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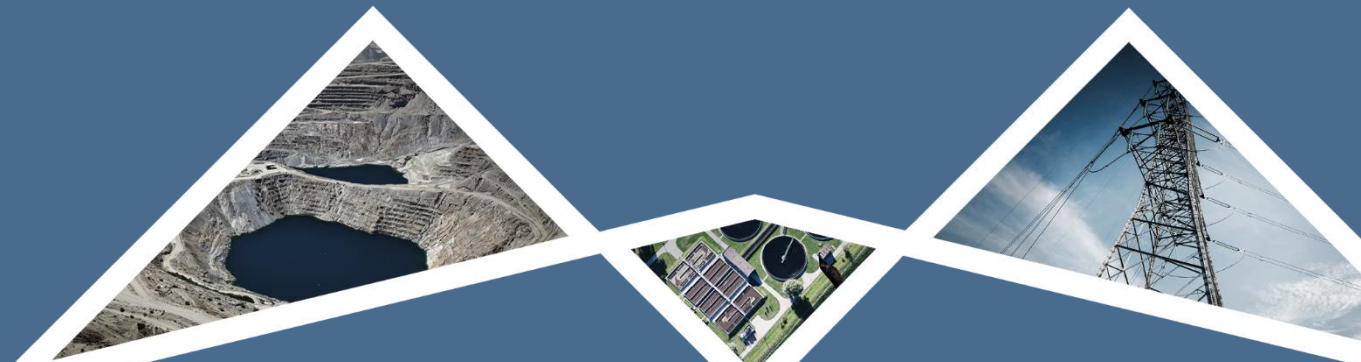
EIA REPORT FOR PUBLIC REVIEW

PROPOSED HARMONY VALLEY TAILINGS STORAGE FACILITY PROJECT

DMRE REF: FS 30/5/1/2/3/2/1 (84) EM



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REVISION AND AMENDMENTS

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ACRONYMS AND ABBREVIATIONS

AIP	:	Alien Invasive Plant
AQSR	:	Air Quality Sensitive Receptors
ASTM	:	American Standard Testing Methodology
CA	:	Competent Authority
CARA	:	Conservation of Agricultural Resources Act, 1983
CMA	:	Catchment Management Agency
DESTEA	:	Department of Economic, Small Business Development, Tourism & Environment
DFFE	:	Department of Forestry, Fisheries and the Environment
DMRE	:	Department of Mineral Resources and Energy
DWS	:	Department of Water and Sanitation
EA	:	Environmental Authorisation
EC	:	Electrical Conductivity
ECA	:	Environmental Conservation Act
EAP	:	Environmental Assessment Practitioner
EIA	:	Environmental Impact Assessment
EIMS	:	Environmental Impact Management Services (Pty) Ltd
ELWU	:	Existing Lawful Water Use
EN	:	Endangered
EMPr	:	Environmental Management Programme
FSN	:	Free State North
GA	:	General Authorisation
GIS	:	Geographic Information Systems
GN	:	Government Notice
GQM	:	Groundwater Quality Management
HDPE	:	High Density Polyethylene
HGM	:	Hydrogeomorphic
HIA	:	Heritage Impact Assessment
I&AP	:	Interested and Affected Party
IDP	:	Integrated Development Plan
IEM	:	Integrated Environmental Management
IWML	:	Integrated Waste Management Licence
IWULA	:	Integrated Water Use License Application
LC	:	Leachable Concentration
LED	:	Local Economic Development
LOM	:	Life of Mine

MAE	:	Mean Annual Evaporation
MAP	:	Mean Annual Precipitation
MAR	:	Mean Annual Runoff
MPRDA	:	Minerals and Petroleum Resources Development Act, 2002
MR	:	Mining Right
NAAQS	:	National Ambient Air Quality Standards
NAEIS	:	National Atmospheric Emissions Inventory System
NDCR	:	National Dust Control Regulations
NDP	:	National Development Plan
NEM:AQA		National Environmental Management: Air Quality Act, 2004
NEM:WA	:	National Environmental Management: Waste Amendment Act, 2008
NEMA	:	National Environmental Management Act, 1998
NEMBA	:	National Environmental Management: Biodiversity Act, 2004
NGDB	:	National Groundwater Database
NGO	:	Non-Governmental Organization
NHRA	:	National Heritage Resources Act, 1999
NNR	:	National Nuclear Regulator
NT	:	Near Threatened
NWA	:	National Water Act, 1998
ONAs	:	Other Natural Areas
PHRA	:	Provincial Heritage Resources Authority
PIA	:	Palaeontological Impact Assessment
POI	:	Point of Interest
PPP	:	Public Participation Process
RE	:	Remaining Extent
RWD	:	Return Water Dam
SAHRA	:	South African Heritage Resources Agency
SANS	:	South African National Standards
SAWS	:	South African Weather Service
SCC	:	Species of Conservation Concern
SDF	:	Spatial Development Framework
SLP	:	Social & Labour Plan
SO_4	:	Sulphate
SPLUMA	:	Spatial Planning and Land Use Management Act
SWMP	:	Stormwater Management Plan
TC	:	Total concentration

TDS	:	Total Dissolved Solids
TSF	:	Tailings Storage Facility
TSP	:	Total Suspended Particles
WMA	:	Water Management Area
WML	:	Waste Management License
WULA	:	Water Use License Application
WUL	:	Water Use Licence

EXECUTIVE SUMMARY

Harmony Gold Mining Company Limited (hereafter referred to as Harmony / "the applicant") has appointed Environmental Impact Management Services (Pty) Ltd (EIMS) as the Environmental Assessment Practitioner (EAP) to undertake the necessary environmental authorisation and associated consultation processes for a proposed new Tailings Storage Facility (TSF) near Welkom in the Matjhabeng Local Municipality in the Free State province.

A new deposition site will be required for Harmony One Plant to replace the FSS2 and St. Helena 4 Tailings Storage Facilities by July 2024. Several alternative sites were identified and assessed as possible suitable deposition sites for the tailings from Harmony One Plant but, apart from the Nooitgedacht site which is the subject of a separate EIA, none were found feasible. Following a review of other possibilities for the One Plant's future tailings deposition, an option to utilise the space between the Free State North (FSN) 1 and Free State North 2 (FSN) TSFs and portion of the footprint of the FSN4 TSF as shown in Figure 1 has been identified as a possible deposition site. The proposed TSF (hereafter referred to as the Valley TSF) will cover an area of approximately 163 ha. The proposed TSF will be located on Farm portions Rietpan 14 (0) and Ouders Gift 48 (0/RE).

EIMS will compile and submit the required documentation in support of applications for of applications for:

- Environmental Authorisation (EA) and Waste Management License (WML) in accordance with the National Environmental Management Act – NEMA (Act 107 of 1998)- Listed activity: Listing Notice 2, Activity 15 as well as various Listing Notice 1, 2 and 3 activities as well as the National Environmental Management: Waste Act – NEMWA (Act 59 of 2008)- Activity A14, B7, B10 and B11; and
- Water Use Licence (WUL) in accordance with the National Water Act – NWA (Act 36 of 1998). Water uses: Section 21 (c), Section 21 (i) and Section 21 (g). A separate application for a Water Use Licence (WUL) has been lodged with the Department of Water and Sanitation (DWS) for the water use triggers.

PURPOSE OF THE EIA REPORT

The Scoping Phase of the EIA process identified potential issues associated with the proposed project, and defined the extent of the studies required for the EIA Phase. The Scoping Phase also identified potentially sensitive areas within the study site.

The EIA Phase addresses those identified potential environmental impacts and benefits (direct, indirect, and cumulative impacts) associated with all phases of the project including design, construction, operation, decommissioning and closure. The EIA Phase recommends appropriate mitigation measures for potentially significant environmental impacts.

The EIA Phase aimed to achieve the following:

- Provide an overall description and assessment of the social and biophysical environments affected by the proposed alternatives put forward as part of the project.
- Assess potentially significant impacts (direct, indirect and cumulative, where required) associated with the proposed project.
- Comparatively assess identified feasible alternatives put forward as part of the project.
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts; and
- Undertake a fully inclusive public involvement process to ensure that I&AP are afforded the opportunity to participate, and that their issues and concerns are recorded.

PUBLIC PARTICIPATION PROCESS

The Public Participation Process (PPP) for the proposed project has been undertaken in accordance with the requirements of the National Environmental Management Act (NEMA) in line with the principles of Integrated Environmental Management (IEM). The PPP commenced on the 4 April 2023 with an initial notification and call to register as interested and affected parties (I&APs). The comments received from I&APs during the initial call to register and commenting period so far have been captured in Public Participation Report in Appendix C.

Comments received during this EIA Report review period will also be collated and added to the Public participation report submitted to the Competent Authority (CA).

This EIA Report is being made available for public review and comment for a period of 30 days from 22 March 2024 until 24 April 2024 .

PROJECT ALTERNATIVES AND ENVIRONMENTAL IMPACT ASSESSMENT

Each of the identified risks and impacts at the various project phases were assessed. The assessment criteria include the nature, extent, duration, magnitude / intensity, reversibility, probability, public response, cumulative impact, and irreplaceable loss of resources.

The most significant risks and impacts identified were those that remain high in terms of significance even post mitigation measures being considered. The following identified impacts were determined to have a potentially moderate final significance at this stage:

- Reduction in air quality during operation;
- Continued employment during operation phase (positive impact);
- Implementation of the NNR-approved decommissioning plan (positive impact);
- Soil compaction and erosion during operation and decommissioning phases; and
- Direct loss, disturbance and degradation of wetlands.

The negative impacts have been interrogated and assessed during the EIA phase of the project. Mitigation measures were identified and were refined based on input from the Environmental Assessment Practitioner (EAP), public consultation, and specialist assessments during the EIA phase of the project. The associated Environmental Management Programme (EMPr) identifies appropriate mitigation mechanisms for avoidance, minimisation and / or management of the negative impacts and enhancement of the positive aspects.

The following EIA-phase specialist studies were conducted:

- Biodiversity (Terrestrial including birds and bat);
- Heritage;
- Agriculture Potential, Soils and Land capability;
- Geohydrology;
- Aquatic and Wetland;
- Air quality;
- Closure Costing and Rehabilitation;
- Palaeontology;
- Noise;
- Visual; and
- Health Risk and Radiological.

Mitigation measures have been identified based on input from the Environmental Assessment Practitioner (EAP), public consultation, and specialist assessments during the EIA phase of the proposed Valley TSF project.

The EMPr (Appendix H) includes appropriate mitigation mechanisms for avoidance, minimisation and / or management of the negative impacts and enhancement of the positive.

The findings of the specialist studies conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented. Based on the nature and extent of the proposed project, the local level of disturbance predicted as a result of the construction and operation of the mine, the findings of the EIA studies, and the understanding of the significance level of potential environmental impacts, it is the opinion of the EIA project team that the significance levels of the majority of identified negative impacts can generally be reduced by implementing the recommended mitigation measures.

Despite the negative impacts caused by the TSF, it must be considered that there are positive impacts as well, mostly based on job opportunities and SLP initiatives. Based on the nature and extent of the proposed and the predicted impacts as a result of the construction, operation and closure of the facility, the findings of the EIA, and the understanding of the low - moderate post-mitigation significance level of all identified potential environmental impacts, it is the opinion of the EIA project team that the environmental impacts associated with the application for the proposed Valley TSF project can be mitigated to an acceptable level and the project should be authorized.

1 INTRODUCTION

Harmony Gold Mining Company Limited (hereafter referred to as Harmony / "the applicant") has appointed Environmental Impact Management Services (Pty) Ltd (EIMS) as the Environmental Assessment Practitioner (EAP) to undertake the necessary environmental authorisation application and associated consultation processes for a proposed new Gold Tailings Storage Facility (TSF) near Welkom in the Matjhabeng Local Municipality in the Free State province.

A new deposition site will be required for Harmony One Plant to replace the FSS2 and St. Helena 4 Tailings Storage Facilities by July 2024. Several alternative sites were identified and assessed as possible suitable deposition sites for the tailings from Harmony One Plant but, apart from the Nooitgedacht site, which is the subject of a separate EIA, none were found feasible. Following a review of other possibilities for the One Plant's future tailings deposition, an option to utilise the space between the Free State North (FSN) 1 and FSN2 TSFs and portion of the footprint of the FSN4 TSF as shown in Figure 1 has been identified as a possible deposition site. The TSF will cover an area of approximately 163 ha. The proposed TSF will be located on Farm portions Rietpan 14 (0) and Ouders Gift 48 (0/RE).

EIMS will compile and submit the required documentation in support of applications for of applications for:

- Environmental Authorisation (EA) and Waste Management License (WML) in accordance with the National Environmental Management Act – NEMA (Act 107 of 1998)- Listed activity: Listing Notice 2, Activity 15 as well as various Listing Notice 1, 2 and 3 activities as well as the National Environmental Management: Waste Act – NEMWA (Act 59 of 2008)- Activity A14, B7, B10 and B11; and
- Water Use Licence (WUL) in accordance with the National Water Act – NWA (Act 36 of 1998). Water uses: Section 21 (c), Section 21 (i) and Section 21 (g). A separate application for a Water Use Licence (WUL) has been lodged with the Department of Water and Sanitation (DWS) for the water use triggers.

The following activity details are relevant to the current application:

- Infrastructure will include the TSF and associated infrastructure such as water management infrastructure including pipelines and a return water dam.
- Tailing deposition method to be used: combination of spigot and cyclone deposition. Based on prior experience, the maximum rate of rise of 3.7m/year allows for safe upstream deposition. The stage capacity analysis indicates that the facility will provide a capacity of 56.8 million tons over 8.0 years at 600 000tpm.
- The Valley TSF will have a maximum height of 36m and a footprint area of approximately 163.5Ha.
- Stage capacities were developed for the Valley TSF based on a tailings in-situ dry density of 1.45 tons/m3 at the design outer profile. The designed outer profile comprises an overall outer slope of 1V:4H with 8.0m high intermediate slopes of 1V:3H between each 8.0m wide bench.
- TSF barrier system for technology alternative 2 as determined in consultation with the authorities and in compliance with relevant norms and standards for determination of liner requirements in terms of the NEM:WA (GN R. 636).

It should be noted that a separate EA and WML application is being conducted by the same EAP for the same applicant for the adjacent proposed Nooitgedacht TSF to the immediate south of the area proposed for the Valley TSF. That project is the subject of a separate application and public consultation process and should not be confused with this Valley TSF application.

1.1 REPORT STRUCTURE

This report has been compiled in accordance with the 2014 NEMA EIA Regulations, as amended. A summary of the report structure, and the specific sections that correspond to the applicable regulations, is provided in Table 1 below.

Table 1: Report structure

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(a):	Details of – i. The EAP who prepared the report; and ii. The expertise of the EAP, including a curriculum vitae;	1.2
Appendix 3(b):	The location of the activity, including: (i) the 21-digit Surveyor General code of each cadastral land parcel; (ii) where available, the physical address and farm name; (iii) where the required information in items (i) and (ii) is not available, the coordinates of the boundary of the property or properties on which the activity is to be undertaken;	2
Appendix 3(c):	A plan which locates the proposed activity or activities applied for as well as the associated structures and infrastructure at an appropriate scale, or, if it is - (i) a linear activity, a description and coordinates of the corridor in which the proposed activity or activities is to be undertaken; (ii) on land where the property has not been defined, the coordinates within which the activity is to be undertaken;	3.1
Appendix 3(d):	A description of the scope of the proposed activity, including (i) all listed and specified activities triggered and being applied for; and (ii) a description of the associated structures and infrastructure related to the development;	3
Appendix 3(e):	A description of the policy and legislative context within which the development is located and an explanation of how the proposed development complies with and responds to the legislation and policy context;	4
Appendix 3(f):	A motivation for the need and desirability for the proposed development, including the need and desirability of the activity in the context of the preferred location;	5
Appendix 3(g):	A motivation for the preferred development footprint within the approved site;	6
Appendix 3(h):	A full description of the process followed to reach the proposed development footprint within the approved site, including: (i) details of the development footprint alternatives considered;	6

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	(ii) details of the public participation process undertaken in terms of regulation 41 of the Regulations, including copies of the supporting documents and inputs; (iii) a summary of the issues raised by interested and affected parties, and an indication of the manner in which the issues were incorporated, or the reasons for not including them; (iv) the environmental attributes associated with the development footprint alternatives focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects; (v) the impacts and risks identified including the nature, significance, consequence, extent, duration and probability of the impacts, including the degree to which these impacts (aa) can be reversed; (bb) may cause irreplaceable loss of resources; and (cc) can be avoided, managed or mitigated; (vi) the methodology used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks; vii) positive and negative impacts that the proposed activity and alternatives will have on the environment and on the community that may be affected focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects; (viii) the possible mitigation measures that could be applied and level of residual risk; (ix) if no alternative development locations for the activity were investigated, the motivation for not considering such; and (x) a concluding statement indicating the preferred alternative development location within the approved site;	
Appendix 3(i)	A full description of the process undertaken to identify, assess and rank the impacts the activity and associated structures and infrastructure will impose on the preferred location through the life of the activity, including (i) a description of all environmental issues and risks that were identified during the environmental impact assessment process; and (ii) an assessment of the significance of each issue and risk and an indication of the extent to which the issue and risk could be avoided or addressed by the adoption of mitigation measures;	9.2 and 9.3
Appendix 3(j)	An assessment of each identified potentially significant impact and risk, including (i) cumulative impacts; (ii) the nature, significance and consequences of the impact and risk; (iii) the extent and duration of the impact and risk;	9.3 and Appendix E

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	(iv) the probability of the impact and risk occurring; (v) the degree to which the impact and risk can be reversed; (vi) the degree to which the impact and risk may cause irreplaceable loss of resources; and (vii) the degree to which the impact and risk can be mitigated;	
Appendix 3(k):	Where applicable, a summary of the findings and recommendations of any specialist report complying with Appendix 6 to these Regulations and an indication as to how these findings and recommendations have been included in the final assessment report;	11
Appendix 3(l):	An environmental impact statement which contains (i) a summary of the key findings of the environmental impact assessment: (ii) a map at an appropriate scale which superimposes the proposed activity and its associated structures and infrastructure on the environmental sensitivities of the preferred site indicating any areas that should be avoided, including buffers; and (iii) a summary of the positive and negative impacts and risks of the proposed activity and identified alternatives;	11.3
Appendix 3(m)	Based on the assessment, and where applicable, recommendations from specialist reports, the recording of proposed impact management objectives, and the impact management outcomes for the development for inclusion in the EMPr as well as for inclusion as conditions of authorisation;	9.3
Appendix 3(n)	The final proposed alternatives which respond to the impact management measures, avoidance, and mitigation measures identified through the assessment;	11
Appendix 3(o)	Any aspects which were conditional to the findings of the assessment either by the EAP or specialist which are to be included as conditions of authorisation;	11.4
Appendix 3(p)	Description of any assumptions, uncertainties and gaps in knowledge which relate to the assessment and mitigation measures proposed;	12
Appendix 3(q)	A reasoned opinion as to whether the proposed activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation;	11.3
Appendix 3(r)	Where the proposed activity does not include operational aspects, the period for which the environmental authorisation is required and the date on which the activity will be concluded and the post construction monitoring requirements finalised;	N/A – activity includes operational aspects
Appendix 3(s)	An undertaking under oath or affirmation by the EAP in relation to: (i) the correctness of the information provided in the reports; (ii) the inclusion of comments and inputs from stakeholders and I&APs;	13

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	(iii) the inclusion of inputs and recommendations from the specialist reports where relevant; and (iv) any information provided by the EAP to interested and affected parties and any responses by the EAP to comments or inputs made by interested or affected parties;	
Appendix 3(t)	where applicable, details of any financial provisions for the rehabilitation, closure, and ongoing post decommissioning management of negative environmental impacts;	Closure objectives are included in Section 6 of Appendix H. Closure costing included as Appendix J.
Appendix 3(u)	An indication of any deviation from the approved scoping report, including the plan of study, including (i) any deviation from the methodology used in determining the significance of potential environmental impacts and risks; and (ii) a motivation for the deviation;	Amendments made to application form – refer to Section 4 and Appendix A
Appendix 3(v)	Any specific information that may be required by the competent authority; and	Specific information is provided in various sections of the report line with DMRE comments on the FSR
Appendix 3(w)	Any other matters required in terms of section 24(4)(a) and (b) of the Act	7, 8 and 9

1.2 DETAILS OF THE EAP

EIMS is appointed by Harmony as the independent EAP and to assist in preparing and submitting the EA and WML applications, Scoping and EIA Reports, and undertaking a Public Participation Process (PPP) in support of the proposed tailings storage facility. The contact details of the EIMS consultant and EAP who compiled this Report are as follows:

- Name: John von Mayer
- Tel No: +27 11 789 7170
- Fax No: +27 86 571 9047
- E-mail address: valley@eims.co.za

In terms of Regulation 13 of the EIA Regulations (GN R. 982) as amended, an independent EAP, must be appointed by the applicant to manage the application. EIMS is compliant with the definition of an EAP as defined in Regulations 1 and 13 of the EIA Regulations, as well as Section 1 of the NEMA. This includes, inter alia, the requirement that EIMS is:

- Objective and independent;
- Has expertise in conducting EIA's;
- Comply with the NEMA, the environmental regulations and all other applicable legislation;
- Considers all relevant factors relating to the application; and
- Provides full disclosure to the applicant and the relevant environmental authority.

EIMS is a private and independent environmental management-consulting firm that was founded in 1993. EIMS has in excess of 30 years' experience in conducting EIA's, including many EIA's for mines and mining related projects. Please refer to the EIMS website (www.eims.co.za) for examples of EIA documentation currently available.

John von Mayer is a senior consultant at EIMS and has been involved in numerous significant projects the past 14 years. He has experience in Project Management, small to large scale Environmental Impact Assessments, Environmental Auditing, Water Use Licensing, and Public Participation. He is a Registered Professional Natural Scientist (400336/11) with the South African Council Natural and Scientific Professions (SACNASP) as well as a registered EAPASA Environmental Practitioner (2019/1247).

The Curriculum Vitae of the EAP that is responsible for the compilation of this Report is included in Appendix B.

1.3 SPECIALIST CONSULTANTS

Specialist studies have been undertaken to address the key impacts, and these include:

- Biodiversity (Terrestrial);
- Heritage;
- Agriculture Potential, Soils and Land capability;
- Geohydrology;
- Aquatic and Wetland;
- Air quality;
- Palaeontology;
- Visual; and
- Health Risk and Radiological.

Engineering inputs have also be obtained to inform the design of the TSF. The specialist studies listed above involved the gathering of data relevant to identifying and assessing environmental impacts that may occur as a result of the proposed project. These impacts were assessed according to pre-defined impact rating methodology (Section 9.1). Mitigation / management measures to minimise potential negative impacts or enhance potential benefits are put forward in this report.

2 DESCRIPTION OF THE PROPERTY

Table 2 indicates the farm portions that fall within the proposed project including details on the project location as well as the distance from the proposed project area to the nearest towns.

Table 2: Locality details

Farm Name	Rietpan 14 (0) and Ouders Gift 48 (0/RE)		
Application Area (Ha)	Approximately 163 Hectares.		
Magisterial District	Matjhabeng Local Municipality within the Lejweleputswa District Municipality (Free State Province).		
Distance and direction from nearest towns	Welkom is located 3,7km southeast and Odendaalsrus is located 3 km northeast of the proposed TSF site. The geographic coordinates at the centre of the site are: 27°54'59.44"S, 26°40'22.09"E.		
21-digit Surveyor General Code for Property on which Project is Located	**Farm Name:**	**Portion:**	**21 Digit Surveyor General Code**
	Rietpan 14	0	F03900000000001400000
	Ouders Gift 48	0/RE	F03900000000004800000

The locality and extent of the proposed TSF is shown in Figure 1 and the proposed Valley TSF in relation to the existing mining right area is shown in Figure 2.

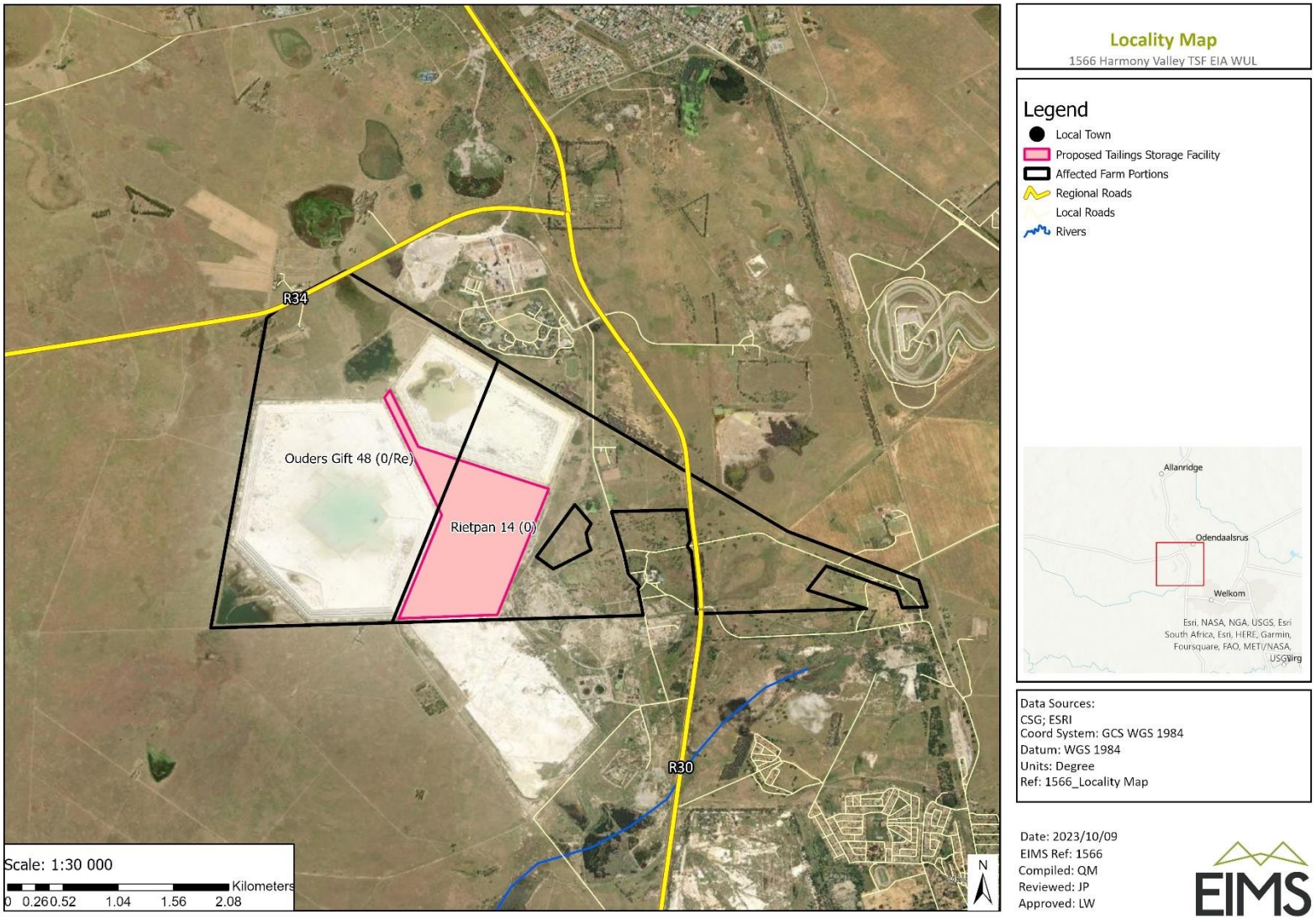

Figure 1: Aerial imagery locality map indicating the location of the proposed new tailings storage facility.

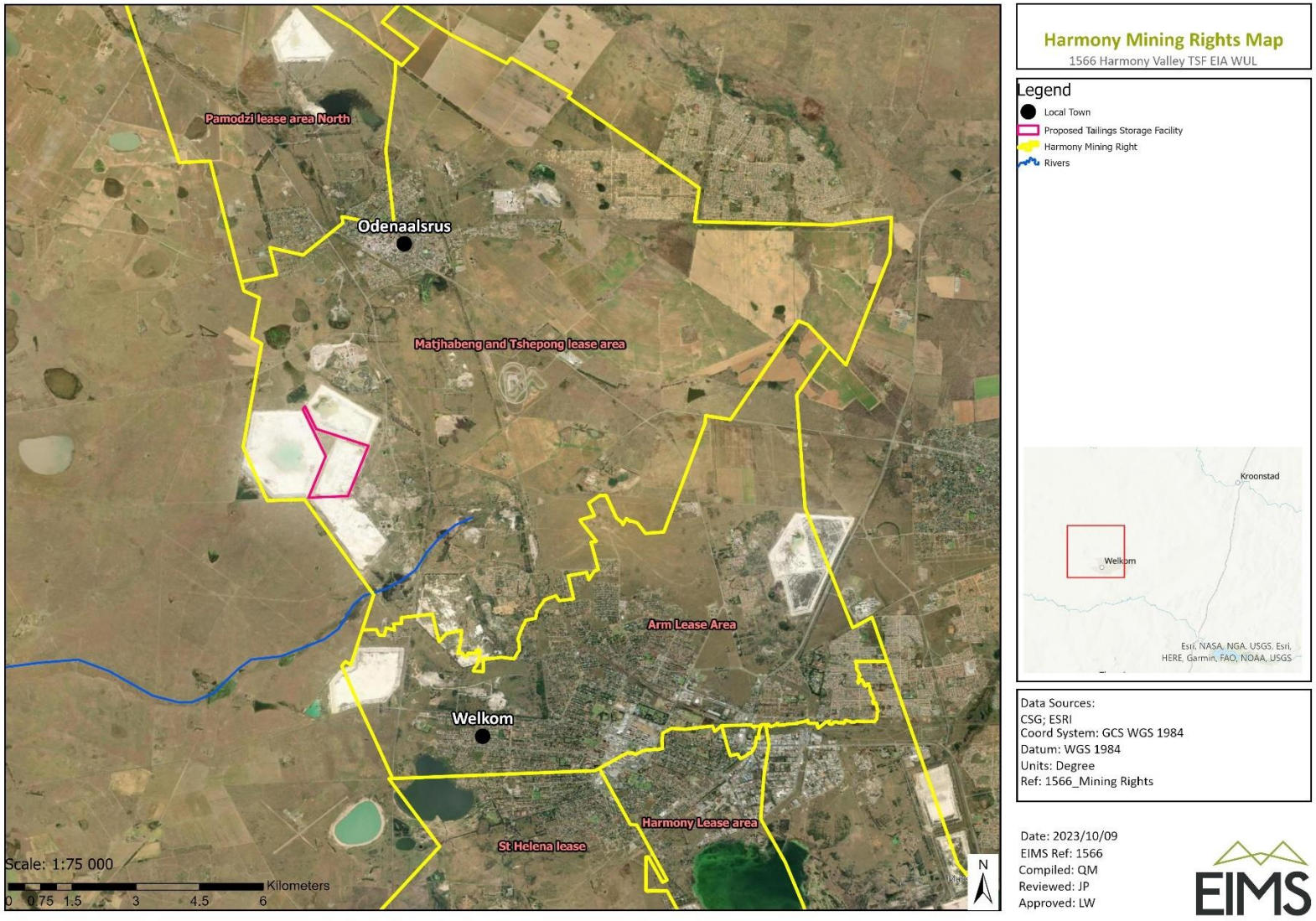

Figure 2: Locality map indicating the location of the proposed new tailings storage facility in relation to Harmony's mining right areas.

3 DESCRIPTION AND SCOPE OF THE PROPOSED ACTIVITY

Harmony (the applicant) holds an approved Mining Right (MR) and Environmental Management Programme (EMPr), in terms of the Minerals and Petroleum Resources Development Act (Act 28 of 2002, as amended) (MPRDA), for the mining of gold at various operations in the Welkom area (Mining Right Ref: MR84). The proposed Valley TSF will fall within this MR84.

A new deposition site will be required for Harmony One Plant to replace the FSS2 and St. Helena 4 Tailings Storage Facilities by July 2024. Of the alternative sites, apart from the Nooitgedacht site which is the subject of a separate EIA, several were identified and assessed as possible suitable deposition sites for the tailings from Harmony One Plant but none were found feasible. Following a review of other possibilities for the One Plant's future tailings deposition, an option to utilise the space between the Free State North 1 and FSN2 TSFs and portion of the footprint of the FSN4 TSF as shown in Figure 1 has been identified as a possible deposition site. The TSF will cover an area of approximately 163 ha. The proposed TSF will be located on Farm portions Rietpan 14 (0) and Ouders Gift 48 (0/RE).

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- Water Use Licence (WUL) in accordance with the National Water Act – NWA (Act 36 of 1998). Water uses: Section 21 (c), Section 21 (i) and Section 21 (g). A separate application for a Water Use Licence (WUL) has been lodged with the Department of Water and Sanitation (DWS) for the water use triggers.

3.1 DESCRIPTION OF ACTIVITIES TO BE UNDERTAKEN

The construction phase of the project will consist of site establishment, site clearance, excavation, topsoil stockpiling, layering and compacting, prior to deposition of tailings at the site.

Two technology alternatives are proposed in this EIA report: Alternative 1 is the option to construct the facility without a liner. Alternative 2 is the option of constructing the facility with a liner.

Key Parameters of the Valley TSF design are:

- Maximum final height: 36m
- Footprint area: 163.5 Ha
- Total capacity: 56.8 million tons
- Deposition period at 600 000 tons per month: 8 years
- Maximum rate of rise (Basin): 4.12m/year
- Maximum rate of rise (Embankment): 3.99m/year
- Deposition method: Cyclone

Further details are provided below:

- The Valley TSF provides a storage capacity of 56.8 million tons over a deposition period of 8.0 years at the target deposition rate of 600 000tpm with a maximum rate of rise of 4.12m/year (basin) and 3.99m/year (embankment). This rate of rise will be achieved by cyclone deposition.
- Valley TSF will be developed with an intermediate outer slope of 1V:3H between benches. The overall slope with benches is 1V:4H. The inter-bench height is 8.0m and the benches are 8.0m wide.

- The maximum toe wall embankment height is 3m with a 3m wide crest, outer slope of 1V:1.5H and 1V:2H inner slope. The toe wall embankment will be constructed in 150mm layers to 95% Proctor density at 0% to +2% Optimum Moisture Content (OMC). The toe wall material will be obtained from the basin of the facility.
- The cyclone walls will be constructed 50m away from the toe wall on the northwest, eastern and southern flanks of the Valley TSF. The other flanks butt up against the dormant FSN1 and FSN2 facilities and no cyclone deposition will occur from these flanks. Spigotting or open-end deposition will be done for pool control only when required.
- These cyclone walls will provide an elevated platform to allow for overflow tailings deposition. The cyclone wall is 3m high with a 3m wide crest, outer slope of 1V:2H and 1V:2H inner slope.
- According to GISTM, the Valley TSF has a Very High Consequence Classification rating.
- Based on SANS 10286, the Valley TSF has a High Hazard classification rating.
- The minimum Factor of Safety against failure, based on the Limit Equilibrium method of stability analysis, is 2.0 under drained conditions, 1.6 under undrained conditions, 1.2 under post seismic, post liquefaction or residual conditions and 1.3 under pseudo static conditions. These Factors of Safety comply with the local legislation and international slope stability standards.
- Most dormant up-stream deposited facilities, including FSN1 and FSN2, do not meet new legislated Factor of Safety requirements. To ensure the entire complex complies at closure, remedial works for FSN1 and FSN2 may be incorporated into the Valley TSF closure plan. Conceptual-level work has been carried out to assess the required remedial work based on the limit equilibrium method for stability calculations. This work will be updated once the proposed stability assessments using finite element analyses are conducted on Harmony's dams.
- The gold tailings material classified as a Type 3 waste according to the waste classification report by Jones and Wagner. This necessitates a Class C barrier system. However, as per an independent review by Legge and Associates, an 'inverted barrier' system can be used. The inverted barrier reduces seepage by changing the flow through the liner from Bernoulli flow at discontinuities to D'Arcian flow controlled by the tailings permeability at these points. The stability of the TSF is also improved by omitting lower strength compacted clay layers and the geomembrane cushion layer (replaced by tailings). The inverted barrier system is used in the design of the Valley TSF barrier system.
- The Valley TSF barrier system has two different areas. Liner area 1 is within the central area of the dam basin. This liner system comprises (from top down), a 300mm thick layer of tailings, above liner drains, 1.5mm smooth HDPE liner underlain by a 300mm ripped and recompacted in-situ base layer.
- Liner area 2 is present at the outer walls of the facility where high liner stresses exist and a 150T geogrid (or similar approved) is required. The geogrid (or similar approved) will be placed from the toe wall inwards for 50m. This liner system comprises (from top down), a 300mm thick layer of tailings, a 150T size geogrid (or similar approved), a 300mm thick layer of tailings, above liner drains, 1.5mm double textured HDPE liner underlain by a 300mm ripped and recompacted in-situ base layer.
- The TSF underdrainage system is provided above the liner to intercept seepage through the facility. The above liner drains lower the phreatic surface, thereby improving the overall stability of the facility. The above liner drains comprise of blanket drains and herringbone drains.
- The herringbone drains pipes comprise of 160mm slotted Drainex HDPE pipes surrounded in 19mm stone which is enclosed in a geofabric. These drains are spaced 100m apart. The blanket drains comprise of 160mm slotted Drainex HDPE pipes surrounded in 19mm stone overlain by a layer of 6mm stone and graded filter sand which is enclosed in a geofabric.

- All above liner drains in the south-east section discharge into the solution trench located to the south of Valley TSF and water will flow to the existing Return Water Dam (RWD). The above liner drains on the north-western section discharge into the solution trench located to the north-west of Valley TSF and will flow to the new RWD.

- The under-liner leakage detection drains on the Valley TSF comprise of 160mm slotted Drainex HDPE pipes surrounded in 19mm stone which is enclosed in a geofabric. Similarly to the above-liner drains, the south-eastern under liner drains flow to the existing RWD and the north-western section discharges into the new RWD.

- A 150mm thick reinforced concrete lined solution trench is provided along the north-west, south and south-eastern sections of the TSF. The trapezoidal solution trench is 1m deep with side slopes of 1V:1.5H and a base width of 1m. The solution trench on the north-western section of the TSF will accommodate the maximum peak discharge from the penstock of 1.02m3/sec and flows into the new RWD. The solution trench on the south and south-eastern sections of the TSF will accommodate drain flow only of 46.14m3/day and flows into the existing RWD.

- A hydrotechnical assessment was done to determine climatic and meteorological data. This data was used to size the new RWD situated north-west of the TSF and the associated water infrastructure. A capacity assessment was carried out on the existing RWD, situated south-west of the TSF.

- The new Return Water Dam has a total storage capacity of 220 000m3 which is sufficient to ensure that it does not spill more than once every 50 years with the inflow from the penstock and underdrains on the north-west of the TSF, when operated at a level of 0.3m.

- The new Return Water Dam liner system comprises 200mm high geocells filled with 20Mpa concrete, underlain by a 1.5mm thick smooth HDPE liner and a 300mm in-situ base preparation layer. The underdrainage comprises 160mm slotted HDPE pipes encased in 19mm washed stone. The stone will be wrapped in geofabric.

- A concrete lined spillway is provided at the new RWD to safely discharge excess water without overtopping of the RWD embankment walls. The RWD spillway has a freeboard of 800mm and has been designed to discharge the 1:10 000 24-hour Probable Maximum Flood volume of 9.9m3/sec.

- A silt trap is installed upstream of the new RWD. The silt trap includes infrastructure to enable cleaning. The silt trap allows solids to settle out of the water before entering the RWD, thereby minimising sedimentation in the RWD. The silt trap is a 2.0m deep reinforced concrete water retaining structure with a concrete spillway to route de-silted water to the RWD.

- A capacity assessment was done on the existing RWD, which has a capacity of 300 000m3. The inputs to this dam are low, as only drain water and rainfall will flow to the RWD. Due to evaporation and seepage, the dam is not expected to hold more than 50 000m3 and easily accommodates the expected inputs.

- Concrete poles with warning signs will be installed around the TSF. A 5m wide access road is provided around the facility for operational and monitoring requirements.

The facility is to be constructed and operated to ensure that the future designed outer slope profile is achieved and to ensure the safe, efficient and environmentally responsible management of the Valley TSF and associated infrastructure.

An independent review of the liner system has been done by Legge and Associates. The review report recommended that an 'inverted barrier' system be used as opposed to a Class C barrier system. A comparison of these two barrier systems is shown in Figure 3.

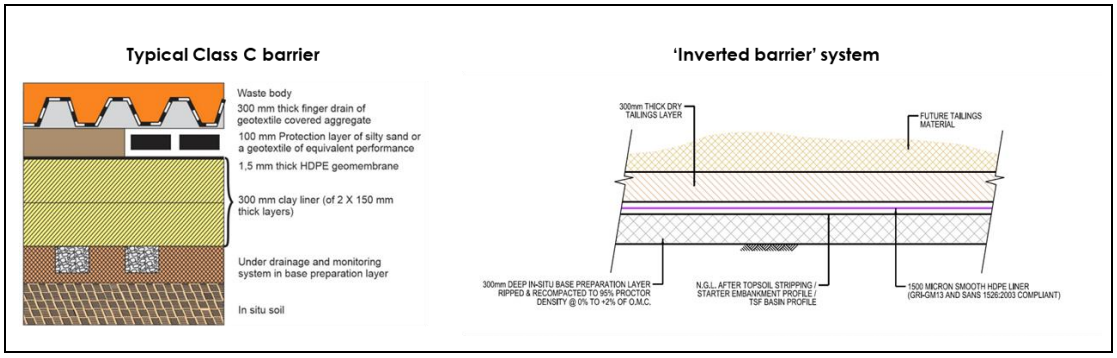

Figure 3: TSF Inverted Liner system proposed for technology alternative 2.

The inverted barrier system has superior performance as compared to the Class C barrier system in terms of reducing seepage, and equivalent performance in terms of service life considerations. This is a more feasible option as it removes the need for a compacted clay liner below the geomembrane. The stability of the TSF is also improved by omitting lower strength compacted clay layers and the geomembrane cushion layer (replaced by tailings). The effectiveness of the proposed inverted liner system considers flow through the tailings due to the possible holes in the liner. Strict construction quality control is assumed therefore the liner system is assumed to have a maximum of 5 holes per hectare, with each hole being 10mm in diameter. When a hole forms in the liner, the fine tailings will clog it, therefore Darcy's law was applied to consider seepage through the holes. The seepage through a typical 1.5mm HDPE liner with no holes used in landfill applications is negligible (R. Kerry Rowe, 2012). The proposed TSF barrier system comprises of two areas as shown in Figure 4. The proposed TSF barrier system cross-sections are shown in Figure 5 and Figure 6.

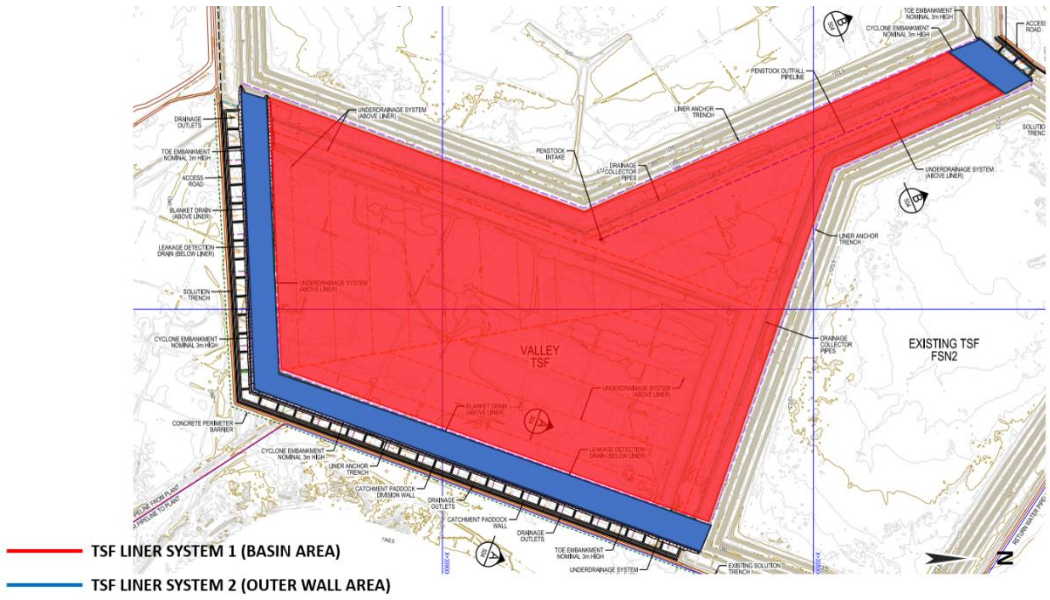

Figure 4: Proposed liner areas

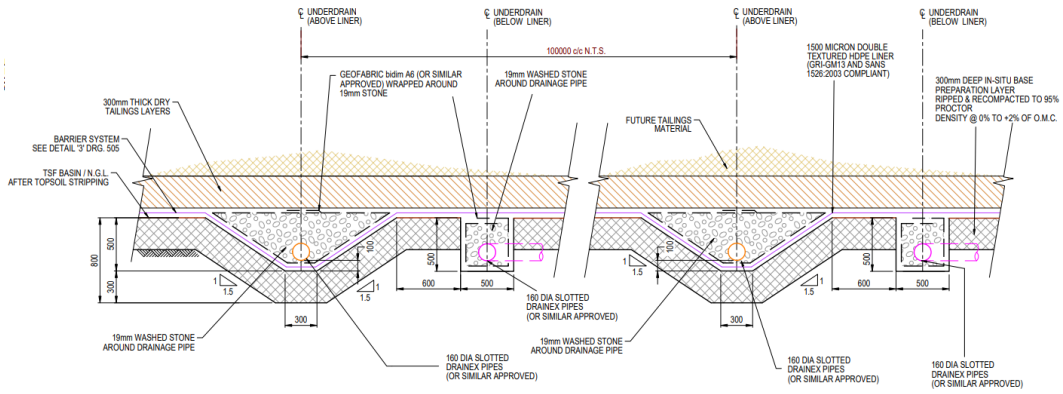

Figure 5: TSF liner system 1 (basin area) cross section

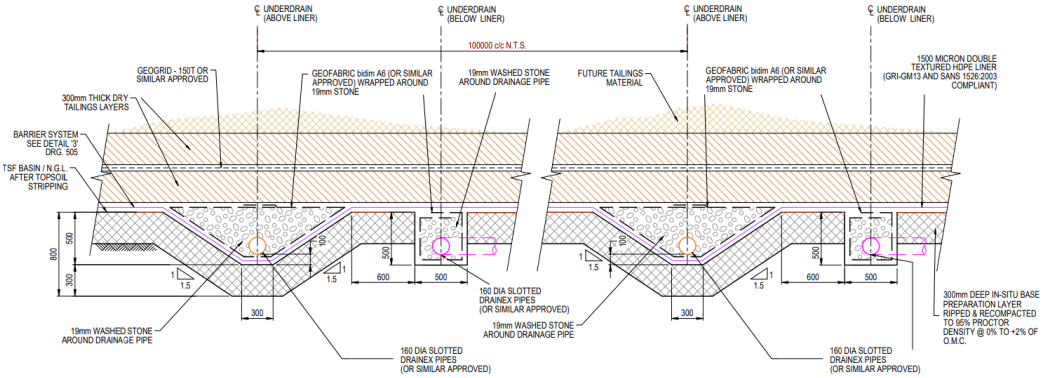

Figure 6: TSF liner system 2 (outer wall area) cross section

The Valley TSF liner system 1 is shown in Figure 14 above and comprises the following layers (from top down):

- 300mm thick layer of tailings material. This is to be sourced from the FSN4's TSF footprint.
- Above liner drain comprising 160mm perforated HDPE pipes placed in a trapezoidal trench. The pipes will be encased in 19mm washed stone and wrapped in geofabric.
- 1.5mm thick smooth HDPE membrane (GRI-GM13 and SANS 1526:2003 compliant).
- Ripping and recompacting of the in-situ base material, 300mm to 95% Proctor density at a moisture content between 0% and +2% of optimum moisture content.
- Leakage detection system comprising 160mm perforated HDPE pipes placed in a 500mm by 500mm trench. The pipes will be encased in 19mm washed stone and wrapped in geofabric.

The Valley TSF liner system 2 is shown in Figure 15 above and comprises the following layers (from top down):

- 300mm thick layer of tailings material. This is to be sourced from the FSN4's TSF footprint.
- 150T polypropylene geogrid or similar approved. The 150T geogrid is to be placed 100m from the outer walls only.
- 300mm thick layer of tailings material.
- Above liner drain comprising 160mm perforated HDPE pipes placed in a trapezoidal trench. The pipes will be encased in 19mm washed stone and wrapped in geofabric.
- 1.5mm thick double textured HDPE membrane (GRI-GM13 and SANS 1526:2003 compliant).

- A 300mm in-situ base preparation layer that is ripped and recompacted to 95% Proctor density at a moisture content between 0% and +2% of optimum moisture content.
- Leakage detection system comprising 160mm perforated HDPE pipes placed in a 500mm by 500mm trench. The pipes will be encased in 19mm washed stone and wrapped in geofabric.
- This flexible, high-strength polypropylene geogrid is used to reinforce the tailings layer over the liner. The polypropylene geogrid is made from high-modulus, low-creep synthetic materials enclosed in a protective polymer coating for protection from installation damage and short term ultraviolet exposure.

A layout map is included as Figure 7. Also refer to the accompanying design report included in Appendix I for detailed layout information showing further details on all proposed infrastructure along with explanatory notes.

It should be noted that a separate EA and WML application is being conducted for the adjacent proposed Nooitgedacht TSF to the immediate south of the area proposed for the Valley TSF by the same applicant. That project is the subject of a separate application and public consultation process and should not be confused with this Valley TSF application.

The waste management system shall provide for adequate waste including storage (in the form of waste skips and bins with lids), waste separation for recycling, and frequent removal of non-recyclable waste for permanent disposal at an appropriately licensed waste disposal facility. No waste material will be disposed of on site. Temporary toilets will be provided during construction for workers on the site.

