</b>
14(ii), (iv), (vi), (x), (xii),	The development of— (ii) channels exceeding 10 square metres in size; (iv) dams, where the dam, including infrastructure and water surface area, exceeds 10 square metres in size; (vi) bulk storm water outlet structures exceeding 10 square metres in size; (i) dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 10 square metres; or (ii) infrastructure or structures with a physical footprint of 10 square metres or more; where such development occurs— (a) within a watercourse; (c) if no development setback has been adopted, within 32 metres of a watercourse, measured from the edge of a watercourse, excluding the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour.	Construction of stormwater control measures

## 5 BASELINE HYDROLOGY

### 5.1 Climate and Hydrological Settings

The area of the Rand Waters VG New System 1 infrastructure and 7 km Sludgelines site is located in an industrial zone, while the Panfontein Water Treatment Residue site and 1.5km sludgeline are in a relatively rural setting characterised by grassland and dry farming. The area is typically characterised by a temperate climate (Cwb) (Kottek, 2006), which experiences dry, cold winters and wet, periodic summers. Long-term-average temperature records for a station located in Vereeniging indicate that the coldest month (July) experiences a minimum of 5°C, while hot summers record the maximum temperature of 28°C (see Figure 5-1).

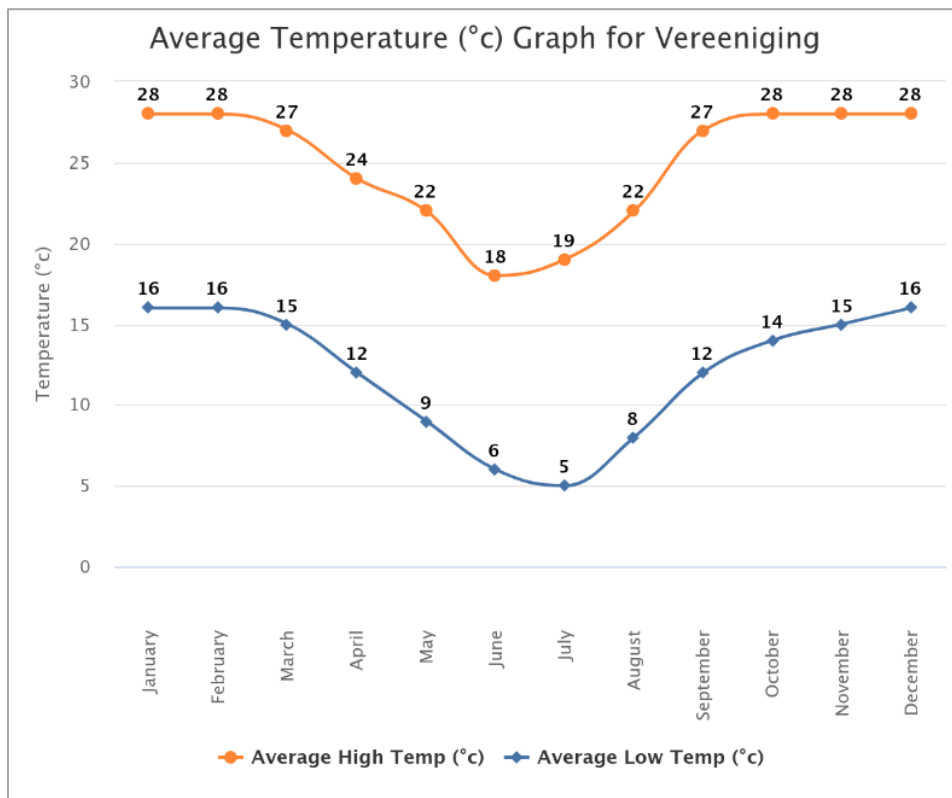
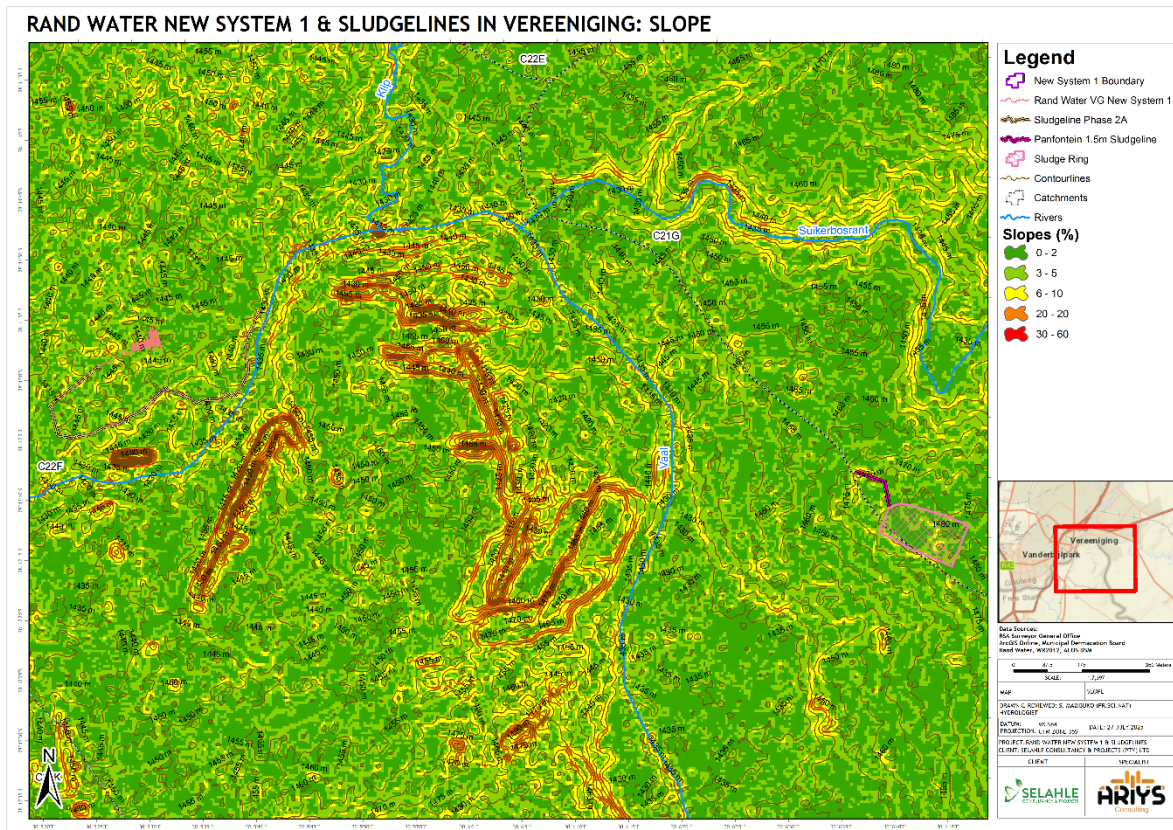


