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Environmental impact assessment and management programme report for changes to the pit, tailings dam and waste rock facilities; a chrome sand drying plant and other operational and surface infrastructure changes

FILE 1 OF 4

Submitted with due regard to consultation with communities and interested and affected parties as required in terms of:

Regulation 49 of the Mineral and Petroleum Resources Development Act (Act 28 of 2002), and in accordance with the standard directive for the compilation thereof as published on the official website of the Department of Mineral Resources; and

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IDENTIFICATION OF THE REPORT

Herewith I, the person whose name and identity number is stated below, confirm that I am the person authorised to act as representative of the applicant in terms of the resolution submitted with the application, and confirm that the above report comprises EIA and EMP compiled in accordance with the guideline on the Departments official website and directive in terms of Sections 29 and 39(5) in that regard.

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ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT PROGRAMME REPORT FOR CHANGES TO THE PIT, TAILINGS DAM AND WASTE ROCK FACILITIES; A CHROME SAND DRYING PLANT AND OTHER OPERATIONAL AND SURFACE INFRASTRUCTURE CHANGES

CONTENTS

EXECUTIVE SUMMARY I
INTRODUCTION I
SECTION 1: ENVIRONMENTAL IMPACT ASSESSMENT I
1 DESCRIPTION OF THE BASELINE ENVIRONMENT 1-1
1.1 ON-SITE ENVIRONMENT (BIO-PHYSICAL) RELATIVE TO SURROUNDING ENVIRONMENT (BIO-PHYSICAL) 1-1
1.1.1 GEOLOGY BASELINE 1-1
1.1.2 TOPOGRAPHY BASELINE 1-4
1.1.3 CLIMATE BASELINE 1-5
1.1.4 SOIL AND LAND CAPABILITY BASELINE 1-10
1.1.5 BIODIVERSITY BASELINE 1-15
1.1.6 SURFACE WATER BASELINE 1-38
1.1.7 GROUNDWATER BASELINE 1-44
1.1.8 AIR QUALITY BASELINE 1-50
1.1.9 NOISE BASELINE 1-56
1.1.10 VISUAL BASELINE 1-59
1.2 ENVIRONMENTAL ASPECTS WHICH MAY REQUIRE PROTECTION OR REMEDIATION 1-62
1.3 LAND USE, CULTURAL AND HERITAGE ASPECTS AND INFRASTRUCTURE 1-62
1.3.1 LAND USE 1-62
1.3.2 HERITAGE (INCLUDING CULTURAL) AND PALAEONTOLOGICAL ASPECTS 1-69
1.3.3 SOCIO-ECONOMIC 1-73
1.4 MAPS SHOWING THE SPATIAL LOCALITY AND AERIAL EXTENT OF ENVIRONMENTAL FEATURES 1-77
1.5 SUPPORTING DOCUMENTS 1-91
2 PROJECT DESCRIPTION 2-1
OVERVIEW AND INTRODUCTION 2-1
2.1 MINERALS TO BE MINED 2-3
2.2 MINING METHODS TO BE USED 2-4
2.2.1 MINING OPERATIONS – OPENCAST MINING 2-4
2.2.2 MINERAL PROCESSING OPERATIONS – CONCENTRATOR COMPLEX 2-5
2.3 LIST OF MAIN ACTIONS/ACTIVITIES/PROCESSES FOR THE PROJECT 2-6
2.4 PLAN SHOWING LOCATION AND EXTENT OF OPERATIONS 2-6
2.5 LISTED ACTIVITIES IN TERMS OF NEMA EIA REGULATIONS 2-11
2.6 INDICATION OF PHASES AND TIMEFRAMES 2-12
2.7 ADDITIONAL INFORMATION 2-12
2.7.1 MINING CONTRACTOR AREA 2-12
2.7.2 TRANSPORT SYSTEMS 2-13
2.7.3 POWER SUPPLY 2-14
2.7.4 WATER MANAGEMENT 2-14
2.7.5 NON-MINERALISED WASTE MANAGEMENT 2-23
2.7.6 MINE RESIDUE DISPOSAL 2-24
2.7.7 ADDITIONAL SUPPORT SERVICES AND FACILITIES 2-29
2.7.8 EMPLOYMENT AND HOUSING 2-30
2.8 DECOMMISSIONING AND CLOSURE 2-31
2.9 PROJECT ALTERNATIVES 2-33
2.9.1 THE "NO PROJECT" OPTION 2-33
2.9.2 THE NORTH EAST WASTE ROCK DUMP 2-33

3 POTENTIAL IMPACTS ... 3-1
3.1 LIST OF POTENTIAL IMPACTS ... 3-1
3.2 LIST OF POTENTIAL IMPACTS ON ENVIRONMENTAL ASPECTS ... 3-1
3.2 LIST OF POTENTIAL CUMULATIVE IMPACTS ... 3-3
3.3 POTENTIAL FOR ACID MINE DRAINAGE OR GROUNDWATER CONTAMINATION ... 3-3
4 ALTERNATIVE LAND USE OR DEVELOPMENT ... 4-1
4.1 DESCRIPTION OF ALTERNATIVE LAND USE OF THE AREA ... 4-1
4.1.1 MAIN FEATURES AND INFRASTRUCTURE RELATED TO ALTERNATIVE LAND USE / DEVELOPMENT ... 4-1
4.2 PLAN SHOWING LOCATION AND EXTENT OF ALTERNATIVE LAND USE / DEVELOPMENT ... 4-1
5 POTENTIAL IMPACTS OF ALTERNATIVE LAND USE OR DEVELOPMENT ... 5-1
5.1 LIST OF POTENTIAL IMPACTS ... 5-1
5.2 LIST OF POTENTIAL CUMULATIVE IMPACTS ... 5-1
6 POTENTIAL SOCIAL AND CULTURAL IMPACTS ... 6-1
6.1 LIST OF POTENTIAL IMPACTS ON SOCIO-ECONOMIC CONDITIONS OF THIRD PARTY LAND USE ACTIVITIES 6-1
6.2 CULTURAL ASPECTS AND POTENTIAL IMPACTS THEREON ... 6-1
6.3 HERITAGE FEATURES AND POTENTIAL IMPACTS THEREON ... 6-1
6.3.1 HERITAGE (AND CULTURAL) FEATURES ... 6-1
6.3.2 PALEONTOLOGICAL FEATURES ... 6-1
6.4 QUANTIFICATION OF IMPACT ON SOCIO-ECONOMIC CONDITIONS ... 6-1
7 ASSESSMENT AND EVALUATION OF POTENTIAL IMPACTS ... 7-1
7.1 LIST OF EACH POTENTIAL IMPACT ... 7-1
7.2 IMPACT RATING FOR EACH POTENTIAL IMPACT ... 7-1
7.2.1 ISSUE: LOSS AND STERILIZATION OF MINERAL RESOURCE ... 7-2
7.2.2 ISSUE: HAZARDOUS EXCAVATIONS AND INFRASTRUCTURE ... 7-3
7.2.3 ISSUE: SURFACE SUBSIDENCE ... 7-5
7.2.4 ISSUE: LOSS OF SOIL RESOURCES AND LAND CAPABILITY THROUGH PHYSICAL DISTURBANCE ... 7-7
7.2.5 ISSUE: LOSS OF SOIL RESOURCES AND LAND CAPABILITY THROUGH POLLUTION ... 7-11
7.2.6 ISSUE: PHYSICAL DESTRUCTION OF BIODIVERSITY ... 7-15
7.2.7 ISSUE: GENERAL DISTURBANCE OF BIODIVERSITY ... 7-20
7.2.8 ISSUE: ALTERATION OF SURFACE DRAINAGE PATTERNS ... 7-24
7.2.9 ISSUE: CONTAMINATION OF SURFACE WATER RESOURCES ... 7-28
7.2.10 ISSUE: GROUNDWATER CONTAMINATION ... 7-31
7.2.11 ISSUE: REDUCTION IN GROUNDWATER LEVELS/AVAILABILITY ... 7-36
7.2.12 ISSUE: AIR POLLUTION THROUGH DUST GENERATION AND GASEOUS EMISSIONS ... 7-41
7.2.13 ISSUE: NOISE POLLUTION ... 7-45
7.2.14 ISSUE: NEGATIVE VISUAL IMPACTS ... 7-49
7.2.15 ISSUE: BLASTING IMPACTS ... 7-53
7.2.16 ISSUE: LOSS OF HERITAGE PALAEONTOLOGICAL AND CULTURAL RESOURCES ... 7-58
7.2.17 ISSUE: RELOCATION ... 7-60
7.2.18 ISSUE: LOSS OF OR CHANGES TO EXISTING LAND USES ... 7-60
7.2.19 ISSUE: ROAD DISTURBANCE AND TRAFFIC SAFETY ... 7-63
7.2.20 ISSUE: ECONOMIC IMPACT (POSITIVE AND NEGATIVE) ... 7-66
7.2.21 ISSUE: INWARD MIGRATION AND ASSOCIATED SOCIAL ISSUES ... 7-69
7.3 DEFINITION OF CRITERIA USED ... 7-73
7.4 PHASES AND TIMEFRAMES OF POTENTIAL IMPACTS ... 7-75
8 COMPARATIVE LAND USE ASSESSMENT ... 8-1
8.1 ALTERNATIVE LAND USES WHICH COULD BE IMPACTED ON ... 8-1
8.2 RESULTS OF SPECIALIST COMPARATIVE LAND USE ASSESSMENT ... 8-1
9 LIST OF SIGNIFICANT IMPACTS ... 9-1
10 STAKEHOLDER ENGAGEMENT PROCESS ... 10-1
10.1 IDENTIFICATION OF INTERESTED AND AFFECTED PARTIES ... 10-1
10.2 DETAILS OF ENGAGEMENT PROCESS ... 10-2

10.2.1 SOCIAL SCAN 10-2
10.2.2 LETTERS, SITE NOTICES AND NEWSPAPER ADVERTISEMENTS....10-2
10.2.3 BACKGROUND INFORMATION DOCUMENT 10-3
10.2.4 2012/2013 SCOPING MEETINGS....10-3
10.2.5 IAP REVIEW OF INITIAL SCOPING REPORT 10-4
10.2.6 AUTHORITY REVIEW OF INITIAL SCOPING REPORT....10-5
10.2.7 2014 SCOPING MEETINGS....10-5
10.2.8 IAP REVIEW OF REVISED SCOPING REPORT....10-6
10.2.9 REGULATORY AUTHORITY REVIEW OF REVISED SCOPING REPORT 10-6
10.2.10 REVIEW OF EIA AND EMP REPORT BY IAPS....10-7
10.2.11 REVIEW OF THE EIA AND EMP REPORT FOR BY REGULATORY AUTHORITIES....10-7
10.3 MANNER IN WHICH ISSUES RAISED WERE ADDRESSED 10-8
11 ADEQUACY OF PREDICTIVE METHODS AND ASSUMPTIONS AND UNCERTAINTIES....11-1
11.1 ENVIRONMENTAL ASSESSMENT LIMIT....11-1
11.2 PREDICTIVE MODELS IN GENERAL....11-1
11.3 BIODIVERSITY 11-1
11.4 AIR QUALITY....11-1
11.5 GROUNDWATER 11-2
11.6 HERITAGE AND CULTURAL RESOURCES 11-3
11.7 NOISE 11-3
11.8 ECONOMIC IMPACT....11-4
12 ARRANGEMENT FOR MONITORING AND MANAGEMENT OF IMPACTS....12-1
12.1 IMPACTS THAT REQUIRE MONITORING PROGRAMMES....12-1
12.2 FUNCTIONAL REQUIREMENTS OF MONITORING PROGRAMMES 12-1
12.3 ROLES AND RESPONSIBILITIES 12-2
12.4 TIMEFRAMES FOR MONITORING AND REPORTING 12-2
13 TECHNICAL SUPPORTING INFORMATION....13-1
SECTION 2 – ENVIRONMENTAL MANAGEMENT PROGRAMME....II
14 ENVIRONMENTAL OBJECTIVES AND SPECIFIC GOALS FOR CLOSURE....14-1
14.1 ENVIRONMENTAL ASPECTS THAT DESCRIBE THE PRE-MINING ENVIRONMENT 14-1
14.2 MEASURES TO CONTROL OR REMEDY ANY CAUSES OF POLLUTION OR DEGRADATION 14-1
15 ENVIRONMENTAL OBJECTIVES AND SPECIFIC GOALS FOR MANAGEMENT OF IDENTIFIED ENVIRONMENTAL IMPACTS....15-1
15.1 IMPACTS THAT REQUIRE MONITORING PROGRAMMES....15-1
15.2 ACTIVITIES AND INFRASTRUCTURE 15-1
15.3 MANAGEMENT ACTIVITIES 15-1
15.4 ROLES AND RESPONSIBILITIES 15-1
16 ENVIRONMENTAL OBJECTIVES AND SPECIFIC GOALS FOR SOCIO-ECONOMIC CONDITIONS....16-1
16.1 ASPECTS OF THE SOCIO-ECONOMIC CONDITIONS 16-1
16.2 OBJECTIVES AND GOALS....16-1
17 ENVIRONMENTAL OBJECTIVES AND SPECIFIC GOALS FOR HISTORICAL AND CULTURAL ASPECTS 17-1
17.1 ASPECTS OF THE HERITAGE AND CULTURAL CONDITIONS....17-1
17.2 OBJECTIVES AND GOALS....17-1
18 APPROPRIATE TECHNICAL AND MANAGEMENT OPTIONS CHOSEN FOR EACH IMPACT.18-1
18.1 PROJECT ACTIONS, ACTIVITIES AND PROCESSES....18-1
18.2 TECHNICAL AND MANAGEMENT OPTIONS....18-1
19 ACTION PLANS TO ACHIEVE OBJECTIVES AND GOALS 19-1
20 EMERGENCY RESPONSE PROCEDURES 20-1

20.1 ON-GOING MONITORING AND MANAGEMENT MEASURES 20-1
20.2 PROCEDURES IN CASE OF ENVIRONMENTAL EMERGENCIES 20-1
20.2.1 GENERAL EMERGENCY PROCEDURE 20-1
20.2.2 IDENTIFICATION OF EMERGENCY SITUATIONS 20-2
20.3 TECHNICAL, MANAGEMENT AND FINANCIAL OPTIONS 20-2
21 PLANNED MONITORING AND EMP PERFORMANCE ASSESSMENT 21-1
21.1 WATER 21-1
21.1.1 WATER QUALITY AND LEVELS 21-1
21.1.2 SURFACE WATER FLOW 21-5
21.1.3 WATER BALANCE 21-5
21.1.4 PROCESS WATER 21-5
21.2 AIR 21-5
21.3 BLASTING 21-6
21.4 NOISE 21-6
21.5 BIO MONITORING 21-6
21.6 TAILINGS AND OTHER DAMS WITH A WALL OF 5M OR MORE AND A CAPACITY OF 50 000M^3 OR MORE 21-7
21.7 GENERAL 21-7
21.8 SUBMISSION OF INFORMATION 21-7
21.9 MAINTENANCE, DECOMMISSIONING AND CLOSURE 21-7
22 FINANCIAL PROVISION 22-1
22.1 PLAN SHOWING LOCATION AND AERIAL EXTENT OF PROPOSED OPERATION 22-1
22.2 ANNUAL FORECASTED FINANCIAL PROVISION 22-1
22.3 CONFIRMATION OF AMOUNT TO BE PROVIDED 22-1
22.4 METHOD OF PROVIDING FINANCIAL PROVISION 22-1
23 ENVIRONMENTAL AWARENESS PLAN 23-1
23.1 ENVIRONMENTAL POLICY 23-1
23.2 STEPS TO ACHIEVE THE ENVIRONMENTAL POLICY OBJECTIVES 23-2
23.3 TRAINING OBJECTIVES OF THE ENVIRONMENTAL AWARENESS PLAN 23-3
23.3.1 GENERAL CONTENTS OF THE ENVIRONMENTAL AWARENESS PLAN 23-3
24 TECHNICAL SUPPORTING INFORMATION 24-1
25 CAPACITY TO MANAGE AND REHABILITATE THE ENVIRONMENT 25-1
25.1 AMOUNT REQUIRED TO MANAGE AND REHABILITATE THE ENVIRONMENT 25-1
25.2 AMOUNT PROVIDED FOR 25-1
26 UNDERTAKING SIGNED BY APPLICANT 26-1
27 ENVIRONMENTAL IMPACT STATEMENT & CONCLUSION 27-1
28 REFERENCES 28-1

LIST OF FIGURES

FIGURE 1: REGIONAL SETTING IX
FIGURE 2: LOCAL SETTING X
FIGURE 1.1: LOCAL GEOLOGICAL STRATIGRAPHY 1-78
FIGURE 1.2: ANNUAL AVERAGE, DAY-TIME AND NIGHT-TIME WIND ROSES 1-79
FIGURE 1.3: SEASONAL WIND ROSES 1-80
FIGURE 1.4: SOIL TYPES PRESENT IN THE AREA 1-81
FIGURE 1.5: LAND CAPABILITY OF SOILS IN THE AREA 1-82
FIGURE 1.6: NORTH WEST CRITICAL BIODIVERSITY AREAS 1-83
FIGURE 1.7: REGIONAL VEGETATION TYPES IN THE AREA 1-84
FIGURE 1.8: HABITAT UNITS AND AREAS OF BIODIVERSITY SENSITIVITY 1-85

FIGURE 1.9: WETLANDS IDENTIFIED WITHIN THE PROJECT AREA 1-86
FIGURE 1.10: FLOODLINES AND WATERCOURSE 100M OFFSETS WITHIN THE PROJECT AREA 1-87
FIGURE 1.11: HYDROCENSUS IN THE PROJECT AREA 1-88
FIGURE 1.12: HERITAGE RESOURCES IDENTIFIED AT THE MINE 1-89
FIGURE 1.13: LAND USE IN AND SURROUNDING THE MINE 1-90
FIGURE 2.1: THARISA MINE LAYOUT SHOWING PROJECT CHANGES 2-10
FIGURE 2.2: WATER BALANCE – AVERAGE DRY SEASON 2-16
FIGURE 2.3: WATER BALANCE – AVERAGE WET SEASON 2-17
FIGURE 2.4: CONCEPTUAL STORMWATER MANAGEMENT PLAN 2-22
FIGURE 21.1: COMBINED MONITORING PROGRAMME 21-2

LIST OF TABLES

TABLE 1.1: LOCAL GEOLOGY 1-2
TABLE 1.2: AVERAGE MONTHLY RAINFALL AND EVAPORATION ADOPTED FOR THE THARISA MINE 1-6
TABLE 1.3: RAINFALL DATA FOR THE MINE AREA 1-7
TABLE 1.4: RAINFALL DEPTH INTENSITIES FOR THARISA MINE 1-8
TABLE 1.5: AVERAGE TEMPERATURES RECORDED IN THE REGION OF THE MINE – BUFFELSPOORT 1-9
TABLE 1.6: SOILS PRESENT IN THE AREA 1-11
TABLE 1.7: LAND CAPABILITY DISTRIBUTION 1-14
TABLE 1.8: COMMONLY OCCURING VEGETATION SPECIES – UNDISTURBED AREAS 1-19
TABLE 1.9: COMMONLY OCCURING VEGETATION SPECIES – TRANSFORMED AREAS 1-20
TABLE 1.10: COMMONLY OCCURING VEGETATION SPECIES – ROCKY OUTCROPS 1-21
TABLE 1.11: COMMONLY OCCURING VEGETATION SPECIES – WETLANDS 1-23
TABLE 1.12: PROBABILITY OF RED DATA FLORAL SPECIES OCCURING WITHIN THE PROJECT AREA 1-24
TABLE 1.13: TNCO LISTED SPECIES FOUND WITHIN THE PROJECT AREA 1-25
TABLE 1.14: MEDICINAL SPECIES 1-26
TABLE 1.15: INTRUDER PLANT SPECIES 1-29
TABLE 1.16: COMMON MAMMALS IN THE PROJECT AREA 1-30
TABLE 1.17: MAMMALS WHICH MAY OCCUR IN THE RPOJECT AREA 1-30
TABLE 1.18: AVIFAUNA WITHIN THE PROJECT AREA 1-31
TABLE 1.19: REPTILES AND AMPHIBIANS WITHIN THE PROJECT AREA 1-32
TABLE 1.20: REPTILES AND AMPHIBIANS EXPECTED TO OCCUR WITHIN THE PROJECT AREA 1-33
TABLE 1.21: INVERTEBRATE SPECIES WITHIN THE PROJECT AREA 1-33
TABLE 1.22: RED DATA LISTED AVIFAUNA WHICH MAY OCCUR WITHIN THE PROJECT AREA 1-35
TABLE 1.23: WETLAND FEATURES IDENTIFIED IN THE PROJECT AREA 1-37
TABLE 1.24: MEAN ANNUAL RUNOFF (BASED ON WR2005 DATA) 1-40
TABLE 1.25: FLOOD PEAKS AND VOLUMES 1-40
TABLE 1.26: PRE-MINING SURFACE WATER QUALITY (NOVEMBER 2007) 1-42
TABLE 1.27: BASELINE (PRE-MINING) GROUNDWATER QUALITY FOR THE PROJECT AREA (2007) 1-49
TABLE 1.28: NATIONAL AMBIENT AIR QUALITY STANDARDS 1-53
TABLE 1.29: NATIONAL AMBIENT AIR QUALITY STANDARDS FOR SO_2 1-54
TABLE 1.30: NATIONAL AMBIENT AIR QUALITY STANDARDS FOR NO_2 1-54
TABLE 1.31: NOISE SURVEY RESULTS (2009) 1-57
TABLE 1.32: SUMMARY OF NOISE MEASUREMENTS TAKEN IN 2012 1-58
TABLE 1.33: SURFACE RIGHTS 1-63
TABLE 1.34: HERITAGE RESOURCES IDENTIFIED AT THARISA MINE 1-71
TABLE 2.1: OUTLINE OF PROJECT COMPONENTS 2-1
TABLE 2.2: LIST OF ACTIONS / ACTIVITIES / PROCESSES RELEVANT TO THE PROJECT COMPONENTS 2-7
TABLE 2.3: NEMA LISTED ACTIVITES RELEVANT TO THE PROJECT COMPONENTS 2-11
TABLE 2.4: TIMEFRAMES OF THE PROJECT COMPONENTS 2-12
TABLE 2.5: WATER HOLDING FACILITIES AT THARISA 2-18
TABLE 2.6: WATER HOLDING FACILITIES DESIGN PRINCIPLES 2-18

TABLE 2.7: INDUSTRIAL, HAZARDOUS AND DOMESTIC WASTES....2-23
TABLE 2.8: OUTLINE OF CHANGES TO THE WASTE ROCK DUMPS....2-25
TABLE 2.9: DESIGN DETAILS FOR THE WASTE ROCK DUMPS....2-26
TABLE 2.10: OUTLINE OF CHANGES TO THE TAILINGS STORAGE FACILITY....2-27
TABLE 2.11: DESIGN PRINCIPLES FOR THE TAILINGS COMPLEX....2-27
TABLE 3.1: LIST OF POTENTIAL IMPACTS AS THEY RELATE TO PROJECT ACTIONS/ ACTIVITIES (EXCLUDING SOCIAL AND CULTURAL)....3-1
TABLE 7.1: SOIL CONSERVATION PROCEDURE....7-10
TABLE 7.2: WASTE MANAGEMENT PRACTICES FOR DOMESTIC AND INDUSTRIAL WASTE....7-13
TABLE 7.3: REDUCTION IN MEAN ANNUAL RUNOFF FOR OPERATIONS AND POST CLOSURE....7-25
TABLE 7.4: PROXIMITY OF THIRD PARTY INFRASTUCTURE TO THE OPEN PITS....7-55
TABLE 7.5: CRITERIA FOR ASSESSING IMPACTS....7-74
TABLE 16.1: ENVIRONMENTAL OBJECTIVES AND GOALS- SOCIO-ECONOMIC CONDITIONS....16-1
TABLE 17.1: ENVIRONMENTAL OBJECTIVES AND GOALS- HERITAGE AND CULTURAL CONDITIONS....17-1
TABLE 19.1: ACTION PLAN – LOSS AND STERILIZATION OF MINERAL RESOURCE....19-2
TABLE 19.2: ACTION PLAN – SURFACE SUBSIDENCE....19-2
TABLE 19.3: ACTION PLAN – HAZARDOUS EXCAVATIONS AND INFRASTRUCTURE....19-3
TABLE 19.4: ACTION PLAN – LOSS OF SOIL RESOURCES AND LAND CAPABILITY THROUGH PHYSICAL DISTURBANCE....19-4
TABLE 19.5: ACTION PLAN – LOSS OF SOIL RESOURCES AND LAND CAPABILITY THROUGH POLLUTION.19-5
TABLE 19.6: ACTION PLAN – PHYSICAL DESTRUCTION OF BIODIVERSITY....19-6
TABLE 19.7: ACTION PLAN – GENERAL DISTURBANCE OF BIODIVERSITY....19-7
TABLE 19.8: ACTION PLAN – ALTERATION OF SURFACE DRAINAGE PATTERNS....19-8
TABLE 19.9: ACTION PLAN – CONTAMINATION OF SURFACE WATER RESOURCES....19-9
TABLE 19.10: ACTION PLAN – GROUNDWATER CONTAMINATION....19-11
TABLE 19.11: ACTION PLAN – REDUCTION IN GROUNDWATER LEVELS/AVAILABILITY....19-12
TABLE 19.12: ACTION PLAN – AIR POLLUTION THROUGH DUST GENERATION AND GASEOUS EMISSIONS....19-13
TABLE 19.13: ACTION PLAN – NOISE POLLUTION....19-14
TABLE 19.14: ACTION PLAN – NEGATIVE VISUAL IMPACTS....19-15
TABLE 19.15: ACTION PLAN – LOSS OF HERITAGE PALAEONTOLOGICAL AND CULTURAL RESOURCES19-16
TABLE 19.16: ACTION PLAN – LOSS OF OR CHANGES TO EXISTING LAND USES....19-16
TABLE 19.17: ACTION PLAN – BLASTING IMPACTS....19-17
TABLE 19.18: ACTION PLAN – ROAD DISTURBANCE AND TRAFFIC SAFETY....19-19
TABLE 19.19: ACTION PLAN - ECONOMIC IMPACT (POSITIVE AND NEGATIVE)....19-20
TABLE 19.20: ACTION PLAN - INWARD MIGRATION AND ASSOCIATED SOCIAL ISSUES....19-21
TABLE 20.1: EMERGENCY RESPONSE PROCEDURE....20-3
TABLE 21.1: WATER MONITORING PROGRAMME....21-3
TABLE 21.2: MONITORING PARAMETERS....21-4
TABLE 22.1: FINANCIAL PROVISION....22-1
TABLE 25.1: ESTIMATED COSTS FOR IMPLEMENTING TECHNICAL AND MANAGEMENT OPTIONS ASSOCIATED WITH THE PROJECT COMPONENTS....25-1
TABLE 27.1: SUMMARY OF THE SIGNIFICANCE RATING FOR POTENTIAL IMPACTS....27-2

LIST OF APPENDICES

APPENDIX A: INFORMATION SHARING WITH AUTHORITIES AND IAPS....A
APPENDIX B: IAPS DATABASE....B
APPENDIX C: ISSUES AND CONCERNS TABLE....C
APPENDIX D: SOIL AND LAND CAPABILITY STUDY....D
APPENDIX E: BIODIVERSITY STUDIES....E
APPENDIX F: HYDROLOGICAL ASSESSMENT AND GROUNDWATER STUDY....F
APPENDIX G: AIR QUALITY STUDY....G

APPENDIX H: NOISE STUDY .... H
APPENDIX I: VISUAL SPECIALIST STUDY I
APPENDIX J: BLASTING REPORT .... J
APPENDIX K: HERITAGE, CULTURAL AND PALAEONTOLOGICAL ASSESSMENTS .... K
APPENDIX L: ALTERNATIVE LAND USE ECONOMIC ASSESSMENT REPORT L
APPENDIX M: FINANCIAL PROVISION .... M

ACRONYMS AND ABBREVIATIONS

Below a list of acronyms and abbreviations used in this report.

Acronyms / Abbreviations	Definition
%	Percentage
°C	Degrees Celcius
Airshed	Airshed Planning Professional (Pty) Ltd
AFM	African Faith Mission
AEL	Air Emission Licence
Al	Aluminium
Ar	Arcadia (soil)
AR	Alternative Rational
ASAPA	Association for Southern African Professional Archaeologist
ASTM	American Society for Testing and Materials standard method for collection and analysis of dust fall
BIC	Bushveld Igneous Complex
BID	Background information document
BIF	Banded Iron Formation
BMR	Base Metals Refinery
Bo	Bonheim (soil)
BPDM	Bojanala Platinum District Municipality
Ca	Calcium
Cd	Cadmium
CEC	Cation exchange capacity
CH_4	Methane
Cl	Chloride
CO	Carbon monoxide
CO_2	Carbon Dioxide
Cr	Chromium
dBA	A-weighted decibel
DDF	Depth-Duration Frequency
DEDECT	North West Department of Economic Development, Environment, Conservation and Tourism
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
DFS	Definite feasibility study
DMR	Department of Mineral Resources
DOA	North West Department of Agriculture
DRDLR	Department of Rural Development and Land Reform
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EAP	Environmental Assessment Practitioner
EAPSA	Environmental assessment practitioners of Southern Africa
EC	Electrical conductivity (EC)
EIA	Environmental impact assessment
EMP	Environmental management programme
EMPR	Environmental Management Programme Report

Acronyms / Abbreviations	Definition
ESS	Earth Science Solutions
ESIA	Environmental Social Impact Assessment
Fe	Iron (Fe)
GCS	Groundwater Consulting Services
GDP	Gross domestic profit
GGP	Gross Geographic Product
ha	Hectare
HCO_3	Bicarbonate
HDPE	High density polyethylene
HEC-RAS	Hydrologic Engineering Centres River Analysis System
HIA	Heritage Impact Assessment
HIV	Human Immunodeficiency Virus
HPGR	High pressure grinding roll
hr	hour
Hu	Hutton (soil)
IBA	Important Bird Area
IAPs	Interested and/or affected parties
IDF	Intensity-Duration-Frequency
IDP	Integrated Development Plan
IFM	International Ferro Metals SA (Pty) Ltd
IRS	Impala Refining Services
K	Potassium
km^2	Square kilometres
kV	Kilovolt
LIMS	Low intensity magnetic strip
LOM	Life of mine
M	Meters
mamsl	Meters above mean sea level
mbgl	Metres Below Ground Level
m/s	Meters per second
m^2	Square meter
m^3	Cubic meter
MAP	Mean Annual Precipitation
MAR	Mean annual runoff
Metago	Metago Environmental Engineers (Pty) Ltd
Mg	Magnesium
MG	Middle Group
MLM	Madibeng Local Municipality
mm	Millimetres
Mn	Manganese
MPRDA	Mineral and Petroleum Resources Development Act
MPNE	Magaliesberg Protected Natural Environment
Mk	Milkwood (soil)
MQF	Magaliesberg Quartzite Formation
Ms	Mispah (soil)
MRS	Marikana Railway Siding
MVA	Megavolt ampere

Acronyms / Abbreviations	Definition
MW	Megawatts
My	Mayo (soil)
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
Na	Sodium (Na)
NB	Nominal Bore
NBA	National Biodiversity Assessment
NEAC	New Earth Apostolic Church
NEMA	National Environmental Management Act
NEM:AQA	National Environmental Management: Air Quality Act
Ni	Nickel
NEMBA	National Environmental Management: Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Areas Project
NGA	National Groundwater Archive
NLA	Newton Landscape Architects
NO2	Nitrous oxide
NO_3	Nitrate
NOx	Mono-Nitrogen Oxides
NPAES	National Protected Area Expansion Strategy
NSS	Natural Scientific Services
NWA	National Water Act
NW-DACE	North West Department of Agriculture, Conservation and Environment
NWHRA	North West Heritage Resources Agency
NWPT	Norh West Parks and Tourism Transport
NWDTRCS	North West Department of Transport Roads and Community Safety
Oa	Oakleaf (soil)
PO_4	Phosphate
PAHs	Polycyclic Aromatic Hydrocarbons
PGMs	Platinum Group Metals
PM10	Particulate matter with a fraction smaller than 10µm (microns)
POC	Probability of Occurence
PRECIS	Pretoria Computer Information Systems
PrSciNat	Registered professional in natural science
PS	Protected Species
RDSIS	Red Data Sensitivity Index Score
PMR	Precious Metals Refinery
R704	Regulation 704
RLS	Rustenburg Layer Suite
RMF	Regional Maximum Flood
ROM	Run-of-mine
RWD	Return water dam
SA	South Africa
SACNASP	South African Council for Natural Scientific Professionals
SAHRA	South African Heritage Resources Agency
SANBI	South African National Botanical institute
SANS	South African National Standards
SAS	Scientific Aquatic Services

Acronyms / Abbreviations	Definition
Se	Selenium
SDF	Standard Design Flood
SHE	Safety, Health, Environment
SLP	Socio and Labour Plan
SLR	SLR Consulting (Africa) (Pty) Ltd
SO_2	Sulphur dioxide
SO_4	Sulphate (SO4)
Se	Sepane (soil)
Ss	Sterkspruit (soil)
SVOC's	Semi-Volatile Organic Compounds
Sw	Swartland (soil)
SW	Surface Water
TDS	Total dissolved solids
TAC	Ts'enolo Apostolic Church
Tharisa	Tharisa Minerals (Pty) Ltd
Ti	Titanium
TNCO	Transvaal Nature Conservation Ordinance
TSF	Tailings storage facility
UH	Unit Hydrograph
TSP	Total suspended particles
UMD	Unified model
URC	Uniting Reform Church
USBM	United States Bureau of Mines
Va	Valsrivier (soil)
VCT	Voluntary Counselling and Testing
VOCs	Volatile Organic Compounds
WHIMS	Wet high intensity magnetic separator
WMA	Water Management Area
WUL	Water Use License
WR	Water Resources of South Africa
WRC	Water Research Commision
WRD	Waste Rock Dump
XRF	X-Ray Fluorescence

ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT PROGRAMME REPORT FOR CHANGES TO THE PIT, TAILINGS DAM AND WASTE ROCK FACILITIES; A CHROME SAND DRYING PLANT AND OTHER OPERATIONAL AND SURFACE INFRASTRUCTURE CHANGES

EXECUTIVE SUMMARY

Introduction and project location

Tharisa Minerals (Pty) Ltd (Tharisa) is an opencast mining operation that produces chrome and platinum group metals (PGM) concentrate at its Tharisa Mine near Marikana town. The mine is located within the Rustenburg Local Municipality (RLM), Madibeng Local Municipality (MLM) and Bojanala Platinum District Municipality (BPDM) in the North West Province (see regional and local setting below).

REGIONAL SETTING OF THE MINE	
Aspect	**Detail**
Province	North West Province
Magisterial district	Rustenburg
Regional authority	Bojanala Platinum District Municipality
Local authority	Rustenburg and Madibeng Local Municipalities
Local Municipal Ward Number	Ward 8 and 10
Farms (and portions) on which the activities will take place	Kafferskraal 342 JQ Elandsdrift 467 JQ
Nearest towns	Marikana, Rustenburg, Mooinooi and Buffelspoort
Surrounding communities	Various formal and informal community groupings – land owners, land occupiers, informal and formal settlements
Use of land immediately adjacent to mine	Residential, business (shops and bed and breakfast), mining and farming.
Use of land immediately adjacent to the proposed additional surface infrastructure	
Water catchment and management area	Crocodile River Basin – Quaternary Catchment A21K
Topographic landmarks	Magaliesberg Mountain Range

The project comprises the following components:

- Deepening and extending of the pits and related additional waste rock and tailings material storage
- A chrome sand drying plant
- Changes to the tailings storage facility design
- Re-shaping and re-alignment of waste rock dumps
- Partial backfilling of the open pits
- Changes to the general surface infrastructure layout and operations at Tharisa Mine.

Legal framework and process

Given that the project will take place at a mine and that it incorporates several listed environmental activities, the environmental assessment process and report was done and compiled in accordance with the requirements of the Mineral and Petroleum Resources Development Act, 28 of 2002 (MPRDA) and National Environmental Management Act, 107 of 1998 (NEMA) and the regulations there under. Other approvals/permits needed for the project as identified during the process, an amendment to the mine's water use license, an air emissional license and a waste managemrnt license for new waste facilities, will be applied for at the required time.

SLR Consulting (Africa) (Pty) Ltd (SLR) is the independent firm of consultants that has been appointed by the applicant to undertake the environmental impact assessment (EIA) and related processes. The EIA and environmental management programme (EMP) report is the product of the EIA process and provides a detailed description of the project, presents the results of specialist investigations, identifies and assesses potential impacts and recommends mitigation measures should the project be approved. As part of the EIA process, a stakeholder engagement process was conducted comprising notification of interested and affected parties (IAP) through newsletters, newspaper advertisements, site notices and a background information document; various focussed and general stakeholder meetings; and distribution of reports and report summaries for review. A team of professional specialists were appointed by SLR to investigate potential issues associated with the projet components. All issues, concerns and comments raised by IAPs have been addressed in the EIA and EMP report and included in the comments and response report in Appendix C of the EIA and EMP report. Full copies of correspondence are included in Appendix A.

This is a **summary** of the EIA and EMP report for the project.

Overview of the project

An overview of the changes to operations and infrastructure at the mine that make up the project components is provided in the table below.

<table>
<tr><th colspan="4">CHANGES TO INFRASTRUCTURE AND OPERATIONS</th></tr>
<tr><th colspan="3">Project components</th><th rowspan="2">Data from approved 2008 EIA and EMP report</th></tr>
<tr><th>Component</th><th>Aspect</th><th>Details</th></tr>
<tr><th colspan="4">Mining</th></tr>
<tr><td rowspan="4">Deepening and widening of the open pits</td><td>High wall height</td><td>On average approx. 180m for both pits</td><td>120m for both pits</td></tr>
<tr><td>Footprint</td><td>West pit extended by approx. 15 ha (total of approx.106.3ha)
East pit extended by approx. 90ha (total of approx. 225.3ha)</td><td>West pit approx. 91.3ha
East pit approx. 135.3ha</td></tr>
<tr><td>Life of mine</td><td>Increased to 18 years</td><td>12 years</td></tr>
<tr><td>Minerals to be mined</td><td>Remains unchanged</td><td>Platinum group metals (PGMs), copper ore, nickel ore and chrome ore found in the middle group (MG) seams</td></tr>
<tr><td rowspan="2">East Mine waste rock storage</td><td>Modifications to approved facilities</td><td>One consolidated dump (Eastern waste rock dump)
<u>Footprint</u>: 78ha
<u>Height</u>: approx. 70m (in 15m high lifts)
<u>Volume</u>: 17.58 million m^3 (40.44 million tons of waste)</td><td>Two separate dumps
East 1 and East 2 each with a footprint of 22ha and a volume of 5.89 million m^3</td></tr>
<tr><td>Addition of new north eastern waste rock dump</td><td><u>Footprint</u>: 95ha
<u>Height</u>: approx. 70m (in 15m high lifts)
<u>Volume</u>: 19.98 million m^3 (45.95 million tons of waste)</td><td>-</td></tr>
</table>

CHANGES TO INFRASTRUCTURE AND OPERATIONS			
Project components			**Data from approved 2008 EIA and EMP report**
Component	**Aspect**	**Details**	
West Mine waste rock storage	Modifications to approved facilities	Western waste rock dump Footprint: 58ha Height: approx. 70m (in 15m high lifts) Volume: 23.2 million m^3	West 2: Footprint: 49ha Volume: 13.33 million m^3
		Central waste rock dump Footprint: approx. 70ha Height: approx. 70m (in 15m high lifts) Volume: 18.49 million m^3 (42.53 million tons of waste)	West 1: Footprint: 22ha Volume: 5.89 million m^3
Waste rock side slopes	All dumps	Not less than 1V:3H	1V:4H
Waste rock storm water control	All dumps	Dirty storm water to be contained within each of the WRD through benching and catchment paddocks	Settlement facility at each WRD
Rehabilitation	All dumps	Residual waste rock dumps will remain on surface at closure and properly rehabilitated.	Use of waste rock dumps to backfill the open pits, however any waste rock remaining on surface would be properly rehabilitated.
	Pits	Partial backfilling of the open pits with a final void remaining at closure	Complete backfill
Chrome circuit			
Addition of a chrome sand drying plant	Production capacity	25,000 tons / month	Not included
	Feed material	A portion of the wet chrome concentrate from the chrome plant	-
	Other resources needed	Coal or light fuel oil for heating purposes (approx. 475 tons per month)	-
	Product	Dried chrome stored in 1 ton bags in a covered storage area	-
	Emissions	Exhaust gas (NO_x, SO_2, CO, VOC's, PM_{10} and $PM_{2.5}$ – if diesel is used as the fuel source – this presents a worst case scenario) The chrome sand drying plant will be fitted with a baghouse to collect particulate matter.	-
Fuel storage and use	For chrome sand drying plant	Location: near to plant, within concentrator plant footprint Volume: approximately 460 m^3 storage volume required	-
Residue deposits			
Tailings storage facility design	TSF1	Footprint: 74ha Height: 40m Volume: 8.1 million m^3 Comprises two paddocks	Footprint: 52ha Height: 33m Volume: 5.4 million m^3 Comprised 1 paddock
	TSF2	Footprint: 130ha Height: 45m Volume: 22.7 million m^3	Footprint: 100ha Height: 31m Volume: 12.8 million m^3
	Items removed from design	Black turf under containment walls Low permeability liner along inside of TSF face Clay cut-off keys 1V: 3H of the outer slope	-

CHANGES TO INFRASTRUCTURE AND OPERATIONS			
Project components			**Data from approved 2008 EIA and EMP report**
Component	**Aspect**	**Details**	
	Items added to the design	Toe drains on inside toe of TSF Seepage collection trenches 1:V: 2.5H of the outer slope	-
Support facilities / activities			
Concentrator complex	Plant layout	Orientation and layout of facilities within plant footprint optimised	-
	Storage of materials	ROM – 380 000 tonnes, PGM concentrate – 8 000 tonnes (in a shed), chrome product tonnes (total) – 160 000 tonnes, Met grade spiral product – 136 000 tonnes, chemical grade spiral product – 20 000 tonnes, foundry grade – 4 00 tonnes (in a shed) All of these stockpiles will be open air stockpiles in concrete bunded areas	PGM ROM – 15 000 tonnes, chrome ROM – 10 000 tonnes, chrome product lumpy – 8000 tonnes, chrome chips – 8000 tonnes, Met grade spiral product – four x 8000 tonnes, chemical grade spiral product – two x 2000 tonnes, mill feed – 4000 tonnes. All of these stockpiles will be open air stockpiles in concrete bunded areas
Water management	Water supply and storage	A review of water supply options to meet the mine's requirements taking into consideration supply availability and costs as well as changes in water storage dams.	-
Waste management	General and hazardous waste	Waste to be sorted and temporarily stored at source prior to removal for disposal	Provision for salvage yard areas within mine
Transport	Truck parking area	Near to the mine entrance comprising a one-way road for queuing/parking trucks with a gravel parking area of approximately 1ha	Not included
	Traffic volumes	Negligible change in traffic volumes.	Vehicle movements (arrivals and departures) per day – 6 days a week: Staff: 140/day Product: 320/day for chrome and 8/day for PGM Other: 17/day
Soil screening berms	Eastern topsoil storage	Orientation changed <u>Final height</u>: between 10 and 30m	Noise berm to the south of the concentrator complex with a height of between 5 and 10m
	Western topsoil storage	Location changed to screen the school and properties to south west <u>Final height</u>: between 10 and 30m	Noise berm to the south of the western operations with a height of between 5 and 10m
		Stockpile added north of West Mine <u>Final height</u>: between 10 and 30m	-
Mining contractor facilities	Fuel depot Salvage yard Workshop and yard	One central area with supporting services and facilities Located adjacent to concentrator plant (within the original plant footprint)	Separate facilities located at the East and West Mines
Diverted D1325	Minor re-alignment	Due to the deepening of the pit and position of the high wall as well as the training camp	-
Training	Training centre	Training related to induction programs, equipment training, core skills. Located north of the mine	-

CHANGES TO INFRASTRUCTURE AND OPERATIONS			
Project components			**Data from approved 2008 EIA and EMP report**
Component	**Aspect**	**Details**	
Workforce	Additional workforce	A maximum of 100 jobs during construction and 35 during operations comprising a combination of contractors and current workforce, where possible	-

Project motivation (need and desirability)

The motivation for the project as outlined by Tharisa is provided below.

- The purpose of the chrome sand drying plant is to produce higher-value chrome sand suitable for use as foundry sand
- The deepening of the open pits will allow access to more resource and will increase the economic viability of the mine by extending the life of mine by approximately six years. This will result in the generation of additional waste rock which cannot be avoided. The design of the waste rock dumps at the mine have therefore been optimised to accommodate this and optimise available space at the mine. Where required additional facilities have been proposed
- The eastern waste rock dump consolidates two of the four previously approved waste rock dumps. The location and footprint of the waste rock dumps has changed to avoid sterilization of ore reserves and accommodate the volume of waste rock generated by the mine and the fact that these facilities will remain in perpetuity.
- The changes in the tailings design will optimise tailings disposal via the installation of toe drains on the inside toe of the TSF containment walls. These drains will draw down the phreatic surface of the tailings dam thus making it more stable, helping the tailings consolidate and improve the placed density and reducing the hydrostatic pressures acting on the containment walls
- The other changes to the general surface infrastructure will optimise the available space at the mine
- The purpose of the truck parking area and loop is to provide sufficient parking and/or waiting area for the trucks enroute to Marikana Railway Siding (MRS). The additional parking area is aimed at ensuring trucks arriving at the mine have a dedicated place to park prior to entrying the mine thereby reducing the stopping of trucks on the Marikana Road.

Environmental setting

The mine and project are located in the western limb of the Bushveld Igneous Complex. Both platinum and chrome ore resources occur on site and are being mined by the approved mining operations. There are geological structures in the area that may influence groundwater flow. Groundwater is one of the sources of water supply for some of the surrounding communities and contributes to the baseflow of streams, including the Sterkstroom.

The mine falls within highveld climatic conditions, with hot and wet summers and cold and dry winters. Winds blow from the north-west (mainly during the day time) and south east (mainly at night) however seasonal differences are observed. Winds hardly reach speeds higher than 5m/s which influences the dispersion of dust or air emissions.

Through the development of the approved mine, land within the mining footprint has changed from a mix of agriculture and residential (including community activities) to mining. The landscape character and quality of the visual resource has been altered. Land within the project footprints is mainly agricultural or transformed, with some pockets of natural vegetation (and some private homesteads and associated structures (within the central waste rock dump footprint). Land surrounding the mine is mostly used for mining operations, crop farming, livestock grazing and general community activities. Residential areas surrounding the mine range from private farmsteads to villages of varying scales including a primary school. Potential sensitive receptors to pollution and/or emissions from the mine do occur in the area surrounding the mine. Some of these receptors are located within the mining rights boundary and relatively close to the mining area. The ambient noise environment (excluding the mine's operations) is higher than the anticipated ratings for a rural area.

The soils found at the project sites are similar to those found within the approved mine footprint. Soils are structured with a high clay content. Beneath the mineralised waste facilities the *in-situ* clay type soils are kep in place and needed as part of the liner system. Land capable for use as grazing dominates the project area.

The mine falls within the Marikana Thornveld which is an important vegetation type that requires careful consideration when developing mining projects. The project area includes a terrestrial Critical Biodiversity Area and a critically endangered river (the Sterkstroom) defined by the North-West Province 2009 biodiversity assessment, and a High Biodiversity area in terms of the recently published Mining Biodiversity Guidelines. It is important to note that these national guidelines and assessments were published after the mine was approved in 2008.

The area has been transformed by agricultural and mining activities (both on the project sites and in the surrounding areas), yet aquatic and terrestrial habitat, although limited, does still exist within the project area which is suitable for fauna and flora species, including some Red Data and protected species.

There are a number of surface water systems within the mine and project area. Apart from the Sterkstroom (where surface water is used for domestic purposes), drainage lines within the mining area were not well defined and did not have distinct channels.

Results from the mine's monitoring programmes are summarized below.