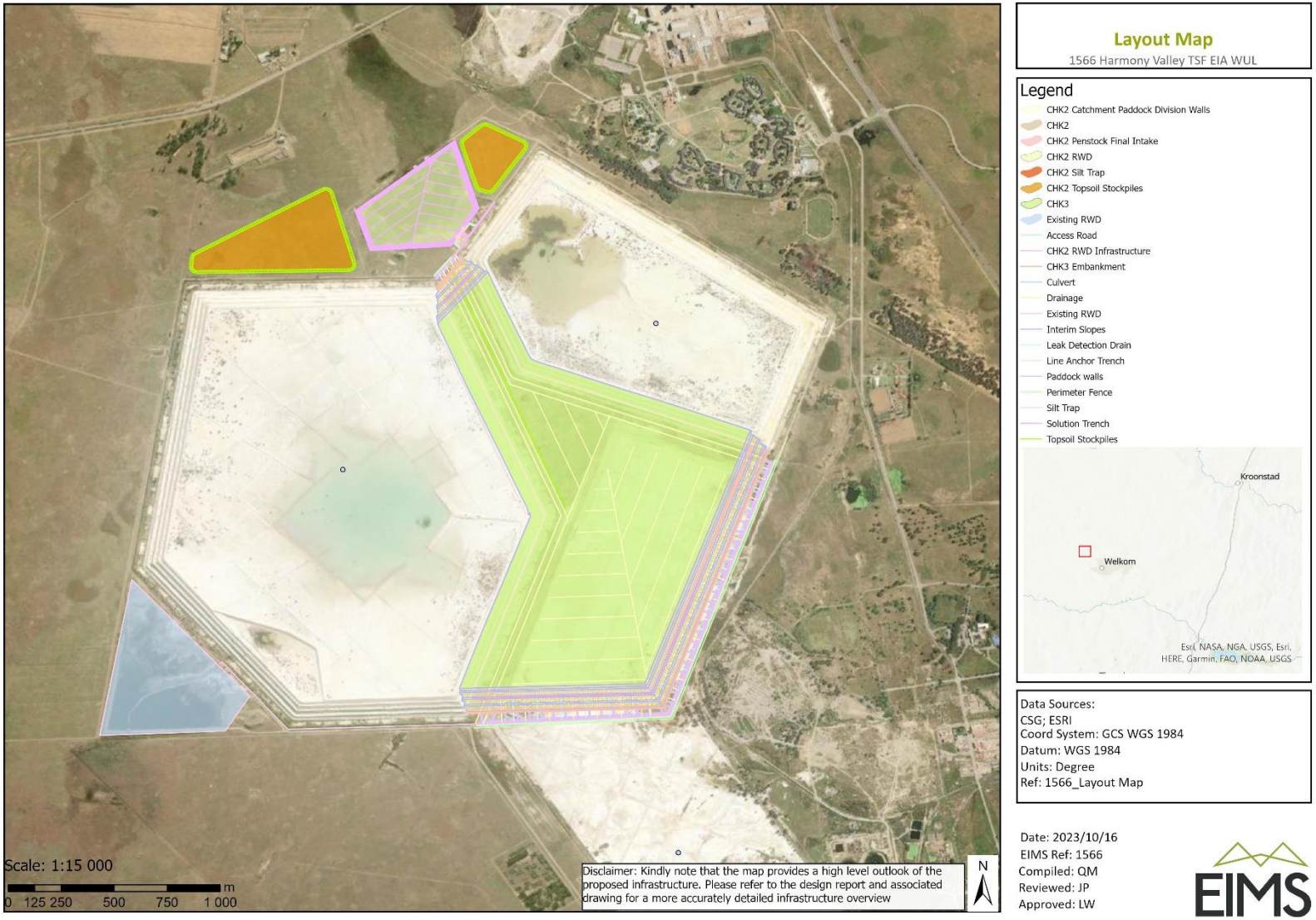

Figure 7: Layout and general arrangement of the proposed Valley TSF (the map also includes the liner alternative as per technology alternative 2)

3.2 LISTED AND SPECIFIED ACTIVITIES TRIGGERED

The proposed TSF requires amongst others an EA and a WML to operate, this will be undertaken as an integrated application. The listed activities that are triggered by the project in terms of the 2014 EIA Regulations GN983, 984 and 985 promulgated under the National Environmental Management Act (Act 107 of 1998 - NEMA) are specified below. Various changes have been made to the applicable listed activities since the scoping phase. The updated listed is presented Table 3 below. A revised application form is being submitted to DMRE in line with this list (Appendix A). Activities considered to be no longer applicable have been struck out.

Table 3: Relevant NEMA listed activities.

Activity No(s):	Activity	Portion of the proposed project to which the applicable listed activity relates.
GN983, Activity 10	The development and related operation of infrastructure exceeding 1 000 metres in length for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes- (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more; excluding where- (a) such infrastructure is for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes inside a road reserve or railway line reserve; or (b) where such development will occur within an urban area.	Various pipelines over 1000m in length and 0.36m in diameter are proposed as part of the project which will trigger this activity including penstock pipelines and drainage collection pipelines.
GN983, Activity 12	The development of- (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- (a) within a watercourse; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse;- excluding- (aa) the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such development activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such development occurs within an urban area;	Various wetlands were identified within and in close proximity to the proposed TSF site. The TSF has a footprint of over 100 square meters and will be located across various identified wetlands.

Activity No(s):	Activity	Portion of the proposed project to which the applicable listed activity relates.
	(ee) where such development occurs within existing roads, road reserves or railway line reserves; or (ff) the development of temporary infrastructure or structures where such infrastructure or structures will be removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared.	
GN983, Activity 19	"The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse; but excluding where such infilling, depositing, dredging, excavation, removal or moving- (a) will occur behind a development setback; (b) is for maintenance purposes undertaken in accordance with a maintenance management plan; (c) falls within the ambit of activity 21 in this Notice, in which case that activity applies; (d) occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or (e) where such development is related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies."	Various wetlands were identified within and in close proximity to the proposed TSF site. Infilling and dredging of over 10 cubic meters of material in these identified wetlands within the TSF footprint will be required.
GN983, Activity 21D	Any activity including the operation of that activity which requires an amendment or variation to a right or permit in terms of section 102 of the Mineral and Petroleum Resources Development Act, as well as any other applicable activity contained in this Listing Notice or in Listing Notice 3 of 2014, required for such amendment.	Amendment of the approved Mining Right EMPr through a MPRDA Section 102 application will be required.
~~**GN983, Activity 24**~~	~~The development of a road-~~ ~~(ii) with a reserve wider than 13,5 meters, or where no reserve exists where the road is wider than 8 metres;~~ ~~but excluding a road-~~ ~~(a) which is identified and included in activity 27 in Listing Notice 2 of 2014;~~ ~~(b) where the entire road falls within an urban area; or~~ ~~(c) which is 1 kilometre or shorter.~~	~~Details of access roads are still to be confirmed however this activity may be triggered.~~ Access roads for facility will not be wide enough to trigger this activity.
~~**GN983, Activity 31**~~	~~The closure of existing facilities, structures or infrastructure for-~~ ~~(i) any development and related operation activity or activities listed in this Notice, Listing Notice 2 of 2014 or Listing Notice 3 of 2014;~~ ~~excluding where-~~ ~~(aa) .....~~ ~~(bb) the closure is covered by part 8 of the National Environmental Management: Waste~~	~~Closure and Decommissioning of the TSF in the future.~~ No longer deemed necessary – closure forms part of a mining application.

Activity No(s):	Activity	Portion of the proposed project to which the applicable listed activity relates.
	~~Act, 2008 (Act No. 59 of 2008) as decommissioning, in which case the National Environmental Management: Waste Act, 2008 applies; or~~ ~~(cc) such closure forms part of a mining application, in which case the requirements of the Financial Provisioning Regulations apply.~~	
~~**GN983, Activity 46**~~	~~The expansion and related operation of infrastructure for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes where the existing infrastructure-~~ ~~(i) has an internal diameter of 0,36 metres or more; or~~ ~~(ii) has a peak throughput of 120 litres per second or more; and~~ ~~(a) where the facility or infrastructure is expanded by more than 1 000 metres in length; excluding where such expansion-~~ ~~(aa) relates to the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes within a road reserve or railway line reserve; or~~ ~~(bb) will occur within an urban area.~~	Expansion no longer deemed applicable – this is a new project.
~~**GN983, Activity 48**~~	~~The expansion of-~~ ~~(i) infrastructure or structures where the physical footprint is expanded by 100 square metres or more; or~~ ~~where such expansion occurs-~~ ~~(a) within a watercourse;~~ ~~(c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse;~~ ~~excluding-~~ ~~(aa) the expansion of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour;~~ ~~(bb) where such expansion activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies;~~ ~~(cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 23 in Listing Notice 3 of 2014, in which case that activity applies;~~ ~~(dd) where such expansion occurs within an urban area; or~~ ~~(ee) where such expansion occurs within existing roads, road reserves or railway line reserves.~~	Expansion no longer deemed applicable – this is a new project.
~~**GN 983, Activity 56**~~	~~The widening of a road by more than 6 metres, or the lengthening of a road by more than 1 kilometre-~~ ~~(i) where the existing reserve is wider than 13,5 meters; or~~	~~Details of access roads are still to be confirmed however this activity may be triggered.~~

Activity No(s):	Activity	Portion of the proposed project to which the applicable listed activity relates.
	~~(ii) where no reserve exists, where the existing road is wider than 8 metres;~~ ~~excluding where widening or lengthening occur inside urban areas.~~	No widening or lengthening of roads required.
GN984, Activity 6	The development of facilities or infrastructure for any process or activity which requires a permit or licence or an amended permit or licence in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent, excluding- (i) activities which are identified and included in Listing Notice 1 of 2014; (ii) activities which are included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case the National Environmental Management: Waste Act, 2008 applies; (iii) the development of facilities or infrastructure for the treatment of effluent, polluted water, wastewater or sewage where such facilities have a daily throughput capacity of 2 000 cubic metres or less; or (iv) where the development is directly related to aquaculture facilities or infrastructure where the wastewater discharge capacity will not exceed 50 cubic metres per day.	Although the TSF is included in the list of waste management activities, the WUL application includes 21(g) activities for which this activity will find applicability.
GN984, Activity 15	The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan.	Clearance of over 20ha of indigenous vegetation will be required for the TSF footprint. The total area to be cleared is 163ha. The amount of indigenous vegetation to be cleared was calculated to be just over 20 ha.
GN985 Activity 4	The development of a road wider than 4 metres with a reserve less than 13,5 metres. b. Free State (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;	A 5m wide all-weather access road is provided around the facility to all key infrastructure for operational and monitoring requirements. The new roads will be 2km in length, Part of the site falls within an ESA 2 area (refer to map included in Appendix I).
GN985 Activity 12	The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. b. Free State	Clearance of over 300 square meters of indigenous vegetation is required from within wetland areas. Part of the site also falls within an ESA 2 area.

Activity No(s):	Activity	Portion of the proposed project to which the applicable listed activity relates.
	iv. Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland	
GN985 Activity 14	"The development of- (ii) infrastructure or structures with a physical footprint of 10 square metres or more; where such development occurs- (a) within 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.". b. Free State (ff) Critical biodiversity areas or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans	Various wetlands were identified within the identified TSF site. Part of the site falls within an ESA 2 area.
~~**GN985 Activity 18**~~	~~The widening of a road by more than 4 metres, or the lengthening of a road by more than 1 kilometre.~~ ~~b. Free State~~ ~~(cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority.~~	~~Details of access roads are still to be confirmed however this activity may be triggered. Part of the site falls within an ESA 2 area.~~ No widening or lengthening of roads required.
~~**GN985 Activity 23**~~	~~The expansion of-~~ ~~(ii) infrastructure or structures where the physical footprint is expanded by 10 square metres or more;~~ ~~where such expansion 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;~~ ~~b. Free State~~ ~~(cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority.~~	Expansion no longer deemed applicable – this is a new project.

The listed activities that are triggered by the project in terms of GN921 promulgated under the National Environmental Management Waste Act (Act 59 of 2008 - NEMWA) are specified in Table 4 below:

Table 4: Applicable NEMWA Activities

Activity No(s):	Activity	Portion of the proposed project to which the applicable listed activity relates.
Category A, Activity 14	The decommissioning of a facility for a waste management activity listed in Category A or B of this Schedule.	TSF decommissioning once operational phase (deposition) has concluded.
Category B, Activity B7	The disposal of any quantity of hazardous waste to land.	TSF operation
Category B, Activity B10	The construction of a facility for a waste management activity listed in Category B of this	TSF construction

Activity No(s):	Activity	Portion of the proposed project to which the applicable listed activity relates.
	Schedule (not in isolation to associated waste management activity).	
Category B, Activity B11	The establishment or reclamation of a residue stockpile or residue deposit resulting from activities which require a mining right, exploration right or production right in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)	TSF construction / operation

The Department of Mineral Resources and Energy (DMRE) has been identified as the CA for the NEMA and NEM:WA listed activities triggered by the project. A separate application for a Water Use Licence (WUL) has also been lodged with the Department of Water and Sanitation (DWS) for the water use triggers.

4 POLICY AND LEGISLATIVE CONTEXT

This section provides an overview of the governing legislation identified which relates to the proposed project .Environmental legislation applicable to the project includes those discussed below.

4.1 THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT (MPRDA)

The MPRDA aims to "make provision for equitable access to, and sustainable development of, the nation's mineral and petroleum resources". The MPRDA outlines the procedural requirements that need to be met to acquire mineral and petroleum rights in South Africa. The MPRDA further governs the sustainable utilisation of South Africa's mineral resources.

Several amendments have been made to the MPRDA. These include, but are not limited to, the amendment to Section 102 which concerns the amendment of rights, permits, programmes and plans, to requiring the written permission from the Minister for any amendment or alteration; and the Section 5A(c) requirement that landowners or land occupiers receive twenty-one (21) days' written notice prior to any activities taking place on their properties. One of the most recent amendments requires all mining related activities to follow the full NEMA process as per the 2014 EIA Regulations, which came into effect on 4 December 2014 as was last amended in April 2017.

In support of the separate WML application specifically, the applicant is required to conduct an EIA process comprising of the preparation of environmental Scoping and EIA Reports, an EMPr, as well as Interested and Affected Party (I&AP) consultations, all of which must be submitted to the DMRE for adjudication. This report has been compiled in accordance with Regulation 49 of the MPRDA and Regulation 21 and Appendix 2 of the EIA Regulations (2014, as amended) in order to satisfy the criteria for an EIA Report. This EIA Report pertains to both the NEMA and WML application for the proposed new Valley TSF.

4.2 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (NEMA)

The main aim of the National Environmental Management Act, 1998 (Act 107 of 1998 – NEMA) is to provide for co-operative governance by establishing decision-making principles on matters affecting the environment. In terms of the NEMA EIA Regulations, the applicant is required to appoint an EAP to undertake the EIA process, as well as conduct the public participation process towards an application for EA/WML. In South Africa, EIA's became a legal requirement in 1997 with the promulgation of regulations under the Environment Conservation Act (ECA). Subsequently, NEMA was passed in 1998. Section 24(2) of NEMA empowers the Minister and any MEC, with the concurrence of the Minister, to identify activities which must be considered, investigated, assessed and reported on to the competent authority responsible for granting the relevant EA. On 21 April 2006, the Minister of Environmental Affairs and Tourism (now DFFE) promulgated regulations in terms of Chapter 5 of the NEMA. These regulations, in terms of the NEMA, were amended in June 2010 and again in December 2014 as well as April 2017. The 2014 NEMA EIA Regulations (as amended) are applicable to this project. Mining activities, including activities such as the proposed TSF officially became governable under the NEMA EIA Regulations (as amended) in December 2014 with the competent authority identified as the DMRE for the waste listed activities and provincial DESTEA for the NEMA listed activities.

The objective of the EIA Regulations is to establish the procedures that must be followed in the consideration, investigation, assessment and reporting of the listed activities that are triggered by the proposed project. The purpose of these procedures is to provide the competent authority with adequate information to make informed decisions which ensure that activities which may impact negatively on the environment to an unacceptable degree are not authorised, and that activities which are authorised are undertaken in such a manner that the environmental impacts are managed to acceptable levels.

In accordance with the provisions of Sections 24(5) and Section 44 of the NEMA the Minister has published Regulations (GN R. 982) pertaining to the required process for conducting EIA's in order to apply for, and be considered for, the issuing of an EA/WML. These EIA Regulations provide a detailed description of the EIA process to be followed when applying for EA/WML for any listed activity.

An environmental Scoping and Impact Assessment process is reserved for activities which have the potential to result in significant impacts which are complex to assess. Scoping and Impact Assessment studies accordingly provide a mechanism for the comprehensive assessment of activities that are likely to have more significant environmental impacts. Figure 8 below provides a graphic representation of all the components of a full EIA process.

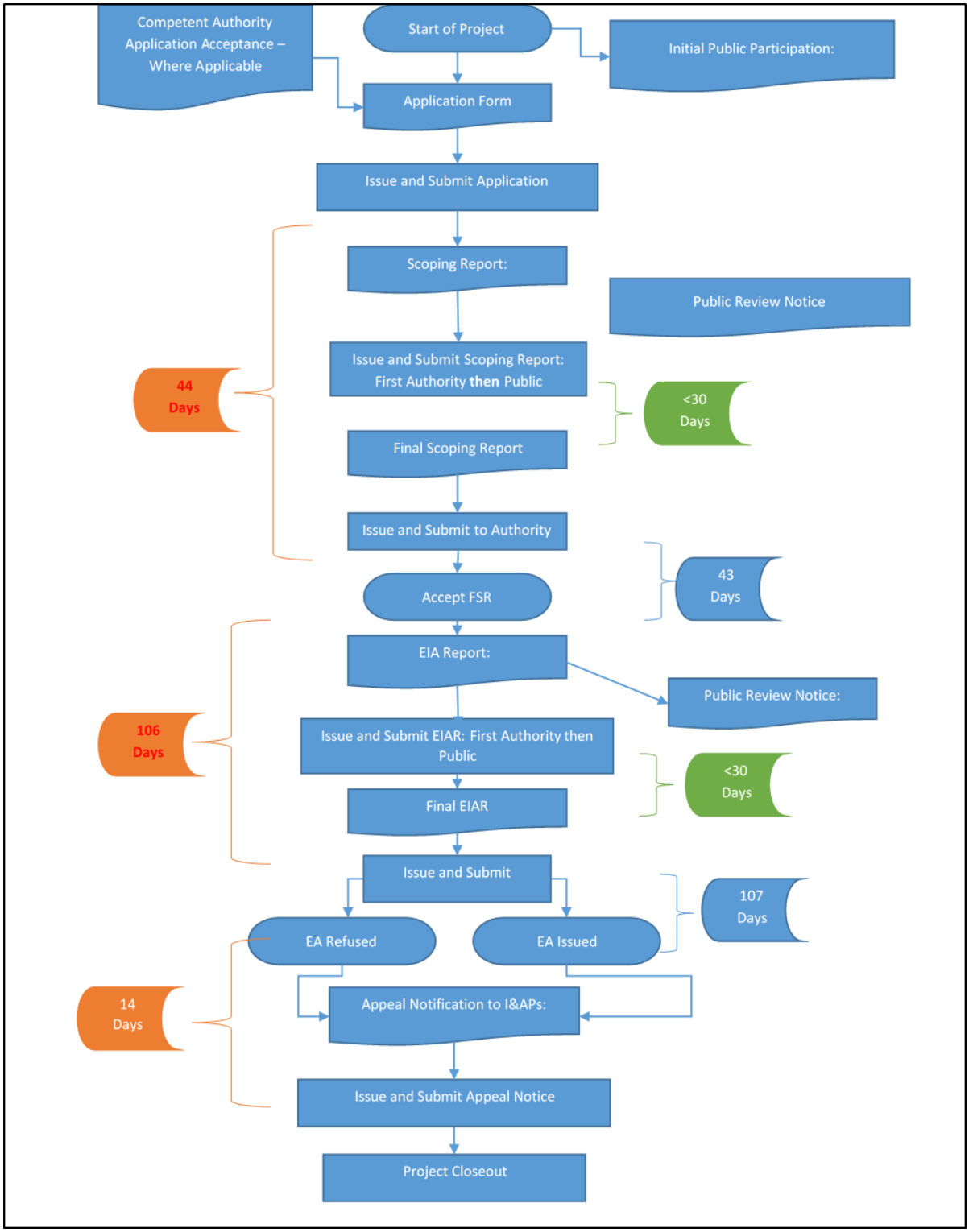

Figure 8: EIA process diagram

Section 24P of the NEMA requires that an applicant for an environmental authorisation relating to prospecting, mining or production must, before the Minister responsible for mineral resources issues the EA, comply with

the prescribed financial provision for the rehabilitation, closure and ongoing post decommissioning management of negative environmental impacts. Therefore, the potential environmental liabilities associated with the proposed activity must be quantified and the method of financial provision indicated in line with the NEMA Financial Provision Regulations (2015). The financial provision costs are included as Appendix J.

4.3 THE NATIONAL WATER ACT (NWA)

The National Water Act, 1998 (Act 36 of 1998 – NWA) makes provision for two types of applications for water use licences, namely individual applications and compulsory applications. The NWA also provides that the responsible authority may require an assessment by the applicant of the likely effect of the proposed licence on the resource quality, and that such assessment be subject to the NEMA EIA Regulations. A person may use water if the use is –

- Permissible as a continuation of an existing lawful water use (ELWU);
- Permissible in terms of a general authorisation (GA);
- Permissible under Schedule 1; or
- Authorised by a licence.

These water use processes are described in Figure 9.

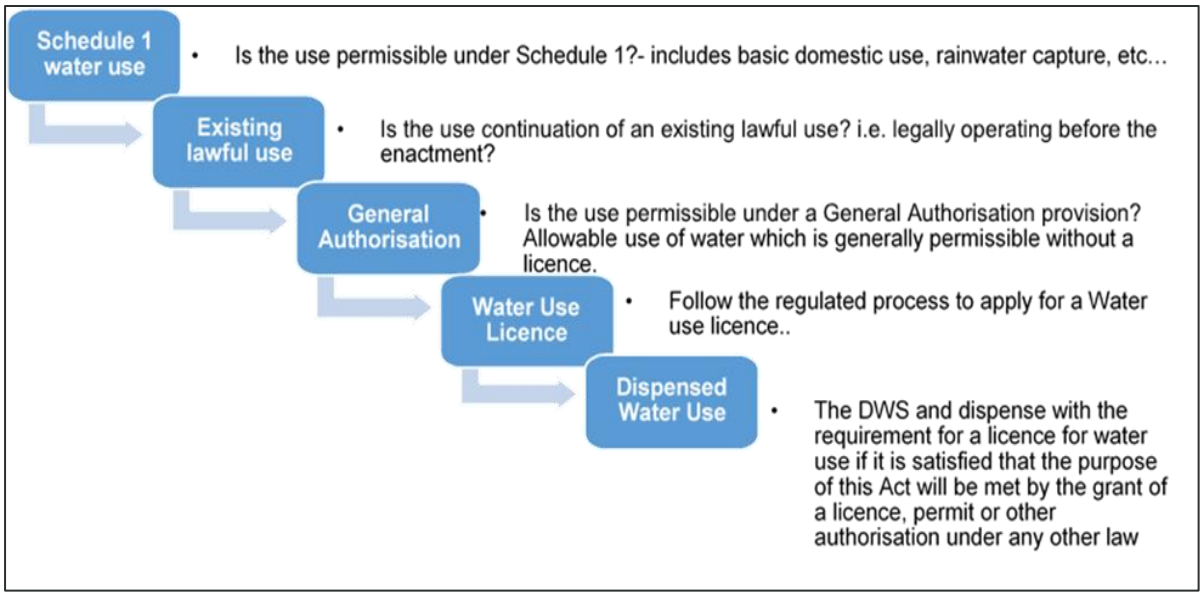

Figure 9: Authorisation processes for new water uses

The NWA defines 11 water uses. A water use may only be undertaken if authorised by the Department of Human Settlements Water and Sanitation (DHSWS). The water uses for which an authorisation or licence can be issued include:

- Taking water from a water resource;
- Storing water;
- Impeding or diverting the flow of water in a watercourse;
- Engaging in a stream flow reduction activity contemplated in section 36;
- Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);
- Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduits;

- Disposing of waste in a manner which may detrimentally impact on a water resource;
- Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
- Altering the bed, banks, course or characteristics of a watercourse;
- Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
- Using water for recreational purposes.

4.4 NWA GOVERNMENT NOTICE 704 (GN 704)

GN 704 (Government Gazette 20118 of June 1999) was established to provide regulations on the use of water for mining and related activities aimed at the protection of water resources. The five main principal conditions of GN 704 applicable to this project are:

- Condition 4 – which defines the area in which, mine workings or associated structures may be located, with reference to a watercourse and associated flooding. Any residue deposit, dam, reservoir together with any associated structure or any other facility should be situated outside the 1:100 year flood-line. Any underground or opencast mining, prospecting or any other operation or activity should be situated or undertaken outside of the 1:50 year flood-line. Where the flood-line is less than 100 metres away from the watercourse, then a minimum watercourse buffer distance of 100 metres is required for infrastructure and activities;
- Condition 5 – which indicates that no residue or substance which causes or is likely to cause pollution of a water resource may be used in the construction of any dams, impoundments or embankments or any other infrastructure which may cause pollution of a water resource;
- Condition 6 – which describes the capacity requirements of clean and dirty water systems. Clean and dirty water systems must be kept separate and must be designed, constructed, maintained and operated to ensure conveyance the 1:50 year peak flow. Clean and dirty water systems should not spill into each other more frequently than once in 50 years. Any dirty water dams should have a minimum freeboard of 0.8m above full supply level;
- Condition 7 – which describes the measures which must be taken to protect water resources. All dirty water or substances which may cause pollution should be prevented from entering a water resource (by spillage, seepage, erosion, etc.) and ensure that water used in any process is recycled as far as practicable; and
- Condition 10 – which describes the requirements for operations involving extraction of material from the channel of a watercourse. Measures should be taken to prevent impacts on the stability of the watercourse, prevent scour and erosion resulting from operations, prevent damage to in-stream habitat through erosion, sedimentation, alteration of vegetation and flow characteristics, construct treatment facilities to treat water before returning it to the watercourse, and implement control measures to prevent pollution by oil, grease, fuel and chemicals.

The proposed new TSF will not be located within the 1:100 year floodline of a watercourse and is located almost 3km from the closest stream / river, however, it will be located within 100m from the edge of a watercourse (i.e. the identified wetlands). Therefore, exemption from GN704 requirements will find applicability as part of the WULA for the project.

4.5 CATCHMENT MANAGEMENT STRATEGIES

South Africa is divided into nineteen Water Management Areas (WMAs). The delegation of water resource management from central government to catchment level is achieved by establishing Catchment Management Agencies (CMAs) at WMA level. Each CMA progressively develops a Catchment Management Strategy (CMS) for

the protection, use, development, conservation, management and control of water resources within its WMA. This is to ensure that on a regional scale, water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner for the benefit of all persons. The main instrument that guides and governs the activities of a WMA is the Catchment Management Strategy (CMS) which, while conforming to relevant legislation and national strategies, provides detailed arrangements for the protection, use, development, conservation, management and control of the region's water resources. The site is positioned within quaternary catchment C43B which has an area of 723 km^2 and C25B which has an area of 1 895km^2 both of which are located within the Middle Vaal WMA. The Mahemspruit River is the only defined river relevant to this assessment (when considering the more detailed 1:50,000 topographical map data).

According to the Middle Vaal WMA Internal Strategic Perspective (2004), the land use in the Middle Vaal WMA is characterised by agriculture with the main irrigation crops being wheat, maize, groundnuts, sorghum and sunflowers. There are also extensive gold mining activities located in the Middle Vaal water management area. These activities are generating substantial return flow volumes in the form of treated effluent from the urban areas and mine dewatering that are discharged into the river system. These discharges are having significant impacts on the water quality in the main stem of the Vaal River in the Middle Vaal WMA.

The Broad Management Objectives within the Middle Vaal WMA include:

- To manage the water quality by setting WQOs and developing a CMS as per the Water Quality Management Strategy.
- The monitoring of the system to provide management information for water quality management, abstraction control and input to the overarching operations and planning processes.
- Provide input into the supply of local authorities from local groundwater and surface water resources. This will be in the form of strategic level guidance as to where water can be obtained, and the level of study needed to be submitted with the license application.
- Promotion of WC&DM through the water service providers and local authorities to achieve efficient use of water. Only once efficient use has been achieved can further transfers be considered.

Harmony has submitted an IWULA to ensure that any water resources (surface and groundwater as well as wetlands) affected by the proposed project activities are licensed and managed in accordance with the relevant water and environmental legislation.

4.6 THE NATIONAL ENVIRONMENTAL MANAGEMENT WASTE ACT (NEMWA)

On 2 June 2014, the National Environmental Management: Waste Amendment Act came into force. Waste is, accordingly, no longer governed by the MPRDA but is subject to all the provisions of the National Environmental Management: Waste Act, 2008 (NEMWA).

Section 16 of the NEMWA must also be considered which states as follows:

1. A holder of waste must, within the holder's power, take all reasonable measures to-
    a) "*Avoid the generation of waste and where such generation cannot be avoided, to minimise the toxicity and amounts of waste that are generated;*
    b) *Reduce, re-use, recycle and recover waste;*
    c) *Where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner;*
    d) *Manage the waste in such a manner that it does not endanger health or the environment or cause a nuisance through noise, odour, or visual impacts;*
    e) *Prevent any employee or any person under his or her supervision from contravening the Act; and*
    f) *Prevent the waste from being used for unauthorised purposes.*"

These general principles of responsible waste management will be incorporated into the requirements in the EMPr to be implemented for this project.

Waste can be defined as either hazardous or general in accordance with Schedule 3 of the NEMWA (2014) as amended. "Schedule 3: Defined Wastes" has been broken down into two categories – Category A being hazardous waste; and Category B being general waste.

In order to attempt to understand the implications of these waste groups, it is important to ensure that the definitions of all the relevant terminologies are defined:

- Hazardous waste: means "*any waste that contains organic or inorganic elements or compounds that may, owning to the inherent physical, chemical or toxicological characteristic of that waste, have a detrimental impact on health and the environment and includes hazardous substances, materials or objects within business waste, residue deposits and residue stockpiles*."
- Residue deposits: means "*any residue stockpile remaining at the termination, cancellation or expiry of a prospecting right, mining right, mining permit, exploration right or production right*."
- Residue stockpile: means "*any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, mineral processing plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated within the mining area for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or, production right or an old order right, including historic mines and dumps created before the implementation of this Act*."
- General waste: means "*waste that does not pose an immediate hazard or threat to health or to the environment and includes – domestic waste; building and demolition waste; business waste; inert waste; or any waste classified as non-hazardous waste in terms of the regulations made under Section 69*."

Furthermore, the NEMWA provides for specific waste management measures to be implemented, as well as providing for the licensing and control of waste management activities. The proposed new TSF waste management activities in terms of Category B of GN R. 921 which states that "*a person who wishes to commence, undertake or conduct an activity listed under this Category, must conduct an environmental impact assessment process, as stipulated in the environmental impact assessment regulations made under section 24(5) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) as part of a waste management licence application*."

The listed waste activities that are triggered by the new TSF, and which form the basis of this waste management licence application, are presented in Table 5.

Table 5: List of waste activities that are triggered by the proposed TSF

Waste Category and Number	Description
Category B7	The disposal of any quantity of hazardous waste to land.
Category B10	The construction of a facility for a waste management activity listed in Category B of this Schedule (not in isolation to associated waste management activity).
Category B11	The establishment or reclamation of a residue stockpile or residue deposit resulting from activities which require a mining right, exploration right or production right in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).

4.7 NEMWA WASTE CLASSIFICATION AND MANAGEMENT REGULATIONS, 2013 (GN R. 634)

These regulations pertain to waste classification and management, including the management and control of residue stockpiles and residue deposits from a prospecting, mining, exploration or production operation which is relevant to the proposed project. The purpose of these Regulations is to –

- Regulate the classification and management of waste in a manner which supports and implements the provisions of the Act;
- Establish a mechanism and procedure for the listing of waste management activities that do not require a Waste Management Licence;
- Prescribe requirements for the disposal of waste to landfill;
- Prescribe requirements and timeframes for the management of certain wastes; and
- Prescribe general duties of waste generators, transporters and managers.

Waste classification, as presented in Chapter 4 of these regulations, entails the following:

- Wastes listed in Annexure 1 of these Regulations do not require classification in terms of SANS 10234;
- Subject to sub regulation (1), all waste generators must ensure that the waste they generate is classified in accordance with SANS 10234 within one hundred and eighty (180) days of generation;
- Waste must be kept separate for the purposes of classification in terms of sub regulation (2), and must not be mixed prior to classification;
- Waste-must be re-classified in terms of sub regulation (2) every five (5) years, or within 30 days of modification to the process or activity that generated the waste, changes in raw materials or other inputs, or any other variation of relevant factors;
- Waste that has been subjected to any form of treatment must be re-classified in terms of sub regulation (2), including any waste from the treatment process; and
- If the Minister reasonably believes that a waste has not been classified correctly in terms of sub regulation (2), he or she may require the waste generator to have the classification peer reviewed to confirm the classification.

Furthermore, Chapter 8 of the Regulations stipulates that unless otherwise directed by the Minister to ensure a better environmental outcome, or in response to an emergency so as to protect human health, property or the environment –

- Waste generators must ensure that their waste is assessed in accordance with the Norms and Standards for Assessment of Waste for Landfill Disposal set in terms of section 7(1) of the Act prior to the disposal of the waste to landfill;
- Waste generators must ensure that the disposal of their waste to landfill is done in accordance with the Norms and Standards for Disposal of Waste to Landfill set in terms of section 7(1) of the Act; and
- Waste managers disposing of waste to landfill must only do so in accordance with the Norms and Standards for Disposal of Waste to Landfill set in terms of section 7 (1) of the Act.

The TSF barrier system for technology alternative 2 has been determined in consultation with the authorities and will be in compliance with these norms and standards. The gold tailings material classified as a Type 3 waste as provided by Jones and Wagner.

4.8 NEMWA NATIONAL NORMS AND STANDARDS FOR THE DISPOSAL OF WASTE TO LANDFILL, 2013 (GN R. 636)

Once the waste has been assessed and waste type determined, these Norms and Standards can be used to determine the minimum requirements for the landfill and containment barrier design. This will distinguish between Class A, Class B, Class C, or Class D landfills and the associated containment barrier requirements. Although these Norms and Standards prescribe the containment barrier or liner design for each determined waste type, the recent amendments in chapter 3 of the regulations to the planning and management of residue stockpiles and residue deposits, a competent person must recommend the pollution control measures suitable for a specific residue stockpile or residue deposit on the basis of a risk analysis as contemplated in regulations 4 and 5 of the regulations. The recommendation should be founded on a risk analysis based on the characteristics and classification in regulation 4 and 5 of these Regulations, towards determining the appropriate mitigation and management measures. The waste material solutes classify as a Type 3 waste. This requires a Class C liner system for the TSF and upgrades to the RWD.

4.9 THE REGULATIONS REGARDING THE PLANNING AND MANAGEMENT OF RESIDUE STOCKPILES AND RESIDUE DEPOSITS AND ASSOCIATED AMENDMENT

These Regulations, which pertain to the planning and management of residue stockpiles and residue deposits from a prospecting, mining, exploration or production operation, were published in 2015 and were amended in 2018. The Regulations and associated amendment relate to the assessment of impacts and the analyses of risks relating to the management of residue stockpiles and residue deposits, and involve the following:

- The identification and assessment of environmental impacts arising from the establishment of residue stockpiles and residue deposits must be done as part of the environmental impact assessment conducted in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998);
- A risk analysis based on the characteristics and the classification set out in regulation 4 (characterisation of residue stockpiles and residue deposits) and 5 (classification of residue stockpiles and residue deposits) of these regulations must be used to determine the appropriate mitigation and management measures; and
- A competent person must recommend the pollution control measures suitable for a specific residue stockpile or residue deposit on the basis of a risk analysis as contemplated in regulations 4 and 5 of these Regulations.

The proposed new TSF will be subject to these regulations. In this regard, the containment barrier design (including requirements for a liner and nature of the liner), will be addressed in accordance with chapter 3 of these Regulations and their associated amendments.

4.10 THE NATIONAL ENVIRONMENTAL MANAGEMENT AIR QUALITY ACT (NEMAQA)

The National Environmental Management: Air Quality Act (Act No. 39 of 2004 as amended – NEMAQA) is the main legislative tool for the management of air pollution and related activities. The Object of the Act is:

- To protect the environment by providing reasonable measures for –
    i. the protection and enhancement of the quality of air in the republic;
    ii. the prevention of air pollution and ecological degradation; and
    iii. securing ecologically sustainable development while promoting justifiable economic and social development; and

- Generally, to give effect to Section 24(b) of the constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people.

The NEMAQA mandates the Minister of Environment to publish a list of activities which result in atmospheric emissions and consequently cause significant detrimental effects on the environment, human health and social welfare. All scheduled processes as previously stipulated under the Air Pollution Prevention Act (APPA) are included as listed activities with additional activities being added to the list. The updated Listed Activities and Minimum National Emission Standards were published on the 22nd of November 2013 (Government Gazette No. 37054).

According to the NEMAQA, air quality management control and enforcement is in the hands of local government with District and Metropolitan Municipalities as the licensing authorities. Provincial government is primarily responsible for ambient monitoring and ensuring municipalities fulfil their legal obligations, with national government primarily as policy maker and co-ordinator. Each sphere of government must appoint an Air Quality Officer responsible for co-ordinating matters pertaining to air quality management. Given that air quality management under the old Act was the sole responsibility of national government, local authorities have in the past only been responsible for smoke and vehicle tailpipe emission control.

The National Pollution Prevention Plans Regulations were published in March 2014 (Government Gazette 37421) and tie in with the National Greenhouse Gas (GHG) Emission Reporting Regulations which took effect on 3 April 2017. In summary, the Regulations aim to prescribe the requirements that pollution prevention plans of greenhouse gases declared as priority air pollutants, need to comply with in terms of the NEMAQA. The Regulations specify who needs to comply, and by when, as well as prescribing the content requirements. Mines have an obligation to report on the GHG emissions under these Regulations.

4.11 NATIONAL DUST CONTROL REGULATIONS

Dustfall is assessed for nuisance impact and not for inhalation health impact. The National Dust Control Regulations (Department of Environmental Affairs, 2013) prescribes measures for the control of dust in residential and non-residential areas. Acceptable dustfall rates are measured (using American Standard Testing Methodology (ASTM) D1739:1970 or equivalent) at and beyond the boundary of the premises where dust originates. In addition to the dustfall limits, the National Dust Control Regulations prescribe monitoring procedures and reporting requirements. Dust that may be created from the proposed TSF will be managed in accordance with these Regulations.

4.12 THE NATIONAL HERITAGE RESOURCES ACT (NHRA)

The National Heritage Resources Act (Act 25 of 1999 – NHRA) stipulates that cultural heritage resources may not be disturbed without authorisation from the relevant heritage authority. Section 34(1) of the NHRA states that, "*no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority…*" The NHRA is utilised as the basis for the identification, evaluation and management of heritage resources and in the case of Cultural Resource Management (CRM) those resources specifically impacted on by development as stipulated in Section 38 of NHRA, and those developments administered through the NEMA, MPRDA and the Development Facilitation Act (FDA) legislation. In the latter cases the feedback from the relevant heritage resources authority is required by the State and Provincial Departments managing these Acts before any authorisations are granted for a development. The last few years have seen a significant change towards the inclusion of heritage assessments as a major component of Environmental Impact Processes required by the NEMA and MPRDA. This change requires us to evaluate the Section of these Acts relevant to heritage (Fourie, 2008).

The NEMA 23(2)(b) states that an integrated environmental management plan should, "*…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage*". A study of subsections (23)(2)(d), (29)(1)(d), (32)(2)(d) and (34)(b) and their requirements reveals the compulsory inclusion of the identification of cultural resources, the evaluation of the impacts of the proposed activity on these resources, the identification of alternatives and the management procedures for such cultural resources for each of the documents noted in the Environmental Regulations. A further important aspect to be

taken into account of in the EIA Regulations under the NEMA relates to the Specialist Report requirements (Appendix 6 of EIA Regulations 2014, as amended).

The MPRDA defines 'environment' as it is in the NEMA and, therefore, acknowledges cultural resources as part of the environment. Section 39(3)(b) of this Act specifically refers to the evaluation, assessment and identification of impacts on all heritage resources as identified in Section 3(2) of the NHRA that are to be impacted on by activities governed by the MPRDA. Section 40 of the same Act requires the consultation with any State Department administering any law that has relevance on such an application through Section 39 of the MPRDA. This implies the evaluation of Heritage Assessment Reports in Environmental Management Plans or Programmes by the relevant heritage authorities (Fourie, 2008).

In accordance with the legislative requirements and EIA rating criteria, the regulations of the South African Heritage Resources Agency (SAHRA) and Association of Southern African Professional Archaeologists (ASAPA) have also been incorporated to ensure that a comprehensive and legally compatible Heritage assessment report compiled.

4.13 NATIONAL ENVIRONMENTAL MANAGEMENT BIODIVERSITY ACT (NEMBA)

This Act is applicable since is protects the quality and quantity of arable land in South Africa. Loss of arable land should be avoided and declared Weeds and Invaders in South Africa are categorised according to one of the following categories, and require control or removal:

- *Category 1a Listed Invasive Species*: Category 1a Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be combated or eradicated;
- *Category 1b Listed Invasive Species*: Category 1b Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be controlled;
- *Category 2 Listed Invasive Species*: Category 2 Listed Invasive Species are those species listed by notice in terms of section 70(1)(a) of the Act as species which require a permit to carry out a restricted activity within an area specified in the Notice or an area specified in the permit, as the case may be; and
- *Category 3 Listed Invasive Species*: Category 3 Listed Invasive Species are species that are listed by notice in terms of section 70(1)(a) of the Act, as species which are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of Act, as specified in the Notice.

The provisions of this Act have been considered and where relevant will be incorporated into the proposed mitigation measures and requirements of the EMPr.

4.14 THE SUB-DIVISION OF AGRICULTURAL LAND ACT

In terms of the Subdivision of Agricultural Land Act (Act 70 of 1970), any application for change of land use must be approved by the Minister of Agriculture, and while under the Conservation of Agricultural Resources Act (Act 43 of 1983) no degradation of natural land is permitted. No rezoning or subdivision of land is anticipated to be required for the Valley TSF project as the properties are located within a mining right area.

4.15 THE CONSERVATION OF AGRICULTURAL RESOURCES ACT (CARA)

The law on Conservation of Agricultural Resources (Act 43 of 1983) aims to provide for the conservation of the natural agricultural resources of the Republic by the maintenance of the production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants. In order to achieve the objectives of this Act, control measures related to the following may be prescribed to land users to whom they apply:

- The cultivation of virgin soil;
- The utilisation and protection of land which is cultivated;
- The irrigation of land;

- The prevention or control of waterlogging or salination of land;
- The utilisation and protection of vleis, marshes, water sponges, water courses and water sources;
- The regulating of the flow pattern of run-off water;
- The utilisation and protection of the vegetation;
- The grazing capacity of veld, expressed as an area of veld per large stock unit;
- The maximum number and the kind of animals which may be kept on veld; The prevention and control of veld fires;
- The utilisation and protection of veld which has burned;
- The control of weeds and invader plants;
- The restoration or reclamation of eroded land or land which is otherwise disturbed or denuded;
- The protection of water sources against pollution on account of farming practices;
- The construction, maintenance, alteration or removal of soil conservation works or other structures on land; and
- Any other matter which the Minister may deem necessary or expedient in order that the objects of this Act may be achieved.

Further, different control measures may be prescribed in respect of different classes of land users or different areas or in such other respects as the Minister may determine. Potential impacts on the soil, biodiversity and water resources have been identified with regards to the proposed new TSF, and mitigation and management measures recommended. These will be updated during the EIA phase of this project as and where necessary.

4.16 THE SPATIAL PLANNING AND LAND USE MANAGEMENT ACT (SPLUMA)

The Spatial Planning and Land Use Management (Act 16 of 2013 – SPLUMA) is set to aid effective and efficient planning and land use management, as well as to promote optimal exploitation of minerals and mineral resources. The SPLUMA was developed to legislate for a single, integrated planning system for the entire country. Therefore, the Act provides a framework for a planning system for the country and introduces provisions to cater for development principles; norms and standards; inter-governmental support; Spatial Development Frameworks (SDFs) across national, provincial, regional and municipal areas; Land Use Schemes (LUS); and municipal planning tribunals. Furthermore, the SPLUMA strengthens the position of mining right holders when land needs to be re-zoned for mining purposes. No rezoning of any of the properties for the Valley TSF site will be required as the properties fall within an approved mining right.

4.17 ENVIRONMENT CONSERVATION ACT (ECA)

The Environment Conservation Act (Act 73 of 1989 – ECA) was, prior to the promulgation of the NEMA, the backbone of environmental legislation in South Africa. To date the majority of the ECA has been repealed by various other Acts, however Section 25 of the Act and the Noise Regulations (GN R. 154 of 1992) promulgated under this section are still in effect. These Regulations serve to control noise and general prohibitions relating to noise impact and nuisance.

4.18 NOISE CONTROL REGULATIONS, 1992 (GN R.154)

In terms of section 25 of the ECA, the National Noise Control Regulations (GN R. 154 – NCRs) published in Government Gazette No. 13717 dated 10 January 1992, were promulgated. The NCRs were revised under GN R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations. Provincial noise control regulations have been promulgated in Free State Province. The NCRs will need to be considered in relation to

the potential noise that may be generated mainly during the construction phase of the proposed project. The two key aspects of the NCRs relate to disturbing noise and noise nuisance.

Section 4 of the Regulations prohibits a person from making, producing or causing a disturbing noise, or allowing it to be made produced or caused by any person, machine, device or apparatus or any combination thereof. A disturbing noise is defined in the Regulations as "*a noise level which exceeds the zone sound level or if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more*."

Section 5 of the NCRs in essence prohibits the creation of a noise nuisance. A noise nuisance is defined as "*any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person".* The South African National Standard 10103 also applies to the measurement and consideration of environmental noise and should be considered in conjunction with these Regulations.

4.19 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from mines, industry and roads. They are:

- South African National Standard (SANS) 10103:2008 – 'The measurement and rating of environmental noise with respect to annoyance and to speech communication';
- SANS 10210:2004 – 'Calculating and predicting road traffic noise';
- SANS 10328:2008 – 'Methods for environmental noise impact assessments';
- SANS 10357:2004 – 'The calculation of sound propagation by the Concave method';
- SANS 10181:2003 – 'The Measurement of Noise Emitted by Road Vehicles when Stationary'; and
- SANS 10205:2003 – 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful per se.

4.20 NATIONAL RADIOACTIVE WASTE DISPOSAL INSTITUTE ACT 53 OF 2008

In terms of this Act the generators of radioactive waste are responsible for technical, financial and administrative management of such waste within the national regulatory framework at their premises and when such waste is transported to an authorised waste disposal facility. The generators of radioactive waste are responsible for technical, financial and administrative management of such waste within the national regulatory framework at their premises and when such waste is transported to an authorised waste disposal facility.

Generators of radioactive waste must:

(a) develop and implement site-specific waste management plans based on national policy;

(b) provide all relevant information on radioactive waste as required by the chief executive officer;

(c) demonstrate compliance with any conditions of a radioactive waste disposal certificate;

(d) provide site access to staff of the Institute for inspection against any conditions of the radioactive waste disposal certificate.

The TSF slurry is considered radioactive waste. Generators of radioactive waste remain responsible for all liabilities in connection with such radioactive waste under their control.

4.21 OTHER APPLICABLE ACTS AND GUIDELINES

Other applicable acts and guidelines include The National Veld and Forest Fire Act 101 of 1998 and The Matjhabeng Local Municipality Land Use Scheme, 2021/22. In addition, the municipal planning documents such as The Matjhabeng Local Municipality Spatial Development Framework, and The Matjhabeng Local Municipality By-laws on Spatial Planning and Land Use Management are also applicable to the project. In addition the GISTM is also applicable to the TSF management.

4.21.1 GLOBAL INDUSTRY STANDARD ON TAILINGS MANAGEMENT (GISTM) AND SOCIAL PERFORMANCE

The Global Industry Standard on Tailings Management (GISTM) is organised around six Topic areas, 15 Principles and 77 auditable Requirements. The aim of the standard is to adopt an integrated approach to tailings management. Social performance spans all six Topic Areas of the Standard, with specialist components defined in 14 (18 %) of the Standard's 77 Requirements, with a further 18 Requirements (23 % of the Standard) requiring operators to integrate social performance inputs into processes, systems, and decisions about tailings facility management (Joyce & Kemp, 2020).

Figure 10: Summary of GISTM

Under Topic I, Affected Communities there are four explicit social performance requirements namely consideration of human rights throughout the lifecycle of the TSF, Free, Prior, Informed Consent of indigenous

and tribal people, meaningful engagement, and a grievance mechanism. Topic II, Integrated Knowledge Base package social, environmental, and local economic conditions together. Understanding of local context, human exposure and vulnerability is important in this topic. Impact assessment and mitigation plans fall under this topic. Although Topic III, Design, Construction, Operation and Monitoring deals mainly with technical aspects, social requirements are included when additional steps to minimise consequences are considered, and in the mention that international standards should be followed if involuntary resettlement is required.

Topic IV, Management and Governance requires the establishment of a tailings governance framework and confirms the Environmental and Social Management System (ESMS) as an integral component. This topic nominates one or more Accountable Executive(s) as responsible for, amongst other matters, avoiding or minimising the consequences of a tailings facility failure for local people. Other requirements include multi-disciplinary risk assessments, and the review and audit of the ESMS as it relates to the tailings facility.

Topic V, Emergency Preparedness and Recovery is critically important from a social performance perspective. It requires meaningful engagement with employees and contractors in the development of Emergency Preparedness and Response Plans, and 'locks in' the role of project-affected people in the co-development of community-focused emergency preparedness measures. Topic V also cover the long-term recovery of people and the environment in the event of a catastrophic failure event – a topic that is not covered in any other tailings or social performance standard. Requirement 14.1 asks operators to take reasonable steps, before a failure event, to meaningfully engage with public sector agencies and other organisations that would participate in medium- and long-term social and environmental post-failure response strategies. These agencies are likely to be quite different to the first responder groups engaged. Topic V would involve post hoc impact assessments, and stakeholder engagement to develop and implement plans that enable the participation of affected people in restoration and recovery works and ongoing monitoring activities.

The documents listed under Topic VI, Public Disclosure and Access to Information will likely be in the hands of other functions, such as external affairs and legal, many of these concerns fall within the purview of social performance. Regularly publishing and updating information and responding to reasonable requests for additional information is fundamental to meaningful engagement at the local-level, and for generating trust across the stakeholder spectrum (Joyce & Kemp, 2020). Harmony aims to align their operations with the requirements of the GISTM.

4.21.2 MUNICIPAL PLANNING GUIDELINES

For the purpose of this project, Integrated Development Plan (IDP) documents of two municipalities need to be considered: the Lejweleputswa District Municipality and the Matjhabeng Local Municipality.

The Lejweleputswa District Municipality IDP (2022/23) highlights that the purpose of municipal integrated development planning is to:

- Ensure sustainable provision of services;
- Promote social and economic development;
- Promote a safe and healthy environment;
- Give priority to the basic needs of communities; and
- Encourage involvement of communities.

Matjhabeng Local Municipality identified the following mayoral strategic priorities (IDP 2023/24):

- Road maintenance;
- Local economic development;
- Replacement of ageing infrastructure;
- Achieving housing accreditation;
- Build internal capacity;

- Develop climate change strategy, adaptation, and mitigation;
- Improve private-public partnerships for growth and development;
- Economic corridors linking six towns; and
- Economic infrastructure and development.