Figure 5-1: Average minimum and maximum temperatures for Vereeniging

### 5.2 Drainage Patterns

The majority of the project falls across quaternary catchments C22F, while a segment of the Panfontein Water Treatment Residue site is on C21G of the Upper Vaal River, which forms part of the Vaal-Orange Water Management Area (WMA). Vaal River is the main channel that collects runoff, and the Suikerbosrant is a tributary flowing north of the Panfontein site. Along the project area, slopes are relatively flat, ranging between 2 and 10% rise in elevation – based on the 30m ALOS Digital Simulation Model (DSM) shown in Figure 5-2. Detailed slope patterns for the two sites are shown in Appendix 10.1.



**Figure 5-2: Slope analysis across the two project sites**

Satellite imagery and 30 m topographic data were all used to identify water flow paths draining water in the areas of the proposed development. Slope patterns and their associated surface water flow direction show that the area surrounding the Rand Water VG New System 1 infrastructure will drain its stormwater in the westerly direction, while along the 7 km sludgeline, flow is expected towards the riparian reaches of the Vaal River. The Panfontein Water Treatment Residue site is in the sub-drainage boundary, which drains away from the highly elevated drying beds towards Suikerbosrant (northerly) and Vaal River (south and westerly). The drainage patterns identified are mapped in Figure 5-3 and Figure 5-4.

The VG New System 1 Infrastructure area is characterised by an urban and industrial setting with a larger proportion of the area cemented. A large volume of storm runoff in this area is expected to be generated from large buildings' rooftops and paved surfaces. The existing stormwater drains, which discharge to the municipal drainage system for conveyance, collect this runoff. On the Panfontein site, the area is predominantly in a neutral grassland state with historical patches of soil disturbances through farming. In this area, soils are less compacted, and they enhance infiltration with consideration of the dominant slopes. Stormwater drains to the natural flow paths towards the Vaal River and Suikerbosrant.