- The pre-mining surface water quality within the Sterkstroom already showed elevated concentrations of certain parameters. The mine's water quality monitoring shows some increase in ambient water quality concentrations downstream of the mine, particularly for nitrates and TDS.
- Groundwater quality monitoring shows elevated concetrations of TDS, EC and nitrates which pre-dates mining activities. Monitoring data is showing inconsistences with respect to other contaminants and this needs to be investigated further to determine if the mine is impacting on groundwater qualities.
- For the most part, the mine's monitoring programme indicates that for the activities that have occurred on site to date, dust fallout impacts are contained within the mining area and that the crushing facilities are the most significant contributor to dust levels. PM10, SO_2 and NO_2 monitoring results show compliance with current South African standards. The project components involve similar activities to those already taking place on site and therefore have the potential to contribute to ambient air quality.

Heritage resources of high significance occur within the extended footprint of the central waste rock dump. These include graves and houses of histricial significance. No paleontological resources are expected within the mining right area.

The socio-economic statistical data reflects a community where there is unemployment, pressure on basic infrastructure and services and pressure on delivery of basic services (health, education, sanitation, water etc.), although the mine has contributed through employment, procurement, skills development and paymemt of taxes.

Summary of environmental impacts and conclusion

Potential environmental impacts were identified by SLR in consultation with IAPs, regulatory authorities, specialist consultants and the mine. The range of environmental issues considered in the EIA was given specific context and focus through consultation with authorities and IAPs. All identified impacts are considered in a cumulative manner such that the impacts of the current baseline conditions on and surrounding the site and those potentially associated with the project are discussed and assessed together. A summary of the potential impacts (as per Section 7 of the EIA and EMP report) and the associated significance rating, in the unmitigated and mitigated scenarios, is provided in the table below.

In summary, the assessment of the project components presents the potential for negative impacts to occur (in the unmitigated scenario in particular) on the bio-physical, cultural and socio-economic environments both on the project sites and/or in the surrounding area. In most instances with mitigation these potential impacts can be prevented or reduced to acceptable levels. This assumes that all mitigation measures included in the EMP are effectively implemented by the mine.

Impacts as a result of the project components do contribute to the overall impact of the mine. When considering the on-site cumulative impact which takes into consideration the approved operations together with the project components the more significant impacts are associated with the physical disturbance of soils and air pollution impacts. In both instances the cumulative on-site significance rating as presented in this report either remains high or reduces to medium depending on the mitigation implemented. These are discussed further below.

In the case of the loss of soil resources through physical disturbance, the overall rating for the mine with mitigation is influenced by the increase in mine footprint (by 35%) and the need to retain an *in-situ* layer of clay below project-related mineralised waste facilities (which includes the majority of the project footprint).

In the case of air pollution, the model predicts that with mitigation that focuses on minimising pollution at the source there may still be exceedances of the NAAQ limits for PM_{10} and $PM_{2.5}$ (particulate matter with a diameter less than 10 micron and less than 2.5 micron) emissions that could result in health related impacts. If monitoring confirms the model predictions, then relocation of sensitive receptors within the exceedance zone may be required.

The alternative land use assessment and sustainability analysis shows that mining is economically a preferred land use when compared to the loss of existing land uses. Some local negative economic impacts may be experienced in the immediate vicinity of the mine if the mitigation as presented in Section 19 is not effectively implemented. It follows that provided the EMP is effectively implemented there is no environmental, social or economic reason why the project should not proceed. For the overall mine, careful consideration will need to be given to mitigation measures associated with closure planning and minimising health impacts on sensitive receptors within the mining rights boundary.

SUMMARY OF THE SIGNIFICANCE RATING FOR POTENTIAL IMPACTS					
Environmental component	**Potential impact**	**Significance of the impact (the ratings are negative unless otherwise specified)**			
		Rating from approved EIA and EMP (Metago, 2008)		**Cumulative on-site rating**	
		Unmitigated	**Mitigated**	**Unmitigated**	**Mitigated**
Geology	Loss and sterilization of mineral resources	No impact expected		No impact expected	
Topography	Hazardous excavations and infrastructure	H	M	H	M
	Surface subsidence	M	L	M	L
Soils and land capability	Loss of soil resources and land capability	H	M	Assessed separately as outlined below	
	Loss of soil resources and land capability through physical disturbance	Not assessed separately in the approved EIA and EMP		H	M-H

SUMMARY OF THE SIGNIFICANCE RATING FOR POTENTIAL IMPACTS					
Environmental component	**Potential impact**	**Significance of the impact (the ratings are negative unless otherwise specified)**			
		Rating from approved EIA and EMP (Metago, 2008)		**Cumulative on-site rating**	
		Unmitigated	**Mitigated**	**Unmitigated**	**Mitigated**
	Loss of soil resources and land capability through pollution			H	L
Biodiversity	Physical destruction of biodiversity	H	M	H	M
	General disturbance of biodiversity	H	M	H	M
Surface water	Alteration of surface drainage lines	H	M	H	M
	Contamination ofsurface water resources	H	L	H	L
Groundwater	Groundwater contamination	H	M	H	M
	Reduction in groundwater levels / availability – impacts on third party users	H	L	H	L
	Reduction in groundwater levels / availability – impacts on baseflow	H	M	H	M
Air quality	Air pollution through dust generation (including PM_{10} and $PM_{2.5}$)	H	M	H	H-M
Noise	Noise pollution	H	M	H-M	M-L
Visual	Negative visual impacts	H	M	H	M
Heritage, palaeontological and cultural resources	Loss of heritage, palaeontological and cultural resources	H	L	H	L
Land use	Loss of or changes to existing land uses	Not assessed in the approved EIA and EMP		H	M-L L (at closure)
Socio-economic	Blasting impacts	H	M	H	M
	Road disturbance and traffic safety	H	M	Remains unchanged	
	Economic impact (negative)	M+	M+	M+	M+
	Economic impact (positive)	M	M-L		
	Inward migration and associated social issues	H-M	M-L	H	M-L

Interpretation of the significance		
Significance		**Decision guideline**
H	High	It would influence the decision regardless of any possible mitigation.
M	Medium	It should have an influence on the decision unless it is mitigated.
L	Low	It will not have an influence on the decision.
	+	Denotes a positive impact.

ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT PROGRAMME REPORT FOR CHANGES TO THE PIT, TAILINGS DAM AND WASTE ROCK FACILITIES; A CHROME SAND DRYING PLANT AND OTHER OPERATIONAL AND SURFACE INFRASTRUCTURE CHANGES

INTRODUCTION

Tharisa Minerals (Pty) Ltd (Tharisa) is an opencast mining operation that produces chrome and platinum group metals (PGM) concentrate at its Tharisa Mine near Marikana town. The mine is located within the Rustenburg Local Municipality (RLM), Madibeng Local Municipality (MLM) and Bojanala Platinum District Municipality (BPDM) in the North West Province. The regional setting of Tharisa Mine is illustrated in Figure 1.

The project comprises the following components:

- Deepening and extending of the pits and related additional waste rock and tailings material storage
- A chrome sand drying plant
- Changes to the tailings storage facility design
- Re-shaping and re-alignment of waste rock dumps
- Partial backfilling of the open pits
- Changes to the general surface infrastructure layout and operations at Tharisa Mine.

Tharisa Mine is located on the farms Kafferskraal 342 JQ and Elandsdrift 467 JQ. The local setting is illustrated in Figure 2.

Legal framework

Environmental decisions for various components of the project are required from the following regulatory authorities:

- Department of Mineral Resources (DMR): a decision in terms of Section 102 of the Mineral and Petroleum Resources Development Act (MPRDA), 28 of 2002, is required on the amendment of the environmental impact assessment (EIA) and environmental management programme (EMP) report. This amendment caters for changes in the mining depth and infrastructural changes at the mine.
- North West Department of Economic Development, Environment, Conservation and Tourism (DEDECT): a decision in terms of the National Environmental Management Act (NEMA), 107 of 1998, is required as the project incorporates listed environmental activities (refer to Table 2.3). As both basic assessment and full scoping and EIA related activities are triggered (R544 and R545 of 18 June 2010, respectively), a full scoping and EIA process in terms of the 2010 EIA Regulations has been followed.
- Department of Water Affairs (DWA): an amendment to the Tharisa water use license in terms of the National Water Act (NWA), 36 of 1998, is required as the project incorporates water use changes.

- DEDECT: an air emission license (AEL) in terms of the National Environmental Management: Air Quality Act (NEM:AQA), 39 of 2004, is required as the project incorporates an activity listed in Government Notice 248 of 31 March 2010. The activity relates to the drying of mineral solids at the chrome sand drying plant (activity sub-category 4.1: Drying and Calcining).

Given the legal framework above, this report has been compiled to meet the requirements of the 2010 EIA Regulations and MPRDA Regulations. In this regard, the new DMR report structure template has been used. To assist with cross-referencing in the report, the chapter numbering in the EMP section follows on from the chapter numbering in the EIA section.

In terms of Regulation 543 of the 2010 EIA Regulations, the table provides a guide to the relevant sections where the information is contained. Separate documents will be prepared for the NWA and NEM:AQA requirements.

Chapter in report	Environmental Regulation 543
Environmental impact assessment (EIA)	
Introduction	Comment on the need and desirability of the proposed activity(ies) in the context of alternatives
Introduction	Details of the person who compiled the EIA, and his/her expertise
1	A description of the environment that may be affected by the activity and the manner in which aspects of the environment may be affected
1.3.1 and 1.4	Description of the property and location of the activity on the property
2	Description of proposed activity(ies)
2.9	Description of identified potential alternatives to the proposed activity
7	Description of environmental issues, assessment of significance, and extent to which these can be mitigated
7	Assessment to include: cumulative impacts, nature, extent, duration, probability, reversibility of resource loss, mitigation
7.3	Methodology used to determine impact significance
8 and Appendix L	Description and comparative assessment of alternatives identified during the EIA
11	Assumptions, uncertainties and knowledge gaps
10, Appendix A to C	Details on the public involvement process including –compliance with the PSS, IAP database, issues table, additional comments/objections
27	Provide an authorisation opinion – with possible conditions
27	Environmental impact statement – summary of key findings and comparative assessment of the positive and negative implications of the activity and alternatives
Throughout document	Summary of findings and recommendations of specialist reports
See appendices	Specialist reports as appendices
Environmental management programme (EMP)	
Introduction	Details of the person who compiled the EMP, and his/her expertise
2	Detailed description of the activity aspects covered in the EMP
18 and 19	Details on the management/mitigation measures from planning and design stages through to closure (where relevant)
19	Time frames for implementation where appropriate
19	Identification of responsible persons for implementation
14, 15, 18, 19 and 22	Description of the manner in which is intended to modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation

Chapter in report	Environmental Regulation 543
19 and 21	Proposed mechanisms for monitoring compliance with and performance assessment against the environmental management programme and reporting thereon
19	Measures to rehabilitate environment affected by the undertaking of any listed activity
19	Process to manage any environmental damage, pollution, pumping and treatment of extraneous water or ecological degradation
2.8, 14, 15, 16 and 17	Closure plans, including closure objectives
23	Environmental awareness plan

The related environmental assessment process comprises two phases: a scoping phase and environmental impact assessment and management programme amendment (EIA) /EMP) amendment phase. This report documents the EIA/EMP amendment phase.

Other permits or licenses required for the project

Other permits or licenses that may be required for the project are listed below.

- Tharisa holds a water use license issued by Department of Water Affairs (DWA) in July 2012, in terms of Section 21 of the National Water Act, 36 of 1998. The license authorises uses related to taking water from a water resource, storing of water, impeding or diverting the flow of water in a watercourse, altering the beds, banks or characetristics of a watercourse, disposing of waste or water containing waste and removing water found underground. Tharisa has submitted a WUL amendment request (as per Section 18 of the NWA) to the DWA Regional office in order to address administrative errors contained in Tharisa's WUL. The project components trigger the need to amend the mine's water use license. Prior to conducting any water uses as defined, Tharisa will apply for authorization from the DWA. The water uses and exemptions that may be required for the project components include:
  - Section 21(g) Water Use (Disposing of waste in a manner which could detrimentally impact upon a water resource): to cater for the changes and additions to waste rock disposal and the tailings storage facility; changes to the pollution control dams that result from the updated stormwater management plan and storage of excess water in the Hernic quarry should also be authorised
  - Section 21(j) Water Use (Removing water from underground for the safe continuation of an activity) and 21(a) Water Use (taking water from a water resource): to cater for dewatering of the deepened open pits and use of this water at the mine
  - Section 21(c) (Impeding or diverting the flow of water in a watercourse) and 21(i) Water Use (Altering the beds, banks, course or characteristics of a watercourse): to cater for disturbances to drainage lines as a result of the project components
  - Regulation 704 (R704) exemption for Condition 4a (Locate or place any residue deposit, dam, reservoir, together with any associated structure within 1:100 year flood-line or within a horizontal distance of 100 m of a watercourse or borehole, excluding boreholes drilled specifically to monitor the pollution of ground water, or on ground likely to become water-logged, undermined, unstable or cracked): to cater for the placement of project infrastructure

- R704 exemption for Condition 4b (Carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, whichever is greatest): to cater for the extension of the east pit
- R704 exemption for Condition 5 (May not use any residue or substance which causes or is likely to cause pollution of water resource for the construction of any dam or other impoundment or any embankment, road or railway or for any other purpose which is likely to cause pollution of a water resource): to cater for the use of waste rock in the construction of roads and containment facilities.

- As from the 2 September 2014, a waste management license will be required in terms of the National Environmental Management: Waste Act, 59 of 2008, for mineralised waste disposal facilities. The applicability of this to changes to already approved facilities under the MPRDA and NEMA is uncertain. For new facilities it is assumed that a waste management license will be required. Given the lack of transitional arrangements and clarity on the required license at the time of compiling this report, Tharisa will consult with the relevant competent authority to obtain input on the way forward.
- It is understood that the TSFs at Tharisa have been registered with DWA as dams with a safety risk in terms of the National Water Act, 36 of 1998. If required, this registration will be updated to cater for changes as a result of the project
- Tharisa obtained a permit in terms of the National Heritage Act, 25 of 1999, for the exhumation and relocation of graves to be disturbed by the mining of the east pit. For the project components, prior to damaging or removing heritage resources within the central waste rock dump footprint, permissions will be sought in terms of the National Heritage Act, 25 of 1999
- Prior to removing or damaging any protected plant species within the project component footprints, the necessary permits will be obtained from DWA in terms of the National Forests Act, 84 of 1998
- Tharisa has confirmed that the D1325 road deviation (as included in the approved EIA and EMP, Metago 2008) approval has been obtained from the North West Department of Roads and Transport in terms of the relevant Provincial Road Ordinance. Any changes to the approved deviation as a result of the east pit extension will need to be discussed and agreed to with the North West Department of Transport Roads and Community Safety.

Environmental assessment process and approach

A summary of the key steps in the environmental process is provided in the table below. Further detail on the public consultation process is included in Section 10.

Objectives	Corresponding activities
Pre-application phase	
• Familiarise the project team with the project site and project scope	• Site visit conducted by project team members • Review of available studies and reports covering the current operations and project • Review of available maps (1:250,000 and 1:50, 000 scale) and imagery • Identification of potential positive and negative impacts by considering the project description and site conditions
Application phase (May – December 2011)	
• Notify the decision making authorities of the project components. • Initiate the environmental assessment process.	• DMR notified of the project components. • Subimssion of an application to DEDECT for listed activities under NEMA. • Submission of an application to the Department of Environmental Affairs (DEA) for waste associated with the smelter complex. This application was withdrawn when the smelter was removed from the project scope. • DWA and other commenting authorities notified of project
Scoping phase (January -July 2012)	
• Identify interested and/or affected parties (IAPs) and involve them in the scoping process through information sharing. • Determine the issues associated with the project components. • Consider alternatives. • Identify any fatal flaws. • Determine the terms of reference for additional assessment work.	• Notify IAPs of the project and environmental assessment process (social scans, distribution of background information document s (BIDs), newspaper advertisements, telephone calls and site notices) in (January 2012). • Scoping meetings (February 2012). • Compilation and submission of the scoping report to interested and affected parties (IAPs) and the regulatory authorities (March- July 2012). • Update the scoping report to include comments from the review period and submit final scoping report to DEDECT (July 2012) • Two focussed meetings were held with representatives of the residents of Buffelspoort (south of the mine and N4) (23 February 2013)
Additional scoping phase (January - June 2014)	
• Identify any additional IAPs relevant to the new project footprint and involve them in the scoping process • Determine the issues associated with the change in project scope • Consider alternatives • Identify any fatal flaws • Determine the terms of reference for additional assessment work	• Notify IAPs of the change in project scope and updated environmental assessment process (telephonic discussions, newspaper advertisements, site notices and distribution of the scoping report summary) (February – March 2014) • Scoping meetings (March 2014) • Update the scoping report and submit the revised draft scoping report to IAPs and the regulatory authorities for review. At the same time submit a copy of the report to DEDECT for their records (April 2014) • Update the scoping report to include comments from the review period and submit final scoping report to DEDECT. At the same time, notify IAPs of the availability of the final report for review (June 2014)

Objectives	Corresponding activities
EIA and EMP phase (June 2012- December 2014)	
Detailed specialist investigations (June 2012 – June 2014)	
• Describe the affected environment. • Define potential impacts. • Give management and monitoring recommendations.	• Specialist studies in line with the terms of reference agreed to in the scoping report and comments received from IAPs(See Section 1.5 for a list of specialist studies).
Reporting (October 2012 to January 2014)	
• Assess potential impacts with assistance from appointed specialists where required. • Identify appropriate management measures.	• Compilation of EIA and EMP report • Submission of the draft EIA and EMP report to IAPs and the regulatory authorities for review. At the same time submit a copy of the draft EIA and EMP report to DEDECT for their records (September 2014) • Focussed and public feedback meetings with IAPs (September 2014) • Record comments (September - October 2014) • Forward IAP comments to the DMR (October 2014) • Update the EIA and EMP report to include comments from the review period and submit final report to DEDECT. At the same time, notify IAPs of the availability of the final report for review (October 2014)
• Determine outcome of application	• Distribute the record of decision from decision making authorities

EIA team

SLR Consulting (Africa) (Pty) Ltd (SLR) is an independent company of consultants that has been appointed by the applicant to undertake the environmental assessment and related processes. Stella Moeketse (Project Manager) has five years of relevant experience. Alex Pheiffer (Reviewer) has over ten years of relevant experience and is a registered Environmental Scientist with the South African Council for Natural Scientific Professions.

Neither SLR nor the project team members have any interest in the project other than fair payment for consulting services rendered as part of the environmental assessment process.

The project team is outlined in the table below.

Team	Name	Designation	Tasks and roles	Company
Project management	Stella Moeketse	Project Manager	Management of the assessment process, stakeholder engagement and report compilation.	SLR
	Alex Pheiffer	Project Reviewer	Report and process review	
Specialist input	Jude Cobbing	Groundwater specialist	Groundwater impact assessment	
	Paul Klimczak	Hydrologist	Surface water impact assessment and water balance update	
	Stephen van Niekerek	Engineer	Closure cost estimate and conceptual waste rock design	
	Garry Paterson	Soil scientist	Soil and land capability study	ISCW-ARC
	Ben van Zyl	Noise specialist	Noise study	Acusolv
	Eric Kohler	Blasting consultant	Blast study	Cambrian CC
	Yonanda Martin	Visual specialist	Visual study	Newton Landscape Architects

Team	Name	Designation	Tasks and roles	Company
	Hanlie Liebenberg-Enslin	Air Quality impact specialist	Air quality impact assessment	Airshed
	Dr Julius Pistorius	Archaeologist and Heritage Consultant	Heritage and cultural assessment	Archaeologist and Heritage Management Consultant
	Bruce Rubidge	Palaeontologist	Palaeontological assessment	BPI for Palaeontological Research
	Gerrie Muller	Socio-economic specialist	Alternative land use and economic assessment	Strategy4Good

Contact details of the applicant

The contact details for the project team/mine are included below.

Details	Group SHE Manager	Environmental Manager
Name	Tharisa Minerals (Pty) Ltd	Tharisa Minerals (Pty) Ltd
Postal address	Postnet Suite 473 Private bag X51 Bryanston 2021	Postnet Suite 473 Private bag X51 Bryanston 2021
Telephone number	014 572 0714	014 572 0716
Contact person	Derek Baker	Thulani Ntshanga

Regional setting

The regional and local setting of the mine is outlined below, and illustrated in Figure 1 and Figure 2 respectively.

Aspect	Detail
Province	North West Province
Magisterial district	Rustenburg
Regional authority	Bojanala Platinum District Municipality
Local authority	Rustenburg and Madibeng Local Municipalities
Local Municipal Ward Number	Ward 8 and 10
Farms (and portions) on which the activities will take place	Kafferskraal 342 JQ Elandsdrift 467 JQ
Nearest towns	Marikana, Rustenburg, Mooinooi and Buffelspoort
Surrounding communities	Various formal and informal community groupings – land owners, land occupiers, informal and formal settlements
Use of land immediately adjacent to mine	Residential, business (shops and bed and breakfast), mining and farming.
Use of land immediately adjacent to the proposed additional surface infrastructure	
Water catchment and management area	Crocodile River Basin – Quaternary Catchment A21K
Topographic landmarks	Magaliesberg Mountain Range

Note: This information has been sourced from the approved EIA and EMP report, Metago, 2008

Project motivation (need and desirability)

The motivation for the project as outlined by Tharisa is provided below.

- The purpose of the chrome sand drying plant is to produce higher-value chrome sand suitable for use as foundry sand
- The deepening of the open pits will allow access to more resource and will increase the economic viability of the mine by extending the life of mine by approximately six years. This will result in the generation of additional waste rock which cannot be avoided. The design of the waste rock dumps at the mine have therefore been optimised to accommodate this and optimise available space at the mine. Where required additional facilities have been proposed
- The eastern waste rock dump consolidates two of the four previously approved waste rock dumps. The location and footprint of the waste rock dumps has changed to avoid sterilization of ore reserves and accommodate the volume of waste rock generated by the mine and the fact that these facilities will remain in perpetuity.
- The changes in the tailings design will optimise tailings disposal via the installation of toe drains on the inside toe of the TSF containment walls. These drains will draw down the phreatic surface of the tailings dam thus making it more stable, helping the tailings consolidate and improve the placed density and reducing the hydrostatic pressures acting on the containment walls
- The other changes to the general surface infrastructure will optimise the available space at the mine
- The purpose of the truck parking area and loop is to provide sufficient parking and/or waiting area for the trucks enroute to Marikana Railway Siding (MRS). The additional parking area is aimed at ensuring trucks arriving at the mine have a dedicated place to park prior to entrying the mine thereby reducing the stopping of trucks on the Marikana Road.

FIGURE 1: REGIONAL SETTING

FIGURE 2: LOCAL SETTING

SECTION 1: ENVIRONMENTAL IMPACT ASSESSMENT

1 DESCRIPTION OF THE BASELINE ENVIRONMENT

This section provides a record of baseline information for the existing mine area and the project components.

Information contained in this section was derived from the mine's approved EIA and EMP report (Metago 2008) (which included specialist studies), monitoring data from the mine, and specialist studies undertaken for the mine and project components. Specialist reports completed for this project are listed in Section 1.5 and included as appendices. Figures illustrating the baseline environment are included in Section 1.4.

1.1 ON-SITE ENVIRONMENT (BIO-PHYSICAL) RELATIVE TO SURROUNDING ENVIRONMENT (BIO-PHYSICAL)

1.1.1 GEOLOGY BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008) and should be read with reference to Figure 1.1 (Section 1.4).

Introduction and link to impacts

As a baseline, the geology and associated structural features provides a basis from which to understand the potential for sterilisation of mineral reserves; the geochemistry and related potential for the pollution of water from mineralised waste facilities and stockpiles; and the geophysics and related potential for geological lineaments such as faults and dykes. Faults, dykes and other lineaments can act as preferential flow paths of groundwater, which can influence both the dispersion potential of pollution plumes and the inflow of water into mine workings.

Geological processes also influence soils forms (see Section 1.1.4) and the potential for palaeontological resources (see Section 1.3.2). To understand the basis of these potential impacts as they relate to the project components, a baseline situational analysis is described below.

Data collection

For the approved EIA and EMP report (Metago, 2008) regional geological data collection was accomplished through review of available studies and topographical maps. Geophysical surveys were undertaken to identify potential geological lineaments. Geochemistry related analysis work was conducted to understand the pollution potential of mineralised waste facilities.

Results

Regional Geology

Rocks of the Rustenburg Layered Suite (RLS) of the old Bushveld Igneous Complex (BIC) underlie the Tharisa Mine area. The RLS layered sequence is generally planar in nature and gently folds around a thickened part of the floor rocks (Magaliesberg Quartzite Formation (MQF)). All the chromitite and platinum mineralisation is located in the RLS. These layered rocks have a maximum thickness of up to about 8 km consisting of pyroxenite, norite, gabbro and other mafic to ultramafic lithogens.

The RLS comprises five stratigraphic zones representing the sequential fractional crystallisation that accompanied the cooling of this magmatic body:

- The Marginal Zone, which comprises pyroxenites and norites with no economic potential
- The Lower Zone which comprises ultramafic rocks, such as pyroxenites and harzburgites, containing thin, high-grade chromitite seams
- The Critical Zone pyroxenites, norites and anorthosites that host all the significant platinum group metals chromite deposits
- The Main Zone, which consists mainly of homogeneous norites and gabbros that are locally exploited as dimension stone
- The Upper Zone norites, gabbros and diorites, which host over 20 massive magnetite seams, some of which are exploited for vanadium and iron ore.

Local Geology

The target ore body is the Chrome Middle Group (MG1 –MG4). Generally, the strike is east-west and the dip is to the north.The entire MG package is developed over a true thickness of 47m on the eastern portion of Kafferskraal and thins to 25m to the west near the Spruitfontein upfold. The MG package has four main chromite layers hosted in anorthosite, norite and feldspathic pyroxenite. Figure 1.1 illustrates the general representative profile with the average thickness of the individual layers outlined in Table 1.1 below.

TABLE 1.1: LOCAL GEOLOGY

MG Layer	**Average (m)**	**Max (m)**	**Min (m)**	**Median (m)**
MG4A	1.843	4.636	0.802	2.719
MG4	1.458	2.103	0.518	1.311
MG4(0)	0.592	1.594	0.377	0.985
MG4+MG4(0)	2.758	4.871	1.330	3.101
MG3	2.698	6.162	1.144	3.653
Anorthositic marker	5.75	8.437	2.553	5.495
MG2C	0.636	1.247	0.303	0.775
MG2B	0.518	1.213	0.137	0.675
MG2A	0.566	0.998	0.181	0.589
MG2s	4.191	7.542	1.937	4.739
MG1	1.199	1.638	0.455	1.047

Of the four main chromite layers (seams), the MG1 has the highest chrome content. It is common for the MG1 to be divided into more than one band. Shearing in the MG1 is also common but the location varies. The MG2s have three subdivisions, with the MG2A, MG2B and MG2C identifiable from the base upwards. MG2A and MG2B usually occur as one layer but are distinguishable by their definite analytical signature. Of the three subdivisions MG2C contains the highest content of Platinum Group Metals (PGMs) followed slightly by MG2A. MG2B has a much lower content in comparison. The MG2s are hosted in a felspathic pyroxenite but directly underlay the anorthositic marker. The anorthositic marker is a prominent anorthosite and often a norite separating the MG2s and the overlying MG3. Chrome stringers are sometimes present within the marker and can be high in PGM content. The MG3 appears as a banded layer of chrome stringers and bands within norite and anorthosite. The MG4s are subdivided into the MG4(0) at the base, MG4 and MG4A at the top.

<u>Structural Features</u>

There are minor faults and some dykes within the mining right area. There are no major displacements. North north west – South south east striking joints and normal faults as well as East - West joints are common in the area.

Data recorded from underground workings (approximately at a depth of 2000 m) in adjacent areas of the RLS shows that many reverse faults dip moderately steeply towards the south in this area. Normal faults, in contrast, generally dip moderately steeply towards the North East and South West. In general, fractures or openings will close with depth due to overburden pressure. Therefore it is the opinion of the groundwater specialists that with information currently available on the project, deepening of the pits should not lead to disproportionately higher risk of contaminant migration due to faulting.

<u>Geochemistry</u>

Laboratory scale tests such as acid base accounting, XRF analysis, leach testing and mineralogical examination were used to determine whether the waste streams for the operations were potentially acid generating (Metago, 2008). Laboratory testing and historic monitoring of similar sites showed that none of the waste streams (tailings and waste rock) were expected to generate acid leachate, but do in fact have a medium neutralising potential.

Under the worst case scenario of mildly acidic conditions (i.e. acid rain), there is possible leaching of aluminium and manganese, as well as, elevated salt loads (TDS) from the waste rock dumps.

Conclusion

The structures that are present in the area may influence groundwater flow by forming preferential flow paths for groundwater, influence dewatering (zone of influence) along zones of enhanced transmissivity. The presence of these within the geological formations on site seem to be constant across the stratigraphy. Laboratory testing and historic monitoring of similar sites showed that none of the waste streams (tailings and waste rock) were expected to generate acid leachate, but do in fact have a medium neutralising potential. Under the worst case scenario of mildly acidic conditions (i.e. acid rain), there is possible leaching of aluminium and manganese, as well as, elevated salt loads (TDS) from the waste rock dumps. As indicated in the approved EIA and EMP (Metago, 2008), the potential for leachate from the mineralised waste facilities requires consideration of pollution prevention measures.

In line with the commitments of the approved EIA and EMP (Metago, 2008), the siting of additional surface infrastructure has taken into account the location of mineral ore reserves.

1.1.2 TOPOGRAPHY BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008) and site observations by the SLR project team and should be read with reference to Figure 2 (Section 1.4).

Introduction and link to anticipated impact

The topography of a project area influences surface water flow, safety of third parties and animals, the location of soils and the visual character of a landscape. Existing mining infrastructure and activities have altered the topography of the site. The project components have the potential to contribute to the alterations. This in turn could result in changes to drainage patterns, landforms which could prove hazardous to people and animals, as well as changes to the visual character of the site. As a baseline, this section provides an understanding of the topographical features relevant to the project site and surrounding area from which to measure potential change.

Data collection

For the approved EIA and EMP report (Metago, 2008), data on topography was sourced through the studying of topographical maps and observations made by the project team during site visits. The topographical maps included both the 1:250 000 and 1:50 000 topographical maps of the area (used as the base maps to Figure 1: and Figure 2 respectively).

Results

Tharisa Mine lies on a relatively flat plain with a gentle slope down towards the north. The area has an elevation of approximately 1200 meters above mean sea level (mamsl). Approximately 2km to the south of the mine lies the Magaliesberg Mountain range (Figure 2). Peaks in this part of the Magaliesberg rise to approximately 1400mamsl. The perennial Sterkstroom and various non-perennial tributaries of the Sterkstroom and Maretlwane run through the mine area. The natural topography surrounding the mine has been changed by third-party mining activities to the north, east and west of the mine. The topography within the project area has been significantly altered by the development of mine infrastructure.

Conclusion

The topography of the site has been altered by approved mining activities that range from open pits to mineralised waste facilities (WRDs and TSFs). Not all of the approved facilities have been constructed as yet. The project components include increased sizes of the open pits, waste rock dumps, the tailings storage facilities and soil berms. Deepening of the mining pits will also take place. These changes to the approved mining operations need careful consideration of with respect to safety, water and visual aspects.

1.1.3 CLIMATE BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008), the project-specific hydrology study (Appendix E) and project-specific air quality study (Appendix G). This section should be read with reference to Figure 1.2 and Figure 1.3 (Section 1.4).

Introduction and link to anticipated impact

As a whole, the various aspects of the climate that are discussed influence the potential for environmental impacts and related mine/infrastructure design. Specific issues are listed below.

- Rainfall could influence erosion, evaporation, vegetation growth, rehabilitation planning, dust suppression, and surface water management planning
- Temperature could influence air dispersion through impacts on atmospheric stability and mixing layers, vegetation growth, and evaporation which could influence rehabilitation planning
- Wind could influence erosion, the dispersion of potential atmospheric pollutants, and rehabilitation planning.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

Data collection

For the approved EIA and EMP report (Metago, 2008) climatic data for the area was sourced from Anglo Platinum's meterological station (10km north of Tharisa Mine) and the Buffelspoort meterological station (5km south of the Tharisa Mine).

For the current study, this data was reviewed and updated where relevant as part of the hydrology and air quality studies.

Results

Regional Climate

Tharisa Mine falls within the Highveld Climatic Zone, as defined by Schulze (1974). This is a warm temperate climate. Rain generally occurs in the summer from October to March. The average annual precipitation ranges from 650 mm (west) to 900 mm (east) (WRC, 1994). Rainfall is generally in the form of thunderstorms; on average 75 storms each year. These can be of high intensity with lightening and strong gusty south-westerly winds. Hail frequency is high, tending to occur 4 to 7 times per season.

Rainfall and evaporation

The Buffelspoort weather station is the closest station to the Tharisa Mine and has therefore been used in hydrological calculations. The monthly average rainfall and evaporation is presented in Table 1.2 and analysis of 24 hour maximum rainfall depths, maximum and minimum monthly rainfall recorded and average number of rain days is presented in Table 1.3.

TABLE 1.2: AVERAGE MONTHLY RAINFALL AND EVAPORATION ADOPTED FOR THE THARISA MINE

Month	Rainfall Depth* (mm)	Average S-Pan** (mm)	S-Pan to Lake Evap. factor	Lake Evaporation Depth (mm)	Net Gain(+)/ Loss(-)
January	123	195	1	195	-72
February	97	165	1	165	-68
March	85	158	1	158	-73
April	41	125	1	125	-84
May	17	107	1	107	-90
June	8	87	1	87	-79
July	5	97	0.8	78	-73
August	6	128	0.8	102	-96
September	18	168	0.8	134	-116
October	57	193	0.8	154	-97
November	88	189	1	189	-101
December	119	199	1	199	-80
TOTALS	**664**	**1 811**	**-**	**1 693**	**-1 029**

** Supplied by the South African Weather Service based on monthly figures from 1925 to 2007 measured at Buffelspoort II weather station*

*** Supplied by the Department of Water Affairs and Forestry based on monthly figures from 1942 to 2007 measured at Buffelspoort Dam weather station*

TABLE 1.3: RAINFALL DATA FOR THE MINE AREA

Month	24hr Max Rainfall		Total Rainfall per month / year				Average No. of Days with Rainfall >= 0.1mm						
	Depth (mm)	Date (yy/dd)	Max (mm)	Year	Min (mm)	Year	Avg	Max	Min	1mm	5mm	10mm	30mm
January	103	76/05	286	1977	23	1969	12,8	17	7	11,1	7,0	4,3	1,0
February	70	80/16	193	1974	10	1963	10,2	17	4	9,0	5,4	2,9	0,5
March	91	76/19	198	1968	4	1965	9,3	16	2	8,2	4,6	2,7	0,4
April	83	76/02	134	1961	3	1985	6,6	14	1	5,7	2,9	1,5	0,2
May	47	69/20	72	1976	0	1989	2,5	11	0	2,0	1,2	0,4	0,1
June	19	89/03	44	1989	0	1990	1,3	7	0	0,9	0,5	0,3	0,0
July	29	82/26	36	1982	0	1989	0,7	4	0	0,6	0,2	0,0	0,0
August	20	87/26	31	1979	0	1988	1,6	10	0	1,0	0,3	0,1	0,0
September	37	73/29	96	1987	0	1990	2,3	9	0	2,0	1,0	0,6	0,1
October	77	76/02	140	1973	9	1980	7,4	16	3	6,1	3,4	2,1	0,3
November	91	79/25	239	1979	31	1981	11,1	18	5	9,4	5,5	3,2	0,3
December	87	64/12	305	1966	41	1980	11,8	18	6	10,3	5,5	4,0	1,0
YEAR	**103**	**76/05**	**1062**	**1976**	**499**	**1981**	**78**	**94**	**63**	**66**	**38**	**22**	**4**

Maximum rainfall intensities

Design storm estimates for various return periods and storm durations were sourced from the Design Rainfall Estimation Software for South Africa, developed by the University of Natal in 2002 as part of a Water Research Commission (WRC) project K5/1060 (Smithers and Schulze, 2002). This method provides site-specific estimates of intensity-duration-frequency (IDF) rainfall, based on surrounding observed records. For this project, the six nearest rain stations with similar Mean Annual Precipitations (MAP) and altitudes were used. The relevant maximum rainfall intensities and depths are included in Table 1.4. The Smithers and Schulze method of IDF rainfall estimation is widely accepted to be more robust than previous single site methods. WRC Report No. K5/1060 provides further detail on the verification and validation of the method (SLR, 2014a).

TABLE 1.4: RAINFALL DEPTH INTENSITIES FOR THARISA MINE

Duration (hours)	Rainfall Depth (mm)						
	1:2yr	**1:5yr**	**1:10yr**	**1:20yr**	**1:50yr**	**1:100yr**	**1:200yr**
0.08	10.4	14.2	16.8	19.6	23.4	26.5	29.8
0.167	15.5	21.1	25.1	29.1	34.8	39.4	44.3
0.25	19.6	26.6	31.6	36.8	43.9	49.7	55.9
0.5	24.8	33.6	40	46.5	55.6	63	70.8
0.75	28.5	38.6	46	53.4	63.9	72.3	81.3
1	31.4	42.6	50.7	58.9	70.5	79.8	89.6
1.5	36	48.9	58.2	67.7	80.9	91.6	102.9
2	39.7	54	64.2	74.6	89.2	101	113.5
4	47.3	64.2	76.4	88.9	106.3	120.3	135.2
6	52.4	71.1	84.6	98.4	117.7	133.2	149.7
8	56.3	76.5	91	105.8	126.5	143.2	160.9
10	59.6	80.9	96.3	111.9	133.8	151.5	170.2
12	62.4	84.7	100.8	117.2	140.1	158.6	178.2
16	67.1	91.1	108.3	126	150.6	170.5	191.6
20	71	96.3	114.6	133.3	159.3	180.4	202.7
24	74.3	100.9	120	139.5	166.8	188.9	212.2

Temperature

The average monthly maximum and minimum values for the Buffelspoort Weather station (Station No. 0511 855 W) are shown in Table 1.5 below. From the table it can be seen that the area experiences an average maximum temperature of 26.2°C and an average minimum temperature of 11.1°C. The area has experienced a maximum of 40.2°C in summer and a minimum of 8.0°C in winter over the last 29 years the station was operational (1961 – 1990).

TABLE 1.5: AVERAGE TEMPERATURES RECORDED IN THE REGION OF THE MINE – BUFFELSPOORT

Month	Average of daily temperatures (°C)				Highest maximum (°C)		Lowest minimum (°C)	
	Maximum	Minimum	Mean	Range	Maximum	Date	Minimum	Date
January	301	17.1	23.6	13.0	40.2	73/19	17.1	72/23
February	29.4	16.8	23.1	12.6	39.3	64/26	17.5	88/10
March	28.1	15.1	21.6	13.0	38.4	70/01	14.6	75/18
April	25.3	11.4	18.3	13.9	36.5	79/15	13.3	72/30
May	22,9	6.8	14.9	16.1	33.0	73/07	13.3	81/28
June	20.0	3.3	11.7	16.7	27.0	72/01	8.3	64/19
July	20.6	3.0	11.9	17.6	26.5	90/25	10.7	79/09
August	23.6	5.5	14.5	18.1	31.8	78/16	12.1	72/01
September	27.4	9.9	18.6	17.5	35.8	73/21	8.0	74/04
October	28.5	13.0	20.8	15.5	38.5	65/31	12.2	73/17
November	29.0	14.9	21.9	14.1	38.0	90/14	11.3	68/11
December	29.8	16.1	22.9	13.7	39.0	72/05	15.4	79/25
Year	26.2	11.1	18.6	15.1	40.2	73/19	8.0	74/04

Wind Data

In characterising the dispersion potential of the site, the approved EIA and EMP report referred to hourly average meteorological data recorded at Anglo Platinum's Klipfontein meteorological station for the period January to December 2007. The Klipfontein ambient monitoring station was regarded at that time as representative of the local meteorology. For this project, hourly average meteorological data modelled by SAWS (unified model) for a point located within the mine property for the period January 2009 to December 2011 has been used and is presented below. It is the air quality specialist's opinion that there is sufficient agreement between the measured Klipfontein data and Unified Model modelled data for the more recent modelled data, that was available for a longer period, to be used.

The average annual wind roses generated by the Unified Model show that the dominant wind direction is from the north west (Figure 1.2). Winds from the south west sector are the least common. Wind speeds hardly reach speeds higher than 5m/s. Day-time and night-time wind roses differ significantly with day-times dominated by winds from the north west and north north-west whereas night times are dominated by winds from the opposite direction and the south. Seasonal wind roses indicate that summer, spring and autumn winds are dominantly from the north-west, while winter winds are prevailingly from the south (Figure 1.3). The highest wind speeds are associated with spring time (Airshed, 2014).

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. The mixing layer at the mine site ranges in depth from 0 metres (i.e. only a stable or neutral layer exists) during night-times to the base of the lowest-level elevated inversion during unstable, day-time conditions. The atmospheric boundary layer is normally unstable during the day as a result of turbulence from the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5 to 6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and a slower developing mixing layer. During the night, a stable layer with limited vertical mixing exists. During windy and/or cloudy conditions, the atmosphere is normally neutral. For elevated releases, the highest ground level concentrations would occur during unstable, daytime conditions. The wind speed resulting in the highest ground level concentration depends on the plume buoyancy. If the plume is considerably buoyant (high exit gas velocity and temperature) together with a low wind, the plume will reach the ground relatively far downwind. With stronger wind speeds, on the other hand, the plume may reach the ground closer, but due to the increased ventilation, it would be more diluted. A wind speed between these extremes would therefore be responsible for the highest ground level concentrations. The highest concentrations for low level releases would occur during weak wind speeds and stable (night-time) atmospheric conditions.

<u>Extreme weather conditions</u>

Rainfall conditions are highly variable and droughts and floods do occur.

Conclusion

Tharisa Mine falls within highveld climatic conditions, with hot and wet summers and cold and dry winters. On average, winds blow from the north-west (mainly during the day time) and south east (mainly at night) however seasonal differences are observed. Wind speeds hardly reach speeds higher than 5m/s. Wind direction, speed and atmospheric conditions influence the area of impact and the extent to which pollution can occur. The highest concentrations for low level releases would occur during weak wind speeds and stable (night-time) atmospheric conditions. These climatic aspects need to be taken into consideration during the assessment of impacts and the design and implementation of the mitigation measures.

1.1.4 SOIL AND LAND CAPABILITY BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008) and the study conducted by the Institute for Soil, Climate and Water (Appendix D). This section should be read with reference to Figure 1.4 and Figure 1.5 (Section 1.4).

Introduction and link to impacts

Soil is the medium in which most vegetation grows. It forms the basis for most functional ecosystems. Moreover, soil characteristics influence the natural capability of land. Soil resources have the potential to be lost through physical disturbance, erosion by wind and water, and contamination. As part of the initial mine development, soils have been stripped and stockpiled on site. To understand the basis of potential impacts, a baseline situational analysis is described below.

Data collection

For the approved EIA and EMP report (Metago, 2008) baseline soil data collection was done through a specialist investigation which included a site specific soil and land capability survey and review of available databases and maps. For the north east waste rock dump area a soil survey was conducted in 2014 which followed the same desktop and fieldwork approach (ARC, 2014).

Results - Soils

Soil Forms and Depth

All areas included in the study have been ranked according to the Taxonomic Soil Classification System for South Africa (Mac Vicar et al, 2nd edition 1991). Soils include those of the orthic phase (Hutton), structured forms (Mayo, Shortlands, Sterkspruit, Swartland and Valsrivier), and hydromorphic forms (Bonheim and Oakleaf) (Table 1.6, Figure 1.4). The heavy structured black and dark brown clay soils (Sterkspruit, Mayo and Swartland soil forms) are commonly referred to as “black-turf” or “Cotton Soils”. The table includes the associated soil depths and areas of coverage for the soils.

TABLE 1.6: SOILS PRESENT IN THE AREA

Label on Figure 1.4*	Soil name	Soil depth (m)	Area covered by soil type (ha)
2 Bo	Bonheim	0-2	18.548
2 My	Mayo	0-2	43.550
2-4 Se	Sepane	2-4	34.079
4 Se	Sepane	0-4	6.831
4 Ss	Sterkspruit	0-4	26.416
4 Ss/Sw	Sterkspruit/Swartland	0-4	126.512
4-6 Ss	Sterkspruit	4-6	55.275
4-6 Hu	Hutton	4-6	231.797
4-6 Oa	Oakleaf	4-6	53.938
4-6 Sd	Shortlands	4-6	122.689
6 Sd	Shortlands	0-6	42.314
4-6 Sw	Swartlands	4-6	304.855
<4 Va	Valsrivier	<4	37.251
4 Va/Hu	Valsrivier/Hutton	0-4	98.328
4-6 Va	Valsrivier	4-6	545.243
Wb	Witbank (transformed)	-	96.806
Ar	Arcadia	0-1	65.7
Se	Sepane	0-1	5.1
E	Excavation of more than 10m in depth (existing)	n/a	3.7
River	River	-	38.589
		Total study area (2008 and 2014)	**1957.521**

** The letters are an abbreviation for the soil name while the numbers preceding the letters refer to the soil depths.*

Hutton (Hu)

These soils comprise predominantly fine grained sandy, to silty loams or fine to medium grained sandy clay loams, depending on the lithological unit from which they are derived. They generally exhibit an apedal to weak crumby structure. In terms of colours, they returned pale red/brown to yellow red in the topsoils and fine to medium grained sandy clay and clay loams, with dark orange reds and dark red in the subsoil horizons. These strong red colours are mainly due to the high magnesium and iron content of the soils. Clay content varies from 10% to 15% in sandy topsoils to 25% in some instances and to over 65% in the subsoils. The effective rooting depths varies from 200mm to greater than 1100mm.

Shortlands (Sd) and Valsrivier (Va)

These soils are generally found associated with the Hutton Form and have similar chemistry. They are generally dark red to dark red brown and exhibit moderate crumbly to weak blocky structure. They have moderately low intake rates, high water holding capabilities and in certain cases showed evidence of expansive clays (predominantly smictite) and a large range in depths of 200m to 1200mm. These soils are more widely distributed within the study area than the Hutton soil forms, have a very high clay content and are erosive in nature.

Mispah (Ms), Mayo (My) and Milkwood (Mk)

These soils are characterised by effective rooting depths of between 100mm and 500mm. A major constraint anticipated with these soil types is tillage, sub surface hindrance and erosion. The restrictive layer associated with these soils is a hard lithocutanic layer in the form of weathered parent material or rock. The effective soil depth is therefore restricted, resulting in reduced soil volumes, which in turn result in depletion in water holding capacity as well as nutrient capacity. These soils have moderate to high clay percentages ranging from 20% to 32% (Ms) and 25% to 45% (Mk and My). They also have low internal drainage and low water holding capacities.

Sterkspruit (Ss) and Swartland (Sw)

These soils are generally blocky to prismatic (prismacutanic) in structure and grey to dark brown or black in colour. They are generally found associated with the intrusive and more basic geological host material. The Swartland form is of a lower order in comparison to Valsrivier in terms of land capability, irrigation potential and general workability even thought it is less intensely structured. They are moderate blocky (pedocutanic) to prismatic or prismacutanic, have low intake rates, moderate water holding capabilities and show evidence of expansive clays, with a fair range in depths, 200mm to 600mm.

Sepane (Se)

These soils are generally found associated with and down slope of the dry soils and fall within the hydromorphic category of soils. They are influenced by a rising and falling water table, hence the mottling within the lower portion of the profile and the pale background colours. Generally, these soils are high in transported clay in the lower “B” horizon with highly leached topsoils and pale denuded horizon at shallow depths. The depths vary from 200mm to 400mm. Rooting depths that are less than 400mm are classified as having a wetland capability.

Bonheim (Bo)

These soils are found associated with more basic derived lithologies that occur in the area. They are highly sensitive to compaction and erosion, mainly due to their often hydromorphic nature and exceptionally strong structure. These soils are prone to the formation of hard “clods” when they dry out.