4.21.3 PROVINCIAL GROWTH AND DEVELOPMENT STRATEGIES

The Free State Provincial Growth and Development Strategy (FGDS) is based on six pillars, each with its own set of drivers (FSDF, 2012).

The Free State Provincial Spatial Development Framework (FSDF) supplements the FGDS as guidance document for the province to use resources in a way that will ensure sustainable outcomes based on provincial development needs and priorities (FSDF, 2012). The FSDF outlines Vision 2030, a collective response to the need for the province to describe and map its future destiny through long-term development planning, and to forge a common and shared development agenda across a wide spectrum of service delivery mechanisms. The Free State Vision 2030 envisages that, by 2030, the Free State shall have a resilient, thriving, and competitive economy that is inclusive, with immense prospects for human development anchored on the principles of unity, dignity, diversity, equality and prosperity for all (FSDF, 2012).

Encouraged by this vision, the Free State of 2030 will be characterised by an economy that encourages the development of new growth sectors with emphasis on the knowledge-based industries and the green economy (FSGDS).

The Free State Vision 2030 furthermore envisages that, by 2030, ownership and control patterns of the economy will be transformed, spatial under-development will be addressed, basic services such as healthcare, education, electricity, water, and sanitation will be equitably accessed by the people of the province. In the quest for inclusive economic growth and development, the environment will be protected for future generations. Lasting responses to climate changes will be part of the landscape of the development of the province. Steeped within the democratic principles, the Provincial Government will be accountable, transparent, effective, efficient, responsive to people's needs, and corruption will be eliminated (FSDF, 2012).

5 NEED AND DESIRABILITY OF THE PROPOSED ACTIVITY

A reserve reclamation study which looked at the reclamation and treatment of the 774Mt of tailings contained in reserve status in TSFs in the Free State indicated that Harmony will require deposition space in future. A new deposition site will be required for Harmony One Plant to replace the FSS2 and St. Helena 4 Tailings Storage Facilities by July 2024. Several alternative sites were identified and assessed as possible suitable deposition sites for the tailings from Harmony One Plant but none were found feasible. Following a review of other possibilities for the One Plant's future tailings deposition, an option to utilise the space between the Free FSN1 and FSN2 TSFs and portion of the footprint of the FSN4 TSF has been identified as a possible deposition site.

The needs and desirability analysis component of the "Guideline on need and desirability in terms of the EIA Regulations (Notice 819 of 2014)" includes, but is not limited to, describing the linkages and dependencies between human well-being, livelihoods and ecosystem services applicable to the area in question, and how the proposed development's ecological impacts will result in socio-economic impacts (e.g. on livelihoods, opportunity costs, etc.). Table 6 present the needs and desirability analysis undertaken for the project.

Table 6: Needs and desirability analysis for the proposed TSF.

Ref No.	Question	Answer
1	Securing ecological sustainable development and use of natural resources	
1.1	How were the ecological integrity considerations taken into account in terms of: Threatened Ecosystems, Sensitive and vulnerable ecosystems, Critical Biodiversity Areas, Ecological Support Systems, Conservation Targets, Ecological drivers of the ecosystem, Environmental Management Framework, Spatial Development Framework (SDF) and global and international responsibilities.	A number of specialist studies will inform this application and include: • Biodiversity (Terrestrial) • Heritage • Agriculture Potential, Soils and Land capability • Geohydrology • Aquatic and Wetland • Air quality • Palaeontology • Visual • Health Risk and Radiological • Closure Costing The conclusions of these studies are included in this EIA report.
1.2	How will this project disturb or enhance ecosystems and / or result in the loss or protection of biological diversity? What measures were explored to avoid these negative impacts, and where these negative impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	Refer to baseline ecological statement in Section 8 below, and the impact assessment in Section 9 of this report.
1.3	How will this development pollute and / or degrade the biophysical environment? What measures were explored to either avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	
1.4	What waste will be generated by this development? What measures were explored to avoid waste, and where waste could not be avoided altogether, what measures were explored to minimise, reuse and / or recycle the waste? What measures have been explored to safely treat and/or dispose of unavoidable waste?	Waste will not be generated during the operational phase, apart from the tailings material. During construction, the types of waste generated include sewage waste, biodegradable wastes, and non-biodegradable solid waste. Waste has been identified as an impact and assessed in Section 9 below. However, it is anticipated that the following measures can be utilised to reduce the impact of the waste on the receiving environment:

Ref No.	Question	Answer
		• Waste must be stored correctly. • All hazardous waste such as oil must be stored separately and disposed of at a registered facility. • Proof of disposal must be kept by the Applicant.
1.5	How will this project disturb or enhance landscapes and / or sites that constitute the nation's cultural heritage? What measures were explored to firstly avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	A heritage impact assessment was conducted as part of the EIA with the findings thereto provided in Section 8.6 and the impact assessment provided in Section 9.
1.6	How will this project use and / or impact on non-renewable natural resources? What measures were explored to ensure responsible and equitable use of the resources? How have the consequences of the depletion of the non-renewable natural resources been considered? What measures were explored to firstly avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	Refer to the impact assessment in Section 9 of this report. As a result of the fact that this project entails only a new TSF only it is anticipated that this project will not lead to a significant impact or depletion of non-renewable resources.
1.7	How will this project use and / or impact on renewable natural resources and the ecosystem of which they are part? Will the use of the resources and / or impacts on the ecosystem jeopardise the integrity of the resource and / or system taking into account carrying capacity restrictions, limits of acceptable change, and thresholds? What measures were explored to firstly avoid the use of resources, or if avoidance is not possible, to minimise the use of resources? What measures were taken to ensure responsible and equitable use of the resources? What measures were explored to enhance positive impacts?	Refer to the impact assessment in Section 9 of this report. It is anticipated that the project will have a low impact on the localised ecology.
1.7.1	Does the proposed project exacerbate the increased dependency on increased use of resources to maintain economic growth or does it reduce resource dependency (i.e. de-materialised growth)?	The proposed project is only for additional deposition space required for Harmony's Free State operations.
1.7.2	Does the proposed use of natural resources constitute the best use thereof? Is the use justifiable when considering intra- and intergenerational equity, and are there more important priorities for which the resources should be used?	The proposed project will not, at this stage, involve the use of the natural resources apart from the TSF footprint area to be cleared.

Ref No.	Question	Answer
1.7.3	Do the proposed location, type and scale of development promote a reduced dependency on resources?	The proposed project is only for additional deposition space required for Harmony's Free State operations.
1.8	How were a risk-averse and cautious approach applied in terms of ecological impacts:	
1.8.1	What are the limits of current knowledge (note: the gaps, uncertainties and assumptions must be clearly stated)?	The limitations and/or gaps in knowledge are presented in Section 12.
1.8.2	What is the level of risk associated with the limits of current knowledge?	The level of risk is considered low at this stage.
1.8.3	Based on the limits of knowledge and the level of risk, how and to what extent was a risk-averse and cautious approach applied to the development?	At this stage it is anticipated that this project will not lead to a significant impact on the receiving environment. Refer to the impact assessment in Section 9 of this report.
1.9	How will the ecological impacts resulting from this development impact on people's environmental right in terms following?	
1.9.1	Negative impacts: e.g. access to resources, opportunity costs, loss of amenity (e.g. open space), air and water quality impacts, nuisance (noise, odour, etc.), health impacts, visual impacts, etc. What measures were taken to firstly avoid negative impacts, but if avoidance is not possible, to minimise, manage and remedy negative impacts?	The proposed activities are anticipated to have low negative ecological impacts. Refer to the impact assessment in Section 9 in this report.
1.9.2	Positive impacts: e.g. improved access to resources, improved amenity, improved air or water quality, etc. What measures were taken to enhance positive impacts?	
1.10	Describe the linkages and dependencies between human wellbeing, livelihoods and ecosystem services applicable to the area in question and how the development's ecological impacts will result in socio-economic impacts (e.g. on livelihoods, loss of heritage site, opportunity costs, etc.)?	A moderate impact on third party wellbeing and livelihoods is expected. Low ecosystem service impacts are currently foreseen. Refer to the impact assessment in Section 9 of this report.
1.11	Based on all of the above, how will this development positively or negatively impact on ecological integrity objectives / targets / considerations of the area?	The proposed activities are anticipated to have generally low negative ecological impacts. Refer to the impact assessment in Section 9 in this report.
1.12	Considering the need to secure ecological integrity and a healthy biophysical environment, describe how the alternatives identified (in terms of all the different elements of the development and all the different impacts being	Refer to Section 6 - details of the alternatives considered.

Ref No.	Question	Answer
	proposed), resulted in the selection of the "best practicable environmental option" in terms of ecological considerations?	
1.13	Describe the positive and negative cumulative ecological / biophysical impacts bearing in mind the size, scale, scope and nature of the project in relation to its location and existing and other planned developments in the area?	Refer to Section 9 of this report.
2	Promoting justifiable economic and social development	
2.1	What is the socio-economic context of the area, based on, amongst other considerations, the following:	
2.1.1	The IDP (and its sector plans' vision, objectives, strategies, indicators and targets) and any other strategic plans, frameworks or policies applicable to the area	Refer to Section 8.5 of this report for a breakdown of the demographics and social environment in the project area. The Matjhabeng IDP identifies Economic infrastructure and development as one of the key mayoral strategic priorities (IDP 2023/24).
2.1.2	Spatial priorities and desired spatial patterns (e.g. need for integrated of segregated communities, need to upgrade informal settlements, need for densification, etc.),	It is anticipated that the use of local labour will be utilised as far as possible. Labourers will mostly be sourced from surrounding towns and areas such as Welkom. The Free State Provincial Growth and Development Strategy (FGDS) is based on six pillars, each with its own set of drivers (FSDF, 2012). One of the drivers included is to minimise the impact of the declining mining sector and ensure that existing mining potential is harnessed
2.1.3	Spatial characteristics (e.g. existing land uses, planned land uses, cultural landscapes, etc.), and	Refer to the baseline environment in Section 8 of this report.
2.1.4	Municipal Economic Development Strategy ("LED Strategy").	Considering the location of the activities, it is not anticipated to significantly promote or facilitate spatial transformation and sustainable urban development.
2.2	Considering the socio-economic context, what will the socio-economic impacts be of the development (and its separate elements/aspects), and specifically also on the socio-economic objectives of the area?	Refer to the impact assessment in Section 9 in this report.
2.2.1	Will the development complement the local socio-economic initiatives (such as local economic development (LED) initiatives), or skills development programs?	It is anticipated that the use of local labour will be utilised as far as possible. Labourers will mostly be sourced from surrounding towns and areas such as Welkom. In addition Harmony

Ref No.	Question	Answer
		has various social and LED initiatives required under their Social & Labour Plan (SLP) commitments.
2.3	How will this development address the specific physical, psychological, developmental, cultural and social needs and interests of the relevant communities?	Refer to the public participation process and feedback contained in Appendix C.
2.4	Will the development result in equitable (intra- and inter-generational) impact distribution, in the short- and long-term? Will the impact be socially and economically sustainable in the short- and long-term?	Refer to the impact assessment and mitigation measures in Section 9 of this report.
2.5	In terms of location, describe how the placement of the proposed development will:	
2.5.1	Result in the creation of residential and employment opportunities in close proximity to or integrated with each other.	It is anticipated that the use of local labour will be utilised as far as possible. Labourers will mostly be sourced from surrounding towns and areas such as Welkom.
2.5.2	Reduce the need for transport of people and goods.	The activities are not anticipated to have an impact on the transportation of goods and people.
2.5.3	Result in access to public transport or enable non-motorised and pedestrian transport (e.g. will the development result in densification and the achievement of thresholds in terms of public transport),	The activities are not anticipated to have any significant impact on the public transport.
2.5.4	Compliment other uses in the area,	The surrounding area is impacted by existing TSF facilities.
2.5.5	Be in line with the planning for the area.	Refer to item 2.1.1 of this table (above).
2.5.6	For urban related development, make use of underutilised land available with the urban edge.	Not applicable. The proposed project is not located in an urban area.
2.5.7	Optimise the use of existing resources and infrastructure,	Refer to Section 3 of this report.
2.5.8	Opportunity costs in terms of bulk infrastructure expansions in non-priority areas (e.g. not aligned with the bulk infrastructure planning for the settlement that reflects the spatial reconstruction priorities of the settlement),	

Ref No.	Question	Answer
2.5.9	Discourage "urban sprawl" and contribute to compaction / densification.	Not applicable. The proposed project is not located within an urban area.
2.5.10	Contribute to the correction of the historically distorted spatial patterns of settlements and to the optimum use of existing infrastructure in excess of current needs,	Refer to items 2.5.7 – 2.5.9 of this table (above).
2.5.11	Encourage environmentally sustainable land development practices and processes	Refer to impact assessment in Section 9 of this report.
2.5.12	Take into account special locational factors that might favour the specific location (e.g. the location of a strategic mineral resource, access to the port, access to rail, etc.),	Refer to alternative analysis in Section 6.
2.5.13	The investment in the settlement or area in question will generate the highest socio-economic returns (i.e. an area with high economic potential).	It is anticipated that the use of local labour will be utilised as far as possible. Labourers will mostly be sourced from surrounding towns and areas such as Welkom. In addition Harmony has various social and LED initiatives required under their various SLP commitments.
2.5.14	Impact on the sense of history, sense of place and heritage of the area and the socio-cultural and cultural-historic characteristics and sensitivities of the area, and	Refer to impact assessment in Section 9 of this report.
2.5.15	In terms of the nature, scale and location of the development promote or act as a catalyst to create a more integrated settlement?	Given the scale of the development it is not anticipated that the activities will contribute significantly to settlements or areas in terms of direct socio-economic returns however the development will allow operations at the Harmony One Plant and various Harmony Welkom mining operations to continue..
2.6	How was a risk-averse and cautious approach applied in terms of socio-economic impacts:	
2.6.1	What are the limits of current knowledge (note: the gaps, uncertainties and assumptions must be clearly stated)?	Refer to Section 12 of this report.
2.6.2	What is the level of risk (note: related to inequality, social fabric, livelihoods, vulnerable communities, critical resources, economic vulnerability and sustainability) associated with the limits of current knowledge?	The level of risk is low as the project is not expected to have far reaching negative impacts on socio-economic conditions.

Ref No.	Question	Answer
2.6.3	Based on the limits of knowledge and the level of risk, how and to what extent was a risk-averse and cautious approach applied to the development?	The level of risk is low as the project is not expected to have far reaching negative impacts on socio-economic conditions.
2.7	How will the socio-economic impacts resulting from this development impact on people's environmental right in terms following:	
2.7.1	Negative impacts: e.g. health (e.g. HIV-Aids), safety, social ills, etc. What measures were taken to firstly avoid negative impacts, but if avoidance is not possible, to minimise, manage and remedy negative impacts?	Refer to the impact assessment in Section 9 of this report.
2.7.2	Positive impacts. What measures were taken to enhance positive impacts?	Refer to the impact assessment in Section 9 of this report.
2.8	Considering the linkages and dependencies between human wellbeing, livelihoods and ecosystem services, describe the linkages and dependencies applicable to the area in question and how the development's socioeconomic impacts will result in ecological impacts (e.g. over utilisation of natural resources, etc.)?	Refer to the impact assessment in Section 9 of this report.
2.9	What measures were taken to pursue the selection of the "best practicable environmental option" in terms of socio-economic considerations?	Refer to the impact assessment in Section 9 of this report.
2.10	What measures were taken to pursue environmental justice so that adverse environmental impacts shall not be distributed in such a manner as to unfairly discriminate against any person, particularly vulnerable and disadvantaged persons (who are the beneficiaries and is the development located appropriately)? Considering the need for social equity and justice, do the alternatives identified, allow the "best practicable environmental option" to be selected, or is there a need for other alternatives to be considered?	Refer to the impact assessment in Section 9 of this report.
2.11	What measures were taken to pursue equitable access to environmental resources, benefits and services to meet basic human needs and ensure human wellbeing, and what special measures were taken to ensure access thereto by categories of persons disadvantaged by unfair discrimination?	By conducting an EIA Process, the applicant ensures that equitable access has been considered. Refer to the impact assessment in Section 9 of this report.
2.12	What measures were taken to ensure that the responsibility for the environmental health and safety consequences of the development has been addressed throughout the development's life cycle?	Refer to the impact assessment in Section 9 of this report. The EMPr will specify timeframes within which mitigation measures must be implemented.

Ref No.	Question	Answer
2.13	What measures were taken to:	
2.13.1	Ensure the participation of all interested and affected parties.	Refer to Section 7 of this report, describing the public participation process undertaken for the proposed project.
2.13.2	Provide all people with an opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation,	Refer to Section 7 of this report, describing the public participation process undertaken for the proposed project. advertisement, notification letter and site notice have been made available in English, Afrikaans and Sesotho to assist in understanding of the project. Further public consultation will be held during the review period of the EIA report for the project.
2.13.3	Ensure participation by vulnerable and disadvantaged persons,	
2.13.4	Promote community wellbeing and empowerment through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means,	
2.13.5	Ensure openness and transparency, and access to information in terms of the process,	
2.13.6	Ensure that the interests, needs and values of all interested and affected parties were taken into account, and that adequate recognition were given to all forms of knowledge, including traditional and ordinary knowledge,	
2.13.7	Ensure that the vital role of women and youth in environmental management and development were recognised and their full participation therein will be promoted?	
2.14	Considering the interests, needs and values of all the interested and affected parties, describe how the development will allow for opportunities for all the segments of the community (e.g. a mixture of low-, middle-, and high-income housing opportunities) that is consistent with the priority needs of the local area (or that is proportional to the needs of an area)?	Refer to Section 7 of this report, describing the public participation process undertaken for the proposed project.
2.15	What measures have been taken to ensure that current and / or future workers will be informed of work that potentially might be harmful to human health or the environment or of dangers associated with the work, and what measures have been taken to ensure that the right of workers to refuse such work will be respected and protected?	Potential future workers will have to be educated on a regular basis as to the environmental and safety risks that may occur within their work environment. Furthermore, adequate measures will have to be taken to ensure that the appropriate personal protective equipment is issued to workers based on the conditions that they work in and the requirements of their job.

Ref No.	Question	Answer
2.16	Describe how the development will impact on job creation in terms of, amongst other aspects:	
2.16.1	The number of temporary versus permanent jobs that will be created.	It is anticipated that the use of local labour will be utilised as far as possible. Labourers will mostly be sourced from surrounding towns and areas such as Welkom. The project will ensure job security for currently employed people, as they will be able to continue with their current jobs. This impact would be experienced on a wider level since it will allow them to meet the needs of their family members. It is not clear exactly how many jobs will be created, but in a similar project the construction phase was 5 years and approximately 300 jobs were created, of which the majority were unskilled or semi-skilled (GCS,2020). The staff compliment for the Valley TSF is expected to be as follows: • Peak manpower on site during construction = 370 people • Approximately 66 people during normal deposition during operational phase.
2.16.2	Whether the labour available in the area will be able to take up the job opportunities (i.e. do the required skills match the skills available in the area).	
2.16.3	The distance from where labourers will have to travel.	
2.16.4	The location of jobs opportunities versus the location of impacts.	
2.16.5	The opportunity costs in terms of job creation.	
2.17	What measures were taken to ensure:	
2.17.1	That there were intergovernmental coordination and harmonisation of policies, legislation and actions relating to the environment.	The EIA Process requires governmental departments to communicate regarding any application. In addition, all relevant departments are notified at various phases of the project by the EAP.
2.17.2	That actual or potential conflicts of interest between organs of state were resolved through conflict resolution procedures.	
2.18	What measures were taken to ensure that the environment will be held in public trust for the people, that the beneficial use of environmental resources will serve the public interest, and that the environment will be protected as the people's common heritage?	Refer to Section 7 of this report, describing the public participation process implemented for the application, as well Section 8, the impact on any national estate.
2.19	Are the mitigation measures proposed realistic and what long-term environmental legacy and managed burden will be left?	Refer to the impact assessment and mitigation measures in Section 9 of this report.
2.20	What measures were taken to ensure that the costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects will be paid for by those responsible for harming the environment?	The proposed survey activities are not anticipated to produce significant pollution, environmental damage or adverse health effects in the long term. Refer to Appendix J for closure costing.

Ref No.	Question	Answer
2.21	Considering the need to secure ecological integrity and a healthy bio-physical environment, describe how the alternatives identified (in terms of all the different elements of the development and all the different impacts being proposed), resulted in the selection of the best practicable environmental option in terms of socio-economic considerations?	Refer to Section 6, description of the process followed to reach the proposed preferred site.
2.22	Describe the positive and negative cumulative socio-economic impacts bearing in mind the size, scale, scope and nature of the project in relation to its location and other planned developments in the area?	Refer to the impact assessment and mitigation measures in Section 9.

6 PROJECT ALTERNATIVES

As this application relates only to a new TSF, there are limited feasible and/or reasonable alternatives that can be considered and which are described and motivated below.

6.1 LOCATION ALTERNATIVES

The assessment of location alternatives is limited due to the available open space in close proximity to the mining activities (and especially the gold processing plant). Several alternative sites were identified and assessed as possible suitable deposition sites for the tailings from Harmony One Plant but apart from the Nooitgedacht site which is the subject of a separate EIA, none were found feasible. Following a review of other possibilities for the One Plant's future tailings deposition, an option to utilise the space between the FSN1 and FSN2 TSFs and portion of the footprint of the FSN4 TSF as shown in Figure 1 has been identified as the preferred deposition site The existing TSF is surrounded by existing or planned mining infrastructure and therefore expansion of the existing facility in other directions is not feasible as part of this application. The study area contains open space to the south of the TSF which is currently under consideration for the Nooitgedacht TSF EIA, also being undertaken by EIMS.

Several alternative sites were identified and assessed as part of a 2008 study completed by Golder Environmental. Various sites were identified as part of this 2008 study as indicated in Figure 11 below.

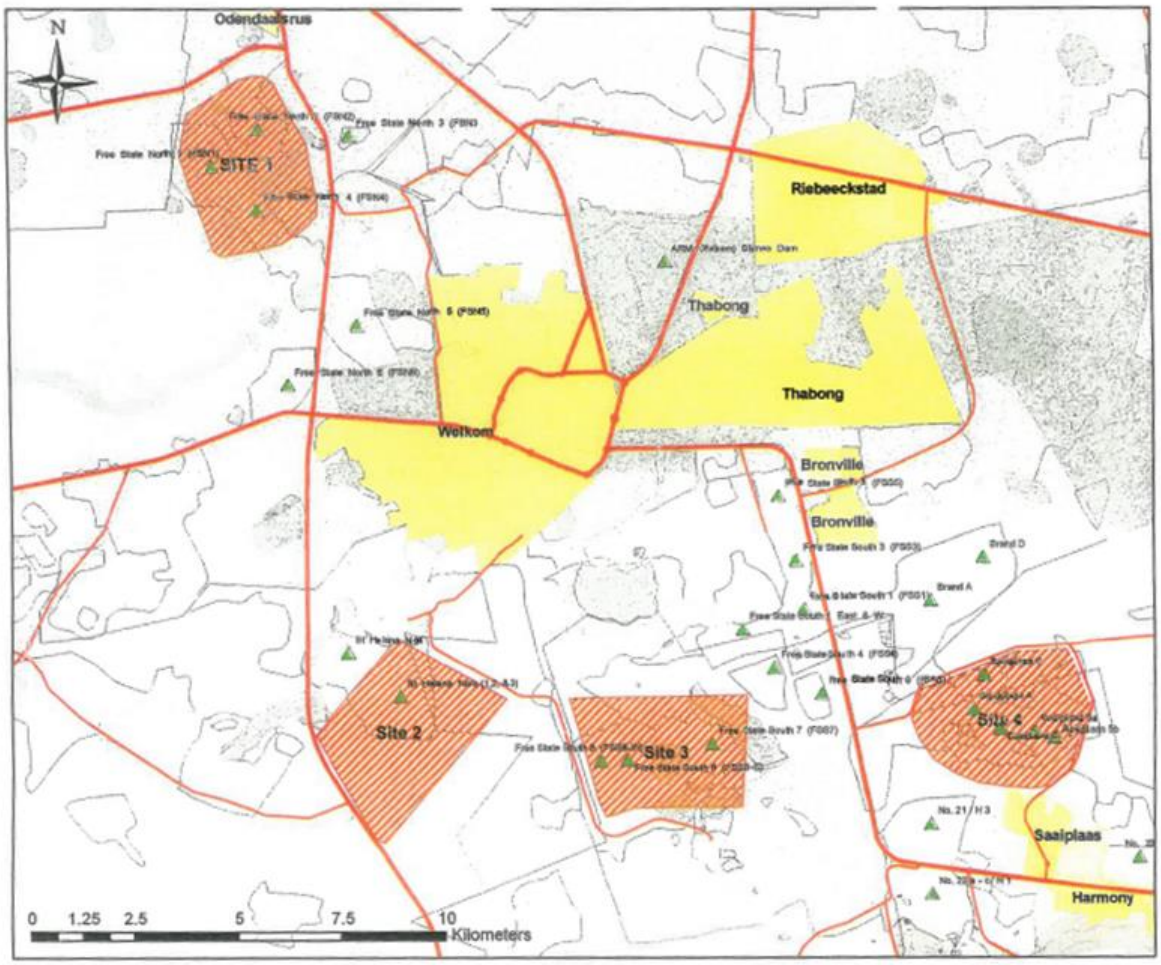

Figure 11: Sites assessed in the 2008 Golder Site Selection Study.

As part of the 2008 Golder Study various specialist input was obtained from ecological, surface water and groundwater specialists. During a Steering Committee meeting involving various stakeholders including DWS

that was convened on the 25 October 2007 the site selection findings were discussed and an optimal site selected. Site 1 was agreed upon as the preferred site for the TSF (as agreed by the Steering Committee). This site overlaps with the Valley site currently being proposed for the TSF. The reason for this is that the proposed footprint is largely brownfields with a partial greenfields take. The resultant negative impacts on agriculture and ecosystems are considered to be negligible but outweighed by the positive attributes of the site. As such, no further location alternatives are considered in this assessment. The previous 2008 site selection study is considered suitable motivation for the current Valley TSF site. A copy of the site selection summary report completed as part of the 2008 study is included in Appendix G.

The only feasible and reasonable location for the new TSF is the area proposed. This proposed area is vacant, disturbed land surrounded by existing TSF structures and is ideally situated to be used as additional deposition space. As such, no further location alternatives are considered in this assessment.

6.2 LAYOUT AND DESIGN ALTERNATIVES

The total volume of material to be deposited of on the TSF is based on the forecast gold reserves to be processed at the existing One Plant. As such, the total volume is a firm parameter which cannot be downscaled. The potential to reduce the footprint of the new TSF would require altering the dimensions of the facility by making it either higher with steeper side slopes or lower with a greater footprint area. Increasing the height would result in greater visual impacts and possibly increasing the secondary impacts such as fugitive dust generation and erosion of the steeper side slopes. Alternatively, reducing the height of the facility would result in a larger footprint, however, there is insufficient available space to do so in the proposed location.

The EIA process being undertaken includes the assessment of potential impacts and the identification of environmental sensitivities within and in the vicinity of the proposed project area thereby allowing for the recommendation of mitigation measures towards the avoidance, minimisation and / or management of the anticipated impacts. The layout will be planned to avoid any no-go areas identified from the various specialist studies, if required, otherwise no additional layout or design alternatives are considered applicable to this application.

6.3 TECHNOLOGY ALTERNATIVES

The main available technology alternatives relate to the liner design for the TSF however the liner requirements are based on the waste classification of the material and geohydrological modelling and risk assessment. No additional technology alternatives are considered applicable.

Testing was done by Waterlab (Pty) Ltd (facilitated by Jones and Wagner) to determine the geochemical properties as well as the waste classification of the tailings material. The total concentration leachable concentration results were compared to the Total Concentration Threshold (TCT) and Leachable Concentration Threshold (LCT) values as prescribed in GN 635: National Norms and Standards for the Assessment of Waste for Landfill Disposal. The conclusions from the geochemical assessment indicate that the gold tailings material sampled classifies as a Type 3 waste according to the classification parameters set out by the National Environmental Management Waste Act (Act 59 of 2008).

GN 636: National Norms and Standards for Disposal of Waste to Landfill requires a Class C barrier system for a Type 3 waste. A typical Class C barrier system is illustrated in Figure 12. The Groundwater numerical model was used to simulate the following scenarios:

- **Contaminant seepage from the Tailings Dam without any liner for periods 10-, 50- and 100-years:** The TSF was modelled as a constant source (worst-case scenario) as it is assumed that the facility will continue to release impacted seepage to the environment. The impacts after 10 years, 50 years and 100 years were simulated. Seepage from the proposed TSF migrates to the southwest, towards the Mahemspruit. Slightly elevated concentrations, between 200 – 500 mg/L reaches the stream after approximately 100 years. The simulated sulphate concentration increase, at an observation point some 2 000m down-gradient from the TSF, shows that after 48 years the sulphate concentration will exceed the SANS 241 limits.

- **Contaminant seepage from the Tailings Dam with an engineered liner for periods 50- and 100-years:** The gold tailings that will be deposited on the Valley TSF are classified as a Type 3 waste in terms of the NEMWA Regulations 2013 requiring a Class C containment barrier performance. The Class C single composite barrier system has an expected seepage rate in the order of 140 litres / hectare / day (Legge, 2024). By making use of an ”ïnverted barrier system” comprising of underdrainage and a base preparation layer; a 1.5mm thick geomembrane ; and covered tailings the barrier system performance is improved by (a) seepage losses are reduced from about 140 l/ha/day to about 3 l/ha/day due to the change from Bernoulli flow at discontinuities to D’Arcian flow controlled by the tailings permeability at these points (Legge, 2024). These leakage rates were included in the model and the impact simulated. The result from the 100-year simulation shows that any contamination from the site will be contained. The small volume of seepage that may flow through the liner system is diluted to the extent that contamination is not detected.

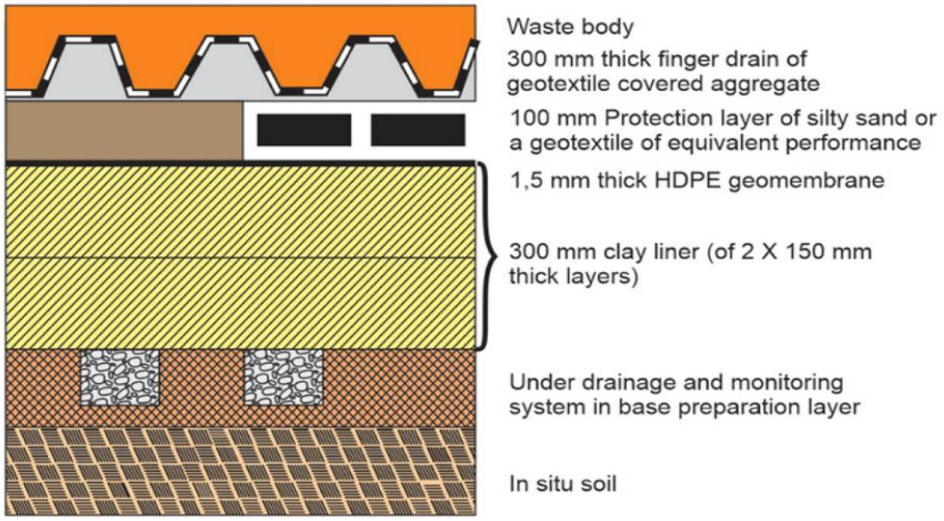

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Figure 12: Typical Class C Liner

Two technology alternatives are being proposed:

- Technology alternative 1: Construction of the facility without a liner
- Technology alternative 2: Construction of the facility with a liner.

It is evident from this assessment that the area is already impacted by the historical activities. Plume migration is, however, slow and although the simulated current plume has reached the Mahemspruit, the concentrations are <500 mg/L. The Mahemspruit is, however, impacted not only by this tailings facility, but also by other contaminant sources in the region.

The expected contribution of the impact from the Valley TSF is low and contained within the current impacted footprint. The unmitigated impact shows that a contaminant plume will migrate from the proposed TSF towards the only down-gradient receptor, the Mahemspruit. This contaminant flow is very slow and small impacts (<500 mg/L SO_4) will only reach the stream after approximately 100 years.

With reference to the modelled plumes, it appears that the lining of the proposed Valley TSF will have net positive impact on the down-gradient groundwater quality. It is, however noted that although the positive impact is not visible on the extent of the plume, there is nevertheless a reduction in the contaminant concentration over time. The reduction in the sulphate concentration down-gradient from the facility, with a liner installed, is approximately 50mg/L after 30 years.

This is a small improvement and it is therefore recommended that a rehabilitation plan be developed to address the groundwater deterioration from the existing TSF, in conjunction with the lining of the Valley TSF.

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This modelling exercise did not include any remedial options. It is, however, expected that remediation, of which phyto-remediation is recommended, and the very slow contaminant migration rates will negate the need for a liner system.

There are also various **deposition techniques** which are applicable to tailings storage facilities. Once the tailings slurry (dilute or paste consistency) has arrived at the tailings storage area, there are several possible ways it can be deposited. These include the spigotting method, cyclone deposition and the paddocking method.

Spigots are multiple outlets along a delivery pipeline. This technology is only used when it is easily possible to cause a gravitational grading split between the coarse and the tailings' fine fractions.

Figure 13: Example of spigot deposition (source: www.researchgate.net)

Paddock deposition requires construction of small impoundments or containment berms with dried-out tailings borrowed from the previous layer deposited around the perimeter or edge of the paddock. These shallow paddocks are then filled with dilute slurry.

Figure 14: Example of paddock deposition

In **cyclone deposition** is a cyclone deposition device consisting of conical housing equipped with a feed pipe that enters the cone at its larger diameter closed end. A second pipe enters the cone and intrudes into the body of the cone. The slurry feed enters under pressure and is forced to swirl with a spiral motion towards the smaller end. In the process, centrifugal forces cause the larger particles in the slurry to move down and away from the axis, towards the narrow exit of the cone. The net effect is that the finer particles and most of the water leave the cyclone through the vortex finder and form the "overflow," while the partially dewatered larger particles leave at the opposite end as the coarser "underflow material. The purpose of using a cyclone is to create underflow material that has good geotechnical characteristics, i.e., high permeability, fast consolidation and strength gain rate than the original tailings so that the underflow can be used to form an impoundment wall to the tailings storage facility. Effective operations of a cyclone TSF can also result in high water recoveries.

Figure 15: Example of cyclone deposition (source: international mining)

Currently cyclone deposition is the vastly preferred method of deposition for all of Harmony's current TSF operations due to the reasons described above. The environmental impacts associated with each deposition method are similar however cyclone deposition has higher water recovery rates and is also preferred from a geotechnical perspective. For the Valley TSF a combination of spigot and cyclone deposition is recommended.

Based on prior experience, the maximum rate of rise of 3.7m/year allows for safe upstream deposition. The stage capacity analysis indicates that the facility will provide a capacity of 56.8 million tons over 8.0 years at 600 000tpm. As such no other deposition methods or technologies are considered in the EIA phase.

6.4 PROCESS AND ACTIVITY ALTERNATIVES

Process or activity alternatives imply the investigation of alternative processes, methods or activities to achieve the same goal for the proposed TSF. A new deposition site will be required for Harmony One Plant to replace the FSS2 and St. Helena 4 Tailings Storage Facilities by July 2024 and for this there are no feasible or applicable activity or process alternatives, additional deposition space will be required for the tailings material. No other process or activity alternatives have been identified that could be applicable to the TSF application.

6.5 NO GO ALTERNATIVE

The no go alternative would imply that no TSF is constructed for the safe deposition of new mine tailings from Harmony's Welkom operations. A new deposition site will be required for Harmony One Plant to replace the FSS2 and St. Helena 4 Tailings Storage Facilities by July 2024. The no go option would mean that the new TSF project would not proceed, and this would therefore negatively affect the future viability of Harmony's Welkom mining operations from July 2024 and beyond due to lack of deposition space. This would have a significant financial impact on not only Harmony but also have a direct negative impact on the workforce on the mine and surrounding businesses and communities that are directly or indirectly linked to the operations. As such, the no go alternative is not considered feasible or reasonable.

7 STAKEHOLDER ENGAGEMENT

The Public Participation Process (PPP) is a requirement of several pieces of South African legislation and aims to ensure that all relevant Interested and Affected Parties (I&APs) are consulted, involved and their comments are considered, and a record included in the reports submitted to the Authorities. The process ensures that all stakeholders are provided this opportunity as part of a transparent process which allows for a robust and comprehensive environmental study. The PPP for the proposed project needs to be managed sensitively and according to best practises to ensure and promote:

- Compliance with international best practice options;
- Compliance with national legislation;
- Establishment and management of relationships with key stakeholder groups; and
- Involvement and participation in the environmental study and authorisation/approval process.

As such, the purpose of the PPP and stakeholder engagement process is to:

- Introduce the proposed project;
- Explain the authorisations required;
- Explain the environmental studies already completed and yet to be undertaken (where applicable);
- Solicit and record any issues, concerns, suggestions, and objections to the project;
- Provide opportunity for input and gathering of local knowledge;
- Establish and formalise lines of communication between the I&APs and the project team;
- Identify all significant issues for the project; and
- Identify possible mitigation measures or environmental management plans to minimise and/or prevent negative environmental impacts and maximize and/or promote positive environmental impacts associated with the project.

7.1 GENERAL APPROACH TO SCOPING AND PUBLIC PARTICIPATION

The PPP for the proposed project has been undertaken in accordance with the requirements of the MPRDA and NEMA EIA Regulations (2014), and in line with the principles of Integrated Environmental Management (IEM). IEM implies an open and transparent participatory process, whereby stakeholders and other I&APs are afforded an opportunity to comment on the project and have their views considered and included as part of project planning.

An initial I&AP database has been compiled based on known key I&AP's, Windeed searches, and stakeholder databases provided by the mine. The I&AP database includes amongst others, landowners, communities, regulatory authorities and other special interest groups.

7.1.1 LIST OF PRE-IDENTIFIED ORGANS OF STATE/ KEY STAKEHOLDERS IDENTIFIED AND NOTIFIED

Government Authorities were notified of the proposed project and include:

- Civil Aviation Authority;
- Eskom Holdings SOC Limited;
- Endangered Wildlife Trust;
- Lejweleputswa District Municipality;
- Matjhabeng Local Municipality;

- Free State Department of Agriculture& Rural Development;
- Free State Department of Cooperative Governance and Traditional Affairs;
- Free State Department of Public Works and Infrastructure;
- Free State Department of Police, Roads and Transport;
- Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs;
- Free State Development Corporation;
- Free State Department of Mineral Resources and Energy;
- Free State Department of Small Business, Tourism, and Environmental Affairs;
- National Department of Agriculture, Forestry and Fisheries;
- National Department of Mineral Resources and Energy;
- National Department of Rural Development and Land Reform;
- National Department of Human Settlements Water and Sanitation;
- South African Civil Aviation Authority;
- South African Heritage Resources Agency;
- South African National Roads Agency Limited; and
- Transnet SOC Limited.

7.1.2 INITIAL NOTIFICATION

The PPP commenced on the 4th of April 2023 with an initial notification and call to register for a period of 30 days. The initial notification was given in the following manner:

7.1.2.1 REGISTERED LETTERS, FAXES AND EMAILS

Notification letters (English, Afrikaans and Sesotho), faxes, and emails were distributed to all pre-identified key I&APs including government organisations, NGOs, relevant municipalities, ward councillors, landowners and other organisations that might be affected.

The notification letters included the following information to I&APs:

- List of anticipated activities to be authorised;
- Scale and extent of activities to be authorised;
- Information on the intended mining operation to enable I&APs to assess/surmise what impact the activities will have on them or on the use of their land;
- The purpose of the proposed project;
- Details of the affected properties (including details of where a locality map could be obtained);
- Details of the relevant NEMA Regulations;
- Initial registration period timeframes; and
- Contact details of the EAP.

7.1.2.2 NEWSPAPER ADVERTISEMENTS / GOVERNMENT GAZETTE

Advertisements describing the proposed project and EIA process were placed in newspapers with circulation in the vicinity of the study area. The initial advertisements were placed in the Vista Newspaper as well as the provincial Gazette (in English, Afrikaans and Sesotho) on the 6th of April 2023. The newspaper adverts included the following information:

- Project name;
- Applicant name;
- Project location;
- Nature of the activity and application; and
- Relevant EIMS contact person for the project.

7.1.2.3 SITE NOTICE PLACEMENT

A1 Correx site notices in English and Afrikaans were placed at 10 locations within the local project area on the 4th of April 2023. The on-site notices included the following information:

- Project name;
- Applicant name;
- Project location;
- Map of proposed project area;
- Project description;
- Legislative requirements; and
- Relevant EIMS contact person for the project.

7.1.2.4 POSTER PLACEMENT

A3 posters in English and Afrikaans were placed at local public gathering places in Welkom namely the Post Office and the Municipal Offices.

The notices and written notification afforded all pre-identified I&APs the opportunity to register for the project as well as to submit their issues/queries/concerns and indicate the contact details of any other potential I&APs that should be contacted. The contact person at EIMS, contact number, email and faxes were stated on the posters. Comments/concerns and queries were encouraged to be submitted in either of the following manners:

- Electronically (fax, email);
- Telephonically; and/or
- Written letters.

7.1.3 AVAILABILITY OF SCOPING REPORT

Notification regarding the availability of the Scoping Report for public review was given in the following manner to all registered I&APs (which includes key stakeholders and landowners):

- Registered letters with details on where the scoping report can be obtained and/or reviewed, public meeting date and time, EIMS contact details as well as the public review comment period;
- Facsimile notifications with information similar to that in the registered letter described above; and/or
- Email notifications with a letter attachment containing the information described above.

The scoping report was made available for public review from the 10 June 2023 to the 12 July 2023 for a period of 30 days. A public meeting was held on 28 June 2023.

7.1.4 AVAILABILITY OF EIA REPORT

Notification regarding the availability of this EIA Report for public review was given in the following manner to all registered I&APs (which includes key stakeholders and landowners):

- Registered letters with details on where the EIA report can be obtained and/or reviewed, public meeting date and time, EIMS contact details as well as the public review comment period;

- Facsimile notifications with information similar to that in the registered letter described above; and/or
- Email notifications with a letter attachment containing the information described above.

This EIA report is being made available for public review from 22 March 2024 until 24 April 2024 for a period of 30 days. A second public meeting will be scheduled during the EIA report review period.

7.2 PUBLIC PARTICIPATION PROGRESS

Comments raised to date have been addressed in a transparent manner and included in the Public Participation Report (Appendix C). Specialist input into the EIR/EMPr phase investigated and address relevant I&AP concerns in more detail. The key issues raised to date in the PP process are the potential groundwater contamination impacts in and the effect of the dust on grazing and health.

8 ENVIRONMENTAL ATTRIBUTES AND BASELINE ENVIRONMENT

This section of the EIA Report provides a description of the environment that may be affected by the proposed project. Aspects of the biophysical, social and economic environment that could be directly or indirectly affected by, or could affect, the proposed development have been described. This information has been sourced from existing information available for the area as well as baseline information provided by certain specialists_The DFFE screening tool was also used to inform this section and a copy of the screening report is included in Appendix F.

8.1 LOCATION

The study area falls within a landscape that contains pipelines and existing TSFs, thus the area can be described as largely disturbed. The landscape has historically been used for informal cattle grazing. Other elements of disturbance identified within the study area include farm and provincial roads and other infrastructure associated with the existing pipelines and other mining activities. The TSF will cover an area of approximately 163ha. The proposed TSF will be located on Farm portions Rietpan 14 (0) and Ouders Gift 48 (0/RE). The locality map is included in Figure 1. The study area is serviced by the R34, R30, provincial gravel roads and farm roads. Existing infrastructure includes mine infrastructure such as existing TSFs, electricity transmission lines, telephone lines, fences and other recent structures.

8.2 TOPOGRAPHY

The topography of the location of the proposed TSF is fairly flat, comprising of undulating terrain. An analysis of topographical data indicated a slope of less than 1:10 over most of the project area.

8.3 GEOLOGY

The Free State Goldfield which forms a triangle between Allanridge, Welkom and Virginia, produces gold from auriferous bearing reefs situated within sediments of the Central Rand Group of the Witwatersrand Supergroup. A detailed description of the geology of the Welkom Goldfields is provided by in Minter *et. al*; (1986). The mine geology, from shallow to deep, consist of the following:

- Karoo Supergroup;
- Ventersdorp Supergroup; and
- Witwatersrand Supergroup.

Sediments of the Vryheid Formation of the Ecca Group underlie the study area. The Vryheid Formation (Ecca Group) mainly comprises mudstone, siltstone and fine- to coarse-grained sandstone (pebbly in places).

Within the Free State Goldfield, the Ventersdorp Supergroup can be divided into the Pniel sequence, the Platberg Group and the basal Klipriviervberg Group consisting of alternating sediments, amygdaloidal and non-amygdaloidal andesitic lavas, tuffs and agglomerates (Minter *et.al*; 1986). Based on prospecting/exploration drilling, the Ventersdorp Supergroup has an average thickness of 1 319m in the study area.

The Witwatersrand Supergroup is unconformably overlain by the volcanic and sedimentary rock of the Ventersdorp Supergroup. Within the Free State Goldfield, the Witwatersrand Supergroup, comprising a thick succession of clastic sediments with minor intercalated lava flows, rests on the granites and schist of the Archean Basement. The Central Rand Group of the Witwatersrand Supergroup contains the economic reef horizons mined throughout the basin. The Central Rand Group is dominated by quartzite with minor shale and conglomerate. Several unconformities in the succession are overlain by the economic auriferous paleoplacers (reefs). Refer to Figure 16 for a map showing the regional geology. It should be noted that the project area is a seismically active area.

The site is underlain by stiff clays and will provide suitable liner material for the tailings dam. Due to their inherently impermeable properties, together with the drainage designs, will minimise potential downward migration of contaminated water. Geotechnical engineering parameters were developed based on correlations

between the findings from the geotechnical site investigation, similarly classified material as well as the analysis of the June 2023 CPTu test results. The summarised geotechnical engineering parameters used for slope stability analyses and for the design of embankments etc. are discussed in the attached design report in Appendix I.

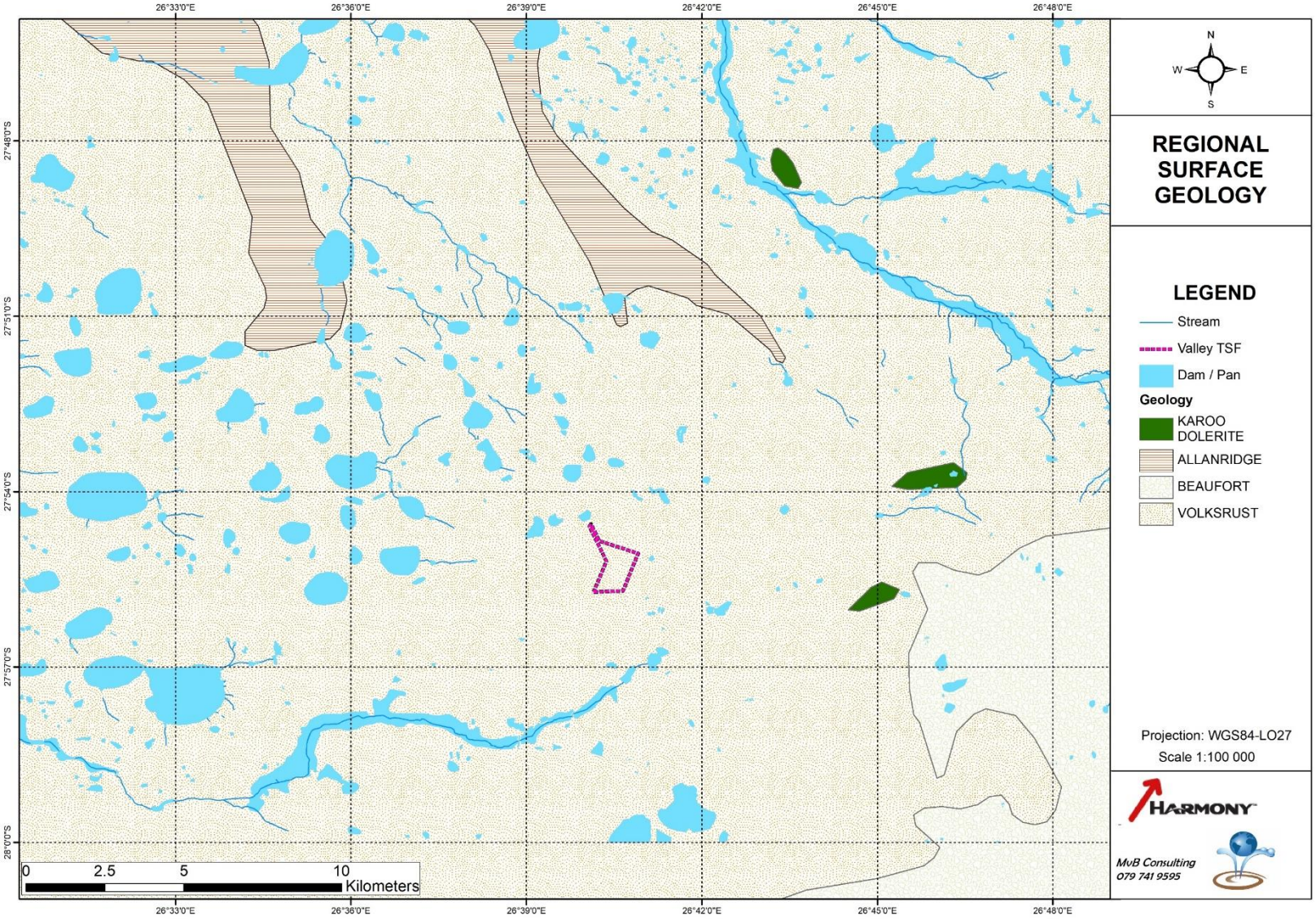

Figure 16: Regional surface geology

8.4 CLIMATE

The average climate for the site is presented in Figure 17 using the outcome of the investigation into rainfall and evaporation for the site. The combination of rainfall (Pegram, 2016) and evaporation and temperature (Schulze and Lynch, 2006) result in a cold arid steppe climate according to the Köppen-Geiger climate classification1.