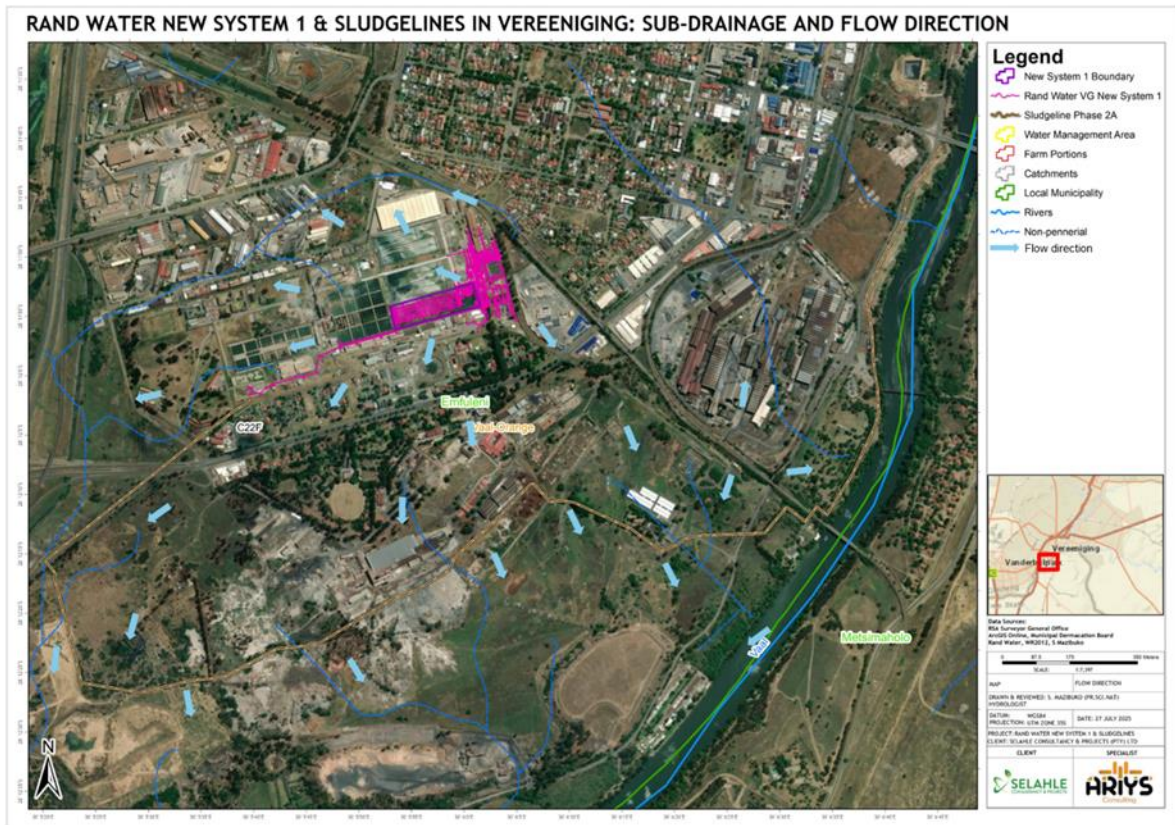


Figure 5-3: Sub-drainage areas and flow direction around VG New System 1 infrastructure



Figure 5-4: Sub-drainage areas and flow direction surrounding the Panfontein Area

### 5.3 Rainfall and Evaporation

Catchment average-based rainfall records from the 90-year record WR2012 study (Bailey & Pitman, 2015) indicate that the quaternary catchment C22F area experiences a Mean Annual Precipitation (MAP) of 655 mm while the Mean Annual Evaporation (MAE) is 1 500 mm. The statistical distribution of monthly rainfall and evaporation is presented in Figure 5-5 and Table 5-1 indicates monthly evaporation values. The graphic shows that rainfall is the highest from November through February.

