APPENDIX E: SPECIALIST ASSESMENTS

APPENDIX E.1: ARCHAEOLOGICAL AND HERITAGE RESOURES IMPACT ASSESSMENT

Archaeological and Heritage Resources Impact Assessment

(REQUIRED UNDER SECTION 38(8) OF THE NHRA (No. 25 OF 1999)

Of LISTED ACTIVITIES ASSOCIATED WITH MINING RIGHT ACTIVITIES AT NORTHAM PLATINUM LIMITED

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Zondereinde Division

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Report Outline

Appendix 6 of the GNR 326 EIA Regulations published on 7 April 2017 provides the requirements for specialist reports undertaken as part of the environmental authorisation process. In line with this, Table 1 provides an overview of Appendix 6 together with information on how these requirements have been met.

Table 1: Specialist Report Requirements.

Requirement from Appendix 6 of GN 326 EIA Regulation 2017	Chapter
Details of - (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae	Section 1 Section 12
Declaration that the specialist is independent on a form as may be specified by the competent authority	*Declaration of Independence*
Indication of the scope of, and the purpose for which, the report was prepared	Section 1
An indication of the quality and age of base data used for the specialist report	Section 3.4 and 7.1
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 9
Duration, Date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.4
Description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 8 and 9
Identification of any areas to be avoided, including buffers	Section 9
Map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 8
Description of any assumptions made and any uncertainties or gaps in knowledge	Section 3.7
A description of the findings and potential implications of such findings on the impact of the proposed activity **including identified alternatives on the environment** or activities	Section 9
Mitigation measures for inclusion in the EMPr	Section 9 and 10
Conditions for inclusion in the environmental authorisation	Section 9 and 10
Monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 9 and 10
Reasoned opinion - (i) as to whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and (ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 10.2
Description of any consultation process that was undertaken during the course of preparing the specialist report	Section 6
A summary and copies of any comments received during any consultation process and where applicable all responses thereto	To be included after the public comment period
Any other information requested by the competent authority	Section 10

Executive Summary

Prism EMS were appointed to conduct an Environmental Impact Assessment for the proposed Extended Mining Right Area at Northam Platinum Limited. The study area is located 18km northwest of Northam and 35km south of Thabazimbi in the Thabazimbi Municipality. HCAC was appointed to conduct an Archaeological and Heritage Resources Impact Assessment of the proposed project to determine the presence of cultural heritage sites and the impact of the proposed activities on these non-renewable resources. The study area was assessed both on desktop level and by a high-level site visit.

The study area is known to contain several stone walled sites conforming to the CCP along the base and between the saddles of the hills. These sites consist of central kraals, smaller livestock enclosures, lower grindstones and ceramic scatters. These sites form part of a larger settlement complex dating to the Later Iron Age. Middle Stone Age artefacts are found scattered over the study area with higher frequencies of artefacts found around small hills and rocky outcrops. As this is an underground mine no impact is foreseen on surface indicators of heritage sites. The SAHRIS Paleontological Sensitivity Map indicate that the area is of insignificant paleontological significance. Therefore, no further mitigation prior to construction is recommended in terms of Section 35 for the proposed activities to proceed.

Similarly, no impact is foreseen on the built environment or on burial sites as the proposed activities consist of an underground mine with no surface impacts. No public monuments are located within or close to the study area. The study area is surrounded by mining activities and road infrastructure developments and the proposed activities will not impact negatively on significant cultural landscapes or viewscapes. During the public participation process undertaken to date, no heritage concerns were raised.

As this is an underground mine with no surface impacts the impact of the proposed project on heritage resources is considered low and it is recommended that the proposed project can commence on the condition that the following recommendations are implemented as part of the EMPr and based on approval from SAHRA.

Any surface infrastructure development will have to be subjected to a Heritage Impact Assessment.

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Declaration of Independence

Specialist Name	Jaco van der Walt
Declaration of Independence	I declare, as a specialist appointed in terms of the National Environmental Management Act (Act No 108 of 1998) and the associated 2014 Environmental Impact Assessment (EIA) Regulations, that I: • I act as the independent specialist in this application; • I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant; • I declare that there are no circumstances that may compromise my objectivity in performing such work; • I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity; • I will comply with the Act, Regulations and all other applicable legislation; • I have no, and will not engage in, conflicting interests in the undertaking of the activity; • I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; • All the particulars furnished by me in this form are true and correct; and • I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
Signature	
Date	7 July 2017

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ABBREVIATIONS

AIA	Archaeological Impact Assessment
ASAPA	Association of South African Professional Archaeologists
BGG	Burial Ground and Graves
BIA	Basic Impact Assessment
CFP	Chance Find Procedures
CMP	Conservation Management Plan
CRR	Comments and Response Report
CRM	Cultural Resource Management
DEA	Department of Environmental Affairs
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment*
EIA	Early Iron Age*
EMP	Environmental Management Programme
ESA	Early Stone Age
ESIA	Environmental and Social Impact Assessment
GIS	Geographical Information System
GPS	Global Positioning System
GRP	Grave Relocation Plan
HIA	Heritage Impact Assessment
HTA	Human Tissues Act
LIA	Late Iron Age
LSA	Late Stone Age
MEC	Member of the Executive Council
MIA	Middle Iron Age
MPRDA	Mineral and Petroleum Resources Development Act
MSA	Middle Stone Age
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NHRA	National Heritage Resources Act, 1999 (Act No. 25 of 1999)
NID	Notification of Intent to Develop
NoK	Next-of-Kin
PHRA	Provincial Heritage Resource Agency
SADC	Southern African Development Community
SAHRA	South African Heritage Resources Agency

**Although EIA refers to both Environmental Impact Assessment and the Early Iron Age both are internationally accepted abbreviations and must be read and interpreted in the context it is used.*

GLOSSARY

Archaeological site (remains of human activity over 100 years old)
Early Stone Age (~ 2.6 million to 250 000 years ago)
Middle Stone Age (~ 250 000 to 40-25 000 years ago)
Later Stone Age (~ 40-25 000, to recently, 100 years ago)
The Iron Age (~ AD 400 to 1840)
Historic (~ AD 1840 to 1950)
Historic building (over 60 years old)

1 INTRODUCTION AND TERMS OF REFERENCE

Heritage Contracts and Archaeological Consulting CC (“**HCAC**”**)** were appointed by Prism Environmental Management Services (“**Prism EMS**”) to conduct an Archaeological and Heritage Resources Impact Assessment of the proposed mining activities. The report forms part of the Environmental Impact Assessment Report (EIA) and Environmental Management Programme Report (EMPR) Amendment for the Northam Platinum Limited (“**Northam**”).

The aim of the study was to assess the impact of the proposed project on non-renewable heritage resources, and to submit appropriate recommendations with regard to the responsible cultural resources management measures that might be required to assist the developer in managing the discovered heritage resources in a responsible manner. It was also conducted to protect, preserve, and develop such resources within the framework provided by the National Heritage Resources Act of 1999 (Act No 25 of 1999). The report outlines the approach and methodology utilized before and during the survey, which includes: Phase 1, review of relevant literature; Phase 2, a high-level field survey of portions of the study area was conducted; Phase 3, reporting the outcome of the study.

General site conditions and features on sites were recorded by means of photographs, GPS locations, and site descriptions. Possible impacts were identified and mitigation measures are proposed in the following report. SAHRA as a commenting authority under section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) require all environmental documents, complied in support of an Environmental Authorisation application as defined by NEMA EIA Regs section 40 (1) and (2), to be submitted to SAHRA. As such the Basic Assessment report and its appendices must be submitted to the case as well as the EMPr, once it’s completed by the Environmental Assessment Practitioner (EAP).

1.1 Terms of Reference

1.1.1 Field Study

Conduct a field study to:

- locate, identify, record, photograph and describe sites of archaeological, historical or cultural interest;
- record GPS points of sites/areas identified as significant areas;
- determine the levels of significance of the various types of heritage resources potentially affected by the proposedactivities.

1.1.2 Reporting

Report on the identification of anticipated and cumulative impacts the operational units of the proposed project activity may have on the identified heritage resources for all 3 phases of the project; i.e., construction, operation and decommissioning phases. Consider alternatives, should any significant sites be impacted adversely by the proposed project. Ensure that all studies and results comply with the relevant legislation, SAHRA minimum standards and the code of ethics and guidelines of ASAPA.
To assist the developer in managing the discovered heritage resources in a responsible manner, and to protect, preserve, and develop them within the framework provided by the National Heritage Resources Act of 1999 (Act No 25 of 1999).

Table 2: Project Description.

Size of farm and portions	1632,2827 hectares on: 1. A part of the remainder of farm Elandsfontein 386-KQ 2. A part of Ptn 1 of farm Elandsfontein 386-KQ 3. A part of Ptn 2 of farm Moddergat 389-KQ 4. A part of the remainder of farm Moddergat 389-KQ 5. A part of the remainder of farm Goevernements Plaats 417-KQ 6. A part of the remainder of Ptn 1 of farm Goevernements Plaats 417-KQ 7. A part of Ptn 2 of farm Goevernements Plaats 417-KQ 8. A part of the remainder of Ptn 3 of farm Goevernements Plaats 417-KQ 9. A part of Ptn 4 of farm Goevernements Plaats 417-KQ 10. Ptn 7 of farm Goevernements Plaats 417-KQ
Magisterial District	Thabazimbi
1: 50 000 map sheet number	2427CD
Central co-ordinate of the activities	24° 51' 42.5047" S 27° 18' 35.1470" E

Table 3: Infrastructure and project activities.

Type of development	Mining Activities
Project size	1632,2827 hectares
Project Components	Underground mining of Merensky and access to the UG2 Reefs

1.1.3 Expertise of the Specialist

Jaco van der Walt has been practising as a CRM archaeologist for 15 years. He obtained an MA degree in Archaeology from the University of the Witwatersrand focussing on the Iron Age in 2012 and is a PhD candidate at the University of Johannesburg focussing on Stone Age Archaeology with specific interest in the Middle Stone Age (MSA) and Later Stone Age (LSA). Jaco van der Walt is an accredited member of ASAPA (#159) and have conducted more than 500 impact assessments in Limpopo, Mpumalanga, North West, Free State, Gauteng, KZN as well as he Northern and Eastern Cape Provinces in South Africa.

Jaco van der Walt has worked on various international projects in Zimbabwe, Botswana, Mozambique, Lesotho, DRC Zambia and Tanzania. Through this he has a sound understanding of the IFC Performance Standard requirements, with specific reference to Performance Standard 8 – Cultural Heritage.

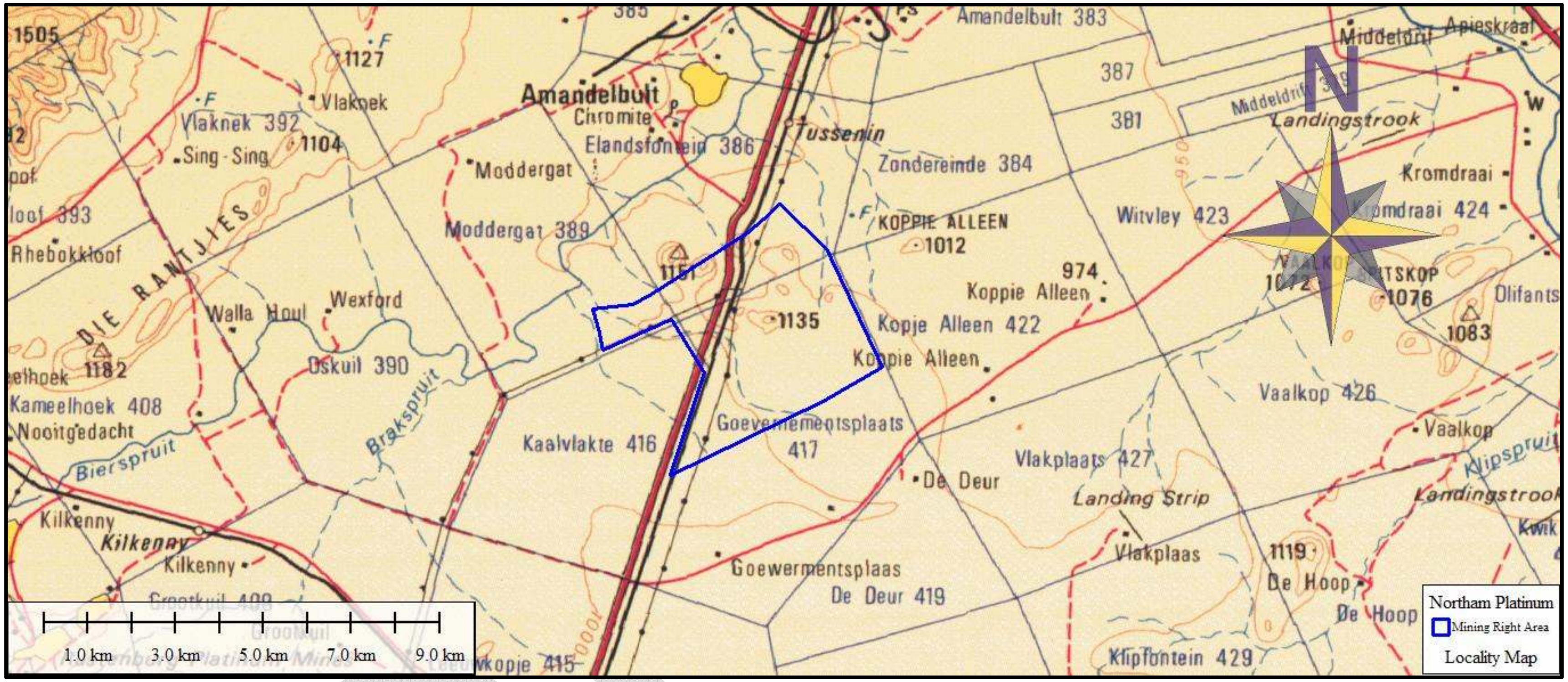

Figure 1: Provincial locality map (1: 250 000 topographical map).

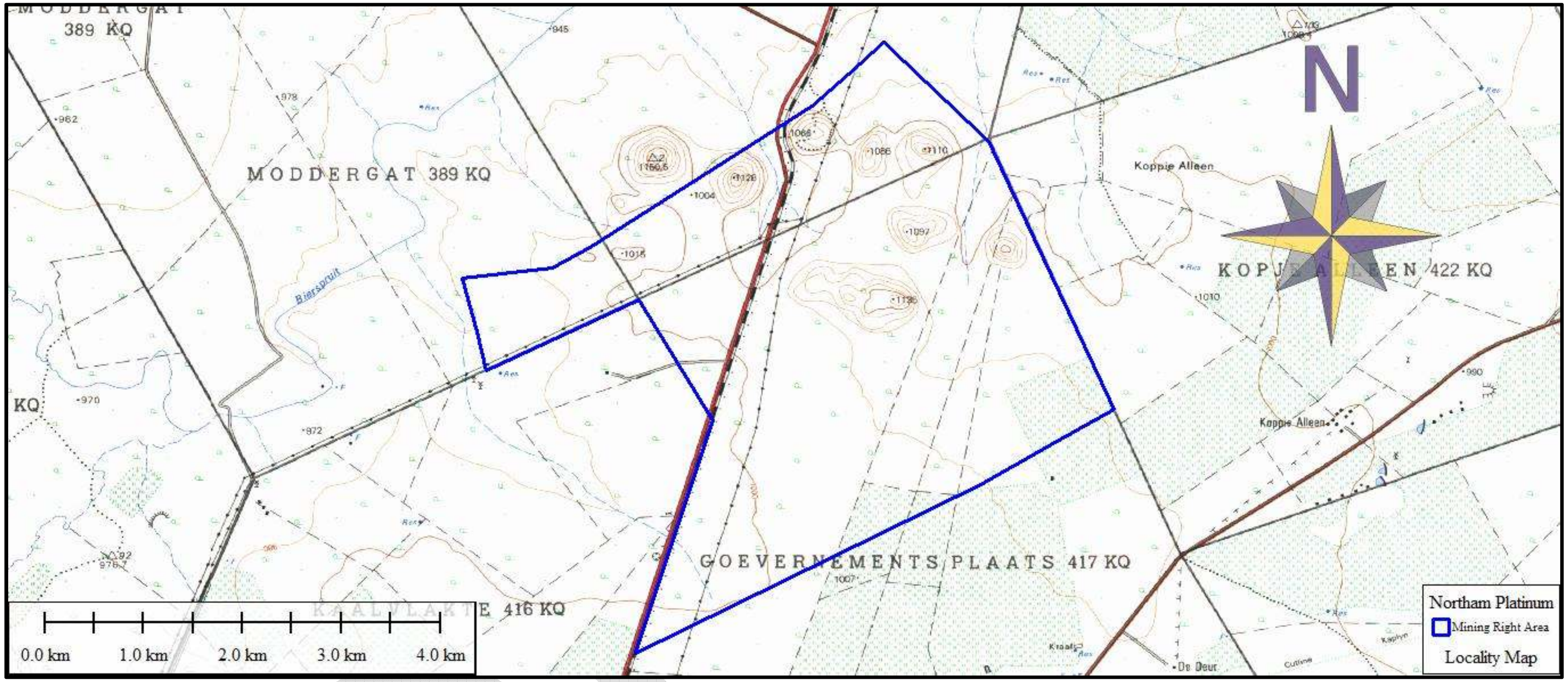

Figure 2: Regional locality map (1:50 000 topographical map).

Figure 3: Satellite image indicating the study area in blue (Google Earth 2017).

2 LEGISLATIVE REQUIREMENTS

The HIA, as a specialist sub-section of the EIA, is required under the following legislation:

- National Heritage Resources Act (NHRA), Act No. 25 of 1999)
- National Environmental Management Act (NEMA), Act No. 107 of 1998 - Section 23(2)(b)
- Mineral and Petroleum Resources Development Act (MPRDA), Act No. 28 of 2002 - Section 39(3)(b)(iii)

A Phase 1 HIA is a pre-requisite for development in South Africa as prescribed by SAHRA and stipulated by legislation. The overall purpose of specialist input is to:

- Identify any heritage resources, which may be affected;
- Assess the nature and degree of significance of such resources;
- Establish heritage informants/constraints to guide the development process through establishing thresholds of impact significance;
- Assess the negative and positive impact of the activities/development on these resources; and
- Make recommendations for the appropriate heritage management of these impacts.

The HIA should be submitted, as part of the impact assessment report or EMPr, to the PHRA if established in the province or to SAHRA. SAHRA will ultimately be responsible for the professional evaluation of Phase 1 reports upon which review comments will be issued. 'Best practice' requires Phase 1 reports and additional development information, as per the impact assessment report and/or EMPr, to be submitted in duplicate to SAHRA after completion of the study. SAHRA accepts Phase 1 AIA reports authored by professional archaeologists, accredited with ASAPA or with a proven ability to do archaeological work.

Minimum accreditation requirements include an Honours degree in Archaeology or related discipline and 3 years post-university CRM experience (field supervisor level). Minimum standards for reports, site documentation and descriptions are set by ASAPA in collaboration with SAHRA. ASAPA is based in South Africa, representing professional archaeology in the SADC region. ASAPA is primarily involved in the overseeing of ethical practice and standards regarding the archaeological profession. Membership is based on proposal and secondment by other professional members.

Phase 1 AIA's are primarily concerned with the location and identification of heritage sites situated within a proposed development area. Identified sites should be assessed according to their significance. Relevant conservation or Phase 2 mitigation recommendations should be made. Recommendations are subject to evaluation by SAHRA.

Conservation or Phase 2 mitigation recommendations, as approved by SAHRA, are to be used as guidelines in the developer's decision-making process. Phase 2 archaeological projects are primarily based on salvage/mitigation excavations preceding development destruction or impact on a site. Phase 2 excavations can only be conducted with a permit, issued by SAHRA to the appointed archaeologist. Permit conditions are prescribed by SAHRA and includes (as minimum requirements) reporting back strategies to SAHRA and deposition of excavated material at an accredited repository.

In the event of a site conservation option being preferred by the developer, a site management plan, prepared by a professional archaeologist and approved by SAHRA, will suffice as minimum requirement.

After mitigation of a site, a destruction permit must be applied for with SAHRA by the applicant before the proposed activities may proceed.

Human remains older than 60 years are protected by the NHRA, with reference to Section 36. Graves older than 60 years, but younger than 100 years fall under Section 36 of NHRA, as well as the HTA, and are the jurisdiction of SAHRA. The procedure for Consultation Regarding Burial Grounds and Graves

(Section 36(5)) of Act 25 of 1999) is applicable to graves older than 60 years that are situated outside a formal cemetery administrated by a local authority. Graves in this age category, located inside a formal cemetery administrated by a local authority, require the same authorisation as set out for graves younger than 60 years, in addition to SAHRA authorisation. If the grave is not situated inside a formal cemetery, but is to be relocated to one, permission from the local authority is required and all regulations, laws and by-laws, set by the cemetery authority, must be adhered to.

Human remains that are less than 60 years old are protected under Section 2(1) of the Removal of Graves and Dead Bodies Ordinance (Ordinance No. 7 of 1925), as well as the HTA, and are the jurisdiction of the National Department of Health and the relevant Provincial Department of Health and must be submitted for final approval to the office of the relevant Provincial Premier. This function is usually delegated to the Provincial MEC for Local Government and Planning; or in some cases, the MEC for Housing and Welfare. Authorisation for exhumation and reinternment must also be obtained from the relevant local or regional council where the grave is situated, as well as the relevant local or regional council to where the grave is being relocated. All local and regional provisions, laws and by-laws must also be adhered to. To handle and transport human remains, the institution conducting the relocation should be authorised under Section 24 of HTA.

3 METHODOLOGY

3.1 Literature Review

A brief survey of available literature was conducted to extract data and information on the area in question to provide general heritage context into which the activities would be set. This literature search included published material, unpublished commercial reports and online material, including reports sourced from the South African Heritage Resources Information System (SAHRIS).

3.2 Genealogical Society and Google Earth Monuments

Google Earth and 1:50 000 maps of the area were utilised to identify possible places where sites of heritage significance might be located; these locations were marked and visited during the field work phase. The database of the Genealogical Society was consulted to collect data on any known graves in the area.

3.3 Public Consultation and Stakeholder Engagement

Stakeholder engagement is a key component of any BAR process, it involves stakeholders interested in, or affected by the proposed activities. Stakeholders are provided with an opportunity to raise issues of concern (for the purposes of this report only heritage related issues will be included). The aim of the public consultation process was to capture and address any issues raised by community members and other stakeholders during key stakeholder and public meetings. The process involved:

- Placement of advertisements and site notices
- Stakeholder notification (through the dissemination of information and meeting invitations)
- Stakeholder meetings undertaken with I&APs
- Authority Consultation
- The compilation of a Basic Assessment Report (BAR)
- The compilation of a Comments and Response Report (CRR)

3.4 Site Investigation

A high-level field survey of portions of the study area was conducted and the results of previous surveys were used to inform the results of this report.

Table 4: Site Investigation Details.

	Site Investigation
Date	2016 & 2017
Season	Early Winter – vegetation in the study area is relatively low and archaeological visibility is high.

3.5 Site Significance and Field Rating

Section 3 of the NHRA distinguishes nine criteria for places and objects to qualify as 'part of the national estate' if they have cultural significance or other special value. These criteria are:

- Its importance in/to the community, or pattern of South Africa's history
- Its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
- Its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage
- Its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects
- Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group
- Its importance in demonstrating a high degree of creative or technical achievement at a particular period
- Its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons
- Its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa
- Sites of significance relating to the history of slavery in South Africa.

The presence and distribution of heritage resources define a 'heritage landscape'. In this landscape, every site is relevant. In addition, because heritage resources are non-renewable, heritage surveys need to investigate an entire project area, or a representative sample, depending on the nature of the project. In the case of the proposed project the local extent of its impact necessitates a representative sample and only the footprint of the Extended Mining Right Area were surveyed. In all initial investigations, however, the specialists are responsible only for the identification of resources visible on the surface. This section describes the evaluation criteria used for determining the significance of archaeological and heritage sites. The following criteria were used to establish site significance with cognisance of Section 3 of the NHRA:

- The unique nature of a site
- The integrity of the archaeological/cultural heritage deposits
- The wider historic, archaeological and geographic context of the site
- The location of the site in relation to other similar sites or features
- The depth of the archaeological deposit (when it can be determined/is known)
- The preservation condition of the sites
- Potential to answer present research questions

In addition to this criteria field ratings prescribed by SAHRA (2006), and acknowledged by ASAPA for the SADC region, were used for the purpose of this report. The recommendations for each site should be read in conjunction with Section 10 of this report.

Table 5: Field Ratings

FIELD RATING	*GRADE*	*SIGNIFICANCE*	*RECOMMENDED MITIGATION*
National Significance (NS)	Grade 1	-	Conservation; national site nomination
Provincial Significance (PS)	Grade 2	-	Conservation; provincial site nomination
Local Significance (LS)	Grade 3A	High significance	Conservation; mitigation not advised
Local Significance (LS)	Grade 3B	High significance	Mitigation (part of site should be retained)
Generally Protected A (GP.A)	-	High/medium significance	Mitigation before destruction
Generally Protected B (GP.B)	-	Medium significance	Recording before destruction
Generally Protected C (GP.C)	-	Low significance	Destruction

3.6 Impact Assessment Methodology

The criteria below are used to establish the impact rating on sites:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the Extended Mining Right Area) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high)
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0-1 years), assigned a score of 1
  - the lifetime of the impact will be of a short duration (2-5 years), assigned a score of 2
  - medium-term (5-15 years), assigned a score of 3
  - long term (> 15 years), assigned a score of 4
  - permanent, assigned a score of 5
- The **magnitude**, quantified on a scale from 0-10 where; 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability of occurrence**, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1-5 where; 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- **The significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and

- the status, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the degree to which the impact can be mitigated.

The **significance** is calculated by combining the criteria in the following formula:
S=(E+D+M)P
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e., where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e., where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- 60 points: High (i.e., where the impact must have an influence on the decision process to develop in the area).

3.7 Limitations and Constraints of the Study

The authors acknowledge that the brief literature review is not exhaustive on the literature of the area. Due to the high-level scan and subsurface nature of archaeological artefacts, the possibility exists that some features or artefacts may not have been discovered/recorded during the survey and the possible occurrence of unmarked graves and other cultural material cannot be excluded. Similarly, the depth of the deposit of heritage sites cannot be accurately determined due its subsurface nature. This report only deals with the footprint area of the proposed activities mostly based on a desktop assessment. This study did not assess the impact on medicinal plants and intangible heritage as it is assumed that these components would have been highlighted through the public consultation process if relevant. It is possible that new information could come to light in future, which might change the results of this Impact Assessment.

4 DESCRIPTION OF SOCIO ECONOMIC ENVIRONMENT

The Thabazimbi IDP indicates that "*Thabazimbi lies within the southern African bushveld eco region of Limpopo, renowned for cattle ranching and game farming. Platinum and iron ore mining are major contributors to the economy of the region. The total area of the Thabazimbi Local Municipality is approximately 986 264.85 ha. It consists mainly of commercial farms, game farming, etc. but a few towns and informal settlements are found in the area. There are no former homeland areas located within the municipal area*." The unemployment rate is at around 20%.

5 DESCRIPTION OF THE PHYSICAL ENVIRONMENT

The topography of the area is relatively flat characterised by deep turf and sandy soils. The study area falls within a Savannah Biome with the bioregion described by Mucina *et al* (2006) as the Central Bushveld Bioregion with the vegetation described as Dwaalboom Thornveld. Land use in the general area is characterized by mining and agriculture, dominated by game and cattle farming as well as chrome mines. Several small hills occur in the study area that would have been focal points in antiquity.