Oakleaf (Oa)

Oakleaf soils are made up of an upper horizon (orthic A) overlying unconsolidated material (neucutanic B) which has formed recently in sediments or other unconsolidated materal, which in turn is underlain by unspecified material which shows no signs of wetness. Families are distinguished on the basis of colour (bleached or non-bleached upper horizon and red or non-red lower horizon) and where there is an increase in clay down the soil profile.

Arcadia (Ar)

Arcadia soils are characterised by high clay contents, often of a swelling variety that saturate easily, drain slowly, and crack when dried out. They are generally pale in colour (grey to grey brown), highly leached, and are, in almost all cases associated with the bottomland areas were accumulations of transported soils make up the majority of the soil pedogenissis. The vertic structure is the distinctive feature of these soils, the Arcadia by definition being a vertic horizon on a soft rock base.

<u>Soil Chemical Characteristics</u>

Soils in the study area are neutral to slightly alkaline (5.25 to 7.30), generally within the accepted range for good nutrient mobility. However, some of the soils derived from intrusive material will tend to be more alkaline than indicated by these results due to the potential buffering capacity of the moderately high levels of calcium carbonate.

<u>Soil erosion and compaction</u>

The majority of the soils within the study area can be classified as having a moderate erodeability index that is ascribed to the generally low organic carbon content and sensitivity of the soils (solube of calcium). The wet and highly structured soils are suspectible to compaction due to the swelling clays that are common in the majority of the materials classified. These soils will need to be managed well both during the stripping operation and the stockpiling/storage and rehabilitation stages of the mine operation.

Results – Land capability

The distribution of the land capability classes of the study area was classified according to the Chamber of Mines Guidelines, 1991 (Table 1.7, Figure 1.5).

TABLE 1.7: LAND CAPABILITY DISTRIBUTION

Land Capability	Area (Ha)	Description	% of study area
Arable	118.814	Substantial areas have already been cultivated and sustained by large capital inputs, highly resistant and high yielding crops and good water/drainage management. Rehabilitation of areas to an arable land capability is limited to the utilisation of deep well drained soils and deeper hydromorphic soil forms.	6.07%
Wilderness	281.904	These areas are found associated with the more structured and shallower rocky soils.	14.40%
Grazing	1356.85	These areas are generally confined to shallower and transitional hydromorphic soil forms that are moderately well drained.	69.31%
Man made	96.806	Man made use in the study area includes mining, residential, small business and general community activities.	4.95%
River	38.589	The perennial Sterkstroom and other non-perennial watercourses run through the study area.	2%
Wet based soils	64.558	These zones can incorporate hydromorphic soils that may be or may not be associated with functional wetlands.	3.30%
Total study area (2008 and 2014)	**1957.521**	**-**	**100%**

Dryland agricultural (production)

Due to the general low levels of potassium, zinc and phosphorous in the soils, the dryland production potential, especially of the shallower Valsrivier, Swartland, Sterkspruit, and Mayo soil forms is poor to moderate. Arcadia soils are prone to cracking when dry and can damage plant roots, in addition to surface crusting which can reduce rainfall infiltration. In order to increase the productivity to a viable and sustainable cropping potential, additional fertilizers, water (irrigation) and good drainage management will be required.

Irrigation Potential

In terms of soil structure and drainage capability, the irrigation potential of the soils can be described as “moderate”. With adequate drainage and good water management, the soils can be economically cultivated to irrigated crops. There was already irrigation taking place in and around the area prior to the mine operation. The spatial distribution of soils with good soil rooting depths is a limitation to the size of the area that can be cultivated.

Conclusion

The approved EIA and EMP (Metago, 2008) identified that the mine would disturb soils in an area of approximately 750ha. Soils at the project sites are structured and have a high clay content. These soils are not prone to erosion but compaction and contamination remain concerns that require assessment and mitigation. The soils found at the project sites are similar to those found within the approved mine footprint. Stripping and stockpiling soils is an important component of the mitigation measures, but this needs to be balanced with the fact that some of the *in-situ* clay type soils are also needed as part of the liner system beneath the mineralised waste facilities. This is the case for the approved waste rock dumps and tailings storage facilities. Where available, the mine has stockpiled soil resources in the form of noise and visual berms. Land capable for use as grazing dominates the study area.

1.1.5 BIODIVERSITY BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008), as well as the 2013 and 2014 biodiversity studies conducted by Scientific Aquatic Services (SAS) (Appendix E). This section should be read with reference to Figure 1.6 to Figure 1.9 (Section 1.4).

Introduction and link to impacts

In the broadest sense, biodiversity provides value for ecosystem functionality, aesthetic, spiritual, cultural, and recreational reasons. The known value of biodiversity and ecosystems is as follows:

- soil formation and fertility maintenance
- primary production through photosynthesis, as the supportive foundation for all life
- provision of food and fuel
- provision of shelter and building materials
- regulation of water flows and water quality
- regulation and purification of atmospheric gases
- moderation of climate and weather
- control of pests and diseases
- maintenance of genetic resources

The establishment of additional mining-related infrastructure and support facilities have the potential to result in the loss of vegetation, habitat and related ecosystem functionality through physical disturbance and/or contamination of soil, air and/or water resources.

As a baseline, this section provides an outline of the type of vegetation occurring in the project area and the status of the vegetation and highlights the occurrence of sensitive ecological environments including sensitive/endangered species (if present) that require protection and/or additional mitigation should they be disturbed.

Data collection

In the approved EIA and EMP report (2008) biodiversity data collection was accomplished through review of species distribution lists, use of 1: 50 000 topographical maps and Google Earth Images (2007) and detailed field surveys in December 2007 during the wet/summer season when many plants are evident. The 2013 and 2014 SAS studies followed a similar desktop research and fieldwork approach. As part of the 2013 and 2014 desktop study, a number of national guidelines were reviewed for applicability to the project. Field surveys were conducted in November 2013 and May 2014. Further detail on the methodologies used are included in the specialist reports.

Information that is provided in this section reflects a combination (in undisturbed areas) of the pre-mining state of the biodiversity in 2008 and in disturbed areas, the transformation that has occurred as a result of the mine development. In this regard, some habitat has been removed/disturbed in the process of establishing the current operations and the related surface infrastructure.

Results – National Guidelines

<u>Importance of the project area according to national guidelines</u>

The Mining and Biodiversity Guideline (DEA *et al,* 2013) provides explicit direction in terms of where mining-related impacts are legally prohibited, where biodiversity priority areas may present high risks for mining projects and where biodiversity may limit the potential for mining. The guideline distinguishes between four categories of biodiversity priority areas in relation to their importance from a biodiversity and ecosystem service point of view, as well as the implications for mining. The project area falls within an area identified with High Biodiversity Importance. High biodiversity importance areas are considered to be important for conserving biodiversity, supporting or buffering other biodiversity important areas and for maintaining important ecosystem services for particular communities or the country as a whole.

The National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA) provides for listing of threatened or protected ecosystems. Threatened ecosystems are listed in order to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function and composition of threatened ecosystems. The purpose of listing protected ecosystems is primarily to conserve sites of exceptionally high conservation value. Although the project area falls within the Marikana Thornveld vegetation type which is classified as vulnerable, the Marikana Thornveld <u>ecosystem</u> is divided into 'original extent' and 'remaining extent' by the National List of Threatened Terrestrial Ecosystems for South Africa (2011). The natioanla list maps a small 'remaining extent' of the Marikana Thornveld ecosystem within the centre of the mine area, bordering the Sterkstroom (Figure 1.7). This area was therefore specifically investigated by SAS to groundtruth the classification. SAS found that these areas have already been converted to mining and agricultural areas. It is therefore concluded that limited, if any, intact Marikana Thornveld is present.

A National Protected Area Expansion Strategy (NPAES) has been developed by the South African National Botanical Institute (SANBI) and aims to achieve cost effective protected area expansion for ecological sustainability and adaptation to climate change (SAS, 2014). The NPAES sets targets for protected area expansion, provides maps of the most important areas for protected area expansion, and makes recommendations on mechanisms for protected area expansion. According to the NPAES database, the project area does not fall within an area earmarked for expansion of a National Protected Area (SAS, 2014).

The National Freshwater Ecosystem Priority Areas Project (NFEPA) was developed by SANBI, DWA and other stakeholders and organisations. This project was aimed at identifying strategic spatial priority areas for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. SAS consulted the NFEPA database and concluded that the wetlands within the project area are at a

Level 4A in terms of the NFEPA classification system and are characterised as flat, unchanelled valley bottom and valley head seeps. NFEPA assigns a “no importance” value to these wetlands through its ranking system (SAS, 2014) (Figure 1.9).

The National Biodiversity Assessment (NBA) conducted in 2011 was led by the SANBI in partnership with the Department of Environmental Affairs and a range of other organisations. The study provides an assessment of South Africa’s biodiversity and ecosystems. This assessment also provides a summary of biodiversity priority areas that have been identified through systematic plans at national, provincial and local levels. The project area is not located within a formally or informally protected area in terms of this assessment (SAS, 2014).

The North-West Province published a biodiversity conservation assessment report in 2009, which includes a list of Critical Biodiversity Areas. These areas are terrestrial and aquatic features that are critical for retaining biodiversity and supporting continued ecosystem functioning and services. According to the 2009 list, the project area is located within a terrestrial Critical Biodiversity Area. In addition, an aquatic Critical Biodiversity Area is located approximately 6 km to the south-west of the project area. The Sterkstroom is indicated as a critically endangered ecosystem (SAS, 2014).

Results - Natural Vegetation

Veld-type classification and conservation importance

Tharisa mine falls within the savanna biome. The savanna biome is the largest biome in southern Africa, occupying 46% of its area, and over 33% of this is within South Africa. The majority of the mine area falls within the Marikana Thornveld vegetation unit (also referred to as the Rustenburg Gabbro Thornveld, according to NW DACE, 2003) with a small portion in the western section falling within the Moot Plains Bushveld vegetation unit (Mucina & Rutherford, 2006) (Figure 1.7). The project components fall within the Marikana Thornveld and Moot Plains Bushveld vegetation types. The Gold Reef Mountain Bushveld lies immediately south of the mine (SAS, 2013). These vegetation types are described below.

The Marikana Thornveld: this unit occurs in the North-West and Gauteng Provinces, on plains from the Rustenberg area in the west, through Marikana and Brits to the Pretoria area in the east (SAS, 2013). It is characterised by open *Acacia karoo* woodlands, which occur in valleys and slightly undulating plains, and some lowland hills. This vegetation unit been significantly transformated through cultivation and urbanisation.

The Moot Plains Bushveld: this unit occurs in the North-West and Gauteng Provinces, immediately south of the Magaliesberg mountain range (SAS, 2013). It is characterised by an open to closed thorny savanna dominated by various Acacia species. This vegetation unit has also been significantly transformed through cultivation and urbanisation. The ecosystem status, together with protection levels and irreplaceability, are used to identify priority areas for conservation.

The Gold Reef Mountain Bushveld: this unit occurs in the North-West, Free State, Gauteng and Mpumalanga Provinces. It occurs on the rocky quartzite ridges of the Magaliesberg and the parallel ridge to the south, from around Boshoek and Koster in the west to near Bronkhortspruit in the east. It also occurs on the west-east trending ridge of the Witwatersrand from around Krugersdorp in the west, through Roodepoort and Johannesburg to Bedfordview. Inner ridges (e.g. Dwarsdberg and Witkop) of the Vredefort Dom on the Vaal River, north-west of Parys and part of the Suikerbosrand as well as other hills around Heidelberg (SAS, 2013).

Vegetation based habitat zones

The following vegetation/habitat zones were mapped within the mine area by Natural Scientific Services (NSS, 2008). The related hectares are only applicable to pre-mining conditions as at 2008:

- Scattered open woodland (338 ha)
- Transformed cultivated land and built up areas (1276 ha)
- Rocky outcrops (23 ha)
- Wetland: river system and associated riparian vegetation (26 ha)
- Azonal vegetation units which comprised man made areas such as quarries, leaking pipes etc.

These correlate closely with the habitat types mapped by SAS in 2013 and 2014 (SAS, 2013 and 2014), however these notably include land transformed by mining activities (refer to Figure 1.8):

- Scattered open bushveld
- Transformed habitat which includes agricultural areas (transformed by agriculture, mining and infrastucture)
- Rocky outcrop habitat
- Wetland habitat

Each of these are discussed below.

Scattered Open Woodland/Scattered Open Bushveld

This was the most dominant assemblage within the mine area in 2008. It is generally associated with the deep vertic clays or gabbros. It is a short microphyllous woodland with a well developed graminoid (grass) layer that is interspersed by distinctive bush clumps comprising of many wood species. The 2013 and 2014 SAS studies noted that this habitat unit occurs in less disturbed areas, but noted that some edge effects such as bush encroachment and loss of vegetation structure was evident particularly in the area of the north east WRD. Table 1.8 provides a general description and list of commonly occurring species within the scattered open woodlands/open bushveld, combining the NSS 2008 and SAS 2013 and 2014 surveys. It should be noted that the table does not provide a full list of the species found during the surveys – refer to the specialist reports for the full lists (Appendix E).

TABLE 1.8: COMMONLY OCCURING VEGETATION SPECIES – UNDISTURBED AREAS

Status	Natural & grazed
Conservation Priority	Moderate in its own right; however because the habitat falls within a terrestrial CBA, the remaining bushveld may be considered important in order to reach provincial conservation targets.
Soil	Deep vertic clay
Rockiness	1%

Scientific Name	Common Name	Scientific Name	Common Name
Acacia caffra	Common Hook-thorn	*Hypoxis hemerocallidea*	Star-flower
Acacia karroo	Sweet Thorn	*Hypoxis rigidula*	Silver-leaved Star-flower
Acacia nilotica	Scented Pod	*Ipomoea bachycolpos*	-
Acacia robusta	Splendid Thorn	*Ipomoea ommaneyi*	Beespatat
Acacia tortilis subsp. heteracantha	Umbrella Thorn	*Ischaemum afrum*	Turf Grass
Aloe greatheadii	-	*Jacaranda mimosifolia**	Jacaranda
Aristida bipartita	Rolling Grass	*Kohautia virgata*	-
Aristida congesta subsp. barbicollis	Spreading Three-awn	*Lantana camara**	Lantana
*Arauajia sericiifera**	White moth vine	*Lantana rugosa*	Wild Grassland Lantana
Asclepias eminens	Large Turret Flower	*Ledebouria revoluta*	-
Asparagus laricinus	Cluster-leaved Asparagus	*Lippia javanica*	Lemon Bush
*Bidens bipinnata**	Spanish Black-jack	*Melia azedarach**	Seringa
*Bidens pilosa**	Common Black-jack	*Melinis repens*	Natal grass
Bothriochloa insculpta	Pinhole Grass	*Monsonia angustifolia*	Pink Monsonia
Celtis africana	White Stinkwood	*Nidorella resedifolia*	-
Ceratothea triloba	Wild foxglove	*Ocimum angustifolium*	-
Chamasyce inaequilatera	Smooth Creeping Milkweed	*Olea europaea subsp. africana*	Wild Olive
Chamasyce sp.	Creeping Milkweed	*Oxalis obliquifolia*	Oblique-leaved Sorrel
Dicanthium annulatum	Marvel grass	*Panicum maximum*	Guinea Grass
Clematis brachiata	Traveller's Joy	*Panicum schinzii*	Buffalograss
Commelina africana	Yellow Commelina	*Pappea capensis*	Jacket-plum
Convolvulus sagittatus	-	*Paspalum dilatatum*	Dallis grass
Corchorus cf. confuses	-	*Pogonnarthia squarrosa*	Herringbone Grass
Crabbea hirsuta	Prickle Head	*Rhus lancea*	Karee tree
*Crinum macowanii***	River Lily	*Rhus leptodictya*	Mountain Karee
Cucumis hirsutus	Wild Cucumber	*Rhus pyroides var. pyroides*	Common Current
Cynodon dactylon		*Rhynchosia caribaea*	-
Cyphostemma sandersonii	Felted Tree Grape	*Salvia reflexa*	Mintweed
Dicrostachys cinerea	Sickle-bush	*Salvia repens*	Kruipsalie
Digitaria eriantha	Common Finger Grass	*Scabiosa columbaria*	Wild Scabiosa
Diospyros lycioides subsp. guerkei	Bluebush	*Sclerocarya birrea* subsp *caffra***	Marula tree
Dipcadi viride	-	*Setaria nigrirostris*	-
Ehretia rigida subsp. rigida	Puzzle Bush	*Sida rhombifolia*	-
Elionurus muticus	Wire Grass	*Solanum pandiruforme*	Poison Apple
Eragrostis chloromelas	Narrow Curly Leaf	*Sorghum versicolor*	Black-seed Sorghum
Eragrostis curvula	Weeping Love Grass	*Tagetes minuta**	Khaki-weed
Eragrostis lehmanniana	Lehmann Love Grass	*Tarchonanthus camphoratus*	Wild Camphor Bush
Eragrostis rigidior	Curly Leaf	*Tephrosia sp.*	-

Scientific Name	Common Name	Scientific Name	Common Name
Euclea crispa subsp. crispa	Blue Guarrie	*Themeda triandra*	Red Grass
Euphorbia ingens	Naboom	*Thesium sp.*	-
Felicia muricata	-	*Tragus berteronianus*	Carrot-seed Grass
Fingerhuthia africana	Blousoetgras, Borseltjiegras, Haargras	*Vernonia oligocephala*	-
*Galinsoga parviflora**	Gallant Soldier	*Urochloa mosambicensis*	
*Gladiolus antholyzoides***	-	*Zinnia peruviana**	Redstar Zinnia
*Gladiolus crassifolius***	Thick-leaved Gladiolus	*Ziziphus mucronata*	Buffalo Thorn
Grewia flava	Velvet Raisin	*Gymnosporia buxifolia*	Common Spike-thorn
Heteropogon contortus	Spear Grass	*Hibiscus trionum*	Bladder Hibiscus
Hypoxis rigidula	-	*Homeria pallida*	Yellow Tulip
Hyparrhenia hirta	Common Thatching Grass	*Hyperthelia dissoluta*	Yellow Thatching Grass

** Exotic taxa*
*** Protected taxa according to the Nature Conservation Ordinance of Transvaal, 1983 (No 12 of 1983)*
 # Trees protected in terms of the National Forests Act, 1998 (Act No. 84 of 1998)
- No Common Name

Transformed cultivated land and built up areas

Typical of old agricultural lands and disturbed areas, this assemblage is in close proximity to human settlement areas. It is a pioneer grassland, with the forb layer represented by many agrestal weed species. Historical quarrying activities has left depressions and are dominated by dense stands of *Dischrostacys cinerea* (sickle bush). Table 1.9 provides a general description and list of commonly occurring species within the transformed cultivated land and built up areas, combining the NSS 2008 and SAS 2013 and 2014 surveys. It should be noted that the table does not provide a full list of the species found during the surveys – refer to the specialist reports for the full lists (Appendix E).

TABLE 1.9: COMMONLY OCCURING VEGETATION SPECIES – TRANSFORMED AREAS

Status	Transformed and cultivated
Conservation Priority	Low
Soil	Deep vertic clay
Rockiness	0%

Scientific Name	Common Name	Scientific Name	Common Name
*Argemone mexicana**	Yellow Mexican Poppy	*Heteropogon contortus*	Steekgrass
Aristida bipartite	Rolling Grass	*Hibiscus trionum*	Bladder Hibiscus
Aristida congesta subsp. barbicollis	Spreading Three-awn	*Hyparrhenia hirta*	Common Thatching Grass
Aristida congesta subsp. congesta	Tassel three-awn	*Hyperthelia dissolute*	Yellow Thatching Grass
*Bidens bipinnata**	Spanish Black-jack	*Ischarmum afrum*	Turfgras
*Bidens pilosa**	Common Black-jack	*Melinis repens*	Natal Red Top
Bothriochloa insculpta	Pinhole Grass	*Nicotiana glauca**	Wild Tobacco
Cenchrus ciliaris	Foxtail Buffalo Grass	*Nidorella resedifolia*	-
Chamasyce inaequilatera	Smooth Creeping Milkweed	*Panicum schinzii*	Sweet Grass
Chamasyce sp.	Creeping Milkweed	*Pennisetum setaceum**	Fountain Grass
Cleome monophylla	-	*Pentarrhinum insipidum*	-
*Conyza albida**	Tall Fleabane	*Pogonarthria squarrosa*	Herringbone Grass
*Conyza bonariensis**	Horseweed	*Salvia reflexa*	Mintweed

Scientific Name	Common Name	Scientific Name	Common Name
Cynodon dactylon	Couch Grass	*Schkuhria pinnata**	Dwarf Marigold
*Datura ferox**	Large Thorn-apple	*Senecio consanguineus*	Starvation Senecio
*Datura stramonium**	Common Thorn Apple	*Sesamum triphyllum*	Wild Sesame
Dichanthium annulatum	Vlei Finger Grass	*Sesbania bispinosa**	Spiny Sesbania
Dicrostachys cinerea	Sickle-bush	*Sida rhombifolia*	-
Digitaria eriantha	Common Finger Grass	*Solanum panduriforme*	Bitter Apple
Enneapogon cenchroides	Nine-awned Grass	*Sorghum cf. halepense*	Johnson Grass
Eragrostis curvula	Weeping Love Grass	*Sorghum versicolor*	Black-seed Sorghum
Eragrostis lehmanniana	Lehmann Love Grass	*Tagetes minuta**	Khaki-weed
Eragrostis chloromelas	Blue Love Grass	*Themeda triandra*	Red oat grass
*Euphorbia geniculata**	Wild Pointsettia	*Tragus berteronianus*	Carrot-seed Grass
Felicia muricta	Bloubossie	*Urochloa mosambicensis*	Bushveld Signal Grass
Gladiolus sp.	Gladiolus	*Vernonia oligocephala*	-
Gomphocarpus fruticosus	Milkweed	*Xanthium strumarium**	Large cocklebur
Grewia flava	Brandybush	*Zinnia peruviana**	Redstar Zinnia

** Exotic taxa*
- No Common Name

Rocky Outcrops

This vegetation unit is concentrated on norite outcrops and consisted of open mesophylluous woodland with a dense graminoid layer composed of late-successional species. It is rich in woody species and is structurally and floristically more diverse in comparison to other vegetation units. Table 1.10 provides a general description and list of commonly occurring species found in the rocky outcrops, combining the NSS 2008 and SAS 2013 and 2014 surveys.

TABLE 1.10: COMMONLY OCCURING VEGETATION SPECIES – ROCKY OUTCROPS

Status	Natural
Conservation Priority	High
Soil	Shallow, well drained
Rockiness	70-85%

Scientific Name	Common Name	Scientific Name	Common Name
Acacia caffra	Common Hook-thorn	*Hypoxis rigidula*	Silver-leaved Star-flower
Acacia karroo	Sweet Thorn	*Indigofera oxytropis*	-
Acacia robusta	Splendid Thorn	*Ipomoea bachycolpos*	-
Aloe greatheadii	-	*Ipomoea magnusiana*	Small Pink Ipomoea
Anthephora pubesens	Wool Grass	*Jasminum cf. breviflorum*	Wild Jasmine
Aristida congesta subsp. Congesta	Tassel three-awn	*Kyllinga alba*	-
Asparagus suaveolens	Bushveld Asparagus	*Lantana rugosa*	Wild Grassland Lantana
Berchemia zeyheri	Red Ivory	*Ledebouria revoluta*	-
*Bidens bipinnata**	Spanish Black-jack	*Loudetia simplex*	Common Russet Grass
*Bidens pilosa**	Common Black-jack	*Melinis nerviglumis*	Bristle-leaved Red Top
Boophone disticha	Fan-leaved Boophone	*Melinis repens*	Natal Red Top
Bothriochloa insculpta	Pinhole Grass	*Mormordica balsamina*	African Cucumber
Brachiaria eruciformis	Sweet Signal Grass	*Mundulea sericea*	Cork Bush

Scientific Name	Common Name	Scientific Name	Common Name
Bulbostylis cf. humilis	-	*Olea europaea subsp. africana*	Wild Olive
Celtis Africana	White Stinkwood	*Osyris lanceolata*	Transvaal Sumach
Chascanum hederaceum	White Trumpets	*Ozoroa paniculosa*	Common Resin Tree
Chrysopogon serrulatus	Golden Beard Grass	*Panicum maximum*	Guinea Grass
Combretum molle	Velvet Bushwillow	*Panicum schinzii*	Sweet Grass
Commelina africana	Yellow Commelina	*Pappea capensis*	Jacket-plum
Commelina erecta	-	*Pavetta zeyheri*	Small-leaved Bride's Bush
Commelina livingstonii	-	*Pellaea calomelanos***	-
Convolvulus sagittatus	-	*Pentarrhinum insipidum*	-
Croton gratissimus	Lavender Croton	*Prunus persica**	Peach tree
*Cussonia paniculata***	Highveld Cabbage Tree	*Pseudognaphalium luteo-album*	Jersey Cudweed
Cheilanthes viridis	-	*Raphionacme sp.*	-
Cyanotis speciosa	Doll's Powderpuff	*Rhoicissus tridentata*	Bushman's Grape
Cyphostemma cirrhosum	-	*Rhus leptodictya*	Mountain Karee
Dicrostachys cinerea	Sickle-bush	*Rhus pyroides var. pyroides*	Common Current
Digitaria eriantha	Common Finger Grass	*Rhus zeyheri*	Blue Karee
Diospyros lycioides subsp. Guerkei	Bluebush	*Rhynchosia totta*	Yellow Carpet Bean
Dipcadi viride	-	*Sarcostemma viminale*	Caustic Vine
Dombeya rotundifolia	Wild Pear	*Sclerocarya birrea subsp. Caffra***	Marula
Ehretia rigida subsp. rigida	Puzzle Bush	*Setaria lindenbergiana*	Mountain Bristle Grass
Elephantorrhiza burkei	Sumach Bean	*Setaria nigrirostris*	-
Enteropogon macrostachys	Mopane Grass	*Setaria pallide-fusca*	Garden Bristle Grass
Eragrostis curvula	Weeping Love Grass	*Sida rhombifolia*	-
Eragrostis superba	Saw-tooth Love Grass	*Solanum panduriforme*	Bitter Apple
Erythrina lysistemon	Common Coral Tree	*Sporobolus stapfianus*	Fibrous Dropseed
Euclea crispa subsp. crispa	Blue Guarrie	*Tacoma stans**	Yellow elder
*Eulophia cf. streptopetala***	Twisted-petal Eulophia	*Tagetes minuta**	Khaki-weed
Euphorbia ingens	Naboom	*Talinum caffrum*	-
Felicia muricata	White Felicia	*Themeda triandra*	Red Grass
Ficus thonningii	Common Wild Fig	*Vanguaria infausta*	Wild Medlar
Flueggea virosa	White-berry Bush	*Vangueria parvifolia*	-
*Gladiolus crassifolius***	Thick-leaved Gladiolus	*Vernonia staehelinoides*	-
Grewia flava	Velvet Raisin	*Vitex zeyheri*	Silver Pipe-stem Tree
Gymnosporia buxifolia	Common Spike-thorn	*Xerophyta retinervis***	Monkey's Tail
Heteropogon contortus	Spear Grass	*Zanthoxylum capense*	Small Knobwood
Heteropyxis natalensis	Lavender Tree	*Zinnia peruviana**	Redstar Zinnia
*Huernia hystrix***	Porcupine Huernia	*Ziziphus mucronata*	Buffalo Thorn
Hyperthelia dissolute	Yellow Thatching Grass		
Hypoestes forskaolii	White Ribbon Bush		

** Exotic taxa*
*** Protected taxa according to the Nature Conservation Ordinance of Transvaal, 1983 (No 12 of 1983)*
- No Common Name

Wetlands: River Systems and Associated Riparian Vegetation

The wetland units are associated with the perennial Sterkstroom River and other non-perennial drainage lines within the project area. A number of invader species were also noted in the NSS 2008 and SAS 2013 and 2014 studies. Table 1.11 provides a general description and list of commonly occurring species along river systems and associated vegetation unit (wetlands), combining the NSS 2008 and SAS 2013 and 2014 surveys. It should be noted that the table does not provide a full list of the species found during the surveys – refer to the specialist reports for the full lists (Appendix E).

TABLE 1.11: COMMONLY OCCURING VEGETATION SPECIES – WETLANDS

Status	Natural
Conservation Priority	High
Soil	Hydromorphic
Rockiness	0-50%

Scientific Name	Common Name	Scientific Name	Common Name
Acacia karroo	Sweet Thorn	*Melia azedarach**	Seringa
Acacia robusta	Splendid Thorn	*Morus alba**	White Mulberry
Agrostis lachnantha	Bent Grass	*Panicum schinzii*	Sweet Grass
Andropogon schirensis	Rumiya	*Paspalum urvillei**	Vasey Grass
*Bidens bipinnata**	Spanish Black-jack	*Persicaria lapathifolia**	Spotted Knotweed
*Bidens pilosa**	Common Black-jack	*Persicaria serrulata*	Snake Root
Bothriochloa bladhii	Purple Plume Grass	*Phragmites australis*	Common Reed
Bothriochloa insculpta	Pinhole Grass	*Polygala hottentotta*	-
Carissa bispinosa	Num-num	*Populus x canescens**	-
Celtis africana	White Stinkwood	*Ranunculus multifidis*	Common Buttercup
Clematis brachiata	Traveller's Joy	*Rhus lancea*	Karee
Combretum erythrophyllum	River Bushwillow	*Rhus pyroides var. pyroides*	Common Current
Cynoglossum cf. hirsutum	Hound's Tongue	*Rumex crispus**	Curly Dock
Cynodon dactylon	Couch Grass	*Salvia repens*	Kruipsalie
Cyperus cf. longus	-	*Schoenoplectus cf. corymbosus*	-
Dichanthium annulatum	Vlei Finger Grass	*Schkuhria pinnata**	Bitterbos
Eragrostis plana	Tough Love Grass	*Searsia lancea*	-
Eragrostis curvula	Weeping Love Grass	*Searsia pyroides*	-
Eragrostis lehmanniana	Lehmann Love Grass	*Sesbania bispinosa**	-
*Eucalyptus sp.**	Gum	*Setaria nigrirostris*	-
Heteropogon contortus	Spear Grass	*Solanum seaforthianum**	Slender Potato Creeper
Hyparrhania dregeana	Blue Thatching Grass	*Sporobolus africanus*	Ratstail Dropseed
Hyparrhenia hirta	Common Thatching Grass	*Tagetes minuta**	Khaki-weed
Hyperthelia dissoluta	Yellow Thatching Grass	*Themeda triandra*	Red Grass
Imperata cylindrica	Blady Grass	*Tiphonia rotundifolia**	Red Sunflower
*Jacaranda mimosifolia**	Jacaranda	*Typha capensis*	Bulrush
Jamesbrittenia aurantiaca	-	*Verbena bonariensis**	Tall Verbena
Juncus effusus	-	*Veronica anagallis-aquatica**	-
*Lantana camara**	Lantana	*Zinnia peruviana**	Redstar Zinnia
Ledebouria revoluta	-	*Ziziphus mucronata*	Buffalo Thorn

** Exotic taxa*
- No Common Name

<u>Ecologically Sensitive Habitats at Tharisa Mine</u>

A biodiversity sensitivity map was developed by SAS in 2013 and this was supplemented by the 2014 study which focused on the north east waste rock dump area (Figure 1.8). Salient points regarding these sensitive areas are summarized below (SAS, 2013):

- All wetland areas, including the Sterkstroom River, are regarded as having increased ecological sensitivity due to the contribution of these features to faunal migratory connectivity, wetland eco-services provision and the unique habitat provided for fauna and flora. Taking the condition of each group of wetlands into account it was determined that the Sterkstroom is of high ecological sensitivity; the north-eastern, south-western and north-western wetlands are moderately sensitive; the artificial wetland and south-eastern wetlands are of low sensitivity
- The transformed habitat unit has low ecological sensitivity
- The rocky outcrop habitat unit contains intact habitat structure and high levels of ecological functioning and therefore has a high ecological sensitivity
- The scattered habitat Bushveld unit has been less impacted than the transformed habitat unit and still hosts a reasonably high level of biodiversity and suitable habitat for fauna and flora. These areas are however fragmented and have been impacted by edge effects from adjacent mining and agriculture.

Further afield, the Magaliesberg Protected Natural Environment (MPNE) occurs towards the south of Tharisa Mine.

<u>Red Data Listed Floral and Protected Tree Species</u>

SAS sourced Red Data species lists from the Pretoria Computer Information Systems (PRECIS) for the relevant map grid references (2527CB, 2527DA and 2527DC). SAS then determined the probability of occurrence of these Red Data species by considering habitat suitability within the project area. This assessment found that there is a low probability of any of these species occurring within the project area as outlined in the table below.

TABLE 1.12: PROBABILITY OF RED DATA FLORAL SPECIES OCCURING WITHIN THE PROJECT AREA

Scientific Name	Probability of occurrence	Motivation
Frithia pulchra	13%	No suitable habitat
Ilex mitis	33%	No suitable habitat
Stenostelma umbelliferrum	40%	If present, this species will be located within the wetland habitat
Prunus Africana	20%	No suitable habitat

Two floral species, namely *Hypoxis hemerrocallidae* and *Crinum macowanii* have not been recorded for the relevant quarter degree square (mapping grids) but are listed by the IUCN as “declining”. These species were found in the Scattered Bushveld Habitat unit.

Sclerocarya birrea subsp caffra (Morula Tree) is present within the Scattered Bushveld Habitat and Rocky Outcrops Habitat units and is protected in terms of the National Forests Act of 1998 (Act 84 of 1998). A permit must be obtained from DWA before this species may be removed from site.

There are also a number of plant species that are protected under the old Transvaal Nature Conservation Ordinance (TNCO) (No 83 of 1983); however the current legal standing of this Bill is uncertain. Species listed in the TNCO and found in the project area are listed in the table below. In addition, it is considered to be highliy likely that *Boohana distichia* occurs on site, although it was not actually recorded during the surevys. This species is also protected by the TNCO.

TABLE 1.13: TNCO LISTED SPECIES FOUND WITHIN THE PROJECT AREA

Scientific Name	Common Name
Palleae calomelanos	Hard fern
Cheilanthes viridis	-
Cussonia paniculata	Highveld Cabbage Tree
Eulophia cf. streptopetala	Twisted-petal Eulophia
Xerophyta retinervis	Black Stick Lily
Gladiolus (various species)	Gladiolus

<u>Medicinal Species</u>

A list and description of the medicinal plant species found within the mine area by NSS and SAS during the 2008, 2013 and 2014 studies respectively, is provided in Table 1.14.

TABLE 1.14: MEDICINAL SPECIES

Species Name	Common Name	Growth Form	Medicinal Use
Acacia caffra	Common hookthorn	Tree	Bark - emetic for "blood cleansing'"; Leaves - relieve abdominal troubles.
Acacia karroo	Sweet Thorn	Tree	Bark & leaves - diarrhoea and dysentery
Acacia nilotica	Scented - pod Thorn	Tree	Bark - treat a variety of ailments.
Acacia tortilis ssp heteracantha	Umbrella Thorn	Tree	Bark - traditional medicine; Leaves & pods - nutritious to game.
Aloe greatheadii	Grass Aloe	Succulent	Plant - burns and wounds.
Argemone mexicana	Yellow Mexican Poppy	Forb	Plant - used as a sedative; Oil - treat dropsy, jaundice & skin diseases.
Asclepias eminens	Large Turret – flower	Forb	Plant - used as a tonic.
Asclepias fruiticosa	Milkweed	Frob	Leaves and roots – used as snuff to treat headaches and tuberculosis.
Asparagus laricinus	Wild asparagus	Forb	Rhizomes and fleshy roots – treat tuberculosis, kidney ailments and rheumatism.
Berchemia zeyheri	Red Ivory	Tree	Bark - used as enema to relieve pains in back, treat rectal ulceration in children.
Bidens pilosa	Common Blackjack	Forb	Plant - rheumatism, pain, diarrhoea, ear ailments.
Boophone disticha	Fan - leaved Boophone	Geophyte	Bulb - boils or septic wounds, alleviate pain, headaches, abdominal pain, weakness, eye conditions
Carissa bispinosa	Num – num	Shrublet	Roots - treat toothache & regarded as aphrodisiac.
Caranthus roseus	Madagascar periwinkle	Shrub	Roots and leaves – treat diabetes. Used in chemotherapy.
Clematis brachiata	Traveller's Joy	Climber	Leaves - used by Xhosa, Zulu, Sotho, & Tswana to ease headaches, coughs & colds, chest ailments & abdominal upsets. Tea - soothing wash for aching feet, soothes cracked skin & blisters; Stem & tendrils - clear a blocked nose, ease painful sinus & induce sneezing; Roots, stems & leaves & steam - used for easing colds, malaria, sinus infections & asthma
Combretum erythrophyllum	River Bushwillow	Tree	Roots & bark - treat venereal diseases, also thought to be a prophylactic against such diseases. Leaves - cure for coughs & stomach pain.
Combretum molle	Velvet Bushwillow	Tree	Leaves - used as wound dressings; roots & leaves - snakebite remedy; roots - treat infertility, abortions & constipation; bark decoctions - stomach disorders & intestinal worms.
Commelina africana	Yellow Commelina	Forb	Treat a wide variety of ailments including fits, pain, heart complaints, venereal disease, bladder ailments.
Crabbea hirsute	Prickle Head	Forb	Used in traditional medicine.
Crinum macowanii	River Lily	Geophyte	Plant - treat urinary infections, itchy rashes, for poultices, bandages & as protective charms.
Croton gratissimus	Lavender Fever Berry	Tree	Bark - treatment of intestinal disorders, for bleeding gums & as a purgative. Burnt leaf fumes used for coughs, & smoke is inhaled for insomnia.
Cussonia paniculata	Highveld Cabbage Tree	Tree	Roots - Edible.
Cyanotis speciosa	Doll's Powderpuff	Forb	Roots - treat infertility.
Datura stramonium	Thornapple	Tree	Leaves and green fruit – treat asthma and pain. Also used as hypotic and aphrodisiac.
Dichrostachys cinerea	Sickle Bush	Shrub/Parasite	Leaves - treat snakebite, toothache & sore eyes, they are believed to have anaesthetic properties.
Diospyros lycioides subsp. Guerkei	Transvaal Bluebush	Tree	Twigs and roots - used as chewing sticks to clean teeth; Roots - epilepsy & to produce a yellowish - brown dye.

Species Name	Common Name	Growth Form	Medicinal Use
Dodonea angustiflora	Sand olive	Tree	Leaves and tips of twigs – treat colds, fever, influenza, stomach trouble, arthiritis, skin rashes and measles.
Dombeya rotundifolia	Wild Pear	Tree	Bark decoction - delay the onset of labour, & to induce an abortion. Bark - treat a headache, stomach ailments & fevers.
Ehretia rigida subsp. rigida	Puzzlebush	Tree	Roots and branches - chest & stomach pains.
Elephantorrhiza burkei	Sumach Bean	Tree	Roots - constipation & an anti - emetic drug.
Elephantorrhiza elephantine	Elansbean	Tree	Underground rhizomes – treat diarrhea, dysentery, stomach disorders, haemorrhiods, perforated peptic ulcers, acbe.
Erythrina lysistemon	Common Coral Tree	Tree	Leaves or bark - treat sores, wounds & arthritis; Vhavenda use bark to treat toothache.
Euclea crispa subsp. crispa	Blue Guarri	Tree	Berries - edible; Root infusions - treat epilepsy, stomach disorders, rheumatism, coughs & diabetes.
Euphorbia ingens	Tree Euphorbia	Succulent	Latex - highly toxic & causes severe irritation & blisters to the skin, a drop in the eye causes blindness & loss of the eye. Used by Venda & Sotho cure for cancer; also used as cure for ulcers.
Felicia muricata	White Felicia	Forb	Plant - relieve headaches & as a douche for cows ill after calving.
Flueggea virosa	White - berry Bush	Shrub	Plant - relieve malaria, remedy for snakebite, as a treatment for diarrhoea & pneumonia.
Gladiolus crassifolus	Thick - leaved Gladiolus	Geophyte	Plant - cure headaches.
Gomphocarpus fruticosus	Milkweed	Shrub	Plant - poisonous to livestock; Leaves - used as snuff & as a sedative in the treatment of headaches & tuberculosis. Roots -relieve stomach pain & general aches in the body.
Grewia flava	Velvet Raisin Bush	Shrub	Bark - used for making baskets; Fruit - intoxicating drink; Dried fruit - ground into meal from which porridge is made. Pegs made from this plant are used as a protection against lightning.
Heteropyxis natalensis	Lavender Tree	Tree	Leaves & roots - treat worms in stock; Decoction of roots - inhaling steam to heal a bleeding nose; Roots - treatment of mental disorders.
Hibiscus trionum	Bladder Hibiscus	Forb	Plant - worms, internal parasites.
Hypoxis hemerocallidea	Star – flower	Geophyte	Plant - headaches, dizziness, mental disorders, cancers, inflammation and HIV.
Hypoxis rigidula	Silver - leaved Star - flower	Geophyte	Plant - used in traditional medicine.
Lantana rugosa	Birds' Brandy	Shrub	Plant - abdominal complaints, sore eyes, coughs, sprains and rheumatism.
Ledebouria revoluta	Common Ledebouria	Geophyte	Plant - skin irritations, wounds, lumbago and gall sickness in animals.
Leonotis leonurus	Wild dagga	Shrub	Leaves, stems and roots – snake bite remedy, treatment of other bites and stings. Also used externally to treat boils, eczema, skin diseases, itching and muscular cramps. Used internally to treat coughs, cols and influenza, bronchitis, high blood pressure and headaches.
Lippia javanica	Lemon Bush	Shrub	Plant - coughs, rashes, sore muscles.
Melia azedarach	Syringa	Tree	Fruit - extremely toxic, causing death among humans, poultry & stock. Effective deterrent for various leaf - eating insects, notably grasshoppers. Various parts used medicinally.
Mormordica balsamina	Wild Cucumber	Climber	Plant - treatment of liver diseases & disorders, cirrhosis, backache & pain, gonorrhoea, hepatitis and persistent dyspepsia (indigestion).
Mundulea sericea	Cork Bush	Shrublet	Bark & seeds - used as fish poison. The leaves, bark and roots - used in traditional medicine.

Species Name	Common Name	Growth Form	Medicinal Use
Olea europaea subsp. Africana	African Olive	Tree	Traditional remedies prepared from this plant serve as eye lotions and tonics, lower blood pressure, improve kidney function & deal with sore throats. The early Cape settlers used the fruits to treat diarrhea
Pappea capensis	Jacket Plum	Tree	Seeds - yield oil which is a mild purgative, as a cure for ringworm. Leaves, bark and the oil extracted from the seed - baldness, ringworm, nosebleeds, chest complaints, eye infections, & venereal disease.
Pallea calomelanos	Hard fern	Shrub	Leaves – treat head colds, chest colds and asthma.
Persicaria serrulata	Knotweed	Forb	Plant - sores.
Rhoicissus tridentata	Bushman's Grape	Creeper	Plant - stomach ailments, kidney and bladder complaints.
Rhus leptodictya	Mountain Karee	Tree	An intoxicating liquor can be made from the fruit.
Rhynchosia caribaea		Creeper	Plant - rheumatic pains and headaches.
Rinicus communis	Castor oil plant	Shrub	Oil – treat stomach ache. Root poultice applies to wounds.
Sarcostemma viminale	Caustic Vine	Parasite	Plant - heartburn, ulcers, septic sores, venereal disease, as a diuretic, increase milk lactation.
Scabiosa columbaria	Wild scabious	Shrub	Leaves and fleshy roots – treat colid, heartburn, wound-healing ointment, baby powder.
Sclerocarya birrea subsp. Caffra	Morula	Tree	Bark, roots and leaves - diarrhoea, dysentery & stomach ailments.
Solanum panduriforme	Poison Apple	Forb	Plant - skin infections, toothache, haemorrhoids.
*Tagetes minuta **	Khaki Weed	Forb	Leaves, flowers - nematode infestations, fleas on dogs
Tarchonanthus camphoratus	Camphor Bush	Tree	Smoke from burning green leaves - blocked sinuses & headache; Boiled mixture of leaves & water treat coughing, toothache, abdominal pain & bronchitis.
Typha capensis	Bulrush	Chrub	Rhizomes – treat venereal diseases during pregnancy, dysmenorrhea, diarrhea,
Vangueria infausta	Wild Medlar	Tree	Roots - remedy for a number of complaints, including malaria & pneumonia.
Vernonia oligocephala	Bitterbossie	Forb	Plant - intestinal and other complaints
*Veronica anagallis - aquatica**	Water Speedwell	Forb	Root & leaves - appetizers & have agents that gradually restore health, & that induce urination. Leaves - treatment of scurvy, impurity of the blood etc Plant - bruised & applied externally as a poultice on burns & ulcers.
Xerophyta retinervis	Black Stick Lily	Shrub	Roots - asthma. Plant - nose bleeding
Zanthoxylum capense	Small Knobwood	Tree	Plant - ease colic, especially flatulence, & treat palsy. Infusion of the leaves - Gastric & intestinal disorders, as well as intestinal parasites; Bark - taken as tonic or chewed to relieve toothache.
Ziziphus mucronata	Buffalo Thorn	Tree	Roots and bark – treat cough & chest problems, diarrhoea & dysentery; boils, sores & glandular swellings; pain relief

Intruder or Exotic Species

Scattered alien and invasive plant species are located throughout the mine area. A list of many of the species found by NSS in 2008 and SAS during the 2013 and 2014 studies is provided in Table 1.15 below. It should be noted that the table does not provide a full list of the species found during the surveys – refer to the specialist reports for the full lists (Appendix E).

TABLE 1.15: INTRUDER PLANT SPECIES

Species Name	Common Name	Growth Form	Category
Amaranthus spinosa	Thorny pigweed	Forb	-
Araujia sericifera	Moth catcher	Shrub	Category 1
Argemone Mexicana	Yellow Mexican Poppy	Forb	Category 1
Bidens pilosa	Common Blackjack	Forb	Weed
Datura ferox	Large Thorn Apple	Forb	Category 1
Datura stramonium	Common Thorn Apple	Forb	Category 1
Brachiaria eruciformis	Sweet Signal Grass	Grass	Weed
Eucalyptus camaldulensis	Red river gum	Tree	Category 2
Euphorbia geniculate	Wild Pointsettia	Succulent	Weed
Galinsoga parviflora	Gallant Soldier	Forb	Weed
Gomphrena celosiodes	Prostrate globe amaranth	Shrub	Weed
Grevellia robusta	Australian silky oak	Tree	Category 3
Hibiscus trionum	Bladder Hibiscus	Forb	Weed
Jacaranda mimosifolia	Jacaranda	Tree	Category 3
Lantana camara	Common Lantana	Shrub	Category 1
Lepidium bonariense	Pepperweed	Forb	Weed
Melia azedarach	Syringa	Tree	Category 3
Morus alba	White Mulberry	Tree	Category 3
Nicotiana glauca	Wild Tobacco	Shrub	Category 1
Oxalis obliquifolia	Oblique - leaved Sorrel	Forb	Weed
Paspalum urvillei	Vasey Grass	Grass	Weed
Pennisetum setaceum	Fountain Grass	Grass	Category 1
Persicaria lapathifolia	Spotted Knotweed	Forb	Weed
Persicaria serrulata	Knotweed	Forb	Weed
Populus x canescens	Grey Poplar	Tree	Category 2
Physalis angulate	Wild gooseberry	Shrub	Weed
Prunus persica	Peach tree	Tree	-
Pseudognaphallum luteo - album	Cudweed	Forb	Weed
Phytolacca dioica	Belhambra	Tree	Category 3
Rumex crispus	Curly Dock	Forb	Weed
Salvia reflexa	Mintweed	Forb	Weed
Schkuhria pinnata	Dwarf Marigold	Forb	Weed
Sesbania bispinosa	Spiny sessbania	Shrub	Weed
Sida rhombifolia	Arrowleaf Sida	Forb	Weed
Solanum seaforthianum	Slender Potato Creeper	Forb	Weed
Sorghum halepense	Aleppo Grass	Grass	Category 2
Tacoma stans	Yellow bells	Tree	Category 1
Tagetes minuta	Khaki Weed	Forb	Weed
Tipuana tipu	Tipu tree	Tree	Category 3
Verbena bonariensis	Tall Verbena	Forb	Weed

Species Name	Common Name	Growth Form	Category
Veronica anagallis - aquatica	Water Speedwell	Forb	Weed
Xanthium strumarium	Large cocklebur	Shrub	Category 1
Zinnia peruviana	Redstar Zinnia	Forb	Weed

Results - Terrestrial animal life

Commonly occurring faunal species

The Transformed habitat is the dominant habitat unit in the project area. This habitat provides less suitable habitat for faunal species than the Rocky Outcrop and Wetland Habitat units where most of the faunal species were found (SAS, 2013). Mammal species identified by NSS in 2008 and SAS in 2013 in the project area by direct observation and evidence of prescence are listed in the table below. No mammals were observed during the 2014 survey conducted by SAS. Livestock such as goats were also noted in 2013 and 2014.