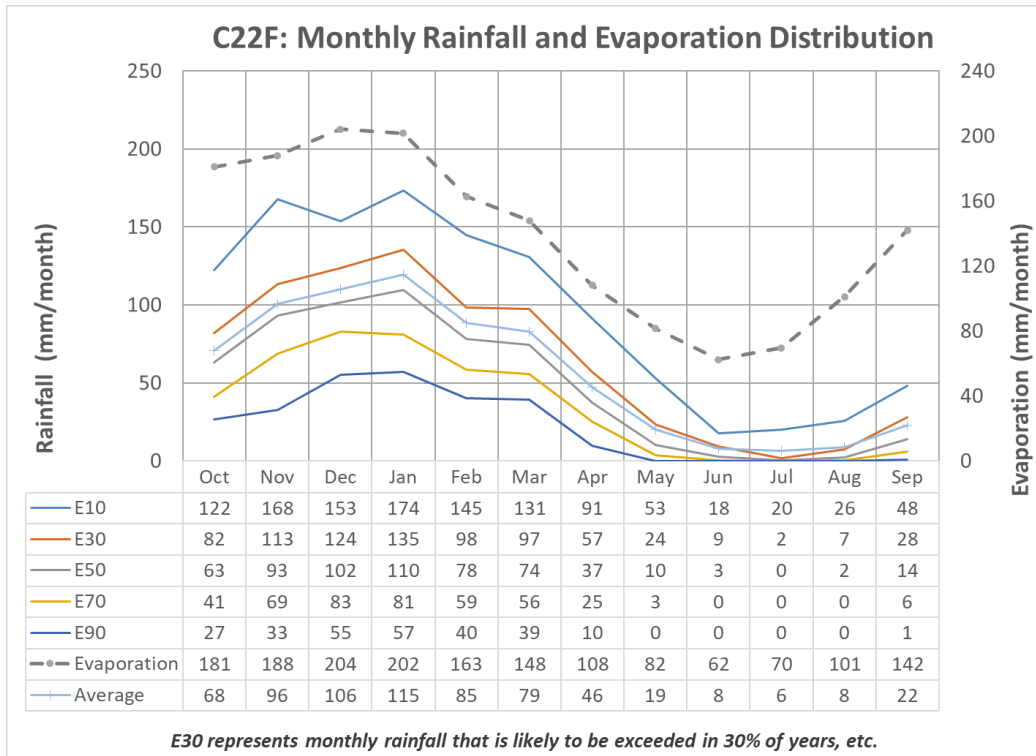


Figure 5-5: Seasonal distribution of rainfall and evaporation (Bailey and Pitman, 2015)

Table 5-1: Monthly evaporation for the study area

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
181	188	204	202	163	148	108	82	62	70	101	142

### 5.4 Design Rainfall

The design storm rainfall depths were obtained from the design rainfall software (Smithers and Schulze, 2003). The program is able to extract the storm rainfall depths for various return periods for the closest rainfall stations, as summarised in Table 5-2. These data contain patched rainfall data from the South African Weather Services (SAWS) stations. It was concluded that the Maccauvlei (highlighted) was the most suitable for this study due to its record and proximity and its storm depths (for 24-hour events) are given in Table 5-3. The cumulative rainfall record for various statistical storm return periods is graphically presented in Figure 5-6.

**Table 5-2: Summary of the five closest SAWS rain stations used in the Design Rainfall Estimation**

Station Name	SAWS No.	Distance (km)	Record (yrs)	MAP (mm)	Altitude (mamsl)
<b><u>MACCAUVLEI</u></b>	<b><u>0438791_W</u></b>	<b><u>0</u></b>	<b><u>45</u></b>	<b><u>641</u></b>	<b><u>1 442</u></b>
VEREENIGING-LESLIE	0438760_W	4	36	682	1 440
RAND WATER-BOARD	0438731_A	5.4	28	673	1 435
VEREENIGING (POW)	0438729_W	6.5	59	691	1 445
VILJOENSDRIFT (POL)	0438734_W	6.5	94	629	1 440

**Table 5-3: Summary of the design rainfall depths for various return periods**

Time	1:2 yr	1:5 yr	1:10 yr	1:20 yr	1:50 yr	1:100 yr	1:200 yr
5 min	10	14	16	18	21	24	26
10 min	15	20	24	27	32	35	39
15 min	19	25	30	34	40	44	48
30 min	24	32	37	43	50	55	61
45 min	27	36	43	49	57	63	69
1 hr	30	40	47	54	63	69	76
1.5 hrs	34	46	54	61	72	79	87
2 hrs	38	50	59	68	79	87	96
4 hrs	44	58	68	78	91	101	111
6 hrs	47	63	74	85	98	109	120
8 hrs	50	67	78	90	104	116	127
10 hrs	52	70	82	94	109	121	133
12 hrs	54	73	85	97	113	126	138
16 hrs	58	77	90	103	120	133	147
20 hrs	60	81	94	108	126	139	154
24 hrs	<b><u>63</u></b>	<b><u>84</u></b>	<b><u>98</u></b>	<b><u>112</u></b>	<b><u>131</u></b>	<b><u>145</u></b>	<b><u>159</u></b>
2 days	65	87	102	117	136	151	166
3 days	73	97	114	130	151	168	185
4 days	79	106	124	142	165	183	202
5 days	85	113	133	152	177	196	215
6 days	90	119	140	160	187	207	228
7 days	94	125	147	168	195	217	238