6 RESULTS OF PUBLIC CONSULTATION AND STAKEHOLDER ENGAGEMENT

Adjacent landowners and the public at large were informed of the proposed activity as part of the EIA process. Site notices and advertisements notifying interested and affected parties were placed at strategic points and in local newspapers as part of the process.

7 LITERATURE / BACKGROUND STUDY

7.1 Literature Review

On the 1.50 000 map sheet 2427 CD several sites are on record for the larger study area at the Wits Archaeological database consisting of historic and LIA (Moloko) sites. Several previous CRM surveys are on record for the larger study area e.g. van Schalkwyk (2004), Huffman (2006) and van der Walt (2009; 2014 and 2016).

Mitigation conducted in the study area by the National Cultural History Museum on the farm Elandsfontein 386 KQ, Amandelbult Platinum Mine (van Schalkwyk 2004) included the survey and mapping of sites in and around the Madeleine Robinson Nature Reserve of the Amandelbult Platinum Mine as part of the proposed extension of the mines operations into the area. From the survey, several stone walled sites conforming to the CCP were identified along the base and between the saddles of the hills. Sites contained central kraals, smaller livestock enclosures, lower grindstones and ceramic scatters. These sites form part of a larger settlement complex dating to the Later Iron Age.

Mitigation of the Rhino Andalusite Mine by Archaeological Resources Management (ARM) (Huffman 2006) to the north of the study area resulted in excavation and recording of several Early and Late Iron Age sites. Specifically, the Happy Rest and Mzonjani facies (EIA) and the Icon and Madikwe facies of the Moloko group (LIA) have been identified. Additionally, ancient mine workings for ochre have been identified. A Survey for the Cronimet Underground Mine and Process Plant (van der Walt & du Piesanie 2009) recorded 37 sites ranging from historic dwellings, graves, MSA and Iron Age sites. Some of these are located within the current study area.

7.1.1 Genealogical Society and Google Earth Monuments

No cemeteries have been identified for the area under investigation.

7.2 General History of the Area

7.2.1 Archaeology of the Area

South Africa has one of the longest archaeological sequences in the world because humanity evolved in the area stretching from the Cape to Ethiopia. Most of this sequence covers the times when our ancestors used stone tools. It is worthwhile, thus, to review the archaeological record for southern Africa and to place in context the known occurrences. The archaeology of the area can be divided into the Stone Age, Iron Age and Historical timeframe. These can be divided as follows:

7.2.1.1 Stone Age

South Africa has a long and complex Stone Age sequence of more than 2 million years. The broad sequence includes the Later Stone Age, the Middle Stone Age and the Earlier Stone Age. Each of these phases contains sub-phases or industrial complexes, and within these we can expect regional variation regarding characteristics and time ranges. For Cultural Resources Management (CRM) purposes it is often only expected or possible to identify the presence of the three main phases. Yet sometimes the recognition of cultural groups, affinities or trends in technology and/or subsistence practices, as represented by the sub-phases or industrial complexes, is achievable (Lombard 2011). The three main phases can be divided as follows;

- Later Stone Age; associated with Khoi and San societies and their immediate predecessors. Recently to ~30 thousand years ago.
- Middle Stone Age; associated with Homo sapiens and archaic modern humans. 30-300 thousand years ago.

- Earlier Stone Age; associated with early Homo groups such as Homo habilis and Homo erectus. 400 000-> 2 million years ago.

Early Stone Age

The Early Stone Age in Southern Africa is defined by the Oldowan complex, primarily found at the sites Sterkfontein, Swartkrans and Kromdraai, situated within the Cradle of Humankind, just outside Johannesburg (Kuman, 1998). Within this complex, tools are more casual and expediently made and tools consist of rough cobble cores and simple flakes. The flakes were used for such activities as skinning and cutting meat from scavenged animals. This industry is unlikely to occur in the study area.

The second complex is that of the more common Acheulean, defined by large handaxes and cleavers produced by hominids at about 1.4 million years ago (Deacon & Deacon, 1999). Among other things these Acheulian tools were probably used to butcher large animals such as elephants, rhinoceros and hippopotamus that had died from natural causes. Acheulian artefacts are usually found near the raw material from where they were quarried, at butchering sites, or as isolated finds. No Acheulian sites are on record near the project area, but isolated finds are possible. However, isolated finds have little value. Therefore, the project is unlikely to disturb a significant site.

Middle Stone Age

During the Middle Stone Age, significant changes start to occur in the evolution of the human species. These changes manifest themselves in the complexity of the stone tools created, as seen in the diversity of tools, the standardisation of these tools over a wide spread area, the introduction of blade technology, and the development of ornaments and art. What these concepts ultimately attest to is an increase or development of abstract thinking. By the beginning of the Middle Stone Age (MSA), tool kits included prepared cores, parallel-sided blades and triangular points hafted to make spears (Volman, 1984). MSA people had become accomplished hunters by this time, especially of large grazing animals such as wildebeest, hartebeest and eland.

These hunters are classified as early humans, but by 100,000 years ago, they were anatomically fully modern. The oldest evidence for this change has been found in South Africa, and it is an important point in debates about the origins of modern humanity. In particular, the degree to which behaviour was fully modern is still a matter of debate. The repeated use of caves indicates that MSA people had developed the concept of a home base and that they could make fire. These were two important steps in cultural evolution (Deacon & Deacon, 1999). Accordingly, if there are caves in the study area, they may be sites of archaeological significance. MSA artefacts are common throughout Southern Africa, but unless they occur in undisturbed deposits, they have little significance. Some MSA sites are on record close to the Mining Right Area.

Later Stone Age

By the Late Stone Age, human beings are anatomically and culturally modern. Tools associated with this time period are specialised, and commonly associated with hunter-gatherer groups. It is also within this period that contacts with migrating groups occur throughout southern Africa. Initial contact was between hunter-gatherer groups and expanding Bantu farming societies, and secondly with the arrival of colonist along the coast.

San rock art has a well-earned reputation for aesthetic appeal and symbolic complexity (Lewis-Williams, 1981). Several rock art sites are on record to the north and east of the general project area.

In addition to art, LSA sites contain diagnostic artefacts, including microlithic scrapers and segments made from very fine-grained rock (Wadley, 1987). Spear hunting probably continued, but LSA people also hunted small game with bows and poisoned arrows. Sites in the open are usually poorly preserved and therefore have less value than sites in caves or rock shelters. If there are rock shelters or caves in the Extended Mining Right Area, they may contain LSA sites of significance. The closest Stone Age terrain to the

Extended Mining Right Area is located a small distance to the west thereof. This Early Stone Age terrain is situated near the Rooiberg Hill and the Blaauwberg Stone Age Terrain (Bergh 1999: 4).

7.2.1.2 Iron Age (General)

The Iron Age as a whole represents the spread of Bantu speaking people and includes both the pre-Historic and Historic periods. It can be divided into three distinct periods:

- The Early Iron Age: Most of the first millennium AD
- The Middle Iron Age: 10th to 13th centuries AD
- The Late Iron Age: 14th century to colonial period

The Iron Age is characterised by the ability of these early people to manipulate and work Iron ore into implements that assisted them in creating a favourable environment to make a better living.

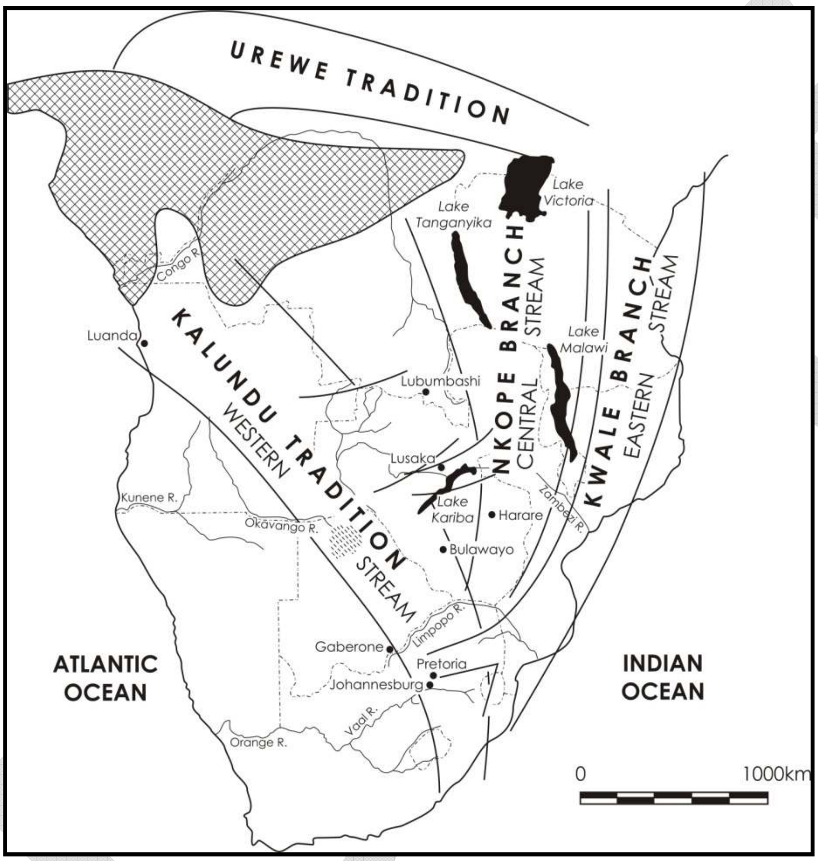

Figure 4: Movement of Bantu speaking farmers (Huffman 2007)

Early Iron Age

Early in the first millennium AD, there seem to be a significant change in the archaeological record of the greater part of eastern and Southern Africa lying between the equator and Natal. This change is marked by the appearance of a characteristic ceramic style that belongs to a single stylistic tradition. These Early Iron Age people practised a mixed farming economy and had the technology to work metals like iron and copper. A meaningful interpretation of the Early Iron Age has been hampered by the uneven distribution of research conducted so far; this can be partly attributed to the poor preservation of these early sites.

Sites belonging to the EIA consisting of *Happy Rest and Mzonjani facies* have been recorded to the north of the project area. Happy Rest and Mzonjani pottery form part of two traditions (Kalundu and Urewe) that represent the spread of mixed farmers into southern Africa during the Early Iron Age (See Figure 4). This find is important as it provides evidence for early interaction between these groups. Later, by the 8th and 9th centuries, the two merged to form a new facies, *Doornkop*.

Middle Iron Age
No sites dating to this period are on record close to the Extended Mining Right Area.

Late Iron Age
For the area in question the history and archaeology of the Sotho Tswana are of interest. The ceramic sequence for the Sotho Tswana is referred to as Moloko and consists of different facies with origins in either the Icon facies or a different branch associated with Nguni speakers. Several sites belonging to the Madikwe and Olifantspoort facies (from Icon) have been recorded close to the project area. These sites date to between AD 1500 and 1700 and predate stone walling ascribed to Sotho-Tswana speakers. Sotho Tswana stonewalled sites with Uitkomst pottery have been found close to the study area and dates to the seventeenth to nineteenth centuries. Stone walled sites belonging to the LIA have also been identified next to the Extended Mining Right Area but so far have not been linked to a cultural group.

Late Iron Age peoples were attracted to the area because of the relatively fertile soils around the hills and valleys, and because of the iron ore and red ochre. Mining techniques associated with the ancient mine workings are the same as those found in the Rooiberg area some 30km from Thabazimbi (Huffman 2006). Three groups are found in the Rooiberg area, specifically Madikwe, Melora and Rooiberg groups. Stratigraphically, the relationship between Madikwe and Rooiberg is evident where the Madikwe site 20/85 lies underneath the Rooiberg site 11/85, suggesting that Rooiberg is the more recent (Mason 1986). Ceramic evidence suggests then that at one time Sotho-Tswana people were mining at Rooiberg. The ceramic evidence from the Rhino Andalusite Mine shows that the Sotho-Tswana people living there were directly related to the miners at Rooiberg: both belonged to the Western Sotho-Tswana cluster. Therefore, the relationship, between the ochre mine and Madikwe settlements, is of importance. Associated with the Madikwe settlements, in addition to the ochre mine is the several maize grindstones found.

Trade connections for ochre and tin have a bearing on the presence of maize. Trade networks spanned a wide area, up to the Zimbabwe culture area in the north, and as far as Maputo in the east before the arrival of the Dutch (Friede & Steel 1976). Maize came to Maputo sometime after the early 16th century through Portuguese trade with the New World. The grindstones found at the site CB14 in the Rhino Andalusite Mine indicate that maize was grown in the Thabazimbi area during the 17th century (Huffman 2006). If one accepts the grindstone as diagnostic, then maize was cultivated some 150 years earlier than in KwaZulu-Natal.

Evidence for Iron Age activity will most likely be concentrated along water courses and rocky outcrops marked by ceramic clusters or dry-stone walling and similar sites are expected within the mining right area.

7.3 Historical Background

The historic timeframe sometimes intermingles with the later parts of the Stone and Iron Age, and can loosely be regarded as times when written and oral accounts of incidents became available.

Since the mid 1800's up until the present, South Africa had been classified into various different districts. In 1848, farms in the study area would have been located in the Soutpansberg District. Since 1851, however, the farm area formed part of the Rustenburg District. This remained the case up until 1977, when the country was subdivided into various smaller Magisterial Districts. The study area fell under the authority of the Thabazimbi Magisterial District. This still remains the case today (Bergh 1999: 17-27).

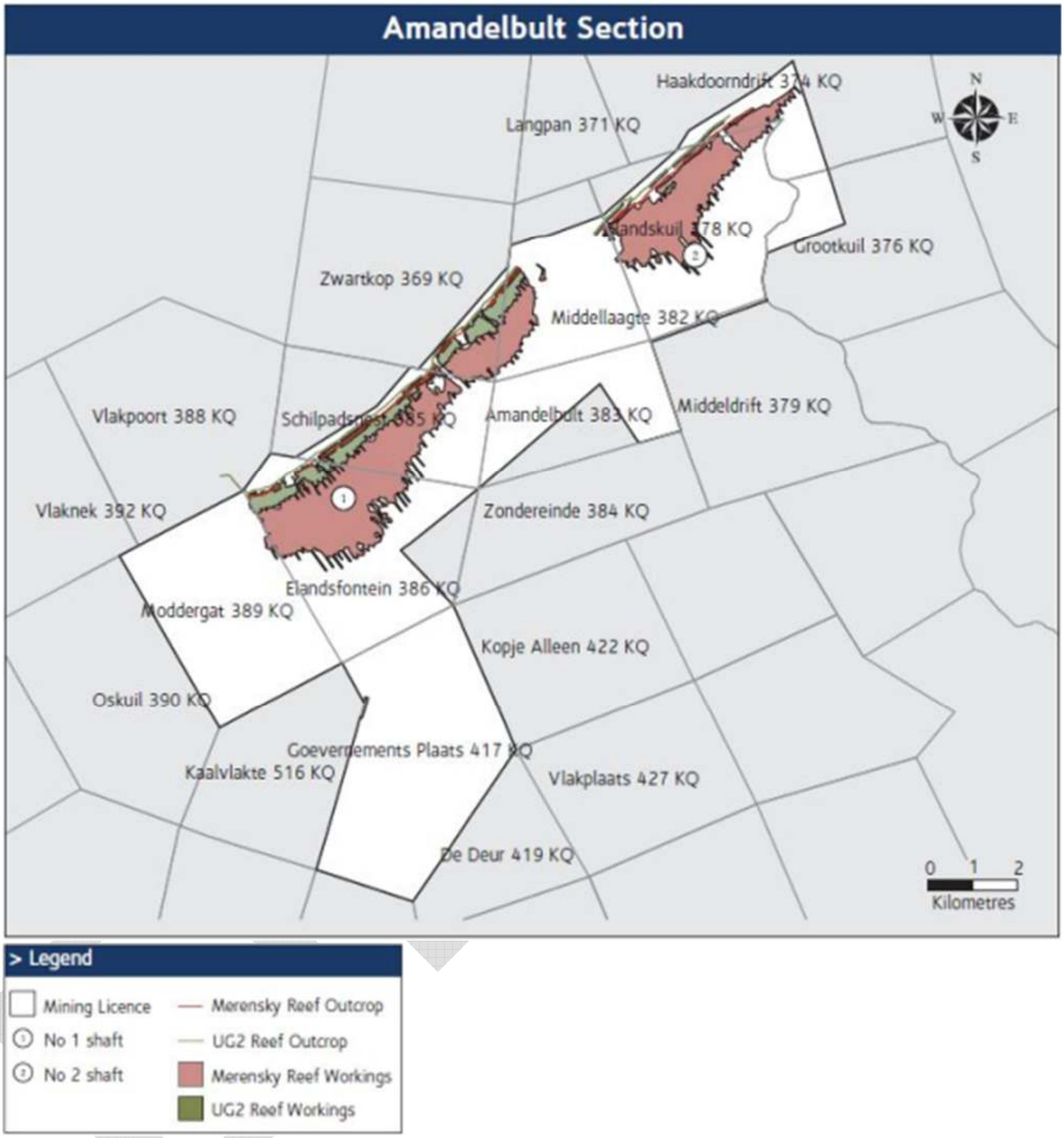

Figure 5: Anglo Platinum Map showing present-day mining activities on Elandsfontein and Goverments Plaats. (Anglo Platinum 2011).

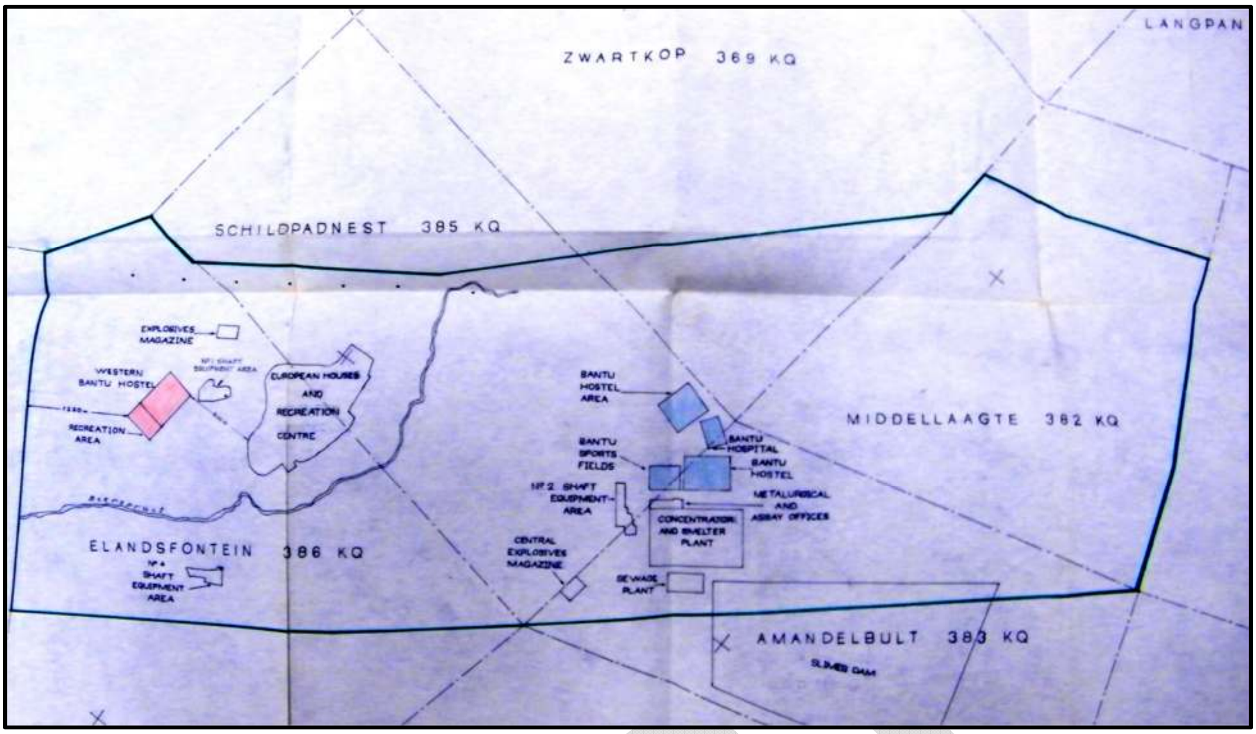

Figure 6: Map of the farm Elandsfontein 366 KQ and the proposed black residential developments thereon (National Archives of South Africa, 1973).

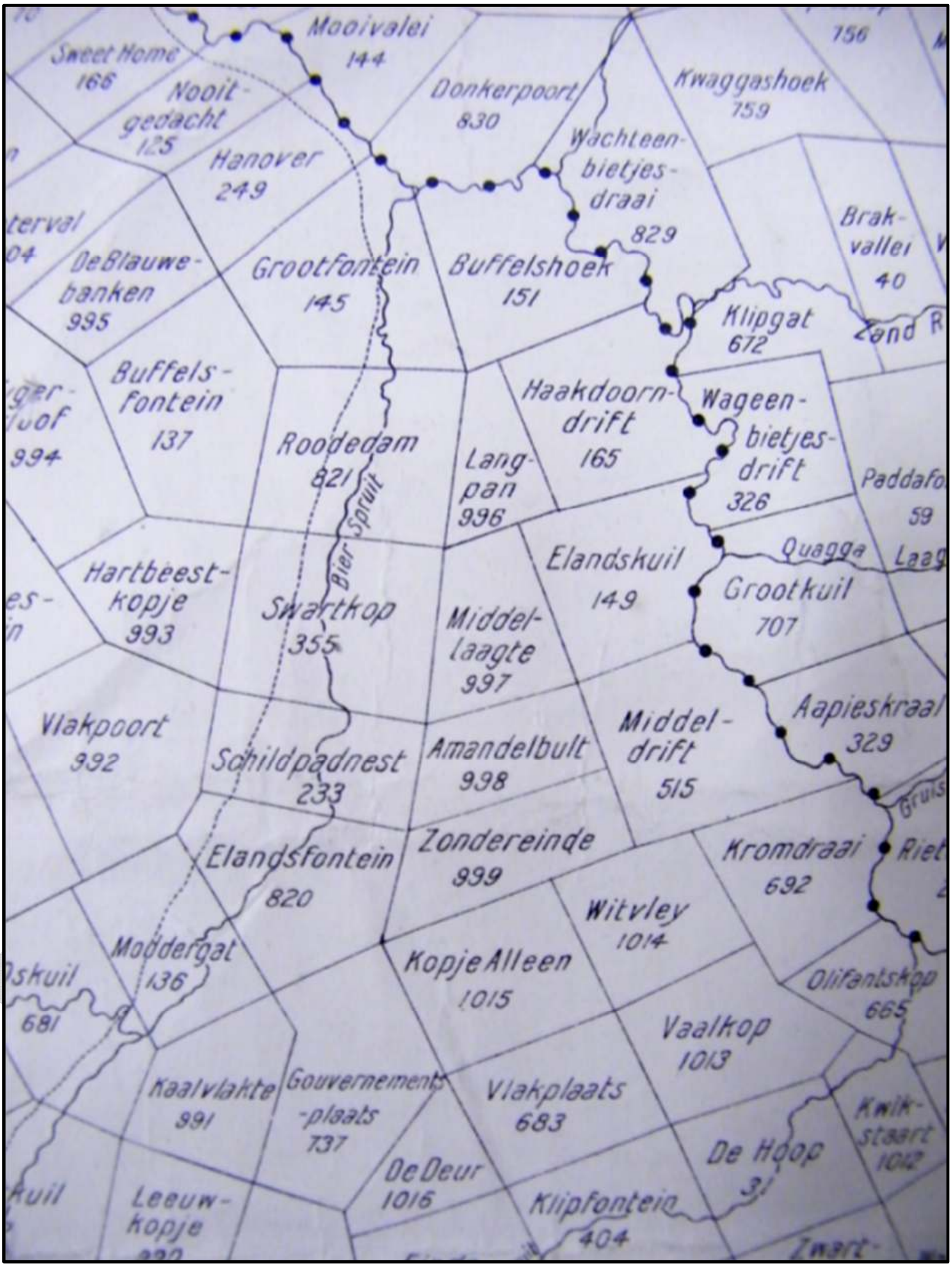

Figure 7: 1921 Rustenburg Magisterial Map, indicating the location of Elandsfontein, Moddergat and Government Plaats then known as Gouvernements-plaats and its neighbouring farms. (National Archives of South Africa, 1921).

7.4 A Brief History of the General Study Area

The general study area includes the Extended Mining Right Area as well as the surrounding area. J. S. Bergh's historical atlas of the four northern provinces of South Africa is a very useful source for the writing of local and regional histories. It seems that, by the start of the nineteenth century, the predominant black community living in the area was the Kgatla (Bergh, 1999: 11). In a few decades, however, the sociographic nature of the then Transvaal province would change forever. The Difaqane (Sotho), or Mfekane ("the crushing" in Nguni) was a time of bloody upheavals in Natal and on the Highveld, which occurred around the early 1820's until the late 1830's. (Bergh, 1999: 109-115). It came about in response to heightened competition for land and trade, and caused population groups like gun-carrying Griquas and Shaka's Zulus to attack other tribes (Bergh, 1999: 14; 116-119). Whereas several tribes were scattered and displaced from their original residences, the Kgatla still inhabit this part of the country today. Though especially the Ndebele of Mzilikazi troubled this tribe during the Difaqane, these people mostly returned to their original settlements after this time of upheaval. The areas settled by the Kgatla included the land to the north of Pretoria in the area of the Crocodile-, Pienaars- and Apies Rivers; the Magaliesberg Mountain; the area of the present-day Brits, Rustenburg, Warmbad (Bela Bela), Nylstroom (Modimolle); as well as the Pilanesberg and the Waterberg areas. The specific Kgatla community that lived in the Rustenburg district, and possibly in the study area, was the Modimosana ba Maake-Kwena under Kgaswane and the Modimosana ba Matlhaku-Kwena of Madintsi (Bergh, 1999: 106).

During the time of the Difaqane, a northwards migration of white settlers from the Cape was also taking place. Some travellers, missionaries and adventurers had gone on expeditions to the northern areas in South Africa – some as early as in the 1720's. A year after the second British occupation of the Cape in 1806, a number of white travellers with official authorization ventured northward with the intention of reaching Delagoa Bay by land. This expedition was led by Dr Andrew Cowan and Lieutenant Donovan. These travellers passed close by the area where the study area is located in 1808. The entire party however disappeared, and it is believed that they either perished from fever or at the hand of black tribes (Bergh, 1999: 12, 117). From the 1830's onward, a number of other adventurers also passed through or close by the area. These were Hume (1930), Harris (1836) and Livingstone (1847). (Bergh, 1999: 13) David Hume, a Scottish trader, advanced to the north of the Limpopo into the inland. It is possible that he was the first European person to travel this far north in South Africa. (Bergh, 1999: 120) The flamboyant British officer, Captain William Cornwallis Harris, left Port Elizabeth in 1836 on a hunting expedition to the northern provinces. He was accompanied by a friend, William Richardson, and a number of servants. These travellers managed to meet the Ndebele chief, Mzilikazi, during their travels. Harris is well known for his descriptions and sketches of wild animals that he saw during his journey. David Livingstone is very well known, and he did not only travel in South Africa, but also deep into mid Africa. Livingstone arrived in Kuruman in 1841 as a missionary of the London Mission Society. In the following years, he undertook various travels in the northern provinces, establishing mission stations where he went. (Bergh, 1999: 122-123).

By the late 1820's, a mass-movement of Dutch speaking people in the Cape Colony started advancing into the northern areas. This was due to feelings of mounting dissatisfaction caused by economical and other circumstances in the Cape. This movement later became known as the Great Trek. This migration resulted in a massive increase in the extent of that proportion of modern South Africa dominated by people of European descent. (Ross, 2002: 39) These Dutch settlers allocated farms in the greater study darea during the 1940s. (Bergh, 1999: 15) It therefore is possible that the farms may date back to the middle of the 19th century (Bergh, 1999: 15). The district of Waterberg was established in 1866 (Bergh, 1999: 139). This indicates that there must have been enough people to make the establishment of a district a viable option.