TABLE 1.16: COMMON MAMMALS IN THE PROJECT AREA

Scientific name	Common name	IUCN and NW conservation status*
Lepus saxatilis	Scrub Hare	Least concern
Sylricapra grimmia	Common Duiker	Least concern
Raphicerus campestris	Steenbok	Least concern
Helogale parvula	Dwarf Mongoose	Least concern
Hystrix africaeaustralis	Porcupine	Least concern
Galerella sanguinea	Slender Mongoose	Least concern
Cynictis penicillata	Yellow Mongoose	Least concern
Ichneumia albicauda	White tailed mongoose	Least concern
Genetta tigrina / genetta	Large-spotted or Small-spotted Genet	Least concern
Ictonyx striatus	Striped Polecat	Least concern
Crocidura mariquensis	Swamp musk shrew	Least concern
Lemniscomys rosalia	Single-stripped mouse	Least concern

** Same status unless specifically shown otherwise.*

In addition to the species noted in the project area, Table 1.17 lists mammal species which may occur in the project area.

TABLE 1.17: MAMMALS WHICH MAY OCCUR IN THE RPOJECT AREA

Scientific name	Common name	IUCN and NW conservation status*
Caracal caracal	Caracal	Least concern
Leptailrus serval	Serval	Least concern
Canus mesomelas	Black-backed jackal	Least concern

* Same status unless specifically shown otherwise.

Bird species identified on site (pre mining), through actual observation or capture, and through evidence of presence during the NSS 2008 and 2013 and 2014 SAS studies, are listed below. It should be noted that the table does not provide a full list of the species found during the surveys – refer to the specialist reports for the full lists (Appendix E).

TABLE 1.18: AVIFAUNA WITHIN THE PROJECT AREA

Scientific name	Common name	IUCN conservation status
Anhinga rufa	African darter	Least concern
Ardea melanocephala	Black - headed Heron	Least concern
Plectropterus gambensis	Spur - winged Goose	Least concern
Streptopelia senegalensis	Laughing Dove	Least concern
Streptopelia capicola	Cape Turtle Dove	Least concern
Ploceus velatus	Southern Masked Weaver	Least concern
Euplectes orix	Southern Red Bishop	Least concern
Bostrychia hagedash	Hadeda Ibis	Least concern
Threskiornis aethiopicus	Sacred Ibis	Least concern
Pycnonotus nigricans	Dark - capped Bulbul	Least concern
Oxylophus jacobinus	Jacobin Cuckoo	Least concern
Vidua macroura	Pin - tailed Whydah	Least concern
Colius striatus	Speckled Mousebird	Least concern
Euplectes albonotatus	White - winged Widowbird	Least concern
Dendroperdix sephaena	Crested Francolin	Least concern
Centropus burchellii	Burchell's Coucal	Least concern
Uraeginthus angolensis	Blue Waxbill	Least concern
Passer domesticus	House Sparrow	Least concern
Acridotheres tristis	Common Myna	Introduced
Pternistis swainsonii	Swainson's Spurfowl	Least concern
Egretta alba	Great Egret	Least concern
Alopochen aegyptiaca	Egyptian Goose	Least concern
Vanellus armatus	Blacksmith Lapwing	Least concern
Vanellus coronatus	Crowned Lapwing	Least concern
Corvus albus	Pied Crow	Least concern
Lanius collaris	Common Fiscal	Least concern
Prinia subflava	Tawny - flanked Prinia	Least concern
Hirundo cucullata	Greater Striped Swallow	Least concern
Hirundo rustica	Barn Swallow	Least concern
Bubulcus ibis	Cattle Egret	Least concern
Numida meleagris	Helmeted Guineafowl	Least concern
Asio capensis	Marsh Owl	Least concern
Dicrurus adsimilis	Fork - tailed Drongo	Least concern
Corythaixoides concolor	Grey Go - Away - Bird	Least concern
Cisticola juncidis	Zitting Cisticola	Least concern
Cisticola chiniana	Rattling Cisticola	Least concern
Cisticola fulvicapillus	Neddicky	Least concern
Myrmecocichla formicivora	Southern Anteating Chat	Least concern
Lanius collurio	Red - backed Shrike	Least concern
Chrysococcyx caprius	Diderick Cuckoo	Least concern
Elanus caeruleus	Black - shouldered Kite	Least concern

Scientific name	Common name	IUCN conservation status
Phalacrocorax africanus	Reed Cormorant	Least concern
Merops bullockoides	White - fronted Bee - eater	Least concern
Euplectes progne	Long - tailed Widowbird	Least concern
Phoeniculus purpureus	Green Wood – hoopoe	Least concern
Anas spatsa	African Black Duck	Least concern
Anas undulate	Yellow-billed Duck	Least concern
Passer melanurus	Cape Sparrow	Least concern
Tockus nasutus	African Grey Hornbill	Least concern
Circaetus pectoralis	Black-chested Snake-eagle	Least concern
Fulica cristata	Red knobbed coot	Least concern
Ardea cinerea	Grey heron	Least concern
Ardea melanocephala	Black headed heron	Least concern
Quelea quelea	Red billed quelea	Least concern
Bostrychia hagedash	*Hadeda ibis*	Least concern

The project area is situated within the Magalies/Witwatersberg Important Bird Area (IBA SA025) (SAS, 2013). This IBA is relatively large and well conserved. Red Data Listed bird species may utilize the less disturbed parts of the project area for foraging and as a migratory corridor. The two most important bird species of concern in this IBA are the Secretary Bird and Cape Vulture, both of which have a high probability of occurrence in the project area.

Reptile and amphibian species identified on site (pre-mining), through actual observation or capture, and through evidence of presence during the NSS 2008 study and SAS 2013 study, are listed below. It should be noted that the table does not provide a full list of the species found during the surveys – refer to the specialist reports for the full lists (Appendix E). Only one common species was found during the 2013 survey conducted by SAS, namely the Striped Skink. No reptiles or amphibians were observed during the SAS 2014 survey.

TABLE 1.19: REPTILES AND AMPHIBIANS WITHIN THE PROJECT AREA

Scientific name	Common name	IUCN and NW conservation status*
Frogs - Order: Anura		
Kassina senegalensis	Bubbling Kassina	Least concern
Phrynomantis bifasciatus	Banded Rubber Frog	Least concern
Afrana angolensis	Common River Frog	Least concern
Schismaderma carens	Red Toad	Least concern
Reptiles - Order: Squamata		
Bitis arietans	Puff Adder	Least concern
Pachydactylis affinis	Transvaal Gecko	Least concern
Trachylepis striata	Eastern Striped Skink	Least concern

* Same status unless specifically shown otherwise.

In addition to the species observed by NSS in 2008, Table 1.20 lists species which are expected to occur within the project area.

TABLE 1.20: REPTILES AND AMPHIBIANS EXPECTED TO OCCUR WITHIN THE PROJECT AREA

Scientific name	Common name	IUCN and NW conservation status*
Reptiles – Order:		
Chamaeleo dilepis	Flap necked chameleon	Least concern
Agama atra	Southern rock agama	Least concern
Meroles squamulosus	Common rough-scaled lizard	Least concern
Reptiles - Order: Squamata		
Hamachatus haemachatus	Rinkhals	Least concern
Dispholidus typas	Boomslang	Least concern
Frogs - Order: Anura		
Ponuntonophrynus fenoulheto	Fenoulhet's toad	Least concern
Amietophrynus garmani	Eastern olive toad	Least concern
Amietophryinus gutteralis	Gutteral toad	Least concern
Amietophrynus poweri	Lowveld toad	Least concern
Cacosternum boettgeri	Common caco	Least concern
Phrynobatrachus natalensis	Natal dwarf puddle frog	Least concern
Ptchadena anchietae	Plain grass frog	Least concern
Ptchadena mossambica	Broad-banded grass frog	Least concern
Strongylopus fasciatus	Striped stream frog	Least concern
Tompoterna cryptotis	Common sand frog	Least concern
Tompoterna natalensis	Natal sand frog	Least concern
Xenopus laevis	Platanna	Least concern

* Same status unless specifically shown otherwise.

Invertebrate species from that were identified on site by NSS in 2008 (pre-mining) as well as by SAS in 2013 and 2014, through actual observation or capture, and through evidence of presence, are listed below. It should be noted that the table does not provide a full list of the species found during the surveys – refer to the specialist reports for the full lists (Appendix E).

TABLE 1.21: INVERTEBRATE SPECIES WITHIN THE PROJECT AREA

Family name	Scientific name	Common name	IUCN conservation status
Class: Insecta			
Order: Coleoptera			
Carabidae	-	Ground Beetles - various sp	Least concern
Scarabaeidae	*Plaesiorrhinella plana*	Yellow-belted Fruit Chafer	Least concern
	Cyrtothyrea marginalis	Common dotted Fruit Chafer	Least concern
Geotruidae	*Geotrupes egeriei*	Earth-boring dung bettles	Least concern
Lycidae	*Lucus melanurus*	Hook winged/Net winged bettle	Least concern
Melyridae	*Astylus atromaculatus*	Spotted Maize Beetle	Least concern
Meloidae	*Mylabris oculata*	CMR Bean Beetle	Least concern
Order: Diptera			
Muscidae	*Musca domestica*	House Fly	Least concern
	Stomoxys calcitrans	Stable Fly	Least concern
Asilidae	-	Robber Flies	Least concern
Order: Hymenoptera & Isoptera			
Formicidae	-	Various species	Least concern
	Anoplolepis custodiens	Pugnacious Ant	Least concern
Apidea	*Apis mellifera scutellata*	African honey bee	

Family name	**Scientific name**	**Common name**	**IUCN conservation status**
Order: Lepidoptera			
Nymphalidae	*Danaus chrysippus aegyptius*	African Monarch	Least concern
	Junonia hierta cebrene	Yellow Pansy	Least concern
	Byblia ilythia	Spotted joker	Least concern
Papilionidae	*Papilio demodocus demodocus*	Citrus Swallowtail	Least concern
	Papilio nireus lyaeus	Green-banded Swallowtail	Least concern
Pieridae	*Belenois aurota aurota*	Brown-veined White	Least concern
	Pontia helice helice	Meadow White	Least concern
	Eurema hecabe	Common grass yellow	Least concern
	Belenois creona	African common white	Least concern
	Colias electo electo	African Cloud Yellow	Least concern
Lycaenidae	*Euchrysops malathana*	Common Smokey Blue	Least concern
	Axiocerses tjoane tjoane	Common Scarlet	Least concern
Saturnidae	*Burnaea alcinoe*	Emperor moth	
Order: Orthoptera			
Anostostomidae	*Onosandrus* sp.	-	
Acrididae	-	Various species	Least concern
Gryllidae	*Gryllus bimaculatus*	Common Garden Cricket	Least concern
Tettigoniidae	*Conocephalus caudalis*	Meadow katydid	
Order: Odonata			
Coenagrionidae	-	Various species	Least concern
Class: Arachnida			
Order: Araneae (Araneomorphs)			
Pisauridae	-	Nursery-web and Fishing Spiders	Least concern
Agelenidae	*Olorunia spp.*	Grass Funnel-web Spiders	Least concern
Order: Scorpiones			
Scorpionidae	*Opistophthalmus glabrifrons*	-	Protected species
Ischnuridae	*Hadogenes gracilis*	-	Protected species
Order: Phasmotodea			
Heteronemiidae	*Maransis rufolineatus*	Grass stick insect	
Order: Neuroptera			
Myrmeleontidae	*Brachyplectron* sp.	Antlion	
Order: Hamiptera			
Cicadidae	*Platypleura haglundi*	Orange winf cicada	
Order: Acari			
	-	Ticks	Least concern
Superclass: Myriapod			
Class: Chilopoda			
-	-	Centipedes	Least concern
Class: Diplopoda			
-	-	Millipedes	Least concern
Order: Mantodea			
Mantidae	*Sphodromantis lineola*	African praying mantis	Least concern

Rare or Endangered Species

Red Data listed animals that have the potential to occur within and/or adjacent to the mine are outlined below. It should however be noted that SAS conducted a Red Data Sensitivity Index Score (RDSIS) for the project area which yielded a low score of 37%. This indicates a low importance with regard to Red Dala Listed faunal species conservation within the region (SAS, 2013 and 2014).

Mammals

According to SAS (2013 and 2014), it is unlikely that any Red Data Listed mammal species occur within the project area, due to the high levels of disturbance and anthropogenic activities.

Birds

No Red Data listed birds were observed during the 2008 NSS study nor the 2013 and 2014 SAS studies. However, the likelihood of occurrence of Red Data listed bird species utilizing the study site for foraging or as a migratory corridor cannot be excluded.

SAS consulted the Red Data listed bird species recorded for the 2527 CB and 2527 DA quarter degree square that could potentially occur within and/ or adjacent to the project area. SAS then conducted a RDSIS, based on the availability of suitable habitat. The species determined to have a probability of occurence (POC) greater than 60% are listed in the table below. It is noted that the species listed in the table below have the ability to migrate away from unfavourable conditions.

TABLE 1.22: RED DATA LISTED AVIFAUNA WHICH MAY OCCUR WITHIN THE PROJECT AREA

Scientific Name	Common Name	NW Status	IUCN Status	POC
Gyps coprotheres	Cape Vulture	Vulnerable	Vulnerable	62%
Polemaetus bellicosus	Martial Eagle	Vulnerable	Near threatened	66%
Falco peregrinus	Peregrin falcon	Rare	Least concern	70%
Saggittarius serpentarius	Secretary bird	Near threatened	Vulnerable	64%
Tyto capensis	African grass owl	Vulnerable	Least concern	63%

Reptiles and amphibians

SAS consulted the Red Data listed reptile and amphibian species recorded for the 2527 CB and 2527 DA quarter degree square that could potentially occur within and/ or adjacent to the project area. SAS then conducted a conducted a RDSIS, based on the availability of suitable habitat. Only the South African Python was determined to have a probability of occurrence greater than 60%. It has a conservation status of vulnerable in the North West Province and has not yet been assessed by the IUCN (SAS, 2013).

Invertebrates

Invertebrate data for the NW Province is limited, whilst, Lepidopteron species have been studied in detail. There are 221 species of Lepidoptera in the Province. Of these, 10 are listed as Red Data, with the Moot Plains Bushveld containing species of medium to high conservation status. No butterflies of conservation significance were observed during the field investigations (NSS, 2008).

Other known groups of macro-invertebrates that are likely to be of conservation importance in the mine area include the Mygalomorph spiders, and scorpions from the geneses *Hadogenes* and *Opistopthalamus*. Species within these geneses are listed as Protected Species (PS). *Opistophthalmus* *glabrifrons* and *Hadogenes gracilis* were both identified during the field assessment (NSS, 2008), but were not recorded during the 2013 and 2014 SAS surveys.

<u>Exotic or invasive species</u>

Invasive, alien or domesticated (not native to SA) mammal species that were observed during field investigations conducted in 2008 and 2013 and included goats, domestic dogs and cats. The disturbed bushveld and farming habitat, together with human settlements provide suitable habitat for the House Rat (*Rattus rattus)* and the House Mouse (*Mus musculus*). Alien bird species associated with these types of habitat include the Indian or Common Myna (*Acridotheres tristis*) and the House Sparrow (*Passer domesticus*).

Results - Aquatic Ecology

Drainage systems within the mine area are outlined in Section 1.1.6. Tharisa Mine falls within the Lower Sterkstroom of the Upper Crocodile Sub-Management Area. The project area additionally falls within the Bushveld Basin Ecoregion, within the A21k quaternary catchment.

Pertinent information obtained from the NFEPA database includes (as cited in SAS, 2013):

- The Upper Crocodile Sub-Management Area is not regarded as important in terms of:
    - Fish sanctuaries, rehabilitation or corridors
    - Translocation and relocation zones for fish
- The Sterkstroom River is the major drainage line in the project area and is a Class C (moderately modified) system
- No NFEPA defined wetlands in the project area are considered to be important in terms of biodiversity conservation.

The vegetation map of SA, Swaziland and Lesotho groups vegetation types according to biomes, which are then divided into bioregions, which are composite terrestrial spatial units defined on the basis of similar biotic and physical features and processes at the regional scale. In order to characterise the regional setting for the wetland component of the NFEPA Project, wetland vegetation groups, referred to as WetVeg groups, were derived by further splitting bioregions into smaller groups using expert input. There are currently 133 WetVeg groups and it is envisaged that these groups could be used as a special framework for the classification of wetlands on a national and regional conservation planning scale (SAS, 2013). According to SAS, two WetVeg groups apply to the project area (SAS, 2013), namely the Central Bushveld Group 2 and Central Bushveld Group 5.

Flat and unchannelled valley bottom wetlands within group 2 are considered to be vulnerable ecosystems, and all other wetlands in this group are considered to be least threatened. Floodplain wetlands in group 5 are considered to be critically endangered ecosystems, and all other wetlands in this group are considered to be least threatened.

SAS identified wetlands within the project area during the 2013 and 2014 studies. These have been grouped as follows (SAS, 2013) (refer to Figure 1.9):

- North-western wetlands (Wetlands 1 and 2)
- North-eastern wetlands (Wetlands 3 to 5)
- South-eastern wetlands (Wetlands 6 and 7)
- South-western wetland (Wetland 10) and artificial wetland (Wetland 9)
- Sterkstroom River (Wetland 8).

The artificial wetland in the south-west is believed to have been formed due to earthworks and increased runoff from the tarred roads to the south, which led to localised changes in hydrology such as ponding, which supports wetland vegetation (SAS, 2013).

During the 2013 SAS survey it was noted that the valley seep wetland (Wetland 3) just north of the west open pit has been impacted by waste rock disposal.

The wetland features are described in the table below.

TABLE 1.23: WETLAND FEATURES IDENTIFIED IN THE PROJECT AREA

Wetland	Type	Ecoservices and function #	Present Ecological state*	Ecological importance and sensitivity
North-west group				
Wetland 1 (west open pit area)	Unchannelled valley bottom	1.1 (moderately low)	Category C	Category C (ecologically important and sensitive on a provincial or local scale)
Wetland 2 (west open pit area)	Channelled valley bottom		Category C/D	
North-east group				
Wetland 3 (east WRD area)	This wetland has been affected by waste rock disposal and SAS could not gain access to this area.			
Wetland 4 (north east WRD area)	Unchannelled valley bottom	1.2 (moderately low)	Category C	Category C (ecologically important and sensitive on a provincial or local scale)
Wetland 5 (north east WRD area)	Channelled valley bottom	1.1 (moderately low)	Category B	
South-eastern wetland group				
Wetland 6 (TSF2 area)	Channelled valley bottom	1.1 (moderately low)	Category C	Category C (ecologically important and sensitive on a provincial or local scale)
Wetland 7 (TSF2 area)				
Sterkstroom River wetland				
Wetland 8 (Sterkstroom River)	Channel (river)	2.0 (moderately high)	Category C	Category C (ecologically important and sensitive on a provincial or local scale)
South-western wetland group				
Wetland 9 (artificial wetland)	Unchannelled valley bottom	Not determined	Not determined	Category C (ecologically important and sensitive on a provincial or local scale)
Wetland 10	Channel (river)	Not determined	Category C (based on vegetation assessment)	

* Category B - largely unmodified Category C – moderately modified Category D – largely modified
# Ecoservices and function ranking ranges from 0.5 (low) to 3 (high)

Conclusion

The project area falls within the Marikana Thornveld which is an important vegetation type that requires careful consideration when developing mining projects. The project area includes a terrestrial Critical Biodiversity Area and a critically endangered river (the Sterkstroom) defined by the North-West Province 2009 biodiversity assessment, and a High Biodiversity area in terms of the recently published Mining Biodiversity Guidelines. It is important to note that these national guidelines and assessments were published after the mine was approved in 2008.

The area has been transformed by agricultural and mining activities (both on the project sites and in the surrounding areas), yet aquatic and terrestrial habitat, although limited, does still exist within the project area which is suitable for fauna and flora species, including some Red Data and protected species.

1.1.6 SURFACE WATER BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008), the project-specific hydrology study (SLR, 2014a) (Appendix F), as well as the relevant surface water monitoring reports and should be read with reference to Figure 1.10 (Section 1.4).

Introduction and link to anticipated impact

Surface water resources include rivers, drainage lines, paths of preferential flow of stormwater runoff as well as the channelling and/or collection of water on the surface such as dams. Mining projects have the potential to alter the drainage of surface water flow across a site and/or result in the contamination of the surface water resources through the placement of infrastructure and seepage and/or spillage of substances, non-mineralised and mineralised wastes.

Key to understanding the hydrology of the site is understanding the climatic conditions of the site (see Section 1.1.3) and topographical features (see Section 1.1.2). As a baseline, this section identifies hydrological catchments that could be affected by the project and the status of surface water features in the mining area.

Data collection

For the approved EIA and EMP report (Metago, 2008) surface water data was collected through the review of available studies, a project-specific hydrocensus done in 2007, review of topographical and survey maps and review of climatic data. Where baseline information was required for the project-specific hydrology study, this was updated by the specialist. For the purposes of this report, information on water quality has been supplemented with information from the mine’s monitoring programme.

Results

Surface Drainage

Tharisa Mine is located within the upper reaches of the A21K quaternary catchment, which falls within the Lower Crocodile Secondary catchment and the Crocodile West and Marico Water Management Area (WMA3).

In the mining area, there are four drainage systems. These include the perennial Sterkstroom, non-perennial tributaries of the Brakspruit on the west, non perennial tributaries of the Maretlwane on the east and a non-perennial tributary of the Elandsdriftspruit in the south east (Figure 1.10). At the north east WRD, there are two non-perennial tributaries of the Maretlwane draining the site. Apart from the Sterkstroom, drainage lines within the mining area are mostly not well defined and only a few watercourses have distinct channels.

The perennial Sterkstroom flows from the Buffelspoort Dam, south of the N4, through the mining operations, between the western and eastern mining areas. Two unnamed non-perennial tributaries of the Brakspruit originate in the north-west of the mine and drain the western side of the mining right area. Mining of the west pit has taken place within the headwaters of these tributaries. The eastern mining area is drained by two non-perennial drainage lines that formed a tributary to the Maretlwane. Mining of the east pit has taken place within the headwaters of these drainage lines. In the south eastern corner of the mine, a tributary of the Elandsdriftspruit which originated just south of the mine falls within the footprint of TSF2. The diversion of this tributary was included in the approved EIA and EMP report (Metago, 2008). The north east WRD is located on two non-perennial drainage lines that originate just south of the WRD and flow in a northerly dirtection towards the Maretlwane.

The non-perennial Elandsdriftspruit flows in a northerly and then north westerly direction into the Middelkraal Dam. The Middelkraal Dam then feeds the perennial Maretlwane which also then feeds into the Sterkstroom downstream of the mine.

Mean Annual Runoff

According to WR2005, quaternary catchment A21K has a catchment area of 865km^2 and an estimated mean annual runoff (MAR) of 22.46 million m^3/year (SLR, 2014a). From the WR2005 data, the MAR in each of the watercourses has been estimated on a pro-rata basis according to catchment area, as presented in Table 1.24. It should be noted that these estimates of MAR based on catchment area should be considered as indicative only, as flow within a catchment is not always directly proportional to the catchment area (SLR, 2014a).

TABLE 1.24: MEAN ANNUAL RUNOFF (BASED ON WR2005 DATA)

Catchment	Area (km^2)	Mean Annual Runoff (MAR) (million m^3/year)
Sterkstroom (downstream of Buffelspoort Dam and upstream of the confluence with Brakspruit)	44.58	1.16
Elandsdriftspruit tributary (upstream of confluence with Elandsdriftspruit)	6.47	0.17
Brakspruit tributaries (upstream of confluence with Brakspruit)	20.75	0.54
Western Maretlwane tributaries (upstream of confluence with Maretlwane)	16.88	0.44
Eastern Maretlwane tributaries (upstream of confluence with Maretlwane)	11.80	0.31
A21K	865.00	22.46

Normal dry weather flow

The normal dry weather flow for the non-perennial Elandsdriftspruit, Brakspruit and Maretlwane tributaries in the mine area is zero. The normal dry weather flow of the Sterkstroom is dependant on the rate of release from the Buffelspoort Dam situated about 3.25km upstream of Tharisa Mine. Flow measured at the Buffelspoort gauge in the Sterkstroom (Gauge No. A2R005; situated downstream of the Buffelspoort Dam and upstream of Tharisa Mine) calculated over the period 1935 to 1988 indicates a normal monthly dry weather flow of 0.83 million m^3 / month (SLR, 2014a).

Flood Peaks and volumes

Flood peaks for the 1:20, 1:50 and 1:100 year storm events were calculated for the Sterkstroom and Elandsdriftspruit tributary only as only these streams required engineering design in terms of floodline determination and/or stream diversion design (Metago, 2008).

Flood peaks for the respective catchment areas were determined using the Alternative Rational (AR), Standard Design Flood (SDF) and Unit Hydrograph (UH) methods. The regional maximum flood (RMF) peak flow rate was determined using Kovács method (1980). The peak flow rates are summarised below. Flood volumes calculated using the calculated flood peaks and the time of concentration for each catchment are also summarised in Table 1.25 below.

TABLE 1.25: FLOOD PEAKS AND VOLUMES

Catchment	Area (km^2)	Return period			
		1:20	1:50	1:100	RMF
Peak Flow Rate (m^3/s)					
Sterkstroom (A)	140.3	314	444	544	1185
Elandsdriftspruit tributary (B)	3.3	25	35	43	181
Flood Volume ($x10^6$ m^3)					
Sterkstroom (A)	140.3	7.36	10.39	12.73	-
Elandsdriftspruit tributary (B)	3.3	0.14	0.19	0.24	-

Floodlines

Flood lines for the Sterkstroom River were determined as part of the approved EIA and EMP report (Metago, 2008) using the software package HEC-RAS River Analysis System version 3.1.3 (2005). Input data included the relevant hydrological data and survey information supplied by Tharisa. Using the peak flows presented below, the 1:50, 1:100 year and Regional Maximum Flood (RMF) flood-lines for the Sterkstroom River were modelled and are presented alongside the 100m offsets (Figure 1.10). The 100m buffers are presented for the other watercourses. Considering the relatively small catchments of these other watercourses (Brakspruit tributaries and Maretlwane tributaries) which will generate only modest flood flows, the 100m buffers are likely to be significantly wider than the 1:50 or 1:100 year flood-lines. In this regard, in the absence of floodlines, the 100m buffers will be taken as the developmental constraint in these locations.

Disturbance of drainage systems

Drainage systems on site have been disturbed as follows:

- The headwaters of the Maretlwane tributary were altered as part of the eastern open pit mining activities. The alteration and impedance of these headwaters has been licensed by DWA. Stormwater upstream of the pit either drains into the plant's stormwater dam or east pit. The eastern waste rock dump is located immediately downstream of the eastern open pit operations, on the same tributary of the Maretlwane
- The headwaters of the Brakspruit tributaries were altered as part of the western open pit mining activities. The alteration and impedance of these headwaters has been licensed by DWA.
- The diversion of the Elandsdriftpruit, located within the footprint of TSF2, was included in the approved EIA and EMP report (Metago, 2008) and is licensed by DWA.

Water Quality

The pre-mining water quality was determined through three surface water samples taken in July and November of 2007. The surface water points included (refer to Figure 1.11):

- SW1 on the Sterkstroom, upstream of the mine (now called TM SW01)
- SW2 on the Sterkstroom, downstream of the mine (now called TM SW02)
- SW3 on the non perennial tributary of the Elandriftspruit.

The pre-mining water quality in the Sterkstroom indicated that the water was of ideal water quality (suitable for lifetime use) when compared to the South African National Standards (SANS) standard for domestic use (SANS 241:2005) and the classification compiled by the Water Research Commission (WRC) together with DWA and the Department of Health (Table 1.26). The quality at SW3 (on tributary of the Elandsdriftspruit) was considered to have marginal water quality (conditionally acceptable – negative effects may occur in some sensitive groups due to elevated iron and manganese).

The sampling results showed that the following parameters were found in higher concentrations downstream of the Tharisa site than upstream: pH, total dissolved solids (TDS), alkalinity, sulphate, calcium, magnesium, and sodium. Concentrations of iron were found in slightly higher concentrations upstream of the Tharisa site than downstream.

The following parameters exceeded one or more of the guidelines values: TDS (irrigation), ammonia (aquatic ecosystems target), manganese (irrigation) and mercury (aquatic ecosystems target and irrigation). The results indicate that, prior to commencement of Tharisa's operations, the water downstream of the mine generally had higher concentrations of major cations, major anions and pH than upstream.

TABLE 1.26: PRE-MINING SURFACE WATER QUALITY (NOVEMBER 2007)

Analyses in mg/l	**SANS water quality guidelines for domestic use**		**Sampling site**		
	Class 1	**Class 2**	**SW1 (TM SW01)**	**SW2 (TM SW02)**	**SW3**
pH Value at 25°C	5.0 – 9.0	4.0 – 10.0	7.1	8.0	7.4
Electrical Conductivity in mS/m at 25°C	<150	150 – 370 (7yrs)	19.9	40.1	12.6
Total Dissolved Solids at 180°C	<1000	1000 – 2400 (7 yrs)	140	258	81
Total Alkalinity as $CaCO_3$	N/A	N/A	72	156	60
Nitrate as N	<10	10 – 20 (7 yrs)	0.5	0.7	1.9
Chloride as Cl	<200	200 – 600 (7 yrs)	13	19	8
Sulphate as SO_4	<400	400 – 600 (7 yrs)	6	29	48
Fluoride as F	<1.0	1 – 1.5 (1 yr)	<0.2	<0.2	<0.2
Chromium as Cr	-	-	<0.025	<0.025	0.616
Calcium as Ca	<150	150 – 300 (7 yrs)	9.7	18.1	13.8
Cadmium as Cd	-	-	<0.01	<0.01	<0.01
Copper as Cu	-	-	<0.01	<0.01	0.01
Iron as Fe	-	-	0.02	<0.01	1.32
Potassium as K	<50	50 – 100 (7 yrs)	0.675	0.48	0.55
Magnesium as Mg	<70	70 – 100 (7 yrs)	12.03	32.71	14.60
Manganese as Mn			<0.01	<0.01	0.83
Sodium as Na	<200	200 – 400 (7 yrs)	6.61	12.74	6.21
Zinc as Zn	-	-	<0.01	<0.01	0.06
CLASSIFICATION (parameters in brackets are those responsible for the class of the water)			**Class 0**	**Class 0**	**Class 2 (Fe, Mn)**

Class 0	Ideal water quality - suitable for lifetime use
Class 1	Good water quality - suitable for use, rare instances of negative effects
Class 2	Marginal water quality - conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality - unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality - totally unsuitable for use. Acute effects may occur.

Tharisa monitors surface water as part of its surface water monitoring programme. In line with the approved EIA and EMP report, there are four sampling points in the local watercourses (refer to Figure 1.11) however typically only the Sterkstroom River can be sampled as the flow is not sufficient to allow sampling at other locations. SW1/TM SW01 is an upstream monitoring point which can be used to give background information on the local water quality, while SW2/TM SW02 is downstream of the mine.

An additional point in the Sterkstroom was added in 2013, namely TM SW03. This point is located adjacent to the open pit operations and Hernic quarry.

The water quality has been compared to the following guidelines (SLR 2014a):

- South African National Standard for Drinking water (SANS 241:2011)
- South African DWA water quality guidelines for livestock, irrigation and aquatic ecosystems.

The average water quality results for 2008 to 2014 indicate that the following parameters are frequently found in higher concentrations downstream (SW2) of the mine than upstream (SW1) pH, total dissolved solids (TDS), alkalinity, nitrate, chloride, sulphate, aluminium, calcium, magnesium, sodium, sulphur; silicon and strontium (SLR, 2014a).

During the pre-mining baseline survey, of the above parameters, all except for nitrate, chloride, aluminium, sulphur, silicon and strontium were identified at higher concentrations downstream of the mine than upstream indicating that the source of these parameters pre-dates mining operations (SLR, 2014a).

When considering the water quality results at both monitoring points SW1 and SW2 over time, there are no identifiable trends showing increasing concentrations of parameters since the mining operation commenced, with the exception of aluminium. On several occasions pH and aluminium exceed guidelines values downstream of the mine, whilst upstream of the mine concentrations are below the guidelines. On one occasion hexavalent chrome was found at the detection limit (exceeds the guideline value), downstream of the mine (SW2) when not observed upstream of the mine (SW1) which indicates that there is a source of pollution between the two sampling points which is possibly the mine.

Comparison of the results against the guideline values concludes that: TDS, ammonia, aluminium, iron and manganese are observed in concentrations which exceed the guideline values in both upstream and downstream samples, suggesting that activities or chemical sources upstream of, and therefore unrelated to the mine, is impacting upon the water quality of Sterkstroom.

Comparison of water quality against drinking water standards concludes that, with the exception of aluminium, none of the parameters analysed for were identified at concentrations above drinking water standards. Aluminium was found at 2.2 and 1.9 times the drinking water standard downstream of the mine, whilst upstream values were below the guidelines. On two occasions out of two sampling rounds, E. coli (which doesn't form part of the usual analytical suite) was observed at levels exceeding the drinking water standard both upstream and downstream of the mine.

Surface Water Use

Water from the Sterkstroom is used for domestic purposes such as washing and bathing, livestock watering and for agricultural purposes.

An irrigation canal flows from north to south, along the eastern boundary of TSF1. It is understood from liaison with the mine that there are no users of this irrigation canal downstream of the TSF.

Conclusion

There are a number of surface water systems within the mine and project area. Apart from the Sterkstroom (where surface water is used for domestic purposes), drainage lines within the mining area were not well defined and did not have distinct channels. There was no notable use of water within these systems. The headwaters of the ephemeral Brakspruit and Maretlwane systems are located within the footprint of the mine and have been altered by open pit mining activities. The diversion of the Elandsdriftspruit tributary that flows through TSF 2 was included in the approved EIA and EMP report (Metago, 2008).

The pre-mining water quality within the Sterkstroom already showed elevated concentrations of certain parameters. The mine's water quality monitoring shows some increase in ambient water quality concentrations downstream of the mine, particularly for nitrates and TDS.

The change in the layout and/or configuration of facilities will influence surface water runoff on the site, which in turn will influence the stormwater management system on site. The proximity of project components to drainage lines needs careful consideration in the assessment of impacts and design of mitigation measures.

1.1.7 GROUNDWATER BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008), monitoring reports and the updated groundwater assessment (SLR, 2014b) (Appendix F). This section should be read with reference to Figure 1.11 (Section 1.4).

Introduction and link to impacts

Groundwater is a valuable resource and is defined as water that is located beneath the ground surface in rock pore spaces and in the fractures of lithologic formations. Understanding the geology of the area (see Section 1.1.1) provides a basis from which to understand the occurrence of groundwater resources. Mining related activities have the potential to contaminate groundwater and result in a reduction of groundwater resources available to both the environment and third party users, through dewatering.

As a baseline, this section provides an understanding of the groundwater conditions (quality, quantity and use) and the potential for changes in dewatering cones of depression and pollution plumes as a result of project-related activities.

Data collection

For the approved EIA and EMP report (Metago, 2008), groundwater data was collected through a project-specific hydrocensus done in 2007 and review of available studies and databases. Where baseline information was required for the project-specific groundwater study, this was updated by the specialist. For the purposes of this report, information on water levels and quality has been supplemented with information from the mine's monitoring programme.

Results

Aquifer Classification

Tharisa Mine is underlain by a shallow upper weathered aquifer and a deeper fractured aquifer. The weathered overburden is highly variable in thickness from 3 m to more than 30 m based on existing borehole logs and evidence of borehole depths. The deeper fractured bedrock aquifer is characterized by very low matrix permeability, poorly connected joints/fractures and dolerite/diabase dykes (that may act as barriers to groundwater flow).

In the vicinity of the water courses, alluvium either fully or partially replaces the weathered overburden and the water courses do lose and gain water to the alluvium aquifer. Recharge of the alluvial aquifers is also through lateral groundwater flow from the shallow weathered aquifer and by rainfall events. The thickness of the alluvial sediments has been estimated at 3 to 5 m with its lateral distribution restricted to the immediate banks of the current active channel.

The interface between the overlying weathered or alluvial aquifer and the deeper fractured aquifer featues is relatively impermeable. Its effective permeability is determined by interconnected and open fracture systems. These fracture systems can potentially allow for rapid vertical groundwater flow from the weathered overburden as well as surface water bodies to greater depths. Whilst in general the weathered aquifer and lower fractured aquifer are poorly connected, this is not always the case.

The aquifer system is defined as a minor aquifer region with potential for higher yielding zones (defined by the groundwater specialist in accordance with Parsons (1995). Pump tests of a range of boreholes indicated that the average upper aquifer yield is between 1 and 2.5 litres /second (Metago, 2008). Two higher yielding boreholes (WGC15 and WGC19) were investigated as higher yielding boreholes. These boreholes are associated with isolated structures within the bigger project area.

Groundwater Recharge

Quaternary catchment A21K receives an estimated average annual groundwater recharge of 24.4 million m^3 (Mm^3), of which 3.4 Mm^3 per annum or 13.8% is required for the Reserve, consisting of both basic human needs (estimated at $0.5Mm^3/a$) and an ecological component (estimated at $2.9Mm^3/a$). This equates to an approximate recharge across the catchment of about 28 mm/a.

Groundwater Flow, Levels and Use

The regional groundwater flow is closely related to the topography, and groundwater flows from higher lying ground in the south towards lower lying areas in the north and towards watercourses, which occur in lower lying areas. Of major importance for groundwater flow in the area is the presence of a relatively impermeable interface between the upper shallow weathered aquifer and the deeper, fractured aquifer. This semi- to impermeable interface prevents rapid vertical drainage of the shallow aquifer on a regional scale, thus permitting lateral groundwater flow in the shallow aquifer driven by groundwater gradients related to local topography. On the mine site, localised groundwater flows are expected to be influenced by pit dewatering.

Most of the boreholes identified during the 2007 hydrocensus are used for domestic and agricultural (livestock and irrigation) purposes. The weathered aquifer, as well as the alluvial aquifer along the Sterkstroom River, supports most irrigation and domestic water-supply boreholes throughout the region. The boreholes present in the study area appear to target the shallow weathered bedrock aquifer, which is highly variable in depth.

The pre-mining groundwater levels within Tharisa Mine area were on average 10mbgl with a range of 2 to 30mbgl. Groundwater levels are monitored in mine boreholes as well as on surrounding properties – refer to Figure 1.11 for the location of these monitoring points. The water levels in the on-site boreholes (WGC series of mine monitoring boreholes) did not fluctuate significantly over the monitoring period. These boreholes are not equipped with pumps and are only purged on sampling day. The constant water level shows that the mining activities at Tharisa did not have an appreciable effect on the water levels during the monitoring period.

Water level fluctuations were detected in certain of the off-site boreholes but these are equipped with pumps so the water level is not always representative of the natural groundwater level in the area. The variations can be expected as a result of the periodic pumping in these boreholes due to their use for domestic and agricultural water provision.

Groundwater Quality

Pre-mining (baseline) and operational phase groundwater monitoring points are shown in Figure 1.11. With reference to Table 1.27, the pre-mining water quality (as sampled during the 2007 wet season hydrocensus) indicated that groundwater was generally of good quality and could either be classified as ideal or good. In some boreholes, elevated nitrates dropped the general classification to that of marginal water quality.

One borehole (WGC 15, located north east of the tailings dam complex), presented marginal water quality concentrations (Class II) with respect to magnesium (Mg) and total dissolved solids (TDS) and dangerous water quality concentrations with respect to nitrate (NO_3 as N) (see and Figure 1.11).

Tharisa monitors a number of boreholes located within and surrounding the mine as part of its groundwater monitoring programme (see Figure 1.11). The water quality results from 2008 to 2014 have been compared to the South African National Standard (SANS) standards for domestic use (241:2011) as well as DWAF's guidelines for irrigation and livestock watering (SLR 2014b).

The monitoring results show the following:

- Consistent exceedance of the electrical conductivity and total dissolved solids agricultural guideline for all boreholes sampled. It is noted that the pre-mining water quality also exceeded these guidelines
- Consistent exceedance of the cadmium agricultural guideline for all boreholes sampled during 2008 to mid 2013; however no exceedance is shown in the late 2013 and 2014 data. It is therefore suggested that Tharisa investigate this further as outlined below
- Frequent exceedance of the nitrate agricultural and domestic use guidelines for most boreholes sampled. It is noted that the pre-mining water quality also exceeded these guidelines
- Sporadic exceedance of the selenium domestic use guidelines in boreholes WGC15 and 18 in 2008, TMGWCOMM2 in 2009, TRH36 in 2009 and 2011, TRH14 and 25 in 2009, TMGWCOMM1 in 2011. The late 2013 and 2014 data records selenium concentration at 0.025 for boreholes TMGWCOMM1, 5, 6, 8, TMGWTSF1, 2 and TMGWMCC. It is therefore suggested that Tharisa investigate this further as outlined below
- The late 2013 and 2014 data for mercury and arsenic concentrations in TMGWCOMM1, 5, 6 and 8 as well as TMGWTSF1, 2 and TMGWMCC were all reported to be 0.015 and 0.023 respectively, which exceed the livestock and domestic use guidelines. However, no exceedances were noted in the preceeding years for boreholes TMGWTSF1 and TMGWCOMM1. No monitoring data is available before mid 2013 and 2014 for the other boreholes where mercury or arsenic were elevated. No pre-mining mercury or arsenic concentrations are available. It is therefore suggested that Tharisa investigate this further as outlined below
- Manganese concentrations exceeded the agricultural guideline at TRH41 and TMGWTSF01 in 2008 to 2011 (no subsequent data is available for these boreholes), TMGWWCOMM1 in 2008 to 2010,

WGC3,11 and 12 in 2008 to 2013 (no subsequent data is available), WGC8 in 2008 to 2012 (no subsequent data is available), as well as other more sporadic exceedances. No exceedance was noted in the late 2013 and 2014 monitoring data. Manganese was however not shown to be elevated in the pre-mining water quality data available. It is therefore suggested that Tharisa investigate this further as outlined below

In order to understand the inconsistent mercury, arsenic, manganese, selenium and cadmium it is suggested that the following be conducted:

- Background samples should be taken further afield within the catchment where mining and other anthropogenic activities are not likely to impact on water quality and compare the results against that found in 2013 and 2014, with particular reference to those community boreholes being monitored which are located upstream of the mine infrastructure
- Conduct a round robin laboratory analysis in an effort to determine the accuracy of laboratory testwork. This involves taking duplicate or triplicate samples and sending the samples to different laboratories in order to compare the results

Conclusion

Three groundwater aquifers occur in the area. These are a shallow weathered aquifer, an alluvium aquifer along watercourses and a deeper fractured aquifer. Connectivity between the shallower and deeper aquifers is mainly through geological structures. Groundwater is one of the sources of water supply for some of the surrounding communities.

Groundwater quality monitoring shows elevated concetrations of TDS, EC and nitrates which pre-dates mining activities. Monitoring data is showing inconsistences with respect to other contaminants and this needs to be investigated further to determine if the mine is impacting on groundwater qualities.

The addition of a new waste rock dump and changes to approved waste rock and tailings facilities need to be appropriately designed and implemented to avoid a reduction in groundwater through potential contamination. Deepening of the pit will also require consideration in the context of surrounding groundwater users and the groundwater flow relationships with the watercourses and the Sterkstroom in particular.

TABLE 1.27: BASELINE (PRE-MINING) GROUNDWATER QUALITY FOR THE PROJECT AREA (2007)

SampleID	StationID	Ca	Mg	K	Na	Mn	Fe	F	Cl	NO_3 as N	SO_4	Si	TDS	Cond	Alk	HCO_3	pH
1	Borehole 17a	27.91	63.48	0.23	18.19	< 0.01	<0.01	<0.2	14.00	5.70	43.00	9.19	432.00	62.00	276.00	356.87	7.6
2	Borehole 18	55.44	80.64	0.20	20.55	<0.01	<0.01	<0.2	83.00	18.00	88.00	9.61	680.00	97.00	260.00	336.18	7.2
3	Borehole 38	33.14	28.01	0.16	22.01	<0.01	<0.01	<0.2	<5	1.40	16.00	9.07	342.00	44.20	224.00	289.63	7.5
4	Borehole 30	36.90	45.62	0.18	23.42	<0.01	1.46	<0.2	5.00	1.30	8.00	7.07	416.00	58.60	328.00	424.10	7.5
5	Borehole 33a	38.60	92.46	0.96	16.68	0.18	<0.01	<0.2	13.00	9.10	84.00	8.25	618.00	84.00	364.00	470.65	7.7
6	Borehole 36	49.59	83.94	0.73	22.34	<0.01	<0.01	<0.2	18.00	11.00	73.00	8.76	612.00	87.40	388.00	501.68	7.7
7	Borehole 41	48.19	59.61	0.00	13.20	<0.01	<0.01	<0.2	22.00	8.30	102.00	3.27	552.00	72.40	252.00	325.84	7.6
8	Borehole 40	23.55	30.13	0.17	7.58	<0.01	<0.01	<0.2	11.00	2.70	12.00	2.42	294.00	37.10	160.00	206.88	7.5
9	Borehole 46	37.17	64.07	0.02	12.89	<0.01	<0.01	<0.2	21.00	14.00	75.00	5.75	516.00	68.90	228.00	294.80	7.6
10	Borehole 50a	24.13	20.71	0.25	9.03	<0.01	<0.01	<0.2	10.00	2.60	<5	4.36	290.00	32.00	148.00	191.36	7.3
11	Borehole 14	45.23	66.12	0.19	14.20	0.03	<0.01	<0.2	28.00	9.90	72.00	2.73	504.00	71.20	260.00	336.18	7.4
12	Borehole 15	22.51	33.07	0.00	9.24	<0.01	<0.01	<0.2	14.00	7.80	29.00	2.70	360.00	43.00	156.00	201.71	7.7

Classification according to the guideline compiled by Water Research Commission (WRC) together with DWAF and the Department of Health

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

1.1.8 AIR QUALITY BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008), the project-specific air quality study (Airshed, 2014) (Appendix G) and monitoring data provided by the mine. This section should be read with reference to Figure 1.13 (Section 1.4).

Introduction and link to impacts

Identification of existing sources of emissions in the region and the characterisation of existing ambient pollution concentrations is fundamental to the assessment of cumulative air impacts. A change in ambient air quality can result in a range of impacts which in turn may cause a disturbance to nearby receptors. Potential receptor sites include the surrounding land owners, land users such as the President van Rensburg/Piet Retief Primary School and farmers, settlements including Mmaditlhokwa/Silver City, Tsilong and Lapologang villages, animals and the natural vegetation around the mine (described further in Section 1.3.1). The climatic conditions at the site will influence the potential for air dispersion (see Section 1.1.3). As a baseline, this section aims to identify existing ambient air concentrations that may be impacted by project emissions.

Data collection

For the approved EIA and EMP report (Metago, 2008) air quality data were identified through the review of available studies and the specialist's knowledge of the project area. A similar approach has been adopted for this report with the addition of available monitoring data from the mine.

Results

Regional Air Quality

The contribution of various sources of emission to ambient particulate and gaseous concentrations within the Rustenburg region is of interest given the elevated concentrations having been recorded in this region. The most significant sources located within the Rustenburg-Brits region include:

- Stack, vent and fugitive emissions from industrial operations - industrial emissions include various criteria pollutants (as SO_2, NOx, CO and particulates), greenhouse gases ($CO_2$and CH_4), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), various heavy metals and other toxins such as dioxins and furans. Industries in the region include three platinum smelter operations, viz.: Anglo Platinum Smelter Operation (Waterval Smelter), Impala Platinum and Lonmin (Western Platinum). Sources of emission at these operations typically include stack emissions, including main stack releases which comprise furnace and converter off-gases, acid plant stack emissions and releases from flash dryer stacks. The furnace and converter operations are also associated with significant fugitive emissions. Ferro-chrome industries situated in the region, include: the Xstrata (Rustenburg) and Xstrata (Wonderkop) operations, Merafe Ferrochrome and IFM. Furnace stack emissions, furnace fugitives and baghouse stack releases represent the main sources at these operations. The induction furnaces at Joerg Foundry (Trek Engineering) represent a smaller source of industry-related emissions.