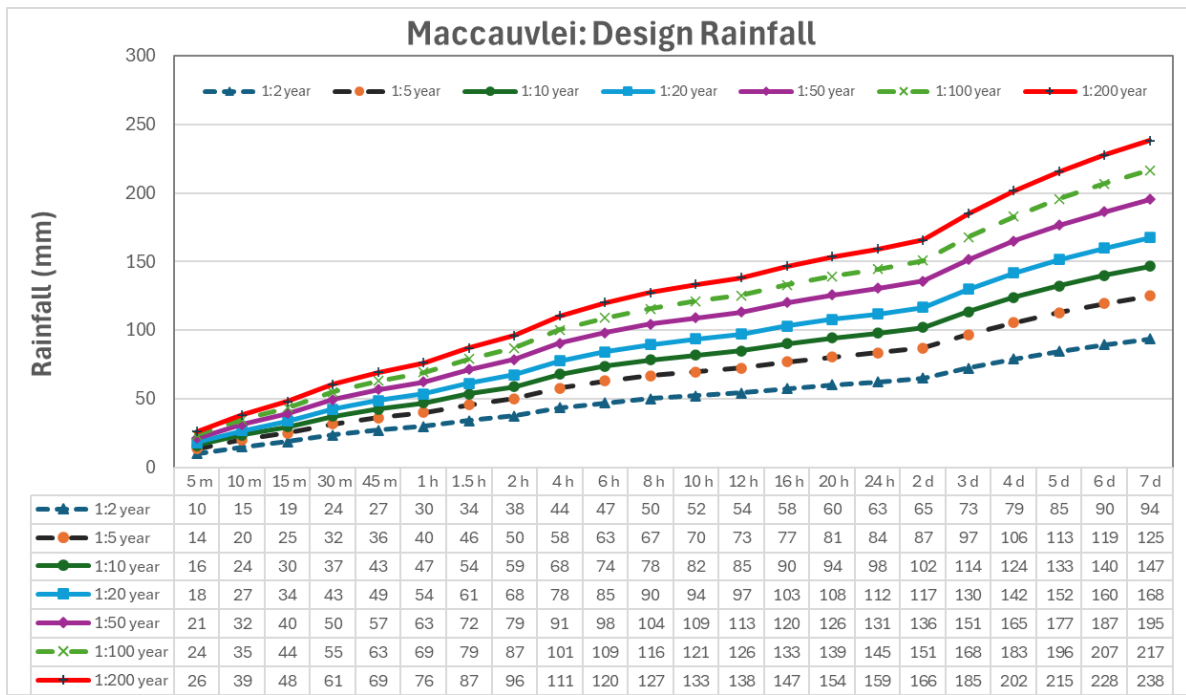


Figure 5-6: Design rainfall depths for Maccauvlei SAWS station

---

## **6 CONCEPTUAL STORMWATER MANAGEMENT PLAN**

A conceptual SWMP for the proposed construction activities was developed, considering the water resources protection principles provided in the NWA (NWA, 1998).

### **6.1 Principles and Legislative Framework**

This SWMP aims to provide guidance on managing stormwater on the construction site. Based on the DWS BPGs principles, a SWMP must prevent pollution, minimise the potential negative impacts of stormwater runoff from the project area on the clean drainage area. The proposed construction activities of the project have the potential to negatively impact the surrounding water resources and environment in the following ways:

- Scheduled earthworks and stripping of vegetation are likely to expose topsoil. During heavy storm events, stormwater can thus contribute to erosion and pollution by increasing levels of suspended solids within local watercourses.
- Storage and use of chemicals and automotive-related pollutants, if not properly managed, could be washed into local watercourses by stormwater, and
- Discharge of polluted or improperly treated stormwater into local watercourses or other clean water systems may occur and if no appropriate prevention measures are implemented, activities related to cement mixing could cause pollution in local watercourses.

An efficient and effective SWMP aims to safeguard and control the conveyance of any storm runoff so that it does not negatively affect the adjacent and/or downstream environment or the watercourse. Where possible, stormwater should be collected into areas where it can be released efficiently using techniques which protect and preserve existing natural drainage areas. Ideally, a SWMP should follow a cautionary approach in being proactive through a holistic analysis of the system, rather than reactive.

### **6.2 Existing Stormwater Network**

An existing stormwater network within the Rand Water WTW area collects all runoff generated on site and routes it into the municipality's stormwater system. It was assumed that roadside drainage lines collect all stormwater along the routes of the developed areas on the proposed sludgeline. In contrast, the undeveloped areas surrounding the Panfontein Water Treatment Residue site do not have existing stormwater infrastructure. Thus, stormwater follows natural drainage patterns to the nearest watercourses.