As can be expected, the movement of whites into the northern provinces would have a significant impact on the black people who populated the land. This was also the case in Limpopo, the then Northern Transvaal area. By 1860, the population of whites in the central Transvaal was already very dense and the administrative machinery of their leaders was firmly in place. Many of the policies that would later be entrenched as legislation during the period of apartheid had already been developed (Bergh, 1999: 170).

Much can be said about the systematic oppression of black people in South Africa. In 1904 about a half of the black population in the Transvaal was living on private land, owned by whites or companies. According to the Squatters' Law of 1895, no more than five families of "natives" could live on any farm or divided portion of a farm, without special permission of the Government in the Transvaal. (Massie 1905: 97) In Bergh's source, one can see a map indicating the areas where blacks had settled by 1904. It is interesting that there were a number of private farms owned by blacks in the vicinity of the study area by 1904. (Bergh 1999: 41) The 1913 and 1936 Acts concerning the establishment of black "homelands" however delimited areas of land that were located to the southeast and southwest of the greater study area. This land, including other portions of land, collectively became known as Bophuthatswana (Bergh, 1999: 42-43).

8 Findings of the Survey

The Extended Mining Right Area is known to contain several stone walled sites conforming to the CCP along the base and between the saddles of the hills. These sites consist of central kraals, smaller livestock enclosures, lower grindstones and ceramic scatters. These sites form part of a larger settlement complex dating to the Later Iron Age and are expected around hills (Figure 8).

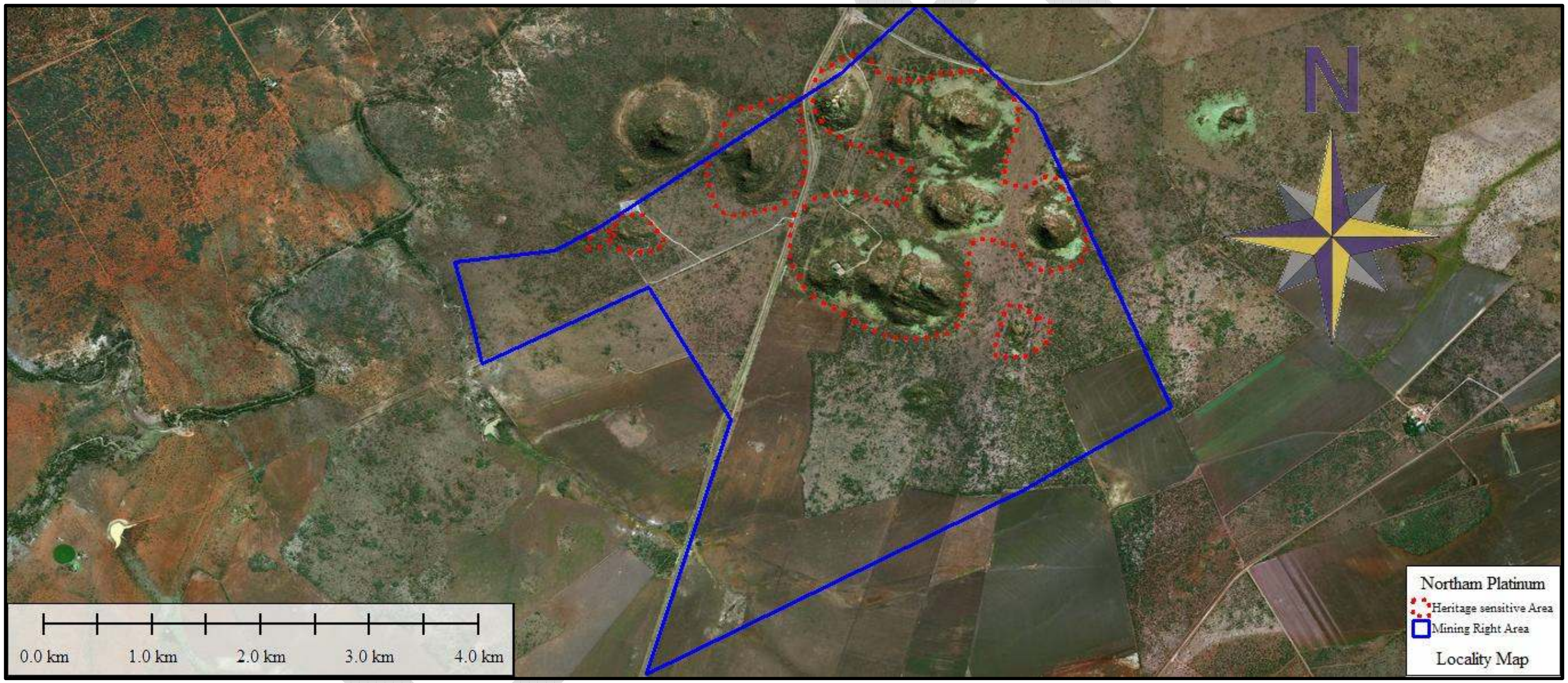

Figure 8: Heritage sensitive areas.

8.1 Built Environment (Section 34 of the NHRA)

Based on aerial imagery and topographic maps of the area no standing structures older than 60 years occur within the Extended Mining Right Area.

8.2 Archaeological and palaeontological resources (Section 35 of the NHRA)

Stone Age artefacts are found scattered over the study area with higher frequencies of artefacts found around small hills and rocky outcrops. Due to sheet erosion, the artefacts are weathered and badly preserved. Diagnostic features on the tools consist of facets on the striking platform indicating Middle Stone Age occupation. Raw material consists of igneous rock, Hornfels and possibly Silcrete.

Figure 9. Example of tools found in the area.

All the sites found in the area are associated with the Later Iron Age. Decorated ceramics found represent stamped ware and could possibly be related to the Rooiberg facies, but a bigger ceramic sample is needed to confirm this. The sites are important because of the alternative stone walled settlement layout. The sites consist of several kraals clustered together without an outer wall. These sites have research potential that could clarify the new stone walled arrangement represented here that has not yet been identified and could hold clues to the interaction between the Uitkoms ceramic facies and Madikwe that formed Rooiberg.

Figure 10: Example of stone walled sites in the study area.

Based on the SAHRIS Paleontological Sensitivity Map (Figure 11) the area is of insignificant paleontological significance.

Figure 11: Study area located in an area of low significance on the SAHRIS Paleontological Map.

8.3 Burial Grounds and Graves (Section 36 of the NHRA)

In terms of Section 36 of the Act burial sites is expected anywhere on the landscape and they should ideally be preserved *in-situ* or alternatively relocated according to existing legislation.

8.4 Cultural Landscapes, Intangible and Living Heritage

Long term impact on the cultural landscape is considered to be negligible as the surrounding area consists of an area extensively mined. As this is an underground mine, visual impacts to scenic routes and sense of place are also considered to be low.

8.5 Battlefields and Concentration Camps

There are no battlefields or related concentration camp sites located in the study area.

8.6 Potential Impact

The chances of impacting unknown archaeological sites in the study area are considered to be negligible as this an underground mine. Any direct impacts that did occur would be on the surface and can be mitigated. Cumulative impacts occur from the combination of effects of various impacts on heritage resources. The importance of identifying and assessing cumulative impacts is that the whole is greater than the sum of its parts. In the case of the underground mine it will not impact any heritage resources directly.

8.6.1 Pre-Construction phase

Because this is an underground mine it is assumed that the pre-construction phase will not impact on any surface features.

8.6.2 Construction Phase

During this phase, the impacts and effects are similar in nature but more extensive than the pre-construction phase. Again, it is assumed that the pre-construction phase will not impact on any surface features.

8.6.3 Operation Phase

No impact is envisaged for heritage resources during this phase.

Table 6: Impact of the project on heritage resources.

Nature: During the construction phase activities resulting in disturbance of surfaces and/or sub-surfaces may destroy, damage, alter, or remove from its original position archaeological material or objects. As this is an underground mine no impact is foreseen on heritage resources.		
	Without Mitigation	**With Mitigation (Preservation/ excavation of site)**
Extent	Local (3)	Local (3)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (2)	Low (2)
Probability	Not Probable (2)	Not probable (2)
Significance	**20 (Low)**	**20 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Not reversible	Not reversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes, all surface developments must be subjected to an HIA.	Yes

Mitigation: Surface infrastructure developments must be subjected to an HIA.
Cumulative Impacts: Due to the lack of apparent significant heritage resources and the fact that the entire development will be conducted underground cumulative impacts are considered to be low.
Residual Impacts: If any sites are destroyed this results in the depletion of archaeological record of the area. However, if sites are recorded and preserved or mitigated this adds to the record of the area.

9 Recommendations and Conclusion

The study area is known to contain several stone walled sites conforming to the CCP along the base and between the saddles of the hills. These sites consist of central kraals, smaller livestock enclosures, lower grindstones and ceramic scatters. These sites form part of a larger settlement complex dating to the Later Iron Age. Middle Stone Age artefacts are found scattered over the study area with higher frequencies of artefacts found around small hills and rocky outcrops. As this is an underground mine no impact is foreseen on surface indicators of heritage sites. The SAHRIS Paleontological Sensitivity Map indicate that the area is of insignificant paleontological significance. Therefore, no further mitigation prior to construction is recommended in terms of Section 35 for the proposed activities to proceed.

Similarly, no impact is foreseen on the built environment or on burial sites as the proposed activities consist of an underground mine with no surface infrastructure and impacts. No public monuments are located within or close to the study area. The proposed Extended Mining Right Area is surrounded by mining developments and road infrastructure developments and the proposed activities will not impact negatively on significant cultural landscapes or viewscapes.

As this is an underground mine with no surface impacts the impact of the proposed Extended Mining Right Area on heritage resources is considered low and it is recommended that the proposed project can commence on the condition that the following recommendations are implemented as part of the EMPr and based on approval from SAHRA. Any surface infrastructure will have to be subjected to a Heritage Impact Assessment.

9.1 Reasoned Opinion

From a heritage perspective, the proposed activities are acceptable, if the above recommendations are adhered to and based on approval from SAHRA, HCAC is of the opinion that the development can continue as the proposed activities will not impact negatively on the heritage record of the area. If during the pre-construction phase or during construction, any archaeological findings are made (e.g. graves, stone tools, and skeletal material), the operations must cease immediately, and the archaeologist must be contacted for an assessment of the finds. Due to the subsurface nature of archaeological material and graves the possibility of the occurrence of unmarked or informal graves and subsurface finds cannot be excluded.

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11 Appendices

Curriculum Vitae of Specialist

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Education:

Particulars of degrees/diplomas and/or other qualifications:

Name of University or Institution:		University of Pretoria
Degree obtained	:	BA Heritage Tourism & Archaeology
Year of graduation	:	2001
Name of University or Institution:		University of the Witwatersrand
Degree obtained	:	BA Hons Archaeology
Year of graduation	:	2002
Name of University or Institution	:	University of the Witwatersrand
Degree Obtained	:	MA (Archaeology)
Year of Graduation	:	2012
Name of University or Institution	:	University of Johannesburg
Degree	:	PhD
Year	:	Currently Enrolled

EMPLOYMENT HISTORY:

2011 – Present:	**Owner – HCAC (Heritage Contracts and Archaeological Consulting CC)**
2007 – 2010:	**CRM Archaeologist,** Managed the Heritage Contracts Unit at the University of the Witwatersrand
2005 - 2007:	**CRM Archaeologist**, Director of Matakoma Heritage Consultants
2004:	**Technical Assistant**, Department of Anatomy University of Pretoria
2003:	**Archaeologist**, Mapungubwe World Heritage Site
2001 - 2002:	**CRM Archaeologists,** For R & R Cultural Resource Consultants, Polokwane
2000:	**Museum Assistant**, Fort Klapperkop

Countries of Work Experience Include:
Republic of South Africa, Botswana, Zimbabwe, Mozambique, Tanzania, The Democratic Republic of the Congo, Lesotho and Zambia.

SELECTED PROJECTS INCLUDE:

Archaeological Impact Assessments (Phase 1)

Heritage Impact Assessment Proposed Discharge of Treated Mine Water Via The Wonderfonteinspruit Receiving Water Body Specialist as part of team conducting an Archaeological Assessment for the Mmamabula mining project and power supply, Botswana.

Archaeological Impact Assessment Mmamethlake Landfill
Archaeological Impact Assessment Libangeni Landfill

Linear Developments

Archaeological Impact Assessment Link Northern Waterline Project at The Suikerbosrand Nature Reserve
Archaeological Impact Assessment Medupi – Spitskop Power Line,
Archaeological Impact Assessment Nelspruit Road Development

Renewable Energy developments

Archaeological Impact Assessment Karoshoek Solar Project

Grave Relocation Projects

Relocation of graves and site monitoring at Chloorkop as well as permit application and liaison with local authorities and social processes with local stakeholders, Gauteng Province
Relocation of the grave of Rifle Man Maritz as well as permit application and liaison with local authorities and social processes with local stakeholders, Ndumo, Kwa Zulu Natal
Relocation of the Magolwane graves for the office of the premier, Kwa Zulu Natal
Relocation of the OSuthu Royal Graves office of the premier, Kwa Zulu Natal

Phase 2 Mitigation Projects

Field Director for the Archaeological Mitigation for Booysendal Platinum Mine, Steelpoort, Limpopo Province. Principle investigator Prof. T. Huffman
Monitoring of heritage sites affected by the ARUP Transnet Multipurpose Pipeline under directorship of Gavin Anderson
Field Director for the Phase 2 mapping of a late Iron Age site located on the farm Kameelbult, Zeerust, North West Province. Under directorship of Prof T. Huffman
Field Director for the Phase 2 surface sampling of Stone Age sites effected by the Medupi – Spitskop Power Line, Limpopo Province

Heritage Management Projects

Platreef Mitigation project – mitigation of heritage sites and compilation of conservation management plan

MEMBERSHIP OF PROFESSIONAL ASSOCIATIONS:

- Association of Southern African Professional Archaeologists. Member number 159

  Accreditation:
  - Field Director Iron Age Archaeology
  - Field Supervisor Colonial Period Archaeology, Stone Age Archaeology and Grave Relocation
- Accredited CRM Archaeologist with SAHRA
- Accredited CRM Archaeologist with AMAFA
- Co-opted council member for the CRM Section of the Association of Southern African Association Professional Archaeologists (2011 – 2012)

PUBLICATIONS AND PRESENTATIONS

- A Culture Historical Interpretation, Aimed at Site Visitors, of the Exposed Eastern Profile of K8 on the Southern terrace at Mapungubwe.
  - J van der Walt, A Meyer, WC Nienaber
  - Poster presented at Faculty day, Faculty of Medicine University of Pretoria 2003
- ‘n Reddingsondersoek na Anglo-Boereoorlog-ammunisie, gevind by Ifafi, Noordwes-Provinsie. South-African Journal for Cultural History 16(1) June 2002, with A. van Vollenhoven as co-writer.
- Fieldwork Report: Mapungubwe Stabilization Project.
  - WC Nienaber, M Hutten, S Gaigher, J van der Walt
  - Paper read at the Southern African Association of Archaeologists Biennial Conference 2004
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- Field Report on the mitigation measures conducted on the farm Bokfontein, Brits, North West Province.
  - J van der Walt, P Birkholtz, W. Fourie
  - Paper read at the Southern African Association of Archaeologists Biennial Conference 2007
- Field report on the mitigation measures employed at Early Farmer sites threatened by development in the Greater Sekhukhune area, Limpopo Province. J van der Walt
  - Paper read at the Southern African Association of Archaeologists Biennial Conference 2008
- Ceramic analysis of an Early Iron Age Site with vitrified dung, Limpopo Province South Africa.
  - J van der Walt. Poster presented at SAFA, Frankfurt Germany 2008

- Bantu Speaker Rock Engravings in the Schoemanskloof Valley, Lydenburg District, Mpumalanga (*In Prep)*
    - J van der Walt and J.P Celliers
- Sterkspruit: Micro-layout of late Iron Age stone walling, Lydenburg, Mpumalanga. W. Fourie and J van der Walt. A Poster presented at the Southern African Association of Archaeologists Biennial Conference 2011
- Detailed mapping of LIA stone-walled settlements' in Lydenburg, Mpumalanga. J van der Walt and J.P Celliers
    - Paper read at the Southern African Association of Archaeologists Biennial Conference 2011
- Bantu-Speaker Rock engravings in the Schoemanskloof Valley, Lydenburg District, Mpumalanga. J.P Celliers and J van der Walt
    - Paper read at the Southern African Association of Archaeologists Biennial Conference 2011
- Pleistocene hominin land use on the western trans-Vaal Highveld ecoregion, South Africa, Jaco van der Walt.
    - J van der Walt. Poster presented at SAFA, Toulouse, France. Biennial Conference 2016

REFERENCES:

1.	Prof Marlize Lombard	Senior Lecturer, University of Johannesburg, South Africa E-mail: mlombard@uj.ac.za
2.	Prof TN Huffman	Department of Archaeology Tel: (011) 717 6040 University of the Witwatersrand
3.	Alex Schoeman	University of the Witwatersrand E-mail:Alex.Schoeman@wits.ac.za

APPENDIX E.2: GROUNDWATER ASSESMENT

Future Flow
GROUNDWATER & PROJECT MANAGEMENT SOLUTIONS

Future Flow Reference: NPM.17.014
Client Reference:

10 August 2017

Northam Platinum Limited
Zondereinde
Main Office, Farm Zondereinde 384KQ
District of Thabazimbi
South Africa

Attention: Orelia Bezuidenhout

NORTHAM PLATINUM ZONDEREINDE
AMANDELBULT EXTENSION

GROUNDWATER ASSESSMENT

Good day Orelia,

Please see attached the groundwater report for the Northam Platinum Zondereinde – Amandelbult Extension Project. The report details baseline groundwater conditions as well as the environmental impact assessment that was done.

Please do not hesitate to contact me should you have any queries.

Best regards,

Martiens Prinsloo Pr.Sci.Nat
Future Flow GPMS cc

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2008/094325/23

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Route21 Corporate Park,
Irene, 0062,
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E-MAIL:
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WEBSITE:
www.ffgpm.co.za

MEMBER:
M.J. Prinsloo (Pr.Sci.Nat)

Future Flow

GROUNDWATER & PROJECT MANAGEMENT SOLUTIONS

Future Flow Reference: NPM.17.014
Client Reference:

REGISTRATION NO:
2008/094325/23

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M.J. Prinsloo (Pr.Sci.Nat)

NORTHAM PLATINUM ZONDEREINDE AMANDELBULT EXTENSION

GROUNDWATER ASSESSMENT

For

Northam Platinum Limited

Future Flow Document: NPM.17.014/Groundwater Report
10 August 2017

NORTHAM PLATINUM ZONDEREINDE
AMANDELBULT EXTENSION

GROUNDWATER ASSESSMENT

For

Northam Platinum Limited

Report Issue	DRAFT		
Reference Number	NPM.17.014		
Title	Northam Platinum Zondereinde – Amandelbult Extension Project. Groundwater EIA assessment		
	Name	**Signature**	**Date**
Author	Martiens Prinsloo (M.Sc.; Pr.Sci.Nat)	[signature]	10 August 2017
Reviewed	Candis Lubbe (Prism EMS)		
Review / Comment	Sandra Gore (Cliffe Dekker Hofmeyr)		

This report has been prepared by Future Flow Groundwater and Project Management CC ("Future Flow") with all reasonable skill, care and diligence within the terms of the contract with the client, and taking into account of the resources devoted to it by agreement with the client. We disclaim any responsibility to the client and any other in respect of any matters outside the scope of the project.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such parties rely on the report at their own risk.

EXECUTIVE SUMMARY

Introduction

Future Flow was contracted by Northam Platinum Limited ("Northam") to conduct a geohydrological investigation for the proposed extension of the Zondereinde Mine (the Project) onto properties which presently form part of the Amandelbult Mine and are included in a Mining Right held by Rustenburg Platinum Mines Limited (RPM) (Extended MRA). Northam has acquired the portion of the Amandelbult Mining Right in respect of the Extended MRA from RPM (subject to the required approvals being obtained).

Northam conducts mining, beneficiation, smelting and base metal removal process at the Zondereinde Mine under the Zondereinde Mining Rights. Various associated infrastructure exists at the Zondereinde Mine to conduct these processes, all of which have been included in the approved Environmental Management Programmes ("EMPs") and, where required, the Water Use Licence ("WUL") for the Zondereinde Mine. Mining is presently carried out by Northam on the properties included the Zondereinde Mining Rights ("Existing MRA"), at depths ranging between 1 294 and 2 300 mbgl to extract the platinum group metals (“PGM”) from the Bushveld PGM Reefs.

The Project will entail an extension of Northam’s current underground mining operations at the Existing MRA onto the Extended MRA. Northam plans to preferentially mine the Merensky and access the UG2 Reefs on the Extended MRA, through the same underground infrastructure present at the Zondereinde Mine. The existing conveyor system will transfer the ore and waste from the Extended MRA to the Concentrator Plants and waste facilities respectively at the Zondereinde Mine. Northam plans to continue Merensky Reef production from the Zondereinde Mine and the addition of the Extended MRA will enable Northam to maintain the current production rates for at least 30 years.

The mined material will be processed in the existing operational Plant and the tailings material will be stored on the existing operational Tailing Storage Facility ("TSF") at the Existing MRA. There is no additional surface infrastructure that is planned as part of the Project.

Desktop studies from previous groundwater investigations at the area held under the Zondereinde Mining Rights ("Existing MRA") were used to characterise the baseline groundwater environment on the Extended MRA and develop a conceptual groundwater flow and contaminant transport model of the Extended MRA.

General Site Description

The Zondereinde Mine is located approximately 16 km north east of Northam and 25 km south of Thabazimbi within the Limpopo Province in the Republic of the South Africa.

The Study Area is situated in a relatively flat area with an elevation that ranges between 960 and 990 mamsl. It slopes gently to the both the east and the west, towards the Crocodile and Bierspruit Rivers respectively. There is a cluster of low hills, located approximately 3 km south west of the Extended MRA. A northeast southwest trending steep ridge is located 10 km north of the Existing MRA.

The surface water drains into both the Crocodile River and the Bierspruit located east and west of the Study Area respectively. There are a number of non-perennial rivers that are seasonal and flow only after periods of rainfall.

Prevailing Groundwater Conditions

<u>Geology</u>

Regional Geology

The PGM deposits in South Africa are situated within the Bushveld Igneous Complex, which extends 480 km from east to west and 240 km north-south over the North West and Limpopo Provinces.

The Proterozoic (2.06Ga to 2.058Ga) Bushveld Complex is divided into the lower Rustenburg Layered Suite, the Lebowa Granite Suite and the felsic extrusive rocks of the Rashoop Granophyre Suite.

The Study Area is located in the Upper Critical Zone of the western lobe of the Rustenburg Layered Suite of the Bushveld Igneous Complex (Smith, Basson, & Reid, 2015). It is located north of the Pilanesberg and comprises of the Swartklip Facies, which is characterised by the much smaller UG2-Merensky separation.

The Merensky Reef within the Study Area is divided into Normal and “Pothole” Reef Sub-Facies. The regional pothole Sub-Facies are further divided into three different reef types. Reef type changes are difficult to predict. The UG2 Reef occurs between 20 and 40 m below the Merensky Reef and displays more consistent characteristics than the Merensky Reef, with insignificant reef disturbances. The UG2 Reef is largely mined below where the Merensky Reef was previously mined.

Local Geology

Site specific geology is obtained from previous reports and the available geological map. The ultramafic / mafic rocks of the Rustenburg Layered Suite dominate the Study Area.

The Study Area is underlain by gabbro norite, magnetite gabbro and granites of the Bushveld Complex. The deeper geology of the Study Area comprises anorthosite, norite and pyroxenite. Alluvium overlies the rocks in the eastern part of the Study Area along the Crocodile River.

Diabase Pilanesberg dykes and faults associated with the northwest-southeast trending Middelaagte Graben extends beyond the Study Area. The maximum thickness of the steeply dipping diabase dykes is estimated to be 50 m.

Hydrogeology

Three aquifers occur in the Study Area, associated with the alluvial aquifer material, shallow weathered fractured material and the underlying competent and fractured rock material.

Alluvial Aquifer

The alluvial aquifer is composed of unconsolidated layers of sand and silt deposits. The aquifer is unconfined and laterally discontinuous, localised within the immediate vicinity of the river banks and the floodplains, and therefore does not extend regionally throughout the total Study Area. These aquifers are usually fairly high yielding due to their interaction with the surface water bodies, coupled with the relatively high storage capacity of the unconsolidated sediments.

Shallow Weathered Material Aquifer

The upper 2 m of the soil consists of the semi-confining black turf layer. The Bushveld Igneous Complex norite weathers to form a dark brown to black, very clayey vertisol soil horizon. During dry weather the soil forms deep open fissures or shrinkage cracks, while the soil becomes sticky and slow draining during wet weather. This results in varying hydraulic conductivities in the expansive clay layer. When saturated the clays are highly impermeable but allow for infiltration and recharge through the surface cracks during dry conditions.

The upper weathered aquifer is below the turf layer and has an average depth of approximately 9 to 12 m. These average values are not absolute values for the entire Study Area.

The borehole yields in this aquifer are seasonally variable, due to the strong dependence on rainfall recharge. The groundwater quality in undisturbed areas is good due to the dynamic recharge from rainfall. This aquifer is, however, more likely to be affected by contaminant sources situated on surface.

Fractured Rock Aquifer

The ultramafic / mafic Rustenburg Layered Suite consists of relatively low permeability sediments that have been subjected to extensive faulting associated with the intrusion of the Bushveld sediments.

Groundwater flows in the fractured rock aquifer are associated with the secondary fracturing in the competent rock and, as such, will be along discrete pathways associated with the fractures. Faults and fractures in the competent rock can be a significant source of groundwater, depending on whether the fractures have been filled with secondary mineralisation.

Groundwater Levels

The groundwater levels vary throughout the Study Area. The deepest groundwater levels are observed in borehole NPG13, which is located east of the Smelter area. There is no certainty around the reason for the low groundwater level in borehole NPG13. The depth to groundwater levels in the other monitoring boreholes are shallower, ranging between 0.9 and 24.1 mbgl.

Plotting groundwater level elevation versus topographical elevation for this Study Area yields an 86.7% correlation. From this it is concluded that the groundwater levels generally mimic topography in the areas where the boreholes are located. Bayesian interpolation is used to interpolate the groundwater levels throughout the Study Area.

Groundwater Potential Contaminants

Underground Mining Area

The existing underground area at the Existing MRA is located at depths of 1 294 to 2 300 mbgl. The Extended MRA will be at similar and greater depths. It is not expected that there will an active aquifer at those depths. The Shaft on the Existing MRA is lined and it is not expected that after closure, when the underground mine area is eventually submerged, there will be significant seepage from the Shaft area into the surrounding aquifers. Additionally, there are no groundwater users accessing water from that depth. Based on this, it is considered that the underground mining on the Extended MRA is not a significant risk to the active aquifers at depths shallower than 100 to 150 mbgl.

Surface Infrastructure on Existing MRA

Baseline data of the surrounding area was included in this report. Surface infrastructure at the Existing MRA has impacted the groundwater. The existing surface infrastructure is managed in accordance with Northam's Approved EMPs and WUL. There are no surface pollution sources on the Extended MRA. Groundwater contamination from the Existing MRA has a limited plume and will not migrate onto the Extended MRA. No cumulative impacts are thus anticipated due to the Project.