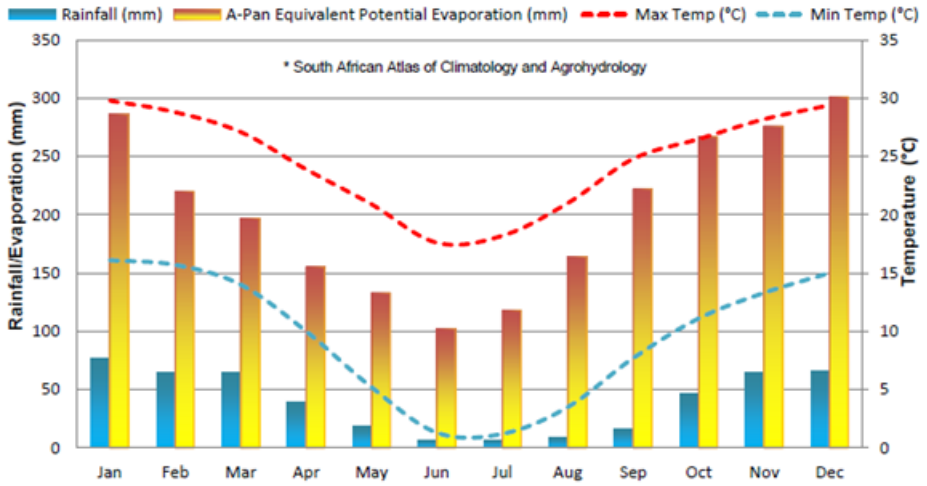

Figure 17: Climate summary

Evaporation data was sourced from the South African Atlas of Climatology and Agrohydrology (Schulze and Lynch, 2006) in the form of A-Pan equivalent potential evaporation. The average monthly evaporation distribution is presented in Table 7 and shows the site has an annual potential evaporation of 2,441mm. Hydrology and meteorology, including climate change increases in rainfall and evaporation is specifically taken into account as part of the engineering design of the TSF.

Table 7: Average Monthly A-Pan Equivalent Evaporation

Month	Evaporation (mm)
January	286
February	220
March	197
April	155
May	133
June	102
July	118
August	164
September	222
October	267

Month	Evaporation (mm)
November	276
December	301

8.5 SOCIO-ECONOMIC

The Lejweleputswa District Municipality is situated in the north western part of the Free State and borders the North West Province to the north; the Fezile Dabi and Thabo Mofutsanyane District Municipalities to the north-east and east respectively; the Xhariep District Municipality and Mangaung Metropolitan Municipality to the south; and the Northern Cape Province to the west. The LDM is accessible from Johannesburg, Cape Town, Klerksdorp and Kimberley through one of South Africa's main national roads, the N1. The district covers an area of 32 286 km2 and make up almost a third of the Free State province. It consists of the Masilonyana, Matjhabeng, Nala, Tokologo and Tswelopele Local Municipalities (www.lejweleputswa.co.za). The economy of the district relies heavily on the gold mining sector which is dominant in the Matjhabeng and Masilonyana Local Municipalities (Lejweleputswa DM IDP 2021/22). The mining sector is on a downward trend and many businesses that have traditionally depended on the mining sector have either closed down are in the process of closing down. The other municipalities are dominated by agriculture.

The main towns in the Matjhabeng Local Municipality are Welkom, Odendaalsrus, Virginia, Hennenman, Allanridge and Ventersburg (www.matjhabeng.fs.gov.za). The economy of the municipality is centred on mining activities in and around Welkom, Allanridge, Odendaalsrus and Virginia. Manufacturing aimed at the mining sector exists to a limited extent in the above towns, with other activities being limited. Other main economic sectors include manufacturing, tourism, agriculture, gold jewellery, transportation (logistics), and retail (Matjhabeng LM IDP 2022/2023).

The number of households in the study area has increased on all levels (Table 8). The proportionate increase in households were greater than the increase in population on all levels and exceeded the growth in households of 12.3% on a national level. The average household size has shown a decrease on all levels, which means there are more households, but with less members.

Table 8: Population density and growth estimates (sources: Census 2011, Community Survey 2016)

Area	Size in km2	Population 2011	Population 2016	Population density 2011	Population density 2016	Growth in population (%)
Free State Province	129,825	2,745,590	2,834,714	21.15	21.83	3.25
Lejweleputswa DM	31,930	627,626	649,964	19.66	20.36	3.56
Matjhabeng LM	5,155	406,461	428,843	78.85	83.19	5.51

The intensity of poverty experienced refers to the average proportion of indicators in which poor households are deprived (Statistics South Africa, 2014). The intensity of poverty has increased slightly on all levels. The intensity of poverty and the poverty headcount is used to calculate the SAMPI score. A higher score indicates a very poor community that is deprived on many indicators. The SAMPI score in the Matjhabeng LM area has decreased, suggesting an improvement in some aspects relating to poverty in this area (Table 9).

Table 9: Poverty and SAMPI scores (sources: Census 2011 and Community Survey 2016).

Area	Poverty headcount 2011 (%)	Poverty intensity 2011 (%)	SAMPI 2011	Poverty headcount 2016 (%)	Poverty intensity 2016 (%)	SAMPI 2016
Free State Province	5.5	42.2	0.023	5.5	41.7	0.023
Lejweleputswa DM	5.6	42.8	0.024	4.8	42.2	0.020
Matjhabeng LM	5.5	43.0	0.024	4.3	41.8	0.018

Ward 35 has the highest proportion of people of economically active age (aged between 15 years and 65 years) that are employed. Since 2010 employment in the gold mining industry showed a steady decline from 157 019 in 2010 to 93 841 in 2022 (www.mineralscouncil.org.za). As such the proportion unemployed people in the area are likely to have increased since 2011. Ward 35 has the highest average household income (Figure 18), indicating more employed people than on local, district or provincial level.

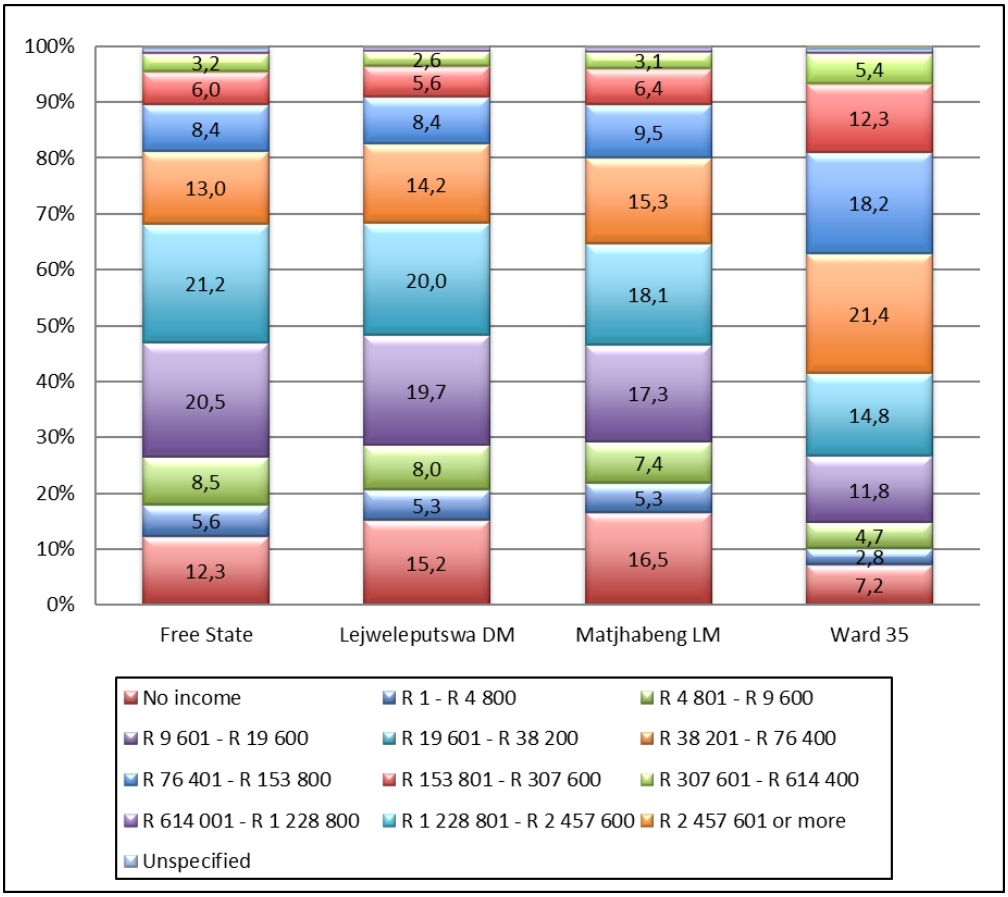

Figure 18: Annual household income (shown in percentage, source: Census 2011)

Ward 35 has the lowest incidence of households that access to water from a local or a regional water scheme, but the highest incidence of households that get their water from another source. Census 2011 does not specify what the 'other' water sources include. Access to piped water, electricity and sanitation relate to the domain of Living Environment Deprivation as identified by Noble et al (2006). Just over three quarters of households in Ward 35 has access to piped water inside the dwelling. This is much higher than on local, district and provincial level. The majority of households in Ward 35 have access to any sanitation services, with the bulk of the households in the ward having access to flush toilets that are connected to a sewerage system.

8.6 CULTURAL, HERITAGE AND FOSSIL RESOURCES

Heritage and paleontological studies were undertaken by PGS and Banzai Environmental respectively (refer to Appendix D) and the baseline information from those reports is presented in this section.

The Free State has a rich archaeological and historical history going back millions of years and includes significant aspects such as Later Stone Age rock art, Battlefields and Iron Age stonewalled enclosures. The general surroundings of the study area became a melting pot of contact and conflict as it represents one of many frontiers where San hunter- gatherers, Nguni and Sotho-Tswana agro-pastoralists, Dutch Voortrekkers and British Colonists all came together. The ravages of war also swept across these plains, and in particular the South African War (1899-1902) as well as the Boer Rebellion (1914-1915). The Free State has a rich archaeological and historical history going back millions of years and includes significant aspects such as Later Stone Age rock art, Battlefields and Iron Age stonewalled enclosures. The general surroundings of the study area became a melting pot of contact and conflict as it represents one of many frontiers where San hunter- gatherers, Nguni and Sotho-Tswana agro-pastoralists, Dutch Voortrekkers and British Colonists all came together. The ravages of war also swept across these plains, and in particular the South African War (1899-1902) as well as the Boer Rebellion (1914-1915).

A heritage screening report was compiled by the Department of Environmental Affairs National Web-based Environmental Screening Tool as required by Regulation 16(1)(v) of the Environmental Impact Assessment Regulations 2014, as amended. According to the heritage screening report, the project area has a Low Heritage Sensitivity. A site visit was conducted by the heritage specialist. The fieldwork team were able to confirm that the study area was disturbed from historical agricultural activities and mining-related activities. No heritage resources were identified in the study area.

According to the Palaeosensitivity Map available on the South African Heritage Resources Information System database (SAHRIS), the Palaeontological Sensitivity of the proposed development areas are mostly rated high) and moderate. A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 17 April 2023. No fossiliferous outcrop was detected in the proposed development area. The apparent rarity of fossil heritage in the proposed development footprint suggests that the impact of the development will be of a Low significance in palaeontological terms.

8.7 SOILS

In considering the Soil Conservation Service for South Africa (SCS-SA) dataset of the site, soils are classified as being of hydrological C (moderately high runoff potential). The soils in the TSF area are mostly medium potential agricultural soils. The natural vegetation of the site is classified as Western Free State Clay Grassland (according to SANBI, 2018). 'Grassland' is predominant over the site according to the DFFE's 2020 land-cover dataset, with 'mines & quarries' positioned to the east in association with an existing TSF (FSN 4.2). Refer to Figure 19 for a map showing the soil types in the study area.

An assessment of the soils present within the project area was conducted during a field survey in March 2023. The site was traversed on foot. A soil auger was used to determine the soil form/family and depth. The soil was hand augured to the first restricting layer or 1,5 m. Soil survey positions were recorded as waypoints using a handheld Global Positioning System (GPS). Soils were identified to the soil family level as per the "Soil Classification: A Taxonomic System for South Africa" (Soil Classification Working Group, 2018). Landscape features such as existing open trenches were also helpful in determining soil types and depth.

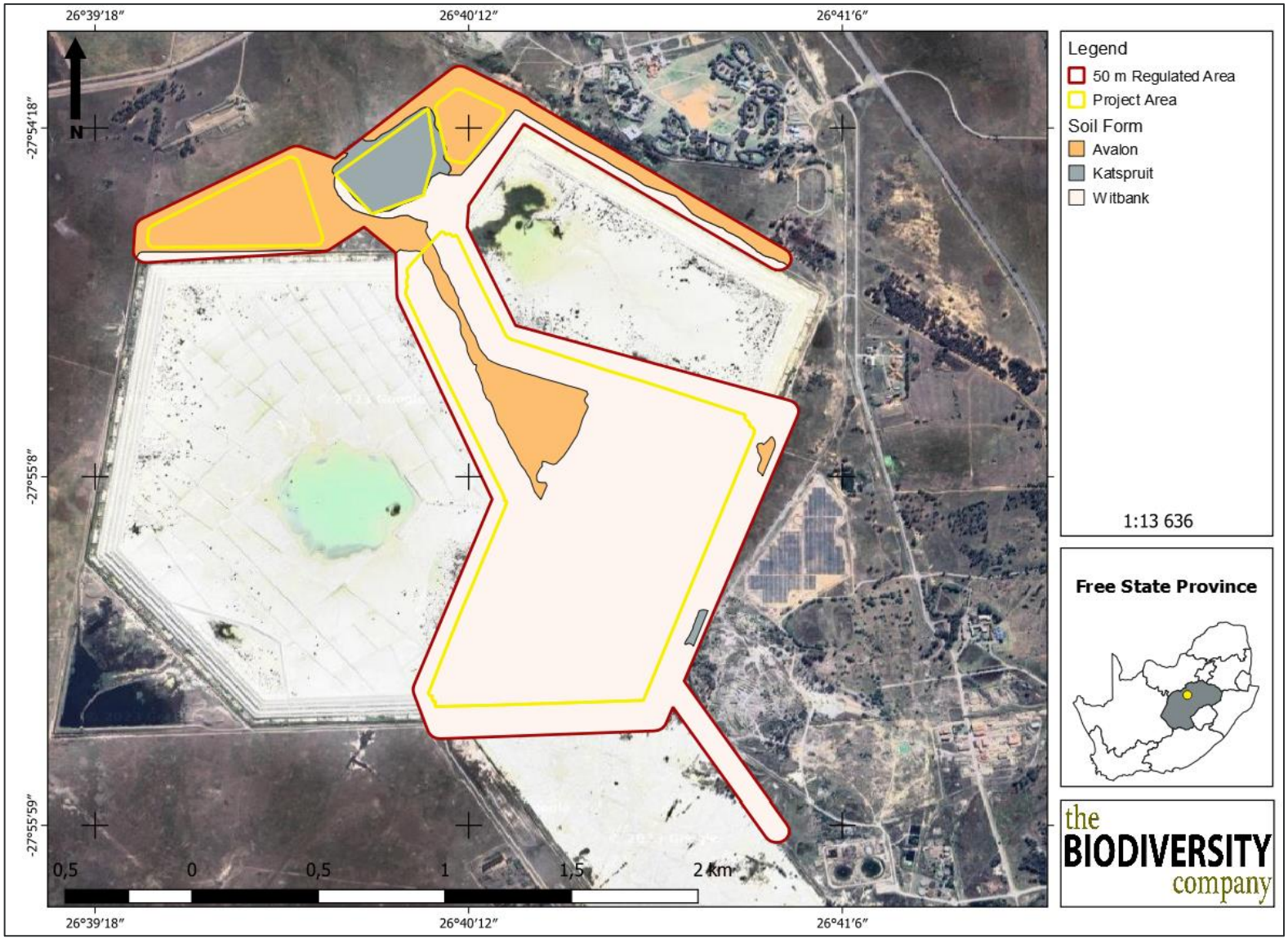

Figure 19: Soil types within study area.

Land capability and agricultural potential will briefly be determined by a combination of soil, terrain and climate features. Land capability is defined by the most intensive long-term sustainable use of land under rain-fed conditions. At the same time an indication is given about the permanent limitations associated with the different land use classes. Agricultural potential is determined by a combination of soil, terrain and climate features. Land capability classes reflect the most intensive long-term use of land under rain-fed conditions. The land capability is determined by the physical features of the landscape including the soils present. The land potential or agricultural potential is determined by combining the land capability results and the climate capability for the region.

The land capability dataset (DAFF, 2017) indicates a varied range throughout the project area, which is predominantly covered with “Very Low” to “Moderate” categories. A small portion is characterized by “Moderate High” capability. There are crop field boundaries, which were identified by means of the Screening Tool (2022), which are characterized by “High” sensitivities, within the project area. Despite portions of the project area coinciding with delineated crop field areas, it was apparent from the assessment that these areas are not actively cultivated. Further to this, no irrigation infrastructure, such as centre pivots or drip irrigation are present within the project area and irrigated agricultural is currently not practiced in the area.

Considering the soil properties, agricultural potential as well as the current land use of the project area, the area has a “Low” agricultural sensitivity. Most selected areas demarcated by the Screening Tool as “Moderate Low or Moderate High” can be categorised as “Very Low” and “Low” with soils like the Witbank characterised with a low land capability. Based on the confirmed sensitivities, the overall sensitivity of the proposed project area can be categorized as “Low.

The proposed Valley TSF project is assigned an overall “Low” land potential, which is regarded to be very restrictive with a low sensitivity. Considering the soil properties, agricultural potential as well as the current land use of the area, the area has an overall “Low” agricultural sensitivity (Figure 20).

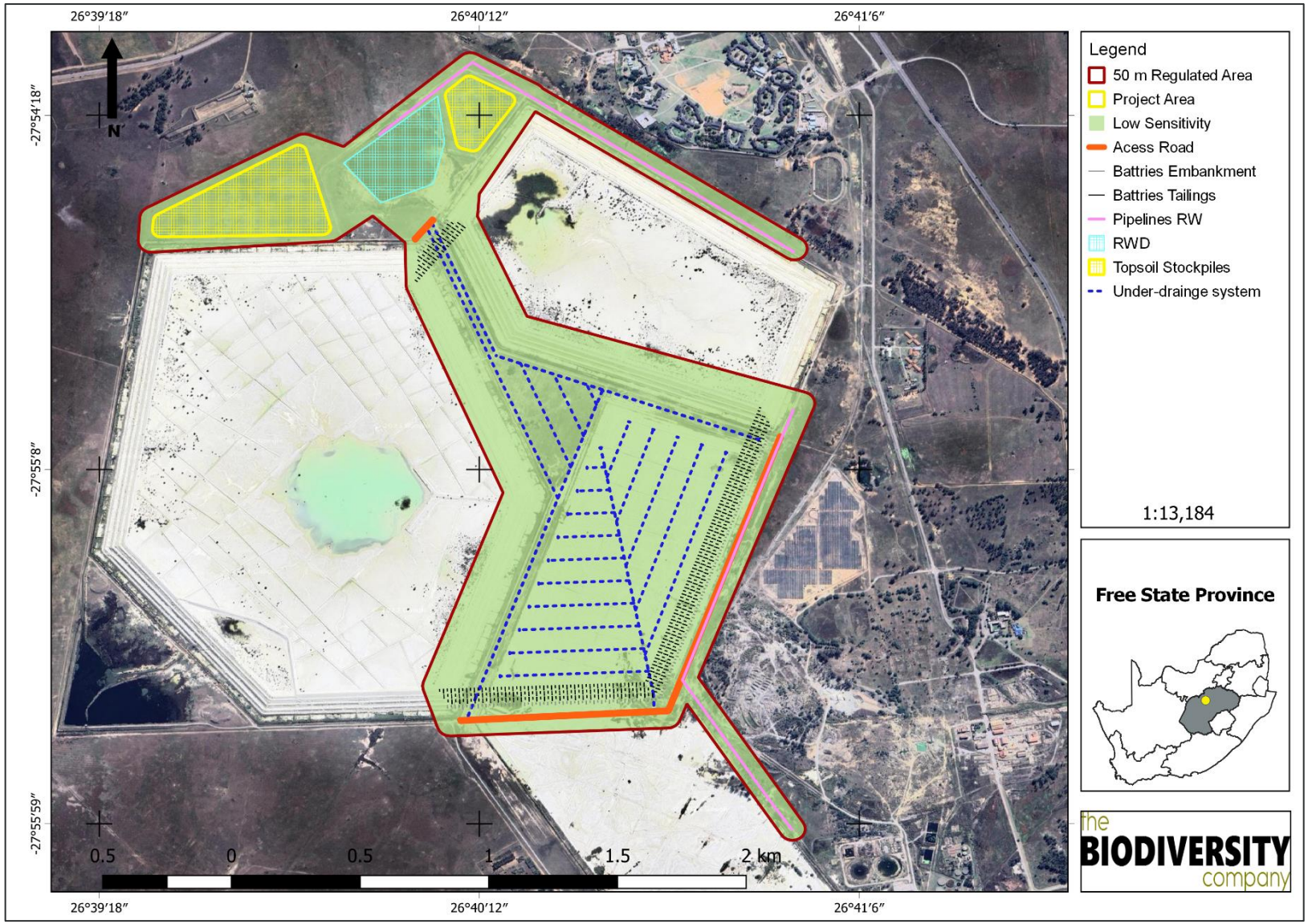

Figure 20: Agricultural sensitivity of the site

8.8 FAUNA AND FLORA

The approach adopted for the fauna and flora assessment has taken cognisance of the recently published Government Notice 320 in terms of NEMA dated 20 March 2020: “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 National Environmental Management Act, 1998, when applying for Environmental Authorisation”. The National Web based Environmental Screening Tool has characterised the plant and animal species and is assigned a “very high sensitivity” and “high sensitivity” respectively (refer to Appendix F).

The project area has historically transformed by mining activities. A change to the land use is not envisioned to have any notable negative effect on the proposed footprint area due to the current transformed state of the area, and due to the project area being isolated from any natural surrounding areas. The project area does not represent the very high plant sensitivity as per the screening report, as it has been determined to be mostly very low based on specialist site visit conducted in April 2023. A specialist site survey was undertaken to identify the current status of the vegetation composition on site as well as to confirm if any species of special concern occur on site. The potential animal species presence on the development site is also very low based on the disturbed state of the site.

The NEMA contains listed activities for clearing of indigenous vegetation and which require environmental authorisation prior to commencing with such clearing. The Valley TSF will require clearance of just over 20ha of indigenous vegetation. A specialist terrestrial ecology compliance statement was conducted as part of the EIA for the project.

A field survey was conducted for the proposed project, which was undertaken on the 11th of April 2023. Each habitat unit is described in Table 10.

Table 10: Sensitivity summary of the habitat types delineated within the Project Area

Habitat	Description	SEI	Photographs
Modified	This habitat unit includes all areas that maintain little to no native vegetation and/or where anthropogenic activity has substantially modified an area’s primary ecological functions and species composition. This habitat unit no longer maintains its functional integrity and does not contribute significantly to ecosystem services. This habitat unit is characterised by areas used for mining related activities, primarily exiting TSF’s. No fauna or flora SCC were recorded or are expected.	**Very Low**	

Habitat	Description	SEI	Photographs
Water Resource	This habitat unit is made up of wetlands and dams and is dominated by hydrophytes. No fauna or flora SCC were recorded or are expected. More information on this habitat unit can be found in the accompanying wetland report (TBC, 2023).	**Medium**	
Degraded Grassland	This habitat unit is characterised by open grassland impacted by alien plant populations, low pioneer grasses, and Alien Invasive Plant (AIP) species. The habitat is constantly disturbed in nature and cannot recover to a more natural state due to ongoing disturbances and impacts received from grazing, edge effects from land use and mismanagement. Dominant species include *Eragrostis gummiflua* and *Cynodon dactylon*. *Vachellia karroo* were also recorded within this habitat unit. Alien invasive plant (AIP) species include *Verbena brasiliensis*, *Opuntia sp.* and *Flaveria bidentis*. No fauna or flora SCC were recorded or are expected.	**Low**	 

8.9 BIRDS AND BATS

During the field assessment 34 avifauna species were observed. No bat species were observed during the field assessment and limited species are expected to occur within the Project Area due to the small and modified nature of the area. No SCC species were observed, however, *Mycteria ibis* (Stork, Yellow-billed) and *Phoenicopterus roseus* (Flamingo, Greater) are known to occur in areas in close proximity to the project area.

8.10 SURFACE WATER AND WETLANDS

The site is positioned within quaternary catchment C43B which has an area of 723 km^2 and C25B which has an area of 1 895km^2 both of which are located within the Middle Vaal WMA. The Mahemspruit River is the only defined river relevant to this assessment (when considering the more detailed 1:50,000 topographical map data). The Mahemspruit is located 2,7 km to the southeast and will not be affected by the construction and operation of the proposed Valley TSF. Two additional (and significant) dams are within close proximity to the site, including D-Dam Complex.

A specialist aquatic ecology survey was conducted as part of the EIA for the project. A site visit was conducted by an aquatic specialist in April 2023. Several wetlands were identified and delineated, however, these are located outside the site or bordering the site for the TSF aside from the two artificial wetlands located within

the proposed TSF footprint area. Apart from the wetlands indicated in Figure 21 the location of the proposed TSF site does not contain any surface water resources and is situated approximately 2 km at its closest from the nearest river/stream (the Mahemspruit River located southeast of the TSF site).

Unchannelled valley-bottom wetlands are typically found on valley floors where the landscape does not allow high energy flows and supports the diffuse flow of water. Depression wetlands are located on the "slope" landscape unit. Depressions are inward draining basins with an enclosing topography which allows for water to accumulate within the system. Depressions, in some cases, are also fed by lateral sub-surface flows in cases where the dominant geology allows for these types of flows. Isolated hillslope seeps are characterised by colluvial movement of material. These systems are fed by very diffuse sub-surface flows which seep out at very slow rates, ultimately ensuring that no direct surface water connects this wetland with other water courses within the valleys.

The ecosystem services provided by the wetland units identified on site were assessed and rated using the WET-EcoServices method (Kotze et al., 2008). The average ecosystem service scores for the delineated systems are illustrated in Table 11. The ecosystem services scores of the delineated wetlands ranges from intermediate to moderately high. Ecosystem services contributing to these scores include flood attenuation, streamflow regulation, sediment trapping, phosphate assimilation, nitrate assimilation, toxicant assimilation and, erosion control.

Table 11: Average ecosystem service scores for delineated wetlands

Moderately High	Intermediate	Moderately Low
HGM 1	HGM 2	HGM 3
HGM 4		HGM 6
HGM 5		

The existing FSN 2 Northern RWD is located within HGM 1. HGM 1, 4 and 5 scored "Moderately High" on the provision of ecosystem services due to the nature of the wetlands, being valley-bottoms and a depression wetland respectively. The valley bottom wetlands will play a major role in streamflow regulation and flood attenuation which is important in terms of runoff from the tailing's facilities. The wetlands will use their hydrophytes to remove toxicants from the runoff/seepage from the water to produce cleaner water downstream. The depression wetlands have high hydrophyte vegetation to provide habitat and resources for many different animals as well as humans. The depression will also act as sinks where toxicants, nitrates and phosphates from the environment.

HGM 2 scored "Intermediate" ecosystem services scores. The wetland has been modified to such an extent that they have lost some of their function. The wetland has loss many of their hydrophyte vegetation with only a few hydrophyte species present within the wetland. The wetland does still play an important role in flood attenuation and streamflow regulation. The wetland will also still purify the water flowing through them. This is attributed to much of the wetland being modified, leaving only a narrow spans of wetland vegetation intact in some reaches of the wetland.

HGM 3 and 6 scored "Moderately Low" for the ecosystem services score due to the low volumes of hydrophyte vegetation present inside the wetland. Hydrophytes help with the accumulation of toxicants as well as phosphates and nitrates from the environment as well as provides habitat and resources so the removal of them lower the ecosystem services dramatically. The construction of a solar farm inside HGM 6 lowered the ecosystem services score of the wetland.

The results of the ecological Importance and Sensitivity assessment are shown in Table 12. Various components pertaining to the protection status of a wetland are considered for the IS, including Strategic Water Source Areas (SWSA), the NFEPA wetland vegetation (wet veg) threat status and the protection status of the wetland. The IS for both the valley bottoms and the seep wetlands were calculated to be "High", which combines the low protection status of the wet veg and the and the high threat status of the wetlands themselves. The depression

wetlands scored “Moderate” sensitivities due to the low threat status of the wet veg and the low threat status of the wetlands themselves.

Table 12: The IS results for the delineated HGM units

HGM Type	NFEPA Wet Veg			NBA Wetlands			SWSA (Y/N)	Calculated IS
	Type	Ecosystem Threat Status	Ecosystem Protection Level	Wetland Condition	Ecosystem Threat Status 2018	Ecosystem Protection Level		
Unchannelled Valley Bottom	Dry Highveld Grassland Group 3	Least Threatened	Not Protected	D/E/F Largely Modified	Critically	Not Protected	N	**High**
Depression	Dry Highveld Grassland Group 3	Least Threatened	Not Protected	A/B Largely Natural	Least Concerned	Not Protected	N	**Moderate**
Hillslope Seep	Dry Highveld Grassland Group 3	Least Threatened	Not Protected	D/E/F Largely Modified	Critically	Not Protected	N	**High**

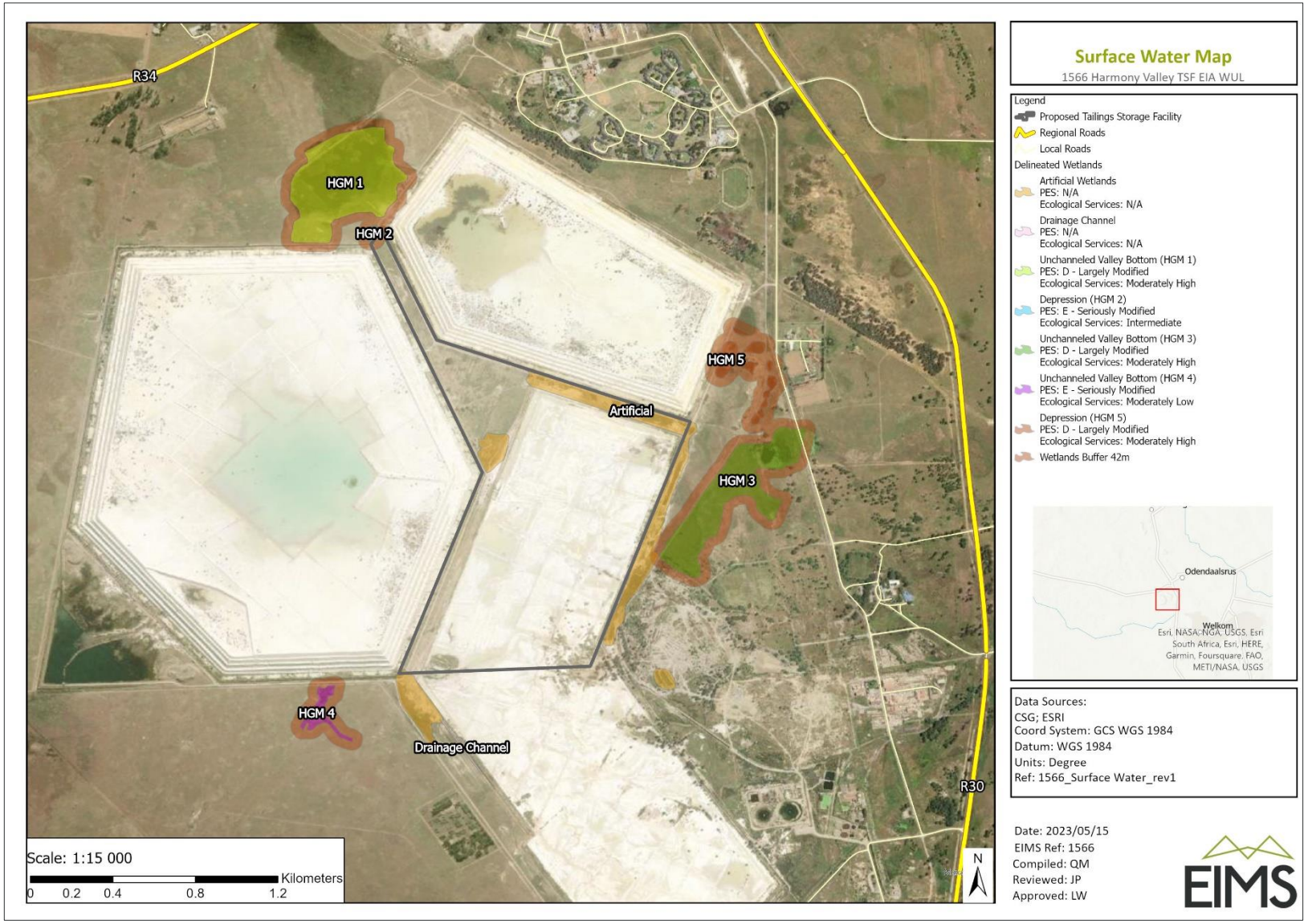

Figure 21: Surrounding surface water features

8.11 GROUNDWATER

A new geohydrological specialist study was conducted as part of this EIA. The geohydrological setting and conceptual model of the study area is described according to the following criteria:

- Borehole information;
- Aquifer type;
- Groundwater use;
- Aquifer parameters;
- Aquifer recharge;
- Groundwater gradients and flow;
- Groundwater quality; and
- Aquifer classification.

8.11.1 BOREHOLE INFORMATION

During a study conducted by Golder Associates in 2009 eighteen new boreholes were drilled to assess the groundwater regime underlying the Valley TSF and surrounds. Information from these boreholes was used to conduct the geohydrological assessment. The localities of the boreholes are shown on Figure 23. The borehole information is summarised in Table 13.

Table 13: Borehole Information (Golder Associates, 2009)

ID	X	Y	Z	Depth (mbc)	Water Level (mbc)
BH1	26.65620	-27.92963	1335	90	5.50
BH2	26.65627	-27.92970	1331	36	6.41
BH3	26.65732	-27.94308	1334	73	54.03
BH4	26.65735	-27.94312	1336	24	Artesian
BH5	26.64065	-27.93760	1327	73	Dry
BH6	26.64062	-27.93755	1330	23	17.99
BH7	26.64061	-27.93019	1336	73	72.38
BH8	26.64057	-27.93023	1336	26	20.87
BH9	26.67978	-27.94499	1330	73	4.12
BH10	26.67975	-27.94496	1329	23	6.47
BH11	26.67250	-27.90450	1350	68	Artesian
BH12	26.67256	-27.90454	1348	27	Artesian
BH13	26.68095	-27.90938	1354	73	52.48
BH14	26.68097	-27.90936	1349	29	2.02
BH15	26.68849	-27.91220	1353	73	52.13
BH16	26.68845	-27.91220	1352	30	Dry
BH17	26.67954	-27.92358	1345	73	40.06

ID	X	Y	Z	Depth (mbc)	Water Level (mbc)
BH18	26.67952	-27.92365	1345	29	4.03

8.11.2 AQUIFER TYPE

The mine infrastructure is situated on interbedded siltstone/sandstone and shale of the Vryheid Formation. Even though the shale and sandstone are not known to contain economic aquifers, groundwater contributes to stream flow and in some instances, high yielding boreholes have been recorded. The following three aquifers underlie the site:

- Weathered Aquifer (Karoo Formations): A shallow, weathered aquifer exists in the weathered shale and sandstone at an average depth of 10m – 20m below ground level. The most consistent water strike is located at the fresh bedrock / weathering interface. The hydraulic conductivity of the weathered aquifer is typically in the order of 0.1 m/day. The vertical permeability is in the order of 0.001 m/day to 0.00010 m/day, which is sufficiently low to confine the groundwater in the underlying fractured rock aquifer.
- Fractured Aquifer (Karoo Formations): The primary porosity of the Vryheid Formation is very low. Any water bearing capacity is therefore associated with secondary joints, bedding planes and faults. The contact zones of dolerite intrusions are characterised by cooling joints and fractures, which are considered the primary source of groundwater flow within the deeper formations. The hydraulic conductivity of the fractured rock aquifer is typically in the order of 0.001 m/day to 0.1 m/day. The depth to groundwater in this aquifer can be variable due to confining layers in parts of the study area.

  The two aquifers may or may not be hydraulically connected, dependent on the local geology.
- Witwatersrand / Ventersdorp Aquifer: The deep brine Witwatersrand aquifer is situated approximately 300m below surface. Mining prospecting boreholes indicated this level to be between 170m to 270m (EMP, 2009). This aquifer is thought to be connate (i.e. original formation water) or extremely old (fossil) water and is usually concentrated on geological structures such as fault zones or igneous intrusions (e.g. dykes). The time gap between the end of the Central Rand Group and the start of the Karoo deposition was in the order of 2.3Ga. There is also a significant time gap between the Central Rand Group and the Ventersdorp Supergroup. During these intervening periods, the older rocks were uplifted and exposed to erosion and the near surface rocks to pressure release. This resulted in the forming of fractures in approximately the upper 150m of the rock succession. Subsequent land surface changes and inundation by a shallow sea allowed marine water to percolate into the network of fractures in the Witwatersrand and Ventersdorp rocks (Young, 1990).
- The major fractures that formed during the Ventersdorp tectonic events were filled with water to a depth of several kilometres. The impermeable nature of the overlying Karoo sediments, particularly the Dwyka Formation at the base of the Karoo, effectively sealed of the aquifer (Van Biljon, 1995). Post-Karoo movement and intrusions provided conduits for leakage from the Karoo aquifers to the deep Witwatersrand aquifer. However, the deep aquifer recharge from surface is regarded as negligible and at best localised (Van Biljon, 1995). The Witwatersrand aquifer has been largely dewatered during the past 40 years of mining and the water levels in the aquifer dropped significantly. In spite of the dewatering of the Witwatersrand aquifer, there is no evidence of dewatering of the Karoo aquifers.

It is, therefore, concluded that:

- There is no or very limited hydraulic connectivity between the Karoo aquifers and the deeper Witwatersrand aquifer.
- Recharge to the Witwatersrand aquifer is negligible.
- Once the Witwatersrand aquifer is dewatered (or the water level lowered) it will not recover. The estimated post-mining water level in the Witwatersrand aquifer will therefore be deeper than the pre-mining water level of ~200m below surface.

A graphical illustration of the aquifers is presented in Figure 22.

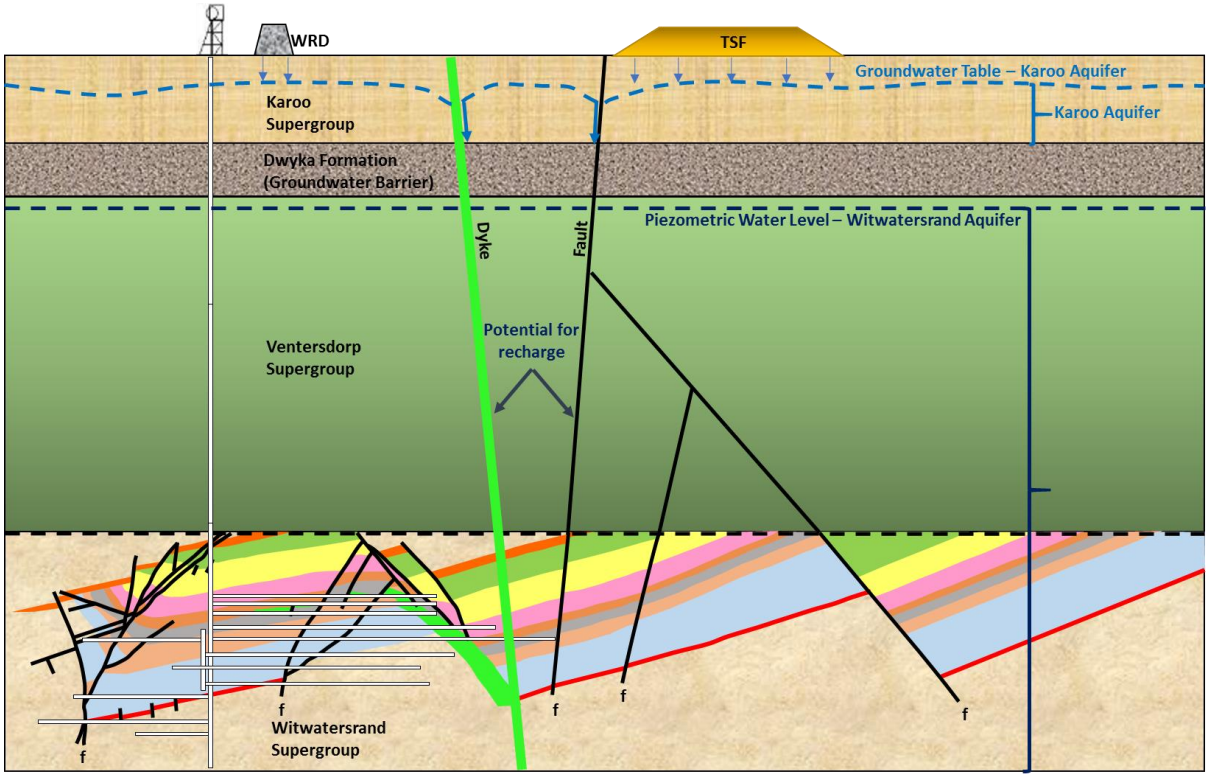

Figure 22: Graphical illustration of the aquifers in the study area

8.11.3 GROUNDWATER USE

There are no large-scale groundwater supply boreholes within the immediate study area. Farmers are, however, reliant on boreholes for domestic use and stock watering. Windmills have traditionally been utilised in the area. There are no springs recorded. Percussion boreholes drilled through the Karoo established the following information (EMP, 2009):

- Number of Boreholes: 43
- Average Thickness of Karoo: 117m
- Percentage of boreholes intersecting dolerite in Karoo: 33%
- Average depth of dolerite from surface: 74m

The drilling indicated that groundwater occurrence is predominantly on the contact zones with dolerite intrusions and on the contact between the Karoo sediments and the Ventersdorp lavas. Measured yields vary from 0.10 litre per second (ℓ/sec) to 22 ℓ/sec.

8.11.4 AQUIFER PARAMETERS

The drilled boreholes noted above were pump tested by Golder Associates (2009). Important parameters that can be obtained from borehole or test pumping include Hydraulic Conductivity (K), Transmissivity (T) and Storativity (S). These parameters are defined as follows (Krusemann and De Ridder, 1991):

- Hydraulic Conductivity: This is the volume of water that will move through a porous medium in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. It is normally expressed in metres per day (m/day).
- Transmissivity: This is the rate of flow under a unit hydraulic gradient through a cross-section of unit width over the full, saturated thickness of the aquifer. Transmissivity is the product of the average

hydraulic conductivity and the saturated thickness of the aquifer. Transmissivity is expressed in metres squared per day (m^2/day).

- Storativity: The storativity of a saturated confined aquifer is the volume of water released from storage per unit surface area of the aquifer per unit decline in the component of hydraulic head normal to that surface. Storativity is a dimensionless quantity.

The average transmissivity of the shallow aquifer is estimated at 2.3 m^2/day, while that of the deep aquifer is estimated at 0.9 m^2/day.

8.11.5 AQUIFER RECHARGE

Recharge is defined as the process by which water is added from outside to the zone of saturation of an aquifer, either directly into a formation, or indirectly by way of another formation. According to the Groundwater Assessment Phase II (GRAII) the recharge is approximately 4% of mean annual precipitation. This implies that approximately 8.64 mm/a of precipitation recharges the groundwater system which is lower than the GRAII values.

8.11.6 GROUNDWATER GRADIENTS AND FLOW

Figure 23 depicts the groundwater level elevations, which as expected mimic the surface contours. Groundwater flow is perpendicular to the groundwater contours and flows predominantly towards the south-west.

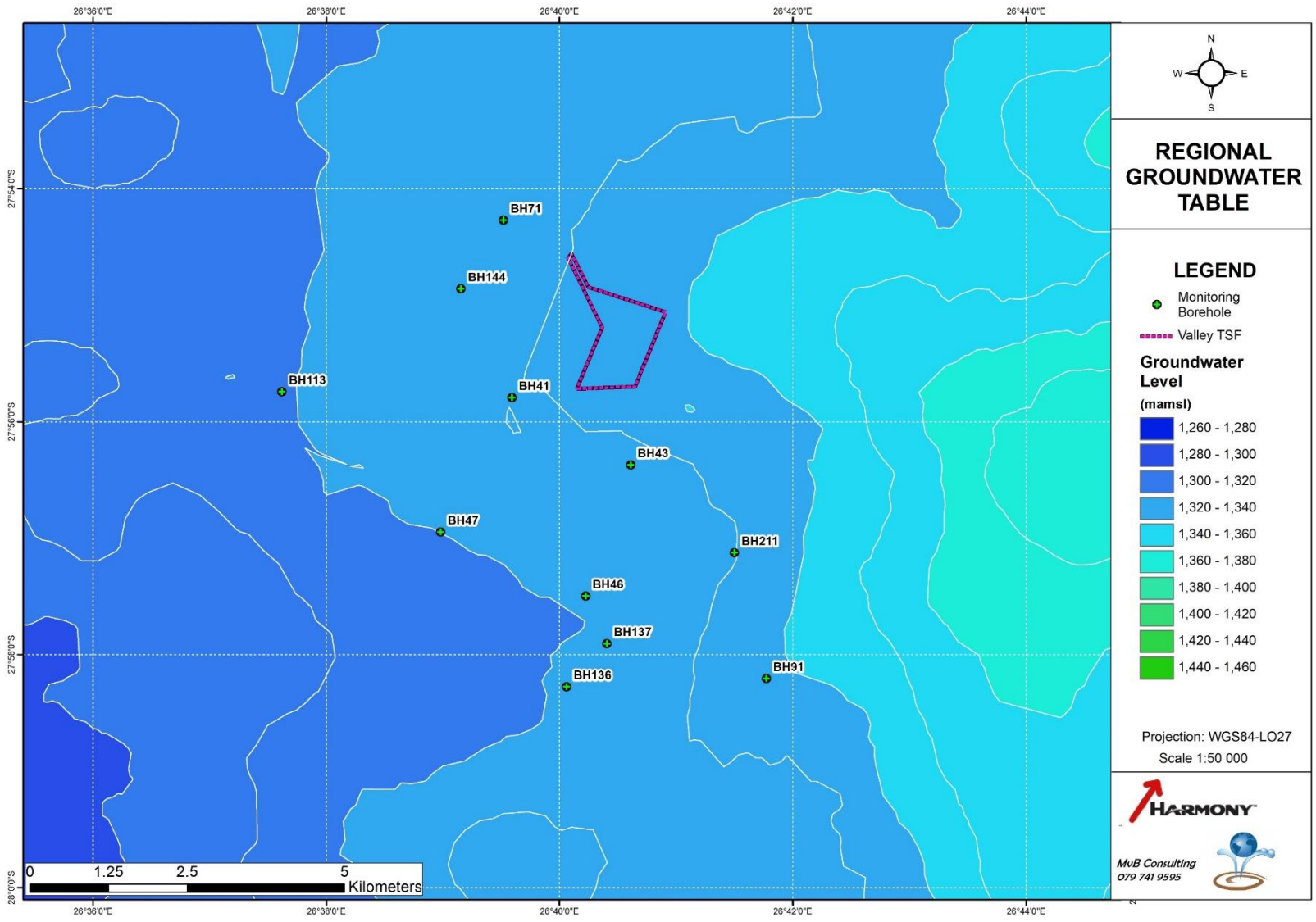

Figure 23: Regional groundwater gradient and borehole locations

8.11.7 GROUNDWATER QUALITY

The groundwater chemistry is compared to the South African Water Quality Guidelines (second edition) Volume 5: Agricultural Use: Livestock Watering (Department of Water Affairs and Forestry, 1996), as well as the SANS 241 (2015). The SANS 241 Drinking Water Specification is the definitive reference on acceptable limits for drinking water quality parameters in South Africa and provides guideline levels for a range of water quality characteristics. The SANS 241 (2015) Drinking-Water Specification effectively summarises the suitability of water for drinking water purposes for lifetime consumption.

The chemical concentrations are compared to the Guidelines for Livestock Watering. Where these guidelines are exceeded, the values are highlighted in red. In the absence of limits for livestock watering the chemical concentrations are compared to the SANS 241 (2015) Guidelines for Drinking Water.

The chemistry of the groundwater is presented in Table 14. The following is observed:

- The groundwater in the Free State is generally saline and most of the boreholes have Electrical Conductivity (EC) and Total Dissolved Solids (TDS) concentrations that exceed the guideline limits. Very high TDS concentrations are recorded in borehole BH46. This borehole is situated very close to a stream indicating that spillage is occurring or has occurred into this stream. The high concentrations are not attributed to natural plume migration.
- The high salt concentrations are primarily attributed to chloride, sulphate and sodium.
- The existing tailings facilities have impacted on the surrounding groundwater environment. The extent of this impact is best illustrated through the sulphate (SO_4) concentrations in the monitoring boreholes (Figure 24). The most impacted areas appear to be associated with the return water dams, and / or spillage into a surface stream and not necessarily the TSF itself.

Table 14: Groundwater chemistry

Parameter	SANS 241	DWAF	BH71	BH144	BH41	BH47	BH43	BH46	BH211	BH137	BH136	BH91	BH113
pH	<5 - >9.7	NG	8.29	7.61	7.89	8.63	2.63	7.80	8.19	8.87	7.66	7.83	8.06
EC mS/m	170	NG	615	1 641	906	146	1 355	4 980	142	141	2 234	302	74
TDS mg/L	1 200	1 000	3 860	11 124	6 110	1 029	8 997	39 137	852	863	14 881	2 381	472
Total Alk mg/L	NG	NG	244	513	501	190	6	551	238	518	472	405	194
Cl mg/L	300	1 500	1 373	4 466	2 229	246	5 106	16 284	171	105	6 854	562	94
SO_4 mg/L	500	1 000	939	2 660	1 583	107	1 121	8 622	233	115	2 723	834	84
NO_3-N mg/L	11	100	38.77	<0.46	0.50	51.43	1.63	<0.46	<0.46	0.59	1.55	<0.46	0.81
Ca mg/L	NG	1 000	284	478	182	31	823	738	90	13	528	241	13
Mg mg/L	NG	500	172	279	214	24	671	1 979	33	4	487	121	10
Na mg/L	200	2 000	746	2 902	1 576	268	1 254	11 146	171	306	3 975	348	138
K mg/L	NG	NG	26	24	18	8	15	29	8	2	19	26	11
Fe mg/L	2	10	0.009	<0.009	0.090	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	0.016	<0.009
Mn mg/L	0.4	10	0.001	<0.001	2.142	<0.001	12.288	<0.001	<0.001	<0.001	<0.001	<0.001	0.011

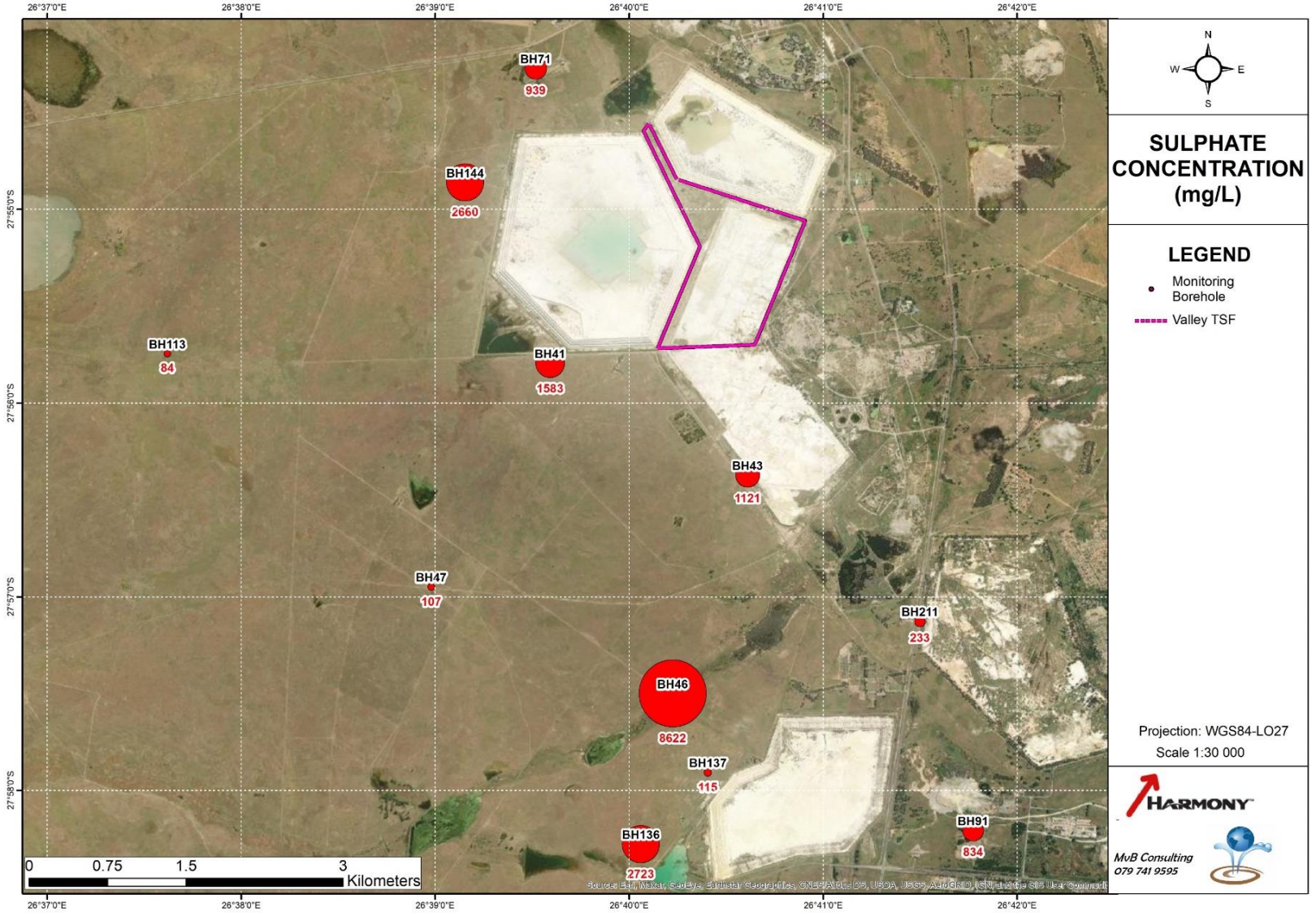

Figure 24: Sulphate concentration distribution in the groundwater monitoring boreholes.