### 6.3 Water Management System

Categorisation of all water management within the WTW is based on the following principles:

- Clean water areas should be kept clean, as far as possible, and be routed to a natural watercourse while preventing or minimising the risk of spillage of clean water into the dirty water system. Containment of dirty or polluted water could minimise the impact on the surrounding water environment.
- Hazardous chemicals and substances on site must be kept outside the 1:100 year floodline, watercourses or identified wetland, or appropriately bunded to prevent spillages to the clean environment and water systems.
- Stormwater systems must be kept separate from any wastewater systems and the contractor must take all reasonable measures to prevent such occurrences.
- The SWMP must be sustainable over the project's life cycle and different hydrological cycles and incorporate risk management principles. Portions of the SWMP, such as those associated with the affected project footprint, may have to remain after completion since management may be required until such time that the impact is considered negligible and the risk no longer exists.
- Groundcover should be maintained during construction to ensure erosion protection, and flow concentration points should be avoided at unstable soil areas and/or stockpile

### 6.4 Water Classification System

Categorisation of all stormwater management within the project site is based on the assumption that there will be: (i) site establishment, (ii) excavation and trenching, (iii) handling, stockpiling, transportation and disposal of excavated material, (iv) trench shoring and other protection work, (v) preparing of bedding and backfilling, (vi) work area reinstatement and rehabilitation, and (vii) de-commissioning and closure, amongst others. As part of ensuring that water resources are protected in the area, three classification categories were drafted based on the assumed activities that are expected to take place and are summarised in Table 6-1.

**Table 6-1: Water classification areas for the project**

Classification	Area	Comment
Clean	Areas surrounding and along the construction zone	Areas outside the project area are grouped as undisturbed and therefore treated as clean. Only suspended solids to consider

	Site offices, excluding storage areas for chemicals, fuel and other materials with the potential for pollution	Unless connected to an area where oil and other hazardous chemicals are handled, only suspended solids need to be considered.
	Construction areas after reinstatement and rehabilitation	Only suspended solids are to be considered.
Moderately dirty	Temporary access roads	Suspended solids and other contaminants are to be considered
	All construction zone areas and the affected surrounding areas	
	Workshops and contractors' yards (where oil is not handled)	
	Material stockpiles	
	Earthwork and other machinery storage areas	Suspended solids and other contaminants to consider, unless machinery is leaking fluids, in which case higher-level treatment is required
Dirty	Storage areas for chemicals, fuel and other materials with pollution potential	Oils, grease and soap, dissolved and suspended contaminants
	Workshops, wash bays and contractors' yards (where oil is handled)	

## 6.5 Construction Site Access Routes

During the construction period, temporary access roads to the construction site must be treated as a modified dirty water system since there is a possibility of runoff that will route suspended sediments and contaminants to the surrounding environment. In areas where natural runoff is to be collected by side drains, this water must be routed through suitable outlet structures to attenuate and dissipate potential energy in the water flow. Necessary erosion protection measures to be implemented to prevent erosion along the natural drainage channels and along the existing or culverts that might be constructed.

## 6.6 Mitigation Measures

A summary of the measures developed to ensure compliance with legislative and design standards for stormwater management plans is presented below, with additional mitigation measures that are also recommended to reduce further residual impacts on the surface water quality and quantity:

### *Construction Phase*

- In case of accidental spillages of oils, hydrocarbons, and hazardous waste, emergency response procedures (e.g., spillage control kits) should be implemented to contain and dispose of the spillage immediately.

- 
- The scheduling of earthworks should be implemented to minimise the footprint at risk of erosion at any given time, or work should be scheduled according to the season. In the case of linear earthworks, phasing of construction areas and progressive rehabilitation must be implemented to minimise the footprint of the extent of the disturbance at any given time, ensuring that overland runoff is reduced and infiltration is enhanced.
  - Construction material on site and removed topsoil must be stored in minimally designated areas to reduce contamination, compaction and erosion (thus must be vegetated).

#### *Operational Phase*

- In case of an accidental discharge of an untreated effluent that could result in the pollution of surface water resources, the emergency response procedure should be implemented.
- Regular monitoring and maintenance of stormwater management infrastructure to ensure efficiency and reduce environmental spillages to the clean environment.

#### *Decommissioning Phase*

- A post-rehabilitation audit should be undertaken during the closure to ascertain whether the landscape and surface water quality rehabilitation has been successful. If not, further measures should be recommended and implemented.
- Designated areas for demolition vehicles must have adequate pollutant storage such that any accidental oil, fuel, and grease spillages are contained and disposed of accordingly before further contaminating the environment through contact with areas susceptible to overland runoff.
- Schedule demolition during the dry season to ensure less erosion of the contaminated soils that may increase siltation and contaminate the downstream water resources. To minimise the flow alteration, the infrastructure's demolition should be scheduled to ensure that the heavy machinery track is kept to a minimum.
- Rehabilitation must ensure that indigenous vegetation is seeded and re-vegetated repeatedly until it becomes sustainable, such that the natural preferential flow into the environment is restored. This will help the catchment to restore its hydrological processes and other environmental dynamics associated with it.