- Stack emissions from boiler operations - boiler stack emissions include particulates, NOx, SO_2, CO, VOCs and CO_2. In addition to various smelter plants, boiler operations are also undertaken at Rainbow Chickens, Rustenburg Abattoir, MKTV Tobacco Limited, Rustenburg Provincial Hospital, British American Tobacco Products, Mageu Number One and Anglo Platinum Base Metals Refinery (BMR).
- Stack emissions from incineration operations - emissions include criteria gases (SO_2, NOx, CO, lead and particulates), acid gases (hydrogen chloride, hydrogen bromide, hydrogen fluoride), metal gases (chromium, arsenic, cadmium, mercury, manganese, etc.) and dioxins and furans. Incineration operations are undertaken at Anglo Platinum Precious Metals Refinery (PMR), with medical waste incineration occurring at Ferncrest Hospital.
- Fugitive emissions from quarrying and mining operations - comprising mainly dust releases, with small amounts of NOx, CO, SO_2, methane, CO_2 being released during blasting operations.
- Fugitive dust emissions from tailings impoundments which are associated with various mines in the region.
- Vehicle tailpipe emissions - significant primary pollutants emitted by motor vehicles include CO_2, CO, hydrocarbons (HCs), SO_2, NOx, particulate matter and lead.
- Household fuel combustion (coal, wood) - coal burning emits a large amount of gaseous and particulate pollutants including SO_2, heavy metals, total and respirable particulates including heavy metals and inorganic ash, CO, polycyclic aromatic hydrocarbons (PAHs), NO_2 and various toxins such as benzo(a)pyrene. Pollutants from wood burning include respirable particulates, NO_2, CO, PAHs, particulate benzo(a)pyrene and formaldehyde. Particulate emissions from wood burning have been found to contain about 50% elemental carbon and about 50% condensed hydrocarbons.
- Biomass burning - major pollutants from veld fires are particulates, CO and VOCs. The extent of NOx emissions depend on combustion temperatures, with minor sulphur oxides being released.
- Various miscellaneous fugitive dust sources, including: agricultural activities, wind erosion of open areas, vehicle-entrainment of dust along paved and unpaved roads.
- Ambient air pollutant concentrations within the Rustenburg region occur not only due to local sources but also as a result of emissions from various remote sources. Regionally-transported air masses comprising well mixed concentrations of 'aged' (secondary) pollutants are known to represent a significant component of ambient fine particulate concentrations within the South African interior. Such air masses contain pollutants released from various remote sources including elevated releases from distant industrial operations and power generation facilities and large scale biomass burning in neighbouring countries. Typical pollutants which circulate within such regionally-transported polluted air masses include nitrates, ammonium nitrate and sulphates.

Dust Fallout Monitoring at Tharisa Mine

Dust fallout is an indicator of the amount of dust generated over a period of time (measured per day as per South African National Standards (SANS)). It is therefore important to understand the status-quo as it will assist in determining whether the construction and operation of the project components will result in an increase in dust generation in the area as well as the related quantities. A dust fallout monitoring network was established at the mine in April 2009 and data available up to February 2011 was reviewed and interpretated by the air quality specialist (Airshed, 2014). The information has been supplemented with results from the 2012 and 2013 annual monitoring reports (SGS, 2012 and 2013).

In the Airshed report, dust deposition rates were evaluated based on the National Dust Control Regulations (NDCR) promulgated in November 2013, providing a residential limit of 600 mg/m²/day and a non-residential limit of 1 200 mg/m²/day, neither to be exceeded more than twice within a year or two sequential months. The SGS monitoring reports compared data to the SANS standards (1929:2011), where 300 mg/m²/day is the annual average target, 600 mg/m²/day is the residential action limit, 1 200 mg/m²/day is the industrial action limit, and 2 400 mg/m²/day is the alert threshhold.

A combination of residential and industrial sites are monitored by the mine. Where access was restricted, equipment stolen and not replaced or the site decommissioned to make way for mining activities, no data has been recorded.

For the 2009 to 2011 monitoring period, residential monitoring sites fell within the residential limit. Exceedances of the resideitial and non-residential limit were observed for sites within the mining rights boundary (Airshed, 2014).

For the 2012 monitoring period, 51% of total dustfall fell within the residential range. Alert dustfall accounted for 5% of total dustfall, while industrial and action accounted for 8%. No data occurred 28% of the time. Six sites [south of crusher within contractor plant footprint, Pelser – immediately east of TSF1, crushing plant - at west pit (this crushing plant no longer exists), waste dump at west pit, veld just north of west pit and south of Mmadithlokwa/Silver City and pink house just south of west pit] exceeded the SANS annual target of 300 mg/m^2/day (SGS, 2012).

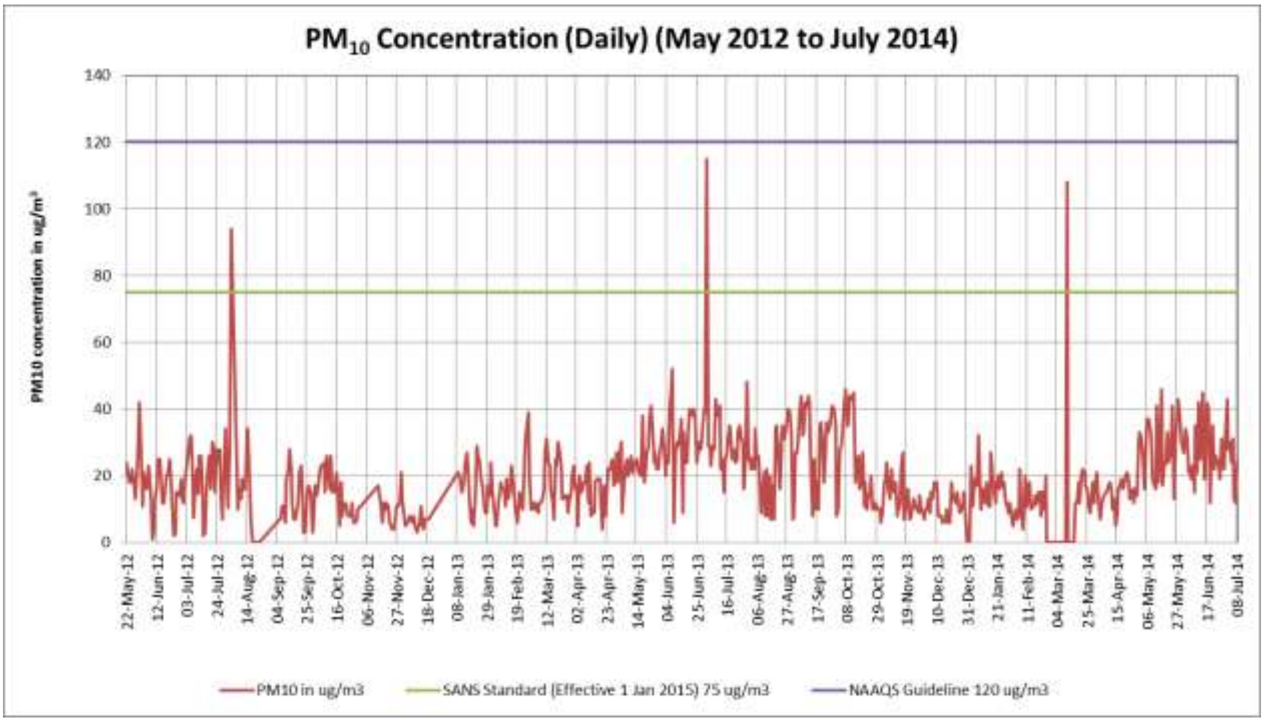
For the 2013 monitoring period, 76% of total dustfall fell within the residential range. Alert and action dustfall accounted for 0% of total dustfall, while industrial dustfall accounted for 5%. No data occurred 19% of the time. All monitoring sites complied with the SANS annual target of 300mg/m^2/day (SGS, 2013) (SGS, 2013).

PM$_{10}$ Monitoring at Tharisa Mine

Tharisa initiated PM$_{10}$ monitoring at the mine in May 2012. The location of the monitoring station is shown on Figure 1.11. Monitoring data from May 2012 to July 2014 has been included in this rpeort. PM$_{10}$ concentrations were evaluated against the national ambient air quality (NAAQ) standards (Table 1.28). The results indicate that for the said monitoring period, PM10 measurements were below the daily average NAAQ standard except for three occasions; one in July 2012, one in July 2013 and one in March 2014 (Graph 1). When compared to the annual averaging period, the annual average concentration was 16 µg/m³ (for 2012) and 21 µg/m³ (for 2013). As the 2014 annual montiroing period is not yet complete, it is not possible to provide an annual average for this period at this stage.

TABLE 1.28: NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Period	Limit Value (µg/m³)	Frequency of Exceedance	Compliance Date
PM$_{10}$	24 hour	120	4	Immediate – 31 Dec 2014
	24 hour	75	4	1 Jan 2015
	1 year	50	0	Immediate – 31 Dec 2014
	1 year	40	0	1 Jan 2015



GRAPH 1: DAILY MEASURED PM10 AT THARISA MINE

<u>SO_2 and NO_2 monitoring at Tharisa Mine</u>

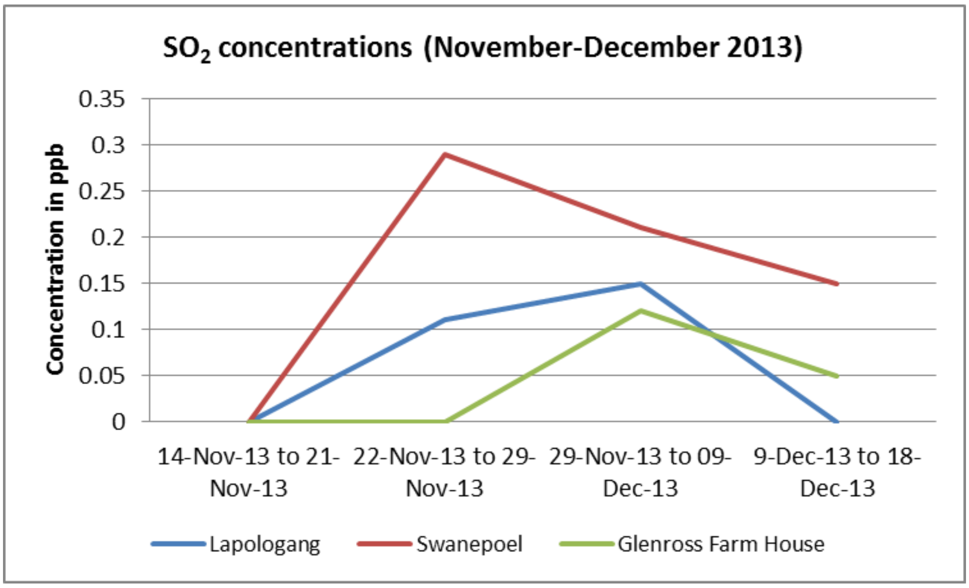
Tharisa undertook a sample run of SO_2 and NO_2 monitoring at the mine in November 2013. The location of the monitoring stations is shown on Figure 1.11. Monitoring data from 14 November 2013 to 18 December 2013 has been included in this report. SO_2 and NO_2 concentrations were evaluated against the national ambient air quality (NAAQ) standards (Table 1.29 and Table 1.30). The results indicate that for the said monitoring period, measurements for both SO_2 and NO_2 were below the standards (Graph 2 and Graph 3.

TABLE 1.29: NATIONAL AMBIENT AIR QUALITY STANDARDS FOR SO_2

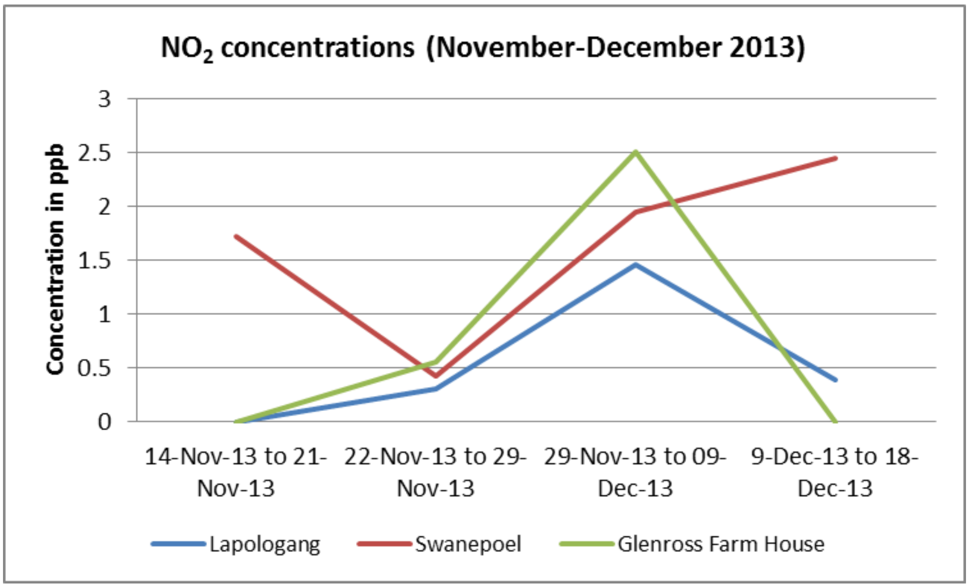
Pollutant	Averaging Period	Limit Value (µg/m³)	Frequency of Exceedance	Compliance Date
SO_2	10 minutes	500 (19ppb)	526	Immediate
	1 hour	350 (134ppb)	88	Immediate
	24 hours	125 (48ppb)	4	Immediate
	1 year	50 (19ppb)	0	Immediate

TABLE 1.30: NATIONAL AMBIENT AIR QUALITY STANDARDS FOR NO_2

Pollutant	Averaging Period	Limit Value (µg/m³)	Frequency of Exceedance	Compliance Date
NO_2	1 hour	200 (106ppb)	88	Immediate
	1 year	40 (21ppb)	0	Immediate



GRAPH 2: MEASURED SO_2 CONCENTRATIONS AT THARISA MINE



GRAPH 3: MEASURED NO_2 CONCENTRATIONS AT THARISA MINE

Potential Receptor Sites

Potential receptors include surrounding land owners, land users such as the school and farmers, settlements including Mmaditlhokwa/Silver City, Tsilong and Lapologang villages, animals and the natural vegetation around the mine.

Conclusion

Tharisa Mine is situated within a region with elevated ambient air pollution. Potential sensitive receptors do occur in the area surrounding the mine. Some of these receptors are located adjacent to the mining area. For the most part, the mine's monitoring programme indicates that for the activities that have occurred on site to date, dust fallout impacts are contained within the mining area and that the crushing facilities are the most significant contributor to dust levels. PM10, SO_2 and NO_2 monitoring results show compliance with current South African standards. The project components involve similar activities to those already taking place on site and therefore have the potential to contribute to ambient air quality. As a result, the project components must be carefully designed and managed to minimise their contribution to ambient air quality impacts.

1.1.9 NOISE BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008) and the updated noise assessment conducted at the mine (Acusolv, 2012) (Appendix H) and should be read with reference to Figure 1.13 (Section 1.4).

Introduction and link to anticipated impact

Activities associated with a project have the potential to cause an increase in ambient noise levels in and around the site. This may cause a disturbance to nearby receptors. Potential receptor sites include the surrounding land owners, land users such as the President van Rensburg/Piet Retief Primary School and farmers, settlements including Mmaditlhokwa/Silver City, Tsilong and Lapologang villages (described further in Section 1.4). As a baseline, this section provides an understanding of existing conditions in the area from which to measure changes as a result of project-related noise.

Data collection

Since no baseline ambient noise levels were measured prior to the mine start up (2008), efforts were made to ascertain quantative baseline data during a noise survey conducted between March and April 2009. For the current study, additional quantitative data collection was done between July and September 2012 (Acusolv, 2012).

Results

<u>Pre-mine environment</u>

Although the area around Tharisa had some rural elements, it was already subjected to elevated noise levels, mainly caused by the various mining operations in the area, road traffic and general community activities (including small business and farming). Despite this, in the absence of quantitative and site-specific measured data, a conservative assumption was made that the SANS 10103 noise levels for a rural environment would apply. It follows that the assumed noise levels were 45 dBA during the day and 35 dBA at night. This would not apply to impact zones associated with the N4 highway which would not be rural in nature.

<u>2009 survey results</u>

In the early stages of the mine development, Tharisa undertook a noise survey to monitor noise in the immediate surroundings of its mining zone; areas such as Buffelspoort where concerns had been raised by residents, as well as other areas further away. Three monitoring points were identified and monitored. These points were located as follows: a residential area in Buffelspoort, President van Rensburg/Piet Retief Primary School and the west end of the mining operations. The related survey results are outlined in Table 1.31 below.

TABLE 1.31: NOISE SURVEY RESULTS (2009)

Monitor Point	Area	Data class	Ambient noise Average level dBA		
			Day	Night	Day-night
M1	Buffelspoort	Baseline	53	50	57
		Mine operating	54	51	58
M2	President van Rensburg/Piet Retief Primary School	Baseline	47	44	50
M3	West end of mine	Baseline	50	42	51

The results from the survey indicated that the only area that was affected by noise from the mine appeared to be Buffelspoort, particularly those houses situated against the north-facing slope parallel to the N4. These were the houses nearest to Tharisa activities at the time (M3). Due to the proximity to the N4 highway, traffic noise levels were exceptionally high for an area which, on the surface, may still appear to be semi-rural. In the absence of Tharisa activities, road traffic noise levels averaged over an 8-hour night-time period were found to be 50 dB, which is 5 dB above the typical night-time level for Urban Districts, according to SANS 10103 ratings. This high background noise considerably raised the threshold above which mining noise becomes audible and disturbing.

Ambient noise levels at Monitoring Point M2 near the President van Rensburg/Piet Retief Primary School were considerably lower, yet still about 9 dB above the typical level for Rural Districts according to SANS 10103 ratings. In the absence of any audible noise from Tharisa or other mines, the night-time level of 44 dBA was caused predominantly by machinery and activity noise on the premises where the monitoring was carried out. In the absence of any noise from Tharisa Mine, the background ambient level at Monitoring Point M1 (“Spyker Redelinghuys” guesthouse) was found to be 42 dBA. This was caused by various noise sources on the premises, such as bird song and geese.

Based on the observations made and measurement results obtained in the course of the 2009 noise monitoring survey, the noise contribution of general mining noise from Tharisa was negligible. Reverse hooters were causing a noise nuisance in the Buffelspoort area.

Current (mine operational) environment

Based on noise measurements done in July and September 2012, the current (inclusive of the mine operations) ambient noise levels vary between 47 and 58 dBA during the day and between 40 and 53 dBA at night which is 8 dB above a typical night-time for urban districts and 18dB above a typical rural district (Table 1.32). In September 2012, Tharisa Mine shut down for a period of time, which enabled monitoring to take place without the influence of Tharisa’s noise sources. In this scenario, the ambient night-time noise level was 50dB, which is 5dB above a typical night-time for urban districts and 15dB above a typical rural district.

TABLE 1.32: SUMMARY OF NOISE MEASUREMENTS TAKEN IN 2012

Point	Location	Period	L_{AeqI} dBA	Comment	Survey period
M1	West pit immediate surroundings	Day	57	The main sources of audible noise that could be discerned from recordings made during the night: o Diesel engine noise of trucks and bulldozers o Occasional reverse alarm noise o Occasional livestock noises (pigs and poultry, cocks crowing) and barking on farmhouse premises o Traffic noise from the N4 approximately 2,3 km away was barely audible above local mining activity noise.	July 2012
		Night	52		
M2	Piet Retief/President van Rensburg School surroundings	Day	47	The main sources of audible noise that could be discerned from recordings made during the night: o Distant truck movements and diesel engine noise o Livestock and barking noises o Traffic noise from the N4 approximately 1,4 km away was barely audible above general mining and local noises.	July 2012 and September 2012
		Night	40		
M3	Closest third party residence to the plant (M Potgieter residence)	Day	56	The main sources of audible noise that could be discerned from recordings made during the night: o N4 traffic noise was the dominating source of noise throughout the night. o Truck noise on the D1325. o Plant and opencast mining noises were barely noticeable in the background o Occasional livestock noises and barking	July 2012 and September 2012
		Night	53		
M4	Area east and south-east of mine	Day	58	Monitoring station M4 was located at a farmhouse (Residence D Potgieter) situated about 1,5 km south-east of Tharisa Plant and 250 m south of the N4. Due to construction activities which were taking place throughout the night at and around the tailings facilities, diesel engine noise of trucks and what sounded like dozers, predominated and masked N4 traffic noise. Traffic noise was seldom audible above continuous bulldozer engine and dozing noise on the night-time audio recordings made at this location	July 2012
		Night	53		
M5	Silver City village (relocated Mmaditlhokwa village) boundary nearest to mine	Day	52	The dominant contribution to ambient noise in this area comes from trucks and other traffic on the D1325 provincial road. Thereafter, at a lower level, is noise from West Mine opencast operations.	September 2012
		Night	42		
M6	500 m south of plant, 100 north of berm	Day	52	Monitoring station M6 was located 500 m south of the plant, 100 m north of the berm. This location was selected, not to monitor ambient levels at any noise-sensitive receptors, but as a reference point for monitoring plant noise levels and for calibration of the predictive noise model. The difference between the level at this location (exposed predominantly to D1325 traffic noise) and the level measured at M3 (exposed to both N4 and D1325 traffic noise) gives an indication of the influence of N4 traffic noise on ambient levels in that area (7dBA).	September 2012
		Night	46		

Conclusion

The baseline noise surveys indicate that pre-mining ambient noise levels were higher than the anticipated ratings for a rural area and that Tharisa's mining operations at the time of the surveys in 2012 contributed to ambient noise in the area particularly during the night time period. In the approved EIA and EMP report (Metago, 2008), in the absence of quantitative data, ambient noise levels were assumed to be 45 dBA during the day and 35 dBA at night. This did not apply to impact zones associated with the N4 highway which would not be rural in nature. Based on follow up quantitative surveys in 2012, when the mine was on shutdown, the measured ambient night-time noise level was 50dB.

Noise sensitive receptors do occur in the area surrounding the mine, with some receptors located within the mining rights boundary and relative close to the mining area. In view of the discussion above, noise levels at nighttime are the most sensitive. The project components have the potential to contribute to noise levels and therefore need to be planned and designed in a manner that will avoid and/or limit increases in ambient noise levels.

1.1.10 VISUAL BASELINE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008), the specialist study undertaken for the north east waste roc dump (NLA, 2014) (Appendix I) and should be read with reference to Figure 1, Figure 2 and Figure 1.13 (Section 1.4).

Introduction and link to anticipated impact

Mining related activities have the potential to alter the landscape character of a site and surrounding area through the establishment of both temporary and permanent infrastructure. As a baseline, this section provides an understanding of the visual aspects (such as landscape character, sense of place, scenic quality, and sensitive views) of the area against which to measure potential change as a result of project infrastructure and activities.

Data collection

For the approved EIA and EMP report (Metago, 2008) data collection was accomplished through review of the 1:50 000 topographical maps, site observations and photos taken of the study area from key vantage points. This data was then evaluated qualitatively to provide a description of the visual resource. This information has been updated by SLR for the purposes of this study. In addition, a specialist study was conducted by Newtown Landscape Architects (NLA) to address the inclusion of the north east WRD.

Results

<u>Landscape character</u>

Tharisa Mine lies on a relatively flat plain with a gentle slope down to the north. The area is characterised by semi-industrial mining-related activities, open cast pits and agriculture. The natural environment within and around the mining right area has been extensively disturbed by past and current mining and agricultural activities. As such, mining activities and specifically residue facilities have become an integral part of the landscape topographical features and character.

The landscape character consists of gently rolling plains with singular and clusters of smaller koppies. The major topographical feature in the area is the Magaliesberg Mountain Range. The foothills of the mountain range lie approximately 1.6km south of the mine. The Sterkstroom, a perennial stream, bisects the mining rights area and flows in a northerly direction from the Buffelspoort Dam, located approximately 3.5km upstream of the mine. Several non-perennial drainage systems occur in the area.

The pre-mining vegetation in the area showed definite effects of mining and agricultural activities and bore little resemblance to the indigenous vegetation once found in the area. Although a large portion of the area has been transformed by various land uses and structures including the current mining operations, there are still scattered patches of natural habitat.

<u>Sense of place</u>

Tharisa Mine is located within a ‘mining belt’. The mining activities and related infrastructure as well as the immediately surrounding mining operations dominate the landscape characteristics of the area. To the east, a series of small koppies are evident and to the south, the Magaliesberg mountain range protrudes prominently above the flat plain. There are also surrounding residential settlements which feature in the landscape – refer to Figure 2.

The fact that the project components will take place within the current Tharisa Mine operations and the existence of the immediately surrounding mining activities, gives the area where project-related infrastructure is located a relatively weak sense of place (when the viewer is within the ‘mining belt’). However, seen in context with the site contained by distant hills, which ‘soften’ the harsh nature of the mining activities (when the viewer views the area from outside the ‘mining belt’), the larger area has a stronger sense of place. Taken together it can be said that the site has a moderate to weak sense of place.

<u>Scenic quality / Visual resource value</u>

The scenic quality is linked to the type of landscapes that occur within an area.The landscape quality of the study area can be divided into the following distinct categories in the local context:

- The landscape when experienced from within the flat areas of the ‘mining belt’ has a low aesthetic value.
- The landscape when experienced from beyond the flat areas or ‘mining belt’ has a moderate aesthetic value, where natural features tend to dominate the scene. In these areas the mining activities are ‘absorbed’ into the landscape due to the flat nature of the topography and the presence of many trees on the plains south of the mining belt.

- The Protected Natural Environment of the Magaliesberg constitutes an area with the highest aesthetic value due to its mostly intact natural features and its tourism potential.

As a whole, the study area has a moderate to low aesthetic value.

<u>Visual Context - Views</u>

Sensitive viewing areas

Tharisa Mine is visible from most of the communities that are located within and immediately around the mining right area as well as the general public that travels on the N4 between Pretoria and Rustenburg, the Marikana road (D1325) between Marikana and Buffelspoort and by people visiting parts of the Magaliesberg (Figure 2).

A number of farmhouses and smallholdings are located along the N4 and numerous local roads on, adjacent to and south of Tharisa Mine. The residential areas of Buffelspoort and Dassieklip are located south of the mine.

The most sensitive viewing areas are expected to be from surrounding residences and those along the Magaliesberg where tourism potential exists. Visitors to the Magaliesberg area would potentially have unobstructed distant views of the mine from vantage points.

Some of the project components will be visible from these same areas, with others shielded by the approved operations.

Non sensitive viewing areas

Most close up views would be from areas within the less sensitive mining belt to the west and north of Tharisa Mine. Views from within this area are not considered by the specialist to be critical with regards to visual impact. These views have either already been compromised by the current mining infrastructure and activities or will be obstructed due to the flat topography and scattered trees.

Conclusion

The landscape character and quality of the visual resource has been altered by various land uses including mining operations at and around Tharisa Mine. Views from residential areas as well as tourism potential areas have been altered since the establishment of the approved mine in 2008. Further disturbance by the addition of the project components needs to be minimised through appropriate design and implementation of mitigation measures.

1.2 ENVIRONMENTAL ASPECTS WHICH MAY REQUIRE PROTECTION OR REMEDIATION

Existing environmental aspects both on the site applied for and in the surrounding area, which may require protection or remediation due to project related components are listed below. This list is based on the concise descriptions provided in Sections 1.1 and 1.3.

- Stripped and stockpiled soils
- In-situ soils and land capabilities (not disturbed by project infrastructure)
- Biodiversity (not disturbed by project infrastructure)
- Perennial surface water resources
- Groundwater resources
- Ambient air qualities
- Noise environment
- Visual and landscape quality
- Surrounding land uses, socio-economic conditions and economic activity
- Heritage (and cultural) resources (not disturbed by project infrastructure).

1.3 LAND USE, CULTURAL AND HERITAGE ASPECTS AND INFRASTRUCTURE

A description of the specific land uses, cultural and heritage aspects and infrastructure on site and on neighbouring properties/farms is provided in this section. This section identifies whether or not there is potential for the socio-economic conditions of other parties to be affected by the project.

1.3.1 LAND USE

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008) and site observations by the SLR project team and should be read with reference to Figure 1, Figure 2 and Figure 1.13 (Section 1.4).

Introduction and link to impacts

Mining projects have the potential to influence current land uses both on the site (through loss) and in the surrounding areas (through direct or secondary positive and/or negative impacts). As a baseline, this section outlines pre-mining land uses, land tenure including surface and prospecting/mining rights (both on the site and in the surrounding area), describes the land uses on site and in the surrounding area, and identifies third party service infrastructure. This section provides the context within which potential impacts on land uses and existing economic activity will be felt.

Data collection

For the approved EIA and EMP report (Metago, 2008), surface right information was sourced by Metago (now SLR) through a deed search conducted at the time and supplemented with information from the mine. Information on existing prospecting/mineral rights was compiled with input from the mine and SLR's knowledge of the area. This information has been updated for the purposes of this study.

Information on land uses, presented in the approved EIA and EMP (Metago, 2008), was provided by the various specialist studies, observations during site visits and studying of aerial and satellite images. This data has been augmented by recent site observations made by SLR for the purposes of this study.

Results – Surface rights

Properties within the mining rights area are owned by the mine and a number of individuals/entities (Table 1.33). The project components will be located within the existing mining rights area. Tharisa is in the process of negotiating land purchase agreements with landowners where relevant.

TABLE 1.33: SURFACE RIGHTS

Note: This table does not represent all interested and/or affected parties (IAPs) registered on the IAP database but gives an indication of land ownership within the mining rights area.

Portion	Title Deed	Property Owner
Farm Name: Kafferskraal 342 JQ		
2	T67069/1995	Tharisa Minerals (Pty) Ltd
3	T38079/1994	
5	T64583/1996	
6	T14551/2006	
7	T76897/2005	
9	T43875/1982	
10	T41909/1990	M.M. Potgieter
11	T1717/2001	A.M. Cronje
12	T113316/2003	Real Time Inv 505 CC
13	T161962/2006	Tharisa Minerals (Pty) Ltd
15	T9685/1981	
16	T147657/2000	
19	T161962/2006	
20	T14551/2006	
22	T12642/2006	
23	T138104/2006	
25	T42329/1989	
26	T134912/1999	
27	T42329/1989	
28	T25210/1961	
29	T38157/2007	
30	T161962/2006	
32	T94260/2002	Western Platinum Ltd
33	T30047/1982	Tharisa Minerals (Pty) Ltd
38	T1842/1971	H.N. Janse van Rensburg
39	T4623/1994	Tharisa Minerals (Pty) Ltd
40	T92592/2007	
41, 47, 48	T161962/2006	
53	T61677/2006	
74	T147657/2000	

Portion	Title Deed	Property Owner
76	T38779/2006	
83	T11736/1993	Gekoop R.J. Smit
84	T11736/1993	Tharisa Minerals (Pty) Ltd
90	T142320/1999	
91	T42560/1981	
94	T29690/2001	
96	T14551/2006	
100	T23910/1985	Republiek van Suid Afrika
101	T36849/2006	B D van Rensburg
104	T85416/1995	Tharisa Minerals (Pty) Ltd
105	T42329/1989	
108	T42830/2005	
109	T114379/2003	Real Time Inv 505 CC
110	T79572/1997	P.H.C. Wolvaart
111	T064124/2011	Tharisa Minerals (Pty) Ltd
114	T25649/1982	
116	T92592/2007	
117	T161962/2006	
118	T42329/1989	
119	T22243/1973	M.J. Barnard
120	T1112/1985	Tharisa Minerals (Pty) Ltd
122	T61179/1989	
123	T3444/1948	
127	T57298/2001	Aquarius Platinum SA (Pty) Ltd.
132	T22243/1973	M.J. Barnard
133	T6182/1987	Tharisa Minerals (Pty) Ltd
135	T6613/1979	Anna C. Retief
137	T161795/2002	Tharisa Minerals (Pty) Ltd
138	T76897/2005	
139	T7863/1995	G.J.C. Pretorius
140	T156819/2002	G.M.J. Breedt
144	T59171/2001	T.J. Janse van Rensburg
145	T71659/2007	J.S. Vorster
146	T41909/1990	M.M. Potgieter
147	T1842/1971	H.N. Janse van Rensburg
148	T6075/2006	Tharisa Minerals (Pty) Ltd
149	T56494/1992	R.J. Labuschagne
150	T101570/1992	E.A.S. Strydom
151	T173614/2004	Western Platinum Ltd
152	T94702/2002	Tharisa Minerals (Pty) Ltd
153	T12496/1930	Laerskool President van Rensburg
154	T128885/2005	Harber Hermanus
155	T46830/1983	Republiek van Suid Afrika
156	T14717/1972	G.J. Smit
157	T37769/1978	G.J. Fouche
158	T17799/2007	B.D. Janse van Rensburg
159	T161626/2003	J.C.B. van Heerden
166	T22741/2006	Mohomed Faizal
175	T8350/1987	H.G. Pieterse

Portion	Title Deed	Property Owner
176	T7551/1949	R.J. Janse van Rensburg
182	T9761/1992	C.C. Henning
183	T14551/2006	Tharisa Minerals (Pty) Ltd
184	T6648/2001	
185	T102310/2005	
186	T11737/1993	
187	T96329/1993	
188, 189	T134912/1999	
190	T102045/2000	
191	T147657/2000	
192	T123083/2002	
193	T105214/2001	
196	T121794/2006	Lukas Olivier
205	T42329/1989	Tharisa Minerals (Pty) Ltd
206	T9685/1981	
207	T42329/1989	
208	T56342/1997	Cornelius van den Berg
209	T86042/2002	Western Platinum Ltd
211	T84739/1991	
212, 213	T161962/2006	Tharisa Minerals (Pty) Ltd
215	T38780/2006	Leonora Els
216	T9136/1974	Leonara Els
217	T38079/1994	Tharisa Minerals (Pty) Ltd
218	T33433/1974	
219	T85416/1995	
220	T3570/1983	
221	T11736/1993	
222	T30047/1982	
224	T592/2003	
225	T19566/2000	
226	T7857/1984	
227	T32266/1998	Rens Trust
229	T59680/2005	Tharisa Minerals (Pty) Ltd
230	T34253/1991	
233	T58999/1997	Gideon de Beer
234	T20862/2007	W. Vorster
235	T20863/2007	J.S. Vorster
236	T36849/2006	B.D. Janse van Rensburg
237	T6215/1987	P.C. van der Westhuizen
238	T110135/2001	M & M Hattingh Familie Trust
239	T89395/1997	H.N. Janse van Rensburg
240	T27622/1985	Tharisa Minerals (Pty) Ltd
241	T91335/2003	
242	T111592/2005	
243	T43875/1982	
250	T73731/1989	
251	T23627/2001	
253, 254, 255	T61895/2005	Western Platinum Ltd

Portion	Title Deed	Property Owner
256	T57231/1989	Tharisa Minerals (Pty) Ltd
257	T47390/1982	
259	T150882/2006	M.A. de Beer
260	T84739/1991	Western Platinum Ltd
261	T84741/1991	Western Platinum Ltd
262	T16452/1962	Tharisa Minerals (Pty) Ltd
265	T40635/1947	Republiek van Suid Afrika
266	T161962/2006	Tharisa Minerals (Pty) Ltd
276	T40767/1980	C.H. Grobler
283	T40815/2002	Tharisa Minerals (Pty) Ltd
285	T115263/2005	
286	T175765/2004	
289	T45714/2003	
297	T102910/2002	
298	T89395/1997	H.N. Janse van Rensburg
301	T514/1956	Dutch Reformed Church
303	T49542/2004	Tharisa Minerals (Pty) Ltd
304	T90087/2000	P.C. van Wyk
305	T18565/2001	G.J. Du Preez
306	T11709/1970	Tharisa Minerals (Pty) Ltd
307	T84739/1991	Western Platinum Ltd
314	T8044/1986	R.J. Smit
310	T45844/2007	Aquarius Platinum South Africa (Pty) Ltd
313/ 151	Consolidated into 151	Western Platinum ({Pty) Ltd
314	T100242/2008	Tharisa Minerals (Pty) Ltd
317	T6076/2006	Tharisa Minerals (Pty) Ltd
318	T161962/2006	
319	T117751/2005	
324	T58859/1981	
329	T8298/1988	
330	T57789/2007	Pierre Kleynhans
331	T45715/2003	Tharisa Minerals (Pty) Ltd
335	T57460/1993	Dabepie Beleggins CC
336	T5221/1991	Patatadraai Beleggings CC
342	T8176/2005	Tharisa Minerals (Pty) Ltd
344	T6704/1979	G.S. Du Toit
350	T40794/1996	W.C. Coetzer
352	T34366/1999	P.J. Schoeman
353	T89395/1997	H.N. Janse van Rensburg
354	T27562/2006	Wellem Vistor David
356	T19032/1984	Tharisa Minerals (Pty) Ltd
357	T49551/1984	
358	T117783/1996	A.W. Janse van Rensburg
361	T16345/1986	Tharisa Minerals (Pty) Ltd
362	T52112/1989	
368	T45843/2007	
370	T32396/2008	SANRAL
381	T25744/2010	SANRAL

Portion	Title Deed	Property Owner
Farm Name: Elandsdrift 467 JQ		
29	T130232/2006	M.M. Potgieter
64	T3799/2007	Tharisa Minerals (Pty) Ltd
69	T14756/2001	Montys Trust
89	T43379/1976	P M Coetzee
90	T100022/1993	Tinus de Beer
91	T31326/1982	Tharisa Minerals (Pty) Ltd
92	T27649/1981	
93	T115743/2001	Jannie Jacobz
94	T985/2006	Tharisa Minerals (Pty) Ltd
111	T3799/2007	Tharisa Minerals (Pty) Ltd
176, 177	T91044/2006	Tharisa Minerals (Pty) Ltd

Results - Right to mine

Tharisa holds a mining right (NW 30/5/1/2/3/2/1/358 MR) for the above-mentioned farms (Figure 2) for the following minerals: platinum group metals (PGMs), copper ore, nickel ore and chrome ore.

Third party prospecting/mining rights in the surrounding area are held by Aquarius, Lonmin, Samancor, and various individuals.

Results - Land uses

Prior to Tharisa, land use in the area was a mixture of farming, residential, mining, small business and general community activities. Similar land uses still take place adjacent to the mine infrastructure and activity areas. These are discussed further below.

<u>Residential and agricultural</u>

There are a number of land users that are actively involved in subsistence and/or commercial farming activities such as livestock, piggery, growing citrus fruits and vegetables in the vicinity of the mine. There are also land users who own small businesses such as accommodation (bed and breakfast places and lodges), shops and restaurants.

Due to overgrazing and subsistence farming practices by informal dwellers as well as the collection of vegetation mainly for firewood, parts of the area have been transformed by misuse.

Residential land use i.e. formal, informal and farmsteads is one of the main land uses near the mine. Communities and community structures include:

- Private land owners/residents
- Surrounding farms
- Lapologang village
- President van Rensburg/Piet Retief Primary School
- Mmaditlhokwa/Silver City (relocated settlement)

- Tsilong Village
- Various other clusters of land dwellers/informal settlements
- Lonmin's Marikana West housing development known as Lapolang Village
- Formal towns such as Marikana, Mooinooi and Buffelspoort.

Within Buffelspoort and to the south of the mine, there is a property development planned, known as Living Waters. The development is being planned as an eco-estate covering an area of approximately 11ha with provision for 102 residential units. It is understood by SLR that the development is in the final stages before proclamation (pers. comms Isabel Hough, Developer Project Manager). Proclamation is expected in September/October 2014.

There are also areas of interest around the mine. These include:
- The Protected Natural Environment of the Magaliesberg (3km south of the mine). This constitutes: an area with a high aesthetic value due to its mostly intact natural features and its tourism potential
- Rustenburg Town lies approximately 28km to the west
- Hartebespoort lies approximately 43km to the south east
- Sun City, which lies approximately 60 km to the north of the mine.

<u>Mining/ Industry</u>

Locally, there are several mining and mining-related activities occurring in the Marikana and Rustenburg areas. These include (Figure 2):
- Aquarius' Marikana Platinum Mine
- Lonmin Platinum's Karee Mine
- Lonmin Platinum's open pit
- Lonmin Platinum's Western Platinum Mine
- First Platinum (previously Salene B&S and Salplats mines)
- Anglo Platinum
- Xstrata Wonderkop
- Mamba Chrome Mine
- Samancor
- Various other small businesses (light industry, transport operations).

<u>Secondary support services/facilities</u>

Infrastructure present in the area is directly linked to the type of land uses occurring in the area as described above. Support infrastructure and facilities identified in the area include (Figure 2 and Figure 1.13):
- **Road network**: A network of roads exists in and around Tharisa Mine. These include:
  - N4
  - P2-4 (Old N4)

  - D2565 – a gravel road in the far western section of the area
  - D1526/1566 - the main gravel road servicing the western part of the area
  - D1325 – Marikana Road
  - D108 – road between Marikana and Rustenburg
  - internal Lonmin tarred road to the north of the area, that runs east – west
  - D2170 – a gravel road linking the eastern part of the area with Mooinooi
  - Various unnamed, private gravel/dirt roads.
- **Railway**: There is a railway siding at Marikana town to the north of Tharisa Mine and an associated railway line running in an east-west direction (Figure 1:).
- **Irrigation supply**: Infrastructure (pipes and canals) associated with the Buffelspoort Irrigation Board canals traverse various sections of the mine area in a south-north direction.
- **Power supply and communication**: A 275kV power line, and associated ESKOM servitude, cross through the eastern part of the mine area in a north-south direction, to the east of the eastern open pit (Figure 2). Smaller rural power lines and telephone lines currently service the residential areas within the western and eastern sections of the mine area.
- **Villages**: Within the towns and villages, there are varying degrees of infrastructure and service provision.

Conclusion

Through the development of the approved mine, land within the mining footprint has changed from a mix of agriculture and residential (including community activities) to mining. Land surrounding Tharisa Mine is mostly used for mining operations, crop farming, livestock grazing and general community activities. Land within the project footprints is mainly agricultural or transformed, with some pockets of natural vegetation and some private homesteads and associated structures (central waste rock dump footprint) . Residential areas surrounding the mine range from private farmsteads to villages of varying scales including a primary school. There is the potential for these land uses to be impacted by to varying degrees by changes to the mine's approved infrastructure and operations. As some of these land uses contribute to the economy of the region together with mineral-related activities, care should be taken when planning the project to limit impacts on these land uses. Third party service infrastructure does exist and care needs to be taken to avoid and/or manage these appropriately.

1.3.2 HERITAGE (INCLUDING CULTURAL) AND PALAEONTOLOGICAL ASPECTS

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008) and specialist heritage (Pistorius, 2007 and 2014) (Appendix K) and palaeontologcal studies (BPI for Palaeontological Research, 2012) (Appendix K) should be read with reference to Figure 1.12 (Section 1.4).

Introduction and link to impacts

Various natural and cultural assets collectively form the heritage. Heritage resources (cultural resources) include all human-made phenomena and intangible products that are the result of the human mind. Natural, technological or industrial features may also be part of heritage resources, as places that have made an outstanding contribution to the cultures, traditions and lifestyles of the people or groups of people of South Africa.

Mining related activities have the potential to disturb both the ground surface (through establishment of infrastructure) as well as soils and rock layers below the surface (through excavations for foundations and open pit mining). In this regard, heritage and palaeontological resources could be disturbed or destroyed. As a baseline, this section identifies the presence of heritage and palaeontological resources and their conservation significance.

Data collection

For the approved EIA and EMP report (Metago, 2008) heritage data was collected by an accredited specialist through the review of available databases, published reports and maps; previous studies done in the region; and site specific field work. A heritage study was conducted specifically for the north east waste rock dump area which involved the same desktop research and fieldwork approach.

A paleontological desktop study was conducted by an accredited specialist to determine the potential for the occurrence of paleontological resources within the mine area. The study involved reviewing of geological information and relevant paleontological research.

Results – Heritage (including cultural) resources

Heritage resources identified in the mining area are summarised in Table 1.34 (Figure 2.1). The most important heritage resources discovered in the area were stone walled settlements, graveyards, a historical village and homestead, mining heritage remains, isolated and randomly scattered stone tools, historical houses and outdated and discarded agricultural implements. Of relevance to the project components are three graveyards and historical structures that are located within the footprint of the central waste rock dump. Graveyards located within the east pit area are in the process of being relocated in line with the approved EIA and EMP (Metago, 2008). Tharisa has already commenced with the consultation process for the relocation of the graves with the relevant families/descendants.

TABLE 1.34: HERITAGE RESOURCES IDENTIFIED AT THARISA MINE

Site	Disturbed by approved activities	Disturbed by project components	Comments	Level of significance
Middle Stone Age				
General objects of heritage significance	Possible	Possible	Scattered throughout the study area. These were not geo-referenced as limited in number. They include implements relating to agricultural activities such as tractors, ploughs, threshing machines and other implements.	-
Late Iron Age (stone walled settlements)				
LIA01	No	No	Remains of stone sites occur in the far south-western corner of the project area. Many of these sites were destroyed over time to make way for agricultural activities. Some have been adapted to be used as a shelter.	High
LIA02	No	No		High
LIA03	No	No		High
Graveyards				
GY01	No	No	Principal graveyard.	High
GY02	No	Yes	Small graveyard, formerly known as the "presidential graveyard".	High
GY03	No	Could be affected	Five labourers' graves.	High
GY04	No	No	Ten squatter graves.	High
GY05	No	Yes	Four Van Rensburg's family members in unmarked graves.	High
GY06	Yes – consultation for relocation in procress	-	Approximately 70 graves in the Mmaditlhokwa village.	High
GY01X	Yes	Yes	Approximately 65 graves.	High
GY02X	No	No	Approximately 25 graves near the Sterkstroom River.	High
GY03X	Yes	Yes	Two piles of stone near the remains of a late Iron Age site.	High
Historical remains (older than 60 years)				
Tobacco drying shed	No	Yes	Located on Mr. Theuns van Rensburg's property (HC01.4)	High
Historical Complexes				
HC01.1	No – care should be taken when blasting is done	Yes	Constructed in 1860 after the first generation of "hartbeeshuisies" (clay dwellings with grass roofs)	High
HC01.2		Yes	Constructed in 1890 after the first generation of "hartbeeshuisies" (clay dwellings with grass roofs)	High
HC01.3		Yes	Constructed in 1935 when the agricultural practises flourished on the farm Kafferskraal.	High
HC01.4		Yes	Constructed in 1905 and associated with the historical tobacco drying shed.	High
HC02.1	Could be affected	Could be affected	Dates back from the 1930s and 1940s. Though altered extensively over the years, it still has its historical core.	High
HC02.2	Could be affected	Could be affected	Dates back from the 1930s and 1940s. Has not been renovated since then.	High
HC02.3	Could be affected	Could be affected	Dates back from the 1880s and not occupied any longer.	High
HC02.4	Could be affected	Could be affected	Dates back from 1930s and 1940s and has been renovated extensively.	High

Site	Disturbed by approved activities	Disturbed by project components	Comments	Level of significance
HC03.1	No – care should be taken when blasting is done	No – care should be taken when blasting is done	Dates back from the 1930s and has largely maintained its original architectural style.	High
HC03.2			Dates back from the 1930s and has had extensions backwards.	High
HC03.3			Dates back from the 1930s, has an associated outbuilding and renovated extensively.	High
Historical houses				
HH01	No – care should be taken when blasting is done	No – care should be taken when blasting is done	Dates back from 1936 and is associated with a rondavel and second outbuilding (possible garage)	High
HH03			Dates back to the 1930s and located next to GY01. Extensive alterations done.	High
HH02		Yes	This house is associated with a garage and an outside oven used to bake bread.	High

There are a number of churches within the mining right area. These churches include the following: The African Faith Mission (AFM), Uniting Reform Church (URC), New Earth Apostolic Church (NEAC) and Ts'enolo Apostolic Church (TAC) and many other apostolic churches whose members assemble at the various venues including private homes, schools and/or hired venues.