8.11.8 AQUIFER CLASSIFICATION

An aquifer classification system provides a framework and objective basis for identifying and setting appropriate levels of groundwater resource protection. This would facilitate the adoption of a policy of differentiated groundwater protection.

The aquifer classification system used to classify the aquifers is the proposed National Aquifer Classification System of Parsons (1995). This system has a certain amount of flexibility and can be linked to second classifications such as a vulnerability or usage classification. Parsons suggests that aquifer classification forms a very useful planning tool that can be used to guide the management of groundwater issues. He also suggests that some level of flexibility should be incorporated when using such a classification system.

The South African Aquifer System Management Classification is presented by five major classes:

- Sole Source Aquifer System;
- Major Aquifer System;
- Minor Aquifer System;
- Non-Aquifer System; and
- Special Aquifer System.

The following definitions apply to the aquifer classification system:

- Sole source aquifer system: “An aquifer that is used to supply 50% or more of domestic water for a given area, and for which there are no reasonable alternative sources should the aquifer become depleted or impacted upon. Aquifer yields and natural water quality are immaterial”.
- Major aquifer system: “Highly 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”.
- Minor aquifer system: “These can be fractured or potentially fractured rocks that do not have a high primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although this aquifer seldom produces large quantities of water, they are both important for local supplies and in supplying base flow for rivers”.
- Non-aquifer system: “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 unusable. However, groundwater flow through such rocks does occur, although imperceptible, and needs to be considered when assessing risk associated with persistent pollutants”.
- Special aquifer system: “An aquifer designated as such by the Minister of Water Affairs, after due process”.

After rating the aquifer system management and the aquifer vulnerability, the points are multiplied to obtain a Groundwater Quality Management (GQM) index. Based on the above, the aquifers in the study area are classified as follows:

Table 15: Aquifer Classification

Description	Aquifer	Vulnerability	Rating	Protection
Weathered Aquifer	Minor (2)	2	4	Medium
Fractured Aquifer	Minor (2)	1	2	Low

8.12 AIR QUALITY

The wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the yellow area, for example, representing winds in between 4 and 5 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated. The period wind field and diurnal variability in the wind field are shown in Figure 26, while the seasonal variations are shown in Figure 27.

During the 2019 to 2021 period, the wind field was dominated by winds from the north-northeast and northeast, followed by northerly and easterly winds. During the day (6AM – 6PM), the prevailing wind field is from the north to northeast and the west, with less frequent winds from the north-westerly sector, the easterly sector and the south-west. During the night, the wind field shifts to the easterly sector (north-northeast to east-southeast), with very little flow from the westerly sector. Long-term air quality impacts are therefore expected to be the most significant to the south and southwest of the project area. The strongest winds (more than 6 m/s) were also from the north and northeast and occurred mostly during the day, with 15 m/s the highest wind speed recorded. The average wind speed over the three years is 3.7 m/s, with calm conditions occurring for 3.5% of the time (Figure 26).

Seasonally, the wind flow pattern conforms to the period average wind flow pattern. The seasonal wind field shows little seasonal differences in the wind fields. During summer and spring, the dominant winds are from the north-northeast to east, with more frequent westerly winds during spring. Autumn reflects dominant north-easterly and easterly winds, with a similar wind field during winter, but with more frequent north-northeasterly and east-southeasterly winds.

Air quality sensitive receptors (AQSRs) refer to places where humans reside. Ambient air quality guidelines and standards, as discussed under section 2.2, have been developed to protect human health. Ambient air quality, in contrast to occupation exposure, pertains to areas outside of an industrial site or boundary where the public has access to and according to the Air Quality Act, excludes air regulated by the Occupational Health and Safety Act (Act No 85 of 1993).

A map showing locations of AQSRs within the Project boundary is included in Figure 25. These include residential areas, farmsteads, schools and hospitals. The closest towns in the immediate region of the project include Welkom and its suburbs (located about 4 km southeast of the Project boundary) and Odendaalsrus (located about 5 km north of the Project boundary).

Harmony samples dust fallout at 44 locations (4 samplers each at 11 sites, Figure 8). Of these sites, five are within the study domain, i.e. Odendaalsrus, Rheederpark, Flamingo Park, Bedelia and St Helena. Dust fallout rates were sampled during the most recent period for which data was available (July 2016 to May 2017). Most of the sites, but specifically the ones in the vicinity of the Project (i.e. Odendaalsrus, Rheederpark, Flamingo Park, Bedelia and St Helena) are in non-compliance, where it exceeded the residential and non-residential limits more than two months in 2017 and for two sequential months.

8.12.1.1 EXISTING SOURCES OF ATMOSPHERIC EMISSION - AGRICULTURE

Neighbouring land-use in the surrounding of the proposed project comprises predominantly of agriculture activities. These land-uses contribute to baseline pollutant concentrations via fugitive and process emissions, vehicle tailpipe emissions, household fuel combustion, biomass burning and windblown dust from exposed areas.

Agriculture is a major land-use activity within and beyond the project boundary. These activities include crop farming such as maize, and livestock farming. Particulate matter is the main pollutant of concern from agricultural activities as particulate emissions are derived from windblown dust, burning crop residue, and dust entrainment as a result of vehicles travelling along dirt roads. In addition, pollen grains, mould spores and plant and insect parts from agricultural activities all contribute to the particulate load. Should chemicals be used for crop spraying, they would typically result in odiferous emissions. Crop residue burning is also an additional

source of particulate emissions and other toxins. Due to the small scale of farming activities these are regarded to have an insignificant cumulative impact.

Livestock farms, especially cattle, are also significant sources of fugitive dust especially when feedlots are used and the cattle trample in confined areas. Pollutants associated with dairy production for instance include ammonia (NH3), hydrogen sulfide (H2S), methane (CH4), carbon dioxide (CO2), oxides of nitrogen (NOx) and odour related trace gasses. According to the US-EPA, cattle emit methane through a digestive process that is unique to ruminant animals called enteric fermentation. The calf-cow sector of the beef industry was found to be the largest emitter of methane emissions. Where animals are densely confined the main pollutants of concern include dust from the animal movements, their feed and their manure, ammonia (NH3) from the animal urine and manure, and hydrogen sulfide (H2S) from manure pits.

Organic dust includes dandruff, dried manure, urine, feed, mould, fungi, bacteria and endotoxins (produced by bacteria, and viruses). Inorganic dust is composed of numerous aerosols from building, materials and the environment. Since the dust is biological it may react with the defence system of the respiratory tract. Odours and VOCs associated with animal manure is also a concern when cattle are kept in feedlots. The main impact from methane is on the dietary energy due to the reduction of carbon from the rumen. Dust and gasses levels are higher in winter or whenever animals are fed, handled or moved.

8.12.1.2 EXISTING SOURCES OF ATMOSPHERIC EMISSION - MINING

Particulates represent the main pollutant of concern at mining operations, whether it is underground or opencast. The amount of dust emitted by these activities depends on the physical characteristics of the material, the way in which the material is handled and the weather conditions (e.g. high wind speeds, rainfall, etc.). Mining of gold, as well as ore extraction and processing plants are all commercial activities situated in the region of the project.

8.12.1.3 EXISTING SOURCES OF ATMOSPHERIC EMISSION - DOMESTIC FUEL COMBUSTION

Domestic households are known to have the potential to be one the most significant sources that contribute to poor air quality within residential areas. Individual households are low volume emitters, but their cumulative impact is significant. It is likely that households within the local communities or settlements utilize coal, paraffin and/or wood for cooking and/or space heating (mainly during winter) purposes. Pollutants arising from the combustion of wood include respirable particulates, CO and SO2 with trace amounts of polycyclic aromatic hydrocarbons (PAHs), in particular benzo(a)pyrene and formaldehyde. Particulate emissions from wood burning have been found to contain about 50% elemental carbon and about 50% condensed hydrocarbons.

Coal is relatively inexpensive in the region and is easily accessible due to the proximity of the region to coal mines and the well-developed coal merchant industry. Coal burning emits a large amount of gaseous and particulate pollutants including SO2, heavy metals, PM including heavy metals and inorganic ash, CO, PAHs (recognized carcinogens), NO2 and various toxins. The main pollutants emitted from the combustion of paraffin are NO2, particulates, CO and PAHs.

8.12.1.4 EXISTING SOURCES OF ATMOSPHERIC EMISSION - FUGITIVE DUST SOURCES

These sources are termed fugitive because they are not discharged to the atmosphere in a confined flow stream. Sources of fugitive dust identified in the study area include paved and unpaved roads and wind erosion of sparsely vegetated surfaces.

8.12.1.5 EXISTING SOURCES OF ATMOSPHERIC EMISSION - ROADS

Emissions from unpaved roads constitute a major source of emissions to the atmosphere in the South African context. When a vehicle travels on an unpaved road the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong turbulent air shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads vary in relation to the vehicle traffic and the silt loading on the roads. Unpaved roads in the region are mainly haul and access roads.

Emissions from paved roads are significantly less than those originating from unpaved roads, however they do contribute to the particulate load of the atmosphere. Particulate emissions occur whenever vehicles travel over a paved surface. The fugitive dust emissions are due to the re-suspension of loose material on the road surface. Paved roads in the region include the R710, R73, R30 and R34.

8.12.1.6 EXISTING SOURCES OF ATMOSPHERIC EMISSION - WIND EROSION OF OPEN AREAS

Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne, its erosion potential has to be restored; that is, the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity. Every time a surface is disturbed, its erosion potential is restored (US EPA, 2004). Erodible surfaces may occur as a result of agriculture and/or grazing activities.

8.12.1.7 EXISTING SOURCES OF ATMOSPHERIC EMISSION - VEHICLE TAILPIPE EMISSIONS

Emissions resulting from motor vehicles can be grouped into primary and secondary pollutants. While primary pollutants are emitted directly into the atmosphere, secondary pollutants form in the atmosphere as a result of chemical reactions. Significant primary pollutants emitted combustion engines include carbon dioxide (CO2), carbon (C), sulfur dioxide (SO2), oxides of nitrogen (mainly NO), particulates and lead. Secondary pollutants include NO2, photochemical oxidants such as ozone, sulfur acid, sulphates, nitric acid, and nitrate aerosols (particulate matter). Vehicle type (i.e. model-year, fuel delivery system), fuel (i.e. oxygen content), operating (i.e. vehicle speed, load) and environmental parameters (i.e. altitude, humidity) influence vehicle emission rates.

Transport in the vicinity of the project is via trucks and private vehicles along the R710, R73, R30 and R34 roads (which are the main sources of vehicle tailpipe emissions), as well as vehicles and machinery travelling on unpaved and private roads.

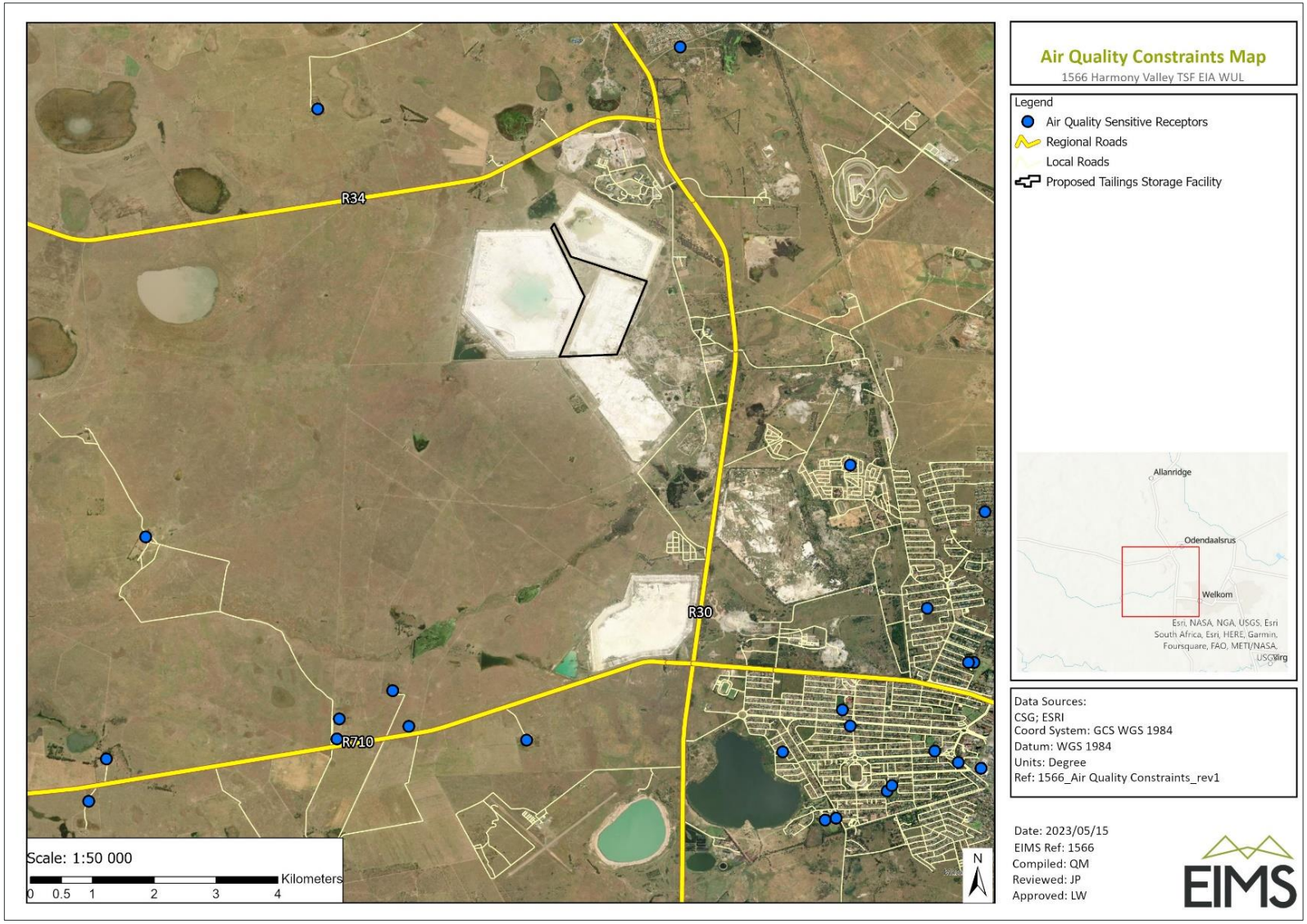

Figure 25: Location of sensitive receptors relative to the Project.

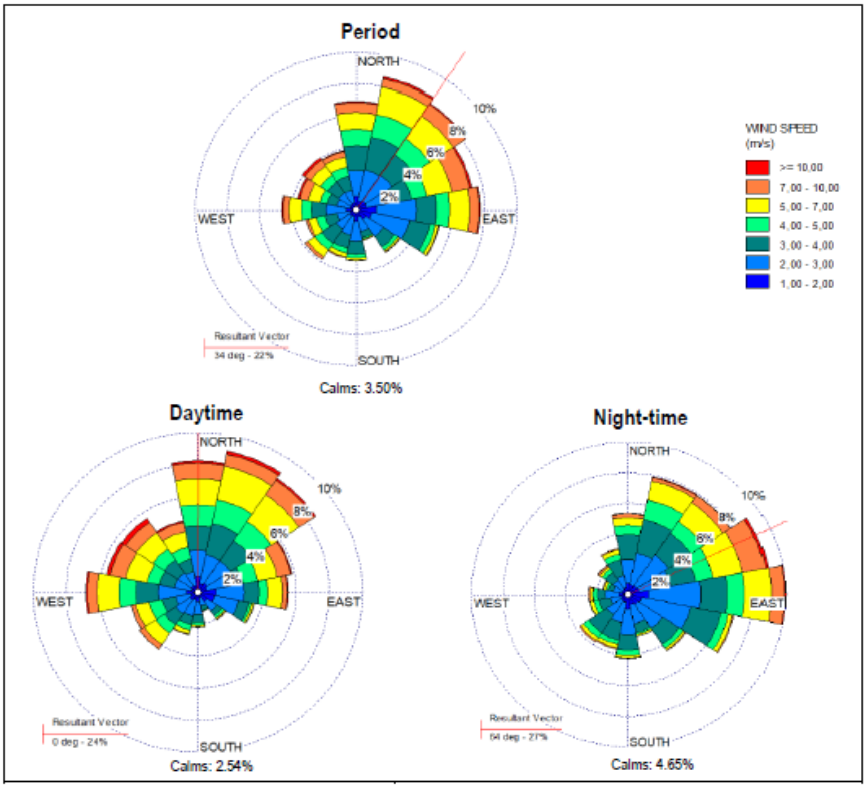

Figure 26: Period, day- and night-time wind roses (SAWS Welkom Data, 2019 to 2021).

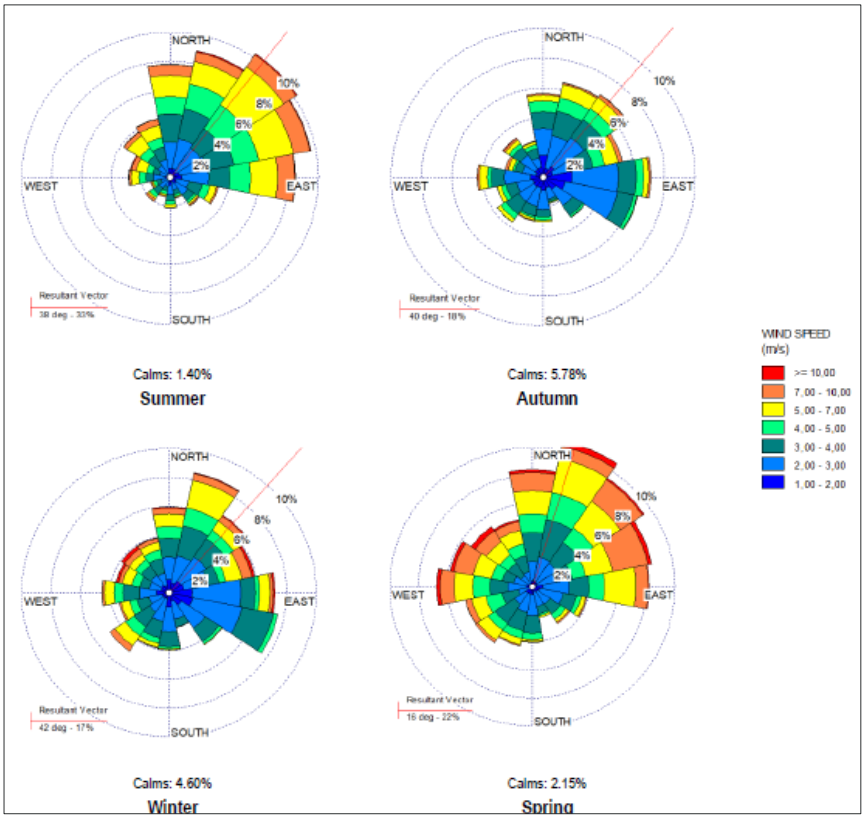

Figure 27: Seasonal wind roses (SAWS Welkom Data, 2019 to 2021)).

According to the Beaufort wind force scale (https://www.metoffice.gov.uk/guide/weather/marine/beaufort-scale), wind speeds between 6-8 m/s equates to a moderate breeze, with wind speeds between 9-11 m/s referred to as a fresh breeze. Wind speeds between 11-14 m/s are described as a strong breeze with winds between 14-17 m/s near gale force winds and 17-21 m/s as gale force winds. Over the 3-year period, wind speeds within 14-17 m/s occurred for 0.03% of the time, and winds between 11-14 m/s for 0.46%. The likelihood for wind erosion to occur from open and exposed surfaces, with loose fine material, but taking into account that the TSF surfaces are typically crusted, was estimated when the wind speed exceeds 9 m/s (Mian & Yanful, 2003). Wind speeds exceeding 9 m/s occurred for 2.27% over the 3-year period.

8.13 VISUAL RECEPTORS AND LANDSCAPE CHARACTER

A visual study was undertaken by Graham Young (refer to Appendix D) and the baseline information from that study is presented in this section. The site is located within an area that is predominantly surrounded by existing mining infrastructure. There are no protected areas in the vicinity of the proposed site. The existing visual condition of the landscape that may be affected by the proposed Project has been described. Most of the study area's scenic quality has been rated moderate to low within the context of the sub-region, and sensitive viewing areas and landscape types identified and mapped indicating potential sensitivity to the project, specifically from farmsteads and people travelling along arterial roads west of the site. The site is in a landscape type rated as moderate to low.

The study area comprises a combination of landscape character types including open grassland (grazing) with some pans, agricultural lands, urbanisation and settlements, and mining and associated infrastructure. The characteristics of the study area can be divided into two distinct zones, the western section, natural/faming zone and the central/eastern section, dominated by mining and settlement landscape types. The proposed Valley TSF is on existing mine land.The result is a landscape characterised by mixed aesthetic and visual qualities.

The original landscape, of which there remain remnants of it scattered throughout the western section was Western Free State Clay Grassland (Mucina and Rutherford 2006:384), scattered with Highveld Salt Pans (Mucina and Rutherford 2006:619). The salt pans manifest as depressions in the landscape containing temporary water bodies containing many species of important taxa. The slightly irregular undulating grasslands are dominated by *Themeda triandra* and other grasses that attribute to desired grazing lands. Dotted across the grasslands at the homesteads are usually tall stands of exotic trees.

Impacts on views are the highest when viewers are identified as being sensitive to change in the landscape, and their views are focused on and dominated by the change. The visual impact of the Project will cause changes in the landscape that are noticeable to viewers experiencing the study area from the R30 and the far western areas of Rheederpark. Visual impacts that would potentially result are likely to be adverse, long-term, and will cause a minor loss to the baseline landscape and visual resources resulting in a low severity of impact.

The visual receptors identified at desktop level within the project area are shown in Figure 28 which identifies receptor locations where people would most likely be susceptible to negative changes in the landscape caused by the physical presence of the Project. The main areas of concern might be:

- Residential areas east of the development site (Rheederpark and Flamingo Park);
- Farmstead(s) east of the R30 and south of Phakisa Freeway; and
- Travellers along the R30 arterial route.

People living and passing through these locations will experience some negative change and s minor loss of the baseline landscape aesthetic due to the scale and extent of the TSF. However, due to the high visual absorption capacity of the existing landscape, sensitive views to the development would mostly be obstructed by existing facilities and tall trees east and south east of the proposed site. These negative changes would occur over an extended time frame i.e. over the life of the mine and beyond as the TSF would remain as a residual structure in the landscape and represent the worst case scenario.

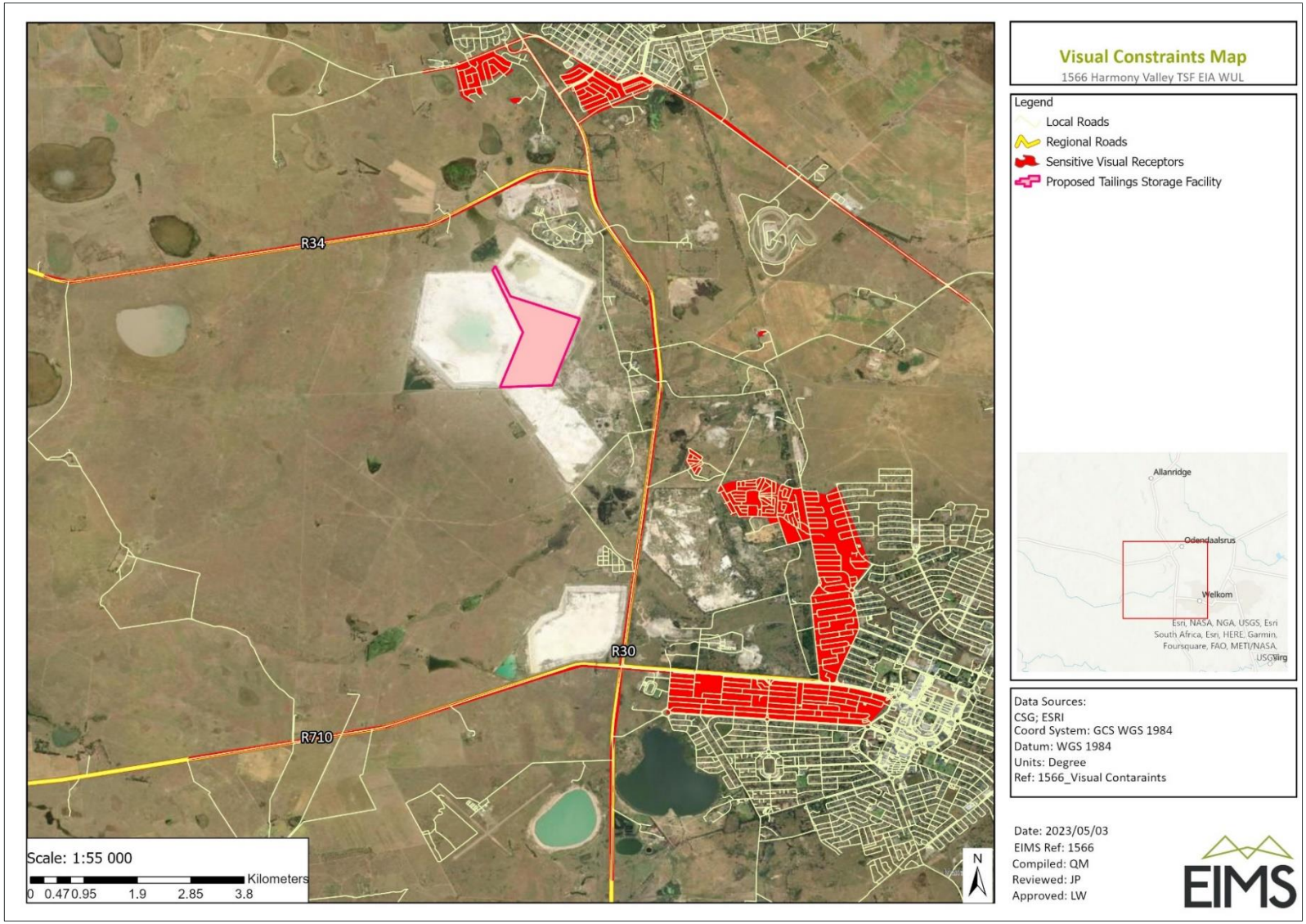

Figure 28: Landscape Character Areas and visual sensitive receptors.

9 ENVIRONMENTAL IMPACT ASSESSMENT

9.1 IMPACT ASSESSMENT METHODOLOGY

The impact significance rating methodology, as provided by EIMS, is guided by the requirements of the NEMA EIA Regulations 2014 (as amended). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. This determines the environmental risk. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S). The impact assessment will be applied to all identified alternatives. Where possible, mitigation measures will be recommended for impacts identified.

9.1.1 DETERMINATION OF ENVIRONMENTAL RISK

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

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

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

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 16 below.

Table 16: Criteria for Determining Impact Consequence.

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).

Aspect	Score	Definition
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/ scored as per Table 17.

Table 17: Probability Scoring.

Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),
	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

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

ER= C x P

Table 18: Determination of Environmental Risk.

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10

	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 19.

Table 19: Significance Classes.

Environmental Risk Score	
Value	Description
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk).
≥9 - <17	Medium (i.e. where the impact could have a significant environmental risk),
≥17	High (i.e. where the impact will have a significant environmental risk).

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

9.1.2 IMPACT PRIORITISATION

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

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

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

Table 20: Criteria for Determining Prioritisation.

Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/ definite that the impact will result in spatial and temporal cumulative change.
	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.

Irreplaceable Loss of Resources (LR)	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 20. The impact priority is therefore determined as follows:

Priority = CI + LR

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 1.5 (Refer to Table 21).

Table 21: Determination of Prioritisation Factor.

Priority	Ranking	Prioritisation Factor
2	Low	**1**
3	Medium	**1.125**
4	Medium	**1.25**
5	Medium	**1.375**
6	High	**1.5**

In order to determine the final impact significance, the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance). 0

Table 22: Final Environmental Significance Rating.

Significance Rating	Description
<-17	High negative (i.e. where the impact must have an influence on the decision process to develop in the area).
≥-17, ≤-9	Medium negative (i.e. where the impact could influence the decision to develop in the area).
>-9, < 0	Low negative (i.e. where this impact would not have a direct influence on the decision to develop in the area).
0	No impact
>0, <9	Low positive (i.e. where this impact would not have a direct influence on the decision to develop in the area).
≥9, ≤17	Medium positive (i.e. where the impact could influence the decision to develop in the area).

Significance Rating	Description
>17	High positive (i.e. where the impact must have an influence on the decision process to develop in the area).

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project. **The EIA impact assessment matrix (including pre- and post-mitigation assessment) is included in Appendix E.**

9.2 IMPACTS IDENTIFIED

This Section presents the potential impacts that have been identified during the scoping phase assessment. It should be noted that this report will be made available to I&APs for review and comment and their comments and concerns will be addressed in the final EIA report submitted to the CA for adjudication. The results of the public consultation will be used to update the identified potential impacts which will be further refined during the course of the EIA assessment and consultation process.

Potential environmental impacts were identified during the scoping process. These impacts were identified by the EAP, the appointed specialists, as well as the public. Table 23 provides the list of potential impacts identified.

Without proper mitigation measures and continual environmental management, most of the identified impacts may potentially become cumulative, affecting areas outside of their originally identified zone of impact. The potential cumulative impacts have been identified, evaluated, and mitigation measures suggested which will be updated during the detailed EIA level investigation.

When considering cumulative impacts, it is important to bear in mind the scale at which different impacts occur. There is potential for a cumulative effect at a broad scale, such as regional deterioration of air quality, as well as finer scale effects occurring in the area surrounding the activity. The main impacts which have a cumulative effect on a regional scale are related to the transportation vectors that they act upon. For example, air movement patterns result in localised air quality impacts having a cumulative effect on air quality in the region. Similarly, water acts as a vector for distribution of impacts such as contamination across a much wider area than the localised extent of the impacts source. At a finer scale, there are also impacts that have the potential to result in a cumulative effect, although due to the smaller scale at which these operate, the significance of the cumulative impact is lower in the broader context.

Table 23: Identified environmental impacts.

Main Activity / Action / Process	Ancillary Activity	Geo-physical (geology, topography, air, water)	Biological	Socio-economic	Heritage and cultural
Site preparation (Planning)	Vegetation clearance Planned placement of infrastructure Topsoil stripping	○ Loss of land capability	○ Temporary disturbance of wildlife		○ Disturbance/ destruction of archaeological sites or palaeontological material (if any)
Human resources management (Planning)	Employment/recruitment I&AP consultations Environmental awareness training HIV/AIDS Awareness programmes Integration with Municipalities' strategic long-term planning			○ Employment opportunities. ○ Perceptions and expectations	
Earthworks (Construction)	Stripping and stockpiling of soils Levelling, grubbing and bulldozing Removal of waste and cleared vegetation Preparing trenches and foundations Establishing storm water management measures Establishment of firebreak	○ Erosion due to storm water runoff ○ Emissions and dust ○ Impacts on wetlands ○ Soil erosion, Land degradation ○ Degradation of wetland vegetation and the introduction and spread of alien and invasive vegetation ○ Increased sediment loads to downstream reaches	○ Loss/ destruction of natural habitat ○ Introduction/ Invasion by Alien Species ○ Displacement of faunal species ○ Impacts on birds and bats	○ Visual impact and impact on sense of place ○ Nuisance and impact on sense of place (i.e. noise, dust, etc.). ○ Safety and security (i.e. access to properties, theft, fire hazards, etc.). ○ Perceptions and expectations ○ Employment opportunities	○ Disturbance/ destruction of archaeological sites or historic structures ○ Disturbance/ destruction of fossils

Main Activity / Action / Process	Ancillary Activity	Geo-physical (geology, topography, air, water)	Biological	Socio-economic	Heritage and cultural
		○ Contamination of wetlands with hydrocarbons ○ Disruption of wetland soil profile and alteration of hydrological regime			
Civil Works (Construction)	Establishment of infrastructure and services Mixing of concrete and concrete works Establishment of dewatering pipelines Sewage and sanitation Establishment of waste area Access control and security General site management	○ Erosion due to storm water runoff ○ Emissions and dust ○ Impacts on wetlands ○ Exhalation and dispersion of radon gas to the atmosphere ○ Soil erosion, Land degradation ○ Increased water inputs (clean) to downstream wetlands	○ Loss/ destruction of natural habitat ○ Introduction/ Invasion by Alien Species ○ Displacement of faunal species ○ Impacts on birds and bats	○ Visual impact and impact on sense of place ○ Nuisance and impact on sense of place (i.e. noise, dust, etc.). ○ Safety and security (i.e. access to properties, theft, fire hazards, etc.). ○ Perceptions and expectations ○ Employment opportunities	○ Disturbance/ destruction of archaeological sites or historic structures ○ Disturbance/ destruction of fossils
Deposition at TSF (Operation)	Deposition of tailings Maintenance and management of stormwater system Water management	○ Emissions and dust ○ Emission and dispersion of particulate matter that contains radionuclides ○ Soil erosion, Land degradation ○ Groundwater quality impacts	○ Continued fragmentation and degradation of habitats and ecosystems ○ Impacts on birds and bats	○ Visual impact and impact on sense of place ○ Nuisance and impact on sense of place (i.e. noise, dust, etc.). ○ Safety aspects related to radiation and health as well as stability.	

Main Activity / Action / Process	Ancillary Activity	Geo-physical (geology, topography, air, water)	Biological	Socio-economic	Heritage and cultural
				○ Employment opportunities	
Closure and Rehabilitation of TSF (Decommissioning and Closure)	Revegetation Slope stabilisation Erosion control	○ Emissions and dust ○ Disruption of wetland soil profile, hydrological regime and increased sediment loads ○ Groundwater quality impacts	○ Alien and invasive species	○ Visual impact and impact on sense of place ○ Safety and security (i.e. access to properties, theft, fire hazards, etc.). ○ Visual, noise and dust ○ Employment opportunities	
Maintenance (Post closure)	Initiate maintenance and monitoring programmes Environmental aspect monitoring	○ Long-term groundwater quality, air quality and radiation impacts	○ Alien and invasive species	○ Site security and access control	

9.3 DESCRIPTION AND ASSESSMENT OF IMPACTS

The following potential impacts were identified during the scoping phase assessment and were assessed in terms of nature, significance, consequence, extent, duration and probability. These impact calculations are based on the EIA phase assessment specialist reports and the results of public consultation undertaken during the Scoping as well as EIA phases. Mitigation / management measures to minimise potential negative impacts or enhance potential benefits are put forward in this EIA Report and described further in the sections below. The EIA impact assessment matrix (including pre- and post-mitigation assessment) is included in Appendix E.

9.3.1 GROUNDWATER (GEOHYDROLOGY) IMPACTS

The proposed Valley TSF will be built between existing tailings facilities. The date of construction of these facilities is unclear but it was assumed that the dams were established during the 1970's. The impact from the existing dams were therefore modelled, based on this assumption, and the current modelled impact from these dams are shown in

Figure 29. The current impact is mainly towards the southwest and the Mahemspruit.

Assuming that the existing facility is 50 years old, the average plume migration can be estimated based on Darcy's law. Contaminants are transported in groundwater by advection, that is, the movement of a solute at the speed of the average linear velocity of groundwater (Anderson, et. al., 1992).

The hydraulic conductivity for the weathered aquifer is estimated as 0.289 m/day. The groundwater gradient averages 0.6% in the study area. The porosity of the aquifer material is estimated to be between 3 - 7% (AquiSim Consulting, 2012). Applying the above formula to the study area assuming a porosity of 5% it is calculated that the groundwater velocity averages a rate of 0.035 m/day or 12.66 m per annum. Iover the 50-year period the plume migration is estimated at 633m, which is supported by the numerical modelling. The potential of impacted seepage from surface infrastructure (tailings dam) affecting downgradient receptors was evaluated. The first part of the assessment looks at the potential future impact from the proposed Valley tailings facility only and the second part of the assessment looks at the cumulative impact from the existing infrastructure and the proposed infrastructure.

The numerical model was used to simulate the following scenarios:

- Contaminant seepage from the Tailings Dam without any liner for periods 10-, 50- and 100-years; and
- Contaminant seepage from the Tailings Dam with an engineered liner for periods 50- and 100-years.

It is evident from this assessment that the area is already impacted by the historical activities. Plume migration is, however, slow and although the simulated current plume has reached the Mahemspruit, the concentrations are <500 mg/L. The Mahemspruit is, however, impacted not only by this tailings facility, but also by other contaminant sources in the region.

The expected contribution of the impact from the Valley TSF is low and contained within the current impacted footprint. The unmitigated impact shows that a contaminant plume will migrate from the proposed TSF towards the only down-gradient receptor, the Mahemspruit. This contaminant flow is very slow and small impacts (<500 mg/L SO_4) will only reach the stream after approximately 100 years.

With reference to the modelled plumes, it appears that the lining of the proposed Valley TSF will have net positive impact on the down-gradient groundwater quality. It is, however noted that although the positive impact is not visible on the extent of the plume, there is nevertheless a reduction in the contaminant concentration over time. The reduction in the sulphate concentration down-gradient from the facility, with a liner installed, is approximately 50mg/L after 30 years.

This is a small improvement and it is therefore recommended that a rehabilitation plan be developed to address the groundwater deterioration from the existing TSF, in conjunction with the lining of the Valley TSF.

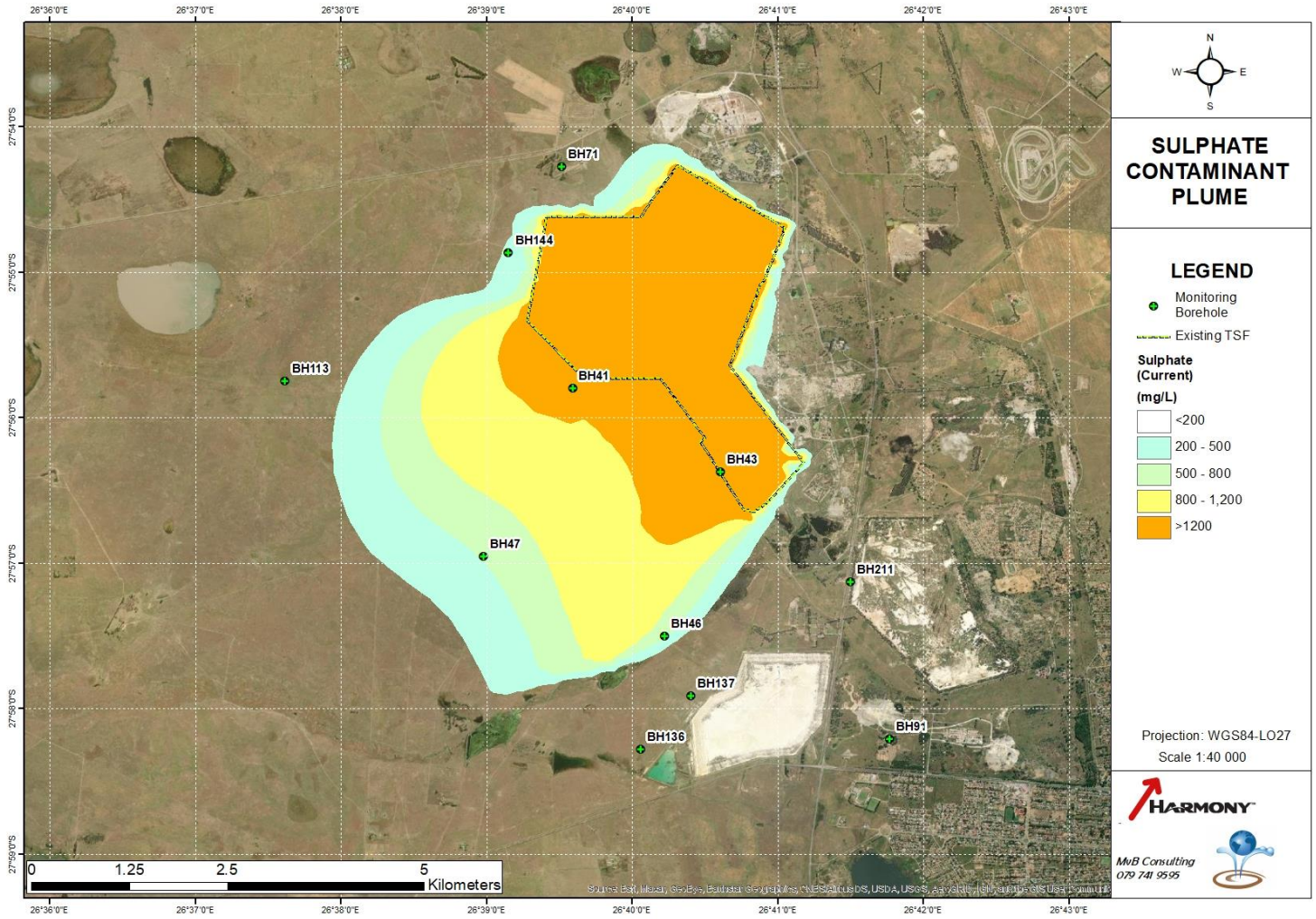

Figure 29: Simulated current sulphate plume from existing tailings facilities[1]

[1] It should be noted with respect to the RWD, since this dam will be lined, the modelling shows no plume (and no mitigation is required).

The Tailings Dam was modelled as a constant source (worst-case scenario) as it is assumed that the facility will continue to release impacted seepage to the environment. The impacts after 10 years, 50 years and 100 years were simulated and the results presented in Figure 30 to Figure 34

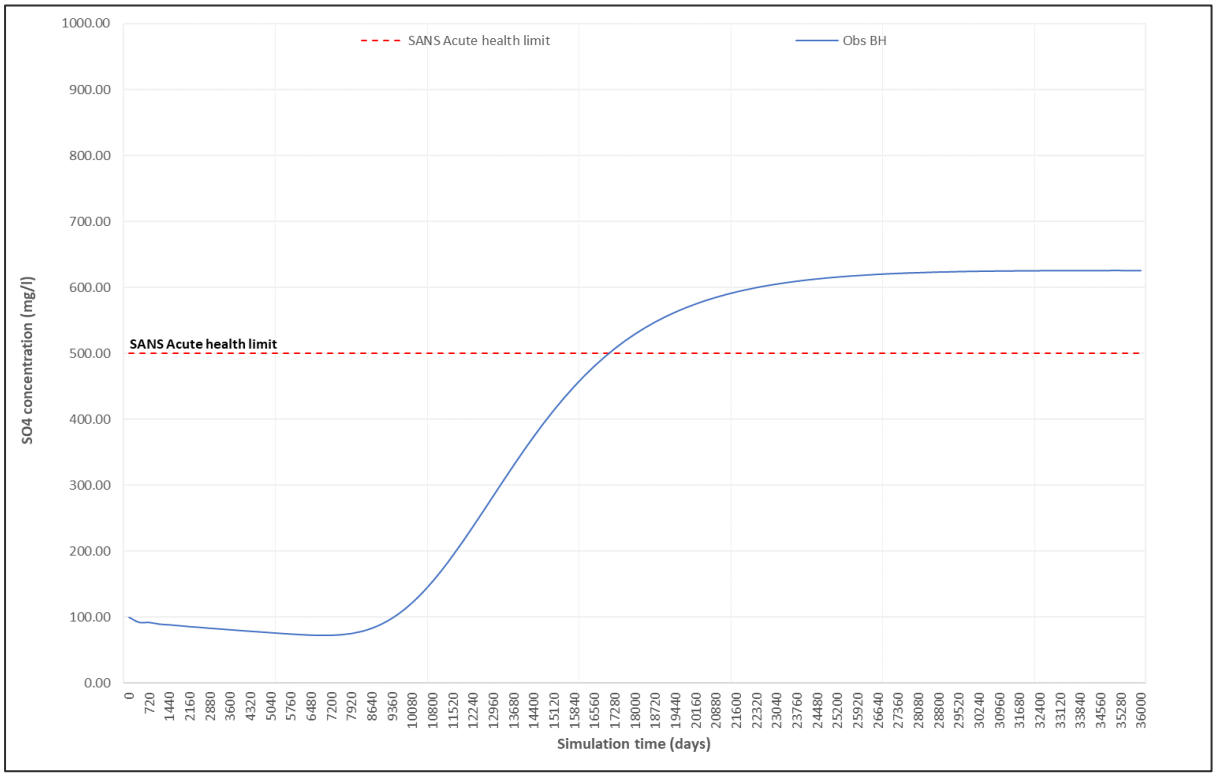

Figure 30: Simulated sulphate concentration in an observation borehole over time.

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The gold tailings that will be deposited on the Valley TSF are classified as a Type 3 waste in terms of the NEMWA Regulations 2013 requiring a Class C containment barrier performance. The Class C single composite barrier system comprises of underdrainage; a base preparation layer; a 300mm thick compacted clay liner (CCL); a 1,5mm thick geomembrane; a dual-purpose ballast and protection layer of at least 100mm thickness, and above liner drainage system. The performance of such a barrier is largely influenced by the design specifications and associated Construction Quality Assurance (CQA). The nature and extent of wrinkles influences the containment performance, with an expected seepage rate to be in the order of 140 litres / hectare / day (Legge, 2024).

By making use of an ”inverted barrier system” comprising of underdrainage and a base preparation layer; a 1.5mm thick geomembrane ; and covered tailings the barrier system performance is improved by (a) seepage losses are reduced from about 140 l/ha/day to about 3 l/ha/day due to the change from Bernoulli flow at discontinuities to D’Arcian flow controlled by the tailings permeability at these points (Legge, 2024).

These leakage rates were included in the model and the impact simulated. The result from the 100-year simulation shows that any contamination from the site will be contained. The small volume of seepage that may flow through the liner system is diluted to the extent that contamination is not detected.

The following scenarios were modelled:

- The impacts from the existing tailings facility as well as the proposed Valley TSF, after 50 years.
- The impacts from the existing tailings facility as well as the proposed Valley TSF, after 100 years.

It is evident from this assessment that the area is already impacted by the historical activities. Plume migration is, however, slow and although the simulated plume has reached the Mahemspruit, the concentrations are <500

mg/L. The Mahemspruit is, however, impacted not only by this tailings facility, but also by other contaminant sources in the region.

The expected contribution of the impact from the Valley TSF is low and contained within the current impacted footprint. The cumulative impact of the current and proposed tailings facilities will continue to impact on the Mahemspruit, but the simulated concentrations remain <500 mg/L. It is important to note that the impact simulations assume a constant source, without any remediation. In other words, a worst-case scenario. The reality is that the source will become depleted over time and the source concentration will improve. This, together with a rehabilitation plan will greatly improve the situation and lessen the impact.

The existing plume from the existing facilities after 50 and 100 years is shown in Figure 31 and Figure 34 respectively. The existing plume with the Valley plume is indicated in Figure 33 and Figure 34 respectively. The figures show negligible difference between those 2 sets of plumes. The comparison indicates that the future impact from this facility will always be contained within the impact footprint from the existing facilities.