---

## **7 STORMWATER MANAGEMENT MONITORING AND MAINTENANCE**

### **7.1 Monitoring**

During the project's construction phase, an appointed environmental compliance officer must regularly monitor the implementation of the stormwater plan. It is recommended that monitoring and mitigation measures be implemented after storm events in case the SWMP infrastructure is compromised. Special attention must be given to the following aspects when it comes to efficient monitoring of the SWMP system:

- Implementing temporary attenuation and runoff routing measures to retain and redirect surface runoff as necessary,
- Fencing or taping off “no-go zones” to prevent construction vehicles in undisturbed areas might increase compaction and the generation of suspended sediments,
- Monitoring dust generation (suppress), erosion, topsoil stockpile locations and handling procedures,
- Determining if temporary berms and cut-off drains are required, dependent on the construction activities of the project, and
- Adheres to separating clean and dirty water systems to ensure they do not mix.

### **7.2 Maintenance**

Depending on the duration of the project's construction phase, it is essential and recommended that overland runoff and potential erosion sites be monitored, controlled and mitigation measures be implemented during this period. This can be ensured through the following:

- Clearing and keeping drains and outlets clean,
- Removal of silts from strategic accumulation points, and
- Re-vegetating disturbed areas and controlling potential manifestations of alien invasive plants.

Is it envisaged that maintenance must be continued during the project's operation to ensure the construction footprints are routinely maintained by monitoring the three elements highlighted above. A summary of the management plans and actions are given in Table 7-1 and Table 7-2.

**Table 7-1: Proposed management plans and actions**

Activity	Management Actions	Standard
<b>Construction Phase</b>		
<p>Site establishment and infrastructure development</p>	<ul style="list-style-type: none"> <li>• Demarcate areas prior to commencement of the construction to minimise construction footprints and control the edge effects from construction activities, ensure that vegetation clearing is kept at a minimum and implement erosion control measures.</li> <li>• Undertake construction during the low flow season, implement rehabilitation activities to address temporary disturbance, and implement stormwater management measures, including water energy dispersers at outlet points, to minimise erosion.</li> <li>• The necessary erosion prevention and protection mechanisms must be employed to ensure the sustainability of structures and activities and to prevent sedimentation within the watercourses.</li> <li>• Any area where active erosion is observed must be immediately rehabilitated in such a way as to ensure that the hydrology of the area is re-instated to conditions which are as natural as possible.</li> <li>• Implement monitoring programs for surface water, and all structures must be inspected regularly for accumulation of debris, blockage, instabilities, erosion of abutments and overflow areas – debris must be removed, and damages must be repaired and reinforced immediately.</li> </ul>	<p>BPG G1 and G3; Section 19, NWA; and Section 30, NEMA</p>
<b>Operational Phase</b>		
<p>Transportation of water within the proposed system</p>	<ul style="list-style-type: none"> <li>• Minimise the risk of spillage of hazardous material by ensuring appropriate bunding of liquid storage, impermeable base liners for storage of chemicals, and drip trays to reduce hydrocarbon spillages.</li> <li>• Implement visual assessments for signs of erosion or leaks and address them accordingly.</li> </ul>	<p>BPG G1 and G3</p>
<b>Decommissioning Phase</b>		
<p>Rehabilitation and closure, site re-vegetation</p>	<ul style="list-style-type: none"> <li>• Ensure proper stormwater management designs are in place</li> </ul>	

**Table 7-2: Proposed mitigation measures for the identified impacts of the three phases**

	<b>Activity</b>	<b>Mitigation Measures</b>
<b>CONSTRUCTION</b>	Site clearing and removal of topsoil and vegetation.	<ul style="list-style-type: none"> <li>• The footprint of the proposed construction area must be demarcated.</li> <li>• Vegetation-clearing activities will be restricted to the demarcated infrastructure footprint area and will be undertaken in a phased manner.</li> <li>• Areas disturbed by pre-construction activities, which will not be required for construction, will be rehabilitated immediately upon completion of construction of each area.</li> <li>• Activities should be limited to months of low rainfall (dry season) to reduce the probability of potential impact.</li> <li>• Use minimal road access for heavy machinery and construction vehicles.</li> </ul>
	Heavy machinery and vehicle movement Hydrocarbon, fuel, chemical handling and spillage	<ul style="list-style-type: none"> <li>• All hazardous substances must be stored and handled on impervious substrates and bunded areas that can contain potential spillage.</li> <li>• Waste handling and storage facilities must be located away from surface water resources and drainage lines.</li> <li>• All construction vehicles and equipment must be kept in good working order and regularly serviced.</li> </ul>
<b>OPERATIONAL</b>	Hydrocarbon spillages Flooding of the Infrastructure	<ul style="list-style-type: none"> <li>• All hazardous substances must be stored and handled on impervious substrates and bunded areas that can contain potential spillage.</li> <li>• Waste handling and storage facilities must be located away from surface water resources and drainage lines.</li> <li>• Maintenance of the flood protection structure</li> </ul>
<b>DECOMMISSIONING</b>	Demolition of the infrastructure	<ul style="list-style-type: none"> <li>• All infrastructure areas should be revegetated to manage erosion, and all rehabilitation activities should be monitored until vegetation is well established.</li> <li>• Use indigenous vegetation planted following the site's slopes.</li> </ul>