In relation to the Existing MRA, from a previous contaminant plume delineation study (Future Flow, October 2015), it was concluded that there are a total of seven potential pollution areas in the Existing MRA, being the Domestic Waste Disposal Site; Concentrator Plant area and Evaporation Dam; Waste Rock Dump (WRD); Sewage Treatment Facility; Smelter and Base Metal Refinery (BMR); Slimes and Return Water Dam (RWD); and Settling Dam. The chloride concentration trends average between 650 to 1 810 mg/L in boreholes surrounding this infrastructure. At the end of life of mine contaminant plumes migrating away from surface infrastructure points on the Existing MRA will have migrated through the weathered material aquifer to a maximum of 550 m down-gradient from the source area and are thus not anticipated to migrate onto the Extended MRA; the Bierspruit or Crocodile River or the non-perennial stream, save for potentially one non-perennial stream post-closure.

Aquifer Characterisation

For aquifer vulnerability, reference is made to the aquifer vulnerability map of South Africa which shows a low aquifer vulnerability for the Study Area. Impacts to the aquifers from the extended MRA are discussed in Section 6 of this report.

The aquifers present in the Study Area are classified as minor aquifers but of high importance to the local landowners, as they are their sole source of water for domestic and agricultural (stock watering and irrigation) purposes.

Environmental Impact Assessment

<u>Construction Phase</u>

At the Existing MRA the underground mining operations are in progress and the surface infrastructure is operational. Mined material is brought to surface, processed, and the tailings material deposited on the TSF. The Extended MRA will only be an extension to the underground mining operations at the Existing MRA and the life of mine will not be extended. No new infrastructure will be established. Therefore, there is no construction phase that has to be evaluated.

<u>Operational Phase</u>

Groundwater Level Changes and the Zone of Influence

The underground mining operations at the Extended MRA will be at depths of 2 300 mbgl or deeper. The underground mining operations at the Existing MRA are at depths between 1 294 and 2 300 mbgl and have had no impacts on the groundwater levels in the Study Area. It is therefore expected that there will be no impact on the groundwater levels from underground mining operations at the Extended MRA.

The combined Extended MRA and Existing MRA are located at depths of 1 294 to 2 300 m and greater. There is no active aquifer at these depths. Any groundwater that does occur at these depths, or along the Shaft area, and enters the underground workings will be dewatered and pumped to surface at the Existing MRA, where it will be handled in the existing water management dams. Thus, any groundwater flows that occur at the depth of the mining will be towards the underground workings at the Extended MRA. This will prevent any contamination within the underground Extended MRA from migrating away from the Extended MRA.

Groundwater Contamination

Surface infrastructure at the Existing MRA has impacted the groundwater. The existing surface infrastructure is managed in accordance with Northam's Approved EMPs and WUL. There are no surface pollution sources on the Extended MRA. Groundwater contamination from the Existing MRA has a limited plume and will not migrate onto the Extended MRA. No cumulative impacts are thus anticipated due to the Project.

At the end of life of mine contaminant plumes migrating away from surface infrastructure points on the Existing MRA will have migrated through the weathered material aquifer to a maximum of 550 m down-gradient from the source area.

The highest chloride concentration on the Existing MRA may be found in borehole NPG34, this is due to the borehole being located on the Slimes Dam perimeter.

There are numerous streams in the Study Area that appear to be non-perennial. The impact assessment results show that none of these streams fall within the zone of influence of the contaminant plumes on the Existing MRA and therefore it is not expected that the Existing MRA will have any impact on the stream water qualities.

<u>Long-term Post-Closure Phase</u>

Recovery of Groundwater Levels and Decant Potential

In the post operational environment groundwater levels and flow patterns in the Study Area will recover to near pre-operational levels. The total volume of the mined-out area that has to be filled / submerged is not known. In addition, the volume of groundwater seeping into the underground mine is also not known. Therefore, the time required for the underground mine to become submerged cannot be calculated.

The underground mining area on the Extended MRA ranges in depth between 1 294 and 2 300 mbgl and deeper. At no point is the floor elevation of the underground mining on the Extended MRA above surface level. No decant is expected to occur.

Contamination Migration

Surface infrastructure at the Existing MRA will have some long-term groundwater impacts. This will also be managed in accordance with Northam's Approved EMPs and WUL. As noted above, there are no surface water pollution sources on the Extended MRA and no long-term cumulative impacts are thus anticipated due to the Project.

The contamination from the Slimes Dam and RWD, which are located within the Existing MRA, is expected to migrate up to 600 m east and will not reach the Crocodile River, which is 5 km east of the RWD.

The majority of contamination from the Domestic Waste Disposal, Settling Dam and Sewage Plant area, which are located within the Existing MRA, is expected to migrate up to 700 m west toward an unnamed non-perennial stream, through the shallow weathered material aquifer. The contaminant plumes will not reach the Bierspruit which is 3.5 km north of the WRD and Sewage Plant.

The shallow weathered aquifer can be expected to contribute poor quality leachate into the unnamed non-perennial stream flow volumes, through baseflow contribution during the rainy season. During the dry season the impact through this aquifer on the non-perennial stream is expected to be minimal due to the seasonal reduction in groundwater level in the aquifer.

Mitigating and Management Measures to be included in the EMP

Monitoring Program
It is recommended that the existing groundwater level and quality monitoring program for the Zondereinde Mine be continued as is.

Remediation of the Physical Activity
The underground mine on the Extended MRA cannot be remediated. The shaft entrance will be closed on the Existing MRA.

Remediation of Environmental Impacts
Mitigation and remediation measures contained in the approved EMPs and WUL should be compiled with by Northam in respect of the Existing MRA, including continuing the existing groundwater monitoring program for at least 5 years after mine closure to monitor the contaminant migration.

Reasoned Professional Opinion
It is recommended that the Project be authorized. This recommendation is based on:

- The impact assessment shows that it not expected that there will be any measurable impact on the groundwater levels in the area. No privately-owned boreholes around the Extended MRA will be impacted by the drawdown in the fractured rock aquifer;
- There will be no groundwater impacts from mining the Extended MRA and no cumulative impacts as a result of the existing impacts on the Existing MRA. No privately owned and used boreholes on neighbouring properties will be impacted;
- Numerical model simulation and analytical impact assessment results show that there will be no impact on the Crocodile and the Bierspruit River.

Overall, it can be concluded that that there are few sensitive receptors in the area and the impacts on those sensitive receptors will be minimal.

Conditions for Authorisation
There are no conditions for authorisation, except commitment to optimal management and monitoring of the expected impacts as described in Sections 8 and 9 of this report.

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1. Introduction

1.1 Background introduction

Future Flow was contracted by Northam Platinum Limited ("Northam") to conduct a geohydrological investigation for the proposed extension of the Zondereinde Mine (the Project) onto properties which presently form part of the Amandelbult Mine and are included in a Mining Right held by Rustenburg Platinum Mines Limited (RPM) (Extended MRA). Northam has acquired the portion of the Amandelbult Mining Right in respect of the Extended MRA from RPM (subject to the required approvals being obtained).

The Project will entail an extension of the current underground mining operations from the Existing MRA onto the Extended MRA. Northam plans to preferentially mine the Merensky and access the UG2 Reefs on the Extended MRA through the same underground infrastructure present at the Zondereinde Mine. The existing conveyor system will transfer the ore and waste from the Extended MRA to the Concentrator Plants and waste facilities respectively. Northam plans to continue Merensky Reef production from the Zondereinde Mine and the addition of the Extended MRA will enable the mine to maintain the existing production rates for at least 30 years, in accordance with the Mine Works Programme for the Zondereinde Mining Rights.

The mined material will be processed in the existing operational Plant, and the tailings material will be stored on the existing operational TSF. There is no additional surface infrastructure that is planned as part of the extension of the underground mining area onto the Extended MRA.

Desktop studies from previous groundwater investigations at the area held under the Zondereinde Mining Rights ("Existing MRA") were used to characterise the baseline groundwater environment on the Extended MRA and develop a conceptual groundwater flow and contaminant transport model of the Extended MRA.

1.2 Potential Impacts

Due to the depth of the proposed operations at the Extended MRA and as no additional surface infrastructure is planned, the following potential impacts from the Project on the surrounding groundwater environment were assessed:

- Present contaminant migration away from surface sources at the Existing MRA during the operational phase of the mine, including the TSF, the smelter and BMR area, and the Concentrator Plant area;
- Extended impacts on the surface water quality due to contaminant migration away from the surface infrastructure within the Existing MRA; and
- Potential decant from the mining area.

It should be noted that due to the fact that the life of mine, as well as the volume of material handled on site, does not increase compared to the originally approved EMP specifications, no significant increase in the impacts are expected.

1.3 Aim of the Investigation

The aim of the groundwater investigation is to characterise the current baseline groundwater environment. This includes aspects such as:

- Identification and characterisation of the aquifers present in the area;
- Aspects that control groundwater flow through the area (geological structures etc.)
- Groundwater flow patterns;
- Recharge from rainfall;
- Predevelopment groundwater quality; and
- Surface water / groundwater interaction.

In addition to the above, the groundwater investigation aims to characterise and quantify the expected impacts on the surrounding groundwater environment due to the mining activities. Impact management strategies will also be evaluated.

1.4 Timing of the Investigation

The study relies on field investigations that were done during previous investigations. These field studies were conducted during both the rainy and dry seasons and therefore incorporate seasonal changes in aspects, such as:

- Depth to groundwater level; and
- Groundwater quality.

1.5 Specialist Expertise

Future Flow is a privately held consulting company based in Pretoria, South Africa that has been in operation since 2008. We provide specialist groundwater consulting services. Our clients range from mining companies and energy suppliers to private developers operating throughout Africa.

Key staff allocated to this project includes:

Martiens Prinsloo: Martiens is a principal hydrogeologist at Future Flow and holds an MSc degree in hydrogeology from the University of the Free State, South Africa. He has more than 19 years' experience in water management studies and environmental impact assessments and has been involved in more than 200 groundwater studies during the past decade. Martiens is responsible for data analysis, the conceptual model, the 3D numerical modelling and reporting.

Martiens has been involved in a number of other mining related studies in the region during the past decade. His CV can be viewed in Appendix A.

1.6 Declaration of Independence

We, Future Flow Groundwater & Project Management Solutions cc, act as the independent specialists in the environmental authorisation for the Project. We will perform the work relating to the environmental authorisation application in an objective manner, even if this results in views and findings that are not favourable to the applicant.

We declare that there are no circumstances that may compromise our objectivity in performing such work. We have expertise in conducting the groundwater specialist study and report relevant to the environmental authorisation application. We confirm that we have knowledge of the relevant environmental Acts, Regulations and Guidelines that have relevance to the proposed activity and my/our field of expertise and will comply with the requirements therein.

We have not, and will not engage in, conflicting interests in the undertaking of the activity that will impact the objectivity of any report, plan or document to be prepared by ourselves for submission to the competent authority.

We undertake to disclose to the applicant and the competent authority all material information in our possession that reasonably has, or may have, the potential of influencing any decision to be taken with respect to the application by the competent authority.

All particulars furnished by me/us in this report are true and correct. We realise that a false declaration is an offence in terms of regulation 48 of the National Environmental Management Act, 107 of 1998 (NEMA) and is punishable in terms of section 24F of the Act.

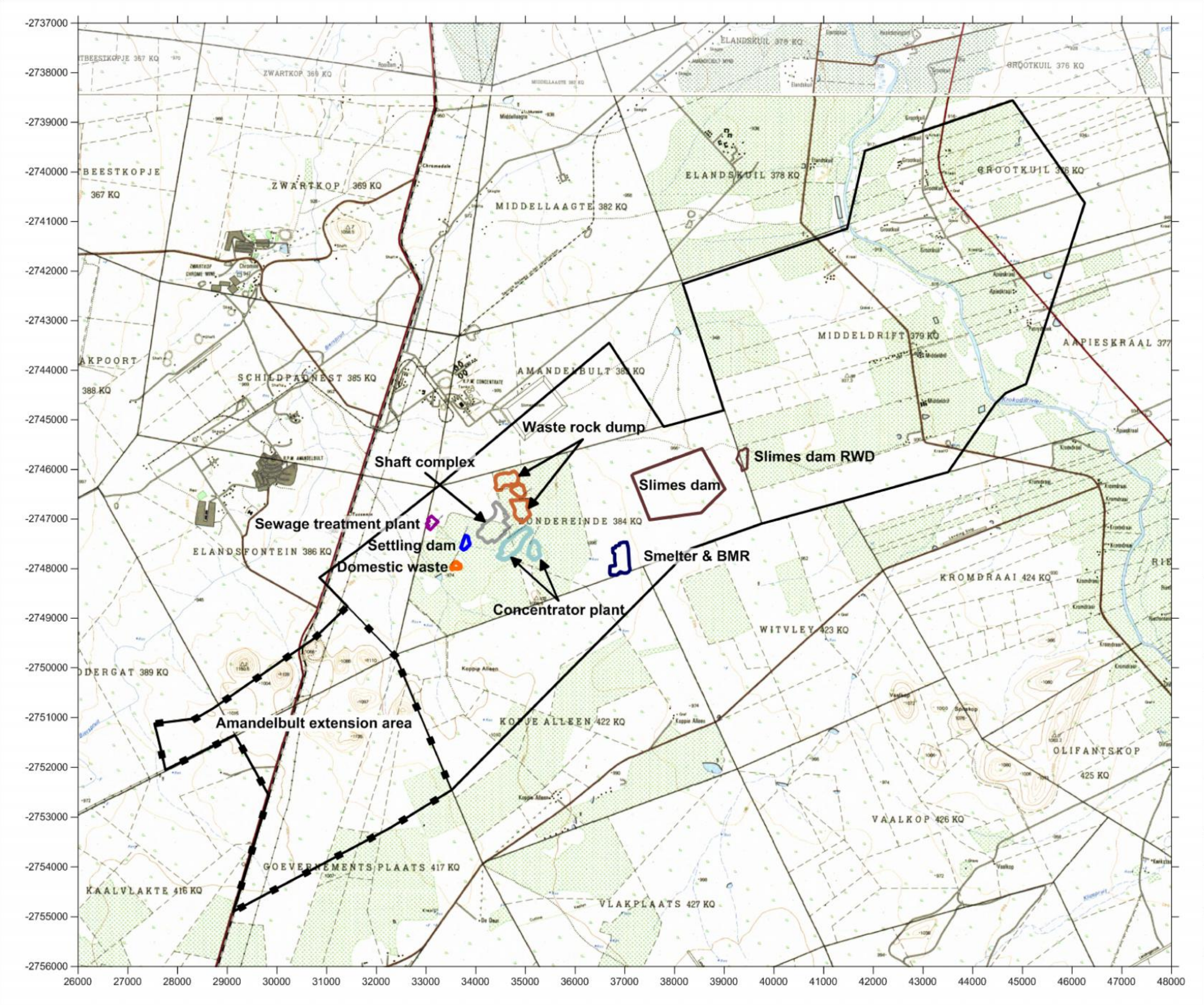
________________________ ____2017/07/27____

Signed Date

1.7 Consultation Process

The consultation process included:

- Discussion with Zondereinde Mine personnel: They have a working relationship with the surrounding land owners who are in regular contact with the Zondereinde Mine.



Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27

Client:
Northam Platinum Limited

Project:
Northam Platinum - Zondereinde Mine
Amandelbult Extension

Figure Number: 1.1

Figure Name:
General site layout

Scale: As shown

Date: June 2017
Revision:

Designed: MP
Approved:

Future Flow
8 Victoria Link, Route21 Corporate Park, Irene, 0062
Postnet Suite 71, Private Bag X8, Elarduspark, 0047
Pretoria, South Africa

2. Geographical Setting

2.1. Topography and Drainage

The Zondereinde Mine is located on the Existing MRA, consisting of various portions of the Farms Zondereinde 383 KQ, Zondereinde 384 KQ, Elandfontein 386 KQ, Kopje Alleen 422 KQ, Amandelbult 383 KQ, Aapieskraal 377 KQ, Witvley 423 KQ, Middeldrift 379 KQ, Vrugbaar 381 KQ and Grootkuil 376 KQ.

The Extended MRA includes a part of the Remainder of Farm Elandsfontein 386-KQ; a part of Ptn 1 of Farm Elandsfontein 386-KQ; a part of Ptn 2 of Farm Moddergat 389-KQ; a part of the Remainder of Farm Moddergat 389-KQ; a part of the Remainder of Farm Goevernements Plaats 417-KQ; a part of the Remainder of Ptn 1 of Farm Goevernements Plaats 417-KQ; a part of Ptn 2 of Farm Goevernements Plaats 417-KQ; a part of the Remainder of Ptn 3 of Farm Goevernements Plaats 417-KQ; a part of Ptn 4 of Farm Goevernements Plaats 417-KQ; and Ptn 7 of Farm Goevernements Plaats 417-KQ, all situated in the Magistrate District of Thabazimbi, Limpopo Province.

The Study Area is located approximately 16 km north east of Northam and 25 km south of Thabazimbi within the Limpopo Province in the Republic of the South Africa. A general locality map is shown in Figure 1.1. Maps relevant to the study area include:

- 1: 50 000 scale topographical maps (2427CA, 2427CB, 2427CC and 2427CD);
- 1: 250 000 scale geological map (2426 - Thabazimbi);
- Surface layouts provided by Northam;
- Satellite image of the area (Google Earth); and
- Other published data on the Study Area[1].

The Study Area[1] falls within the A24F and A24C Quaternary Catchments, within the Lower Crocodile Sub-Catchment of the Crocodile River (West) and Marico Water Management Area (WMA). The Study Area drains into both the Crocodile River and Bierspruit, located east and west of the Study Area respectively (Figure 2.2). There are a number of non-perennial rivers that are seasonal and flow only after periods of rainfall.

2.2. Climate

The Study Area is situated in the Limpopo Province, a semi-arid rainfall region which is characterised by cool, dry winters (May to August) and warm, wet summers (October to March). Temperatures vary from an average monthly maximum and minimum of 31.8°C and 19.4°C for January to 23.7°C and 2.7°C for June respectively. Figure 2.1 shows the average rainfall and temperature data for Northam.

Rainfall station data for Northam indicate average annual rainfall of between 500 and 550 mm/a. However, the evapotranspiration in the Study Area is expected to be relatively high compared to the average annual rainfall, thereby reducing the gross recharge from rainfall. Effective recharge to the aquifers ranges between 1 and 2 % of the mean annual rainfall.

[1] Extended MRA and Existing MRA

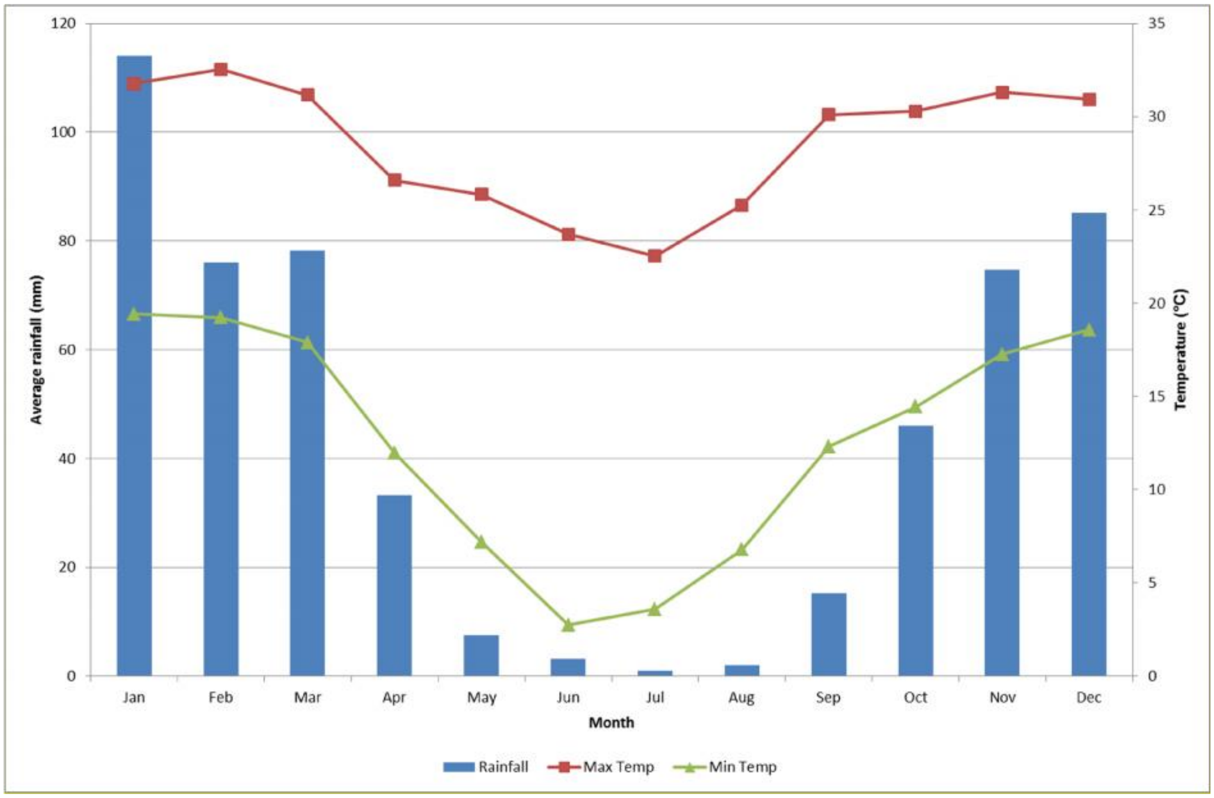
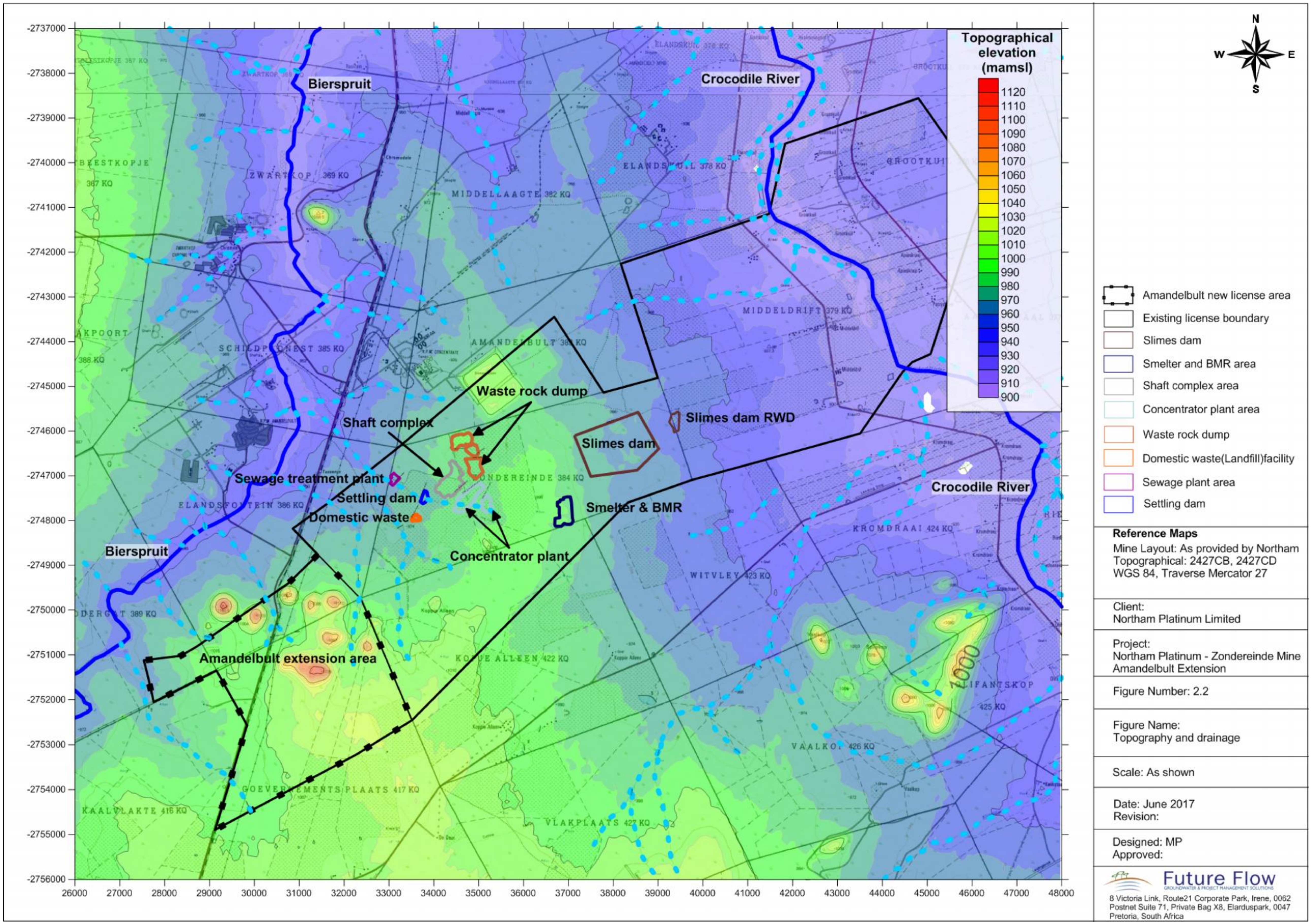


Figure 2.1: Rainfall and temperature distribution in Northam


Topographical elevation (mamsl)
Biersspruit
Crocodile River
Waste rock dump
Shaft complex
Slimes dam
Slimes dam RWD
Sewage treatment plant
Settling dam
Domestic waste
Smelter & BMR
Concentrator plant
Amandelbult extension area
Amandelbult new license area
Existing license boundary
Slimes dam
Smelter and BMR area
Shaft complex area
Concentrator plant area
Waste rock dump
Domestic waste(Landfill)facility
Sewage plant area
Settling dam
Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27
Client:
Northam Platinum Limited
Project:
Northam Platinum - Zondereinde Mine
Amandelbult Extension
Figure Number: 2.2
Figure Name:
Topography and drainage
Scale: As shown
Date: June 2017
Revision:
Designed: MP
Approved:
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Pretoria, South Africa

3. Scope of Work

The scope of work includes:

3.1 Phase 1 – Project Initiation and Desk Study

The existing data was collected and reviewed. Data that was assessed included:

- Any available data that Northam could provide. This included results from the existing groundwater monitoring program at the Existing MRA; details of the Extended MRA and proposed depth; current mine dewatering volumes; and geotechnical and geological information; and
- Public domain information (geological maps, topographical maps, publications on previous studies in the region etc.).

3.2 Phase 2 – Groundwater Risk and Impact Assessment

The risk to the surrounding and overlying aquifers was assessed using analytical methods. In particular impacts on underlying and surrounding groundwater:

- Flow patterns due to mine dewatering;
- Qualities due to seepage from the Existing MRA.

4. Prevailing Groundwater Conditions

4.1. Geology

4.1.1 Regional Geology

The PGM deposits in South Africa are situated within the Bushveld Igneous Complex, which extends 480 km from east to west and 240 km north-south over the North West and Limpopo Provinces.

The Proterozoic (2.06Ga to 2.058Ga) Bushveld Complex is divided into the lower Rustenburg Layered Suite, the Lebowa Granite Suite and the felsic extrusive rocks of the Rashoop Granophyre Suite.

The ultramafic / mafic rocks of the Bushveld Igneous Complex are collectively referred to as the Rustenburg Layered Suite and are divided, from the lower to the upper layers, into the Marginal, Lower, Critical, Main and Upper Zones. The Critical Zone is the host to all PGM mineralisation within the Bushveld Complex.

The Zondereinde Mine is situated in the Upper Critical Zone of the western lobe of the Rustenburg Layered Suite of the Bushveld Igneous Complex (Smith, Basson, & Reid, 2015). It is located north of the Pilanesberg and is comprised of the Swartklip Facies, which is characterised by the much smaller UG2-Merensky separation.