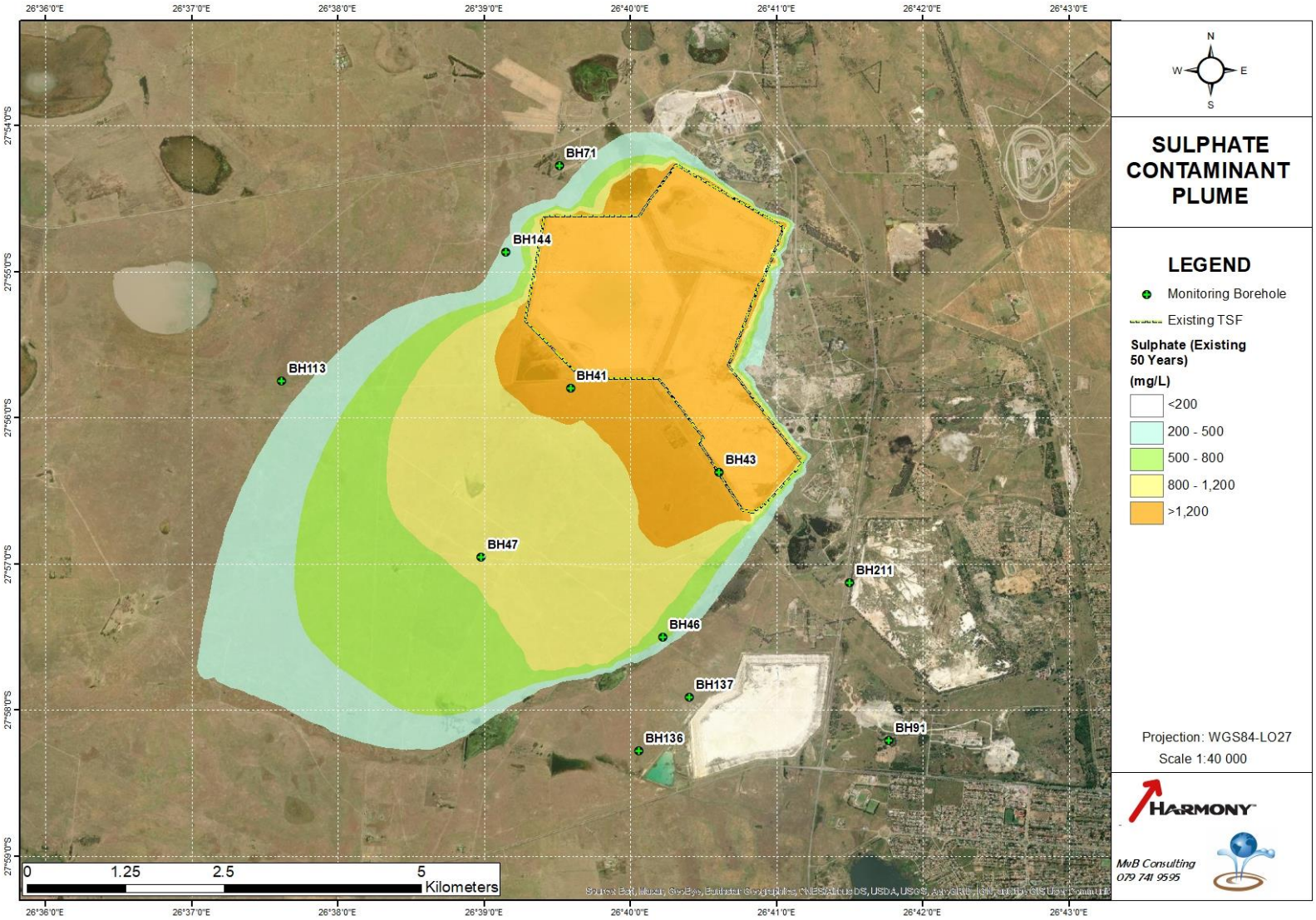

Figure 31: Simulated current sulphate plume from existing tailings facilities after 50 years

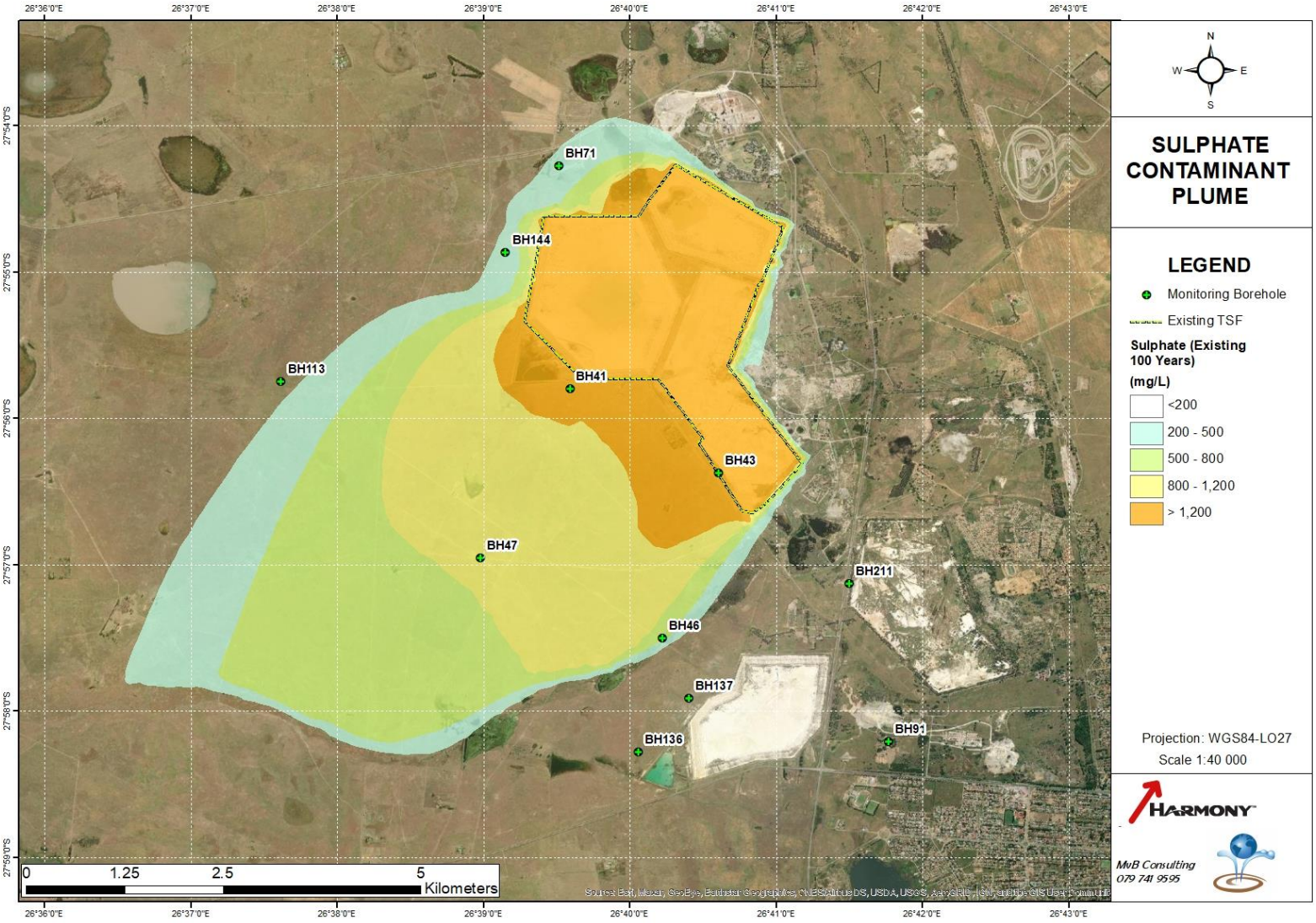

Figure 32: Simulated current sulphate plume from existing tailings facilities after 100 years

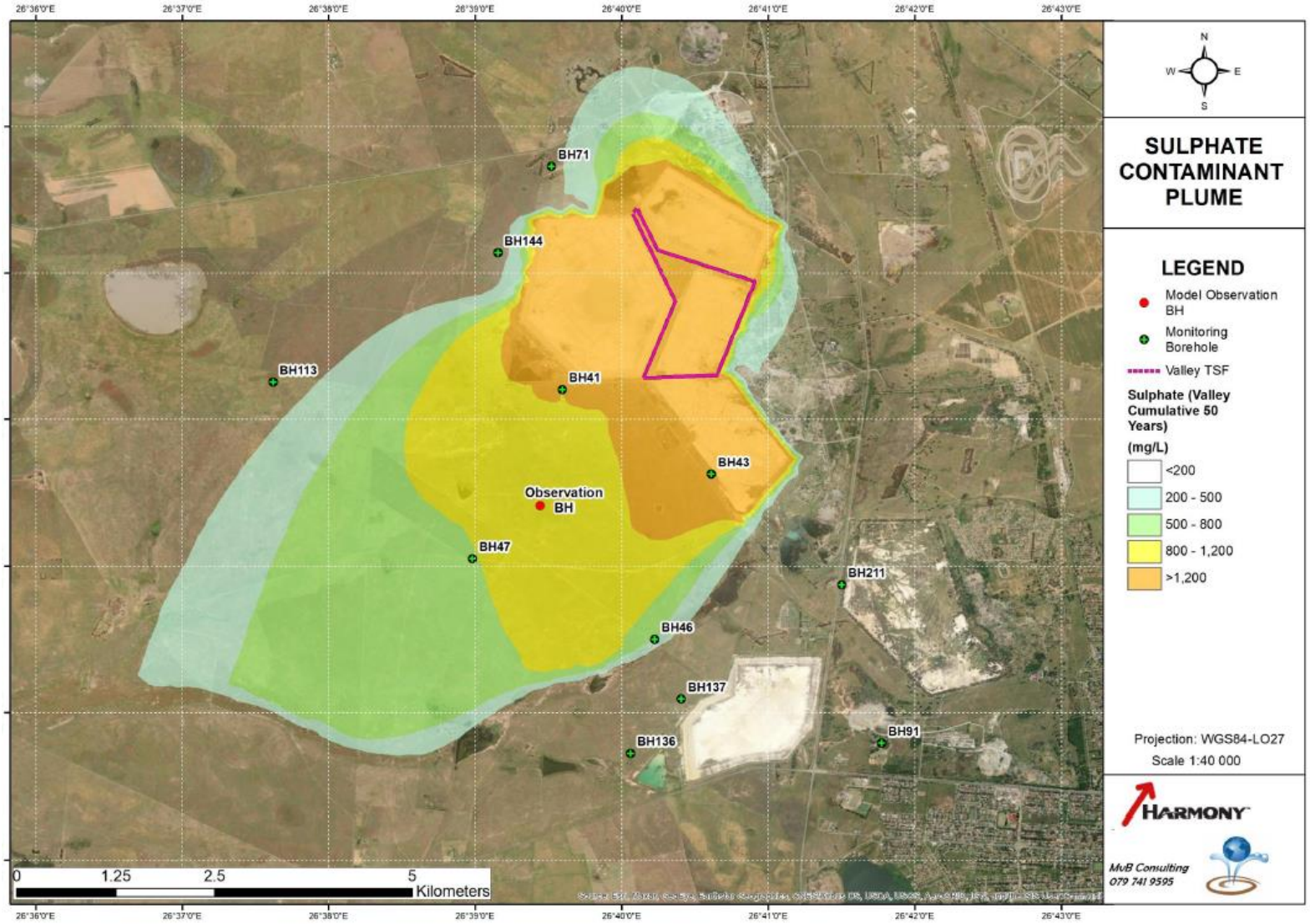

Figure 33: Cumulative impact from the existing and Valley TSF after 50 years

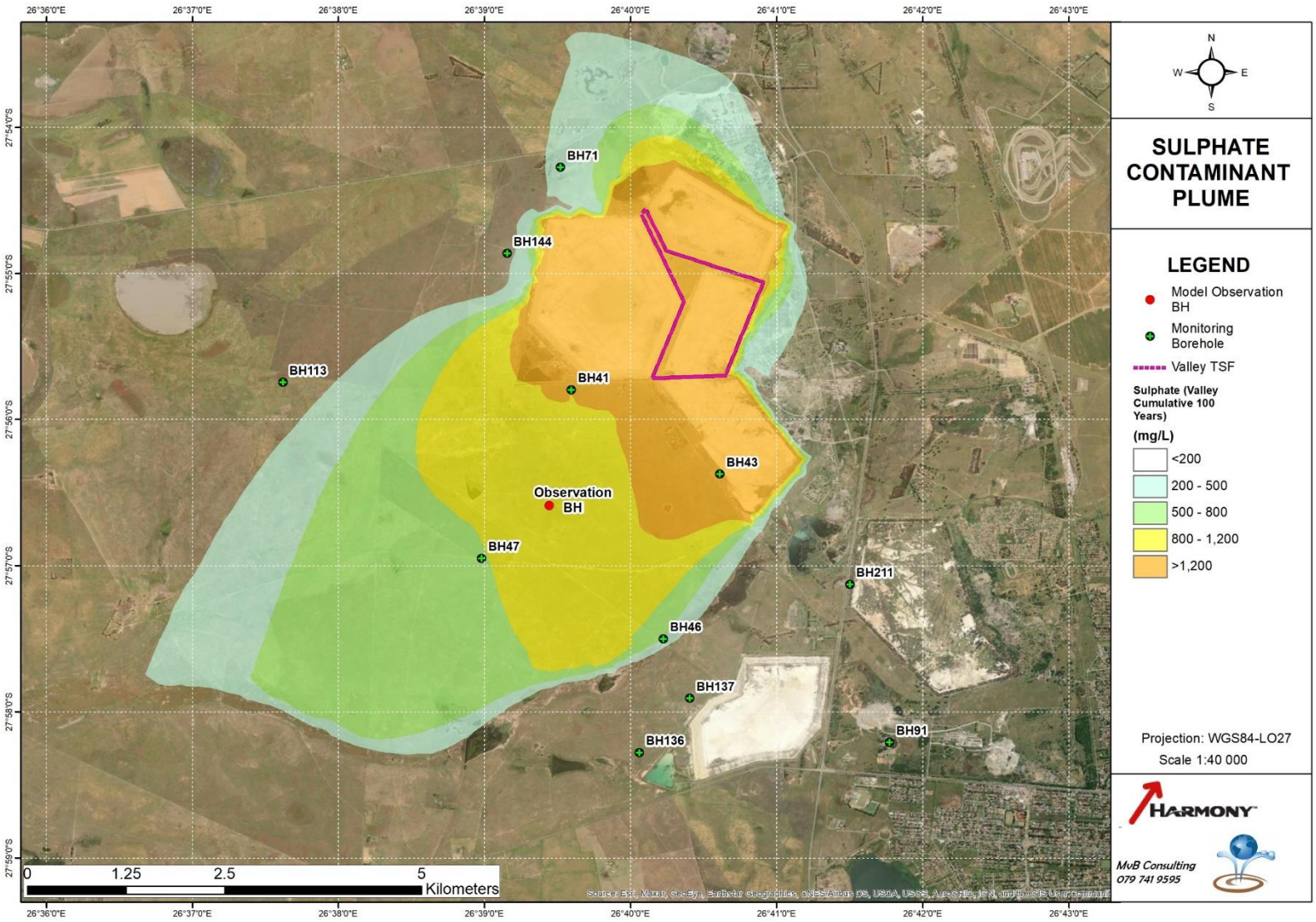

Figure 34: Cumulative impact from the existing and Valley TSF's after 100 years

9.3.1.1 GROUNDWATER MITIGATION MEASURES

A long-term monitoring programme should be developed based on the guideline documented in Best Practice Guideline G3 Water Monitoring Systems (2007) available from the DWS. These guidelines are summarised and implemented in the proposed monitoring plan.

Monitoring within a project area consists of various components as illustrated by the overall monitoring process. It should be recognised and understood that the successful development and implementation of an appropriate, accurate and reliable monitoring programme requires that a defined structured procedure be followed. A monitoring programme should include the location of all monitoring points (indicated on a map), the type of data to be collected, as well as the data collection (protocol / procedure / methodology, frequency of monitoring and parameters determined, quality control and assurance), management (database and assessment) and reporting procedures. This programme should then be implemented. The results from the monitoring programme should be representative of the actual situation. To ensure that the monitoring programme functions properly, an operating and maintenance programme should be developed and implemented. A data management system is necessary to ensure that data is stored / used optimally and is accessible to all the relevant users. The monitoring programme should include quality control measures. It is important to note that this programme is dynamic and should change as the mine and water management needs change.

Effective groundwater monitoring systems consist of the following components:

- Groundwater quality monitoring system.
- Groundwater flow monitoring system.
- Data and information management system.

When designing the monitoring system, the following issues should also be taken into consideration:

- Potential or actual water use.
- Aquifer or catchment vulnerability.
- Toxicity of chemicals.
- Potential for seepage or releases.
- Quantities and frequency of release to the environment (point and non-point).
- Management measures in place to minimise risk.

Groundwater sampling should be done in accordance with industry standards. The sampling procedures are discussed in detail in:

- Weaver, J.M.C. 1992a. Groundwater sampling: A comprehensive guide for sampling methods (WRC Report No. TT 54/92). Pretoria: Water Research Commission.
- Weaver, J.M.C. 1992b. Groundwater sampling: An abbreviated field guide for sampling methods (WRC Report No. TT 56/92). Pretoria: Water Research Commission.

These sampling procedures should be adhered to.

In terms of the groundwater monitoring network, three additional borehole pairs (one shallow and one deep) are recommended as shown in Figure 35.

The following is recommended in terms of monitoring:

- Groundwater levels.
- Groundwater quality.
- Data should be stored electronically in an acceptable database.

- On the completion of every sampling run a monitoring report should be written. Any changes in the groundwater levels and quality should be flagged and explained in the report.
- A compliance report can be submitted to DWS once a year, if required.

In terms of monitoring frequency, the following is recommended:

- A comprehensive quarterly analysis of the dedicated monitoring boreholes.
- Groundwater levels should be monitored monthly in the dedicated groundwater monitoring boreholes.
- Rainfall should be monitored daily.

Samples should be submitted to a SANAS accredited laboratory. The following recommended parameters to be analysed for include: pH, Electrical Conductivity, Total Dissolved Solids, Total Alkalinity. Anions and Cations (Ca, Mg, Na, K, NO_3, NH4, Cl, SO_4, F, Fe, Mn, Al, Cr).

In addition it is also recommended that the possibility of phyto-remediation is considered and implemented as soon as possible. Phytoremediation ('phyto' means plant) is a generic term for the group of technologies that use plants for remediating soils, sludges, sediments and water contaminated with organic and inorganic contaminants. Phytoremediation can be defined as "the efficient use of plants to remove, detoxify or immobilise environmental contaminants in a growth matrix (soil, water or sediments) through the natural biological, chemical or physical activities and processes of the plants" (https://bohatala.com/application-and-techniques-for-phytoremediation/).

Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilise, and/or destroy contaminants in the soil and groundwater. There are several different types of phytoremediation mechanisms. These are:

- Rhizosphere biodegradation. In this process, the plant releases natural substances through its roots, supplying nutrients to microorganisms in the soil. The microorganisms enhance biological degradation.
- Phyto-stabilization. In this process, chemical compounds produced by the plant immobilize contaminants, rather than degrade them.
- Phyto-accumulation (also called phyto-extraction). In this process, plant roots sorb the contaminants along with other nutrients and water. The contaminant mass is not destroyed but ends up in the plant shoots and leaves. This method is used primarily for wastes containing metals. At one demonstration site, water-soluble metals are taken up by plant species selected for their ability to take up large quantities of lead (Pb). The metals are stored in the plants aerial shoots, which are harvested and either smelted for potential metal recycling/recovery or are disposed of as a hazardous waste. As a general rule, readily bio available metals for plant uptake include cadmium, nickel, zinc, arsenic, selenium, and copper. Moderately bio-available metals are cobalt, manganese, and iron. Lead, chromium, and uranium are not very bio-available.
- Hydroponic Systems for Treating Water Streams (Rhizofiltration). Rhizofiltration is similar to phyto-accumulation, but the plants used for clean-up are raised in greenhouses with their roots in water. This system can be used for ex-situ groundwater treatment. That is, groundwater is pumped to the surface to irrigate these plants. Typically, hydroponic systems utilize an artificial soil medium, such as sand mixed with perlite or vermiculite. As the roots become saturated with contaminants, they are harvested and disposed of.
- Phyto-volatilization. In this process, plants take up water containing organic contaminants and release the contaminants into the air through their leaves
- Phytoextraction – uptake and concentration of substances from the environment into the plant biomass.
- Phyto-degradation. In this process, plants metabolise and destroy contaminants within plant tissues.
- Hydraulic Control. In this process, trees indirectly remediate by controlling groundwater. Trees act as natural pumps when their roots reach down towards the water table and establish a dense root mass that takes up large quantities of water.

For the Valley TSF application it is recommended that Phyto-accumulation and Hydraulic Control be further investigated. The main aim of such a study will be to find the most suitable tree species to absorb the chemicals of concern and to obtain the necessary permits from the authorities.

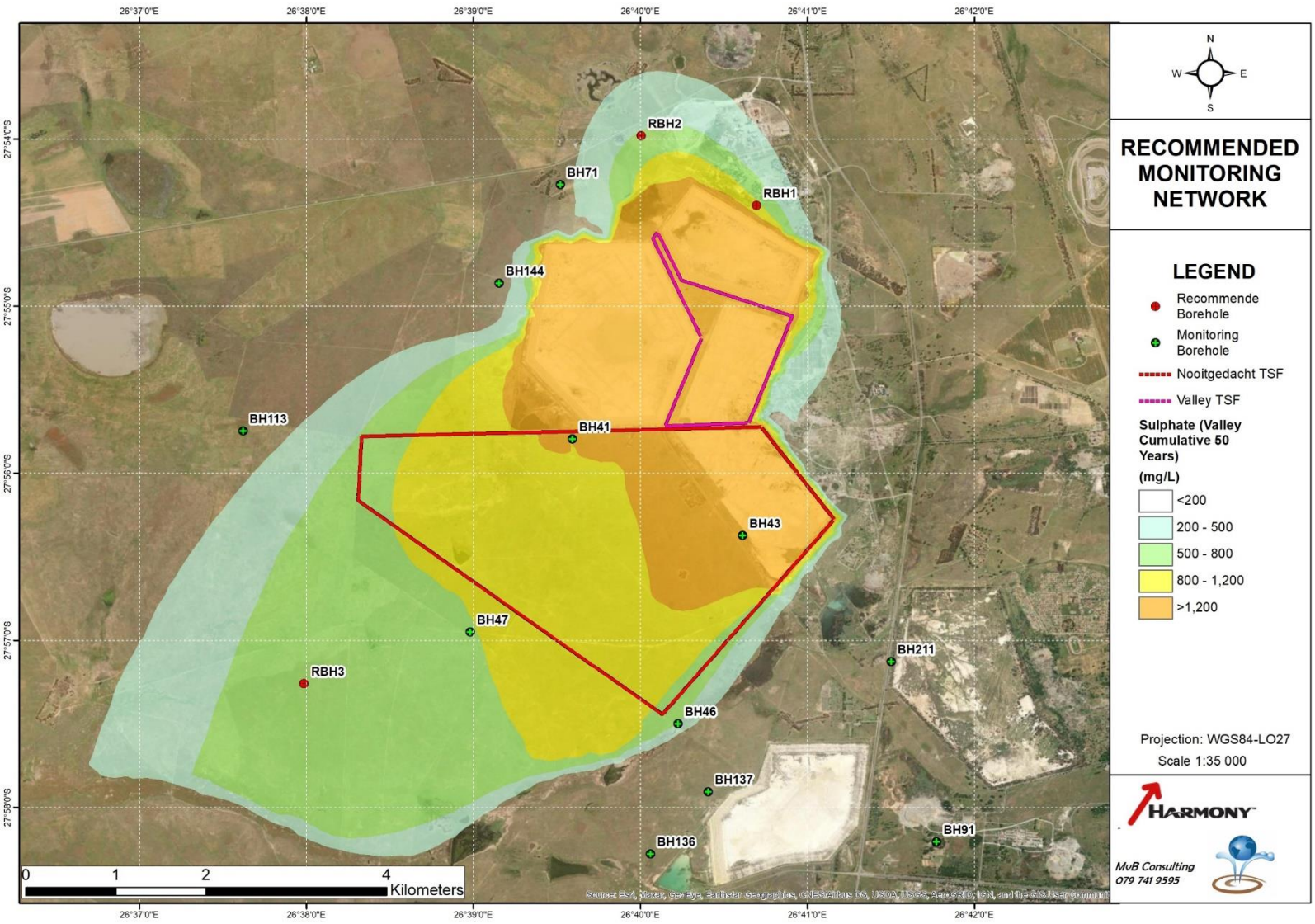

Figure 35: Recommended groundwater monitoring network

9.3.2 VISUAL IMPACTS

Impacts on views are the highest when viewers are identified as being sensitive to change in the landscape, and their views are focused on and dominated by the change. The visual impact of the Project will cause changes in the landscape that are noticeable to viewers experiencing the study area from the R30 and the far western areas of Rheederpark. Visual impacts that would potentially result are likely to be long-term and will cause a minor loss to the baseline landscape and visual resources resulting in a low severity of impact. Effective mitigation is possible and could somewhat reduce the impact.

The cause of these anticipated visual impacts would be:

Establishment Phase:

- Removal of vegetation, the building of access roads, earthworks, and exposure of earth to establish the areas to be developed for the TSF;
- The physical presence of TSF dam walls beginning to rise above the existing TSF on which it will be built; and
- The generation of dust by establishment activities.

Operational Phase

- The physical presence of the TSF; and
- The potential light pollution along the boundary fence of the property and the cause of a spotlight effect.

Refer to the VIA included in Appendix D for simulation views of the TSF from various viewing points indicative of typical views towards the proposed mine.

9.3.2.1 CONSTRUCTION PHASE VISUAL IMPACTS

Establishment activities include the earthworks required to create access routes to establish equipment on the existing TSF. Dust would be generated during this phase. Establishment activities would have a negligible effect on the landscape's visual quality and sense of place relative to its baseline as the activities would not contrast with the patterns that define the visual structure of the landscape. And the change would be restricted to a localized area.

The impact on the visual environment during the establishment phase is assessed to have a low magnitude (i.e. where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected) and would occur over the short term (1-5 years). The unmitigated impact would be localized but would extend beyond the project site to adjacent areas, and the significance of impact is predicted to be LOW (i.e. impact would not have a direct influence on the decision to develop in the area if it is mitigated).

9.3.2.2 OPERATIONAL PHASE VISUAL IMPACTS

Operational activities material being deposited from Harmony One Plant at the TSF and security lights. The impact on the visual environment during the operational phase is assessed to have a low magnitude (i.e. where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected) and would occur over the long term (8 years). The unmitigated impact would be localized but would extend beyond the site to adjacent areas. The significance of impact is predicted to be LOW (i.e. the impact would not have a direct influence on the decision to develop the area if it is mitigated).

The TSF, with its dam walls not exceeding the height of the adjacent TSFs and the presence of tall trees east of the site, would result in the TSF mostly being ‘absorbed’ into the visual scene, rendering the proposed Valley TSF moderately visible from sections of the R30 and the far western areas of Rheederpark. Refer to the viewshed analysis in Figure 28 which suggests that these would be the most visible areas. However, on-site observations indicate that most potential views to the TSF would be completely or partially screened by existing vegetation, structures and other TSFs.

The proposed TSF will contextually fit with the baseline landscape patterns no matter from which angle it is viewed, however, its physical presence will add to the cumulative negative effect of mining operations on the baseline landscape and sensitive viewing areas. Even in its final stages of development, the TSF would mostly be partially screened from view or completely blocked from views north, west and south (by the proposed Nooitgedacht TSF) of the site. Visibility of the activity is therefore considered low.

9.3.2.3 POST-CLOSURE AND REHABILITATION PHASE VISUAL IMPACTS

Rehabilitation activities at the TSF side slopes and surface area, until the areas are self-sustaining. The impact on the visual environment during the post-closure and rehabilitation phase is assessed to have a minor magnitude (Where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected (no associated consequences)) and would occur over the short term. The unmitigated impact would be localized but would extend beyond the Mining Right area to adjacent areas. The significance of impact is predicted to be LOW (Impact or benefit that requires management but that would not have a direct influence on the decision to develop in the area if it is mitigated.

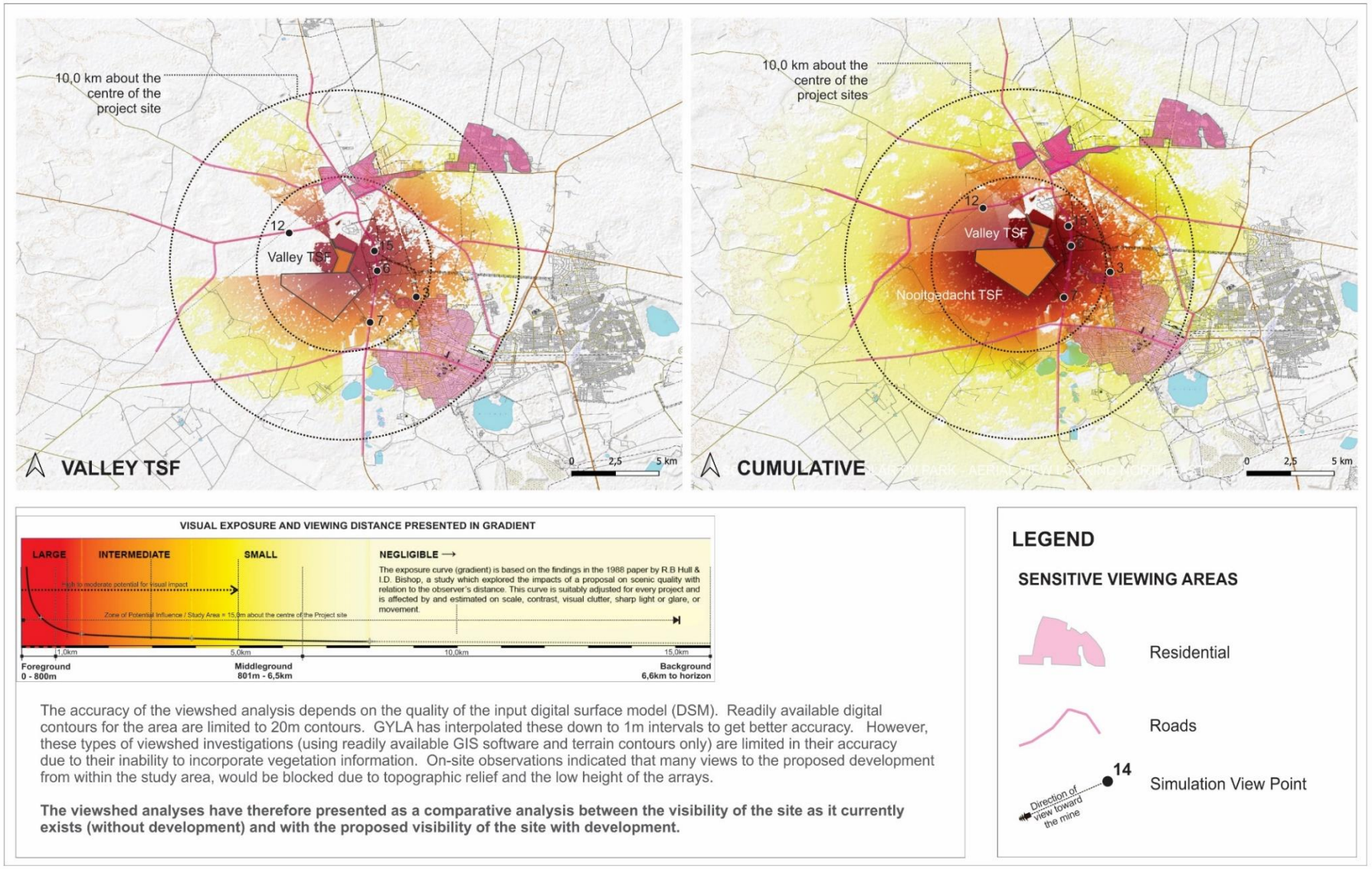

Figure 36: Viewshed analyses undertaken for the TSF

9.3.2.4 VISUAL MITIGATION MEASURES

In considering mitigating measures three rules are considered - the measures should be feasible (economically), effective (how long will it take to implement and what provision is made for management/maintenance), and acceptable (within the framework of the existing landscape and land use policies for the area). To address these, the following principles have been established:

- Mitigation measures should be designed to suit the existing landscape character and needs of the locality. They should respect and build upon landscape distinctiveness.
- It should be recognized that many mitigation measures, especially the establishment of planted screens and rehabilitation, are not immediately effective.

The following general options are recommended:

9.3.2.4.1 PLANNING AND SITE DEVELOPMENT MITIGATION

- Development footprints should be demarcated and clearing to occur within the demarcated areas.
- Ensure, wherever possible, natural indigenous vegetation and tall trees are retained and incorporated into the site rehabilitation.
- All topsoil that occurs within the proposed footprint of an activity must be removed and stockpiled for later use. The construction contract must include the stripping and stockpiling of topsoil. Topsoil would be used later during the rehabilitation phase of disturbed areas and the waste facilities. The presence of degraded areas, which are not rehabilitated, will increase the overall visual impact.
- Apply dust suppression methods to limit the dust generated during the establishment phase.
- Before commencing operation, develop a post-closure rehabilitation plan to acceptable topographic and ecological conditions, particularly for the waste facilities.

9.3.2.4.2 EARTHWORKS MITIGATION

- Earthworks should be executed in such a way that only the footprint and a small ‘construction buffer zone’ around the proposed TSF are exposed. In all other areas, the naturally occurring vegetation should be retained, as well as tall trees, especially along the periphery of the site.
- Topsoil must be exposed for the minimum time possible to avoid prolonged exposure to wind and water erosion and to minimise dust generation. Should the topsoil stockpile be in place for more than 3 months, they should be hydroseeded with indigenous grasses.
- Any soil must be exposed for the minimum time possible once cleared of vegetation to avoid prolonged exposure to wind and water erosion and to minimise dust generation.

9.3.2.4.3 LANDSCAPING AND ECOLOGICAL APPROACH MITIGATION

Where new vegetation is proposed to be introduced to the site, an ecological approach to rehabilitation, as opposed to a horticultural approach should be adopted. For example, communities of indigenous plants will enhance biodiversity, a desirable outcome for the area. This approach can significantly reduce long-term costs as less maintenance would be required over conventional landscaping methods as well as the introduced landscape being more sustainable.

9.3.2.4.4 GOOD HOUSEKEEPING

“Housekeeping” procedures should be developed for the project to ensure that the Project site and lands adjacent to it are kept clean of debris, garbage, fugitive trash, or waste generated onsite; procedures should extend to control of “track out” of dirt on vehicles leaving the active sites and entering the public domain.

9.3.2.4.5 LIGHTING MITIGATION

Light pollution is largely the result of bad lighting design, which allows artificial light to shine outward and upward into the sky, where it is not wanted, instead of focusing the light downward, where it is needed. Ill-

designed lighting washes out the darkness of the night sky and radically alters the light levels in rural areas where light sources shine as 'beacons' against the dark sky and are generally not wanted. Simple changes in lighting design and installation yield immediate changes in the amount of light spilled into the atmosphere. The following are measures, to minimize light pollution beyond the perimeter of the project, that must be considered in the lighting design of the Project:

- Install light fixtures that provide precisely directed illumination to reduce light "spillage" beyond the immediate surrounds of the site i.e. lights (spotlights) are to be aimed away from sensitive viewing areas.
- Avoid high pole top security lighting along the periphery of the site and use only lights that are activated on illegal entry to the site.
- Minimise the number of light fixtures to the bare minimum, including security lighting.

9.3.3 HERITAGE IMPACTS

The fieldwork component of the study was aimed at identifying tangible remains of archaeological, historical and heritage significance. The fieldwork was conducted by an archaeologist and field assistant from PGS on 23 March 2023. The fieldwork team were able to confirm that the study area was disturbed from historical agricultural activities and mining-related activities. No heritage resources were identified in the study area.

9.3.3.1 HERITAGE MITIGATION MEASURES

It is always possible that cultural material may be exposed during construction and may be recoverable, keeping in mind delays can be costly during construction and as such must be minimised. Development surrounding mining and construction results in significant disturbance; however, any excavation work offers a window into the past, and it thus may be possible to rescue some of the data and materials.

The study area occurs within a greater historical and archaeological context as identified during the desktop and fieldwork phase. Soil clearance may uncover unmarked graves. During the Construction Phase, it is important to recognize any significant material being unearthed, making the correct judgment on which actions should be taken. It is recommended that the following chance find procedure should be implemented.

9.3.3.1.1 CHANCE FIND PROCEDURE

- An appropriately qualified heritage practitioner / archaeologist must be identified to be called upon if any possible heritage resources or artefacts are identified.
- Should an archaeological site or cultural material be discovered during construction (or operation), the area should be demarcated, and construction activities halted.
- The qualified heritage practitioner / archaeologist will then need to come out to the site and evaluate the extent and importance of the heritage resources and make the necessary recommendations for mitigating the find and the impact on the heritage resource.
- The contractor therefore should have some sort of contingency plan so that operations could move elsewhere temporarily while the materials and data are recovered.
- Construction can commence as soon as the site has been cleared and signed off by the heritage practitioner / archaeologist.

9.3.4 PALEONTOLOGY IMPACTS

The study area is underlain by the aeolian sand as well as the Permian Volksrust Formation (Ecca Group, Karoo Supergroup). The PalaeoMap of the South African Heritage Resources Information System (SAHRIS) indicates that the Palaeontological Sensitivity of the aeolian sand is moderate while that of the Volksrust Formation (Ecca Group, Karoo Supergroup) is High (Almond et al, 2013; SAHRIS website). However, the Palaeotechnical report of the Free State (Groenewald et al, 2014) allocated a Moderate Palaeontological Sensitivity to the development site. Updated geology (Council of Geosciences, Pretoria) indicates that the development area is underlain by superficial alluvium, colluvium, elluvium and gravel as well as the Volksrust Formation (Ecca Group).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 17 April 2023. No fossiliferous outcrop was detected in the proposed development area. The apparent rarity of fossil heritage in the proposed development footprint suggests that the impact of the development will be of a Low significance in palaeontological terms. It is, therefore, considered that the proposed development is deemed appropriate and feasible and will not lead to damaging impacts on the palaeontological resources of the area. The construction of the development may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.

9.3.4.1 PALAEONTOLOGY MITIGATION MEASURES

If fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the Chance Find Protocol must be implemented by the ECO/site manager in charge of these developments. These discoveries ought to be protected (if possible, in situ) and the ECO/site manager must report to SAHRA so that mitigation (recording and collection) can be carry out by a palaeontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.

9.3.4.1.1 CHANCE FIND PROCEDURE

- If a chance find is made the person responsible for the find must immediately stop working and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately report the find to his/her direct supervisor which in turn must report the find to his/her manager and the ESO or site manager. The ESO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.
- A preliminary report must be submitted to the Heritage Agency within 24 hours of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.
- Upon receipt of the preliminary report, the Heritage Agency will inform the ESO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.
- The site must be secured to protect it from any further damage. No attempt should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- If the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO. Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once the Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

9.3.5 IMPACTS ON WETLANDS

The impact assessment considered the anticipated direct and indirect impacts to the wetland systems as a result of the proposed tailings facility. The mitigation hierarchy as discussed by the Department of Environmental Affairs (2013) was considered for this component of the assessment. In accordance with the mitigation

hierarchy, the preferred mitigatory measure is to avoid impacts by considering options in project location, sitting, scale, layout, technology and project/activity phasing to avoid impacts.

Three levels of risk have been identified and considered for the overall risk assessment, these include high, medium, and low risks. Due to the destructive characteristics of a new tailing's facility on wetlands, High risks are expected for the project. Medium risk refers to wetland areas where the impacts will only occur inside the wetlands buffer and not on the wetlands themselves. Low risks are wetland systems where both the wetlands and their buffers are avoided by die proposed activities. The High risks were the priority for the risk assessment, focussing on the expected potential for these direct risks.

Due to the fact that direct impacts to the wetlands (and buffers) will not be avoided, the risk assessment considered all direct and indirect risks posed to these systems as a result of the project. A risk assessment was conducted in line with Section 21 (c) and (i) of the National Water Act, 1998, (Act 36 of 1998) to investigate the level of risk posed by proposed project.

During the site assessment, six HGM units were identified and assessed within the project area of influence. These comprise of three unchannelled valley bottoms, multiple depression wetlands and a seep wetland. The systems scored an overall PES score of E – "Seriously Modified", due to the modifications arising from anthropogenic influences and surrounding mining activities. The Importance and Sensitivity for both the valley bottoms and the seep wetlands were calculated to be "High", which combines the low protection status of the wet veg and the and the high threat status of the wetlands themselves. The depression wetlands scored "Moderate" sensitivities due to the low threat status of the wet veg and the low threat status of the wetlands themselves. The average ecosystem service score was determined to range between "Moderately Low" and "Moderately High". A post-mitigation buffer of 42 m was assigned to the systems.

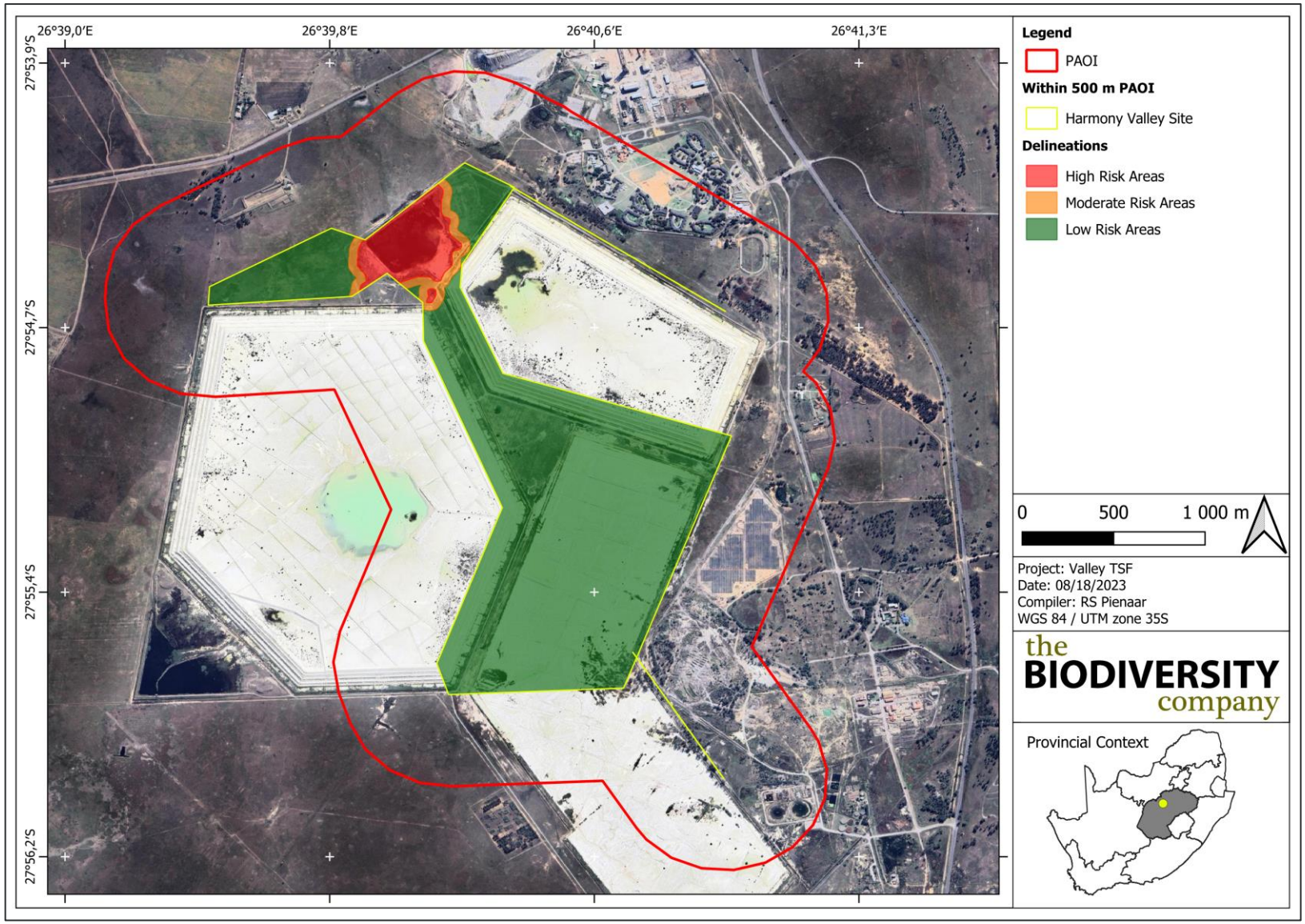

Figure 37: Identified wetlands risk areas

9.3.5.1 WETLANDS MITIGATION

It is important that the mitigations measures are adhered to when upgrading the existing FSN 2 RWD within the HGM 1 wetland. No significant wetland loss is foreseen. It is the opinion of the specialist that the project may be favourably considered, on condition all prescribed mitigation measures and supporting recommendations are implemented.

A key mitigation measure is to ensure that the function of HGM 1 will be the same after the proposed northern FSN 2 RWD has been lined (Figure 37). Various additional mitigation measures are included in the accompanying wetland specialist report (Appendix D) and EMPr (Appendix H). Key mitigation measures are included below:

- Make sure that the function of HGM 1 will be the same after the upgrades to the FSN 2 RWD are done.
- The upgrade to the Northern FSN 2 RWD facility should ensure the same vegetation surrounding as currently present in HGM 1 are maintained as far as possible.
- Restrict all non-essential activities (e.g. cement mixing and equipment wetland machinery storage) to outside of wetlands and their prescribed buffers for wetlands around the edge of the facility that will not be destroyed by the TSF construction.
- Make sure that all the other HGM units and their buffers are avoided as far as possible to limit the impacts on them.
- Minimize unnecessary clearing of vegetation.
- Contain wastewater in a RWD Contaminated water must not be discharged into watercourses untreated
- Conduct regular inspections along the TSF to ensure the integrity of the facility.
- Appropriately contain any generator diesel storage tanks, machinery spills (e.g. accidental spills of hydrocarbons oils, diesel etc.) or construction materials on site (e.g. concrete) in such a way as to prevent them leaking and entering the north-western seep.
- Regularly maintain stormwater infrastructure, pipes, pumps and machinery to minimise the potential for leaks. Check for oil leaks, keep a tidy operation, install bins and promptly clean up any spills or litter.
- Promptly remove all alien and invasive plant species that may emerge during construction (i.e. weedy annuals and other alien forbs) must be removed.
- Try to reduce the disturbance footprint and the unnecessary clearing of vegetation on either side of the TSF facility when traversing wetlands.
- Construct as far as possible during winter when flow volumes are lowest, prioritise this for crossing sites. This will reduce impacts to wetlands due to soil poaching and vegetation trampling under peak saturation levels. Additionally, the risk of vehicles getting stuck and further degrading the vegetation integrity is lowest during this time.
- Keep the TSF activities to the proposed site and only access the tailings facility from the the existing northern access road or from the South to prevent greater loss to the wetlands northern parts.
- Ensure that the TSF is lined to prevent seepage and sloped and vegetated to prevent runoff through rain.
- Mixing of concrete must under no circumstances take place in any wetland or their buffers. Scrape the area where mixing and storage of sand and concrete occurred to clean once finished.

9.3.6 IMPACTS ON SOILS

Infrastructure within the Valley TSF project and associated infrastructure project area assigned to the available land includes new infrastructure and pipelines, TSF expansion area and access roads. The proposed activities` buffer area often impede into designated “High” sensitivity crop fields. Even though these areas are historical

crop field areas, these sensitivities are associated with some arable land potential and capability conditions (i.e., Soil status), therefore high land capability potential areas will be impacted on by the TSF expansion.

Impacts were assessed in terms of the proposed TSF expansion project and associated infrastructure, operational and decommissioning phases.

9.3.6.1 PLANNING PHASE IMPACTS

The planning phase activities are considered a low risk as they typically involve desktop assessments and initial site inspections. This would include preparations and desktop work in support of waste management plans, environmental and social screening assessments, finalising well sites and facilities and consultation with various contractors involved with a diversity of proposed project related activities going forward.

9.3.6.2 CONSTRUCTION PHASE IMPACTS

The project will result in the stripping of topsoil related to the construction of the TSF and alterations to the existing land uses. The changes in the land use will be from agricultural to mining activities development (or transformed). It will impact on areas expected to have high agricultural land capability potential (in some areas), with some aspects affecting “Moderate High” sensitivity areas. It is possible that suitable agricultural land could further be fragmented, resulting in these remaining portions no longer being deemed feasible to farm in the future.

During the construction phase, topsoil often will be cleared, stripped and stockpiled. Access roads will be created with trenches being dug for the installation of relevant cables. The erection of infrastructure where relevant to the current existing TSF structures will occur. Contractor and laydown yards will also be cleared with construction material being transported to laydown yards. Potential erosion is expected during the construction phase due to some erodable soils within the footprint assessment area, such as the Katspruit soil form. The removal of vegetation and changes to the local topography could result in an alteration to surface run-off dynamics. Erosion of the area could result in further loss of soil forms suitable for agriculture and these soils will deposit in downslope areas such as the local watercourses, negatively affecting these ecologically sensitive ecosystems. Soil compaction can also result due to increased traffic on site along the proposed project area. The disturbed soil profiles will change from the original natural condition even through proper stockpiles will be stored. Disturbed soils can result in further water and nutrient losses from the soil matrix.

9.3.6.3 OPERATIONAL PHASE IMPACTS

During the operational phase, limited impacts are foreseen. Only the footprint area will be disturbed, and this will minimise soil and vegetation disturbance of the surrounding area. Revegetation will be carried out on exposed surrounding areas to avoid surface erosion. Maintenance of vegetation, infrastructure maintenance will have to be carried out throughout the life of the project. It is expected that these maintenance practices can be undertaken by means of manual labour.

9.3.6.4 DECOMMISSIONING PHASE IMPACTS

The cumulative decommissioning impacts post-mitigation have been scored “Low,” indicating that the potential incremental, interactive, sequential, and synergistic impacts are limited. It is probable that the impact will result in spatial and temporal cumulative change.

9.3.6.5 SOILS MITIGATION MEASURES

Limited mitigation is required given the fact that the pre-mitigation significance rating has been scored as “Medium – Negative” and the post-mitigation significance rating being scored as Negligible “Low – Negative.” Key mitigation measures include:

- Vegetate or cover all stockpiles after stripping/removing soils. Natural re-vegetation of these areas for the first growing season is allowed, with further action to be determined thereafter, if needed;
- Storage of potential contaminants should be undertaken in bunded areas;
- All contractors must have spill kits available and be trained in the correct use thereof;

- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good "housekeeping";
- No cleaning or servicing of vehicles, machines and equipment may be undertaken in water resources;
- Have action plans on site, and training for contractors and employees in the event of spills, leaks and other impacts to the aquatic systems;
- Continuously monitor erosion on site; and
- Monitor compaction on site.

9.3.7 IMPACTS ON TERRESTRIAL BIODIVERSITY AS WELL AS BIRDS AND BATS

The Project Area is predominantly made up of modified habitat, and what little grassland remains is severely degraded and experiencing high levels of impacts due to the proximity to mining activities. The north-western portions of the Project Area intercept ESA 1 areas, however, these are constantly disturbed in nature and cannot recover to a more natural state due to ongoing disturbances and impacts received from grazing, edge effects from land use and mismanagement.

Completion of the terrestrial biodiversity assessment led to a disputing of the 'Very High' classification for the terrestrial biodiversity theme sensitivity as allocated by the National Environmental Screening Tool. The Project Area is instead assigned an overall sensitivity of 'Low', with the modified areas assigned a sensitivity of 'Very Low' and degraded grassland a sensitivity of 'Low'. The water resource habitat is assigned a sensitivity of 'Medium' and more information regarding this unit can be found in the accompanying wetland report (Appendix D).

9.3.7.1 TERRESTRIAL BIODIVERSITY MITIGATION MEASURES

It is important to consider that undeveloped portions of land can still contribute to land management objectives and protection targets to some degree. It is recommended that care be taken during construction to adhere to mitigation measures. An AIP management plan must be implemented as a priority to prevent the further spread and proliferation of AIP species to the surrounding grassland areas. Investigating the potential installation of leak warning and detection systems on all pipelines must also be made a priority to prevent damage caused by pipe leaks on the surrounding natural areas, particularly near to water resources.