Results – Palaeontological resources

Igneous rocks of the Rustenburg Layered Suite of the Bushveld Igneous Complex underlie the mining right area. This is an intrusive igneous body comprising a series of ultramafic-mafic layers and a suite of associated granitoid rocks. As these rocks are Precambrian in age and are of igneous origin it is highly unlikely that fossils will be affected by any subsurface mining development.

Conclusion

Heritage resources of high significance have been identified within the mining rights area. Tharisa obtained a permit in terms of the National Heritage Act, 25 of 1999, for the exhumation and relocation of graves to be disturbed by the mining of the east pit.

Some resources of high significance occur within the extended footprint of the central waste rock dump. These include graves and houses of histricial significance. These sites are important to the history and culture of South Africa and are protected by national legislation. Any disturbance of these sites requires the necessary permits and further assessment work.

Although no paleontological resources are expected within the mining right area, these resources are protected by national legislation and must be reported to SAHRA should they be identified on-site.

1.3.3 SOCIO-ECONOMIC

Information in this section was sourced from the approved EIA and EMP report (Metago, 2008) and should be read with reference to Figure 1.13 (Section 1.4).

Introduction and link to impact

Mines have the potential to result in both positive and negative socio-economic impacts. The positive impacts are usually economic in nature with mines contributing directly towards employment, procurement, skills development and taxes on a local, regional and national scale. In addition, mines indirectly contribute to economic growth in the local and regional economies because the increase in the number of income earning people has a multiplying effect on the trade of other goods and services in other sectors.

The negative impacts can be both social and economic in nature. In this regard, mines can cause:

- Influx of people seeking job opportunities which can lead to increased pressure on basic infrastructure and services (housing, health, sanitation and education), informal settlement development, increased crime, introduction of diseases and disruption to the existing social structures within established communities;
- A change to not only pre-existing land uses, but also the associated social structure and meaning associated with these land uses and way of life. This is particularly relevant in the closure phase when the economic support provided by mines ends, the natural resources that were available to the pre-mining society are reduced, and the social structure that has been transformed to deal with the threats and opportunities associated with mining finds it difficult to readapt; and
- Relocation of all or parts of communities where the impacts associated with mines are deemed to be highly significant. While the intension of these relocation exercises is often to mitigate environmental impacts, the relocation can itself present a separate range of social, economic and environmental impacts.

To understand the basis of these potential impacts, a baseline situational analysis is described below.

Data collection

The approved EIA and EMP report (Metago, 2008) was informed by a social impact assessment study (Concession Creek Consulting, 2008) and the mine's draft social and labour plan. Socio-economic data was collected through the review of available databases and field observations. This has been augmented by SLR using data from the updated integrated development plans (IDPs) of the relevant municipalities.

Results

Tharisa's approved operations are located on the farms Kafferskraal 342JQ and Elandsdrift 467JQ. Both farms fall within the Bojanala Platinum District Municipality (BPDM). Kafferskraal 342JQ falls within the Rustenburg Local Municipality (RLM) while Elandsdrift 467JQ falls within the Madibeng Local Municipality (MLM).

North West Province

The socio-economic environment in the province can be summarised as follows:

- The North West Province has a population of approximately 3.2 million residents, with an average household size of 3.6.
- Provincilly it was estimated that, in 2009, the most dominant sector contributing to the North West Province's economy was the mining industry. This was demonstrated by 25% of the economically active population being employed in this industry. The sectors with the smallest contributions to the province's Gross Geographic Product (GGP) were electricity and water, as well as the transportation industry.
- It was estimated that the unemployment rate of the province in 2009 was 26% (presenting a similar profile to South Africa as a whole – with an unemployment rate of 25% in the same year).
- Ten percent (10%) of the working age population has had no formal education. Furthermore, only 18% of the total population in the province obtained a grade 12/matric education.
- The majority of the population's households have access to piped water, with only eight percent (8%) using alternate water sources (for example, boreholes, water vendors, wells, tankers, dams, rivers, streams). Approximately 46% of households with toilet facilities utilise pit or bucket latrines. Eight percent (8%) have no toilet facilities. In terms of households' dominant energy source, 86 % use electricity as the primary means for lighting. Refuse removal services are provided to most households, with a small percentage of the population (an estimated nine percent (9%)) not having any refuse disposal facilities.
- Within the province, it is estimated that 22% of the population reside in informal dwellings (with 15% of the population living in informal settlements and seven percent (7%) in backyards).
- Those with a tested HIV positive status account for approximately 13% of the province's population. In 2010, one percent (1%) of the entire province's residents died of AIDS related illness.

Bojanala Platinum District Municipality (BPDM) and Rustenburg and Madibeng Local Municipalities (RLM and MLM respectively)

The socio-economic environment at a municipal level can be summarised as follows:

- The population of BPDM is estimated to be 1 323 921. This is approximately 38% of the total population of the North-West Province. The north-eastern and the north-western areas of the district comprise scattered, low density settlements causing sprawl whereas the south western areas are characterised by concentration of settlements in strategic areas which are more compact. The more formal urban areas are located in the southern side of the district. These include Rustenburg and

Brits which are vibrant economic nodes. RLM is the largest municipality within the district, with a population concentration of approximately 36% and MLM constitutes 28% of the total population of BPDM. The average household size in BPDM is estimated to be 3.6, with RLM's average household size at 3.4 and MLM at 3.5.

- In 2010, approximately 66% of the BPDM residents constituted the working age population. Of these individuals, 19% had completed matric and 7% had received no formal education in line with the South African schooling system. This is a similar for the RLM, with 18% obtaining a matric certificate and 6% of the population with no schooling. Within the RLM, 71% of the population is of working age. In terms of MLM, 19.7% of its population obtained matric and 15.1% of the population has no schooling. Sixty-five percent (65%) of MLM is of working age.
- Mining plays an important role in the region's economy and is the district's major source of employment. It was estimated that in 2010 43% of the district's economically active population was employed in the mining sector. Fifty percent (50%) of RLM's economically active population was employed by this industry. In terms of MLM, 38% of its population is employed mainly in the manufacturing industry (18%), wholesale and retail trade (14.4%) and agriculture (13.7%). Mining in MLM is the fifth industry (12.2%). As reflected at a provincial level, the sectors with the smallest contributions to the province's gross geographic product (ggp) were electricity and water, along with transportation, agriculture and construction– all within the range of a 2 to 4% contribution.
- An unemployment rate of 25%, 20% and 27%, at the district and local municipal levels respectively, has been estimated for 2009.
- The area within district can be classified as rural with very low densities that make the provision of basic services very difficult and expensive. It is estimated that MPDM has the following dwelling types: formal- 64.1%, informal- 34% and traditional- .58%. RLM and MLM have high proportional and actual number of households residing in informal dwellings in the district. Within the RLM, it is estimated that as much as 41% of households are residing in informal dwellings (27% in informal settlements and 14% in backyards) and approximately 33% in the case of MLM (26% in informal settlements and 7.7% in backyards).
- From available information, it is estimated that approximately 54 962 of the households in the district have basic electricity. RLM accounts for 42.1% and MLM for 21.5% of it.
- Approximately 67% of residential consumers receive water above the minimum RDP standards and 33% below BPDM. Nearly 90% of all residential consumer units in the urban areas within BPDM receive water services at minimum RDP standards. The proportion of consumer units receiving water below RDP standards varies between 38.6% in the case of rural villages, 42.9% in dense rural settlements to as high as 58.9% in scattered settlements. The proportional figures in the MLM and RLM of consumers below RDP standards are 28.3% and 31% respectively.
- The amount of waste collected by the different municipalities within the BPDM as part of their legal mandate, has been estimated at 116 000 tonnes/annum. The municipalities collect less than half of the domestic and garden waste generated by the population as this collection figure includes for business waste in certain of the municipalities. Of the five local municipalities in the district, RLM and

MLM provide the greatest percentage waste collection and cleaning services to their communities, although less than 50% of these households do still not receive a service. This service is mainly provided in the urban areas and city centres within the local municipalities. Of the 22 operational landfills within the district (waste sites) identified, 10 are public sites and the remaining 12 are private sites. Five closed landfills were identified. Only 9 of the landfills have been permitted (7 private, 2 public), with two private landfills currently in the process of being permitted. R LM has 5 public landfill sites, 3 garden sites, 5 private landfills. M LM has 1 public landfill, 2 garden sites, 1 transfer station and 3 private landfills.

- Between 14 and 15% of the BPDM and RLM, respectively, have tested positive for HIV. Similar to the provincial level, 1% (one percent) of both the district and local municipalities' residents passed away from AIDS related illnesses.

<u>Local Village Level</u>

Aside from private land owners and their tenants, five settlements have been identified in and around the study area. This includes the villages of Mmaditlhokwa (also known as Silver City), Tsilong, Lapologang as well as the Buffelspoort and Elandsdrift residential areas (Figure 2 and Figure 1.13).. It is noted that the north-western section of Elandsdrift is referred to as "Mamba" by the local people and is located north of the Mambakop koppie.

The pre-mining socio-economic environment (2007/2008) at the local level is summarised below. This information is still deemed to be relevant as Mmaditlhokwa/Silver City was relocated to an area just north of the mine and most of the other settlements have remained relatively unchanged except where the mine has purchased properties needed for the development of its operations.

- Approximately 2727 people resided in the local area. Approximately 67% of the population is of working age (between 19 and 65 years).
- Only 31% of all children (aged between 1 and 18) recorded within the household survey received some form of education.
- Excluding the informal sector, the unemployment and/or not economically active rate was high at an estimated 50% of the economically active age. Mining is considered to be the major formal employment provider (approximately 52%). Income statistics indicate that 84% of households received less than or equal to R1 500 per month, and only 1% received more than R9 500 per month.
- Apart from the formal residences, the housing infrastructure was generally informal in their construction (mainly corrugated iron) and is largely ill equipped with basic services (water, electricity and sanitation). The farmhouses are an exception as they comprise mainly of cement brick homes.

Conclusion

When considering socio-economic impacts the statistical data reflects a community where there is unemployment, pressure on basic infrastructure and services and pressure on delivery of basic services (health, education, sanitation, water etc.). Employment, procurement, skills development and taxes increase the number of income earning people and has a multiplying effect on the trade of other goods and services in other sector, investment and social development.

With the development of Tharisa mine, there have been both positive and negative economic and social impacts (influx of people seeking job opportunities, a change to pre-existing land uses but associated social structure and meaning associated with these land uses and way of life). The aim of any project should be to enhance these positives and minimise the potential negatives.

1.4 MAPS SHOWING THE SPATIAL LOCALITY AND AERIAL EXTENT OF ENVIRONMENTAL FEATURES

Maps showing the spatial locality and aerial extent of all environmental, cultural/heritage, infrastructure and land use features identified on site and on the neighbouring properties and farms are referenced in the baseline description. These include:

- Geological structures (Figure 1.1)
- Wind roses (Figure 1.2 and Figure 1.3)
- Soils and land capability maps (Figure 1.4 and Figure 1.5)
- Biodiversity maps (Figure 1.6, Figure 1.7, Figure 1.8 and Figure 1.9)
- Surface drainage (Figure 1.10)
- Hydrocensus boreholes (Figure 1.11)
- Heritage Resources (Figure 1.12)
- Land use (Figure 1.13)

FIGURE 1.1: LOCAL GEOLOGICAL STRATIGRAPHY

FIGURE 1.2: ANNUAL AVERAGE, DAY-TIME AND NIGHT-TIME WIND ROSES

FIGURE 1.3: SEASONAL WIND ROSES

FIGURE 1.4: SOIL TYPES PRESENT IN THE AREA

FIGURE 1.5: LAND CAPABILITY OF SOILS IN THE AREA

FIGURE 1.6: NORTH WEST CRITICAL BIODIVERSITY AREAS

FIGURE 1.7: REGIONAL VEGETATION TYPES IN THE AREA

FIGURE 1.8: HABITAT UNITS AND AREAS OF BIODIVERSITY SENSITIVITY

FIGURE 1.9: WETLANDS IDENTIFIED WITHIN THE PROJECT AREA

FIGURE 1.10: FLOODLINES AND WATERCOURSE 100M OFFSETS WITHIN THE PROJECT AREA

FIGURE 1.11: HYDROCENSUS IN THE PROJECT AREA

FIGURE 1.12: HERITAGE RESOURCES IDENTIFIED AT THE MINE

FIGURE 1.13: LAND USE IN AND SURROUNDING THE MINE

1.5 SUPPORTING DOCUMENTS

The following specialist studies, undertaken as part of this project, are attached as appendices to this report:

- Soils and land capability study (Appendix D)
- Biodiversity studies (Appendix E)
- Hydrological assessment (Appendix F)
- Groundwater study (Appendix F)
- Air quality study (Appendix G)
- Noise study (Appendix H)
- Visual study (Appendix I)
- Heritage and cultural study (Appendix K)
- Palaeontological report (Appendix K).

2 PROJECT DESCRIPTION

OVERVIEW AND INTRODUCTION

The project comprises the following main components:

- Deepening and extending of the pits and related additional waste rock and tailings material storage
- A chrome sand drying plant within the concentrator complex
- Changes to the tailings storage facility design
- Re-shaping and re-alignment of waste rock dumps
- Partial backfilling of the open pits
- Changes to general surface infrastructure layout and operations at the mine.

Information on the changes is outlined in Table 2.1 below. The positions of these components are indicated in Figure 2.

TABLE 2.1: OUTLINE OF PROJECT COMPONENTS

Project components			**Data from approved 2008 EIA and EMP report**
Component	**Aspect**	**Details**	
Mining			
Deepening and widening of the open pits	High wall height	On average approx. 180m for both pits	120m for both pits
	Footprint	West pit extended by approx. 15 ha (total of approx.106.3ha) East pit extended by approx. 90ha (total of approx. 225.3ha)	West pit approx. 91.3ha East pit approx. 135.3ha
	Life of mine	Increased to 18 years	12 years
	Minerals to be mined	Remains unchanged	Platinum group metals (PGMs), copper ore, nickel ore and chrome ore found in the middle group (MG) seams
East Mine waste rock storage	Modifications to approved facilities	One consolidated dump (Eastern waste rock dump) <u>Footprint</u>: 78ha <u>Height</u>: approx. 70m (in 15m high lifts) <u>Volume</u>: 17.58 million m^3 (40.44 million tons of waste)	Two separate dumps East 1 and East 2 each with a footprint of 22ha and a volume of 5.89 million m^3
	Addition of new north eastern waste rock dump	<u>Footprint</u>: 95ha <u>Height</u>: approx. 70m (in 15m high lifts) <u>Volume</u>: 19.98 million m^3 (45.95 million tons of waste)	-
West Mine waste rock storage	Modifications to approved facilities	Western waste rock dump <u>Footprint</u>: 58ha <u>Height</u>: approx. 70m (in 15m high lifts) <u>Volume</u>: 23.2 million m^3	West 2: <u>Footprint</u>: 49ha <u>Volume</u>: 13.33 million m^3
		Central waste rock dump <u>Footprint</u>: approx. 70ha <u>Height</u>: approx. 70m (in 15m high lifts) <u>Volume</u>: 18.49 million m^3 (42.53 million tons of waste)	West 1: <u>Footprint</u>: 22ha <u>Volume</u>: 5.89 million m^3
Waste rock side slopes	All dumps	Not less than 1V:3H	1V:4H

Project components			Data from approved 2008 EIA and EMP report
Component	**Aspect**	**Details**	
Waste rock storm water control	All dumps	Dirty storm water to be contained within each of the WRD through benching and catchment paddocks	Settlement facility at each WRD
Rehabilitation	All dumps	Residual waste rock dumps will remain on surface at closure and properly rehabilitated.	Use of waste rock dumps to backfill the open pits, however any waste rock remaining on surface would be properly rehabilitated.
	Pits	Partial backfilling of the open pits with a final void remaining at closure	Complete backfill
Chrome circuit			
Addition of a chrome sand drying plant	Production capacity	25,000 tons / month	Not included
	Feed material	A portion of the wet chrome concentrate from the chrome plant	-
	Other resources needed	Coal or light fuel oil for heating purposes (approx. 475 tons per month)	-
	Product	Dried chrome stored in 1 ton bags in a covered storage area	-
	Emissions	Exhaust gas (NO_x, SO_2, CO, VOC's, PM_{10} and $PM_{2.5}$ – if diesel is used as the fuel source – this presents a worst case scenario) The chrome sand drying plant will be fitted with a baghouse to collect particulate matter.	-
Fuel storage and use	For chrome sand drying plant	Location: near to plant, within concentrator plant footprint <u>Volume</u>: approximately 460 m^3 storage volume required	-
Residue deposits			
Tailings storage facility design	TSF1	<u>Footprint</u>: 74ha <u>Height</u>: 40m <u>Volume</u>: 8.1 million m^3 Comprises two paddocks	<u>Footprint</u>: 52ha <u>Height</u>: 33m <u>Volume</u>: 5.4 million m^3 Comprised 1 paddock
	TSF2	<u>Footprint</u>: 130ha <u>Height</u>: 45m <u>Volume</u>: 22.7 million m^3	<u>Footprint</u>: 100ha <u>Height</u>: 31m <u>Volume</u>: 12.8 million m^3
	Items removed from design	Black turf under containment walls Low permeability liner along inside of TSF face Clay cut-off keys 1V: 3H of the outer slope	-
	Items added to the design	Toe drains on inside toe of TSF Seepage collection trenches 1:V: 2.5H of the outer slope	-
Support facilities / activities			
Concentrator complex	Plant layout	Orientation and layout of facilities within plant footprint optimised	-
	Storage of materials	ROM – 380 000 tonnes, PGM concentrate – 8 000 tonnes (in a shed), chrome product tonnes (total) – 160 000 tonnes, Met grade spiral product – 136 000 tonnes, chemical grade spiral product – 20 000 tonnes,	PGM ROM – 15 000 tonnes, chrome ROM – 10 000 tonnes, chrome product lumpy – 8000 tonnes, chrome chips – 8000 tonnes, Met grade spiral product – four x 8000 tonnes,

Project components			Data from approved 2008 EIA and EMP report
Component	**Aspect**	**Details**	
		foundry grade – 4 00 tonnes (in a shed) All of these stockpiles will be open air stockpiles in concrete bunded areas	chemical grade spiral product – two x 2000 tonnes, mill feed – 4000 tonnes. All of these stockpiles will be open air stockpiles in concrete bunded areas
Water management	Water supply and storage	A review of water supply options to meet the mine's requirements taking into consideration supply availability and costs as well as changes in water storage dams.	-
Waste management	General and hazardous waste	Waste to be sorted and temporarily stored at source prior to removal for disposal	Provision for salvage yard areas within mine
Transport	Truck parking area	Near to the mine entrance comprising a one-way road for queuing/parking trucks with a gravel parking area of approximately 1ha	Not included
	Traffic volumes	Negligible change in traffic volumes.	Vehicle movements (arrivals and departures) per day – 6 days a week: Staff: 140/day Product: 320/day for chrome and 8/day for PGM Other: 17/day
Soil screening berms	Eastern topsoil storage	Orientation changed Final height: between 10 and 30m	Noise berm to the south of the concentrator complex with a height of between 5 and 10m
	Western topsoil storage	Location changed to screen the school and properties to south west Final height: between 10 and 30m	Noise berm to the south of the western operations with a height of between 5 and 10m
		Stockpile added north of West Mine Final height: between 10 and 30m	-
Mining contractor facilities	Fuel depot Salvage yard Workshop and yard	One central area with supporting services and facilities Located adjacent to concentrator plant (within the original plant footprint)	Separate facilities located at the East and West Mines
Diverted D1325	Minor re-alignment	Due to the deepening of the pit and position of the high wall as well as the training camp	-
Training	Training centre	Training related to induction programs, equipment training, core skills. Located north of the mine	-
Workforce	Additional workforce	A maximum of 100 jobs during construction and 35 during operations comprising a combination of contractors and current workforce, where possible	-

2.1 MINERALS TO BE MINED

The target minerals being mined include platinum group metals (PGMs), copper ore, nickel ore and chrome ore found in the middle group (MG) seams. These will remain unchanged for the project.

2.2 MINING METHODS TO BE USED

This section should be read with reference to the site layout drawings (Figure 2.1).

2.2.1 MINING OPERATIONS – OPENCAST MINING

Tharisa is an opencast mine. The opencast mine comrpsies two sections namely the East Mine and West Mine (Figure 2.1). The two sections are separated by the Sterkstroom River and the D1325 (Marikana) road.

The mining method at Tharisa comprises a standard open pit truck and shovel method. A mining contractor is employed to conduct the mining activities. The same mining method will be used for deepening the pit and increasing the height of the high wall.

Access to the mining face is by means of haul roads and boxcuts with ramps. Steady state open pit dimensions will differ between the east and west sections because of the varying dip of the target ore body. In the western section, the dimensions are expected to be 360m wide, 1km in length along the outcrop with a final high wall averaging at approximately 180m. On the eastern section, the dimensions are expected to be 580m wide, 1km in length along the outcrop with a final high wall averaging at approximately 180m. The general mining direction is north.

Key activities associated with the mining method, sourced from the approved EIA and EMP report (Metago, 2008), are described below.

- **Removal of topsoil**

  All topsoil is dozed into stockpiles along the low wall (outcrop) sides of the open pits.
- **Drilling and blasting**

  Once the topsoil is removed the area is drilled as per the drill design. Charges are designed to prevent excessive ground vibration, airblast and fly rock. The remaining overburden and the ore is drilled and blasted together. The blast design is modified from time to time in order to optimise grade and minimise dilution.
- **Removal of waste rock/overburden**

  The removal of waste rock/overburden above the ore body is done as a bulk operation by load and haul with large equipment. The material is placed on the pit extremities for the rehabilitation of the final voids.
- **Removal of ore**

  Prior to the ore removal, the top of the reef horizon is cleaned. The footwall is then swept to ensure that all the fines are recovered.

- **Rehabilitation**

  Rehabilitation is concurrent with mining. Waste rock/overburden will be used to backfill voids where required. Overburden material will be used to cater for any settlement. Once the backfill material has settled, topsoil will be placed on top of the overburden and vegetation will be re-established.

With respect to final voids and residual waste rock dumps, mine planning has changed and as such it is anticpated that there will be residual waste rock dumps and a final void at each pit at closure. Any voids that do remain at closure will be made safe in line with the requirements of the DMR. No surface subsidence is expected as measures will be implemented to prevent and rectify this. Any residual waste rock dumps will be rehabilitated according to the mine's conceptual closure plan.

2.2.2 MINERAL PROCESSING OPERATIONS – CONCENTRATOR COMPLEX

Approved operations

The mineral processing operation comprises a concentrator complex. The concentrator complex caters for two streams, namely platinum group metals (PGM) and chrome, to accommodate the different characteristics of the Middle Group (MG) ore seams that are mined. The PGM plant processes run of mine (ROM) from the MG2, 3 and 4 seams and produces PGM comcentrate. The chrome plant processes ROM from the MG1 and MG4A seams and produces chrome concentrate. The target production figures for the plants are approximately 40 000 tonnes of PGM concentrate per year; and approximately 1.5 million tonnes of chrome concentrate per year (2008 EIA and EMP report).

The PGM concentrate is taken by truck to the surrounding smelters in the region. The chrome concentrate is taken by truck to the Marikana Railway Siding where it is transported by rail to Richards Bay.

Chrome sand drying plant

Tharisa is proposing to feed a portion, approximately 25,000 tons per month, of wet chrome concentrate through a chrome sand drying plant to be located near to the chrome stockpiles on site prior to transport off site.

The wet chrome concentrate will be fed by front-end loader to a conveyor feeding a drier feed bin. From the feed bin, it will be fed into the static fluid bed drier where it will be dried by a stream of hot gas blowing through a perforated plate. The hot burner gas will be mixed with air to achieve the correct drier gas temperature. The moisture-laden exhaust gas will be drawn off the top of the drier chamber and ducted to gas cleaning cyclones and a bag filter to remove particulates before discharge to atmosphere. The dried chrome will be discharged from the drier and fed to a similar static fluid bed cooling unit. The dried and cooled product will then be conveyed to a storage bin, from where it will be packaged into 1 ton bags, stored in a covered storage area and loaded by forklift onto trucks for dispatch.

As for the current concentrator complex, the chrome sand drying plant will operate continuously (24 hours per day).

The plant will make use of approximately 475 tons of light fuel oil and/ or coal per month. Approximately 460 m^3 of diesel or fuel oil will be stored in the concentrator plant area. The exhaust gas volume will be approximately 64,000 Am^3/hr at 110^oC. There will be trace amounts of SO_2 and CO_2 in the off gas due to combustion of fuel. The plant will not produce any liquid or solid waste streams.

2.3 LIST OF MAIN ACTIONS/ACTIVITIES/PROCESSES FOR THE PROJECT

Key activities during each phase (construction, operational, decommissioning, closure) are listed in Table 2.2 below. This section focuses on the project components only and does not include actions/activities/processes already approved for the mine. Given that the project components relate mainly to optimising approved mining activities, no real aternatives exist for the project (Section 2.8). Supporting information is provided in Section 2.7.

For the purposes of this report, in broad terms, construction is the phase in which infrastructure is established, operation covers the production phase, decommissioning covers infrastructure removal and site rehabilitation, and the closure phase refers to the period of time when maintenance and aftercare of rehabilitated areas and facilities is required to ensure closure objectives are met.

2.4 PLAN SHOWING LOCATION AND EXTENT OF OPERATIONS

A site layout of the mine and project components is provided in Figure 2.1.

TABLE 2.2: LIST OF ACTIONS / ACTIVITIES / PROCESSES RELEVANT TO THE PROJECT COMPONENTS

Main activity/process	Project actions	Construction of project components	Operation	Decommissioning	Closure
Site preparation	Selective bush clearing in areas where infrastructure will be established	As required	-	-	-
	Removal of existing pre-mining structures such as fencing (if present)	As required	-	-	-
Earthworks Relates mainly to the moving of soil and rock	Stripping and stockpiling soil resources in line with Tharisa's soil management programme	Ongoing	As required	-	-
	Bulldozing activities	Ongoing	Ongoing	-	-
	Establishing and maintaining temporary access tracks	Ongoing	Ongoing	Ongoing	-
	Foundation excavations and compaction	At start of phase	As required	-	-
Civil works Relates mainly to any steel and concrete work	General building activities and erection of structures	At start of phase	For maintenance	-	-
	Steel work (including grinding and welding)	At start of phase	For maintenance	-	-
	Installation of cables/lines and pipelines (process)	As required	For maintenance	-	-
Exploration Exploration will take place to refine the extent of the ore reserves.	Drilling of boreholes using truck-mounted, diesel powered core-recovering drilling machines	On-going	On-going	-	-
	Trenching	On-going	On-going	-	-
	Collection of samples and analysis off-site	As required	As required	-	-
Open pit mining	Drilling and blasting for deepening and widening of the pits	-	Ongoing	-	-
	Loading and hauling	-	Ongoing	-	-
	Dewatering ahead and during the open pit mining operations	-	Ongoing	-	-
Waste rock management	Storage on waste dumps (on-site, on surface)	-	On-going	-	-
	Control of stormwater within boundaries of waste rock dumps	-	Ongoing	Ongoing	-
	Final disposal on waste dumps (on-site, on surface)	-	Ongoing	Permanent	Permanent
Mineral processing operations	Existing concentrator plants and capacities to be used to produce PGM and chrome concentrate	-	Ongoing	-	-
	Chrome sand drying plant:	-	Ongoing	-	-
Tailings management	Delivery of tailings from concentrator plant via pipelines (existing facilities to be used)	-		-	-
	Final disposal on a dedicated TSF	-	Ongoing	-	-

Main activity/process	Project actions	Construction of project components	Operation	Decommissioning	Closure
Resource use	Use of water (sourced from same sources that are planned for the current mine)	As required	Ongoing	-	-
	Power will be sourced from existing Eskom supply (average use of 25kW during construction and 300kW for the operation of the chrome sand drying plant)	Ongoing	Ongoing	Until facilities are no longer needed	-
Process and storm water management	Diversion of clean water around sites (where applicable) in line with stormwater management plan	Ongoing	Ongoing	Until facilities are no longer needed	As required
	Collection of potentially dirty water in line with stormwater management plan	-	Ongoing	Until facilities are no longer needed	-
Transport systems	Use of access points to the mine	Ongoing	Ongoing	Until facilities are no longer needed	As required
	Construction, use and maintenance of truck parking area and access loop to plant	-	Ongoing	-	-
	Vehicle movement to and from mine for material, staff, waste removal and product (via surfaced and gravel roads)	Infrequent *±5 abonormal loads* Ongoing *±66 light vehicles*	Ongoing *±1 tanker per week* *±44 light vehicles*	Ongoing	Infrequent
	Vehicles/machinery movement within mine boundary (via surfaced and gravel roads) (increase in volumes expected)	Ongoing	Ongoing	Ongoing	Infrequent
General and hazardous waste management	Handling and storage of general and hazardous waste at project sites in line with waste management procedure	Ongoing	Ongoing	Until facilities are no longer needed	-
Sewage sludge management	Provision and maintenance of portable sanitation facilities at construction sites (cleaned and serviced twice a week by a contractor)	Ongoing	-	-	-
	Existing sewage plant to be used – no additional capacity needed.	-	-	-	-
Site support services	Existing support services at the mine will be used, no additional requirements are identified for the project	-	-	-	-
Site/contract management	Appointment of contractors and workers	At start of phase and ongoing	At start of phase and ongoing	At start of phase	-
	Site management (monitoring, inspections, maintenance, soil stockpile management, alien invasive management, security, access control)	Ongoing	Ongoing	Ongoing	As required

Main activity/process	Project actions	Construction of project components	Operation	Decommissioning	Closure
	Environmental awareness training and emergency response	Ongoing	Ongoing	Ongoing	As required
	Ongoing rehabilitation of facilities/disturbed areas (where possible)	Ongoing	Ongoing	Ongoing	-
	Implementing and maintaining management programmes	Ongoing	Ongoing	Ongoing	-
Demolition *(unless alternative end land use is identified during the detailed closure planning)*	Dismantling and demolition of all infrastructure (where applicable)	-	-	As required	-
	Removal of all equipment	-	-	As required	-
Rehabilitation	Removing infrastructure	-	-	As required	-
	Replacing soil resources	-	-	As required	To correct subsidence
	Partial backfilling of the open pits with waste rock	-		As required	To correct subsidence
	Landscaping and slope stabilisation	-	-	Ongoing	-
	Re-vegetation of areas where infrastructure was removed	-	-	Ongoing	As required
	Restoration of natural drainage patterns as far as practically possible	-	Ongoing	Ongoing	For maintenance
	Rehabilitation of access tracks unless alternative end land use is identified	-	-	As required	-
	Initiation of aftercare and maintenance.	-	-	At end of phase	-
Maintenance and aftercare	Maintenance of vegetation in rehabilitated areas	-	-	-	As required
	Maintenance of facilities (such as fencing, fire breaks, access roads and ramps, overflow structures)	-	-	-	As required
	Removal of any invasive species from the rehabilitated sites	-	-	-	As required
	Repair of erosion gullies	-	-	-	As required

FIGURE 2.1: THARISA MINE LAYOUT SHOWING PROJECT CHANGES

2.5 LISTED ACTIVITIES IN TERMS OF NEMA EIA REGULATIONS

The listed activities, in terms of the NEMA Regulations, which are relevant to the project components are listed in the table below. As both basic assessment (R544) and full scoping and EIA (R545) related activities are triggered, a full scoping and EIA process in terms of the 2010 EIA Regulations has been followed.

TABLE 2.3: NEMA LISTED ACTIVITES RELEVANT TO THE PROJECT COMPONENTS

Activity Number	NEMA Listed Activity	Description of activity
Notice 544, 18 June 2010		
11	The construction of infrastructure or structures where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line. (Footprint thresholds for jetties, slipways, buildings, infrastructure or structures must exceed 50 square metres in size)	The north east waste rock dump will be developed over two non-perennial drainage lines. The western waste rock dump will encroach on a non-perennial tributary . The applicability of this activity to the extension of the east pit requires input from the decision-making authority.
13	The construction of facilities or infrastructure for the storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of 80 but not more than 500 cubic metres.	Facilities for the storage and handling of 460 m^3 of dangerous goods (diesel or heavy fuel oil).
18	The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from: (i) a watercourse	The north east waste rock dump will be developed over two non-perennial drainage lines. The Western waste rock dump will encroach on a non-perennial tributary.
Notice 545, 18 June 2010		
5	The construction of facilities or infrastructure for any purpose or activity which requires a permit in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent and which is not identified in Notice No. 544 of 2010 or included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case that Act will apply.	The project includes a chrome sand drying plant, which requires an air emission license (AEL) and changes to the TSF and WRDs which may require an amendment of the mine's water use license (WUL).
15	Physical alteration of undeveloped, vacant or derelict land for residential, retail, commercial, recreational, industrial or institutional use here the total area to be transformed is 20 hectares or more.	Changes to the central and western waste rock dumps, the open pits, the TSFs, addition of the north east waste rock dump and addition of topsoil stockpiles and other support facilities will result in the alteration of undeveloped and vacant land with a footprint greater than 20ha.
26	Commencing of an activity, which requires an atmospheric emission license in terms of section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), except where Activity 28 in Notice No. R. 544 of 2010 applies.	The project includes a chrome sand drying plant, which requires an air emission license (AEL).
Notice 546, 18 June 2010		
14	The clearance of an area of 5 hectares or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation (Applicability depends on geographical area and environmental attributes)	The development of the north east waste rock dump will result in the clearance of indigenous vegetation, however most of the footprint is either agricultural or transformed and therefore this activity is no longer deemed applicable.

In addition to the above it is important to note that since the start of this process, the eastern waste rock dump has subsequently been built and therefore this component is excluded from the NEMA process but still remains part of the MPRDA process. A Section 24G application will be submitted to address this non-compliance.

2.6 INDICATION OF PHASES AND TIMEFRAMES

An indication of the phases and estimated timeframes in relation to the main actions, activities or processes and infrastructure is provided in Table 2.2 above.

The timing of the main project components is provided in Table 2.4 below

TABLE 2.4: TIMEFRAMES OF THE PROJECT COMPONENTS

Aspect	**Timeframe**		
	Start	**Duration of construction**	**Life of facility / activity**
Deepening of the pit and related additional waste rock and tailings material storage	From 2019	Not applicable	For the life of mine
Chrome sand drying plant	Construction: May 2017	3 – 6 months	For the life of mine
Re-shaping and realignment of waste rock dumps	Completed within the approved footprint		
Change to the design of the tailings storage facility (TSF 1)	Completed (within the mine boundary		
Change to the design of the tailings storage facility (TSF 2)	August 2014	3.5 to 4 years	12 - 14 years
Other support changes	Already in place or still to be established	As required	For the life of mine

2.7 ADDITIONAL INFORMATION

This section provides additional technical information relative to mine and project components.

2.7.1 MINING CONTRACTOR AREA

The mining contractor area incorporates offices, workshops, stores, diesel (approximately 300 000 litres) and lubricant (approximately 100 000 litres) handling and storage facilities, hard park areas, pollution control measures, water management infrastructure, change houses, ablution facilities and security and access control.

2.7.2 TRANSPORT SYSTEMS

2.7.2.1 Road

Pre-mining there was an existing network of roads servicing the area. These include:

- the N4 between Brits and Rustenburg
- the D1325 between the N4 and Marikana
- the D108 between Marikana and Rustenburg
- a number of gravel roads including: the D1526/ D1566 and the D2565 which service the communities to the west of the Sterkstroom, the D2170 which service people to the east of the project area towards Mooinooi, and the local bridge over the N4 on the eastern side of the project area.

The approved EIA and EMP (Metago, 2008) made provision for changes to road infrastructure, additional roads and access points. These changes included:

- Internal haul roads for the mining operation constructed from suitably sized and compacted waste rock – these are in place
- A permanent amendment to the alignment of a section of the D1325 – still to be implemented
- Three access points off the D1325 with an upgraded road design, stop controls on the side roads only and no stops on the D1325:
  - formal access to the eastern part of the mine site in two places (to the north and south of the open pit) on the D1325 – temporary stops on the D1325 have been established at these access points in consultation with the relevant roads authority
  - formal access to the western part of the mine via the D1526 – this has been replaced by a dedicated entrance from the D1325 to avoid mine trucks travelling through the relocated Mmaditlhokwa/Silver City
- An additional diversion option around Marikana on the D1325 for trucks transporting product to the Marikana siding – still to be implemented
- Potential closure of the local bridge that crosses the N4 and the associated gravel road that runs between the mine site and the residential areas to the south of the N4 and the east of Buffelspoort – this bridge and road has been closed
- Temporary deviation of the D1526 gravel road that runs through the western part of the mining area between the D1325 and the Retief/President van Rensburg School – still to be implemented.

In addition to the above:

- Tharisa has constructed a truck parking area near to the mine entrance. The parking area comprises a one-way road (700m long x 8m wide) for queuing/parking trucks that wait to enter the plant and the main gravel parking area of approximately 200 x 50m. These facilities will operate 24-hours a day. Trucks that will use this facility include the double-trailer 'interlink' type trucks of 22m in length. There is space for 28 trucks to park in the queuing road and 50 trucks in the main parking area. The trucks access the plant from the truck park by crossing the Marikana road (D1325) public road at a 4-way stop constructed at the plant truck entrance. It is estimated that approximately ten trucks will travel from the truck parking area to the plant per hour.

- A minor re-alignment to the approved road diversion is proposed to cater for the extension of the East mine open pit.

2.7.2.2 Railways

The nearest railway is to the north of the mine at the Marikana Siding. Railway transportation of product is the preferred option for the mine. The siding has been upgraded in consultation with Transnet to cater for Tharisa's requirements.

2.7.2.3 Pipelines

A network of pipelines transport potable water to and recycled/process water within the mine site. All pipelines are either be below surface or raised 50cm above ground.

2.7.2.4 Conveyor systems

The approved EIA and EMP (Metago, 2008) makes provision for a conveyor system to transport crushed ROM from the western part of the mine to the concentrator complex. The conveyor would cross the Sterkstroom by means of a bridge structure and go through a culvert under the D1325 road. The conveyor would be equipped with wind protection sides, would be 1.2m above ground and would have a width of approximately 1.2m. This conveyor system has not been established and instead trucks transport ROM directly from the pit to the ROM pad at the plant.

2.7.3 POWER SUPPLY

Power at the mine is sourced from Eskom. From the mine's on-site substation, power is distributed throughout the mining operations via 11kV lines. No additional power requirements are needed for the project. No changes to the power supply are required for the project.

2.7.4 WATER MANAGEMENT

2.7.4.1 Water Supply and use

Water at the mine is sourced from local ground water via abstraction from a wellfield developed by the mine and from the western irrigation canal of the Hartebeespoort dam irrigation system. Tharisa has also secured an allocation from Rand Water through an agreement with Samancor. In terms of the agreement, the total maximum quota to be supplied is 2,666,000 kilolitres per month.

The approved EIA and EMP (Metago, 2008) also makes provision for water to be purchased from other mines in the region that have excess water and new pipeline initiatives of the Rustenburg Joint Water Forum although these options have not been fully investigated at this stage.

In line with its purchase of properties with irrigation rights from the Buffelspoort irrigation scheme, Tharisa has the option of applying for the transfer of its existing water allocation from the Buffelspoort dam from agricultural to industry/ mining water. This option has not been exercised, however it remains a possibility for the mine. Should Tharisa decide to pursue this option, the following criteria would need to be considered:

- the sustainability of both the resource and the supply
- impact on existing water users which would include a census of users relevant to Tharisa's aplication
- water saving and recovery
- water quality
- economic considerations including affordability.

As part of the project the mine's water balance has been updated by SLR. This is presented below.

2.7.4.2 Water balance

A site wide water balance model has been prepared for average wet and dry seasons at the mine (Figure 2.2 and Figure 2.3, respectively) (SLR, 2014a). The water balance model covers the follows aspects of the operation:

- Groundwater seepage into the pits
- Stormwater runoff from dirty water catchments collected within containment ponds and returned for re-use within the mine
- Abstraction from the Buffelspoort irrigation canal
- Abstraction from the well field
- Process water requirement of the concentrator plant
- Return water from the TSF
- Storage of water during times of excess water and use of this water in the dry season.

The results show that during an average wet season, no abstraction from the Buffelspoort irrigation canal is required, abstraction from the well field is 3 064 m^3/month and 166 351 m^3/month of surplus water can be stored for re-use during the dry season. During an average dry season, an average of 151 744 m^3/month will be released from storage for re-use within the processing plant, 6 347 m^3/month will be abstracted from the well field and no abstraction from Buffelspoort irrigation canal will be required. It should be noted that surplus water is stored over five months of the year and released from storage over seven months of the year, therefore the average wet and dry season (average of the wettest / driest three month periods) inflows and outflows from storage are not equal (SLR, 2014a).

The total water requirement of the mine is 4 358 451 m^3 per year, 86 821 m^3 of which is abstracted from the well field and the remaining amount is sourced from groundwater seepage into the pits (1 323 786 m^3) and runoff from dirty catchment areas (2 539 653 m^3).

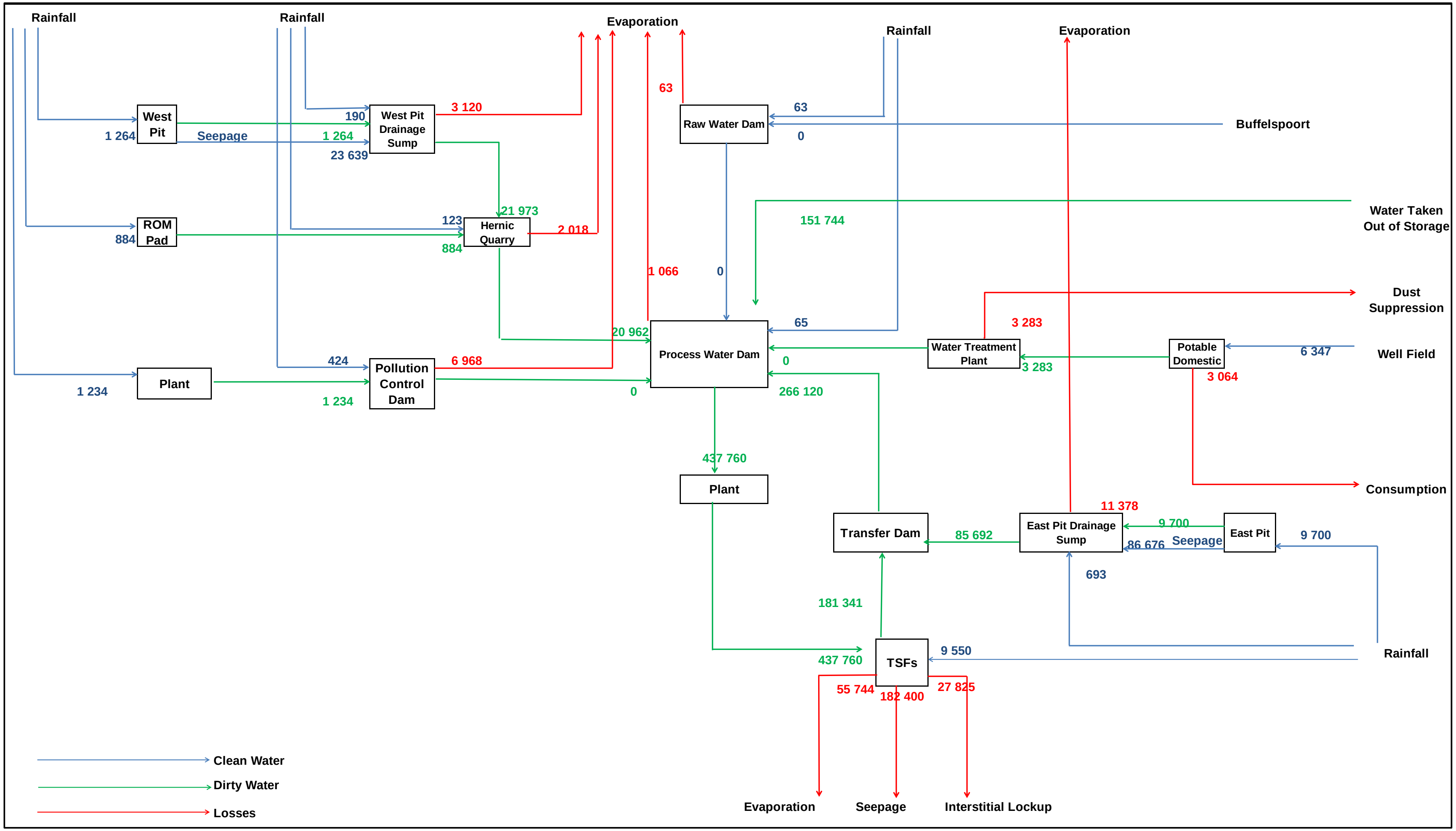


FIGURE 2.2: WATER BALANCE – AVERAGE DRY SEASON

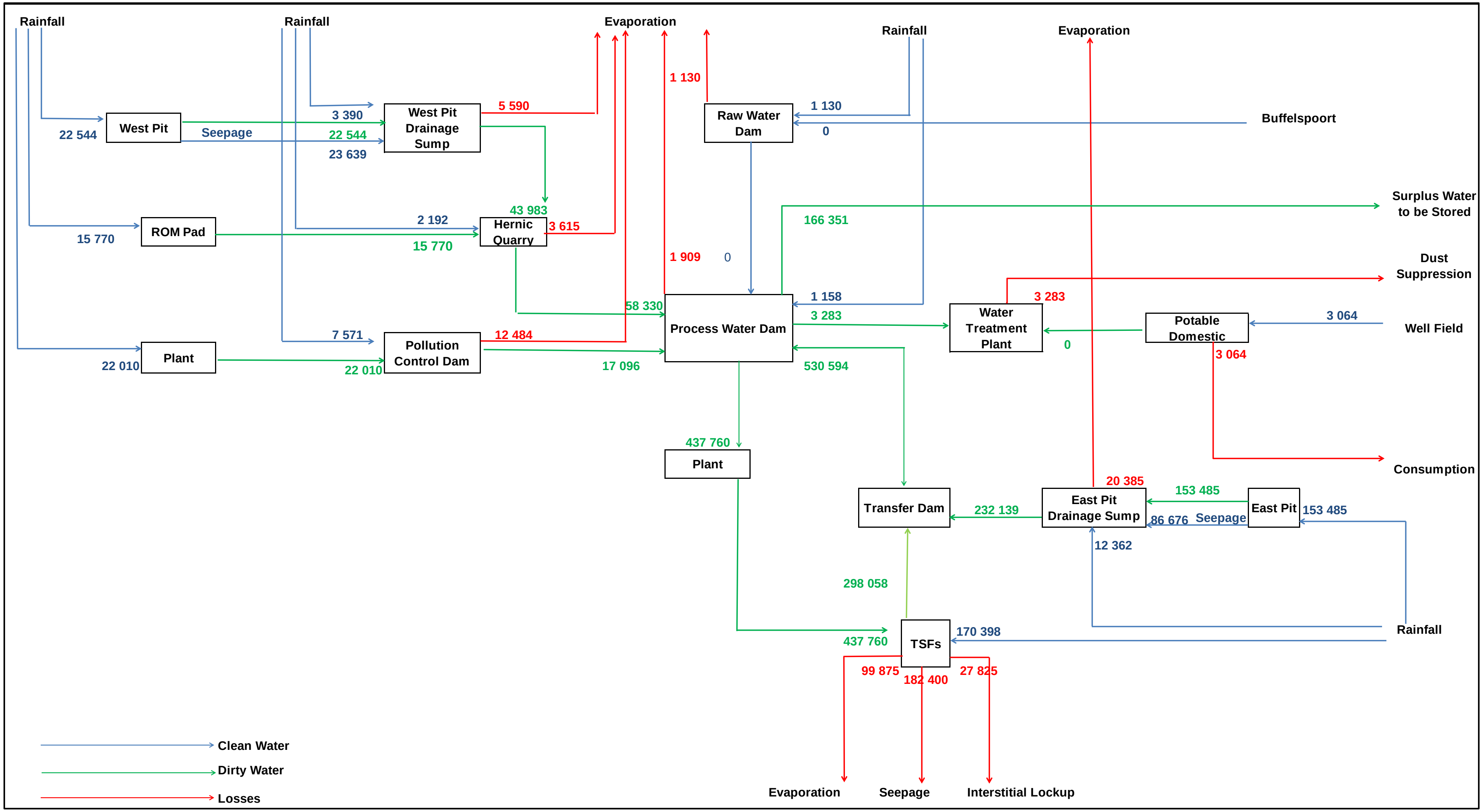


FIGURE 2.3: WATER BALANCE – AVERAGE WET SEASON

2.7.4.3 Water holding facilities

The approved EIA and EMP (Metago, 2008) made provision for the following permanent water holding facilities at the concentrator complex: two raw water (make up) dams (96,000 m^3 each), a dirty process water dam (24,000m^3), a dirty storm water dam (60,000m^3) and temporary transportable pit dewatering facilities. Details on the tailings water holding and return water system have been described in Section 2.7.6. Water holding facilities at the mine are outlined in Table 2.5.