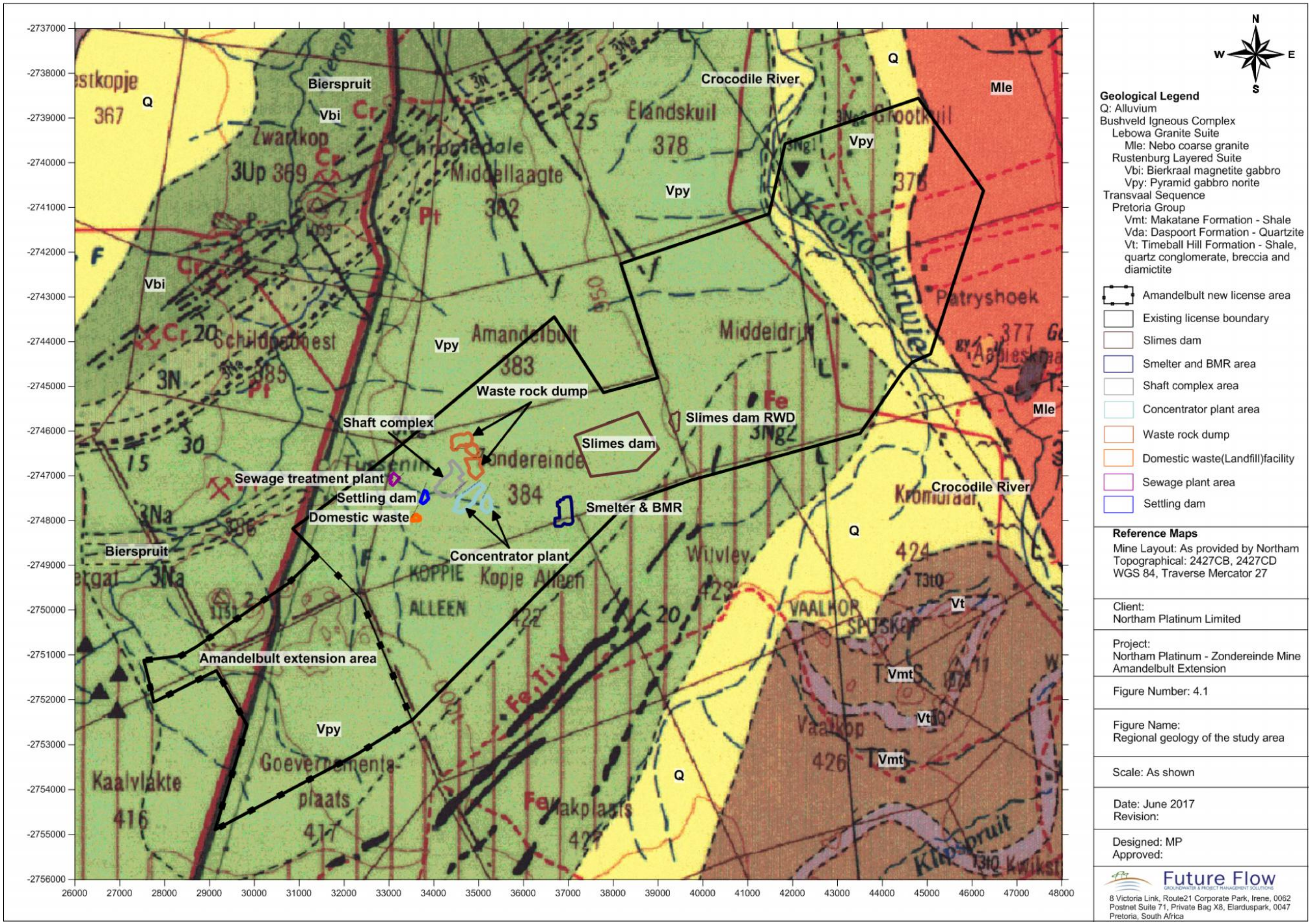
The Merensky Reef in the Study Area is divided into Normal and “Pothole” Reef Sub-Facies. The regional pothole sub-facies are further divided into three different reef types. Reef type changes are difficult to predict. The UG2 Reef occurs between 20 and 40 m below the Merensky Reef and displays more consistent characteristics than the Merensky Reef, with insignificant reef disturbances. The UG2 Reef is largely mined below where the Merensky Reef was previously mined

4.1.2 Local Geology

Site specific geology is obtained from previous reports and the available geological map (Figure 4.1), 1:250 000 2426 Thabazimbi. The ultramafic / mafic rocks of the Rustenburg Layered Suite dominate the Study Area.

The Study Area is underlain by gabbro norite, magnetite gabbro and granites of the Bushveld Complex. The deeper geology of the Study Area comprises anorthosite, norite and pyroxenite as described in a previous geological report (Northam Platinum Limited, 1998). Alluvium overlies the rocks in the eastern part of the Study Area along the Crocodile River.

Diabase Pilanesberg dykes and faults associated with the northwest-southeast trending Middelaagte Graben extends beyond the license boundary (Northam Platinum Limited, 1998). The maximum thickness of the steeply dipping diabase dykes is estimated to be 50 m.


Biersspruit
Crocodile River
Vbi
Vpy
Q
Mle
Amandelbult
Waste rock dump
Shaft complex
Slimes dam RWD
Slimes dam
Sewage treatment plant
Settling dam
Domestic waste
Smelter & BMR
Concentrator plant
Amandelbult extension area
Vt
Vmt
N
W
E
S
Geological Legend
Q: Alluvium
Bushveld Igneous Complex
Lebowa Granite Suite
Mle: Nebo coarse granite
Rustenburg Layered Suite
Vbi: Bierkraal magnetite gabbro
Vpy: Pyramid gabbro norite
Transvaal Sequence
Pretoria Group
Vmt: Makatane Formation - Shale
Vda: Daspoort Formation - Quartzite
Vt: Timeball Hill Formation - Shale, quartz conglomerate, breccia and diamictite
Amandelbult new license area
Existing license boundary
Slimes dam
Smelter and BMR area
Shaft complex area
Concentrator plant area
Waste rock dump
Domestic waste(Landfill)facility
Sewage plant area
Settling dam
Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27
Client:
Northam Platinum Limited
Project:
Northam Platinum - Zondereinde Mine
Amandelbult Extension
Figure Number: 4.1
Figure Name:
Regional geology of the study area
Scale: As shown
Date: June 2017
Revision:
Designed: MP
Approved:
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Pretoria, South Africa

4.2. Hydrogeology

Three aquifers occur in the Study Area. These three aquifers are associated with a) the alluvial aquifer material; b) shallow weathered fractured material; and c) the underlying competent and fractured rock material.

4.2.1. Alluvial Aquifer

The alluvial aquifer is composed of unconsolidated layers of sand and silt deposits. The aquifer is unconfined and laterally discontinuous, localised within the immediate vicinity of the river banks and floodplains, and therefore does not extend regionally throughout the total Study Area. These aquifers are usually fairly high yielding due to their interaction with the surface water bodies, coupled with the relatively high storage capacity of the unconsolidated sediments. The interaction between the alluvial aquifer and the river depends on the differences between the surface water and groundwater levels and the presence or absence of an impervious streambed, which would affect the hydraulic connection.

4.2.2. Shallow Weathered Material Aquifer

The upper aquifer forms due to the vertical infiltration of recharging rainfall through the weathered material being retarded by the lower permeability of the underlying competent rock material. Groundwater collecting above the weathered / unweathered material contact migrates down-gradient along the contact to lower lying areas.

Based on data collected from previous drilling programs performed in the Existing MRA, it is estimated that the upper 2 m of the soil consists of the semi-confining black turf layer. The Bushveld Igneous Complex norite weathers to form a dark brown to black, very clayey vertisol soil horizon. During dry weather the soil forms deep open fissures or shrinkage cracks, while the soil becomes sticky and slow draining during wet weather. This results in varying hydraulic conductivities in the expansive clay layer. When saturated the clays are highly impermeable but allow for infiltration and recharge, through the surface cracks during dry conditions.

The upper weathered aquifer is below the turf layer and has an average depth of approximately 9 to 12 m. These average values are not absolute values for the entire Study Area. Deeper weathering can also occur. However, the mentioned values are considered to provide a good general indication of the Study Area’s conditions.

The borehole yields in this aquifer are seasonally variable, due to the strong dependence on rainfall recharge. The groundwater quality in undisturbed areas is good because of the dynamic recharge from rainfall. This aquifer is, however, more likely to be affected by contaminant sources situated on surface.

4.2.3. Fractured Rock Aquifer

Although the lower permeability of the unweathered rock material will retard vertical infiltration of groundwater, a percentage of the water in the shallow aquifer will recharge the fractured rock aquifer.

The ultramafic / mafic Rustenburg Layered Suite consists of relatively low permeability sediments that have been subjected to extensive faulting associated with the intrusion of the Bushveld sediments.

Groundwater flows in the fractured rock aquifer are associated with the secondary fracturing in the competent rock and, as such, will be along discrete pathways associated with the fractures. Faults and fractures in the competent rock can be a significant source of groundwater, depending on whether the fractures have been filled with secondary mineralisation.

4.3. Groundwater Levels

A groundwater monitoring program is in place, whereby the depth to groundwater level in the boreholes is monitored in the Existing MRA. The monitoring is conducted on a monthly basis. A total of 38 monitoring borehole points were found from the latest Aquatico monitoring report for July 2016 (please refer to Figure 4.5 for the borehole positions).

The results of the 25 monitoring runs between January 2014 and July 2016 were analysed. The latest (July 2016) groundwater levels, as well as details of the boreholes included in the monitoring program, are summarised in Table 4.1. The depth to groundwater level in July 2016 at each of the monitoring boreholes is shown graphically in Figure 4.2.

The groundwater levels vary throughout the Existing MRA. The deepest groundwater levels are observed in borehole NPG13, which is located east of the Smelter area. There is no certainty around the reason for the low groundwater level in borehole NPG13. The depth to groundwater levels in the other monitoring boreholes are shallower, ranging between 0.9 and 24.1 m below ground level (mbgl).

The changes in groundwater levels over time between January 2014 and July 2016 are shown graphically in Figure 4.3. From the figure, it can be seen that the groundwater levels within individual boreholes remained within a similar range during the time January 2014 to July 2016.

In areas where there are no large scale external impacts on the groundwater environment, such as the lowering of groundwater level through dewatering, it is expected that the groundwater level contours will reflect topographical contours. Plotting groundwater level elevation versus topographical elevation yields an 86.7 % correlation as shown in Figure 4.4. From this it is concluded that the groundwater levels generally mimic topography in the areas where the boreholes are located and there is no indication of the aquifers being dewatered. Groundwater level elevation contours for the upper weathered material aquifer are shown in Figure 4.5.

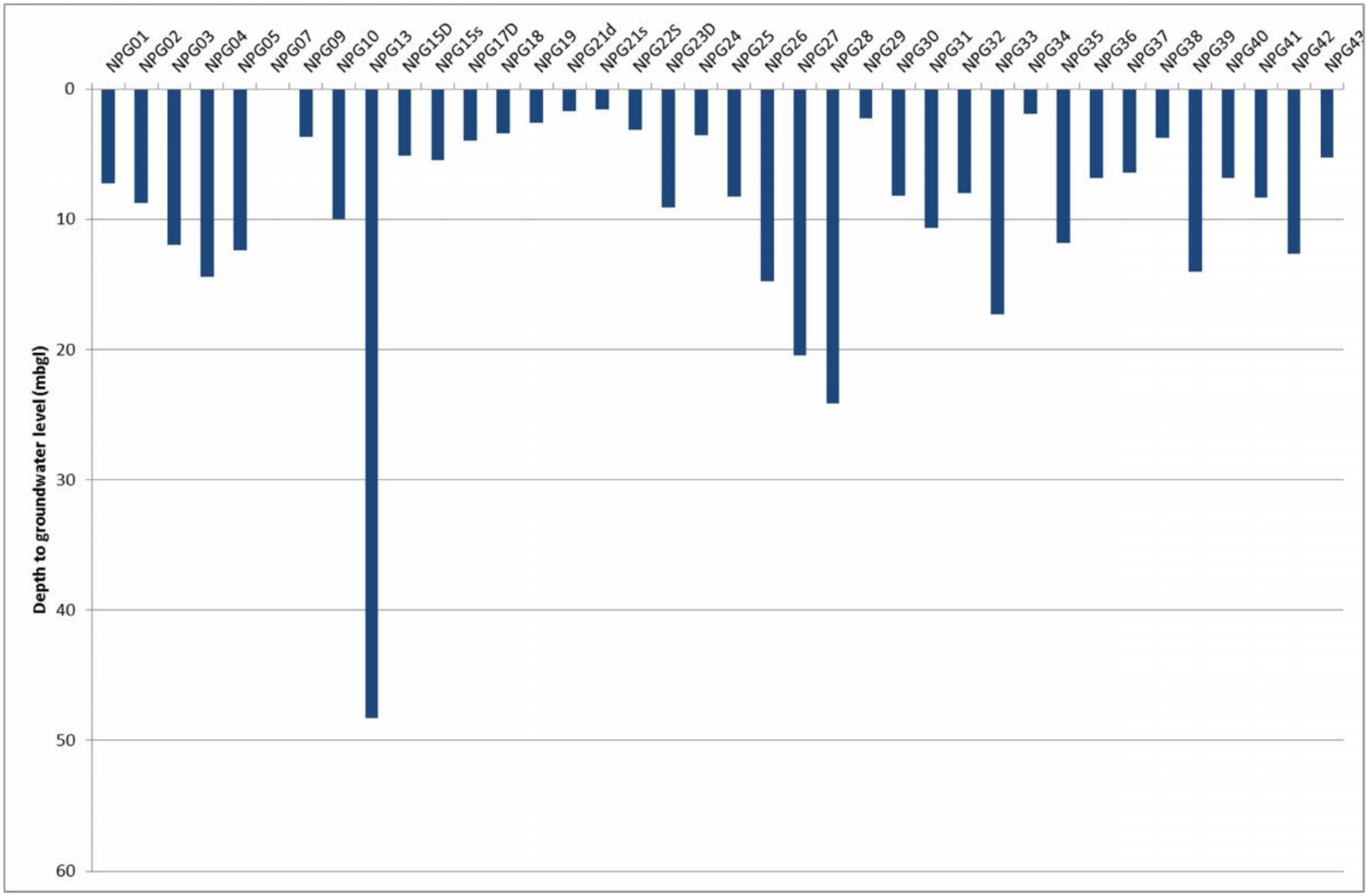


Figure 4.2: Depth to groundwater level.

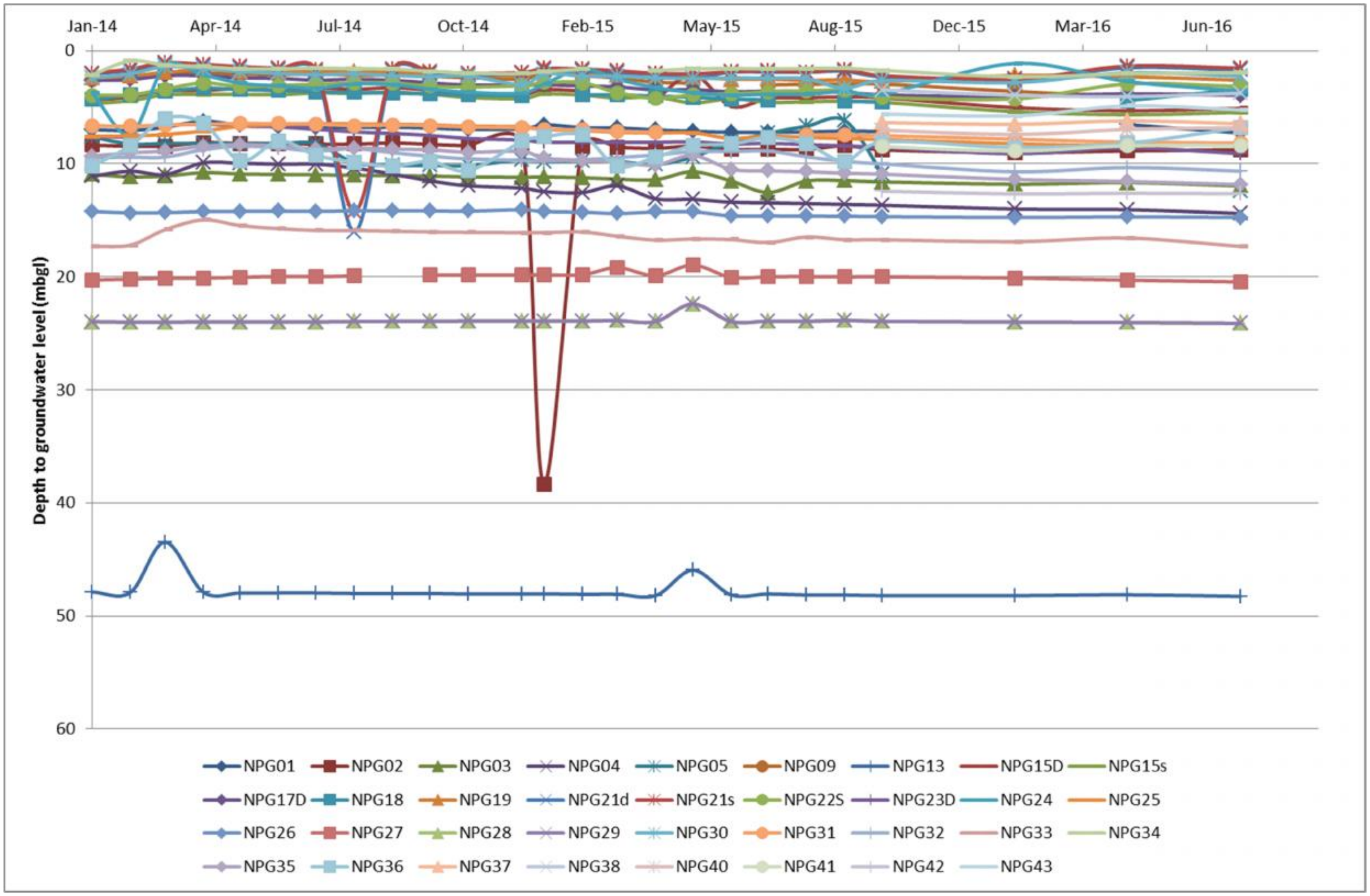


Figure 4.3: Depth to groundwater level over time.

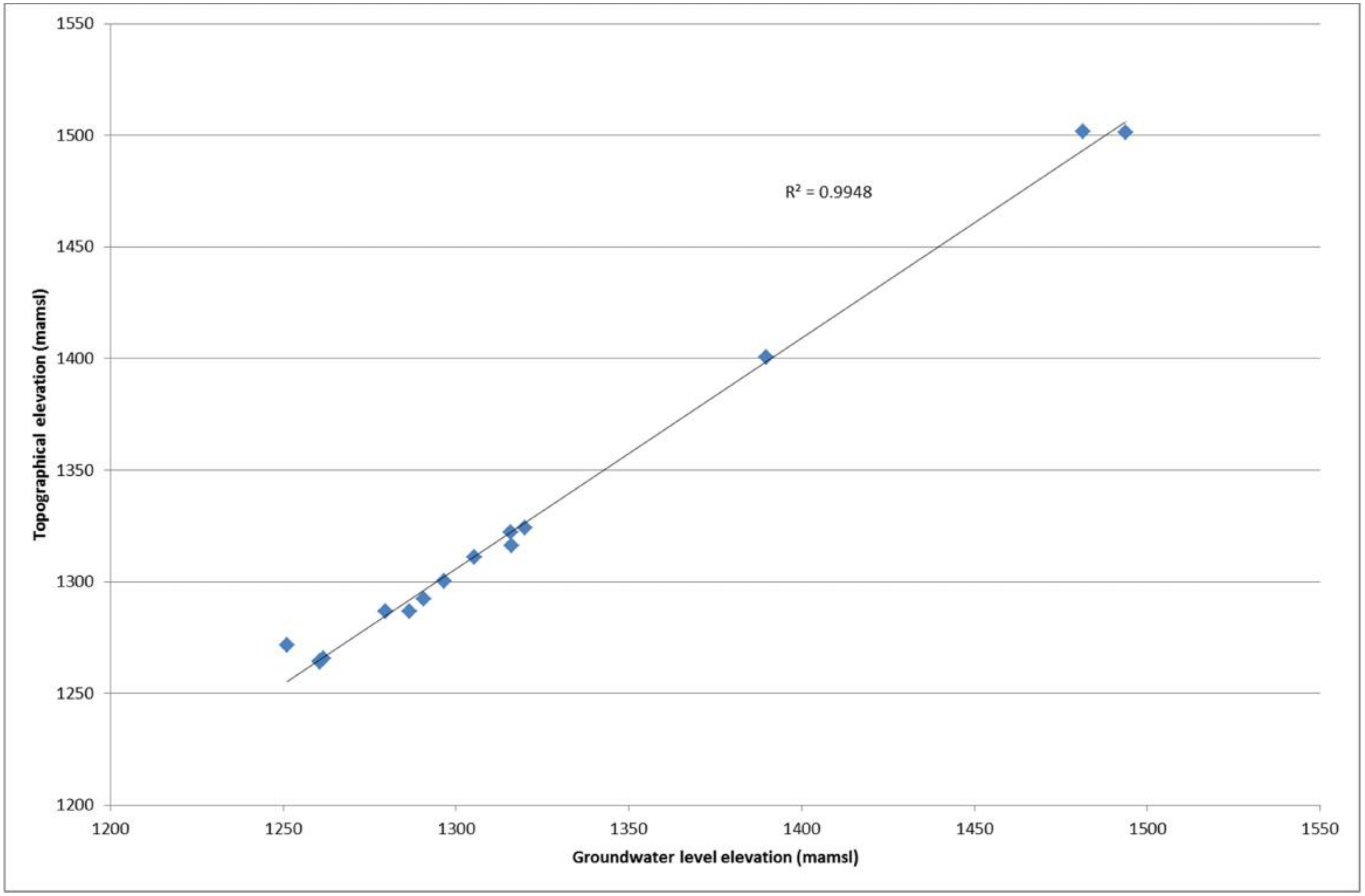


Figure 4.4: Topographical versus groundwater level elevation plot.

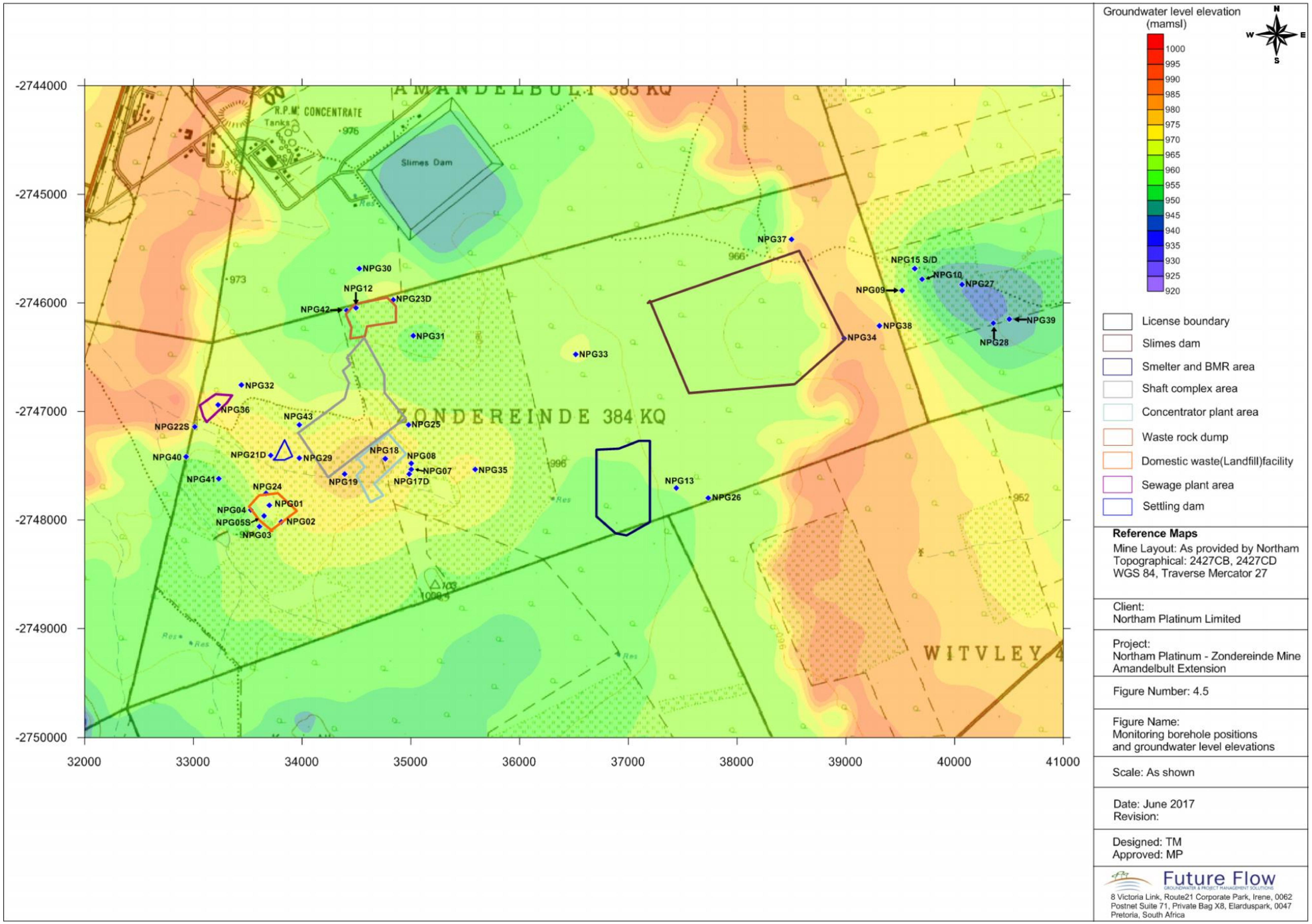

Groundwater level elevation (mamsl)
1000
995
990
985
980
975
970
965
960
955
950
945
940
935
930
925
920
License boundary
Slimes dam
Smelter and BMR area
Shaft complex area
Concentrator plant area
Waste rock dump
Domestic waste(Landfill)facility
Sewage plant area
Settling dam
Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27
Client:
Northam Platinum Limited
Project:
Northam Platinum - Zondereinde Mine
Amandelbult Extension
Figure Number: 4.5
Figure Name:
Monitoring borehole positions
and groundwater level elevations
Scale: As shown
Date: June 2017
Revision:
Designed: TM
Approved: MP
Future Flow
8 Victoria Link, Route21 Corporate Park, Irene, 0062
Postnet Suite 71, Private Bag X8, Elarduspark, 0047
Pretoria, South Africa
ZONDEREINDE 384 KQ
WITVLEY
Slimes Dam
NPG37
NPG15 S/D
NPG10
NPG09
NPG27
NPG38
NPG39
NPG34
NPG28
NPG30
NPG12
NPG42
NPG23D
NPG31
NPG33
NPG32
NPG36
NPG22S
NPG43
NPG25
NPG40
NPG21D
NPG29
NPG18
NPG08
NPG07
NPG35
NPG19
NPG17D
NPG41
NPG24
NPG01
NPG04
NPG05S
NPG02
NPG03
NPG13
NPG26
-2744000
-2745000
-2746000
-2747000
-2748000
-2749000
-2750000
32000
33000
34000
35000
36000
37000
38000
39000
40000
41000

Table 4.1: Monitoring borehole details

BH	East	South	Elevation	Groundwater level (July 2016)		Remarks
	WGS84, LO27	WGS84, LO27	mamsl	mbgl	mamsl	
NPG01	33 701.58	-2 747 862.34	972.67	7.27	965.40	Too low
NPG02	33 812.40	-2 748 017.69	979.44	8.75	970.69	Dry at 8.75
NPG03	33 610.12	-2 748 061.50	974.39	11.95	962.44	Clear
NPG04	33 529.63	-2 747 906.23	973.58	14.4	959.18	Clear
NPG05S	33 650.80	-2 747 961.91	967.93	12.4	955.53	Locked
NPG07	35 006.43	-2 747 533.27	986.61	--	-	Dry at 1 m
NPG08	35 006.57	-2 747 477.89	986.88	-	-	Demolished
NPG09	39 519.71	-2 745 883.87	954.72	3.7	951.02	Turbid
NPG10	39 701.98	-2 745 784.70	950.96	10	940.96	Dry at 10 m
NPG12	34 494.59	-2 746 047.63	982.74	11	971.74	Dry at 11 m
NPG13	37 442.20	-2 747 705.83	978.24	48.27	929.97	Clear
NPG15D	39 631.49	-2 745 684.80	952.71	5.1	947.61	Clear
NPG15S	39 631.49	-2 745 684.80	952.71	5.45	947.26	Clear
NPG17D	34 986.10	-2 747 577.53	985.48	3.95	981.53	Clear
NPG17S	34 986.10	-2 747 577.53	985.48	1	984.48	Blocked at 1 m
NPG18	34 764.07	-2 747 432.96	984.82	3.39	981.43	Clear
NPG19	34 389.68	-2 747 576.03	981.55	2.6	978.95	Clear
NPG21D	33 712.80	-2 747 408.20	975.20	1.72	973.48	Clear
NPG21S	33 712.80	-2 747 408.20	975.20	1.54	973.66	Clear
NPG22S	33 015.93	-2 747 140.66	965.65	3.16	962.49	Clear
NPG23D	34 838.52	-2 745 970.96	979.41	9.1	970.31	Clear
NPG24	33 671.53	-2 747 751.49	975.72	3.56	972.16	Clear
NPG25	34 977.14	-2 747 123.34	986.56	8.26	978.30	Clear
NPG26	37 735.11	-2 747 795.24	972.47	14.75	957.72	Clear
NPG27	40 065.81	-2 745 830.06	949.48	20.45	929.03	Clear
NPG28	40 357.97	-2 746 185.39	947.30	24.11	923.19	Clear
NPG29	33 975.58	-2 747 431.00	975.93	2.25	973.68	Turbid
NPG30	34 525.84	-2 745 682.16	975.63	8.17	967.46	Turbid
NPG31	35 019.66	-2 746 303.73	983.20	10.65	972.55	Clear
NPG32	33 441.45	-2 746 753.98	974.46	8.02	966.44	Turbid
NPG33	36 515.45	-2 746 473.77	990.59	17.3	973.29	Clear
NPG34	38 982.63	-2 746 325.44	960.70	1.93	958.77	Clear
NPG35	35 592.74	-2 747 534.77	992.00	11.83	980.17	Clear
NPG36	33 228.70	-2 746 941.78	972.21	6.8	965.41	Clear
NPG37	38 497.88	-2 745 412.42	965.14	6.45	958.69	Clear
NPG38	39 306.47	-2 746 208.94	957.33	3.76	953.57	Clear
NPG39	40 500.62	-2 746 152.57	947.41	14	933.41	Dry at 14 m
NPG40	32 934.39	-2 747 418.50	967.02	6.8	960.22	Clear
NPG41	33 232.12	-2 747 620.82	971.50	8.37	963.13	Clear
NPG42	34 406.59	-2 746 067.35	980.87	12.64	968.23	Clear
NPG43	33 977.35	-2 747 121.95	978.21	5.23	972.98	Clear

mbgl = metres below ground level
mamsl = metres above mean sea level
All coordinates are provided in Transverse Mercator projection (LO27), and WGS84 datum

4.4. Groundwater Potential Contaminants

4.4.1. Underground Mining Area

The underground workings at the Existing MRA are located at depths of 1 294 to 2 300 mbgl. The Extended MRA will be at similar and greater depths. It is not expected that there will an active aquifer at those depths. The Shaft is lined and it is not expected that after closure, when the underground mine area is eventually submerged, there will be significant seepage from the Shaft area into the surrounding aquifers. Additionally, there are no groundwater users accessing water from that depth. Based on this, it is considered that an underground mine at the Extended MRA will not be a significant risk to the active aquifers at depths shallower than 100 to 150 mbgl.