Various additional mitigation measures are included in the accompanying terrestrial specialist report (Appendix D) and EMPr (Appendix H). Key mitigation measures are included below:

- Laydown and construction preparation activities (such as cement mixing, temporary toilets, etc.) must be limited to already modified areas as far as possible and should take up the smallest footprint possible. he
- It is recommended that areas to be developed/disturbed be specifically demarcated so that during the construction/activity phase, only the demarcated areas be impacted upon.
- Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should not be fragmented or disturbed further.
- The clearing of vegetation must be minimised where possible. All activities must be restricted to within the authorised areas.
- Any observed SCC flora or protected plants must be clearly demarcated prior to the commencement of site clearing. If construction activities are likely to affect any SCC or protected plants these individuals must be relocated as part of a plant rescue and protection plan, and a permit must be obtained before doing so.
- Any materials may not be stored for extended periods of time and must be removed from the Project Area once the construction phase has been concluded. No permanent construction phase structures should be permitted. Construction buildings should preferably be prefabricated or constructed of re-

usable/recyclable materials. No storage of vehicles or equipment will be allowed outside of the designated laydown areas.

- Areas that are denuded during construction need to be re-vegetated with indigenous vegetation according to a habitat rehabilitation plan, to prevent erosion during flood and wind events and to promote the regeneration of functional habitat. This will also reduce the likelihood of encroachment by alien invasive plant species. All grazing mammals must be kept out of the areas that have recently been re-planted.
- A hydrocarbon spill management plan must be put in place to ensure that should there be any chemical spill out or over that it does not run into the surrounding areas. The Contractor shall be in possession of an emergency spill kit that must always be complete and available on site.
- It must be made an offence for any staff member to take any indigenous plant species out of any portion of the Project Area, or to bring any alien plant species into any portion of the Project Area. This is to prevent the spread of exotic or invasive species or the illegal collection of plants.
- A fire management plan needs to be compiled and implemented to restrict the impact fire would have on the surrounding areas.
- All vehicles and personnel must make use of existing roads and walking paths as far as possible, especially construction/operational vehicles.
- Precautions must be taken against the erosion damage that would be caused by unplanned pipe leaks. Monitoring of the pipeline must be undertaken to detect leaks and monitoring should be undertaken at least once a week.
- A qualified environmental control officer must be on site when activities begin. A site walk through is recommended by a suitably qualified ecologist prior to any activities taking place and any SSC or protected species should be noted. In situations where these species are observed and must be removed, the proponent may only do so after the required permission/permits have been obtained in accordance with national and provincial legislation. In the abovementioned situation the development and implementation of a search, rescue and recovery program is suggested for the protection of these species. Should animals not move out of the area on their own, relevant specialists must be contacted to advise on how the species can be relocated.
- Clearing and disturbance activities must be conducted in a progressive linear manner, always outwards and away from the centre of the Project Area and over several days, so as to provide an easy escape route for all small mammals and herpetofauna.
- The areas to be disturbed must be specifically and responsibly demarcated to prevent the movement of staff or any individual into the surrounding environments, signs must be put up to enforce this.
- The duration of the activities should be minimised to as short a term as possible, to reduce the period of disturbance on fauna.
- No trapping, killing, or poisoning of any wildlife is to be allowed and signs must be put up to enforce this. Monitoring must take place in this regard.
- An Alien Invasive Plant Management Plan must be compiled and implemented. This should regularly be updated to reflect the annual changed in AIP composition.
- The footprint area of the construction should be kept to a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas. Footprints of the roads must be kept to prescribed widths.
- A pest control plan must be put in place and implemented; it is imperative that poisons not be used to control pests.

- Dust-reducing mitigation measures must be put in place and must be strictly adhered to. This includes the wetting of exposed soft soil surfaces. No non-environmentally friendly suppressants may be used as this could result in the pollution of water sources.
- Waste management must be a priority and all waste must be collected and stored effectively and responsibly according to a site-specific waste management plan. Dangerous waste such as metal wires and glass must only be stored in appropriate receptacles, before being moved off site as soon as possible.

9.3.8 IMPACTS ON AIR QUALITY

Dispersion simulation was undertaken to determine highest daily, frequency of exceedance and annual average ground level concentrations for PM10 and PM2.5 and dustfall rates for the baseline and project scenarios. These averaging periods were selected to facilitate the comparison of simulated pollutant concentrations with relevant air quality guidelines and health effect screening levels as well as dustfall regulations.

Simulated PM10 concentrations due to project operations were within the daily PM10 NAAQS at all of the identified sensitive receptors, as were simulated PM2.5 concentrations within the post-2030 daily PM2.5 National Ambient Air Quality Standards (NAAQS) at all sensitive receptors. Annual average PM10 and PM2.5 concentrations were within the respective NAAQSs at all receptors. The simulated dust deposition was within National Dust Control Regulations (NDCR) for residential areas at the closest sensitive receptors.

9.3.8.1 CONSTRUCTION PHASE AIR QUALITY IMPACTS

TSFs are built over three stages: initial construction, operation, and closure (Cox et. al., 2022). The initial construction of a TSF includes constructing the infrastructure and structures that need to be in place before depositing any waste products. During operation, as more tailings are produced, the initial dam is raised through a series of 'lifts.' This stage of construction for the TSF may occur over decades, depending on the life of mine. At the end of mine life, the closure plan will be implemented. The closure plan progressively reclaims the TSF to an extent wherein the facility is integrated into the surrounding landscape. This process requires active dam maintenance and monitoring post-closure.

The main pollutant of concern from initial construction operations is particulate matter, including PM10, PM2.5 and TSP (Total Suspended Particulates). PM10 and PM2.5 concentrations are associated with potential health impacts due to the size of the particulates being small enough to be inhaled. Nuisance effects are caused by the TSP fraction (20 µm to 75 µm in diameter) resulting in soiling of materials and visibility reductions. This could in effect also have financial implications due to the requirement for more cleaning materials.

Activities resulting in the release of these pollutants include topsoil removal, material loading and hauling, stockpiling, grading, bulldozing, as well as metal and concrete works for the establishment of infrastructure. Each of these operations has its own duration and potential for dust generation. It is anticipated that the extent of dust emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions. This contrasts with most other fugitive dust sources where emissions are either relatively steady or follow a discernible annual cycle. It is often necessary to estimate area wide construction emissions, without regard to the actual plans of any individual construction process.

Quantified construction emissions are usually lower than operational phase emissions and since the construction schedule was not available (and due to their temporary nature); and the likelihood that these activities will not occur concurrently at all portions of the site; dispersion simulation was not undertaken for construction emissions.

9.3.8.2 OPERATIONAL PHASE AIR QUALITY IMPACTS

A specific concern is windblown dust from the Valley TSF resulting in dust deposits and potentially health impacts in the nearby residential area of Welkom and surrounding AQSRs. Wind-blown dust from mine waste facilities can be a significant source of dust emissions with high dust concentrations reported near mining sites, affecting both the environment and human health. A number of studies have been conducted on the impact from mine tailings – specifically gold mine tailings – on residential areas around and close to the base of these tailings

facilities (Ojelede et al., 2012; Phakedi, 2011; Annegarn, 2006; Annegarn et al., 2000; 2010). These studies indicated that slimes dams in close proximity to human settlements pose a health risk, with measured PM10 concentrations during storm events reported to be between 171 µg/m³ and 462 µg/m³ (Ojelede et al., 2012).

Aside from the concern for dust impacts, the metal content in the slimes pose potential health risks. A study conducted by Maseki (2013) found a range of heavy metals within four gold slimes dams assessed – these included amongst others potassium (K), chromium (Cr) manganese (Mn), nickel (Ni), cadmium (Cd), gold (Au), lead (Pb), Iron (Fe), zinc (Zn), arsenic (As) and uranium (U). In addition, radionuclides are also associated with gold mine tailings.

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g. wind, precipitation and temperature), soil properties (e.g. soil texture, composition and aggregation), land-surface characteristics (e.g. topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements) and land-use practice (e.g. farming, grazing and mining) (Shao, 2008).

Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the friction velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity (Shao, 2008).

The US EPA indicates a friction velocity of 5.4 m/s to initiate erosion from coal storage piles (US EPA, 2006) and Mian & Yanful (2003) calculated a wind speed in excess of 9 m/s is required to initiate wind erosion from two tailings storage facilities in in New Brunswick and Ontario, Canada. Thus, the likelihood exists for wind erosion to occur from open and exposed surfaces, with loose fine material, when the wind speed exceeds at least 5.4 m/s.

As indicated, any binding properties would reduce the potential for wind erosion. One of the most effective measures of minimizing wind erosion emissions from tailings storage facilities is re-vegetation. The control efficiency of vegetation is given as 40% for non-sustaining vegetation and 90% for re-vegetation. Secondary rehabilitation would up the control efficiency to 60% for non-sustaining vegetation (NPI, 2012). The proposed TSF would not be covered during operations and therefore pose the largest risk for wind-blown dust.

Isopleth contour plots for simulated highest daily and annual average PM10 concentrations for the project scenario are provided in Figure 38 and Figure 39 respectively. Simulated highest daily and annual average PM2.5 concentrations for the project scenario are provided in Figure 40 and Figure 41 respectively. Simulated ground level concentrations at AQSRs are provided in Table 24 and Table 25 for PM10 and PM2.5 respectively. Highest daily dustfall rates are provided in Figure 42 and Table 26.

Since plants are constantly exposed to air, they are the primary receptors for both gaseous and particulate pollutants of the atmosphere. In terrestrial plant species, the enormous foliar surface area acts as a natural sink for pollutants especially the particulate ones. Vegetation is an effective indicator of the overall impact of air pollution particularly in context of PM (Rai, 2016). After deposition onto vegetation, the effect of particulate matter depends on the composition of the dust. South African ambient standards are set in terms of PM2.5 and PM10 but internationally it is recognised that there are major differences in the chemical composition of the fine PM (the fraction between 0 and 2.5 µm in aerodynamic diameter) and coarse PM (the fraction between 2.5 µm and 10 µm in aerodynamic diameter). The former is often the result of chemical reactions in the atmosphere, whereas the latter often consists of primary particles due to abrasion, crushing, soil disturbances and wind erosion (Grantz, Garner, & Johnson, 2003). The project impact on vegetation is illustrated in Figure 42, with the green impact area showing plant exposure to dust fall rates greater than 400 mg/m²-day.

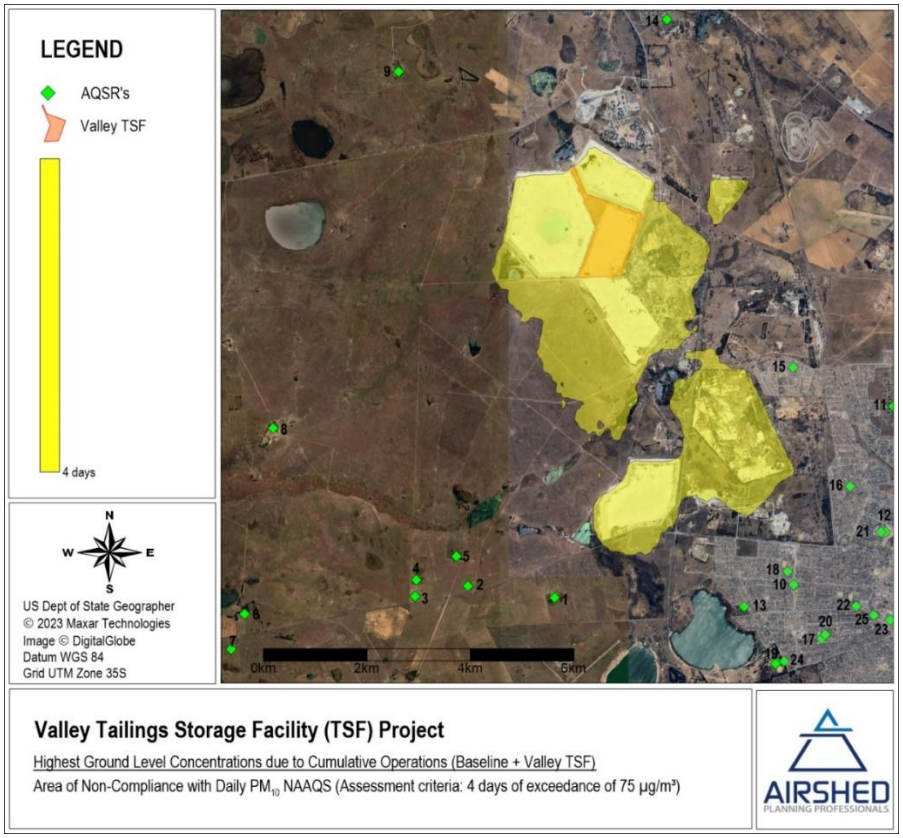

Figure 38: Project scenario – Area of non-compliance with daily PM_{10} NAAQS

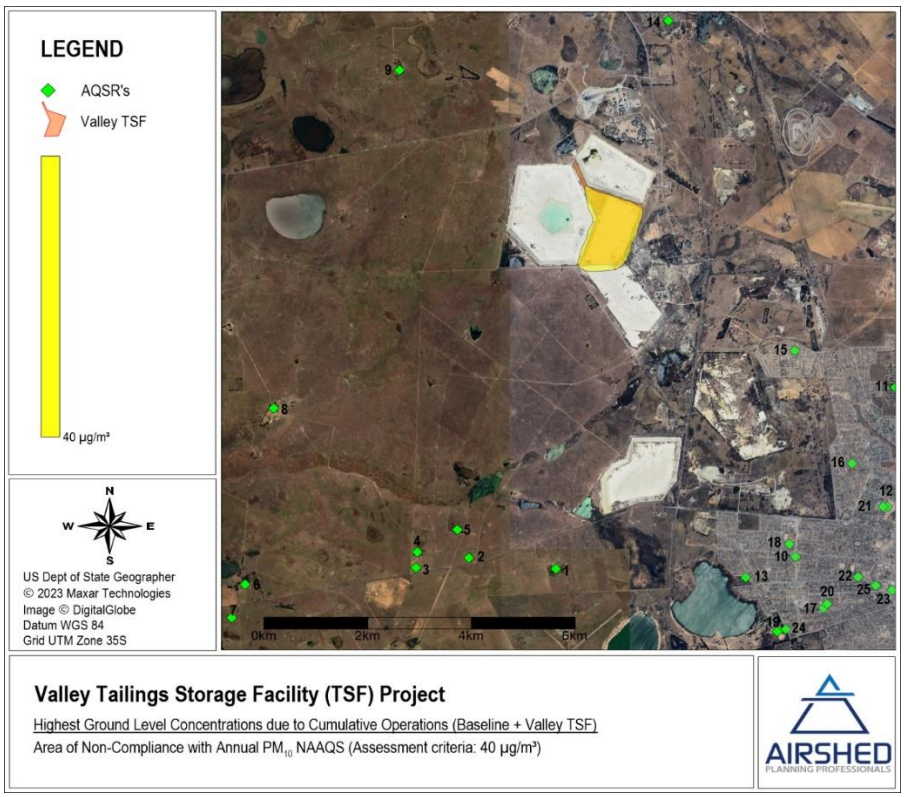

Figure 39: Project scenario – Area of non-compliance with annual PM_{10} NAAQS

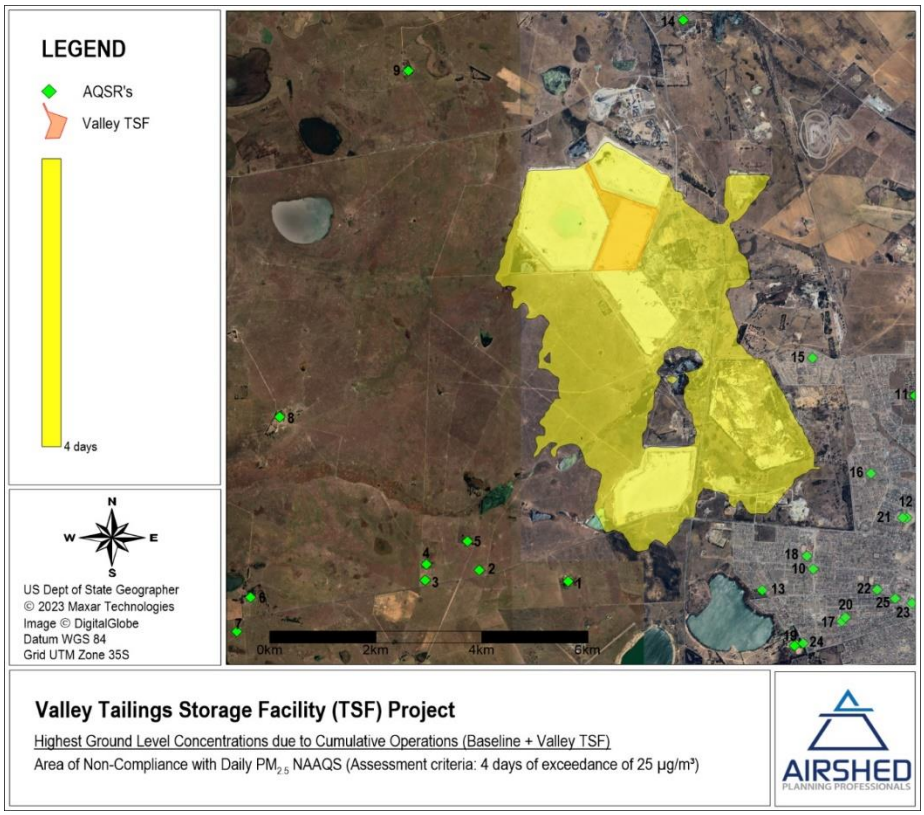

Figure 40: Project scenario – Area of non-compliance with daily $PM_{2.5}$ NAAQS

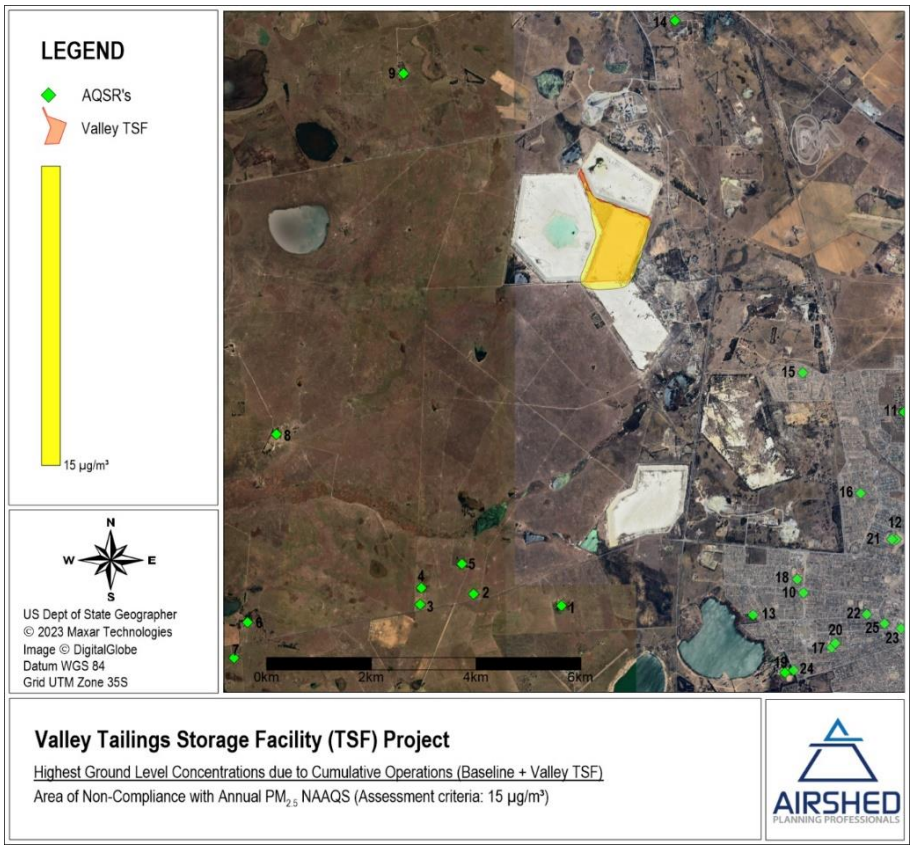

Figure 41: Project scenario – Area of non-compliance with annual $PM_{2.5}$ NAAQS

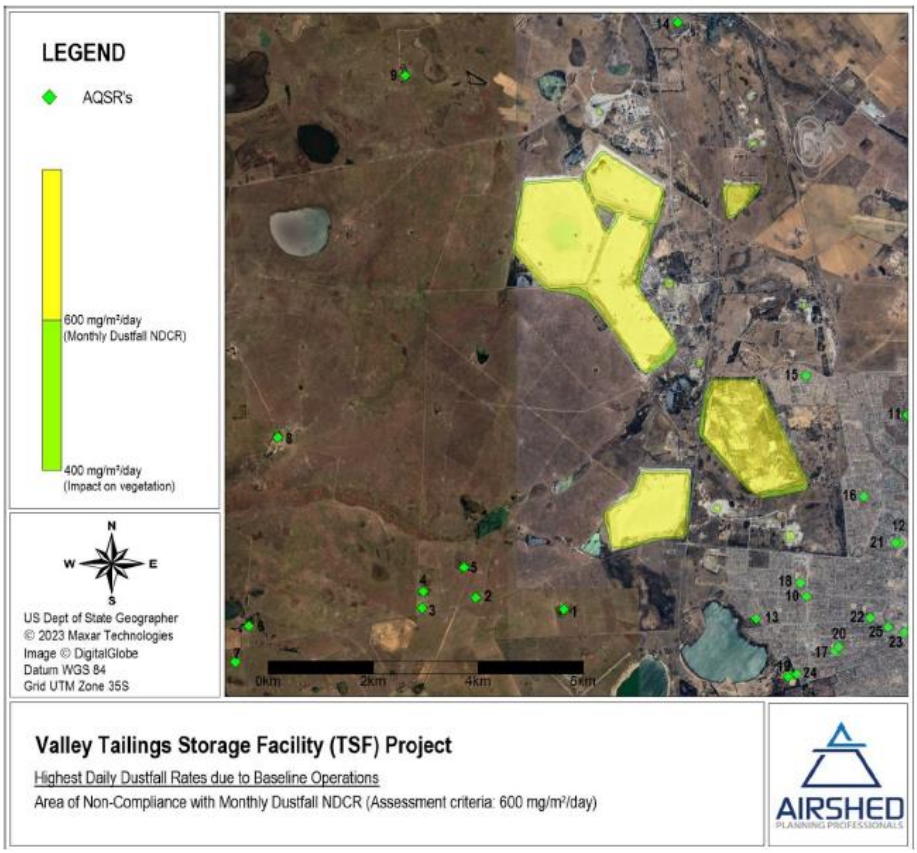

Figure 42: Project scenario – Area of non-compliance with monthly dustfall NDCR

Table 24: Simulated AQSR PM_{10} concentrations (in µg/m³) due to project operations

		Project Operations			
AQSRs	Name	Highest Daily	Annual	No of Exceedances	Compliance (Yes/No)
	NAAQS	**75**	**40**	**4**	**-**
AQSR1	Farmstead 1	61.74	0.56	0	Yes
AQSR2	Farmstead 2	117.79	0.81	1	Yes
AQSR3	Farmstead 3	73.63	0.55	0	Yes
AQSR4	Farmstead 4	60.43	0.56	1	Yes
AQSR5	Farmstead 5	98.80	0.74	2	Yes
AQSR6	Farmstead 6	57.03	0.33	0	Yes
AQSR7	Farmstead 7	35.25	0.28	0	Yes
AQSR8	Farmstead 8	100.36	0.94	1	Yes
AQSR9	Farmstead 9	1.00	0.11	0	Yes
AQSR10	Bedelia	143.79	0.63	3	Yes
AQSR11	Flamingo Park	27.31	0.30	1	Yes
AQSR12	Jim Fouche Park	151.90	0.52	2	Yes
AQSR13	Lakeview	148.20	0.68	2	Yes
AQSR14	Odendaalsrus	0.85	0.12	0	Yes
AQSR15	Rheederpark	81.61	0.59	2	Yes
AQSR16	Seemeeu Park	167.31	0.69	2	Yes
AQSR17	St Helena	76.83	0.43	2	Yes
AQSR18	Bedelia Primary School	177.99	0.73	3	Yes

Project Operations					
AQSRs	Name	Highest Daily	Annual	No of Exceedances	Compliance (Yes/No)
AQSR19	St Andrew's School	96.20	0.44	2	Yes
AQSR20	St Helena School	90.97	0.46	2	Yes
AQSR21	Welkom Gymnasium School	167.49	0.56	2	Yes
AQSR22	Welkom Preparatory School	255.65	0.84	3	Yes
AQSR23	Mediclinic Welkom Hospital	245.79	0.77	2	Yes
AQSR24	St Helena Private Hospital	90.71	0.44	2	Yes
AQSR25	Welkom Sub-Acute Hospital	252.67	0.82	2	Yes

Table 25: Simulated AQSR $PM_{2.5}$ concentrations (in µg/m³) due to project operations

Project Operations					
AQSRs	**Name**	**Highest Daily**	**Annual**	**No of Exceedances**	**Compliance (Yes/No)**
	NAAQS	**25**	**15**	**4**	**-**
AQSR1	Farmstead 1	13.69	0.25	1	Yes
AQSR2	Farmstead 2	19.24	0.38	2	Yes
AQSR3	Farmstead 3	11.98	0.25	1	Yes
AQSR4	Farmstead 4	11.03	0.26	1	Yes
AQSR5	Farmstead 5	19.73	0.34	2	Yes
AQSR6	Farmstead 6	4.23	0.15	1	Yes
AQSR7	Farmstead 7	5.42	0.13	0	Yes
AQSR8	Farmstead 8	35.08	0.44	2	Yes
AQSR9	Farmstead 9	0.42	0.05	0	Yes
AQSR10	Bedelia	23.02	0.28	3	Yes
AQSR11	Flamingo Park	7.29	0.13	1	Yes
AQSR12	Jim Fouche Park	24.41	0.24	2	Yes
AQSR13	Lakeview	23.21	0.30	2	Yes
AQSR14	Odendaalsrus	0.33	0.05	0	Yes
AQSR15	Rheederpark	16.33	0.26	3	Yes
AQSR16	Seemeeu Park	27.40	0.31	2	Yes
AQSR17	St Helena	12.49	0.20	3	Yes
AQSR18	Bedelia Primary School	28.37	0.32	3	Yes
AQSR19	St Andrew's School	15.16	0.20	2	Yes
AQSR20	St Helena School	14.68	0.21	3	Yes
AQSR21	Welkom Gymnasium School	26.87	0.26	2	Yes
AQSR22	Welkom Preparatory School	40.41	0.39	3	Yes
AQSR23	Mediclinic Welkom Hospital	38.94	0.36	2	Yes
AQSR24	St Helena Private Hospital	14.38	0.20	2	Yes
AQSR25	Welkom Sub-Acute Hospital	40.00	0.38	3	Yes

Table 26: Simulated AQSR dustfall rates (in mg/m²/day) due to Project operations

Project Operations		
AQSRs	**Name**	**30-day average**
	NDCR	**600**
AQSR1	Farmstead 1	36.91
AQSR2	Farmstead 2	60.74
AQSR3	Farmstead 3	36.55
AQSR4	Farmstead 4	41.51
AQSR5	Farmstead 5	59.00
AQSR6	Farmstead 6	24.45
AQSR7	Farmstead 7	19.49
AQSR8	Farmstead 8	118.52
AQSR9	Farmstead 9	3.45
AQSR10	Bedelia	67.23
AQSR11	Flamingo Park	24.12
AQSR12	Jim Fouche Park	46.21
AQSR13	Lakeview	64.58
AQSR14	Odendaalsrus	2.76
AQSR15	Rheederpark	41.29
AQSR16	Seemeeu Park	72.35
AQSR17	St Helena	45.80
AQSR18	Bedelia Primary School	76.20
AQSR19	St Andrew's School	45.34
AQSR20	St Helena School	47.39
AQSR21	Welkom Gymnasium School	50.41
AQSR22	Welkom Preparatory School	101.77
AQSR23	Mediclinic Welkom Hospital	94.11
AQSR24	St Helena Private Hospital	44.11
AQSR25	Welkom Sub-Acute Hospital	99.62

Simulated PM10 concentrations due to project operations were within the daily PM10 NAAQS at all of the identified sensitive receptors, as were simulated PM2.5 concentrations within the post-2030 daily PM2.5 NAAQS at all sensitive receptors. Annual average PM10 and PM2.5 concentrations were within the respective NAAQSs at all receptors. The simulated dust deposition was within NDCR for residential areas at the closest sensitive receptors.

9.3.8.3 CLOSURE PHASE AIR QUALITY IMPACTS

All operational activities will have ceased by the closure (decommissioning and post-closure) phase of the project. This will result in a positive impact on the surrounding environment and human health. The potential for impacts during the closure phase will therefore depend on the extent of rehabilitation efforts to be undertaken at the Valley TSF. In general, a combination of soil or rock covers in association with vegetation offers the most protection and stability to the often highly erosive tailings material.

During construction of the vegetative cover, earth and civil works are likely to generate vehicle and wind entrained dust from deposition of material on the TSF. Although the impact is likely to be site-specific, dust suppression techniques such as wetting roads, or application of dust palliatives, are required. Once vegetated the potential for wind entrained particulates should become similar to background conditions.

9.3.8.4 AIR QUALITY MITIGATION MEASURES

The establishment of objectives and targets with regards to fugitive emissions are important to minimise the impacts of these emissions on the surrounding environment. Key performance indicators against which progress of implemented mitigation and management measures may be assessed, form the basis for all effective environmental management practices. In the definition of key performance indicators careful attention is usually paid to ensure that progress towards their achievement is measurable, and that the targets set are achievable given available technology and experience.

9.3.8.4.1 DUST MANAGEMENT MEASURES

A Dust Management Plan (DMP) for the Valley operations should be compiled to follow an iterative process, including: implementation, monitoring, reporting, reviewing and adjustment to the necessary steps.

Any approach that either binds the particles together and make it more resistant to wind erosion or reduce to the force of the wind will result in a reduction in windblown dust emissions.

Surface treatment techniques to reduce dust generation include: wet suppression, chemical stabilisation, covering of surface with less erodible aggregate material and the vegetation of open areas. Wet suppression (the use of sprinklers) can achieve results in the short-term but will require constant maintenance and management to remain effective.

Substantial research has been done on erosion from gold mine tailings. Parameters which have the potential to impact on the rate of emission of fugitive dust include the extent of surface compaction, moisture content, ground cover, the shape of the storage pile, particle size distribution, wind speed and precipitation. Any factor that binds the erodible material, or otherwise reduces the availability of erodible material on the surface, decreases the erosion potential of the fugitive source. High moisture contents, whether due to precipitation or deliberate wetting, promote the aggregation and cementation of fines to the surfaces of larger particles, thus decreasing the potential for dust emissions. Surface compaction and ground cover similarly reduces the potential for dust generation (Burger et al., 1997).

Rock cladding or armouring of the sides of tailings dams has been shown in various international studies to be effective in various instances in reducing wind erosion of slopes. Cases in which rock cladding has been found to be effective in this regard generally involve rock covers of greater than 0.5 m in depth (Ritcey, 1989; Jewell and Newson, 1997). The application of a 300 mm layer of fine rock was found to be the most successful of the non-vegetative measures, resulting in an erosion control efficiency of 90% if the base is levelled and compacted – wind erosion is considered to reduce by 100% through the addition of such a rock cover. The use of rock cover should be investigated.

In addition, screens could be installed on the crest of the tailings dam walls mainly to act as windbreaks and to reduce the potential for dust deposition on the vegetated side walls, hence curbing the growth of the grass.

Vegetation is also considered the most effective control measure in terms of its ability to also control water erosion. In investigating the feasibility of vegetation types the following properties are normally taken into account: indigenous plants; ability to establish and regenerate quickly; proven effective for reclamation elsewhere; tolerant to the climatic conditions of the area; high rate of root production; easily propagated by seed or cuttings; and nitrogen-fixing ability. The long-term effectiveness of suitable vegetation selected for the site will be dependent on (a) the nature of the cover, and (b) the availability of aftercare. The use of vegetation cover should be investigated and implemented to address this impact.

9.3.8.4.2 PERFORMANCE INDICATORS

Source monitoring at operational activities can be challenging due to the fugitive and wind-dependent nature of particulate emissions. The focus is therefore rather on receptor-based performance indicators i.e. compliance with ambient air quality standards and dustfall regulations.

It is recommended that the current dustfall monitoring network be maintained and the monthly dustfall results used as indicators to tract the effectiveness of the applied mitigation measures. Dustfall collection should follow the ASTM method as per the NDCRs. The ASTM method covers the procedure of collection of dustfall and its

measurement and employs a simple device consisting of a cylindrical container exposed for one calendar month (30 ±2 days). The method provides for a dry bucket, which is advisable in the dry environment. The cause of the high dustfall rates should be investigated and these levels should be reduced to be within compliance with the NDCR.

Periodic inspections and external audits are essential for progress measurement, evaluation, and reporting purposes. It is recommended that site inspections and progress reporting be undertaken at regular intervals (at least quarterly), with annual environmental audits being conducted. Annual environmental audits should be continued at least until closure. Results from site inspections and monitoring efforts should be combined to determine progress against source- and receptor-based performance indicators. Progress should be reported to all interested and affected parties (I&APs), including authorities and persons affected by pollution.

Stakeholder forums provide possibly the most effective mechanisms for information dissemination and consultation. Management plans should stipulate specific intervals at which forums will be held and provide information on how people will be notified of such meetings. Given the proximity of the study site to the nearby communities and farmsteads, it is recommended that such meetings be scheduled and held at least on an annual basis. A complaints register must be kept at all times.

Financial provision budget should provide a clear indication of the capital and annual maintenance costs associated with dust control measures and dust monitoring plans. It may be necessary to make assumptions about the duration of aftercare prior to obtaining closure. This assumption must be made explicit so that the financial plan can be assessed within this framework. Costs related to inspections, audits, environmental reporting and I&APs liaison should also be indicated where applicable. Provision should also be made for capital and running costs associated with dust control contingency measures and for security measures. The financial plan should be audited by an independent consultant, with reviews conducted on an annual basis.

9.3.9 HEALTH AND RADIATION IMPACTS

The main objective of the radiological public safety assessment is to assess the potential impact on members of the public that may occur during the operational phase of the Projects, with due consideration of the impact that may occur during the post-closure phase. How members of the public are exposed to ionising radiation induced by the Projects may be different depending on the operational conditions and the specific point in time (either present or future).

Sources of radiation exposure to members of the public associated with mining and mineral processing facilities are often advertently induced. Although the key elements responsible for radiation exposure are naturally occurring radionuclides, human-induced conditions and activities may enhance concentrations of naturally occurring radionuclides in the accessible environment. Alternatively, the potential for human exposure to naturally occurring radionuclides in products, by-products, residues, and other wastes may be enhanced by moving these radionuclides from inaccessible locations to locations where humans can be subject to radiation exposure.

To pose a radiological risk to members of the public and the environment, the naturally occurring radionuclides must first be released from the sources of radiation exposure into the environment. As used here, sources refer to any entity that contains radioactivity and has the potential to release radioactivity into the environment. Release mechanisms can be generalised into the following natural and human-induced conditions:

- The release of radionuclides through natural conditions:
    - Solid release (e.g., windblown dust);
    - Water-mediated release (e.g., leaching through tailings storage facility); and
    - Gas-mediated release (e.g., radon gas exhalation).
- Direct gamma radiation; and
- Controlled or uncontrolled releases of radionuclides as solids or liquids into the environment.

Controlled releases are human-induced as part of the normal operating conditions, while uncontrolled releases are associated with accidents and incidents that are outside the scope of normal operating conditions (e.g., excessive water erosion, pipeline bursts, releases from storage dams overflowing their capacity, or the breaking of dam walls).

A distinction can be made between primary and secondary sources of radiation exposure. The primary sources are associated with physical features or entities at a mining and mineral processing operation, with the potential of naturally occurring radionuclides to be released into the environment. Examples of primary sources that are generally associated with mining and mineral processing operations include:

- Tailings Storage Facilities (TSFs), Waste Rock Dumps (WRDs) or any other stockpile facility used to store waste or other residue material on the surface, from which naturally occurring radionuclides may be dispersed in solid (dust), liquid (seepage), or gaseous (radon gas) form;
- Open pits that developed following open cast mining to extract rock or minerals from the orebody, from which naturally occurring radionuclides may be dispersed in solid (dust), liquid (seepage), or gaseous (radon gas) form;
- Mineral processing activities, where radioactive gasses and dust may be released from the commination (e.g., crushing, milling, and screening) and beneficiation of ore containing radionuclides;
- Water management facilities (e.g., return water dams, process control dams, and evaporation ponds), used to manage excess water generated through mining, mineral processing, and residue disposal activities, and where water may be released to the environment;
- Materials handling activities (e.g., the transfer of material containing naturally occurring radionuclides from one point or facility to another), during which radioactive dust may be released to the environment; and
- Mine ventilation shafts increase airflow in underground workings, where gasses and dust generated underground may be released with the outflowing air.

Radioactivity released from the primary sources into the environment may accumulate in the physical compartments of the environmental system (e.g., groundwater, surface water bodies, surface soils, sediments, etc.), potentially resulting in what can be termed secondary sources of radiation exposure. The following serve as examples of secondary radiation sources:

- Continuous deposition and accumulation of naturally occurring radionuclides associated with airborne dust or contaminated irrigation water on surface soils, resulting in the development of a secondary source at the soil surface;
- Continuous deposition of naturally occurring radionuclides associated with airborne dust in a surface water body, resulting in the development of a secondary source in the sediments and surface water body;
- Uncontrolled release of contaminated mine residue (e.g., tailings material) through surface water erosion of existing TSFs or other stockpile facilities;
- Uncontrolled release (e.g., spillage) of contaminated mine residue (e.g., tailings material) or water on surface soils from pipelines or storage dams, resulting in the development of a secondary source at the soil surface; or
- Uncontrolled release (e.g., spillage) of contaminated mine residue (e.g., tailings material) or water in a surface water body from pipelines or storage dams (as appropriate), resulting in the development of a secondary source in the sediments and surface water body.

Members of the public may potentially be subject to radiation exposure from both primary and secondary sources at a mining and mineral processing operation, with expected differences in modes and duration of exposure.

9.3.9.1 CONSTRUCTION PHASE RADIOLOGICAL IMPACTS

The proposed Valley TSF is a new facility and infrastructure (e.g., TSF, RWD, and topsoil stockpiles). To establish this infrastructure, some construction work will be necessary, including site clearance and footprint preparation for the TSF extension areas and the construction or upgrade of access roads.

Activities performed in these areas during the construction phase will not induce a potential radiological impact on members of the public since the activities do not involve the handling, processing, or releasing of radioactive material to the environment per se. This means that the potential radiological impact on members of the public through the relevant pathway during the construction phase is negligible.

9.3.9.2 OPERATIONAL PHASE RADIOLOGICAL IMPACTS

The radiological impact assessment for the operational phase considers the potential contribution through all three environmental pathways (i.e., surface water, groundwater and atmospheric). However, due to the slow-moving nature of any radionuclide contaminant plume that originates from the facilities through the groundwater system, the potential radiological impact through the groundwater pathway will only occur during the post-closure.

During the operational phase, the following activities were identified that may result in a radiological impact on members of the public:

- Emission and dispersion of particulate matter containing radionuclides from the existing and proposed TSFs: During the operational phase wind erosion will serve as a source of windblown dust (i.e., wind erosion) to the atmosphere for the duration of the operational period. These particulate matter containing radionuclides are dispersed into the environment through the atmospheric pathways. The emission and subsequent dispersion of the particulate matter into the atmosphere results in an airborne radionuclides concentration associated with the PM10, and a soil radionuclides concentration following the deposition of the TSP. Through secondary pathways, the radionuclides in the soil may be transferred to crops and animal products. Contributions to the total effective dose to receptors identified for the Projects include inhalation of airborne dust, ingestion of contaminated soil, crops and animal products, and external gamma radiation through cloud shine and ground shine; and
- Exhalation and dispersion of radon gas from the existing and proposed Valley TSF: During the operational phase, radon gases are generated in the tailings material at the TSF areas due to the presence of Ra-226 This means that these gases are exhaled continuously from this facility into the atmosphere.

9.3.9.3 POST-CLOSURE RADIOLOGICAL IMPACTS

Before the actual closure of the proposed Valley TSF and as part of the anticipated licensing conditions and requirements, a decommissioning and closure plan will be prepared for submission and approval by the regulatory authorities. Amongst others, this plan will define in detail all the activities that will be performed and how the associated radiological impact during the decommissioning and closure phase will be managed.

The following activities were identified that may result in a radiological impact on the receptors during the post-closure phase:

- Implementation of the approved decommissioning plan;
- Exhalation of radon gas and the emission of particulates matter (PM10 and TSP) that contain radionuclides from the remaining facilities (e.g., TSF); and
- Leaching and migration of radionuclides from the remaining facilities (e.g., TSF).

The implementation of the National Nuclear Regulator (NNR)-approved decommissioning plan will result in a positive impact in the sense that all surface infrastructure that contained or that is contaminated with radionuclides is demolished, decontaminated (to the extent possible) and removed from the site and compliance with clearance criteria has been demonstrated.

A gamma radiation survey supplemented with full-spectrum radioanalysis of soil samples will be performed at the infrastructure sites, followed by appropriate rehabilitation and clean-up operations for conditional or unconditional clearance from the regulatory authority. In addition, any area that may have become contaminated during or because of operational activities will also be rehabilitation and clean-up for conditional or unconditional clearance.

During the post-closure phase, some of the facilities (e.g., TSF) will remain at the surface and continue to serve as sources of radiation exposure to members of the public. These facilities will serve as a source of windblown dust (i.e., wind erosion) to the atmosphere during the post-closure period. During the same period, radon gas generated in the tailings materials due to the presence of Ra-226 will continue to be exhaled into the atmosphere.

The emission and subsequent dispersion of the particulate matter into the atmosphere results in an airborne radionuclides concentration associated with the PM10, and a soil radionuclides concentration following the deposition of the TSP. Through secondary pathways, the radionuclides in the soil may be transferred to crops and animal products. Contributions to the total effective dose to receptors include inhalation of airborne dust, ingestion of contaminated soil, crops and animal products, and external gamma radiation through cloud shine and ground shine. Following the exhalation and subsequent dispersion of the radon gas into the atmosphere, inhalation of the airborne gas contributes to the total effective dose to receptors.

From the commissioning of a TSF, radionuclides contained in the tailings material leach from the TSF to the underlying strata. The rate of leaching is controlled by complex geochemical and hydrological processes but generally is a slow process. Once in the underlying strata, migration of these radionuclides is equally slow along the groundwater flow path. Abstraction of groundwater for personal or agricultural purposes may result in a radiological impact on receptors through direct ingestion of water or the ingestion of crops and animal products as secondary pathways. The radiological impact along the groundwater pathway only manifests itself during the post-closure period hundreds to thousands of years after closure.

9.3.9.4 RADIOLOGICAL MITIGATION MEASURES

For Exhalation and Dispersion of Radon Gases, the management objective would be to first ensure that radiation exposure is below the regulatory compliance criteria (i.e., the dose constraint), and secondly to optimise the radiation protection by applying the ALARA principle (As Low As Reasonable Achievable, economic, and social factors taken into consideration).

The total effective dose as a contribution from radon gas released from the tailings material at the TSF areas is well below the regulatory compliance criteria, which means that from a compliance perspective, no additional management or mitigation measures are required for radon inhalation. From a dose optimisation perspective, the following can be noted:

- The radon exhalation rate from the surface of tailings material is determined by several factors, of which moisture content is one. This means that for the area at a TSF that is wet (i.e., beach area), the radon exhalation rate will be reduced marginally. However, it is not effective to wet the TSF deep enough (2 to 4 m) to reduce the radon exhalation rate marginally.
- The most effective way to reduce the radon exhalation rate for the TSF is to provide a covering layer. This will increase the diffusion length to allow for the decay of the radon progeny before being released from the tailings surface.

For Emission and Dispersion of Particulate Matter, the management objective would be to first ensure that radiation exposure is below the regulatory compliance criteria (i.e., the dose constraint), and secondly to optimise the radiation protection by applying the ALARA principle.

The contribution of dust inhalation is less than 10% (on average) of the total effective dose for all age groups at selected receptor locations. This means that from a regulatory compliance perspective, no additional management or mitigation measures are required for dust inhalation. The contribution of external exposure (cloud shine and ground shine) is less than 2% (on average) of the total effective dose for all age groups at selected receptor locations. This means that from a regulatory compliance perspective, no additional

management or mitigation measures are required for external gamma radiation. The contribution of animal and crop ingestion is less than 15% (on average) of the total effective dose for all age groups at selected receptor locations. This means that from a regulatory compliance perspective, no additional management or mitigation measures are required for the ingestion pathways. In addition, the total effective dose at the same locations is less than 5% (on average) of the dose constraint of 250 µSv.year-1 for public exposure.

From a dose optimisation perspective, the following mitigation measures can be applied. These measures, which are in line with the measures proposed in the air quality impact assessment (Airshed, 2023), will contribute to a reduction in the total effective dose if applied for the duration of the operational period:

- Develop an air quality management plan for the proposed Valley TSF, including air quality monitoring to ensure compliance at upwind and downwind locations; and
- Vegetation of exposed areas of the TSF and wind barriers to reduce wind erosion and/or the application of dust suppressants.

For Post-Closure impacts, the management objective would be to first ensure that radiation exposure is below the regulatory compliance criteria (i.e., the dose constraint), and secondly to optimise the radiation protection by applying the ALARA principle.

The total effective dose as a contribution from the windblown dust, as well as radon gas released from the remaining facilities, is well below the regulatory compliance criteria (dose constraint), which means that from a compliance perspective, no additional management or mitigation measures are required.

From a dose optimisation perspective, the following mitigation measures that are in line with the measures proposed by the air quality impact assessment (Airshed, 2023) can be applied for the post-closure phase:

- Vegetation of exposed areas of the TSF and wind barriers to reduce wind erosion and/or the application of dust suppressants;
- Covering layer over the exposed area of the TSF areas to reduce wind erosion and radon exhalation; and
- Implementation of a passive groundwater remediation system downstream of the TSF to capture the contaminant plume.

9.3.10 SAFETY IMPACTS

A feasibility dam break analysis was completed by Geotheta using FLO-2D Overland Flood Modelling. The Dam Break Analysis was completed on the Valley TSF only. Further assessment will need to be done should the surrounding TSF's breach concurrently. The analysis showed the expected inundation area of the Valley TSF, together with the flow depths and mud-flow velocities that would occur should the facility fail. The analyses concluded that there would be extensive damage to both the natural environment and infrastructure within the inundation area.

Tailings flowing into the river will result in the loss of aquatic wildlife and decrease in water quality. It is likely that the pollution of the river and loss of aquatic wildlife would have adverse impacts on the ecosystem of the area and also adversely affect users of the water.

The flood event would inundate households and associated infrastructure located near the facility and the populated area to the north east of the Valley TSF. The potential population at risk falls between 100 – 1 000, with the potential loss of life not exceeding 10.

The SANS 10286 Code of Practice for Mine Residue, requires that all mine residue deposits be classified into one or a combination of the following safety categories:

- High hazard;
- Medium hazard; and
- Low hazard.

The safety classification of the Valley TSF was determined by analysing the zone of influence and applying the safety classification criteria provided in the SANS 10286 Code of Practice for Mine Residue. Based on SANS 10286, the Valley TSF has a High hazard classification rating (Table 27).

Table 27: Safety classification criteria

No of residents in zone of influence	No of workers in zone of influence[1]	Value of third party property in zone of influence[2]	Depth to underground mined workings[3]	Classification
0	<10	0-R2 m	>200 m	Low hazard
1-10	11-100	R2 m-R20 m	50 m-200 m	Medium hazard
>10	>100	>R20 m	<50 m	High hazard

1) Not including workers employed solely for the purposes of operating the deposit
2) The value of third party property should be the replacement value in 1996 terms
3) The potential for collapse of the deposit into the underground workings effectively extends the zone of influence to below ground level.

The environmental classification of the TSF is a residue deposit with a significant impact on any environmental component.

Table 28: Environmental classification criteria

Aspect under consideration	Environmental classification		
	Significant	Possibly significant	Not significant
Surface and groundwater	Deposit has potential to contaminate water that may be consumed by humans.	Deposit has potential to contaminate water that may be consumed by flora or fauna.	No contamination of water supplies likely.
Land	Deposit has potential to permanently render surrounding land unsuitable for its pre-existing potential.	Release of residue from the deposit could have a long-term detrimental effect on land.	Release of residue from the deposit can be completely remediated.
Air	Deposit has potential to degrade air quality to a level that is detrimental to human health.	Deposit has potential to elevate dust nuisance (only) to an unacceptable level.	Deposit has negligible potential to adversely affect air quality.
Physical security	Residue has potential to cause injury on release as a result of structural failure. [1]	Residue has potential to cause injury as a result of structural failure [2]	Residue has negligible potential to cause harm through structural failure.
Business environment	Failure of Deposit has potential to result in business failure of operation.	Failure of Deposit has potential to result in significant economic loss.	Low potential for failure of Deposit to result in economic loss.
Social environment	Failure of Deposit could lead to severe adverse publicity, resulting in business failure and impairment of credibility.	Failure of Deposit could lead to adverse publicity, leading to regulatory intervention and/or financial loss.	Failure of Deposit is unlikely to lead to adverse publicity or indirect losses.
Government	Failure of deposits can lead to Harmony receiving directives/penalties.	Possibility of notice	None

The consequence classification of the Valley TSF was determined by analysing the zone of influence and applying the consequence classification criteria provided in Table 11 of Global Industry Standard on Tailings Management (GISTM). The Valley TSF is categorised as a Very High Consequence Classification facility due to the impact a failure of this facility would have on the life, environment and infrastructure in the inundation zone modelled during the dam break analysis.

High economic losses affecting infrastructure are anticipated within the zone of influence of the facility. The affected infrastructure comprises the mine's own access road, solution trench, return water dam and the silt trap (all part of this design). Other infrastructure such as farmhouses and nearby mining operations may also be affected.

Major environmental losses or deterioration of habitat are expected within the zone of influence footprint area. A potential failure of the facility will inundate and cause significant deterioration of the surrounding environment. There is permanent identifiable population at risk within the zone of influence (Figure 43). These are the permanent operating staff and a residential area north of the facility. The potential loss of life is considered to be ten or fewer based on a staff compliment of 8 persons. Therefore, based on the above, and GISTM the Valley TSF has a Very High Consequence Classification rating.

Figure 43: Zone of influence

9.3.10.1 SAFETY MITIGATION MEASURES

Based on the detailed design of the new Valley TSF, the following conclusions and recommendations can be drawn:

- Safe operating systems and procedures are to be implemented during operation of the facility.
- The Valley TSF will be developed with an intermediate outer slope of 1V:3H between benches. The inter-bench height is 3.0m and the benches are8.0m wide. The overall slope with benches is 1V:4H.
- The maximum starter wall embankment height is 3.0m with a 3.0m wide crest, outer slope of 1V:1.5H and 1V:2H inner slope. The starter wall embankment will be constructed in 150mm layers to 95%

Proctor density at 0% to +2% O.M.C. The starter wall material will be obtained from borrow pits in the basin of the facility.