TABLE 2.5: WATER HOLDING FACILITIES AT THARISA

Dam	Capacity
Raw Water Dam	44,000m^3
MCC Dam	40 000m^3
Plant Stormwater Dam	30,000m^3
Hernic Quarry	250 000m^3
Process Water Dam	25,000m^3

TABLE 2.6: WATER HOLDING FACILITIES DESIGN PRINCIPLES

Feature	Detail
Diversion	The upstream embankments of each dam form a clean water diversion where applicable.
Topsoil Stripping	Topsoil within the dam footprint areas will be stripped and stockpiled in accordance with the topsoil conservation guide. A stripping depth of 500mm has been recommended by the soils study.
Lining	Composite liner to all dams comprising: • 1.5 mm HDPE liner, overlying; • 150mm compacted clay liner; • Leakage detection system to intercept leak in HDPE liner.
Embankments	All inner side slopes 1V:3H All outer slopes 1V:2.5H
Leakage Detection	160mm diameter perforated drainex pipe in a gravel bedding wrapped in geotextile connecting to individual sumps outside the footprint of each dam. Leakage detected through inspection of sumps.
Access and Access Control	4m wide waste rock road to the storm water dam along pipeline route. Barbed wire perimeter fence around each dam with gates as required.
Drown Prevention Facilities	4 manilla ropes in each corner of dam for humans. 2 life rings for each dam.
Settling Facility	A silt trap will be required upstream of the storm water dam.
Emergency Spillway	Each dam to be provided with a spillway of adequate width to ensure controlled spilling during extreme storm events (greater than 1:50year).

Feature	Detail
Monitoring and Maintenance	Daily monitoring to include: • Water levels • Operation of pumps and pump motor control systems Monthly monitoring to include: • Inspection of leakage detection sumps • Pumping flow rates between, from and into the various dams • Physical inspection for damage to liner • Level of silt in storm water dam silt trap Quarterly monitoring: • Groundwater pollution (borehole) monitoring as for TSFs • Pumping flow rates between, from and into the various dams De-silting (either mechanically or hydraulically using slurry pumps) of the storm water dam silt trap will be required occasionally. Silt to be disposed of on the TSFs.
Contingency Plans	In the event that leakage is detected in any of the dams apart from the storm water dam, the dam should be emptied by pumping water to the storm water dam. In the event that leakage is detected in the storm water dam, the dam should be emptied by pumping water to the process water dam. Once the cause for the leakage is located in the empty dam, the leak must be repaired and tested prior to filling with water. In the event that the downstream borehole monitoring indicates possible pollution, the incidence should be investigated by a specialist to identify: • Possible leakage from pipelines • Possible undetected liner leakage • Possible alternative source of pollution • Appropriate action should be implemented to prevent further pollution and if necessary, clean up the existing plume
Closure	Water dams will be removed and the land rehabilitated unless a suitable post-closure use for the dams can be identified. All plastic liners will be removed. It is probable that the water dams will be suitable for use as part of the artificial recharge system possibly to be developed in the backfilled open pits.

2.7.4.4 Polluted water treatment facility

Apart from the sewage plant described in Section 2.7.5, the only other water treatment facility is linked to the borehole water supply for potable water. No polluted water treatment facility is required for the project.

2.7.4.5 Storm water management

A conceptual level Stormwater Management Strategy for the mine was developed as part of the approved EIA and EMP (Metago, 2008) and has been updated to cater for changes in mine infrastructure as presented in this report. A summary of the key design features is presented below (SLR, 2014a):

- Clean stormwater will be diverted around mine infrastructure and, where possible, routed towards existing watercourse(s) or conveyed into the veld
- Wherever possible, the footprint of dirty stormwater catchment areas will be minimised by isolating these areas from clean water run off using bunds and/or channels
- Stormwater from the surface of the TSF facility is pumped to the process water dam for re-use

- Stormwater from the side slopes of TSF1 will drain towards the eastern pit
- Stormwater from the side slopes of TSF2 will drain into the return water dam
- Stormwater from the plant area will drain via channels to the existing plant stormwater dam which will overtop via an existing channel taking excess flow to Hernic quarry
- Stormwater from the run of mine pad will drain via channels to Hernic quarry
- Stormwater from the MCC area will drain to the existing MCC dam, excess flow will be conveyed to Hernic quarry
- Stormwater from the plant stormwater dam, MCC dam and Hernic Quarry will be transferred to the process water dam for re-use in the plant
- Stormwater and groundwater collecting within the pits will be pumped via Hernic Quarry to the process water dam for re-use in the plant
- The topsoil berms will be allowed to re-vegetate, to reduce erosion and prevent silt from washing into nearby watercourses
- Rainfall and runoff from the WRDs will be contained within benches and paddocks and allowed to infiltrate or evaporate (in accordance with Epoch WRD design reports)
- All stormwater channels are designed to prevent clean water coming into contact with potential pollution sources (including waste rock and tailings) and therefore shall be lined channels.

The design of stormwater drainage measures for the TSFs are included as part of the TSF design and is assumed to be fit for purpose and compliant with relevant best practice standards. Stormwater within the pits will naturally move towards the lowest point of the excavation and therefore no formal channels are sized within either of the pits.

The north eastern WRD is situated across the pathway of two non-perennial watercourses which flow towards the north, and if not mitigated will block these flow pathways and lead to ponding of stormwater (runoff from a 200ha (2km^2) catchment) against the side of the WRD and cause flooding of the land to the south of the WRD. Options to manage stormwater in this area are outlined below. A final decision on the preferred option has not yet been made.

- Diversion Channels – from a review of the topography in this area, it appears possible that flows can be diverted around the western and eastern ends of the WRD and re-routed back towards the existing channel. A more detailed review of the hydraulic gradients is required. To maintain a steady gradient the footprint of the WRD may need to be revised (discussed further below). It is likely that runoff from a residual catchment (approximately. 27ha) will remain below the level of any diversion channels and will not be possible to divert, runoff from this residual catchment will still pond against the WRD.
- Allow Ponding – where no risks associated with ponding of water to the south of the WRD are identified, it may be possible to allow runoff to pond and rely on evaporation and infiltration of water after a storm event. It is recommended that the extent of ponding be identified by a water balance

model which considers runoff inflows against infiltration and evaporation losses to estimate the maximum likely volume of water, respective water level and lateral extent of ponding in this location.
- Enhanced Infiltration – measures to encourage infiltration of runoff to groundwater could be installed along the southern side of the WRD to prevent ponding in this locality, for example French drains, or a number of boreholes installed into permeable ground.

SLR determined indicative containment volumes required to store dirty stormwater generated by the dirty water catchments at the mine (SLR, 2014a). Comparison of the existing dam volumes with the recommended containment volumes illustrates that whilst the MCC dam is of sufficient size, the plant stormwater dam is insufficient to contain the required volumes. This does not take into account the storage of any process water. It should be noted that volumes calculated in the specialist report are indicative only, and as R704 requires that dirty water containment facilities are designed, constructed, maintained and operated so that they are not likely to spill into a clean water environment more than once in 50 years, a critical component in sizing the containment pond is the rate at which water is pumped out of dams for re-use at the mine.

FIGURE 2.4: CONCEPTUAL STORMWATER MANAGEMENT PLAN

2.7.5 NON-MINERALISED WASTE MANAGEMENT

2.7.5.1 Domestic and industrial waste

There are no on-site waste disposal facilities and none are planned for the project. Domestic waste from the proposed project will be collected, compressed and then transported to a municipal dump at Rustenburg or Mooinooi. Hazardous waste will be collected and transported back to suppliers for recycling or by a waste disposal company to the Holfontein waste site in Springs, Gauteng. Domestic and industrial wastes will be removed from site on a monthly basis as a minimum.

The types of waste that will be generated by the mine are summarised in Table 2.7. The complete waste management programme is included in Section 19.

TABLE 2.7: INDUSTRIAL, HAZARDOUS AND DOMESTIC WASTES

Waste Type	Method of temporary storage
First aid clinic	Designated sealed containers in covered store
Laboratory chemicals	Designated sealed containers in covered store
Scrap metal	Open air scrap yard and salvage yard
Building rubble	Open air scrap yard
Used oil and grease	Drums in bunded store/collecting sump
Packaging for hazard material	Sealed containers in bunded store
Chemicals/chemical contaminated containers and material	Sealed containers in bunded store
Vehicle parts	Open air scrap yard
General industrial, non-hazardous waste	Designated skip
General domestic, non-hazardous waste	Designated skip
Sewage sludge	Drying beds and then used for rehabilitation
Sewage screenings	Sealed container in bunded store

2.7.5.2 Sewage treatment facilities

The sewage treatment plant is a modular system which makes it highly flexible in its design capabilities. It is currently designed for an anticipated peak of 1500 personnel thus capable of handling sewage and waste water from the plant change house, offices and ablutions and the mining change houses and office areas. The design capacity is in the order of $300m^3$/day with a design peak flow of $25m^3$/h.

The treatment plant consists of:

- a front end buffer tank
- 4 modular units consisting of a diffused bubble aeration compartment (biological reactor) with membrane diffusers, a static up-flow clarifier, return activated sludge system and scum system;
- a chlorine dosing back end tank
- a modified lockable container containing the electrical panel, blowers and chlorine dosing pumps
- concrete/brisk drying beds.

Each of the 4 modular units, being 2.4m wide, 10m long and 3m deep, are prefabricated in the workshop and transported to site for easy installation together with the modified marine container and the modular unit and HDPE tanks.

The 50m^3 front end galvanised modular mild steel buffer tank allows for fluctuations in feed to be absorbed when required such as during shift changes when peak shower water is expected.

The blowers provide the oxygen to the aeration compartment and are supplied complete with filters, pressure gauges, pressure relief, isolation and return valves. The blower units are contained together with the electrical panel and chlorine dosing unit and pump in the lockable modified marine container.

The raw sewerage and waste water flows into the screening unit which by manual rake means allows for the regular removal of non sewerage items (such as plastic bags) before passing into the buffer tank. It either overflows or is lifted by chopper pump in the reactor compartment. Here it mixes with the activated sludge in the reactor compartment. The micro organisms feed on the organic pollutants. The micro organisms are kept alive, multiply and thrive through the supply of oxygen by means of blowing air through fine bubble diffusers in the reactor compartment. The circulation allows for continuous mixing and homogenous treating. The activated sludge on top enters the clarifier where denser particles settle out and are either returned to the front of the reactor compartment to assist in further breakdown of the organic matter in the reactor compartment or when sufficient, pass to the concrete and brick drying beds.

The clear effluent remaining after the denser particles have settled in the clarifier flow over v notches to a chlorine contact channel where between 2% and 5% solution of HTH is dosed to kill the remaining bacteria. After 20 minutes of contact in the 15m^3 HDPE chlorine contact tank, the water will be returned to the process water dam for use in the plant process.

The dried and treated sludge will be used for vegetation establishment on the tailings dam side slopes and for other areas needing rehabilitation.

All screened out material is collected in sealed containers and disposed as hazardous waste.

2.7.6 MINE RESIDUE DISPOSAL

Waste rock and tailings is produced by Tharisa Mine. In both cases the environmental classification was such that there could be potentially significant impacts associated with the facilities, but with mitigation, as included in the EMP of the approved report, the impacts could be mitigated to an acceptable level.

The project components make provision for changes to these facilities. These are discussed below.

Waste rock

Waste rock from the open pit mining operations has been used in the construction of the TSF containment walls, mine haul roads and as general backfill for various platforms. These uses would continue where required. Waste rock will also be used in the backfilling of the open pits on an advancing front basis once the pits have been developed sufficiently.

Excess waste rock is stored in waste rock dumps. The approved EIA and EMP report (Metago, 2008) made provision for four waste rock dumps. The project components make provision for changes to these as well as the addition of a waste rock dump. The changes to these facilities are outlined in Table 2.8. Design details from the approved EIA and EMP report (Metago, 2008) that have remained unchanged are outlined in Table 2.9.

TABLE 2.8: OUTLINE OF CHANGES TO THE WASTE ROCK DUMPS

Project components			**Data from approved 2008 EIA and EMP report**
Component	**Aspect**	**Details**	
East Mine waste rock storage	Modifications to approved facilities	One consolidated dump (Eastern waste rock dump) Footprint: 78ha Height: approx. 70m (in 15m high lifts) Volume: 17.58 million m^3 (40.44 million tons of waste)	Two separate dumps East 1 and East 2 each with a footprint of 22ha and a volume of 5.89 million m^3
	Addition of new north eastern waste rock dump	Footprint: 95ha Height: approx. 70m (in 15m high lifts) Volume: 19.98 million m^3 (45.95 million tons of waste)	-
West Mine waste rock storage	Modifications to approved facilities	Western waste rock dump Footprint: 58ha Height: approx. 70m (in 15m high lifts) Volume: 23.2 million m^3	West 2: Footprint: 49ha Volume: 13.33 million m^3
		Central waste rock dump Footprint: approx. 70ha Height: approx. 70m (in 15m high lifts) Volume: 18.49 million m^3 (42.53 million tons of waste)	West 1: Footprint: 22ha Volume: 5.89 million m^3
Waste rock side slopes	All dumps	Not less than 1V:3H	1V:4H
Waste rock storm water control	All dumps	Dirty storm water to be contained within each of the WRD through benching and catchment paddocks	Settlement facility at each WRD
Rehabilitation	All dumps	Residual waste rock dumps will remain on surface at closure and properly rehabilitated.	Use of waste rock dumps to backfill the open pits, however any waste rock remaining on surface would be properly rehabilitated.

TABLE 2.9: DESIGN DETAILS FOR THE WASTE ROCK DUMPS

Feature	Conceptual Design Detail for the WRDs
Waste Rock Transport and Deposition	Excess open pit waste rock loaded onto mine dump trucks and transported to WRDs. Waste rock access ramps constructed with a maximum gradient of 1V:7H (8°) for mine dump trucks. Waste rock is then dumped and spread / flattened with a bulldozer.
Storm Water Diversion	Storm water trenches and berms around the upstream boundaries of the WRD's that direct clean storm water run-off around and away from the WRDs.
Topsoil Stripping	Topsoil in WRD footprint areas will be stripped and stockpiled in accordance with the topsoil conservation guide. A stripping depth of 500mm has been recommended by the soils study. Stripping and stockpiling of topsoil will be done in advance of dumping.
Under Drains	No under drainage will be provided.Surface run-off and toe seepage will be channelled to a silt trap/sediment pond before being released to stream and/or returned to the process plant for re-use in the mine water circuit (see Section 2.3).
Lining	No lining will be provided in addition to the in-situ black clays or turf found at surface. The low permeability clays will reduce infiltration of leachate from the waste rock to the ground water.
Embankments	Nominally compacted earth training or toe walls around the perimeter of each WRD will delineate the extent of each dump footprint to control dumping. Constructed using local clay or topsoil. WRD developed at overall outside slope of 28 degrees. Compaction limited to vehicle traffic on top surface and ramps.
Access and Access Control	Mining haul roads will have a minimum width of 25m and will be constructed using waste rock. A 4m wide waste rock road will be constructed around the perimeter of each dump for routine inspections and maintenance of the catchment paddocks. A perimeter fence around each WRD is not planned. Rather a perimeter fence around the whole of the mine site will be installed.
Waste Minimisation	Some 11 million m^3 of waste rock will be used for the construction of the TSF containment walls and mine internal and haul roads during the life of mine. The opportunity also exists to crush and sell waste rock as building aggregate.
Monitoring	Monitoring of seepage water retained in the perimeter catchment paddocks and of boreholes around the perimeter of each WRD to determine pH, EC, TDS, NO_3, Ca, Mg, Fe, Mn, Na, Cl, K, SO_4, HCO_3, PO_4, Cr (VI).
Dust Control	Operational Phase: Watering of roads for dust suppression. Post Operational Phase: No measures necessary due to the coarse particle size distribution.
Closure (if waste rock stockpiles /dumps exist at closure)	WRD side slopes will be flattened to 1V:4H, and re-vegetated using a combination of indigenous trees, shrubs, grasses and aloe species etc. to mimic the vegetation cover of natural topographical features in the area. Topsoil stripped prior to development will be used to provide the growth medium. Topsoil will be placed in bowls excavated on the top surface and side slopes of each dump. The vegetation will be irrigated initially until it is no longer dependent on artificial irrigation for survival. Final catchment paddocks constructed of durable waste rock materials covered with a clay layer to be provided. The catchment paddocks will be vegetated in a manner similar to that stated above to blend in to the natural Bushveld. The catchment paddocks will be sized to contain run-off from a 1:100 year 24hr duration storm event and will be provided with an emergency overflow to avoid significant damage associated with events exceeding this magnitude. On closure of the WRD's, access ramps and step-ins will be eliminated (prior to rehabilitation) to reduce erosion risks. The crest of the WRD's will be provided with a durable waste rock berm to prevent drainage from the top surface from eroding the side slopes. No active groundwater protection measures are envisaged given the relatively low pollution potential of the waste rock. In the event that surface water quality monitoring around the WRD's indicates that Class 4 (DWAF classification) water is likely to emanate as surface run-off from the dumps, soak-aways will be provided within the catchment paddocks to minimise the risk of exposure of Class 4 water to wildlife, livestock and humans.

The WRDs have been classified in terms of the requirements of the SANS Code of Practice for Mine Residue Deposits and are rated as a medium hazard (central and north east WRDs) and high hazard (east WRD).

Tailings complex

There is currently provision for one tailings complex comprising two separate tailings storage facilities (TSF) at the mine (Figure 2.1). The project components make provision for changes to the design of these facilities. The changes to these facilities are outlined in Table 2.10. The updated design details based on the detailed design of the facilities (Epoch, 2013) are provided in Table 2.11.

TABLE 2.10: OUTLINE OF CHANGES TO THE TAILINGS STORAGE FACILITY

Project components			**Data from approved 2008 EIA and EMP report**
Component	**Aspect**	**Details**	
Tailings storage facility design	TSF1	Footprint: 74ha Height: 40m Volume: 8.1 million m^3 Comprises two paddocks	Footprint: 52ha Height: 33m Volume: 5.4 million m^3 Comprised 1 paddock
	TSF2	Footprint: 130ha Height: 45m Volume: 22.7 million m^3	Footprint: 100ha Height: 31m Volume: 12.8 million m^3
	Items removed from design	Black turf under containment walls Low permeability liner along inside of TSF face Clay cut-off keys 1V: 3H of the outer slope	-
	Items added to the design	Toe drains on inside toe of TSF Seepage collection trenches 1:V: 2.5H of the outer slope	-

TABLE 2.11: DESIGN PRINCIPLES FOR THE TAILINGS COMPLEX

Feature	**Detail**
Tailings Delivery and Deposition	Two slurry delivery pipelines per processing facility (100,000tpm and 300,000tpm) for pumping tailings in slurry form to the TSFs. HDPE pipes will be used for the delivery pipeline. Each TSF will have delivery pipe uptakes situated on the side of the dam closest to the plants. These uptakes will be connected to a pipeline positioned around the inside crest of each TSF with flanged T piece (allowing for open end deposition) positioned every 75m. Deposition will cycle around each TSF by continually opening and closing a number of the T- Pieces. Deposition in TSF 2 will only commence once TSF 1 has reached full capacity.
Diversion	Storm water diversion trenches or swales around the upstream sides of both TSFs to direct clean surface water run-off around and away from the TSFs.
Topsoil Stripping	Topsoil within the TSF footprint areas will be stripped and stockpiled in accordance with the topsoil conservation guide in close proximity to the final toe on the upstream side of each TSF. A stripping depth of 200mm was recommended by the soils study. Stripping and stockpiling of topsoil will be done as part of the initial TSF construction works.

Feature	Detail
Lining	In-situ low permeability black clays or turf remaining after topsoil stripping will reduce infiltration of leachate from the TSFs to ground water. The black clays vary between 1.0m to 2.0m in the basin of TSF1 and between 4.5m to 6m in the basin of TSF2. Seepage cut off trenches around the perimeter of the TSF's excavated into the insitu norites will assist to collect any water seeping through the basin of the TSFs. These trenches will be dewatered and the water pumped back for processing.
Embankments	Compacted clay toe walls and elevated compacted clay platforms will be constructed along the inner toe of the TSF's to enable the construction and efficient operation of inner toe drains which will assist with the lowering of the elevation of the phreatic surface as well as the consolidation of tailings. Each TSF waste rock containment wall will be developed at an overall outside slope of 1V:3H. The waste rock will be spread in maximum 2m thick layers and compaction will be carried out by 20t vibratory rollers and as well as traffic compaction. The clay beneath the waste rock walls will be removed allowing the walls to be founded on competent norite thus improving the overall stability of the TSF. Various ramps at gradients of 1V:10H (6) will be provided at various locations around each TSF to allow for access by both mine haul trucks and TSF operators onto the containment walls and into each TSF.
Under Drains & Decanting system	A 750mm high by 5m wide wall toe drains constructed using various filter sand and stone material will be installed along the upstream toe of the clay starter wall on a slightly elevated compacted clay platform. Water collected from the drain will be removed via a number of 160mm diameter HDPE pipes running beneath the rockfill wall. Supernatant water will be decanted from each TSF via a central decant (penstock) and report to a concrete lined return water sump, from which water will be pumped back to the plant. The sumps will have a 1000m^3 capacity. Surface run-off from the TSF side slopes and ramps will be retained by a series of nominally compacted catchment paddocks (constructed using local clays) around the perimeter of each TSF Water will then either evaporate or seep into the basin from these catchment paddocks.
Access and Access Control	Mining haul roads for construction of the TSF containment walls will have a minimum width of 25m and will be constructed using waste rock along the northern sides of the TSFs. A 6m wide waste rock road will be constructed around the perimeter of each TSF for access during operations, routine inspections and maintenance. A perimeter fence around each TSF is not planned. Rather a perimeter fence around the whole of the mine site will be installed.
Waste Minimisation	No re-processing of the tailings is envisaged in future. No opportunities for the reduction of the tailings production rate are envisaged.
Rehabilitation	A 500mm topsoil cover to be applied over the outer slopes of the TSF. Topsoil rehabilitation and vegetation establishment to commence on completion of containment wall construction to final height
Monitoring	The monitoring of the TSFs will include: Safety aspects e.g. monthly review of freeboard during operational phase, presence of seepage, functioning of blanket drains etc, quarterly inspections (operational phase) and annual audits. Groundwater pollution aspects including monitoring of at least 3 boreholes located on the perimeter of each TSF to ascertain upstream and downstream groundwater levels and quality including pH, EC, TDS, NO_3, Ca, Mg, Fe, Mn, Na, Cl, K, SO_4, HCO_3, PO_4, Cr (VI) and piezometric level. Monitoring frequency of major cations and anions quarterly, minor constituents annually after 2 years of quarterly monitoring – quarterly report. Vegetation cover and success rate. The rehabilitation and vegetation of the outer slope of each TSF will be done during the operational phase – quarterly report. Erosion damage and general condition of catchment paddocks, drainage outlet pipes, solution trench and sumps – quarterly report. Dust generation – annual report.

Feature	Detail
Dust Control	The height of the TSF waste rock containment walls being a minimum of 1m above the tailings beach gives both TSFs a low dust generation potential due to the coarse particle size of the waste rock. In addition, rehabilitation and vegetation of the TSF outside slopes further reduces the risk of dust generation. During the construction of the TSF containment walls, dust suppression will be undertaken by wetting both the haul roads as well as the TSF walls.
Closure	Ensure final level of tailings is at least 2m below the level of the waste rock containment wall crest to provide freeboard for storm water intercepted on the top surface. The top surface will serve as a store and evaporate facility for rainfall. Adjust the topography of the top surface of the TSFs to create a low area near the centre of the facility. This will be developed as a wetland and will receive run-off from the entire top surface of the facility Remove all pipelines, pumps, barges, catwalks, electrical cables etc. from the TSF surfaces and surrounds. Within a period of between 5 and 10 years after deposition ceases grout up the under drainage outlet pipes. Construct the final cover to the top surface of the TSFs by importing topsoil from the topsoil stockpiles and covering the top surface with a minimum depth of topsoil of 0.3m. Establish vegetation on the top surface of the TSFs using a selection of indigenous trees, shrubs, grasses, aloes etc. The TSF catchment paddocks are rehabilitated in the same manner as for the waste rock dumps.

TAILINGS COMPLEX SAFETY CLASSIFICATION

Criteria No.	Criteria	Comment	Safety Classification
1	No. of Residents in Zone of Influence	The TSF1 zone of influence is not expected to impact on any residents. The TSF2 zone of influence impacts on downstream residents along the tributary to the Elandsdriftspruit. It is thought that more than 10 residents are within the TSF2 zone of influence.	Low Hazard (TSF1) High Hazard (TSF2)
2	No. of Workers in Zone of Influence	The TSF1 zone of influence impacts on the eastern open pit area and the PGM primary crusher. It is thought that between 11 and 100 workers will be at risk. The TSF2 zone of influence impacts on a small portion of the eastern open pit. It is thought that < 10 workers will be at risk.	Medium Hazard (TSF1) Low Hazard (TSF2)
3	Value of 3rd party property in zone of influence	No formal assessment of the value of property has been done in the zone of influence but it is felt that the replacement value would be less than the R2 million for TSF1 but more than R20 million for TSF2 due to its close proximity to Samancor Mine and the N4.	Low Hazard (TSF1) High Hazard (TSF2)
4	Depth to underground mine workings	There are no known underground mine workings beneath the proposed TSF sites.	Low Hazard (TSF1 and TSF2)

2.7.7 ADDITIONAL SUPPORT SERVICES AND FACILITIES

The approved EIA and EMP made provision for the following support services and facilities in addition to the abovementioned core infrastructure and activities:

- laboratory at the plant – used for sample preparation and analysis;
- workshops and wash bays – used for servicing equipment and general maintenance;
- laydown and storage areas;

- stores, tanks and handling areas for storage of raw materials, plant reagents, consumables, oil and diesel. The volume of the combined diesel storage tanks is approximately 300 000 litres. The storage volume of the other substances is as follows: 130 000 litres of oil – stored in sealed drums and/or storage tanks (approximately 100 000 liters of this is for the mining section) , 2 500 litres of hydraulic fluid – stored in sealed drums and/or storage tanks, 2 000 kg of lubricants – stored in sealed drums; varying quantities of reagents – stored in tanks and sealed drums. The storage method of all these substances is to contain them in sealed containers within impermeable, bunded areas with sufficient capacity to contain spilled materials. All spilled materials must drain to sumps with oil traps that must also be equipped to allow collection and removal of spilled substances as per SANS 10089-1:2003;
- salvage yard areas for the temporary storage of waste before re-use or collection and removal;
- an explosives storage magazine and destruction area designed and operated in accordance with the relevant mine explosives safety and security legislation. In this regard, it will be reinforced and locked with strict access control measures and will only be used to store the type and quantity of explosives required in accordance with the final blast design and procedures;
- change houses with ablution facilities for all employees;
- a first aid facility for the primary treatment of injuries and illness;
- bus/taxi off-loading and loading areas at the concentrator complex (security and access control) and mining contractors areas (workshop/yard area);
- security checkpoints at all entrances;
- fencing around and lighting (with masts) within the proposed project area for security and safety reasons;
- infrastructure for communication – telephone lines and communication masts;
- a helicopter landing pad; and
- main office/admin block at the concentrator complex and secondary offices at the mining contractors area.

2.7.8 EMPLOYMENT AND HOUSING

A maximum number of 100 jobs will be created during construction. The appointed contractors will make use of their own personnel and where necessary, the current workforce at Tharisa will be used. The construction contractors will be responsible for housing their workers off site and providing the required facilities and services.

A maximum number of 34 permanent jobs will be created in the operation phase. These workers will be provided with a housing allowance as is practice at the mine. No on-site facilities will be provided for the employees.

2.8 DECOMMISSIONING AND CLOSURE

The closure objective will be to return the land to pre-mining potential or as agreed with the land owners and the relevant authorities. A summary of the conceptual closure planning is provided below. More detail can be found in the specialist report provided in Appendix K. At a conceptual level, decommissioning is a reverse of the construction phase with infrastructure and activities very similar to those described for the construction phase. The conceptual decommissioning plan is as follows:

- Surface infrastructure will be demolished and removed, with the exception of the mineralised waste facilities which will remain in perpetuity. These will be rehabilitated as described in the sections below
- All waste and contaminated soil and water will be removed from the project area and disposed of appropriately
- A soil specialist will be consulted to test the stockpiled soil and advise if any amelioration is required prior to using it for rehabilitation
- Areas where infrastructure has been removed will be levelled and topsoil restored to depths advised by the soil specialist
- A vegetation specialist will be consulted to determine if active seeding is required and what species should be seeded that are suited to the relevant soil type. Vegetation selected will be a combination of indigenous trees, shrubs, grasses and aloe species etc. to mimic the vegetation cover of natural topographical features in the area.

Open pits decommissioning and rehabilitation

The open pits will be decommissioned and rehabilitated as follows:

- Partial backfilling of the open pits with waste rock will be conducted concurrently with mining.
- Final pit voids will be made safe in line with the requirements of the DMR. No surface subsidence is expected as measures will be implemented to prevent and rectify this.
- Once the backfill material has settled, topsoil will be placed on top of the overburden and vegetation will be re-established.

Waste rock dumps decommissioning and rehabilitation

Waste rock will be used for partial backfilling of the open pits, however there will be some residual waste rock that will remain in perpetuity. These waste rock dumps will be decommissioned and rehabilitated once rock deposition ceases as follows:

- The crests of the WRDs will be provided with durable waste rock berms to prevent drainage from the top surface from eroding the side slopes.
- WRD side slopes will have an overall slope of 1V:4H, and re-vegetated. Topsoil stripped prior to development will be used to provide the growth medium. Topsoil will be placed in bowls excavated on the top surface and side slopes of each dump. The vegetation will be irrigated initially until it is no longer dependent on artificial irrigation for survival.

- Final catchment paddocks will be constructed of durable waste rock materials covered with a clay layer. The catchment paddocks will be vegetated in a manner similar to that stated above to blend in to the natural Bushveld. The catchment paddocks will be sized to contain run-off from a 1:100 year 24hr duration storm event and will be provided with an emergency overflow to avoid significant damage associated with events exceeding this magnitude.
- No active groundwater protection measures are envisaged given the relatively low pollution potential of the waste rock. In the event that surface water quality monitoring around the WRD’s indicates that Class 4 (DWA classification) water is likely to emanate as surface run-off from the dumps, soak-aways will be provided within the catchment paddocks to minimise the risk of exposure of Class 4 water to wildlife, livestock and humans
- Surface and groundwater quality will be monitored regularly for a period to be agreed upon with the relevant authorities.

Tailings storage facilities decommissioning and rehabilitation

The tailings storage facilities will be decommissioned and rehabilitated once tailings deposition ceases as follows:

- The outter slopes will be re-vegetated concurrently with tailings disposal once the containment walls are constructed until the final height of each facility
- The final level of tailings will be at least 2m below the level of the waste rock containment wall crests to provide freeboard for stormwater intercepted on the top surface. The top surfaces will serve as a store and evaporate facility for rainfall.
- The top surface of the TSFs will be adjusted to create a low area near the centre of each facility. This will be developed as a wetland and will receive run-off from the entire top surface of each facility
- All pipelines, pumps, barges, catwalks, electrical cables etc. will be removed from the TSFs surfaces and surrounds.
- Within a period of between 5 and 10 years after deposition ceases, the under drainage outlet pipes will be grouted up at each facility.
- The final cover to the top surface of the TSFs will be constructed by importing topsoil from the topsoil stockpiles and covering the top surfaces with a minimum depth of topsoil of 0.3m.
- Vegetation will be established on the top surface of the TSFs using a selection of indigenous trees, shrubs, grasses, aloes etc.
- The TSFs catchment paddocks will be rehabilitated in the same manner as for the waste rock dumps
- Surface and groundwater quality will be monitored regularly for a period to be agreed upon with the relevant authorities.

All other surface components:

- All other surface infrastructure will be broken down and reused or disposed of as waste
- Contaminated soils underlying the structures will be excavated and disposed of appropriately

- The soil and vegetation function of the land will be restored to be free draining as far as practically possible. Hard surfaces may need to be ripped
- Any residual excavations will be backfilled and levelled with selected overburden material and covered with topsoil and vegetated according to the advice of the soil and vegetation specialists.

2.9 PROJECT ALTERNATIVES

Given that the project components relate mainly to optimising approved mining activities, no real alternatives exist for the project.

2.9.1 THE "NO PROJECT" OPTION

The assessment of this option requires a comparison between the alternative of proceeding with the project with that of not proceeding with the project. Proceeding with the project increases the economic viability of the mine and provides access to additional ore reserves. This results in positive economic economic benefits. The development of the project components have the potential for negative environmental and social impacts. Not proceeding with the project leaves the status quo. In the unmitigated scenario, assuming no measures are implemented to control the mine's operations, the significance of potential impacts would be high. Assuming effective implementation of the mitigation and monitoring as outlined in the EIA and EMP report, the significance of impacts can be reduced to acceptable levels. A comparative assessment of the project development versus the alternative land use (which is the current land use) is given in Section 8 of the EIA and EMP report.

2.9.2 THE NORTH EAST WASTE ROCK DUMP

The deepening and extension of the open pits will generate additional waste rock, which cannot all be accommodated in the existing waste rock dump facilities/footprints. A new facility, referred to as the north east waste rock dump, is therefore required (Figure 2.1). There are no feasible alternative positions for this facility due to the following factors:

- There is no remaining surface area within the mining right boundary for the establishment of this facility which must accommodate 45.95 million tons of waste rock. The facility will be 95ha and approximately 70m high
- The mining rights area is surrounded by other mining operations (Western Platinum Mine, Lonmin Platinum Mine, Aquarius Platinum Mine, Samancor and Mamba Chrome Mine) and by communities (Mmaditlhokwa/Silver City, Tsilong Village, Lapoland Village, Elandsdrift and Buffelspoort) (refer to Figure 1.13)
- The Protected Natural Environment of the Magaliesberg lies 3km to the south of the mine (refer to Figure 1.13)

- It is SLR's understanding that shallow chrome resources lie to the south of the north-east waste rock dump position . Samancor has recently lodged an application and is conducting the scoping phase of an EIA process in order to mine this resource.
- Tharisa has confirmed that there is no economically viable shallow resource in the north-east waste rock dump position.
- There are numerous watercourses within the mining rights and project areas (refer to Figure 1 12). The Sterkstroom River is regarded as critically endangered by the NW Province, and as such the mine has made every effort to avoid encroachment of this watercourse.

3 POTENTIAL IMPACTS

3.1 LIST OF POTENTIAL IMPACTS

This section provides a list of potential impacts on environmental aspects (excluding social and cultural aspects) separately in respect of each of the main project actions / activities and processes. The potential impacts are presented for each of the project phases in tabular format (Table 3.1).

3.2 LIST OF POTENTIAL IMPACTS ON ENVIRONMENTAL ASPECTS

The potential impacts are presented for each of the project phases in tabular format (Table 3.1).

TABLE 3.1: LIST OF POTENTIAL IMPACTS AS THEY RELATE TO PROJECT ACTIONS/ ACTIVITIES (EXCLUDING SOCIAL AND CULTURAL)

Activity	Phase	Impacts (unmitigated)
Site preparation Bush clearing, removal of infrastructure	Construction	Physical destruction and disturbance of biodiversity Alteration of drainage patterns Air pollution Disturbing noise Negative visual impact
Earthworks Stripping and stockpiling soils, bulldozing, temporary gravel roads, foundation excavation and compaction	Construction Operation	Hazardous excavations Loss of soil resources and land capability Physical destruction and disturbance of biodiversity Alteration of drainage patterns Pollution of surface water Air pollution Disturbing noise Negative visual impact
Civil works Building activities, erection of structures, steel work, electrical installation, establishing pipelines	Construction Operation	Hazardous excavations Loss of soil resources and land capability Pollution of surface water resources Contamination of groundwater Air pollution Disturbing noise Negative visual impact
Exploration Drilling, trenching, sample analysis	Construction Operation	Loss of soil resources and land capability Physical destruction and disturbance of biodiversity Alteration of drainage patterns Air pollution Disturbing noise
Open pit mining Drilling, blasting, load, hauling, dewatering	Operation Decommissioning and closure (final land form)	Hazardous excavations Loss of soil resources and land capability Pollution of surface water resources Dewatering impacts Air pollution Disturbing noise Negative visual impact

Activity	Phase	Impacts (unmitigated)
Waste rock management Storage, final disposal	Operation Decommissioning and closure (final land form)	Hazardous excavations Loss of soil resources and land capability Disturbance of biodiversity Pollution of surface water resources Contamination of groundwater Air pollution Disturbing noise Negative visual impact
Mineral processing operations Chrome sand drying plant	Operation	Hazardous excavations Disturbance of biodiversity Air pollution Disturbing noise Negative visual impact
Tailings management Storage, final disposal	Operation Decommissioning and closure (final land form)	Hazardous excavations Loss of soil resources and land capability Disturbance of biodiversity Pollution of surface water resources Contamination of groundwater Air pollution Disturbing noise Negative visual impact
Resource use Use of existing water and power supply	Construction Operation	-
Process and storm water management Stormwater channels and berms, collection of dirty, storage for re-use	Construction Operation Decommissioning	Hazardous excavations Alteration of drainage patterns Pollution of surface water resources Contamination of groundwater
Transport systems Use of access points, road transport to and from site for employees and supplies, movement within site boundary (haul roads, conveyors, pipelines)	Construction Operation Decommissioning Closure (limited road)	Road disturbance and safety related impacts
General and industrial hazardous waste management Handling and storage within existing mine boundary	Construction Operation Decommissioning	Pollution of surface water resources Contamination of groundwater Negative visual impact
Site support services Use of existing services	-	-
Site/contract management Appointment of workers/contractors, site management (monitoring, inspections, maintenance, security, access control), awareness training, emergency response, implementing and maintaining programmes	Construction Operation Decommissioning Closure	Management of the site plays a significant role in all identified impacts
Demolition Dismantling, demolition, removal of equipment	Operation (as part of maintenance) Decommissioning	Loss of soil resources and land capability Disturbance of biodiversity Air pollution Disturbing noise Negative visual impact

Activity	Phase	Impacts (unmitigated)
Rehabilitation Replacing soil, slope stabilisation, landscaping, re-vegetation, restoration	Construction Operation Decommissioning Closure	Hazardous excavations Loss of soil resources and land capability Disturbance of biodiversity Alteration of drainage patterns Pollution of surface water resources Contamination of groundwater Air pollution Disturbing noise Negative visual impact
Maintenance and aftercare Inspection and maintenance of remaining facilities and rehabilitated areas	Closure	Loss of soil resources and land capability Disturbance of biodiversity Pollution of surface water Air pollution Negative landscape and visual impact

3.2 LIST OF POTENTIAL CUMULATIVE IMPACTS

This section provides a list of potential cumulative environmental impacts (excluding social and cultural aspects – see Section 6):

- Hazardous excavations and infrastructure
- Loss of soil resources and land capability through physical disturbance
- Loss of soil resources and land capability through pollution
- Physical destruction of biodiversity
- General disturbance of biodiversity
- Alteration of natural drainage patterns
- Contamination of water resources
- Contamination of groundwater
- Reduction in groundwater levels/availability
- Air pollution
- Noise pollution
- Negative visual impacts.

3.3 POTENTIAL FOR ACID MINE DRAINAGE OR GROUNDWATER CONTAMINATION

Geochemical characterisation of the waste streams (tailings and waste rock) was carried out as part of the original EIA and EMP for Tharisa Mine (Metago, 2008). Samples of the following were analysed: waste rock from exploratory drill cores and tailings from pilot metallurgical test work.

The results showed that the waste stream material is non-acid generating and has a medium neutralising potential. Similarly, the project components (particularly the waste rock and tailings) are not expected to generate acid. Therefore the design of pollution abatement measures need to consider the leachability of the waste under natural pH conditions to mildly acidic conditions.

Under the worst case scenario of mildly acidic conditions (i.e. acid rain), there is possible leaching of aluminium and manganese, as well as, elevated salt loads (TDS) from the waste rock dumps.

Conclusions from the leachability testing indicated that in the long term (i.e. after closure and removal of any process water) the waste rock and concentrator tailings have similar pollution potentials. In the short term, the concentrator tailings stream has the highest pollution potential due to the additional effect of re-circulation of process water.

4 ALTERNATIVE LAND USE OR DEVELOPMENT

4.1 DESCRIPTION OF ALTERNATIVE LAND USE OF THE AREA

The project sites associated with the project components are/were used for mining, residential (limited) or agricultural activities. Refer to Section 1.3.1 for a detailed description of existing land uses in the project areas.

Although not all of these sites are in use, some sites such as the southern part of the central waste rock dump and the north east waste rock dump could continue to be used for residential and/or agricultural activities. As a result, as an alternative to the development of the project components, these current land uses would continue.

4.1.1 MAIN FEATURES AND INFRASTRUCTURE RELATED TO ALTERNATIVE LAND USE / DEVELOPMENT

Potential features and infrastructure that could be associated with the alternative land use/development are listed below.

Feature / infrastructure	Description
Livestock farming	Introducing additional/new livestock to the farms. Establishing watering holes.
Agriculture	Preparing and working agricultural fields.

4.2 PLAN SHOWING LOCATION AND EXTENT OF ALTERNATIVE LAND USE / DEVELOPMENT

A plan showing the location and extent of the alternative land use / development is not possible to present at this stage as this would depend on the individual landowners preferences and financial situation.

5 POTENTIAL IMPACTS OF ALTERNATIVE LAND USE OR DEVELOPMENT

5.1 LIST OF POTENTIAL IMPACTS

Potential impacts, expected to occur as a result of the continued alternative land use described in Section 4 above, are listed below:

Feature / infrastructure	Potential impacts
Livestock farming	Loss of soils through incorrect management. Increased income and associated socio-economic benefits. Increased pressure on water resources.
Agriculture	Dust generation from exposed areas. Increased income and associated socio-economic benefits.

5.2 LIST OF POTENTIAL CUMULATIVE IMPACTS

Potential cumulative impacts associated with the alternative land use on site and in the surrounding area are expected to include:

- Increased pressure on water resources
- Increased pressure on veld resources for grazing purposes
- Increased socio-economic benefits.

6 POTENTIAL SOCIAL AND CULTURAL IMPACTS

6.1 LIST OF POTENTIAL IMPACTS ON SOCIO-ECONOMIC CONDITIONS OF THIRD PARTY LAND USE ACTIVITIES

Potential impacts on the socio-economic conditions of other parties land use activities both on site and in the surrounding area, as a result of the project, are discussed in detail in Section 7 and listed below. This list includes potential impacts on cultural and heritage resources (Section 6.3).

- Disturbance to current land uses through impacts on the bio-physical environment
- Loss of heritage, cultural and palaeontological resources
- Project-related road use and traffic
- Economic impacts (positive and negative)
- Informal settlements, safety, security and services and associated social ills.

6.2 CULTURAL ASPECTS AND POTENTIAL IMPACTS THEREON

Cultural aspects are discussed as part of heritage discussion below.

6.3 HERITAGE FEATURES AND POTENTIAL IMPACTS THEREON

6.3.1 HERITAGE (AND CULTURAL) FEATURES

With reference to Section 1.3.2, heritage and cultural resources were identified within the project sites. Potential impacts on heritage (including cultural) features include the loss of these resources for future generations through physical destruction and/or disturbance (described further in Sections 7.2.15). These resources are protected by national legislation and require mitigation prior to any disturbance.

6.3.2 PALEONTOLOGICAL FEATURES

Given the geology, there is no potential for paleontological resources to occur within the mining rights area and therefore no impacts are expected to occur.

6.4 QUANTIFICATION OF IMPACT ON SOCIO-ECONOMIC CONDITIONS

The results of the specialust study are presented in Section 8.2.

7 ASSESSMENT AND EVALUATION OF POTENTIAL IMPACTS

7.1 LIST OF EACH POTENTIAL IMPACT

Potential environmental and socio-economic impacts were identified by SLR in consultation with IAPs, regulatory authorities, specialist consultants and the mine. The impacts are discussed under issue headings in this section. All identified impacts are considered in a cumulative manner such that the current baseline conditions on site and in the surrounding area are discussed and assessed together.

Environmental impacts that will be assessed in this section include the following:

- Loss and sterilization of a mineral resource (Section 7.2.1)
- Hazardous excavations and infrastructure (Section 7.2.2)
- Surface subsidence (Section 7.2.3)
- Loss of soil resources and land capability through physical disturbance (Section 7.2.4)
- Loss of soil resources and land capability through pollution (Section 7.2.5)
- Physical destruction of biodiversity (Section 7.2.6)
- General disturbance of biodiversity (Section 7.2.7)
- Alteration of natural drainage patterns (Section 7.2.8)
- Contamination of water resources (Section 7.2.9)
- Contamination of groundwater (Section 7.2.10)
- Reduction in groundwater levels/availability (Section 7.2.11)
- Air pollution (Section 7.2.12)
- Noise pollution (Section 7.2.13)
- Negative visual impacts (Section 7.2.14)
- Loss of heritage, cultural and palaeontological resources (Section 7.2.15)
- Loss of or changes to existing land uses (Section 7.2.18).
- Blasting impacts (Section 7.2.15)
- Road disturbance and traffic safety (Section 7.2.19)
- Economic impact (positive and negative) (Section 7.2.20)
- Inward migration and associated social issues (Section 7.2.21).

7.2 IMPACT RATING FOR EACH POTENTIAL IMPACT

The impact rating for each potential impact is provided in the section below. The criteria used to rate each impact is outlined in Section 7.3. The assessments provided below are a **cumulative on-site assessment** taking into consideration the approved activities together with the project components. The cumulative ratings are discussed for each criteria. The potential impacts are rated with the assumption that no mitigation measures are applied and then again with mitigation. An indication of the phases in which the impact will occur is provided at the start of each assessment and summarised in Section 7.4 together with the estimated timeframes for each rated impact.

GEOLOGY

7.2.1 ISSUE: LOSS AND STERILIZATION OF MINERAL RESOURCE

Discussion

The placement of infrastructure and activities on or in close proximity to mineral resources preventing access to potential mining areas as well as disposal of mineral resources onto mineralised waste facilities can result in the sterilisation or loss of these resources.

The approved EIA and EMP report (Metago, 2008) stated that mining operations at Tharisa Mine do not sterilise third party minerals. The project aims to maximise the mining of ore reserves through the deepening of the pits and maximise the extraction of minerals through the chrome sand drying plant. In addition, the re-positioning of the two previously approved waste rock dumps north of the east pit to form the eastern waste rock dump allow for the extended mining at the east pit. In line with the commitments in the approved EMP report, the project plan and layout have been designed to prevent sterilisation of third party minerals. Therefore this is not considered an issue for the project.

Conceptual description of mitigation measures

Although there will be no impacts, mitigation provided below and tabulated in the EMP (Section 19) will continue to be implemented by the mine to ensure this.

Objective

To minimise sterilisation of third party mineral rights.

Actions

The mine plan and infrastructure layout will be designed to prevent sterilisation of third party minerals. Future planning at the mine will continue to take this into account.

This issue must be considered by the mine planner, geologist, environmental manager and mine manager in the pre feasibility/planning stage of any changes to the mine plan and infrastructure layout.

Emergency situations

None identified.