4.4.2. Surface Infrastructure

As mentioned previously in the report, the fact that the life of mine, as well as the volume of material handled on site, do not increase compared to the originally approved EMP specifications, no significant increase in the impacts are expected.

However, in order to understand the overall impacts from the mining operations, which include underground mining, process, and surface storage, it is important to refer to the existing impacts from the Existing MRA. There are no surface pollution sources on the Extended MRA. Groundwater contamination from the Existing MRA has a limited plume and will not migrate onto the Extended MRA. No cumulative impacts are thus anticipated due to the Project.

Analysis of the groundwater quality in the Existing MRA as obtained from the groundwater monitoring program results show that there is a marked difference between contaminated and uncontaminated groundwater in the Existing MRA.

4.4.2.1. General background (un-contaminated) groundwater quality trends

- Background chloride concentrations in monitoring boreholes range within 100 – 250 mg/L:
  - Borehole NPG24 (Domestic waste);
  - NPG32 and NPG36 (Sewage Plant area); and
  - NPG33 (Slimes Dam area).
- Background sulphate concentrations in monitoring boreholes range within 10 – 100 mg/L:
  - NPG24 (Domestic waste);
  - NPG17D, NPG25 and NPG35 (Concentrator Plant area);
  - NPG12 (WRD area);
  - NPG22S, NPG32 and NPG36 (Sewage Treatment Facility);
  - NPG13 (Smelter and BMR area); and
  - NPG33 (Slimes Dam area).

4.4.2.2. General contaminated groundwater quality trends

- Elevated chloride concentrations in monitoring boreholes range between 800 – 2 000 mg/L:
  - Borehole NPG01, NPG02, NPG04 and NPG05S (Domestic waste);
  - NPG17D, NPG18, NPG19, NPG25 and NPG35 (Concentrator Plant area);
  - NPG26 (Smelter and BMR area); and

  - NPG09, NPG15, NPG27, NPG28 and NPG34 (Slimes Dam area).
- Elevated sulphate concentrations in monitoring boreholes range between 300 – 2 000 mg/L:
  - NPG01 and NPG02 (Domestic waste);
  - NPG18 and NPG19 (Concentrator Plant area);
  - NPG23D and NPG30 (WRD area);
  - NPG26 (Smelter and BMR area); and
  - NPG27 and NPG34 (Slimes Dam area).

4.4.2.3. Identified Pollution Sources

From a previous contaminant plume delineation study (Future Flow, October 2015), it was concluded that there are a total of seven potential pollution areas:

- Domestic waste disposal site;
- Concentrator Plant Area and Evaporation Dam;
- WRD;
- Sewage Treatment Facility;
- Smelter and BMR;
- Slimes and RWD; and
- Settling Dam.

4.5. Groundwater Quality

The groundwater quality is monitored by boreholes in close proximity to potential pollution sources at the Existing MRA. The monitoring data indicates that there is no widespread contamination in the Existing MRA but limited to within less than 400 m from surface sources. During 2014 six additional monitoring boreholes (NPG37 to NPG43) were drilled near the identified pollution sources in order to confirm the contamination sources in the Study Area and better monitor contaminant plume development.

It should be noted that there is no evidence of contamination from the underground mine in the Existing MRA. Based on this, and with no surface infrastructure planned within the Extended MRA, it is concluded that there is no notable risk of pollution in the Extended MRA to the active aquifers at depths shallower than 100 to 150 mbgl.

4.5.1. Domestic Waste Disposal Site

The groundwater level in the landfill is kept below the lowest level of the waste, using a sump located in the lowest topographical elevation of the Waste Disposal Site. This aims to minimise the formation and migration of leachate from the landfill area.

Chloride concentration trends average 650 to 1 190 mg/L, exceeding the 300 mg/L SANS 241:2015 guideline value. Monitoring boreholes NPG01, NPG02, NPG04 and NPG05, which are situated within the domestic Waste Disposal Site, show average chloride concentration trends exceeding 800 mg/L (refer to Figure 4.6). The contamination from the Waste Disposal Site has migrated 390 m downgradient and is identified by the elevated average chloride concentration of 800 mg/L in the newly drilled borehole NPG41.

4.5.2. Concentrator Plant Area and Evaporation Dam

The majority of the Concentrator Plant area is paved and tarred, in an attempt to limit contamination by reducing recharge into the underlying aquifer.

Figure 4.7 shows that the chloride concentrations in monitoring boreholes NPG17D, NPG18, NPG19 and NPG29 are consistently above the 300 mg/L SANS 241:2015 chloride guideline with a maximum average concentration of 1 020 mg/L recorded in borehole NPG19 near the concentrator plant area. Borehole NPG25 shows an elevated chloride average of 1 295 mg/L; it is likely that the contamination identified in this borehole is from the WRD with similar average chloride concentrations.

4.5.3. The WRD

The new and old WRD facilities are being reworked; therefore, there is minimal waste material on the dump site. Poor groundwater qualities in the area are an indication of the historical impacts on the underlying aquifer.

The average chloride concentration in the waste dump area is above the 300 mg/L SANS241:2015 guideline and range between 895 and 1 280 mg/L (refer to Figure 4.8).

4.5.4. Sewage Treatment Facility

In Figure 4.9 it can be seen that monitoring boreholes NPG22S and newly drilled NPG40 located down-gradient of the Sewage Treatment Facilities show elevated chloride concentrations of 485 mg/L and 530 mg/L above the SANS 241:2015 guideline of 300 mg/L.

4.5.5. Smelter and BMR

The monitoring boreholes located in the Smelter and BMR area show varying depths to groundwater level (NPG26 at 14 mbgl and NPG13 at 48 mbgl) though they are located less than 300 m apart (refer to Figure 4.10). Borehole NPG 26 shows a chloride concentration of 1 710 mg/L, which exceeds the SANS241:2015 water quality guidelines. The average chloride concentration exceeds the one found in borehole NPG13.

4.5.6. Slimes Dam and RWD

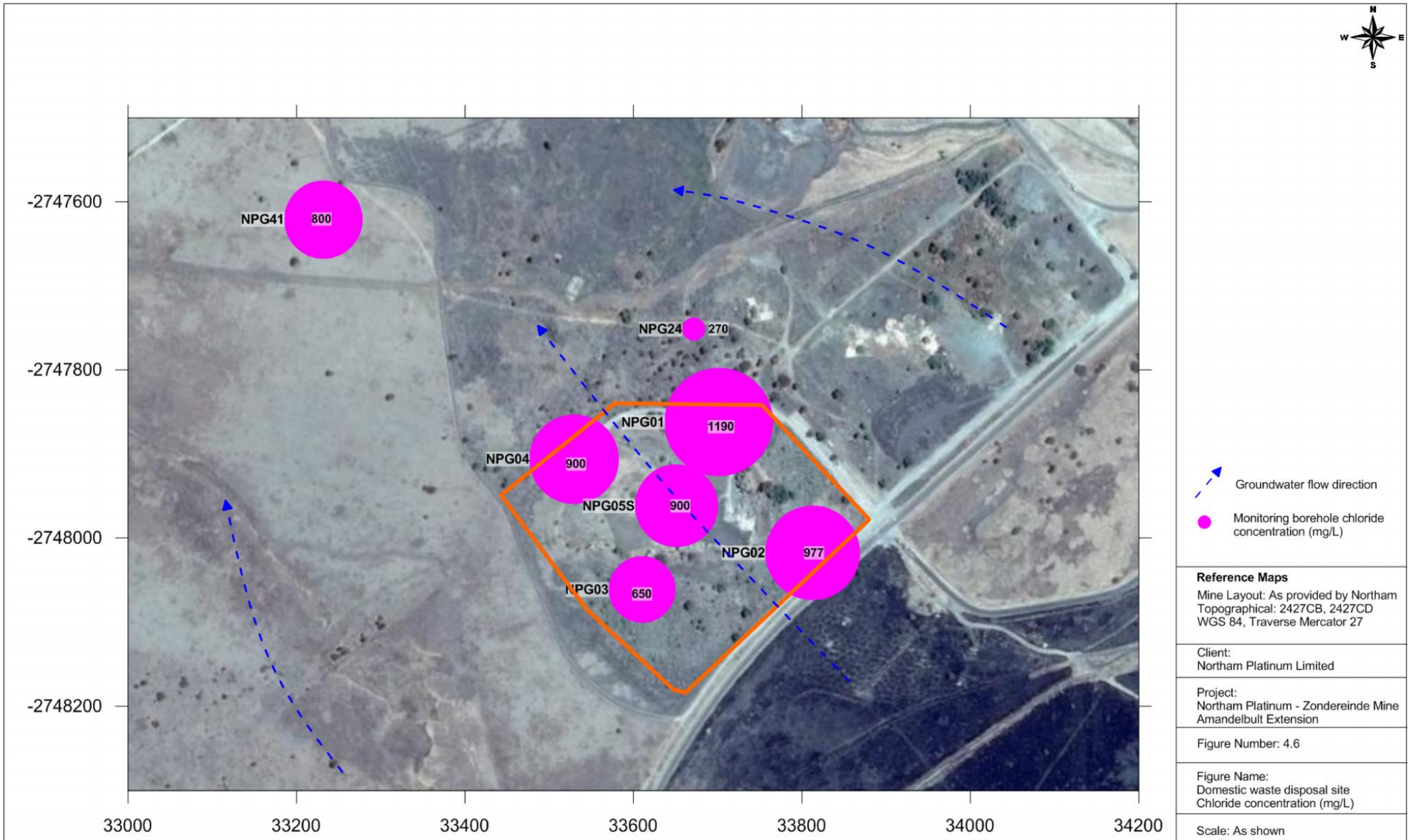
The chloride concentration in the up-gradient monitoring borehole NPG33 (51 mg/L) complies with the SANS241:2015 guidelines, whereas down gradient chloride concentrations vary between 1 160 and 1 810 mg/L above the 300 mg/L standard as shown in Figure 4.11.

Monitoring borehole NPG37 was drilled to determine whether there is contamination from the older Slimes Dam, located north of the new Slimes Dam. The average chloride concentration in the borehole is 2 555 mg/L, which is higher than the averages from the monitoring boreholes down-gradient of the new Slimes Dam.

4.5.7. Settling Dam

The Settling Dam is located in a non-perennial tributary to the Bierspruit (refer to Figure 4.12). The Dam aims to collect potentially contaminated surface run off from the Concentrator Plant area.

Monitoring borehole NPG21D shows that the Settling Dam does not effectively collect the contaminated surface run off from the Concentrator because the average chloride concentration is 580 mg/L, which exceeds the permissible SANS 241:2015 guideline value of 300 mg/L. Newly drilled monitoring borehole NPG43 indicates the chloride contamination has not extended beyond the Shaft complex area. The elevated concentration of 800 mg/L in borehole NPG41 is not from the Settling Dam but rather from the old Sewage Treatment Facility.



Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27

Client:
Northam Platinum Limited

Project:
Northam Platinum - Zondereinde Mine Amandelbult Extension

Figure Number: 4.6

Figure Name:
Domestic waste disposal site
Chloride concentration (mg/L)

Scale: As shown

Date: June 2017
Revision:

Designed: TM
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Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27

Client:
Northam Platinum Limited

Project:
Northam Platinum - Zondereinde Mine Amandelbult Extension

Figure Number: 4.7

Figure Name:
Concentrator plant area and evaporation dam
Chloride concentration (mg/L)

Scale: As shown

Date: June 2017
Revision:

Designed: TM
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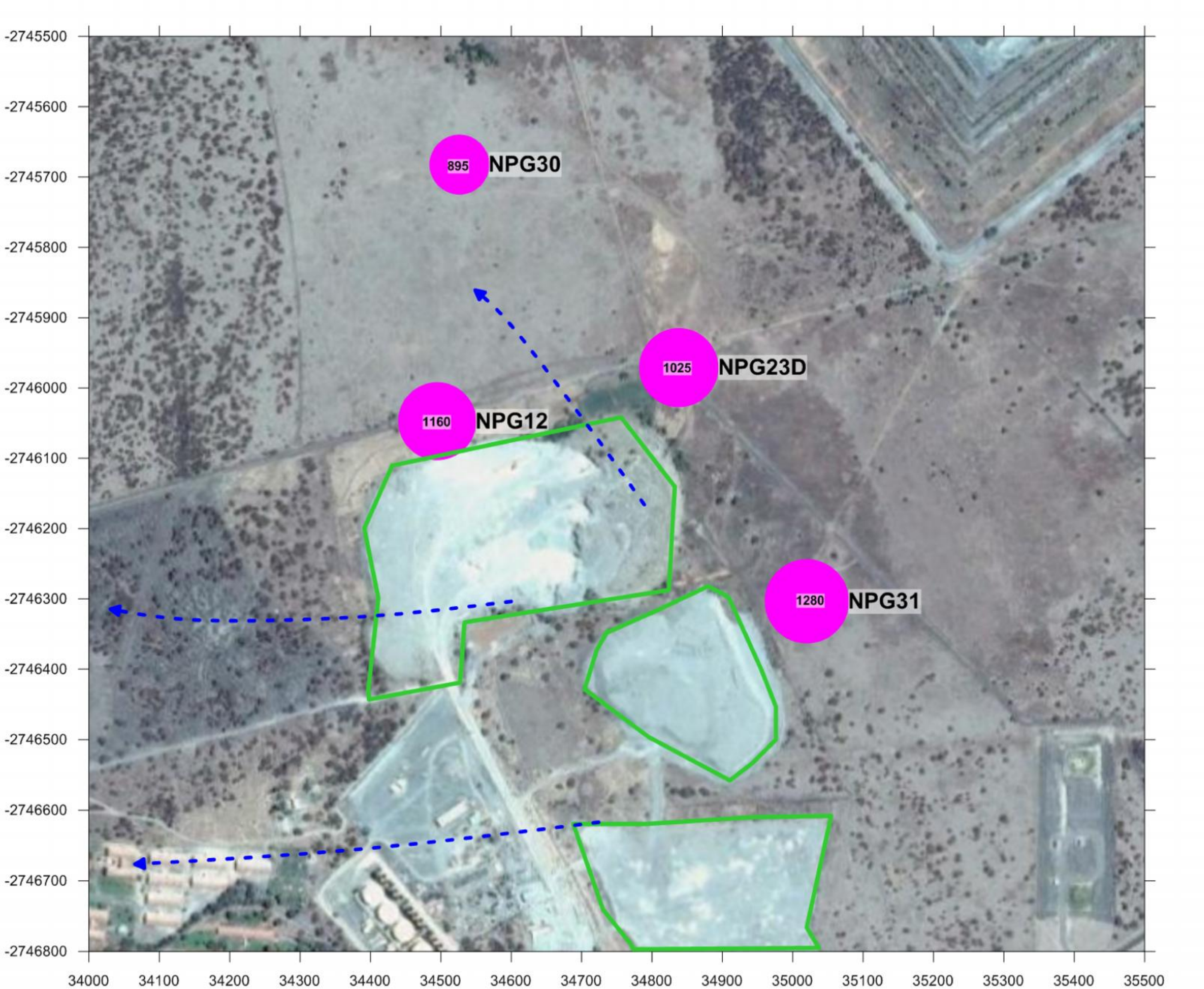
Pretoria, South Africa



Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27

Client:
Northam Platinum Limited

Project:
Northam Platinum - Zondereinde Mine

Figure Number: 4.8

Figure Name:
Waste rock dump
Chloride concentration (mg/L)

Scale: As shown

Date: June 2017
Revision:

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Reference Maps Mine Layout: As provided by Northam Topographical: 2427CB, 2427CD WGS 84, Traverse Mercator 27	
Client: Northam Platinum Limited	
Project: Northam Platinum - Zondereinde Mine Amandelbult Extension	
Figure Number: 4.9	
Figure Name: Sewage treatment facility Chloride concentration (mg/L)	
Scale: As shown	
Date: June 2017 Revision:	
Designed: TM Approved:	
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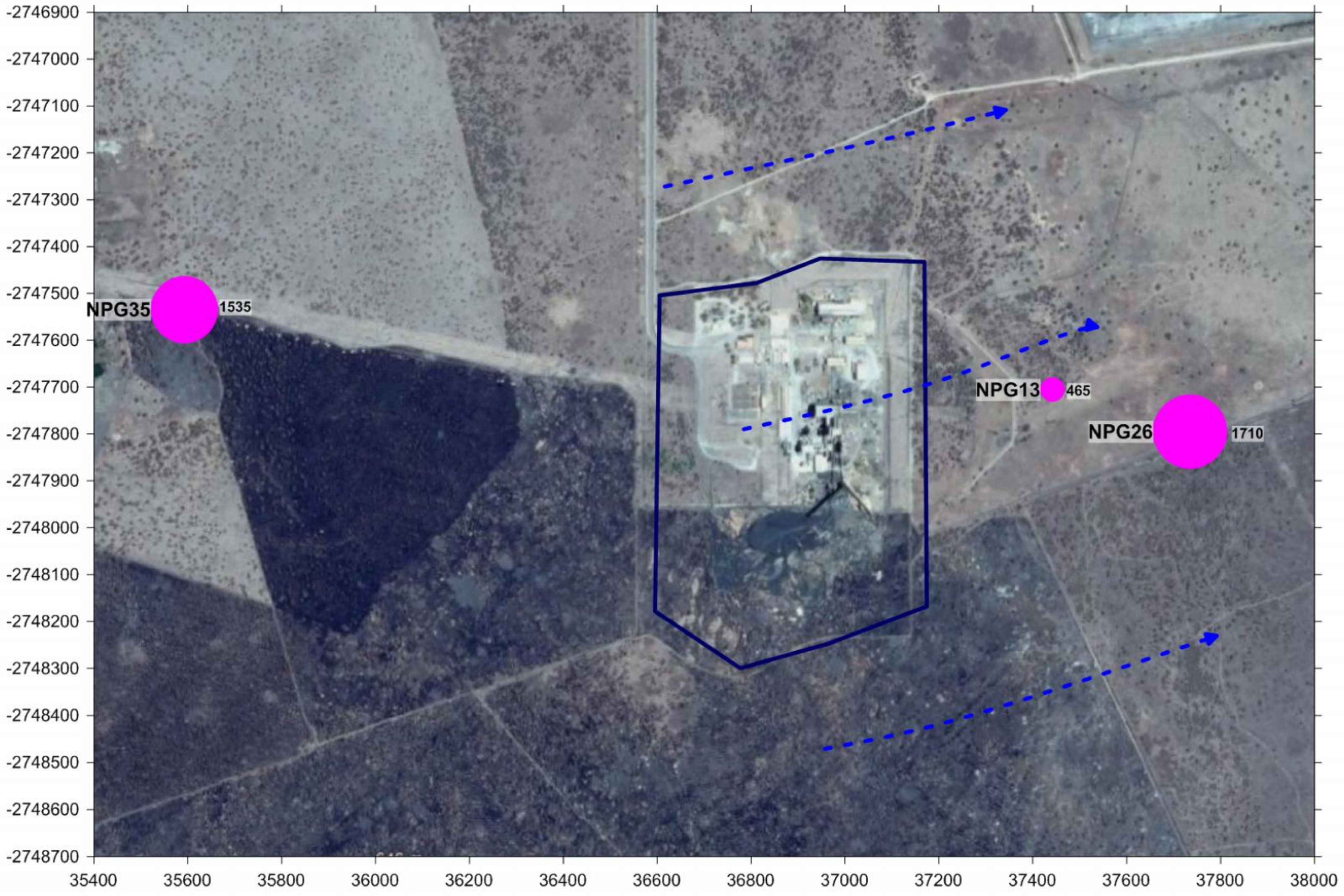

N
W E
S

Smelter and BMR

Groundwater flow direction

Monitoring borehole chloride concentration (mg/L)

Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27

Client:
Northam Platinum Limited

Project:
Northam Platinum - Zondereinde Mine
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Figure Number: 4.10

Figure Name:
Smelter and base metal refinery
Chloride concentration (mg/L)

Scale: As shown

Date: June 2017
Revision:

Designed: TM
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Reference Maps

Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
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Client:
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Project:
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Figure Number: 4.11

Figure Name:
Slimes and return water dam Chloride concentration (mg/L)

Scale: As shown

Date: June 2017
Revision:

Designed: TM
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Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
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Client:
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Project:
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Figure Number: 4.12

Figure Name:
Settling dam
Chloride concentration (mg/L)

Scale: As shown

Date: June 2017
Revision:

Designed: TM
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5. Aquifer Characterisation

5.1. Groundwater Vulnerability

For aquifer vulnerability reference is made to the aquifer vulnerability map of South Africa, which shows a low aquifer vulnerability for the Study Area.

5.2. Aquifer Classification

The aquifers present in the Study Area are classified as minor aquifer but of high importance to the local landowners, as it is their sole source of water for domestic and agricultural (stock watering and irrigation) purposes.

6. Geohydrological Impacts

The environmental impact assessment is conducted based on the available information and analytical assessments. Reference was also made to the numerical model results from the Numerical Contaminant Transport Model Update Study that was done for the Zondereinde Mine during November 2016.

Impacts from the proposed underground mining activities on the Extended MRA, and from the surface infrastructure on the Existing MRA were evaluated and include impacts on:

- groundwater levels, flow patterns and volumes;
- groundwater qualities and plume migration; and
- surface water qualities due to poor quality groundwater seeping into the surface water in the form of baseflow contribution.

During the risk assessment, the risk to the groundwater levels and quality were evaluated. Each of the identified risks was then rated. The rating methodology used is as described in Table 6.1.

The rating is described as follows:

Score out of 100	Significance
1 to 20	Low
21 to 40	Moderate to Low
41 to 60	Moderate
61 to 80	Moderate to high
81 to 100	High

Will **mitigation** be possible (yes or no)? Mitigation measures are further discussed in the EMP section, where post mitigation significance of impacts is also given.

The **Degree of irreplaceable loss of resource** has also been evaluated in the impact assessment table. This has been rated in three categories, including:

Degree of loss	
Low	The resource is renewable or able to recover and therefore negligible loss expected.
Moderate	Resource is at risk of permanent loss but management measures can reduce risk of loss or resource can recover over time or with rehabilitation efforts.
High	Resource will be severely affected and loss will be irreplaceable or very long term, or rehabilitation efforts would be unduly expensive and not economically viable.

Table 6.1: Impact rating methodology.

The status of an impact		
Score	**Status**	**Description**
Pos	Positive:	a benefit to the holistic environment
Neg	Negative:	a cost to the holistic environment
Neut	Neutral:	no cost or benefit
The duration of the impact		
Score	**Duration**	**Description**
1	Short term	Less than 2 years
2	Short to medium term	2 – 5 years
3	Medium term	6 – 25 years
4	Long term	26 – 45 years
5	Permanent	46 years or more
The extent of an impact		
Score	**Extent**	**Description**
1	Site specific	Within the site boundary
2	Local	Affects immediate surrounding areas
3	Regional	Extends substantially beyond the site boundary
4	Provincial	Extends to almost entire province or larger region
5	National	Affects country or possibly world
The reversibility of the impact		
Score	**Reversibility**	**Description**
1	Completely reversible	Reverses with minimal rehabilitation & negligible residual affects
3	Reversible	Requires mitigation and rehabilitation to ensure reversibility
5	Irreversible	Cannot be rehabilitated completely/rehabilitation not viable
The effect (severe or beneficial) of the impact		
Score	**Severe/beneficial effect**	**Description**
1	Slight	Little effect - negligible disturbance/benefit
2	Slight to moderate	Effects observable - environmental impacts reversible with time
3	Moderate	Effects observable - impacts reversible with rehabilitation
4	Moderate to high	Extensive effects - irreversible alteration to the environment
5	High	Extensive permanent effects with irreversible alteration
The probability of the impact		
Score	**Rating**	**Description**
1	Unlikely	Less than 15% sure of an impact occurring
2	Possible	Between 15% and 40% sure of an impact occurring
3	Probable	Between 40% and 60% sure that the impact will occur
4	Highly Probable	Between 60% and 85% sure that the impact will occur
5	Definite	Over 85% sure that the impact will occur

The Consequence	= Severity + Spatial Scale + Duration + Reversibility.
The Significance	= Consequence x Probability.