---

## 8 RECOMMENDATIONS AND CONCLUSIONS

Based on the investigation undertaken, the following recommendations and conclusions are made:

### 8.1 Recommendations

- The type of construction should consider landscape slopes by avoiding slab-on-ground compaction. Thus, a stabilised site access must be established and, if possible, limited to one point only. The access allows for construction vehicles to enter the work area while preventing the unnecessary tracking of sediment onto the nearby environment from multiple locations.
- Implement best management practices for erosion and sediment control. This includes the use of silt fences, sediment basins, and sediment traps. Adopting these measures will help prevent soil erosion and sedimentation into the river during construction.
- The design of all construction site access roads, treatment plant area, ponds, and pump station must include stormwater management and erosion control during both the construction and operational phases of the project.
- Regular monitoring and inspection of drainage channels, silt traps, culverts, pipelines, for signs of erosion, cracking, silting and blockages of inflows, to ensure the efficient performance of the storm water infrastructure is recommended.
- Monitoring should be undertaken monthly during the wet season and after heavy storm events or per the site management schedule.
- Management of silt by ensuring that the disturbance of topsoil is minimised, sediment source and erosion control, phasing of earthworks activities, diversion of upslope runoff from entering the earthworks areas and downstream treatment of any collected sediment runoff, i.e., use of silt traps.

## 8.2 Conclusions

A conceptual SWMP was presented for the proposed construction of Rand Water VG New System 1 infrastructure, 7 km Sludgelines, and 1.5 km Sludgeline connected to the Sludge Ring at Panfontein Water Treatment Residue site. Using high-resolution survey data (5 m contour and 30 m DEM), sub-drainage areas across the project site were delineated to identify natural drainage patterns and flow direction and areas that are likely to be categorised as dirty water systems. Areas likely to generate suspended sediments and contaminate the environment through accidental spillages were categorised as those needing pollution prevention measures to reduce the potential risk of polluting the surrounding environment.

Planned monitoring and maintenance was drafted in accordance with the guidelines of an effective and efficient SWMP, which ensures reduced changes of surface compaction, siltation, erosion and manifestation of alien invasive plants. Depending on the project's construction period, a detailed sizing of stormwater management infrastructure could be required at a later design stage to ensure adequate drainage channels are constructed to collect and convey stormwater. This option will require high-resolution survey data (e.g., 1 m or less), a report on available data from various sources, and the determinations of the various hydrological parameters performed utilising recognised methods and justifiable logic. As such, the results presented were based on verifiable and sound engineering.

---

## 9 REFERENCES

- Bailey, A., and Pitman, W. (2015). *Water Resources of South Africa 2012 Study (WR2012): Executive Summary Version 1*. WRC Report No. K5/2143/1. Gezina, South Africa: Water Research Commission Report.
- DWAF. (2006). *Best Practice Guidelines for Water Resources Protection in the South African Mining Industry. BPG G1: Storm Water Management*. Pretoria: Department of Water Affairs and Forestry.
- JAXA. (2018). *Advanced Land Observation Satellite (ALOS) Global Digital Surface Model (DSM)*. Tokyo: Earth Observation Research Centre (EORC), Japan Aerospace Exploration Agency (JAXA).
- Kottek, M. G. (2006). World Map of the Köppen-Geiger climate classification updated. *Meteorologische Zeitschrift*, 259-263.
- Lynch, S. D., (2004). Development of a raster database of annual, monthly and daily rainfall for Southern Africa. WRC Report No. 1156/1/04. Pretoria: Water Research Commission.
- Schulze, R.E. (1997). South African Atlas of Agrohydrology and Climatology Report TT82/96, Water Research Commission, Pretoria.
- Smithers, J., & Schulze, R., (2003). Design Rainfall and Flood Estimation, WRC Report No. K5/1060. Pretoria: Water Research Commission.
- WorldWeatherOnline. (2025, June 16). *WWO*. Retrieved from <https://www.worldweatheronline.com/vereeniging-weather-averages/>

10 APPENDICES

10.1 Detailed slope patterns for the sites