- The minimum Factor of Safety against failure is 2.0 under drained conditions, 1.6 under undrained conditions, 1.2 under post seismic, post liquefaction or residual conditions and 1.3 under pseudo static conditions. These Factors of Safety comply with the local regulation and international slope stability standards.
- The gold tailings material classified as a Type 3 waste as provided by Jones and Wagner. This necessitates a Class C barrier system. However, as per an independent review by Legge and Associates, an 'inverted barrier' system can be used. The inverted barrier reduces seepage by changing the flow through the liner from Bernoulli flow at discontinuities to D'Arcian flow controlled by the tailings permeability at these points. The stability of the TSF is also improved by omitting lower strength compacted clay layers and the geomembrane cushion layer (replaced by tailings). The inverted barrier system is used in the design of the Valley TSF barrier system.
- A 150T geogrid will be installed to reduce the stresses in the liner to a Factor of Safety of 1.5.
- A 150mm thick reinforced concrete lined solution trench is provided along the north-west, south and south-eastern sections of the TSF. The trapezoidal solution trench is 1m deep with side slopes of 1V:1.5H and a base width of 1m. The solution trench on the north-western section of the TSF will accommodate the maximum peak discharge from the penstock of 1.02m3/sec and flows into the new RWD. The solution trench on the south and south-eastern sections of the TSF will accommodate drain flow only of 46.14m3/day and flows into the existing RWD.
- A concrete lined spillway must be provided to safely discharge excess water without overtopping of the northern FSN 2 RWD embankment walls. The RWD spillway has a freeboard of 800mm and has been designed to discharge the 1:10 000 24-hour Probable Maximum Flood volume of 9.9m^3/sec.
- A perimeter barrier with warning signs will be installed around the perimeter of the TSF. A 5m wide all-weather access road is provided around the facility to all key infrastructure for operational and monitoring requirements.
- The facility is to be constructed and operated to ensure that the future designed outer slope profile is achieved and to ensure the safe, efficient and environmentally responsible management of the Valley TSF and associated infrastructure.
- Safe operating systems and procedures are to be implemented during operation of the facility.
- Monitoring of the facility is to be undertaken as outlined in the Operating, Maintenance and Surveillance Manual.

9.3.11 SOCIAL IMPACTS

Sources of social impacts are often not as clear-cut as those in the biophysical environment. Social impacts are not site-specific but occur in the communities surrounding the proposed site – where the people are. Mitigation measures are context specific and the mitigation measures in this report should be viewed as guidelines.

Given that Harmony has existing TSFs in close proximity to where the new facility is proposed, it must be considered that many of the impacts are existing impacts. When considering existing impacts, the complexity of the social environment must be contemplated. Social impacts are not site-specific but occur in communities surrounding the site. The activities taking place in the area surrounding the project site has also caused a number of impacts. From a social perspective it is not possible to pinpoint which percentage of any given impact result from a specific activity or proponent. For example, agricultural, tourism and mining activities may cause an influx of people into an area due to the possibility of employment creation. It is not possible to say, for example, that 30% of people moving into the area looked for an agricultural job, 60% for a mining job and 10% for a tourism job. It is possible to say that all these industries contributed to the honeypot effect (project-induced in-migration where people move to the project site in search of work or economic opportunities that arise from the project) that compounded unemployment in the area. Harmony and its activities are not the only responsible party for

the existing social impacts in the area, but the mine does contribute greatly to these impacts, and will continue to do so through the life of mine. The following potential impacts will be triggered by the proposed Valley TSF.

9.3.11.1 IMPACT ON LIVELIHOODS

A livelihood refers to the way of life of a person or household and how they make a living, in particular, how they secure the basic necessities of life, e.g., their food, water, shelter and clothing, and live in the community (Vanclay et al., 2015). The farming community in the area is close-knit, and the majority of stakeholders that will be affected by the project rely on farming as a livelihood, in some cases for generations. This includes vulnerable parties like farm workers. The farms are not only their homes, but their businesses. They generate their income from the land. Any aspect that impacts on the ability of a farmer to make a living from his/her land can be seen as an impact on his/her livelihood. The majority of farmers in the area farm with livestock. They report a decrease in the carrying capacity of the land and the birth rates of the livestock. According to the farmers all red grass, an important source of food for the livestock, has disappeared from the area. The farmers feel that they are stuck with farms that have no value and cannot be sold due to the current pollution levels.

There are three major impacts on the livelihoods of the farming community. The first is the cumulative impact on water sources. Harmony provides water to the direct neighbours, but not to all the affected farmers downstream or on the commonage. Another issue is the management of storm water (mine) and sewage (municipality). Farmers claim that it is not managed well at the moment, municipal sewage is pumped into slimes dams and storm water trenches, and contaminated storm water ends up in the Mahemspruit, an intermittent stream in the area, causing pollution for kilometres downstream. Farmers feel that their land has been sterilised by the water and dust pollution, and that they have been forced to decrease farming activities since 1981.

The second impact on the livelihoods of the farmers is the white dust that settles on the soil and plants. Farmers claim that it has an impact on the productivity of the land, as plants cannot photosynthesise, and the soil is less fertile. Plants are less palatable to the animals, and when the animals eat the plants, they also ingest the white dust, which farmers believe is poisonous to their livestock. Farmers reported that the productivity of the land is already compromised, and that the birth-rate of livestock has decreased significantly. The construction of the new TSF will compound these issues.

The third impact on livelihoods is related to fences. Farmers indicated that fences corrode very quickly, and that they are constantly replacing fences. They claim that a fencepost can disintegrate within a year. The farmers need to keep their cattle on their property, but with the bad state of fences it is easier for people to cut the wires and steal cattle. With the construction activities associated with the new TSF there will be more activities and people in the area, and sturdy fences become even more important. The new TSF should also be fenced when operational, with fences strong enough to keep people and livestock out of the area.

Any negative impact on the livelihood of a farmer impacts on farmworkers, who are much less resilient. Many of the affected people have dependents such as elderly parents and young children, in addition to their workers. Impacts on livelihoods are seen as some of the most significant impacts from a social perspective, as the ripple effect of this impact can be felt on so many levels, and people always experience this impact severely on a personal level.

9.3.11.2 COMMUNITY EXPECTATIONS AND SOCIAL LICENSE TO OPERATE

The Matjhabeng Local Municipality is highly politicised and experience frequent service delivery protests. The areas closest to the proposed TSF are Rheederpark Extension 2, Jabulani Village and Reahola Housing Association. Farmers and community members expressed that they do not feel that Harmony has a social license to operate from the local people. They claim to that the community spokesperson for Harmony constantly changes and often makes commitments that are not met. Farmers said that they have become emotional about the issues, because it feels as if nothing that they do makes any difference. Community members feel that they do not receive any support from the mine, and that at the end of the life of the mine, it will pack up and leave without considering the people that are left behind. Due to the mistrust, and the expectations that some community members have, there is a strong possibility of local conflict. The current reality in South Africa is that communities tend to resort to violent protests if they feel that they are not heard. There is a risk that lives can be in danger and property damaged during these protests, and the mine should have emergency procedures in

place should there be protests of this nature that endangers its assets and the lives of staff and community members.

Although some of the community expectations are realistic, the extent to which the mine can meet some of the expectations are limited. Unless the expectations of the community are managed carefully, this impact may pose a significant risk to the mine on different levels. Despite the negative impacts caused by the TSF, it must be considered that there are positive impacts as well, mostly based on job opportunities and SLP initiatives and contribution to the national GDP as well as the local economy.

9.3.11.3 HEALTH AND WELLBEING

The proposed construction of the TSF will create dust, which will continue in the operational phase of the project. The dust potentially has health impacts and impact on the grazing areas of farmers. Dust is also a significant nuisance factor, because even if it is within the legal limits, it is something that is visible to the communities. Communities report that they suffer from asthma, sinusitis, nose bleeds and allergies, which they ascribe to the dust.

People also report that vulnerable parties such as children and the elderly became ill as a result of bathing in the untreated borehole water downstream. The fact that the farmers do not have access to potable water even though they do have boreholes and surface water on their properties and need to rely on external parties (the mine) for water, is another concern that affects their wellbeing. The farmers feel that the establishment of a new TSF will increase the already negative impact.

Another concern is the presence of illegal mine workers (zama-zamas) and open shafts. The farmers and communities fear that during the construction period when there is an increase in activity around the site it may provide new opportunities for the criminals already active in the area.

Although the likelihood is low there is always a risk that a TSF may fail, with dire consequences to people and the environment. Farmers and communities living in the zone of influence of a TSF should be included in the emergency preparedness planning in case of such an event.

Various specialists have recommended the mitigation measures that are subsequently included in this report. These mitigations will form part of compliance obligations against which Harmony will be audited and the results thereof submitted to the department. Similarly on-going monitoring of dust and water quality is taking place with the results thereof submitted to the relevant competent authority.

9.3.11.4 ECONOMIC IMPACTS FROM A SOCIAL PERSPECTIVE

The project will ensure job security for currently employed people, as they will be able to continue with their current jobs. This impact would be experienced on a wider level since it will allow them to meet the needs of their family members. It is not clear how long the construction phase will be, or how many jobs will be created, but in a similar project the construction phase was 5 years and approximately 300 jobs were created, of which the majority were unskilled or semi-skilled (GCS,2020). The staff compliment for the Valley TSF is expected to be as follows:

- Peak manpower on site during construction = 370 people; and
- Approximately 66 people during normal deposition during operational phase.

Wages that employees receive will increase their spending power in the study area. This will be especially beneficial to retail and other service providers. The job creation will be a significant positive impact during the construction phase. There are high levels of poverty and unemployment in the area, and this may cause significant competition for jobs. Communities indicated that job opportunities must be shared in a transparent manner and communicated widely. For general jobs they do not want the mine to use a list of people that qualify, but rather that names are thrown in a hat and drawn by a community member or the ward councillor. In the past competition for jobs caused significant conflict in the area, and therefore this aspect must be handled with care.

Apart from the direct economic impacts of the proposed project, there will also be secondary economic opportunities that can potentially benefit local service providers. The use of local service providers will ensure

that the local economy benefits directly from the proposed project. The positive impact of the mine on the local economy will continue for the life of the mine. The SLP also commits to secondary economic development in the area, and if it is implemented as planned should be a significant contribution.

9.3.11.5 SOCIAL MITIGATION MEASURES

The following mitigation is proposed:

- Harmony must establish an environmental forum that include all the affected farmers - neighbouring and downstream. Results of water and dust monitoring must be shared with the public through the forum.
- If current water delivery points are affected by the placing of the new TSF new points must be determined with input from the farmers. These points must be easily accessible. If water pipes are required, the mine must provide and install the pipes.
- Dust suppression activities should be conducted as prescribed by the relevant specialist.
- If investigations prove actual losses due to the activities performed by Harmony, Harmony will enter into discussions with the landowner. Where compensation is required, it should follow the IFC principles, which states that market related prices should be paid, and if anything is restored, it must be to the same or better standards than before.If areas are fenced, the fences must be checked on a daily basis for the duration of the construction period. All broken fences must be reported to the farmer and the Harmony CLO.
- Harmony must continue to invest in their Stakeholder Relations Division.
- Harmony must continue to implement their grievance mechanism and ensure that it is community-friendly. Harmony must continue to address and keep record of community grievances. Harmony must continue to keep a grievance register. It is important to have documented evidence of community/mine interactions. This will assist the mine to track the issues, and the community to see what actions the mine has taken.
- The mine must include planning and budgeting for external conflict situations (such as roadblocks or invasions) in their emergency response procedure and ensure that their current insurance remains updated. They must also periodically review their stakeholder engagement plan to guide their interaction with stakeholders.
- The relevant specialists will provide scientific mitigation measures for the dust and water issues. From a social perspective it is important to continue to communicate the mitigation, monitoring and management measures to the affected parties. Ongoing rehabilitation can play an important role in minimising the impact.
- The SRM should establish relationships with the surrounding farmers. This can include a yearly courtesy visit and sharing of environmental data to keep the farmers informed. All meetings should be recorded, and records must be included in the communication register.
- The mine management should engage with the farmers about water supply, where necessary and required. The negotiations must be recorded.
- Conduct a water census and repeat periodically as recommended by the relevant specialists. Keep the affected people informed about the census and monitoring results. Share water monitoring results with farmers once a year.
- The mine must ensure that its properties are fenced, the fences are intact, and all abandoned shafts must be covered.
- Harmony must investigate and where possible and feasible adopt and / or adapt the Global Industry Standard on Tailings Management for the existing and new TSF.

- Skills development plans must be focussed on skills that the mine needs, and that are also transferable. Support must be given to people after the training to ensure that their newly acquired skills can be implemented.
- The mine should put measures in place to ensure the most effective local employment strategy.
- Harmony should ensure a fair number of secondary economic opportunities are given to local contractors. A percentage of goods as determined by Harmony and the relevant stakeholders must also be procured locally. Services and goods must be procured locally as far as reasonably possible. Aspects of this positive impact will occur by default when the construction force lives locally and they utilise local services and support local shops.
- Toolbox talks should include talks about the impact of promiscuous behaviour. Harmony should develop an in-house infectious diseases strategy to address health issues within the workforce and align the strategy with a community HIV strategy implemented by a non-profit organisation. Local schools and communities living close to the project must be included in the strategy. The strategy should include voluntary counselling and testing and training of peer educators. A workforce code of conduct should be developed to maximise positive employee behaviour in the local community, and optimise integration.
- Extend the workplace programme for HIV beyond the company's operations, and include all contractors, suppliers, transportation companies and local communities. Make it a contractual requirement. The spread of HIV along transportation routes (roads and railways) is well documented, so this component of the project (transportation of all goods and services to and from the project site) needs special attention.

Refer to Table 29 for a summary of impact assessment scoring for each identified impact.

Table 29: Impact assessment scoring summary (refer to Appendix E for full size version)

		Pre-Mitigation							Post Mitigation								Priority Factor Criteria			
Impact	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score
Impacts on Visual Environment and Sense of Place	Construction	-1	3	2	2	2	2	-4,5	-1	3	2	2	2	2	-4,5	Medium	1	1	1,00	-4,5
Impacts on Visual Environment and Sense of Place	Operation	-1	3	5	2	3	2	-6,5	-1	3	5	2	2	2	-6	High	2	1	1,13	-6,75
Impacts on Visual Environment and Sense of Place	Rehab and closure	-1	3	2	1	2	2	-4	-1	3	2	1	2	2	-4	Medium	1	1	1,00	-4
Increase in air quality impacts due to construction of the TSF	Construction	-1	3	2	3	2	4	-10	-1	2	2	3	2	3	-6,75	Medium	1	1	1,00	-6,75
Increase in air quality impacts due to the operation of Valley TSF	Operation	-1	3	4	3	4	3	-10,5	-1	3	4	2	3	3	-9	Medium	1	1	1,00	-9
Increase in air quality impacts due to decommissioning and closure	Rehab and closure	-1	3	2	3	2	4	-10	-1	2	2	3	2	3	-6,75	Medium	1	1	1,00	-6,75
Disturbance / destruction of sites of heritage significance	Construction	-1	1	2	1	3	2	-3,5	-1	1	2	1	2	1	-1,5	Medium	1	1	1,00	-1,5
Disturbance / destruction of palaeontological resources	Construction	-1	1	5	4	5	4	-15	1	1	5	2	5	2	6,5	Medium	1	1	1,00	6,5
Employment opportunities	Planning	1	3	2	1	1	3	5,25	1	2	1	1	4	3	6	Medium	1	1	1,00	6
Employment opportunities	Construction	1	3	2	2	1	3	6	1	2	2	1	4	3	6,75	Medium	1	1	1,00	6,75
Employment opportunities	Operation	1	3	4	4	1	3	9	1	4	4	1	4	3	9,75	Medium	1	1	1,00	9,75
Employment opportunities	Decommissioning	1	3	2	2	1	3	6	1	2	2	1	4	3	6,75	Medium	1	1	1,00	6,75
Employment opportunities	Rehab and closure	1	3	2	2	1	3	6	1	2	2	1	4	3	6,75	Medium	1	1	1,00	6,75
Expectations regarding creation of opportunities	Planning	-1	3	2	2	5	2	-6	-1	3	2	1	5	2	-5,5	Medium	1	1	1,00	-5,5
Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Operation	-1	3	2	2	5	2	-6	-1	3	2	1	5	2	-5,5	Medium	1	1	1,00	-5,5
Negative perceptions relating to the risk of TSF failure.	Operation	-1	3	2	2	5	2	-6	-1	3	2	1	5	2	-5,5	Medium	1	1	1,00	-5,5
Impacts on livelihoods of landowners.	Operation	-1	3	2	2	5	2	-6	-1	3	2	1	5	2	-5,5	Medium	1	1	1,00	-5,5
Noise impacts	Construction	-1	1	1	2	1	2	-2,5	-1	1	1	1	1	2	-2	Medium	1	1	1,00	-2
Noise impacts	Operation	-1	1	1	2	1	2	-2,5	-1	1	1	1	1	2	-2	Medium	1	1	1,00	-2
Noise impacts	Decommissioning	-1	1	1	2	1	2	-2,5	-1	1	1	1	1	2	-2	Medium	1	1	1,00	-2
Noise impacts	Rehab and closure	-1	1	1	2	1	2	-2,5	-1	1	1	1	1	2	-2	Medium	1	1	1,00	-2
Exhalation and dispersion of radon gas to the atmosphere during the operational phase of the Projects	Operation	-1	2	5	1	3	2	-5,5	-1	2	5	1	3	1	-2,75	Medium	1	1	1,00	-2,75
Emission and dispersion of particulate matter that contains radionuclides to the atmosphere during the operational phase	Operation	-1	2	5	1	2	2	-5	-1	2	5	1	2	1	-2,5	Medium	1	1	1,00	-2,5
Implementation of the NNR-approved decommissioning plan	Rehab and closure	1	2	5	4	5	4	16	1	2	5	4	5	4	16	Medium	1	1	1,00	16
Exhalation, emission and dispersion of radon gas and particulate matter that contains radionuclides during the post-closure phase	Rehab and closure	-1	2	5	1	2	2	-5	-1	2	5	1	2	1	-2,5	Medium	1	1	1,00	-2,5
Leaching and migration of radionuclides from the TSF during the post-closure phase	Rehab and closure	-1	3	5	1	3	2	-6	-1	3	5	1	3	2	-6	Medium	1	1	1,00	-6
Destruction, further loss and fragmentation of the of habitats, ecosystems and vegetation community;	Construction	-1	3	4	2	3	3	-9	-1	2	3	1	3	2	-4,5	Medium	1	1	1,00	-4,5
Introduction of alien and invasive species, especially plants;	Construction	-1	3	4	3	2	3	-9	-1	2	3	3	2	2	-5	Medium	1	1	1,00	-5
Displacement of the indigenous faunal community (incl bird and bats) due to habitat loss, direct mortalities, and disturbance (road collisions, noise, dust, light, vibration, and poaching).	Construction	-1	3	4	3	3	3	-9,75	-1	2	3	2	3	2	-5	Medium	1	1	1,00	-5
Continued fragmentation and degradation of habitats and ecosystems	Operation	-1	2	3	2	3	2	-5	-1	1	2	1	3	2	-3,5	Medium	1	1	1,00	-3,5
Spread of alien and/or invasive species	Operation	-1	3	3	3	2	2	-5,5	-1	2	2	2	1	1	-1,75	Medium	1	1	1,00	-1,75
Ongoing displacement and direct mortalities of the faunal community due to continued disturbance (road collisions, noise, light, dust, vibration, poaching, erosion, etc.).	Operation	-1	3	4	3	3	2	-6,5	-1	2	3	2	2	1	-2,25	Medium	1	1	1,00	-2,25
Loss of land capability	Planning	-1	1	1	1	2	1	-1,25	-1	1	1	1	1	1	-1	Low	1	1	1,00	-1
Soil compaction	Construction	-1	3	3	3	3	3	-9	-1	2	2	2	3	3	-6,75	Medium	2	3	1,38	-9,28125
Soil erosion, Land degradation	Operation	-1	3	3	3	3	3	-9	-1	2	3	2	3	3	-7,5	Medium	2	3	1,38	-10,3125
Soil erosion, Land degradation	Decommissioning	-1	2	2	2	3	3	-6,75	-1	2	2	1	3	2	-4	Low	2	2	1,25	-5
Soil erosion, Land degradation	Rehab and closure	-1	2	2	2	2	2	-4	-1	2	2	1	2	1	-1,75	Low	1	2	1,13	-1,96875
Direct loss, disturbance and degradation of wetlands.	Construction	-1	2	1	5	3	4	-11	-1	2	1	4	3	3	-7,5	High	2	2	1,25	-9,375
Increased bare surfaces, runoff and potential for erosion	Construction	-1	2	1	3	3	3	-6,75	-1	2	1	2	3	3	-6	High	2	2	1,25	-7,5
Degradation of wetland vegetation and the introduction and spread of alien and invasive vegetation	Construction	-1	2	1	4	3	4	-10	-1	2	1	3	3	3	-6,75	High	2	2	1,25	-8,4375
Increased sediment loads to downstream reaches	Construction	-1	2	1	3	3	3	-6,75	-1	2	1	2	3	3	-6	High	2	2	1,25	-7,5
Contamination of wetlands with hydrocarbons due to machinery leaks and eutrophication of wetland systems with human sewerage and other waste.	Construction	-1	2	1	3	3	2	-4,5	-1	2	1	2	3	2	-4	High	2	2	1,25	-5
Disruption of wetland soil profile and alteration of hydrological regime	Construction	-1	2	1	3	3	3	-6,75	-1	2	1	2	3	3	-6	High	2	2	1,25	-7,5
Increased water inputs (clean) to downstream wetlands	Operation	-1	2	4	2	3	3	-8,25	-1	2	4	2	3	3	-8,25	High	2	2	1,25	-10,3125
Degradation of wetland vegetation and proliferation of alien and invasive species	Decommissioning	-1	2	1	4	3	4	-10	-1	2	1	3	3	3	-6,75	High	2	2	1,25	-8,4375
Disruption of wetland soil profile, hydrological regime and increased sediment loads	Decommissioning	-1	2	1	3	3	3	-6,75	-1	2	1	2	3	3	-6	High	2	2	1,25	-7,5
Groundwater contamination	Operation	-1	2	3	2	3	4	-10	-1	1	2	2	3	4	-8	Medium	2	2	1,25	-10
Cumulative groundwater contamination	Operation	-1	3	4	3	3	4	-13	-1	2	3	3	3	4	-11	Medium	2	2	1,25	-13,75
Groundwater contamination	Decommissioning	-1	2	3	2	3	4	-10	-1	1	2	1	2	2	-3	Medium	2	2	1,25	-3,75
Cumulative groundwater contamination	Decommissioning	-1	3	4	3	3	4	-13	-1	2	2	2	3	3	-6,75	Medium	2	2	1,25	-8,4375

10 SENSITIVITY MAPPING

Environmental sensitivity mapping provides a strategic overview of the environmental, cultural and social assets in a region. The sensitivity mapping technique integrates numerous datasets (basemaps and shapefiles) into a single consolidated layer making use of Geographic Information System (GIS) software and analysis tools. Environmental sensitivity mapping is a rapid and objective method applied to identify areas which may be particularly sensitive to development based on environmental, cultural and social sensitivity weightings – which is determined by specialists input within each respective field based on aerial or ground-surveys. Therefore, the sensitivity mapping exercise assists in the identification of low, medium and highly sensitive areas within the study area, towards selecting the preferred location, design and layout, and process or technology alternatives for the proposed activities and infrastructure. This sensitivity mapping approach allows for the proposed activities to be undertaken whilst protecting identified sensitive environmental areas / features. Furthermore, environmental sensitivity is used to aid in decision-making during consultation processes, forming a strategic part of Environmental Assessment processes. Table 30 below provides a breakdown of the sensitivity rating and weightings applied to determine the sensitivity score of each aspect. Figure 44 presents the final combined sensitivity map for the project. Groundwater features are continuous in nature and their sensitivity or vulnerability dependant on various entities (e.g. water travel time, contamination migration, plume stability, soil, etc.) making it difficult to directly and accurately measure or assign sensitivity at project area level. Furthermore social impacts pertain to cannot be allocated sensitivity criteria due to their variability. Lastly, the exclusion of visual and air quality sensitivity as part of the combined sensitivity map does not mean that there will be no visual sensitivities, but indicates that the entire site and its surroundings is already visually impacted upon by similar activities as the proposed development, and thus the project area and its immediate surroundings cannot be assigned different levels of sensitivity. The only identified sensitive areas on site relate to the wetlands around the site, and particularly the HGM1 wetland to the north of the site.

Table 30: Sensitivity rating and weighting

Sensitivity Rating	Description	Weighting
Least concern	The inherent feature status and sensitivity is already degraded or contain no inherent sensitivities. The proposed development will not affect the current status and/or may result in a positive impact. These features would be the preferred alternative for mining or infrastructure placement.	-1
Low/Poor	The proposed development will not have a significant effect on the inherent feature status and sensitivity.	0
Medium	The proposed development will moderately negatively influence the current status of the feature.	1
High	The proposed development will have a significantly negative influence on the current status of the feature.	2
Very High	The proposed development will have a very high significant negative influence on the current status of the feature.	3

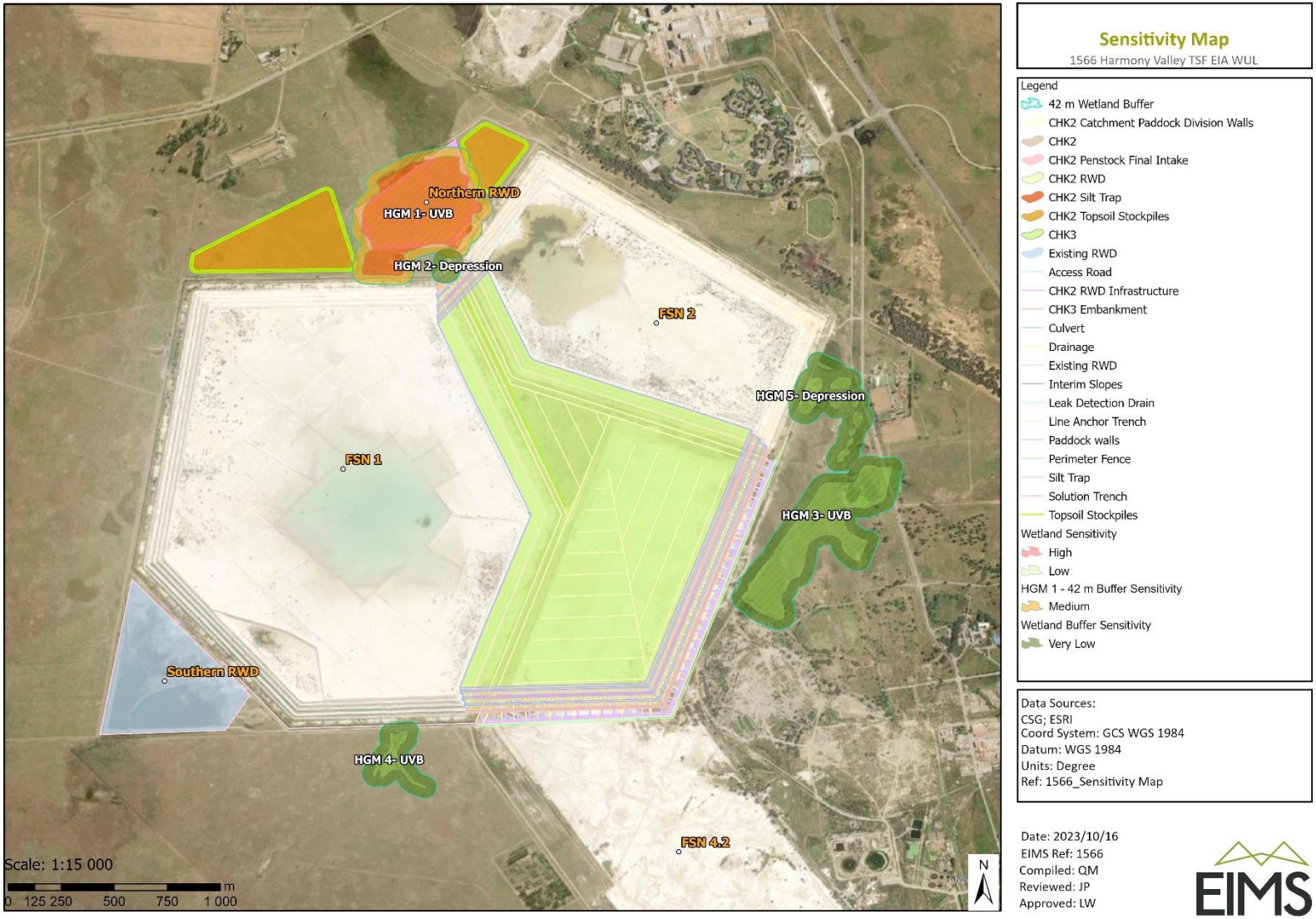

Figure 44: Combined EIA phase sensitivity map

11 CONCLUSIONS AND RECOMMENDATIONS

The Scoping Phase of the EIA process identified potential issues and impacts associated with the proposed project and defined the extent of the studies required within the EIA Phase. The EIA Phase addresses those identified potential environmental impacts and benefits (direct, indirect and cumulative impacts) associated with all phases of the project including design, construction and operation, and recommends appropriate mitigation measures for potentially significant environmental impacts. The EIA report provides sufficient information regarding the potential impacts and the acceptability of these impacts in order for the Competent Authority to make an informed decision regarding the proposed project. The release of an EIA Report for public review provides stakeholders with an opportunity to verify that the issues they have raised through the EIA process had been captured and adequately considered.

The EIA Phase aimed to achieve the following:

- Provide an overall assessment of the social and biophysical environments affected by the proposed project.
- Assess potentially significant impacts (direct, indirect and cumulative, where required) associated with the proposed coal mine extension project and associated infrastructure.
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts; and
- Undertake a fully inclusive public involvement process to ensure that I&APs are afforded the opportunity to participate, and that their issues and concerns are recorded.

11.1 CONCLUSIONS FROM SPECIALIST STUDIES

The conclusions and recommendations of this EIA are the result of the assessment of identified impacts by specialists, and the parallel process of public participation. The public consultation process has been extensive, and every effort has been made to include representatives of all stakeholders in the study area. The main conclusions from each of the specialist studies are presented below.

11.1.1 GEOHYDROLOGY

. It is evident from this assessment that the area is already impacted by the historical activities. Plume migration is, however, slow and although the simulated current plume has reached the Mahemspruit, the concentrations are <500 mg/L. The Mahemspruit is, however, impacted not only by this tailings facility, but also by other contaminant sources in the region.

The expected contribution of the impact from the Valley TSF is low and contained within the current impacted footprint. The unmitigated impact shows that a contaminant plume will migrate from the proposed TSF towards the only down-gradient receptor, the Mahemspruit. This contaminant flow is very slow and small impacts (<500 mg/L SO_4) will only reach the stream after approximately 100 years.

With reference to the modelled plumes, it appears that the lining of the proposed Valley TSF will have net positive impact on the down-gradient groundwater quality. It is, however noted that although the positive impact is not visible on the extent of the plume, there is nevertheless a reduction in the contaminant concentration over time. The reduction in the sulphate concentration down-gradient from the facility, with a liner installed, is approximately 50mg/L after 30 years.

This is a small improvement and it is therefore recommended that a rehabilitation plan be developed to address the groundwater deterioration from the existing TSF, in conjunction with the lining of the Valley TSF

11.1.2 VISUAL

The proposed Valley TSF project would be an addition to existing mining land-use activities currently prominent in the sub-region. The cumulative effect of the Project, which occurs adjacent to existing mine activities (TSFs) and as such there would be a low cumulative effect with respect to the other mining activities in the sub region.

It is the opinion of the visual specialist that the visual impacts associated with the proposed Project, given the worst case scenario, are of a low significance due to the nature, scale and duration of project activities within the context of the receiving environment. The specialist is of the opinion that the impacts associated with the various phases of the Project can be mitigated, however the significance of impact during the operational phase would remain low provided that the recommended mitigation measures are implemented and effectively managed. The Valley TSF project is deemed acceptable from a visual perspective.

11.1.3 HERITAGE

It is the considered opinion of the authors of this report that the overall impact of the proposed development on heritage resources will be Low. Provided that the general recommendations and mitigation measures outlined in this report are implemented, the impact would be acceptably Low or could be totally mitigated to the degree that the project could be approved from a heritage perspective.

11.1.4 PALAEONTOLOGY

The apparent rarity of fossil heritage in the proposed development footprint suggests that the impact of the development will be of a Low significance in palaeontological terms. It is therefore considered that the proposed development is deemed appropriate and feasible and will not lead to damaging impacts on the palaeontological resources of the area. The construction of the development may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.

11.1.5 WETLANDS

It is important that the mitigations measures are adhered to when constructing within the HGM 1 wetland. No significant wetland loss is foreseen. It is the opinion of the specialist that the project may be favourably considered, on condition all prescribed mitigation measures and supporting recommendations are implemented.

11.1.6 SOILS

The most sensitive soil form, which was identified within the project area, is the Avalon soil form. The DAFF (2017) data indicates land capabilities with “Very Low” to “Moderate high” sensitivities. Based on the site-verification, the specialist agrees with some areas which were identified with “Moderate High” land capability sensitivities. However, most areas categorized as “Moderate Low “to “Moderate” have been re-classified as they are associated with soils with a “Very Low to Low” land capability with soils like the Witbank soil form. The project area is, therefore, assigned an overall sensitivity of “Low” based on the verified soil baseline findings on-site.

The project area is associated with arable soils. However, the land fragmentation, available climatic conditions of low annual rainfall and high evapotranspiration potentially limits crop production for the area, resulting in land capabilities with “Moderate Low” ratings. The land capabilities associated with the assessment area are not suitable for most cropping practices, except only for the current livestock grazing in the remaining portions.

The project will not result in the segregation of any potentially high land capability lands. The project will have an overall acceptable residual impact on the agricultural production ability for the affected area. The specialist`s recommendation that the project may be favourably considered for development with implementation of mitigation measures.

11.1.7 TERRESTRIAL BIODIVERSITY

It is the opinion of the specialists that the project may be favourably considered, provided that the mitigation measures presented in this report and accompanying wetland report be implemented correctly, along with the recommendations below. The location, state and size of the ecosystem means that it is unlikely that any functional habitat or SCCs will be lost as a result of the impacts arising from the proposed activities.

It is important to consider that undeveloped portions of land can still contribute to land management objectives and protection targets to some degree. It is recommended that care be taken during construction to adhere to mitigation measures. An AIP management plan must be implemented as a priority to prevent the further spread

and proliferation of AIP species to the surrounding grassland areas. The investigation into the possibility of installing a leak warning and detection systems on all pipelines must also be made a priority, to prevent damage caused by pipe leaks on the surrounding natural areas, particularly near to water resources.

11.1.8 AIR QUALITY

The main findings from the air quality assessment study are as follows:

- Construction Phase Impacts:
    - Impacts were assessed qualitatively by taking into consideration the likely air quality impacts that may arise due to construction activities.
    - Resulting potential air quality health and nuisance impacts were assessed to have Medium significance without mitigation and Low significance with mitigation. The final environmental significance rating is Low.
- Operational Phase Impacts:
    - Impacts were assessed by taking into consideration the cumulative impact from existing sources (ventilation shafts and windblown dust from the existing tailings storage facilities and WRDs within the study domain) and the proposed Valley TSF.
    - Simulated PM10 and PM2.5 concentrations due to baseline operations were well within NAAQS at the closest identified sensitive receptors. The simulated dust deposition was within NDCR for residential areas at the closest sensitive receptors.
    - Simulated PM10 concentrations due to project operations were within the daily PM10 NAAQS at all of the identified sensitive receptors, as were simulated PM2.5 concentrations within the post-2030 daily PM2.5 NAAQS at all sensitive receptors. Annual average PM10 and PM2.5 concentrations were within the respective NAAQSs at all receptors. The simulated dust deposition was within NDCR for residential areas at the closest sensitive receptors.
    - The environmental risk due to both unmitigated and mitigated operations is classified as Medium, although affecting a smaller area with mitigation in place. The final environmental significance rating is Medium.
- Decommissioning Phase Impacts:
    - Impacts were assessed qualitatively by taking into consideration the likely air quality impacts that may arise due to decommissioning and closure activities.
    - Resulting potential air quality health and nuisance impacts were assessed to have Medium significance without mitigation and Low significance with mitigation. The final environmental significance rating is Low.

In conclusion, it is the specialist opinion that the project may be authorised provided that the recommended air quality management measures are implemented. These air quality management measures include:

- Dustfall monitoring ensuring dustfall rate in compliance with the NDCR limits; and
- Mitigation measures aimed at reducing emissions at source, i.e. the grassing of TSF side slopes (progressive rehabilitation).

11.1.9 HEALTH AND RADIATION

Following a systematic Source-Pathway-Receptor analysis approach, two public exposure condition was derived to be representative of the area, namely a Residential Area Exposure Condition and a Commercial Agricultural Exposure Condition. The atmospheric pathway was explicitly included in the definition of the exposure conditions, whereas the surface water and groundwater pathways were treated through sensitivity and uncertainty analysis. It was argued that the public exposure condition is broadly representative of the human

behavioural conditions near the Projects. In addition, other potential exposure conditions that may exist will result in lower levels of radiation exposure.

Given the pre-operational status of the Projects, the radiological assessment is prospective based on available information and reports generated as part of the ESHIA process. The results and conclusion are presented here, therefore, for the conditions and parameter values assumed for the assessment. These may change for future iterations as and when site-specific data and information become available and are used.

The following was concluded from the total effective dose assessment results:

- The most significant contribution from the atmospheric pathway is from the inhalation of airborne radon gas. This is due to the presence of Ra-226 in the source material.
- The contribution from the groundwater pathway was evaluated with the Projects TSFs as the main contributing source. It was illustrated that the potential radiological impact is only visible in thousands of years at maximum total effective doses of less than 200 µSv.year-1, which means that it cannot be considered as a contributing pathway for the Commercial Agricultural Exposure Condition during the operational phase of the Projects;
- The results for the two public exposure conditions were presented as dose isopleths for the different age groups, with more detailed exposure route-specific results at the receptor locations conservatively selected to be close to the infrastructure of the Projects. The results show that notwithstanding the proximity of the receptor locations to the surface infrastructure, the doses are still less than the dose constraint for all age groups, with a maximum contribution of less than 40 µSv.year-1 from the atmospheric pathway.

It can, therefore, be concluded with a reasonable level of assurance that members of the public who can associate themselves with one of the exposure conditions will not be subject to a total effective dose of more than the public dose constraint of 250 µSv.year^{-1}.

11.2 CONCLUSIONS FROM ALTERNATIVE ASSESSMENT

Two technology alternatives are being proposed:

- Technology alternative 1: Construction of the facility without a liner
- Technology alternative 2: Construction of the facility with a liner.

The gold tailings that will be deposited on the Valley TSF are classified as a Type 3 waste in terms of the NEMWA Regulations 2013 requiring a Class C containment barrier performance. The Class C single composite barrier system has an expected seepage rate in the order of 140 litres / hectare / day (Legge, 2024).

By making use of an ”inverted barrier system” comprising of underdrainage and a base preparation layer; a 1.5mm thick geomembrane ; and covered tailings the barrier system performance is improved by (a) seepage losses are reduced from about 140 l/ha/day to about 3 l/ha/day due to the change from Bernoulli flow at discontinuities to D’Arcian flow controlled by the tailings permeability at these points (Legge, 2024).

These leakage rates were included in the model and the impact simulated. The result from the 100-year simulation shows that any contamination from the site will be contained. The small volume of seepage that may flow through the liner system is diluted to the extent that contamination is not detected.

This modelling exercise did not include any remedial options. It is, however, expected that remediation, of which phyto-remediation is recommended, and the very slow contaminant migration rates will negate the need for a liner system. Both options are considered suitable or acceptable from an environmental perspective however based on the above **Technology Alternative 2 (Construction of TSF with a liner) is considered the preferred option.**

11.3 ENVIRONMENTAL IMPACT STATEMENT

The findings of the specialist studies conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented. Based on the nature and extent of the proposed project, the local level of disturbance predicted as a result of the construction and operation of the mine, the findings of the EIA studies, and the understanding of the significance level of potential environmental impacts, it is the opinion of the EIA project team that the significance levels of the majority of identified negative impacts can generally be reduced by implementing the recommended mitigation measures.

Despite the negative impacts caused by the TSF, it must be considered that there are positive impacts as well, mostly based on the employment opportunities and SLP initiatives. Based on the nature and extent of the proposed and the predicted impacts as a result of the construction, operation and closure of the facility, the findings of the EIA, and the understanding of the mostly low - moderate post-mitigation significance level of potential environmental impacts, it is the opinion of the EIA project team that the environmental impacts associated with the application for the proposed Valley TSF project can be mitigated to an acceptable level and the project should be authorized.

11.4 RECOMMENDATIONS FOR INCLUSION IN ENVIRONMENTAL AUTHORIZATION

The following key specialist recommendations are made for inclusion in the EA for the project:

- A Dust Management Plan for the Valley operations should be developed and follow an iterative process, including: implementation, monitoring, reporting, reviewing and adjustment to the necessary steps It is recommended that the current dustfall monitoring network be maintained and the monthly dustfall results used as indicators to tract the effectiveness of the applied mitigation measures. Dustfall collection should follow the ASTM method as per the NDCRs.
- In terms of groundwater monitoring a comprehensive bi-annual analysis of the dedicated monitoring boreholes should be undertaken. Groundwater levels should be monitored monthly in the dedicated groundwater monitoring boreholes and rainfall should be monitored daily.
- It is recommended that the possibility of phyto-remediation is considered and implemented as soon as possible to assist with removing contaminants in the soil and groundwater.
- If fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the Chance Find Protocol must be implemented by the ECO/site manager in charge of these developments.
- Harmony should monitor erosion and compaction on site during operations.
- An AIP management plan must be implemented as a priority to prevent the further spread and proliferation of AIP species to the surrounding grassland areas.
- Precautions must be taken against the erosion damage that would be caused by unplanned pipe leaks. Monitoring of the pipeline must be undertaken to detect leaks and monitoring should be undertaken at least once a week.
- Make sure that all the HGM units and their buffers, apart from those within the TSF footprint itself, are avoided as far as possible to limit the impacts on them.
- Ensure that the TSF is lined to prevent seepage contamination of groundwater, and sloped and vegetated to prevent runoff through rain.
- Conduct regular inspections along the TSF to ensure the integrity of the facility.
- Safe operating systems and procedures are to be implemented during operation of the facility.

- Implement proposed radiological monitoring programme for the project which includes recommendations for the monitoring of surface water, groundwater, sediment, environmental radon, well as dust fallout, including the frequency and type of analysis.
- Harmony must establish an environmental forum that include all the affected farmers - neighbouring and downstream. Results of water and dust monitoring must be shared with the public through the forum.
- If current water delivery points are affected by the placing of the new TSF new points must be determined with input from the farmers. These points must be easily accessible. If water pipes are required, the mine must provide and install the pipes.
- If investigations prove actual losses due to the activities performed by Harmony, Harmony will enter into discussions with the landowner.
- The mine management should engage with the farmers about water supply, where necessary and required. The negotiations must be recorded. Conduct a water census and repeat periodically as recommended by the relevant specialists. Keep the affected people informed about the census and monitoring results. Share water monitoring results with farmers once a year.
- Harmony must investigate and where possible and feasible adopt and / or adapt the Global Industry Standard on Tailings Management for the new TSF.
- Concurrent rehabilitation of the TSF side slopes must investigated.
- The mine must implement a community-friendly external grievance mechanism in conjunction with farmers and communities.

12 ASSUMPTIONS AND LIMITATIONS

Certain assumptions, limitations, and uncertainties are associated with the EIA Phase. This report is based on information that is currently available and, as a result, the following limitations and assumptions are applicable:

- The EIA Report is based on project information provided by the client; and
- The description of the baseline environment has been obtained from specialist studies.

Furthermore, certain assumptions, limitations, and uncertainties are associated with the EIA phase specialist studies and these are detailed for each aspect below.

12.1 GEOHYDROLOGY

The following conditions typically need to be described in a model:

- Geological and geohydrological features.
- Boundary conditions of the study area (based on the geology and geohydrology).
- Initial groundwater levels of the study area.
- The processes governing groundwater flow.
- Assumptions for the selection of the most appropriate numerical code.

Field data is essential in solving the conditions listed above and developing the numerical model into a site-specific groundwater model. Specific assumptions related to the available field data include:

- The top of the aquifer is represented by the generated groundwater heads.
- The available geological / geohydrological information was used to describe the different aquifers. The available information on the geology and field tests is considered as correct.

Many aquifer parameters have not been determined in the field and therefore have to be estimated.

In order to develop a model of an aquifer system, certain assumptions have to be made. The following assumptions were made:

- No abstraction boreholes were included in the initial model.
- The boundary conditions assigned to the model are considered correct.
- The impacts of other activities (e.g. agriculture) have not been considered.

It is important to note that a numerical groundwater model is a representation of the real system. It is, therefore, at most an approximation, and the level of accuracy depends on the quality of the data that is available. This implies that there are always errors associated with groundwater models due to uncertainty in the data and the capability of numerical methods to describe natural physical processes.

12.2 VISUAL

The following assumptions limitations have been made in the study:

- The description of project components is derived from the Background Information Document (BID) for the Project.
- The Project site is the only site under consideration i.e. no alternatives have been assessed.

12.3 HERITAGE

Not detracting in any way from the comprehensiveness of the fieldwork undertaken, it is necessary to realise that the heritage resources located during the fieldwork do not necessarily represent all the possible heritage resources present within the area. Various factors account for this, including the subterranean nature of some

archaeological sites and existing vegetation cover. Fieldwork was focussed on area that was not previously ploughed or disturbed by farming activity, thus focussing on areas with the highest potential to yield heritage resources.

Therefore, should any heritage features and/or objects be located or observed outside the identified heritage sensitive areas during the construction activities, a heritage specialist must be contacted immediately. Such observed or located heritage features and/or objects may not be disturbed or removed in any way until such time that the heritage specialist has been able to make an assessment as to the significance of the site (or material) in question. This applies to graves and cemeteries as well. If any graves or burial places are located during the development, the procedures and requirements pertaining to graves and burials will apply as set out below.

The study area boundaries and development footprints depicted in this report were provided by the client. As a result, these were the areas assessed during the fieldwork. Should any additional development footprints located outside of these study area boundaries be required, such additional areas will have to be assessed in the field by an experienced archaeologist/heritage specialist long before construction starts.

12.4 PALAEONTOLOGY

The focal point of geological maps is the geology of the area and the sheet explanations of the Geological Maps were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have never been reviewed by palaeontologists and data is generally based on aerial photographs alone. Locality and geological information of museums and universities databases have not been kept up to date or data collected in the past have not always been accurately documented.

Comparable Assemblage Zones in other areas is also used to provide information on the existence of fossils in an area which has not documented in the past. When using similar Assemblage Zones and geological formations for Desktop studies it is generally assumed that exposed fossil heritage is present within the footprint. A field-assessment will thus improve the accuracy of the desktop assessment.

12.5 WETLANDS

The following assumptions and limitations are applicable for this assessment:

- The focus area was based on the spatial files provided by the client and any alterations to the area and/or missing GIS information would have affected the area surveyed;
- Only the outline area of the proposed site was provided to the specialist; and
- The GPS used for the survey has a 5 m accuracy and therefore any spatial features may be offset by 5 m.

12.6 SOILS

The following assumptions and limitations are applicable for this assessment:

- Some of the proposed areas where the topsoil stockpiles, RWD, pipelines RW Valley north to dam locations were not assessed during the site visit as the proposed layout was not available when the field visit was done. Soil maps were generated based on previous desktop surveyed soil data;
- The information contained in this report is based on auger points taken and observations on site. There may be variations in terms of the delineation of the soil forms across the area;
- The GPS used for delineations is accurate to within five meters. Therefore, the delineation plotted digitally may be offset by at least five meters to either side; and
- Soil fertility analysis was not conducted on-sites for this report.

12.7 TERRESTRIAL BIODIVERSITY

The following assumptions and limitations are applicable for this assessment:

- It is assumed that all information received from the client and landowner is accurate;
- All datasets accessed and utilised for this assessment are considered to be representative of the most recent and suitable data for the intended purposes;
- The assessment area (Project Area) was based on the footprint areas as provided by the client, and any alterations to the area and/or missing GIS information pertaining to the assessment area would have affected the area surveyed and hence the results of this assessment;
- Additional areas were added to the layout after the field assessment had already been completed, therefore, these areas have been assessed at a desktop level only, making use of representative sampling based on the nearby areas which were surveyed;
- The area was surveyed during a single site visit, therefore, this assessment does not consider temporal trends (note that the data collected is considered sufficient to derive a meaningful baseline);
- The single site visit was conducted during the early dry season, and this means that certain flora and fauna would not have been present or observable due to seasonal constraints, however, most species have likely been recorded;
- This report must be considered in conjunction with the accompanying wetland report (TBC, 2023);
- Whilst every effort was made to cover as much of the Project Area as possible, representative sampling is completed, and by its nature it is possible that some plant and animal species that are present within the Project Area were not recorded during the field investigations; and
- The GPS used in the assessment has an accuracy of 5 m and consequently any spatial features may be offset by up to 5 m.

12.8 AIR QUALITY

The main assumptions, exclusions and limitations are summarized below:

- Meteorological data: Use was made of measured SAWS data for Welkom for the period 2020 to 2022, and this is regarded representative of the project area.
- The quantification of sources of emission was restricted to the project activities and baseline Harmony operations within the study domain only. Although other background sources were identified, such sources were not quantified.
- Information required for the calculation of emissions from fugitive dust sources for the project operations was taken from a previous study for Harmony (Grobler and Liebenberg-Enslin, 2017). The assumption was made that this information was accurate and correct.
- Routine emissions from the operations were estimated and modelled. Atmospheric releases occurring as a result of accidents were not accounted for.

12.9 HEALTH AND RADIATION

The radiological public safety assessment is based on site-specific data as far as practically possible and justified. Where appropriate and justified, the site-specific data and information are supplemented with values from the literature or analogue facilities such as those associated with the Projects. All assumptions and conditions used in the assessment are documented and justified accordingly.

13 UNDERTAKING REGARDING CORRECTNESS OF INFORMATION

I **John von Mayer** herewith undertake that the information provided in the foregoing report is correct to the best of my knowledge, and that the comments and inputs from stakeholders and Interested and Affected Parties as well the level of agreement with Interested and Affected Parties and stakeholders has been correctly recorded in the report where applicable.

Signature of the EAP

Date: 2024/03/18

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Appendix A: Copy of Revised Application Form

Appendix B: EAP CV

Appendix C: Public Participation

Appendix D: Specialist Reports

Appendix E: Impact Assessment Matrix

Appendix F: DFFE Screening Tool Report

Appendix G: Site Selection Summary Report

Appendix H: EMPr

Appendix I: Preliminary Design Report

Appendix J: Closure Costing