6.1. Construction Phase

Underground mining operations are in progress and the surface infrastructure is operational at the Existing MRA. Mined material is brought to surface, processed, and the tailings material deposited on the TSF. The Extended MRA will only be an extension to the underground mine and current production rates will be maintained. No new infrastructure will be established. Therefore, there is no Construction Phase that has to be evaluated.

6.2. Operational Phase

6.2.1. Impacts on Groundwater Levels

The underground mining operations at the Extended MRA will be at depths of 2 300 mbgl or deeper. The underground mining operations at the Existing MRA range in depth between 1 294 and 2 300 mbgl. From the groundwater level monitoring data (please refer to Section 4.3 and Figure 4.3), it can be seen that the previous underground mining operations at the Extended MRA had no impacts on the groundwater levels in the Study Area.

Based on the historic groundwater level data showing that there is no impact on the groundwater levels in the active aquifers in the area, and also due to the underground mining in the Extended MRA being as deep, and deeper than the current mining at the Existing MRA, it is concluded that there will be no impact on the groundwater levels in the Extended MRA.

6.2.2. Groundwater Contamination

6.2.2.1. Underground Mining Area

The underground mining areas of the Existing MRA and Extended MRA are and will be is located at depths of 1 294 to 2 300 m and greater. It is considered that there is no active aquifer at these depths. Any groundwater that does occur at these depths, or along the Shaft area, and enters the underground mine will be dewatered and pumped to surface at the Existing MRA, where it will be handled in the existing water management dams.

Due to mine dewatering taking place where required, any groundwater flows that occur at the depth of the underground mining at the Extended MRA will be towards the Extended MRA. This will prevent any underground contamination within the Extended MRA from migrating away from the Extended MRA.

6.2.2.2. Surface Infrastructure on the Existing MRA

As discussed in Section 4.4.2 of this report, there are a number of surface areas where contamination of the groundwater resource occurs on the Existing MRA. These include:

- Domestic Waste Disposal Site
- Concentrator Plant area and Evaporation Dam
- WRD

- Sewage Treatment Facility
- Smelter and BMR
- Slimes and RWD
- Settling Dam

The historic (since 1991 to date), and expected future development of the contaminant plume on the Existing MRA away from the potential pollution source areas was simulated during November 2016 using the 3-D numerical groundwater flow and contaminant transport model. The source concentrations were established from the monitoring program results. Based on the chemical analysis results chloride source concentrations for the potential pollution source areas on the Existing MRA are:

- Domestic Waste Disposal Site – 1 200 mg/L;
- Concentrator Plant area – 1 500 mg/L;
- WRD – 1 200 mg/L;
- Sewage Plant – 500 mg/L;
- Smelter and BMR area – 1 500 mg/L;
- Slimes Dam and RWD – 1 500 mg/L; and
- Settling Dam – 600 mg/L.

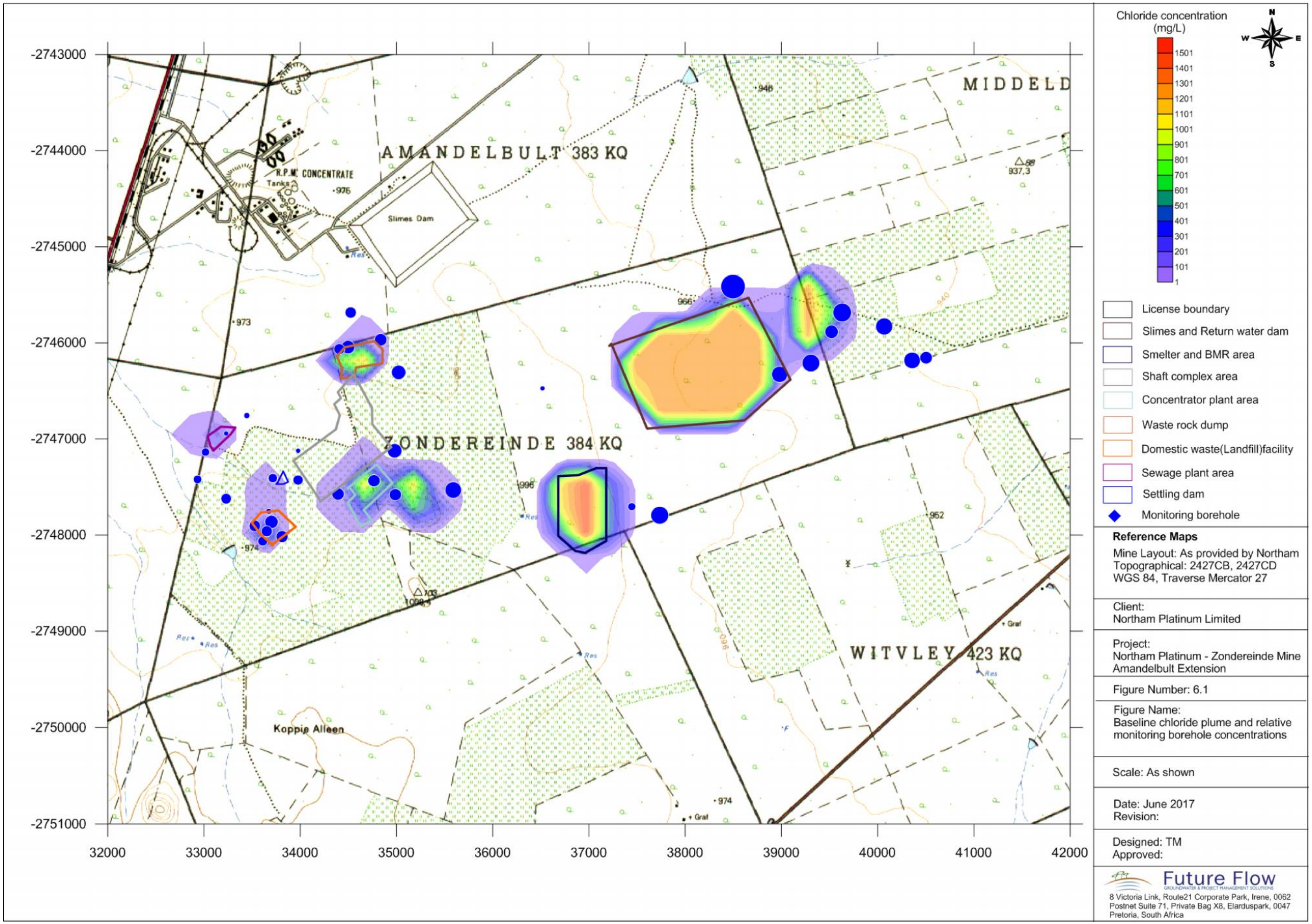
As a first step to the numerical modelling, a baseline contaminant model was developed to calculate the historic contaminant migration on the Existing MRA away from the source areas since 1991. The calculated plume was controlled against the element concentrations obtained from the most recent available monitoring program results.

The baseline contaminant plume was then used to calculate the previous impacts from the Existing MRA on the underlying aquifers and the surrounding surface water bodies during the remaining life of operation.

The expected chloride plumes for the weathered material and fractured rock aquifer are shown in Figure 6.2 and Figure 6.3 respectively.

From Figure 6.2 it can be seen that at the end of the life of operations the plume will have migrated through the weathered material aquifer to a maximum of 550 m down gradient from the source area. The highest chloride concentration may be found in borehole NPG34, this is due to the borehole being located on the Slimes Dam perimeter and there therefore being little opportunity for natural attenuation and dilution of the chloride concentration during migration away from the Slimes Dam.

As noted above, there are no surface pollution sources on the Extended MRA. Groundwater contamination from the Existing MRA has a limited plume and will not migrate onto the Extended MRA. No cumulative impacts are thus anticipated due to the Project. There are numerous streams in the Study Area that appear to be non-perennial. The modelling results show that none of them fall within the zone of influence of the contaminant plumes on the Existing MRA and therefore it is not expected that the surface infrastructure on the Existing MRA will have any impact on the stream water qualities in the Study Area.


Chloride concentration
(mg/L)
1501
1401
1301
1201
1101
1001
901
801
701
601
501
401
301
201
101
1
N
S
W
E
License boundary
Slimes and Return water dam
Smelter and BMR area
Shaft complex area
Concentrator plant area
Waste rock dump
Domestic waste(Landfill)facility
Sewage plant area
Settling dam
Monitoring borehole
Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27
Client:
Northam Platinum Limited
Project:
Northam Platinum - Zondereinde Mine
Amandelbult Extension
Figure Number: 6.1
Figure Name:
Baseline chloride plume and relative
monitoring borehole concentrations
Scale: As shown
Date: June 2017
Revision:
Designed: TM
Approved:
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Pretoria, South Africa
AMANDELBULT 383 KQ
ZONDEREINDE 384 KQ
WITVLEY 423 KQ
MIDDELD
R.P.M. CONCENTRATE
Tanks
Slimes Dam
Koppie Alleen
-2743000
-2744000
-2745000
-2746000
-2747000
-2748000
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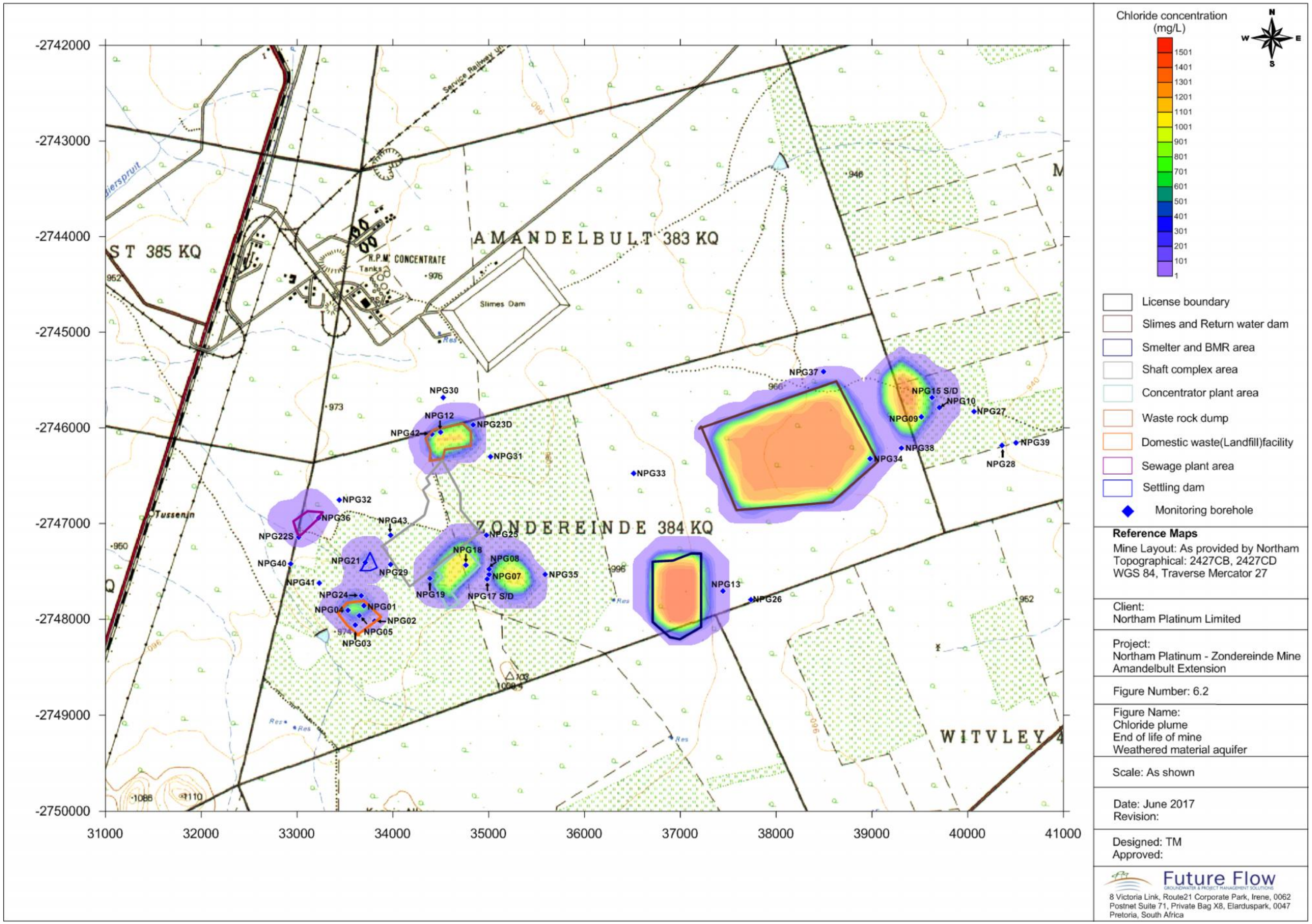
40000
41000
42000


Chloride concentration
(mg/L)
1501
1401
1301
1201
1101
1001
901
801
701
601
501
401
301
201
101
1
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W
E
S
License boundary
Slimes and Return water dam
Smelter and BMR area
Shaft complex area
Concentrator plant area
Waste rock dump
Domestic waste(Landfill)facility
Sewage plant area
Settling dam
Monitoring borehole
Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27
Client:
Northam Platinum Limited
Project:
Northam Platinum - Zondereinde Mine
Amandelbult Extension
Figure Number: 6.2
Figure Name:
Chloride plume
End of life of mine
Weathered material aquifer
Scale: As shown
Date: June 2017
Revision:
Designed: TM
Approved:
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Pretoria, South Africa
-2742000
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AMANDELBULT 383 KQ
ZONDEREINDE 384 KQ
ST 385 KQ
WITVLEY 4
R.P.M. CONCENTRATE
Slimes Dam
NPG30
NPG12
NPG42
NPG23D
NPG31
NPG33
NPG37
NPG15 S/D
NPG10
NPG27
NPG09
NPG38
NPG34
NPG39
NPG28
NPG32
NPG36
NPG22S
NPG43
NPG25
NPG18
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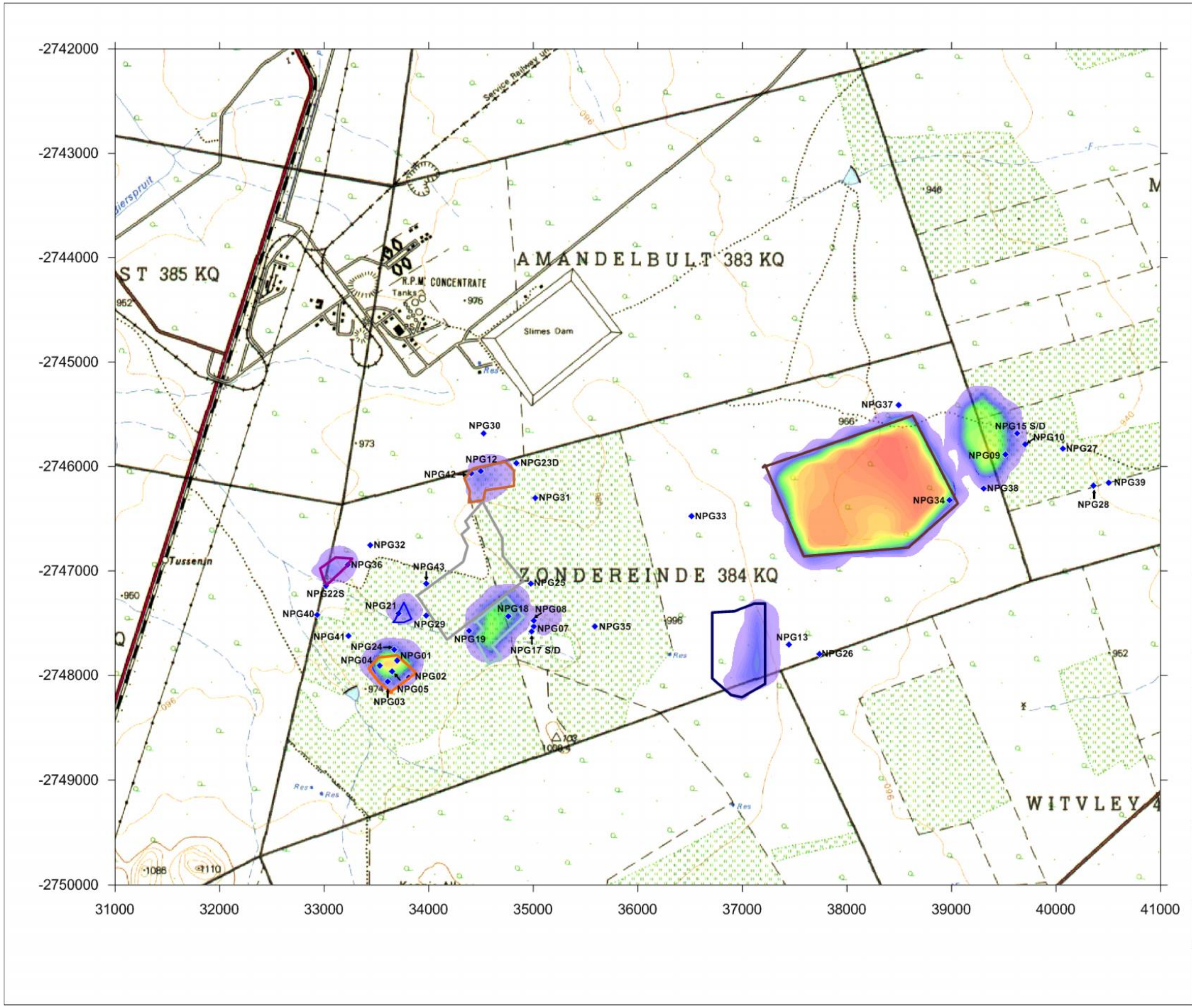
NPG03



Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27

Client:
Northam Platinum Limited

Project:
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Figure Number: 6.3

Figure Name:
Chloride plume
End of life of mine
Fractured rock aquifer

Scale: As shown

Date: June 2017
Revision:

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Table 6.2: Impact rating – Operational phase.

Impact	Status	Effect	Extent	Duration	Reversibility	Consequence	Probability	Significance	Mitigation	Degree of irreplaceable loss	Mitigation	Status	Effect	Extent	Duration	Reversibility	Consequence	Probability	Significance
Impacts on groundwater volumes due to active dewatering of the underground mining area	Neg	1	1	1	1	4	1	4	Y	Low	Monitor groundwater levels	Neg	1	1	1	1	4	1	4
Impacts on surface water and wetland volumes due to active dewatering of the underground mining area	Neg	1	1	1	1	4	1	4	N	Low	Monitor groundwater levels; Monitor stream flow volumes	Neg	1	1	1	1	4	1	4

6.3. Long term Post-Operational Phase

6.3.1. Recovery of Groundwater Levels and Decant Potential

In the post operational environment, groundwater levels and flow patterns in the area will recover to near pre-operational levels. The time required for recovery of the groundwater levels to near pre-operational levels in the Study Area will be dependent on a number of factors:

- There will be inflows into the underground mine from the surrounding aquifers. The inflow rate will depend to a large extent on the groundwater flow gradient between the groundwater level in the surrounding aquifers and the water level in the underground mine; and
- The total volume of the mined-out area that has to be submerged.

The total volume of the mined-out area is not known. In addition, the volume of groundwater seeping into the underground mine is also not known. Therefore, the time required for the underground mine to become submerged cannot be calculated. The underground mining area ranges in depth between 1 294 and 2 300 mbgl and deeper. At no point is the floor elevation of the underground mine above surface level. No decant is expected to occur.

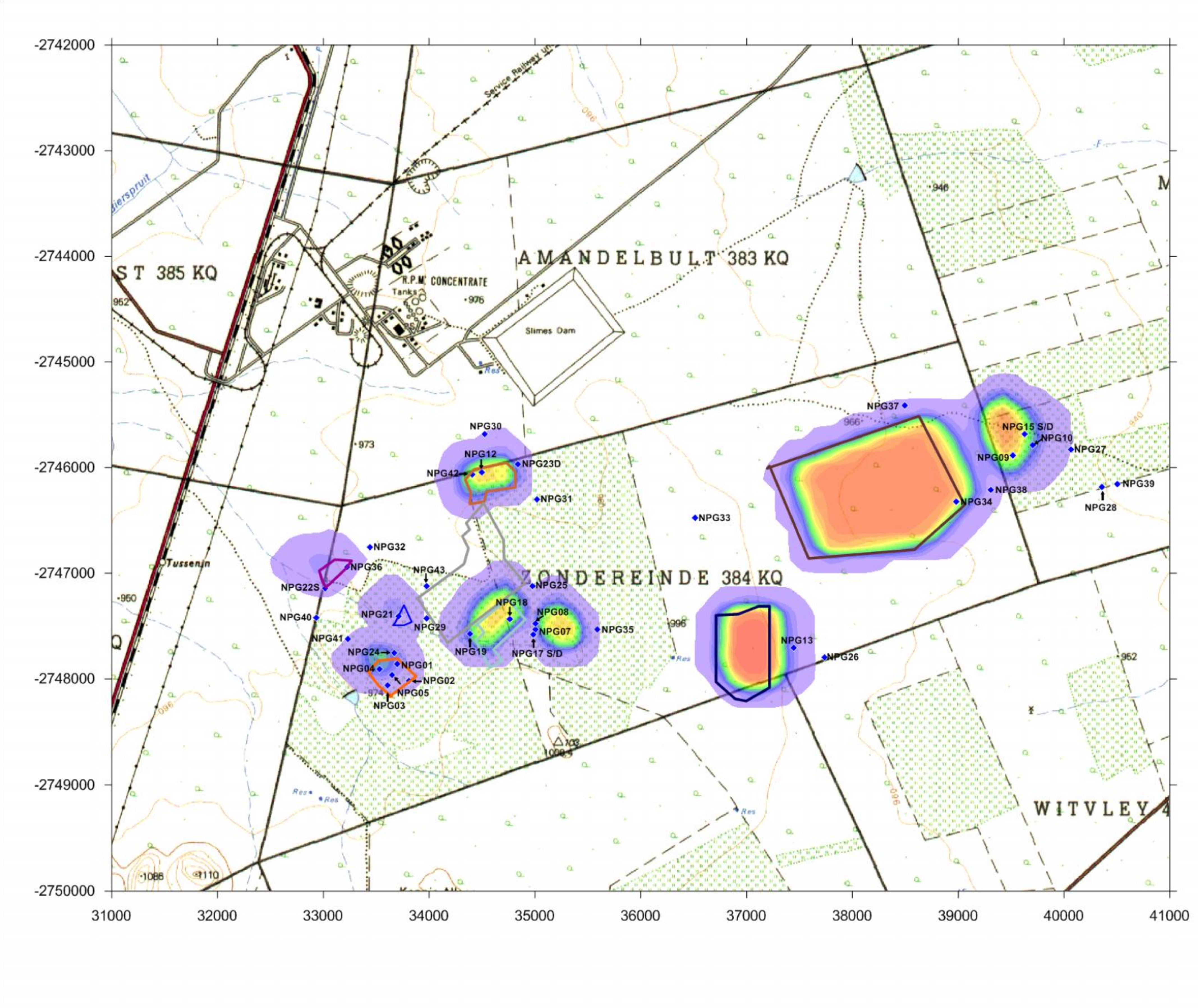
6.3.2. Contaminant Migration

Long term (up to 100 years after operational closure) contaminant migration pathways were simulated during 2016 using the numerical groundwater contaminant transport model, to determine the contaminant migration patterns. As discussed previously the life of operations is not extended, and therefore mining, processing and storage of the Extended MRA material does not add notably to the extent of the expected contaminant plumes at the end of life of operations.

Assessment of the expected plumes taking into consideration the Extended MRA is shown in Figure 6.4 to Figure 6.5. Figure 6.4 and Figure 6.5, reflecting the contaminant plume in the weathered material and fractured rock aquifers at 50 years post closure respectively. Figure 6.6 and Figure 6.7 show the contaminant plumes in the respective aquifers at 100 years post closure.

The contaminant plumes will migrate down gradient, away from the pollution source areas. The contamination from the Slimes Dam and RWD is expected to migrate up to 600 m east and will not reach the Crocodile River, which is 5 km east of the RWD. The majority of contamination from the Domestic Waste Disposal, Settling Dam and Sewage Plant areas is expected to migrate up to 700m west toward an unnamed non-perennial stream, through the shallow weathered material aquifer. The contaminant plumes will not reach the Bierspruit, which is 3.5 km north of the WRD and Sewage Plant.

The shallow weathered aquifer is likely to accumulate the elevated concentrations of chloride over time from the pollution source areas. The aquifer can be expected to contribute poor quality leachate to the unnamed non-perennial stream flow volumes through baseflow contribution during the rainy season. During the dry season, the impact through this aquifer on the non-perennial stream is expected to be minimal, due to the seasonal reduction in groundwater level in the aquifer.



Chloride concentration (mg/L)

1401, 1301, 1201, 1101, 1001, 901, 801, 701, 601, 501, 401, 301, 201, 101, 1

- License boundary
- Slimes and Return water dam
- Smelter and BMR area
- Shaft complex area
- Concentrator plant area
- Waste rock dump
- Domestic waste(Landfill)facility
- Sewage plant area
- Settling dam
- Monitoring borehole

Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
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Client:
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Figure Number: 6.4

Figure Name:
Chloride plume
50 years after closure
Weathered material aquifer

Scale: As shown

Date: June 2017
Revision:

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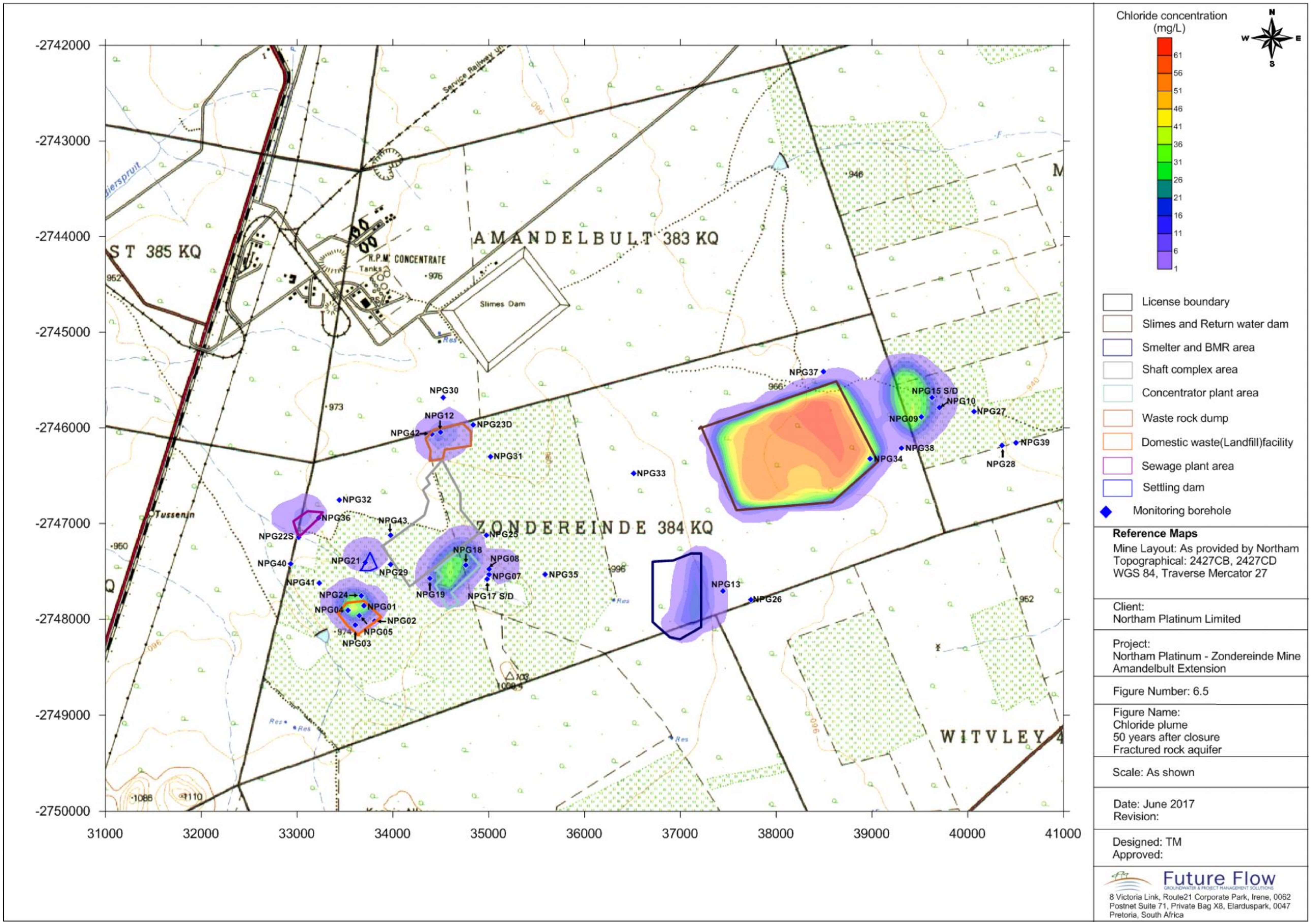
Chloride concentration (mg/L)
61
56
51
46
41
36
31
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License boundary
Slimes and Return water dam
Smelter and BMR area
Shaft complex area
Concentrator plant area
Waste rock dump
Domestic waste(Landfill)facility
Sewage plant area
Settling dam
Monitoring borehole
Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27
Client:
Northam Platinum Limited
Project:
Northam Platinum - Zondereinde Mine
Amandelbult Extension
Figure Number: 6.5
Figure Name:
Chloride plume
50 years after closure
Fractured rock aquifer
Scale: As shown
Date: June 2017
Revision:
Designed: TM
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AMANDELBULT 383 KQ
ZONDEREINDE 384 KQ
WITVLEY
R.P.M. CONCENTRATE
Slimes Dam
Service Railway
Tussenin
NPG37
NPG15 S/D
NPG10
NPG27
NPG09
NPG38
NPG39
NPG28
NPG34
NPG30
NPG12
NPG42
NPG23D
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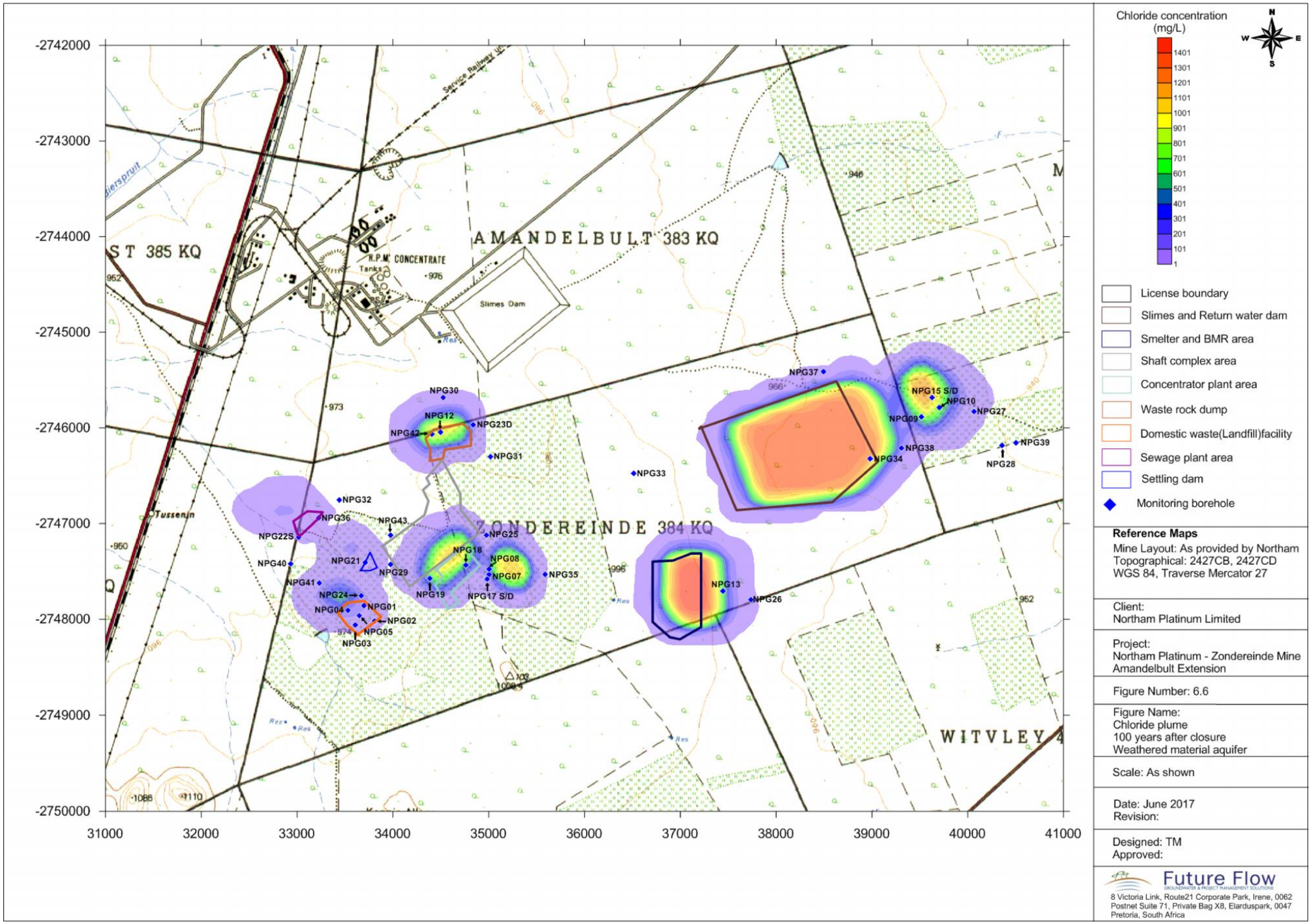
NPG26


Chloride concentration (mg/L)
1401
1301
1201
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1001
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S
License boundary
Slimes and Return water dam
Smelter and BMR area
Shaft complex area
Concentrator plant area
Waste rock dump
Domestic waste(Landfill)facility
Sewage plant area
Settling dam
Monitoring borehole
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Northam Platinum Limited
Project:
Northam Platinum - Zondereinde Mine
Amandelbult Extension
Figure Number: 6.6
Figure Name:
Chloride plume
100 years after closure
Weathered material aquifer
Scale: As shown
Date: June 2017
Revision:
Designed: TM
Approved:
Future Flow
8 Victoria Link, Route21 Corporate Park, Irene, 0062
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Pretoria, South Africa
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AMANDELBULT 383 KQ
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WITVLEY
ST 385 KQ
R.P.M. CONCENTRATE
Slimes Dam
Tussenin
NPG30
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NPG41
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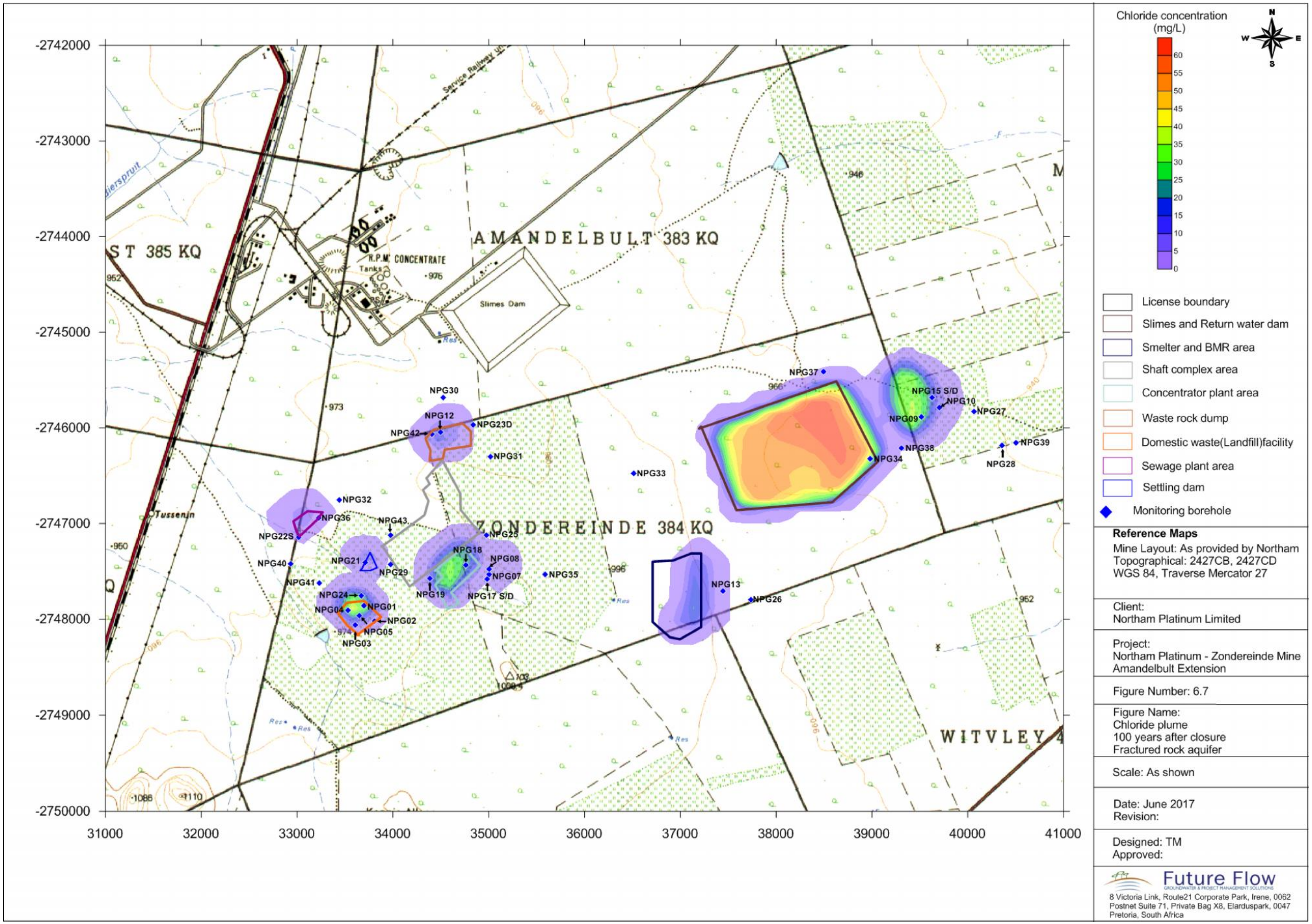
Chloride concentration (mg/L)
60
55
50
45
40
35
30
25
20
15
10
5
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N
W
E
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License boundary
Slimes and Return water dam
Smelter and BMR area
Shaft complex area
Concentrator plant area
Waste rock dump
Domestic waste(Landfill)facility
Sewage plant area
Settling dam
Monitoring borehole
Reference Maps
Mine Layout: As provided by Northam
Topographical: 2427CB, 2427CD
WGS 84, Traverse Mercator 27
Client:
Northam Platinum Limited
Project:
Northam Platinum - Zondereinde Mine
Amandelbult Extension
Figure Number: 6.7
Figure Name:
Chloride plume
100 years after closure
Fractured rock aquifer
Scale: As shown
Date: June 2017
Revision:
Designed: TM
Approved:
Future Flow
8 Victoria Link, Route21 Corporate Park, Irene, 0062
Postnet Suite 71, Private Bag X8, Elarduspark, 0047
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ST 385 KQ
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R.P.M. CONCENTRATE
Slimes Dam
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NPG12
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Table 6.3: Impact rating – long term post-operational phase.

Impact	Status	Effect	Extent	Duration	Reversibility	Consequence	Probability	Significance	Mitigation	Degree of irreplaceable loss	Mitigation	Status	Effect	Extent	Duration	Reversibility	Consequence	Probability	Significance
Recovery of groundwater level after dewatering stopped	Pos	1	1	1	1	4	1	4	N	Low	Positive impact – no remediation needed	-	-	-	-	-	-	-	-

7. Groundwater Monitoring System

7.1. Groundwater Monitoring Network

7.1.1. Source, Plume, Impact and Background Monitoring

Water monitoring is currently undertaken for the existing Zondereinde Mine's operations. A number of boreholes are being monitored for groundwater quality and levels. The monitoring boreholes cover relevant potential pollution sources at the Existing MRA (water management dams etc.). Please refer to Table 4.1 for the monitoring borehole details.

7.1.2. Monitoring Frequency

The current groundwater monitoring takes place on a quarterly basis.

7.2. Monitoring Parameters

Parameters and elements monitored for compliance with the Zondereinde Mine's WUL.

7.3. Monitoring Boreholes

Please refer to Table 4.1 for details on the groundwater monitoring boreholes.

8. Groundwater Environmental Management Programme

8.1. Current Groundwater Conditions

Please refer to Section 4 of this report.

8.2. Predicted Impacts of Facility

Please refer to Section 6 of this report.

8.3. Mitigation Measures

8.3.1. Lowering of Groundwater Levels during Facility Operation

The underground mining operations will be at depths of 2 300 mbgl or deeper. The current underground mining operations at the Existing MRA range in depth between 1 294 and 2 300 mbgl. From the groundwater level monitoring data it can be seen that the current mining has had no impacts on the groundwater levels in the area.

Based on the historic groundwater level data showing that there is no impact on the groundwater levels in the active aquifers in the Study Area, and also as the underground mining in the Extended MRA will be as deep, and deeper than the previous mining in the Existing MRA, it is concluded that there will be no impact on the groundwater levels in the mining area.

No mitigation measures are required.

8.3.2. Rise of Groundwater Levels Post-Facility Operation

This is a positive impact and does not require any mitigation measures.

8.3.3. Spread of Groundwater Pollution Post-Facility Operation

The spread of groundwater contamination is discussed in more detail in Section 6.2.2.2 and Section 8.3.2 of this report. Management measures are included in the Zondereinde Mines approved EMP and WUL.

9. Post Closure Management Plan

9.1. Remediation of Physical Activity

The underground mine cannot be remediated. Closure of the shaft entrance will take.

9.2. Remediation of Storage Facilities

Surface storage facilities should be cleared and remediated in accordance with the Zondereinde Mines approved EMP and WUL.

9.3. Remediation of Environmental Impacts

The groundwater monitoring program be continued for a period of at least 5 years after mine closure to monitor the contaminant migration, in accordance with the Zondereinde Mines approved EMP and WUL. Based on these results remediation requirements can be identified and a remediation plan put in place.

9.4. Remediation of Water Resources Impacts

Groundwater qualities in the Existing MRA should be managed and remediated in accordance with the Zondereinde Mines approved EMP and WUL.

10. Conclusions and Recommendations

10.1. General Conclusions

- The Study Area's topography is in a relatively flat area with an elevation that ranges between 960 and 990 mamsl. It slopes gently to the both the east and the west towards the Crocodile and Bierspruit Rivers respectively;
- The Study Area falls within the A24F and A24C Quaternary Catchments of the Crocodile River (West) and Marico Water Management Area WMA;
- The Study Area drains into both the Crocodile and Bierspruit Rivers, located east and west of the Study Area respectively;
- There are a number of non-perennial rivers that are seasonal and flow only after periods of rainfall.

10.2. Baseline Groundwater Conditions

- There are three aquifers associated with the alluvial aquifer material, shallow weathered fractured material and the underlying competent and fractured rock material;
- The alluvial aquifer is unconfined and laterally discontinuous, localised within the immediate vicinity of the river banks and the floodplains and therefore does not extend regionally throughout the total study area;
- The upper 2 m of the soil consists of the semi-confining black turf layer;
- When saturated, the black clays are highly impermeable but allows for infiltration and recharge through the surface cracks during dry conditions;
- The upper weathered aquifer is below the turf layer and has an average depth of approximately 9 to 12 m;
- The borehole yields in this aquifer are seasonally variable due to the strong dependence on rainfall recharge;
- Groundwater flows in the fractured rock aquifer are associated with the secondary fracturing in the competent rock and, as such, will be along discrete pathways associated with the fractures;
- The general depth to groundwater levels range between 0.9 and 24.1 mbgl;
- Plotting groundwater level elevation versus topographical elevation for this project area yields an 86.7 % correlation;
- Groundwater qualities in the Existing MRA are impacted:
- Surface infrastructure at the Existing MRA has impacted the groundwater. There are no surface pollution sources on the Extended MRA. Groundwater contamination from the Existing MRA has a limited plume and will not migrate onto the Extended MRA. No cumulative impacts are thus anticipated due to the Project.
- In relation to the Existing MRA, from a previous contaminant plume delineation study (Future Flow, October 2015), it was concluded that there are seven potential pollution areas in the Existing MRA, being the Domestic Waste Disposal Site; Concentrator Plant area and Evaporation Dam; WRD; Sewage Treatment Facility; Smelter and Base Metal Refinery BMR; Slimes and RWD; and Settling Dam. The chloride concentration trends average between 650 to 1 810 mg/L in boreholes surrounding this infrastructure.
- The activities on the Existing MRA do not impact the Crocodile River.

- The Bierspruit water quality is consistently poorer down gradient than up-gradient of the Existing MRA. However, monitoring program results show that the contaminant plumes from the Existing MRA do not extend to the Bierspruit. In addition, there are other Mines in the area which are also located up-gradient of the Bierspruit. Based on this, it cannot be said with certainty that the negative impact on the Bierspruit water qualities can be attributed to the Existing MRA.
- The general water quality in the Bierspruit and Crocodile Rivers comply with the SANS 241: 2015 domestic water quality guidelines.

10.3. Environmental Impact Assessment

10.3.1. Operational Phase

- The underground mining operations will be at depths of 2 300 mbgl or deeper. The underground mining operations at the Existing MRA range in depth between 1 294 and 2 300 mbgl. The mining at the Existing MRA has had no impacts on the groundwater levels in the area. It is expected that there will be no impact on the groundwater levels in the Extended MRA.
- The combined Existing MRA and Extended MRA are and will be located at depths of 1 294 to 2 300 m and greater. There is no active aquifer at these depths. Any groundwater that does occur at these depths, or along the Shaft area, and enters the underground mine will be dewatered and pumped to surface at the Existing MRA, where it will be handled in the existing water management dams. Thus, any groundwater flows that occur at the depth of the mining at the Extended MRA will be towards the Extended MRA. This will prevent any contamination within the underground mining area from migrating away from the Extended MRA.
- At the end of life of operations contaminant plumes migrating away from surface infrastructure points located on the Existing MRA will have migrated through the weathered material aquifer to a maximum of 550 m down gradient from the source area.
- As noted above, groundwater contamination from the Existing MRA has a limited plume and will not migrate onto the Extended MRA. No cumulative impacts are thus anticipated due to the Project.
- The highest chloride concentration may be found in borehole NPG34 on the Existing MRA; this is due to the borehole being located on the Slimes Dam perimeter.
- There are numerous streams in the Study Area that appear to be non-perennial. The impact assessment results show that none of these streams fall within the zone of influence of the contaminant plumes and therefore it is not expected that the Existing MRA will have any impact on the stream water qualities.

10.3.2. Long Term Post-Closure Phase

- In the post operational environment groundwater levels and flow patterns in the Study Area will recover to near pre-operational levels. The total volume of the mined-out area that has to be filled / submerged is not known. In addition, the volume of groundwater seeping into the underground mine is also not known. Therefore, the time required for the underground mine to become submerged cannot be calculated.

- The underground mining area ranges in depth between 1 294 and 2 300 mbgl and deeper. At no point is the floor elevation of the underground mine above surface level. No decant is expected to occur.
- The contamination from the Slimes Dam and RWD which are located within the Existing MRA is expected to migrate up to 600 m east and will not reach the Crocodile River, which is 5 km east of the RWD.
- The majority of contamination from the Domestic Waste Disposal, Settling dam and Sewage Plant, which are located within the Existing MRA, is expected to migrate up to 700m west toward an unnamed non-perennial stream, through the shallow weathered material aquifer. The contaminant plumes will not reach the Bierspruit, which is 3.5 km north of the WRD and Sewage Plant.
- The shallow weathered aquifer can be expected to contribute poor quality leachate to the unnamed non-perennial stream flow volumes through baseflow contribution during the rainy season. During the dry season, the impact through this aquifer on the non-perennial stream is expected to be minimal due to the seasonal reduction in groundwater level in the aquifer.
- As noted above in respect of the Operational Phase, groundwater contamination from the Existing MRA has a limited plume and will not migrate onto the Extended MRA. No cumulative impacts are thus anticipated due to the Project.

10.4. Reasoned Professional Opinion

It is recommended that the project be authorized. This recommendation is based on:

- The impact assessment shows that it not expected that there will be any measurable impact on the groundwater levels in the area. No privately-owned boreholes around the Extended MRA will be impacted by the drawdown in the fractured rock aquifer;
- There will be no groundwater impacts from mining the Extended MRA and no cumulative impacts as a result of the existing impacts on the Existing MRA.
- No privately owned and used boreholes on neighbouring properties will be impacted;
- Numerical model simulation and analytical impact assessment results show that there will be no impact on the Crocodile and the Bierspruit Rivers.

Overall, it can be concluded that that there are few sensitive receptors in the area and the impacts on those sensitive receptors will be minimal.

10.5. Conditions for Authorisation

There are no conditions for authorisation, except commitment to optimal management and monitoring of the expected impacts as described in Sections 8 and 9 of this report.

11. Bibliography

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van Gessellen, A. (2014). *Northam Platinum Mine - Annual surface and groundwater report.* Pretoria: Aquatico Scientific.

XMP Consulting. (n.d.). *South African Coal: Desktop Study.* XMP Consulting.

APPENDIX A:

CURRICULUM VITAE

PERSONAL DETAILS

NAME: Martiens Prinsloo
DATE OF BIRTH: 14 January 1976
NATIONALITY: South African
MARITAL STATUS: Married

ACADEMIC QUALIFICATIONS

Year	Qualification & Institution
2008	MBA: Graduate School of Business, University of Cape Town
2005	M.Sc. (Geohydrology): University of the Free State (Bloemfontein)
1997	B.Sc. (Hons) (Geohydrology): University of the Free State (Bloemfontein)
1996	B.Sc. (Earth Sciences): University of Pretoria

PROFESSIONAL REGISTRATION AND AFFILIATIONS

Registered Professional Natural Scientist S.A. (SACNASP Reg. No. 400248/04)
Groundwater Division of the Geological Society of South Africa (Membership no. 234)
International Association of Hydrogeologists (IAH membership no. 122757)
International Mine Water Association (IMWA membership no. 1121)

OTHER COURSES

Course	Institution
FeFlow (2009)	DHI WASY (Johannesburg)
Geochemical and reactive transport modelling – PHREEQC, MT3DMS and PHT3D (2006)	University of the Western Cape (Cape Town)
Model sensitivity analysis, data assessment, calibration and uncertainty evaluation (2006)	USGS (Cape Town)
Contaminant Site Risk Assessment and Groundwater Modelling (2004)	Waterloo Hydrogeologic Inc. (Johannesburg)
Groundwater Modelling Course (2002)	Summer University of Bremen (Germany)

EMPLOYMENT HISTORY

Date	Company & Position
July 2008 - Present	Future Flow Groundwater & Project Management Solutions cc Founding Member
Feb 2007 – June 2008	GCS (Pty) Ltd Manager: Water Resources Unit
Jan 2006 – Jan 2007	GCS (Pty) Ltd Manager: Mining & Modelling Sub-Unit (part of Water Resources Unit)
Apr 2002 – Dec 2005	GCS (Pty) Ltd Hydrogeological modeller / Senior hydrogeologist
Sept 2000 – Mar 2002	GCS (Pty) Ltd Field hydrogeologist
Feb 1998 – Aug 2000	Council for Geoscience Scientific Officer - Hydrogeology

SCIENTIFIC EXPERIENCE

Mining related hydrogeology:

- Hydrogeological investigations for various types of mines including: coal, gold, platinum, nickel, copper, cobalt, uranium, heavy mineral sands and diamond. Work experience range from field data collection to data analysis, chemical characterisation, acid base accounting and waste classification, numerical flow and contaminant transport modelling, water balance calculations and compilation of reports;
- Groundwater monitoring and audit reports. The evaluation of groundwater level fluctuation and water chemical data and the compilation of monthly, quarterly and annual monitoring reports;
- Groundwater monitoring well field designs. The siting and design of monitoring boreholes for the assessment of the influence of mining activities on the regional groundwater environment;
- Groundwater investigations and numerical modelling of both fractured rock and primary aquifers;
- Hydrogeological assessments for both opencast and underground mines;
- Water supply for mining activities;
- Mine dewatering assessments and dewatering program designs; and
- Tailings and waste storage facility site selection and impact assessments.

Groundwater resource assessment and development:

- Water supply studies and well field design ranging from rural water supply (hand pump) to large scale water supply for construction and irrigation projects (4 000 m^3/hr);
- Assessment of geological controls, geophysical exploration methods and the quantification of groundwater exploitation potential in complex and problematic terrain;
- Hydrogeological mapping investigations and catchment resource analysis; and
- Regional hydrogeological and chemical investigations involving reconnaissance investigations, geophysical surveys, drilling and test pumping for the planning and development and utilisation of groundwater resources in Southern Africa.

Waste disposal management:

- Environmental Impact Assessments for the manufacturing and petroleum industries. Experience includes field data collection, hydrogeological and chemical data analysis and report compilation;
- Environmental Impact Assessments and site suitability assessments for waste disposal sites (including HH classified sites); and
- Characterisation and numerical modelling of contaminant plume migration.

Energy:

- Conventional coal powered power stations, including underground coal gasification: Site selection and risk assessment, environmental impact assessments, geochemical characterisation of fly ash disposal facilities, and impact mitigation;
- CSP and PV renewable energy: Site selection and risk assessment and environmental impact assessments;
- Bio-mass-to-energy (various energy sources from plant matter to biological waste products): Site selection and risk assessment and environmental impact assessments.

COUNTRIES WORKED IN

Australia, Burkina Faso, Democratic Republic of the Congo (DRC), Ivory Coast, Lesotho, Madagascar, Mali, Mozambique, Senegal, South Africa, Tanzania, Zambia, and Zimbabwe.

LANGUAGE PROFICIENCY

English and Afrikaans – Speak, read, write.

TEACHING

- Part time lecturing at the University of Johannesburg (2001 – 2005): Civil Engineering Course – Hydrogeology.
- Ad hock lecturing at the University of the Witwatersrand (2007 – 2008): Postgraduate / Industrial Masters Course: Coal mining extraction and exploitation – Groundwater contaminant transport modelling;
- Annual course lecturing at the University of Pretoria (2009, 2001 – 2016): Postgraduate course: Groundwater Numerical Modelling.

PAPERS AND PUBLICATIONS

- Prinsloo, M.J. (2004). "Characterisation of the dolomitic aquifer in the Copperbelt Province, Northern Zambia". Waternet / WARFSA Symposium, Windhoek, Namibia.
- Prinsloo, M.J. (2006). "Prediction of mine inflow volumes". Mine Water Conference, Johannesburg, South Africa.
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- Wilke, A.R. & Prinsloo, M.J. (2009). "Overview of Malian Geohydrology with focus on Mining Projects and their influence on the environment". GSSA GWD: Groundwater Conference, Somerset West, South Africa.
- Prinsloo, M.J. (2011). "Using groundwater modelling to facilitate your mining operations". Strategic Water Drainage Summit 2011 – Optimising Water Usage and Minimising Impact on Water Quality in Mining Operations. Johannesburg, South Africa.

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