TOPOGRAPHY

7.2.2 ISSUE: HAZARDOUS EXCAVATIONS AND INFRASTRUCTURE

Introduction

Hazardous excavations and infrastructure include all excavations, structures or land forms into or off which third parties (non-mine personnel) and animals can fall and be harmed. Included in this category are facilities that can fail such as the tailings storage facilities (TSFs). Hazardous excavations and infrastructure occur in all project phases from construction through operation to decommissioning and closure. In the construction and decommissioning phases these hazardous excavations and infrastructure are temporary in nature, usually existing for a few weeks to a few months. The operational phase will present more long term hazardous excavations and infrastructure and the closure phase will present final land forms that are considered hazardous (partially backfilled final void at each open pit, TSFs, some waste rock dumps).

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Earthworks Civil works Rehabilitation	Waste rock dumps TSF Open pits Stockpiling Mineral processing General site management Rehabilitation	Demolition Final land forms Rehabilitation	Maintenance and aftercare of final land forms

Rating of impact

<u>Severity/ nature</u>

In the approved EIA and EMP report (Metago, 2008), the severity of hazardous excavations and infrastructure associated with the approved operations was rated high in both the unmitigated and mitigated scenario.

The changes to mine operations and infrastructure comprising deepening of the pits, increasing the height of the TSFs and soil stockpiles, increases in the waste rock dumps and establishment of additional infrastructure present a potential risk of injury and/or death to both people and animals. This results in a high severity in both the unmitigated and mitigated scenarios.

When considering this impact cumulatively with the approved operations, the severity rating for the overall mine is high in both the unmitigated and mitigated scenarios.

<u>Duration</u>

In the context of this assessment, death or permanent injury is considered a long term, permanent impact.

Spatial scale/ extent

For the most part, the direct impacts will be located within the site boundary, but the indirect impacts will extend to the communities to which the people / animals belong.

Consequence

The consequence relating to death and/or injury is high in both the unmitigated and mitigated scenario.

Probability

Changes to mining operations and infrastructure are mostly taking place within the existing mine boundaries except for the addition of the north east waste rock dump. There are measures in place in line with the commitments in the approved EMP report, which focus on infrastructure safety as well as on limiting access to third parties and animals. In the absence of these measures, the probability is high. With mitigation, the probability reduces to low.

Significance

In the approved EIA and EMP report (Metago, 2008) the significance rating for the approved operations was rated high in the unmitigated scenario and reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operation, the significance rating for the overall mine is high in the unmitigated scenario and medium in the mitigated scenario.

Assessment of cumulative on-site impact

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	H	H	M	H	L	M

Conceptual description of mitigation measures

Discussion of the mitigation measures is provided below and tabulated in the EMP (Section 19).

Objectives

To ensure that people and animals are not harmed by falling off or into hazardous excavations.

Actions

In the approved EMP (Metago, 2008), it is outlined that:

- Each hazardous excavation will have a barrier around it to prevent access by people and animals. The barrier may be in the form of fences, walls or berms. In addition, the barriers must have warning signs at appropriate intervals. These warning signs must be in picture format and/or written in English, Afrikaans and Tswana.

- Dams with a safety risk (this includes all dams that hold 50 000m^3 of water and that have a wall of 5m or more) will be monitored by a professional civil engineer.
- Implement mitigation measures relating to surface subsidence as per Section 7.2.3 below.

These measures will be applied where applicable to the project.

In addition, the following measures will be implemented:

- Any hazardous structure or excavations will be designed, constructed, operated and closed in a manner to ensure that stability and safety risks to third parties and animals are addressed. These issues will be monitored according to a schedule that is deemed relevant to the type of facility.
- Tharisa will update its surface use area map on a routine basis to ensure that the position and extent of all potentially hazardous excavations, infrastructure is known.
- Where Tharisa has caused injury to third parties and/or animals, appropriate compensation will be provided.

The environmental manager and appointed engineer are responsible for ensuring that these actions are implemented during the construction phase of the excavations, and that they are maintained until rehabilitation and closure.

Emergency situations

If people or animals fall off or into hazardous excavations or infrastructure causing injury, the Tharisa emergency response procedure will be initiated.

7.2.3 ISSUE: SURFACE SUBSIDENCE

Introduction

In the context of open pit mining, surface subsidence can occur once mining areas have been backfilled. In the event that surface subsidence does occur it can create depressions which cause an alteration to surface drainage patterns and pooling of water and can destroy the re-established road surface (that is, the D1526/ D1566 road) once mining is complete. In more severe cases of subsidence the depressions can also be hazardous to people and animals (this is assessed in Section 7.2.2 above).

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Not applicable			
-	Open pit mining	Rehabilitation of open pits	Rehabilitated pits

Rating of impact

<u>Severity/ nature</u>

In the approved EIA and EMP report (Metago, 2008), the severity of surface subsidence associated with the approved open pit operations was rated medium without mitigation and low with mitigation.

Deepening of the open pits is not expected to alter the severity of this impact. Therefore, when considering the project cumulatively with the approved operations, the severity rating for the overall mine remains unchanged.

Duration

In the absence of mitigation, the duration of the impact will be medium. With mitigation measures in place any subsidence will be corrected prior to closure reducing the duration to low.

Spatial scale/ extent

Impacts associated with the surface subsidence will occur within the site boundary.

Consequence

The consequence is medium in the unmitigated scenario. This reduces to low in the mitigated scenario.

Probability

In the unmitigated scenario, surface subsidence affecting drainage lines and roads surfaces is possible. With mitigation, the probability reduces to low.

Significance

In the approved EIA and EMP report (Metago, 2008), the significance rating of the approved operations was medium in the unmitigated scenario and reduced to low in the mitigated scenario.

When considering the project’s impact cumulatively with the approved operation, the significance rating for the overall mine remains unchanged in both the unmitigated and mitigated scenarios.

Assessment of cumulative on site impacts

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
Operation and decommissioning						
Unmitigated	M	M	L	M	M	M
Mitigated	L	L	L	L	L	L

Conceptual description of mitigation measures

Discussion of the mitigation measures is provided below and tabulated in the EMP (Section 19).

Objectives

To prevent surface subsidence at the backfilled opencast pits.

<u>Actions</u>

In the approved EMP (Metago, 2008), it is outlined that:

- Backfilling operations must take the possibility of surface subsidence into account. This may require the calculation of a bulking factor and the initial creation of a slight swell above ground level. Final replacement of topsoil onto the backfilled overburden/waste rock material should be done with the understanding that if subsidence occurs thereafter, re-stripping of topsoil and additional backfilling with overburden/waste rock will be required. Thereafter the topsoil will have to be replaced.
- Specific backfilling and compaction techniques, in consultation with an appropriately qualified civil engineer, will be used to prevent subsidence for the re-establishment of the D1526/ D1566 road and if possible, the headwaters of the non-perennial drainage lines in the eastern and western open pit sections.

These measures will be applied where applicable to the project.

This action is the responsibility of the environmental manager and it will be implemented whenever backfilling of the open pits occur.

Emergency situations

Sudden surface subsidence is considered an emergency situation and will be dealt with in line with Tharisa's emergency response procedure.

SOILS AND LAND CAPABILITY

It is important to note that for the approved EIA and EMP (Metago, 2008), the loss of soil resources due to physical disturbance was assessed together with the loss of soil resources due to pollution. The assessment below considers these two aspects separately. The approved EIA and EMP also assessed soil impacts and land capability impacts separately whereas the assessment below considers these two aspects together.

7.2.4 ISSUE: LOSS OF SOIL RESOURCES AND LAND CAPABILITY THROUGH PHYSICAL DISTURBANCE

Introduction

Soil is the key to re-establishing post closure land capability. There are a number of activities/infrastructure in all phases that have the potential to disturb soils and related land capability through removal, compaction and/or erosion. In the construction phase and decommissioning phases, these activities are temporary in nature, usually existing for a few weeks to a few months. The operational phase will present more long-term activities and the closure phase will present final landforms that may be susceptible to erosion.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Earthworks General site management Transport systems Rehabilitation	General site management Open pit mining TSF WRD Rehabilitation	Demolition General site management TSF WRD Rehabilitation	Final land forms Maintenance and aftercare of final land forms and rehabilitated areas

Rating of impact

Severity/nature

In the approved EIA and EMP report (Metago, 2008), the severity of losing soil resources and reducing land capability, associated with the approved operations was rated high in both the unmitigated and mitigated scenarios.

The approved EMP reported that 750ha of land and associated soil, mainly black turf soils, would be disturbed by the development of the mine. In some areas, soils have been stripped and stockpiled for rehabilitation purposes. The changes in infrastructure and operations disturb an additional 276ha of similar soil types. As a result of deepening the eastern pit, the subsequent consolidation of the eastern WRD is sited on wet-based soils associated with tributaries of the Maretlwane. The north east WRD will be located over two drainage lines with associated wet-based soils. In the unmitigated scenario, physical soil disturbance can result in a loss of soil functionality as an ecological driver. In the case of erosion, the soils will be lost to the area of disturbance. In the case of compaction the soils functionality will firstly be compromised through a lack of rooting ability and aeration, and secondly the compacted soils are likely to erode because with less inherent functionality there will be little chance for the establishment of vegetation and other matter that naturally protects the soils from erosion. It is important to note that for the base of the tailings and waste rock disposal areas (approximately 50% of the mine footprint) the *in-situ* clay soils remain so as to act as a natural liner for pollution control. This amounts to a high severity in both the unmitigated and mitigated scenarios.

When considering the project's impact cumulatively with the approved operations, the severity rating for the overall mine is high in both the unmitigated and mitigated scenarios.

Duration

In the unmitigated scenario the loss of soil and related land capability is long term and will continue after the life of the mine. In the mitigated scenario, soil as far as possible will be conserved and replaced in areas requiring rehabilitation, which reduces the duration of the impact to the life of the operations. Some soils will however be lost forever due to the need to retain an *in-situ* layer of clay below mineralised waste facilities.

Spatial scale/extent

In both the unmitigated and mitigated scenarios for all phases, the potential loss of soil and land capability through physical disturbance will be restricted to within the site boundary.

Consequence

In the unmitigated scenario the consequence is high. In the mitigated scenario the consequence is medium to high.

Probability

Without any mitigation the probability of losing soil resources and related land capability is definite. With mitigation, the probability is reduced to medium because although emphasis is placed on soil conservation and re-establishment as far as possible, soils below mineralised waste facilities will be lost permanently.

Significance

In the approved EIA and EMP report (Metago, 2008), the significance rating for the approved operations was high in the unmitigated scenario and reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, the significance rating for the unmitigated scenario is high. For the mitigated scenario, the significance rating for the overall mine is medium to high due to the mine's increased footprint and the need to retain an *in-situ* layer of clay below project-related mineralised waste facilities (which includes the majority of the project footprint).

Assessment of cumulative on site impacts

Management	Severity/nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	L	H	H	H
Mitigated	H	M-H	L	M-H	M	M-H

Conceptual description of mitigation measures

Discussion of the mitigation measures is provided below and tabulated in the EMP (Section 19).

Objective

To minimise the loss of soil resources and related land capability through physical disturbance, erosion and compaction.

Actions

In the approved EMP (Metago, 2008), it is outlined that:

- Tharisa will implement the soil conservation procedure as set out inTable 7.1 below.
- The stream diversion will incorporate appropriate energy dissipaters for erosion prevention.

TABLE 7.1: SOIL CONSERVATION PROCEDURE

Steps	Factors to consider	Detail
Delineation of areas to be stripped		Stripping will only occur where soils are to be disturbed by activities that are described in the EIA and EMP report, and where a clearly defined end rehabilitation use for the stripped soil has been identified.
Reference to biodiversity action plan		All requirements for moving and preserving fauna and flora according to the biodiversity action plan will be adhered to.
Stripping	Topsoil	A minimum of 50cm of topsoil will be stripped unless the bed rock is less than 50cm from surface.
	Subsoil	If present, subsoil will be removed and stockpiled separately to the topsoil.
Delineation of stockpiling areas	Location	Stockpiling areas have been identified in close proximity to the source of the soil to limit handling and to promote reuse of soils in the correct areas.
	Designation of the areas	Soil stockpiles will be clearly marked to identify both the soil type and the intended area of rehabilitation.
Stockpile management	Vegetation establishment and erosion control	Rapid growth of vegetation on the topsoil stockpiles will be promoted (e.g. by means of watering or fertilisation). The purpose of this exercise will be to encourage vegetation growth on soil stockpiles and to combat erosion by water and wind.
	Storm water controls	Stockpiles will be established with storm water diversion berms to prevent run off erosion.
	Height	Utilisable topsoil will be stockpiled in berms as shown in Figure 2.1. These berms will have a maximum height of 30m and allowed to vegetate naturally in order to limit erosion.
	Waste	No waste material will be placed on the soil stockpiles.
	Vehicles	Equipment movement on top of the soil stockpiles will be limited to avoid topsoil compaction and subsequent damage to the soils and seedbank.
Rehabilitation of disturbed land: restoration of land capability	Placement of soil	A minimum layer of 50cm of topsoil will be replaced.
	Fertilisation	A soil specialist will be consulted to sample the stockpiled soils at relevant depths in the topsoil stockpile berms to determine the nutrient status of the soil. As a minimum the following elements will be tested for: cation exchange capacity, pH and phosphate. These elements provide the basis for determining the fertility of soil. Based on the analysis, the soils specialist will advise if fertilisers must be applied.
	Vegetation	Due to the height of topsoil stockpile berms, a vegetation specialist will be consulted to advise on the need for active seeding of soils used for rehabilitation and on what species will be most suited to the soil type.
	Erosion control	Erosion control measures will be implemented to ensure that the topsoil is not washed away and that erosion gulleys do not develop prior to vegetation establishment.
Pollution of soils	In situ remediation	If soil (whether stockpiled or in its undisturbed natural state) is polluted, the first management priority is to treat the pollution by means of in situ bio-remediation. The acceptability of this option must be verified by an appropriate soils expert and by DWAF, on a case by case basis, before it is implemented.
	Off site disposal	If in situ treatment is not possible or acceptable then the polluted soil must be classified according to the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF 1998) and disposed at an appropriate, permitted, off-site waste facility.

These measures will be applied to the project, where applicable.

The environmental manager is responsible for implementing these actions, procedures and practices from the start of the construction phase through to closure.

Emergency situations

None identified.

7.2.5 ISSUE: LOSS OF SOIL RESOURCES AND LAND CAPABILITY THROUGH POLLUTION

Introduction

Soil is a valuable resource that supports a variety of ecological functions. The project has the potential to damage soil resources through contamination from runoff, spillages and seepage. Contamination of soils also has the potential to impact both surface and groundwater resources (see Sections 7.2.9 and 7.2.10, for water related impacts). The loss of soil resources has a direct impact on the potential loss of the natural capability of the land. This section focuses directly on the potential for contamination of the soil resources and the effect this has on land capability.

In the construction and decommissioning phases, activities are temporary in nature, usually existing from a few weeks to a few months. The operational phase will present more long-term sources and the closure phase will present final landforms that may be susceptible to erosion carrying silt downstream of the site.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Earthworks Civil works General site management Transport systems Rehabilitation	TSF Waste rock dumps General site management Transport systems Rehabilitation	Demolition General site management Transport systems Rehabilitation	Maintenance and aftercare of rehabilitated areas and final land forms

Rating of impacts

<u>Severity/nature</u>

In the approved EIA and EMP report (Metago, 2008), the severity of losing soil resources and reducing land capability associated with the approved operations was rated high in both the unmitigated and mitigated scenarios.

The project components present similar sources of contamination in similar locations as for the approved operations. The project caters for an increased scale of facilities such as the open pits, TSF, WRDs and topsoil stockpiles. In this regard, the use and handling of potential contaminants and poor waste management could result in a permanent loss of soil resources. Potential seepage and/or dirty runoff from mineralised waste stockpiles could alter the soil composition, negatively impacting on the chemistry of the soils such that current growth conditions are impaired. Although there is no potential for acid rock drainage, possible leaching of aluminium and manganese, as well as, elevated salt loads (TDS) from the WRDs found in seepage/runoff waters could negatively impact soil resources. All aspects discussed above, will lead to a reduction and possibly a permanent loss of the natural capability of the soils if not mitigad. In the unmitigated scenario, assuming the absence of existing measures in place at the mine, the severity is high for all phases. With mitigation the severity can be reduced to medium to low depending on the reaction time of clean-up teams and the maintenance of pollution control facilities.

When considering the project's impact cumulatively with the approved operations, the severity rating for the overall mine when considering loss of resources due to contamination is high in the unmitigated scenario and reduces to medium to low with mitigation.

<u>Duration</u>

In the unmitigated scenario, most pollution impacts and associated loss in land capability will remain long after closure. In the mitigated scenario most of these potential impacts should either be avoided or be remedied immediately which reduces the duration to less than the project life. This will be achieved by the effective reaction time of the clean-up team and the chosen remediation methods.

<u>Spatial scale/extent</u>

In the unmitigated scenario, the potential exists for soils off site to be polluted by contaminated runoff or seepage from the mine site. In the mitigated scenario for all phases potential impacts will be restricted to within the mine boundary.

<u>Consequence</u>

In the unmitigated scenario the consequence is high. In the mitigated scenario the consequence is reduced to low as the severity and duration of the impact is reduced.

<u>Probability</u>

Without any mitigation measures in place, the impact is definite. The mitigation measures will reduce the probability to low because emphasis is placed on preventing pollution events and on quick and effective remediation if pollution events do occur.

<u>Significance</u>

In the approved EIA and EMP report (Metago, 2008), the significance of the approved operations was rated high in the unmitigated scenario and medium in the mitigated scenario. It is important to note that for the approved EIA and EMP, the loss of soil resources due to physical disturbance was assessed together with the loss of soil resources due to pollution.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine due to contamination is high in the unmitigated scenario and reduces to low with effective mitigation.

Assessment of cumulative on site impacts

Management	Severity/nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	M-L	L	L	L	L	L

Conceptual description of mitigation measures

Conceptual discussion of the mitigation measures is provided below and detailed in the EMP (Section 19).

<u>Objectives</u>

To prevent soil pollution.

<u>Actions</u>

In the approved EMP (Metago, 2008), it is outlined that:

- Tharisa will conduct all potentially polluting activities in a manner that pollutants are contained at source. In this regard Tharisa will ensure that:
  - all vehicles and equipment will be serviced in workshops and washbays with contained impermeable, floors, dirty water collection facilities and oil traps
  - all chemical, fuel, oil storage and handling facilities will be designed and operated in a manner that all spillages are contained in impermeable areas and cannot be released into the environment
  - ad hoc spills of potentially polluting substances (whether in dirty areas or in the environment) will be reported to the environmental manager immediately and cleaned up/remediated immediately;
  - a dirty water management system that complies with the requirements of Regulation 704 is implemented
  - the waste management practices, as set out in Table 7.2 below, are implemented (these have been updated to cater for the requirements of the new Waste Classification and Management Regulations, 2013).

TABLE 7.2: WASTE MANAGEMENT PRACTICES FOR DOMESTIC AND INDUSTRIAL WASTE

Items to be considered		**Intentions**
General	**Specific**	
Classification and record keeping	General	The waste management procedure for Tharisa will cover the storage, handling and transportation of waste to and from the mine. The mine will ensure that the contractor's responsible are made aware of these procedures.
	Waste opportunity analysis	In line with DWEA's strategy to eliminate waste streams in the longer term, Tharisa will assess each waste type to see whether there are alternative uses for the material. This will be done as a priority before the disposal option.

Items to be considered		Intentions
General	**Specific**	
	Classification	Wastes (except those listed in Annexure 1 of the new Waste Regulations) will be classified in accordance with SANS 10234 within one hundred and eighty (180) days of generation. Waste will be re-classified every five (5) years, or within 30 days of modification to the process or activity that generated the waste, changes in raw materials or other inputs, or any other variation of relevant factors.
	Safety data sheets	Tharisa will maintain, where required in terms of the Regulations, the safety data sheets for hazardous waste (prepared in accordance with SANS 10234).
	Inventory of wastes produced	Tharisa will keep an accurate and up to date record of the management of the waste they generate, which records must reflect: • the classification of the wastes; • the quantity of each waste generated, expressed in tons or cubic metres per month; • the quantities of each waste that has either been re-used, recycled, recovered, treated or disposed of; and • by whom the waste was managed.
	Labelling and inventory of waste produced	Any container or storage impoundment holding waste must be labelled, or where labelling is not possible, records must be kept, reflecting: • the date on which waste was first placed in the container; • the date on which waste was placed in the container for the last time when the container was filled, closed, sealed or covered; • the dates when, and quantities of, waste added and waste removed from containers or storage impoundments, if relevant; • the specific category or categories of waste in the container or storage impoundment as identified in terms of the National Waste Information Regulations, 2012; and • the classification of the waste in terms of Regulation 4 once it has been completed (if required).
	Disposal record	Written evidence of safe disposal of waste will be kept.
	Record keeping	Records will be retained for a period of at least 5 years and will be made available to the Department on request.
Waste management	Collection points	Designated waste collection points will be established on site. Care will be taken to ensure that there will be sufficient collection points with adequate capacity and that these are serviced frequently.
	Laydown/ salvage areas	During decommissioning and closure, lay down areas for re-usable non-hazardous materials will be established.
	General waste	Will be stored in designated skips and removed by an approved contractor for disposal at a licensed facility.
	Scrap metal and building rubble	Care will be taken to ensure that scrap metal and building rubble does not become polluted or mixed with any other waste. The scrap metal will be collected in a designated area for scrap metal (salvage yard). It will be sold to scrap dealers. Building rubble will be used to backfill mining voids
	Hazardous wastes	Medical waste, laboratory chemicals, explosives packaging, used chemicals and chemical containers will be temporarily stored in sealed containers in a bunded store before removal by an approved waste contractor and disposal in a licenced facility.
	Oil and grease	Oil and grease will be collected in suitable containers at designated collection points. The collection points will be bunded and underlain by impervious materials to ensure that any spills are contained. Notices will be erected at each waste oil point giving instructions on the procedure for waste oil discharge and collection. An approved subcontractor will remove oil from site.
	Any soil polluted by a spill	If remediation of the soil *in situ* is not possible, the soils will be classified as a waste in terms of the Waste Regulations and will be disposed of at an appropriate permitted waste facility.

Items to be considered		Intentions
General	**Specific**	
	Dried sewage sludge and screenings from the sewage plant	The first option is to make use of the sludge as part of the fertilising medium for re-vegetation of the tailings dam and other disturbed areas. Any excess sludge will be removed from site with the screenings as hazardous waste and disposed at a licensed facility.
	Mixing of wastes	Waste will not be mixed or treated where this would reduce the potential for re-use, recycling or recovery; or result in treatment that is not controlled and not permanent. Waste may be blended or pre-treated to enable potential for re-use, recycling, recovery or treatment; or reduce the risk associated with the management of the waste.
Disposal	Off site waste disposal facilities	Waste will be disposed of at appropriate permitted waste disposal facilities. For general waste is disposed of at the Lonmin landfill site near Mooinooi. For hazardous waste the closest permitted site is at Holfontein.
		Unless collected by the municipality, Tharisa must ensure that their waste is assessed in accordance with the Norms and Standards for Assessment of Waste for Landfill Disposal set in terms of section 7(1) of the Waste Act prior to the disposal of the waste to landfill.
		Unless collected by the municipality, Tharisa must ensure that the disposal of their waste to landfill is done in accordance with the Norms and Standards for Disposal of Waste to Landfill set in terms of section 7(1) of the Waste Act.
Waste transport	Contractor	A qualified waste management subcontractor will undertake the waste transport. The contractor will provide an inventory of each load collected and of proof of disposal at a licensed facility.
Banned practices	Long-term stockpiling of waste	Stockpiling of waste is a temporary measure. Waste stockpiling sites must have an impervious floor, be bunded and have a drainage system for collection and containment of water on the site.
	Burying of waste	No wastes other than mine residues will be placed on site.
	Burning of waste	Waste may only be burned in legally approved incinerators.

These measures will be applied to the project components, where applicable.

The environmental manager is responsible for implementing these actions, procedures and practices from the start of the construction phase through to closure.

Emergency situations

Major spillage incidents that have the potential to pollute soils both on and off site must be handled in accordance with Tharisa emergency response procedure.

BIODIVERSITY

7.2.6 ISSUE: PHYSICAL DESTRUCTION OF BIODIVERSITY

Introduction

There are activities/infrastructure in all phases that have the potential to destroy biodiversity in the broadest sense. In this regard, the discussion relates to the physical destruction of specific biodiversity areas, of linkages between biodiversity areas and related species which are considered to be significant because of their status, and/or the role that they play in the ecosystem.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
			N/A
Site preparation Earthworks General site management Rehabilitation	General site management Rehabilitation	Demolition General site management Rehabilitation	

Rating of impact

Severity/nature

High biodiversity areas are functioning biodiversity areas with species diversity and associated intrinsic value. In addition, some of these high biodiversity areas host several red data and protected species. The linking areas have value because of the role they play in allowing the migration or movement of flora and fauna between the areas of high biodiversity, which is a key function for the broader ecosystem. The transformation of land for any purpose, including mining and associated activities, increases the destruction of site-specific biodiversity, reduces its intrinsic functionality and reduces the linkage role that undeveloped land fulfils between different areas of biodiversity importance.

In the approved EIA and EMP report (Metago, 2008), the severity of impacts on biodiversity associated with the approved operations was rated high in the unmitigated scenario and was reduced to medium in the mitigated scenario.

The following is relevant with regard to biodiversity within the project area and specifically within the footprint areas of the project components:

- In terms of national guidelines, the project area is located within a high biodiversity area in terms of the Mining and Biodiversity guidelines and a terrestrial Critical Biodiversity Area. In addition, an aquatic Critical Biodiversity Area in terms of the North-West Province biodiversity conservation assessment report (2009) is located approximately 6 km to the south-west of the project area
- The project components will mostly be developed within the transformed (including old agricultural) habitat types, but some infrastructure will be developed within the scattered bushveld, rocky outcrop and wetland habitat (Figure 1.8). Wetland habitats are discussed separately below. While the transformed habitat unit has been significantly impacted upon by mining and agricultural activity and holds little biodiversity value, the rocky outcrop habitat does offer intact habitat and high levels of ecological functioning. The rocky outcrops are considered to have a high ecological sensitivity. Most of the rocky outcrop habitats identified within the project footprints were predicted to be impacted by the approved operations. The scattered Bushveld has been exposed to fewer disturbances than the transformed habitat and still hosts a reasonably high biodiversity and suitable habitat for a number of floral species such as the protected Morula tree. Patches of scattered Bushveld are located within the pit extension and north-east WRD footprints. Although these areas are fragmented and have been impacted by edge effects of mining and agriculture, physical destruction of the remaining patches is considered significant due to the limited presence of these within the area.

- There are flora species within the scaterred bushveld habitat type such as the Morula Tree that are protected in terms of the TNCO
- The project area is situated within the Magalies/Witwatersberg Important Bird Area and it is possible that Red Data Listed bird species may utilize the less disturbed parts of the project area for foraging and as a migratory corridor. Such species include the Cape Vulture, Martial Eagle, Peregrin falcon, Secretary bird and the African grass owl
- There are several wetlands identified by the NFEPA project within the project area however these have been assigned a "no importance" characterisation in the NFEPA ranking system
- Several wetlands identified by SAS (SAS, 2013 and 2014) will be affected by the development of project components. The present ecological state of these wetlands ranges from Category B (largely unmodified) in the case of Wetland 4 (in the north east WRD area) to C (moderately modified) for all other wetlands within the project footprint. The ecoservices and function provided by these wetlands ranges between 1.1 and 1.2 (moderately low) out of a possible ranking of 3. The Sterkstroom is rated as a 2 (moderately high) out of a possible ranking of 3
- Wetlands within the project sites are considered to have a high to low ecological sensitivity (Figure 1.8). The wetland and buffer associated with the Sterkstroom, which is rated as high, has been avoided
- Of the total project footprint of 276ha, approximately 64ha (23%) is within ecologically sensitive habitats. Given the position of the geology and space constraints of the area, this is unavoidable. The remaining project footprints are within transformed habitats.
- There is a stretch of the perennial Sterkstroom River approximately 2km long that falls within the dewatering cone of depression and may experience a partial or total loss of groundwater contribution to baseflow for the duration of dewatering. This could affect the biodiversity within this stretch of the river and downstrem.

Taking the above points into account, the severity of potential impacts of the project are rated as high in the unmitigated scenario. In the mitigated scenario, the severity reduces to medium (for floral and aquatic impacts) and medium-high (for impacts on faunal habitats) due to the loss of ecologically sensitive habitats.

When considering this impact cumulatively with the approved operations, the significance rating for the overall mine is high in the unmitigated scenario and medium-high in the mitigated scenario due to the loss of ecologically sensitive habitats.

<u>Duration</u>

In the unmitigated scenario, apart from protected plant species that can be removed through appropriate permitting processes, the loss of biodiversity could be permanent or have a long-term effect. With mitigation, the duration reduces to the life of the operation with the implementation of effective rehabilitation measures that take into consideration biodiversity aspects.

Spatial scale / extent

The loss of biodiversity could affect the ecosystem beyond the site boundary because of the linkages between biodiversity components and areas. This is particularly true for animals which may migrate on a periodic basis in search of food, water or breeding areas and for areas downstream of functional wetlands. This spatial scale cannot be significantly reduced with mitigation.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. With mitigation, the consequence reduces to medium.

Probability

Without mitigation the probability associated with the impact is definite. With mitigation, the probability is reduced to medium with the implementation of effective rehabilitation measures that take into consideration biodiversity aspects.

Significance

In the approved EIA and EMP report (Metago, 2008), the significance of impacts on biodiversity associated with the approved operations was rated high in the unmitigated scenario and was reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine is high in the unmitigated scenario. In the mitigated scenario this reduces to medium with the implementation of effective rehabilitation measures that take into consideration biodiversity aspects. Key to the mitigation is the re-establishment of wetland and rocky outcrop habitat at closure that replaces some of ecologically sensitive habitat lost within the project sites.

Assessment of cumulative on site impacts

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	M-H	M	M	M	M	M

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

Objective

The objective of the mitigation measures is to prevent the unacceptable loss of biodiversity and related ecosystem functionality through physical destruction.

<u>Actions</u>

In the approved EMP (June 2008), it is outlined that:

- Tharisa will implement a biodiversity action plan (BAP) that will be refined and implemented in consultation with a biodiversity specialist. This action plan will be in place prior to the construction phase of the mine and it will include the following management actions:
  - Tharisa will limit mine infrastructure, activities and disturbance to those specifically identified and described in the EIA and EMP report with controlled access and zero tolerance of disturbances to the identified sensitive habitats and associated species. As a general rule, a buffer of 100m will be put in place around sensitive habitats that are not disturbed by the approved activities;
  - If removal of protected vegetation species is required for the establishment of approved project infrastructure this may only be done if the required permits are in place;
  - The engineering design work of watercourse diversions, rehabilitation of headwaters and river crossings will be completed in consultation with a qualified ecologist with watercourse related expertise to limit the destruction of habitat and species and to promote re-establishment thereof. Where possible, pebbles, rocks and biodiversity will be re-established in the diversion and the diversion route will be scanned for sensitive fauna and flora prior to construction;
  - There will be planning on the removal of fauna and flora (plants and seeds) species prior to disturbance by mine infrastructure and activities. This will include planning on the preservation, cultivation and re-use of these species in ongoing rehabilitation. Links will also be made to the soil conservation procedure and actions; and
  - An alien/invasive/weed management programme will be implemented in collaboration with DAgric, DWA and Working for Water to control the spread of these plants onto and from disturbed areas. Care will be taken to prevent the encroachment of alien plant species into rehabilitated areas.
- There will be collaboration with the local land users on community grazing, medicinal plant harvesting, animal harvesting and fuel plant harvesting in a manner that promotes sustainable use of natural resources. This is particularly relevant for the sensitive habitats.

These measures will be applied to the project components, where applicable.

In addition to the above, the following conceptual management measures will be implemented:

- As part of the BAP, consideration will be given to rehabilitation efforts that allows for the re-establishment of wetland and rocky outcrop habitat types within the mine area that replaces some of ecologically sensitive habitat lost within the project site
- The following process will be implemented when the footprint areas are to be cleared and if new areas must be disturbed at a later stage in the life of the project:
  - Delineation of proposed area to be cleared or disturbed
  - Obtain any relevant permits for the removal of protected plant species and trees

  - Relocation of species that can effectively be relocated especially protected species and species of conservation concern. Relevant specialists will be consulted to get advice on species to focus on and appropriate relocation techniques. Where possible cordon off protected species such as Morula trees that will not be directly affected by the establishment of infrastucture
  - Cordon off any areas that are to be preserved within the overall area to be disturbed
  - Restoration of the ecosystem functionality, as far as is possible, in areas that have been physically rehabilitated
  - Follow up audits and monitoring, in the short and long-term, to determine the success of the relocation, rehabilitation and restoration activities in terms of a range of species and ecosystem function performance indicators
- Continuation of a biomonitoring programme (as outlined in Section 21.5)
- Workers (permanent and temporary) will be trained on the value of biodiversity and the need to conserve the species and ecosystems. This will be included in induction training as well as relevant follow-up training. This training will also address fire control and prevention
- Effective implementation of the following management plans provided in Section 19:
  - Surface and groundwater management plans
  - Soil management plan
  - Dust management
  - Waste management
- Concurrent and final rehabilitation of residue facilities
- As part of closure planning, the designs of any permanent structures (residue facilities) will take into consideration the requirements for the establishment of long-term species diversity using endemic species, ecosystem functionality, aftercare and confirmatory monitoring.

Emergency situations

None identified.

7.2.7 ISSUE: GENERAL DISTURBANCE OF BIODIVERSITY

Introduction

There are a number of activities/infrastructure that have the potential to disturb vegetation and fauna in all project phases, particularly in the unmitigated scenario. In the construction and decommissioning phases these activities are temporary in nature, usually existing for a few weeks to a few months. The operational phase will present more long term occurrences and the closure phase will present final land forms (rehabilitated areas).

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
			N/A
Site preparation Earthworks General site management Rehabilitation Transport	General site management Rehabilitation	Demolition General site management Rehabilitation Transport	

Rating of impact

Severity / nature

In the approved EIA and EMP report (Metago, 2008), the severity of impacts on biodiversity associated with the approved operations was rated high in the unmitigated scenario and was reduced to medium in the mitigated scenario.

In the unmitigated scenario, biodiversity will be disturbed by the project components in the following ways:

- Where additional lighting is required, lighting can attract large numbers of invertebrates which become easy prey for predators. This can upset the invertebrate population balances.
- Noise and vibration from project activities may scare off vertebrates and invertebrates. In some instances the animals may be deterred from passing close to noisy activities which can effectively block some of their migration paths. In other instances, vertebrates and invertebrates that rely on vibration and noise senses to locate for, and hunt, prey may be forced to leave the vicinity of noisy, vibrating activities.
- Harvesting and killing of plant and animal species in adjacent areas for medicinal use, food, fire wood, for sport, and persecution of predators such as jackal. This could reduce populations of smaller ungulates e.g. Porcupine, and cause the loss of non-target species from indiscriminate trapping methods. Increased wood harvesting could cause a loss of cover for faunal species and tree nesting habitat for birds
- Changes to road infrastructure may result in an increase in road kills
- Blasting from extending the open pit could harm species in the fly rock zone
- Dust deposition can cause soiling of vegetation which can reduce growth and productivity and can lead to vegetation die-off. In the case of animals, grazing on soiled vegetation over extended periods reduces teeth life which can reduce animal life expectancy
- Contamination of water and soil and general litter as well as dust may directly impact on the survival of individual plants, vertebrates and invertebrates and downstream ecosystems.

The disturbance of biodiversity has been rated as having a high severity during all project phases. This can however be reduced to low with the implementation of management and mitigation measures.

When considering this impact cumulatively with the approved operations, the severity rating for the overall mine is high in the unmitigated scenario and medium in the mitigated scenario.

Duration

In the unmitigated scenario, the impacts will continue for the life of the project. In the mitigated scenario, this reduces to medium.

Spatial scale / extent

The disturbance of biodiversity could affect the ecosystem beyond the site boundary because of the linkages between biodiversity components and areas. This is particularly true for animals which may migrate on a periodic basis in search of food, water or breeding areas. This spatial scale cannot be significantly reduced with mitigation.

Consequence

In the unmitigated scenario, the consequence of this potential impact is high. In the mitigated scenario, this reduces to medium because the severity and duration of the impact is reduced.

Probability

Without any mitigation the probability of negatively impacting on biodiversity through multiple disturbance events as a result of the project components is high. With mitigation, the probability will be reduced to medium because most of the disturbances can be controlled through implementation and enforcement of practices, policies and procedures.

Significance

In the approved EIA and EMP report (Metago, 2008), the significance of the impact associated with the approved operations was rated high in the unmitigated scenario and was reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine is high in the unmitigated scenario and medium in the mitigated scenario.

Assessment of cumulative on site impacts

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	M	M	M	M	M	M

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Sections 19).

Objective

The objective of the management measures is to prevent unacceptable disturbance of biodiversity and related ecosystem functionality.

<u>Actions</u>

The following management and mitigation measures will be implemented during the construction, operation and decommissioning phases:

- The use of light will be kept to a minimum, and where it is required, yellow lighting will be used where possible
- Workers (permanent and temporary) will be trained on the value of biodiversity and the need to conserve the species and ecosystems, as well as fire control and prevention. This will be included in induction training as well as relevant follow-up training.
- There will be zero tolerance with respect to the killing or collecting of any biodiversity by anybody working for or on behalf of Tharisa within or adjacent to the mine area
- Strict speed control measures will be implemented on access roads and vehicles will be restricted to travel on designated roads
- Alien plant species proliferation, which may affect floral and faunal diversity, will be controlled in accordance with legislation and in a manner that no additional loss of indigenous plant species occurs
- Effective implementation of the following management plans provided in Section 19:
  - Surface and groundwater management plans
  - Soil management plan
  - Dust management plan
  - Waste management plan
  - Noise management plan
  - Blast management plan
- Concurrent and final rehabilitation of the residue facilities
- Concurrent rehabilitation of areas no longer required for mining activities with a particular focus on establishing indigenous vegetation cover
- As part of closure planning, the designs of any permanent and potentially polluting structures (residue facilitiesp) will take consideration of the requirements for long-term ecosystem functionality, pollution prevention and confirmatory monitoring.

Emergency situations

None identified.

SURFACE WATER

7.2.8 ISSUE: ALTERATION OF SURFACE DRAINAGE PATTERNS

Introduction

There is a stormwater management system at the mine and therefore pre-mining drainage patterns have been altered to a certain extent. Surface drainage patterns can be further altered through changes to this stomwater management system to accommodate the project components, which may reduce the volume of runoff entering a watercourse and lead to a reduction in flows; and development within the floodlines which may impede conveyance within the channel increasing flood levels upstream of the development.

Impacts on biodiversity are discussed in Sections 7.2.6and 7.2.7. Impacts on flow of rivers and non-perennial drainage lines is discussed in Section 7.2.11. This section therefore focusses on losses to the catchment and impacts on downstream domestic users.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Earthworks Civil works Genial site management Rehabilitation Transport systems	General site management Open pit Waste rock dumps	Demolition General site management Rehabilitation	Maintenance and aftercare of final rehabilitated areas

Rating of impacts

<u>Severity/nature</u>

In the approved EIA and EMP report (Metago, 2008), the severity of damaging the headwaters of the non-perennial tributaries by the open pits (east and west pit) as well as the encroachment of two waste rock dumps on the 100m buffer zones around watercourses was not considered significant because these watercourses were not well defined or easily identifiable. However, the report considered the placement of the tailings dam (TSF2) on a tributary of the Elandsdriftspruit to be more significant because it would affect downstream ecosystems, promote erosion of watercourse banks, prevent the flow of water to limited downstream users and cause flooding at the alteration. The report also noted that natural drainage patterns would be altered by the containment of rainfall and contaminated runoff in compliance with R704. Therefore the severity was rated as high in the unmitigated scenario and was reduced to medium in the mitigated scenario. A key mitigation measure was the diversion of the Elandsdriftspruit tributary around the TSF site.

There are a number of drainage lines draining the mine site. Most of these are non-pereniial in nature. The more significant drainage line is the Sterkstroom River. The changes to surface infrastructure will alter drainage patterns as follows:

- the east waste rock dump has been sited immediately downstream of the eastern open pit and over the non-perennial Maretlwane tributary – the headwaters of this tributary were destroyed in line with the approved EIA and EMP report (Metago, 2008) through the open pit mining activities at the eastern open pit
- the north east waste rock dump lies over two non-pereniial tributaries of the Marletwane River
- the west waste rock dump encroaches on the 100m buffer zone of a tributary of Brakspruit – the destruction of the headwaters of this tributary was included in the approved EIA and EMP report (Metago, 2008) as a result of the open pit mining activities at the western open pit
- the west pit and central waste rock dump will encroach on the 100m buffer zone of the Sterkstroom River.

When considering the containment of rainfall and runoff (stormwater) for the mine, including the project footprints, in compliance with R704 and as per the stormwater management plan outlined in Section 19, the following is noted:

- Stormwater from a total mine area of 9.3km^2 will be contained and will be re-used by operations at the mine
- The impacts of the mine on the MAR of the surrounding watercourses during the operational phase of the mine has been estimated and ranges between 0% and 27% – refer to Table 7.3 below
- The impacts of the mine on the MAR of the surrounding watercourses after closure (i.e. after rehabilitation in line with the conceptual closure plan outlined in Section 2.8) has been estimated and ranges between 0% and 23% – refer to Table 7.3 below
- The total reduction in MAR for the quaternary catchment for the operational phase of the mine has been estimated at 1.1% (operational phase) and 0.6% (post closure) – refer to Table 7.3 below

TABLE 7.3: REDUCTION IN MEAN ANNUAL RUNOFF FOR OPERATIONS AND POST CLOSURE

Catchment	**Reduction in MAR**	
	million m^3/year	**%**
Operational phase		
Sterkstroom (downstream of Buffelspoort Dam and upstream of the confluence with Brakspruit)	0.064	5.5%
Elandsdriftspruit tributary (upstream of confluence with Elandsdriftspruit)	0.040	23.8%
Brakspruit tributaries (upstream of confluence with Brakspruit)	0.016	2.9%
Western Maretlwane tributaries (upstream of confluence with Maretlwane)	0.118	27.0%
Eastern Maretlwane tributaries (upstream of confluence with Maretlwane)	0.037	11.9%
A21K	0.238	1.1%
Post closure		
Sterkstroom (downstream of Buffelspoort Dam and upstream of the confluence with Brakspruit)	0.041	3.5%

Catchment	**Reduction in MAR**	
	million m^3/year	**%**
Elandsdriftspruit tributary (upstream of confluence with Elandsdriftspruit)	0.000	0.0%
Brakspruit tributaries (upstream of confluence with Brakspruit)	0.000	0.0%
Western Maretlwane tributaries (upstream of confluence with Maretlwane)	0.101	23.1%
Eastern Maretlwane tributaries (upstream of confluence with Maretlwane)	0.007	2.3%
A21K	0.142	0.6%

Taking the above discussion in account, the overall loss of MAR to the individual streams and quarternary catchment due to changes in mine infrastructure is considered to be a low severity in both the unmitigated and mitigated scenarios.

When considering the above cumulatively with the approved operations, the significance rating for the overall mine remains unchanged.

<u>Duration</u>

The alteration of drainage patterns will be long-term and extend beyond the life of the project due to remaining waste rock dumps and partially backfilled pits. The duration cannot be significantly reduced with mitigation.

<u>Spatial scale/ extent</u>

In the unmitigated scenario, the alteration of drainage patterns could extend beyond the project boundaries to downstream users. With mitigation this can be contained to the project site.

<u>Consequence</u>

The consequence is high in the unmitigated and reduces to medium with mitigation.

<u>Probability</u>

The probability is high and reduces to moderate in the mitigated scenario.

<u>Significance</u>

In the approved EIA and EMP report (Metago, 2008), the significance of the approved operations was rated high in the unmitigated scenario and reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine remains unchanged.

Assessment of cumulative on site impacts

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	M	H	L	M	M	M

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

Objective

The objective of the mitigation measures is to minimise the alteration of the drainage patterns in the project area.

Actions

In the approved EMP (Metago, 2008), it is outlined that:

- The Elandsdriftspruit stream diversion and conveyor river crossing detailed designs will be in accordance with the requirements of Regulation 704, the requirements of DWA as stipulated in the water licence, and will be designed and implemented by an appropriately qualified engineer
- In these designs, considerations will be given to the biodiversity and rehabilitation requirements as outlined in the EIA and EMP report
- The footprint and associated catchment of all project infrastructure will be minimised to limit the impact on stream flow reduction.

These measures will be applied to the project components, where applicable.

In addition, the following measures will be implemented:

- Tharisa will apply for authorisation with respect to all relevant water uses and R704 exemptions required
- Clean and dirty water will be separated and clean water will be diverted around dirty areas and allowed to return to its normal flow path as outlined in the stormwater management plan
- At the north east WRD, further work will be undertaken in line with the recommendations of the hydrology specialist (see Section 2.7.4.5) to determine the best means of addressing clean surface water runoff upstream of the site
- Site rehabilitation will aim to restore surface drainage patterns as far as practically and economically feasible.

Emergency situations

Any significant breach containment facilities is considered an emergency situation.

7.2.9 ISSUE: CONTAMINATION OF SURFACE WATER RESOURCES

Introduction

On site and off site (downstream of project-related infrastructure and activities) surface water resources could be polluted if there are discharges of contaminated substances into these resources. Pollution of water resources can have negative health impacts on both people and animals, and it can negatively impact on the water course related biodiversity. Biodiversity related impacts are discussed in Section 7.2.7.

In the construction and decommissioning phases these potential pollution sources are temporary in nature, usually existing for a few weeks to a few months. Although these sources may be temporary, the potential pollution may be long term. The operational phase will present more long term potential sources and the closure phase will present final land forms that may have the potential to contaminate surface water through long term seepage and/or run-off.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Earthworks Civil works Genial site management Rehabilitation Transport systems	Transport systems General site management Chrome sand plant TSF Waste rock dumps	Demolition General site management Transport systems Rehabilitation	Maintenance and aftercare of final rehabilitated areas

Rating of impacts

<u>Severity/nature</u>

In the approved EIA and EMP report (Metago, 2008), the severity of impacts from the approved operations was rated high in the unmitigated and medium in the mitigated scenarios.

For the project components, in the unmitigated scenario, during the construction phase, pollution sources include sedimentation from erosion, and spillage of construction solvents, paint, fuel, oil, and cement. During operation and decommissioning phases pollution sources include spills of fuel and oil, contaminated discharges from the dirty water systems including: the pits, tailings dam, waste rock dumps, return water dam, chrome sand drying plant, dirty water and waste pipelines, machinery maintenance workshops, fuel depot and salvage yard and sedimentation from erosion. The use of the Hernic quarry to store excess water presents a quality risk to the river in close proximity to it. This amounts to a high severity in the unmitigated scenario and reduces to medium in the mitigated scenario.

When considering this impact cumulatively with the approved operations, the severity rating for the overall mine is high in the unmitigated scenario and reduces to medium in the mitigated scenario.

<u>Duration</u>

The pollution of surface water resources could have long-term effects on both people and animals during all project phases. The implementation of mitigation measures could reduce the duration.

<u>Spatial scale/extent</u>

In both the unmitigated and mitigated scenarios for all phases of the project, there is potential for contamination to extend beyond the site boundary (worst case).

<u>Consequence</u>

In the unmitigated scenario, the consequence is high. In the mitigated scenario the consequence is medium as the severity and duration of the impact is reduced.

<u>Probability</u>

In the unmitigated scenario it is likely that there will be significant pollution incidents that have a real possibility of impacting downstream users. The probability is therefore rated as high in the unmitigated scenario. This can be reduced to low with the implementation of mitigation measures that contain pollution at source or enable fast remediation.

<u>Significance</u>

In the approved EIA and EMP report (Metago, 2008), the significance of the approved operations was rated high in the unmitigated scenario and was reduced to low in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine is high in the unmitigated scenario and reduces to low in the mitigated scenario.

Assessment of cumulative on site impacts

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	M	M	M	M	L	L

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

<u>Objective</u>

The objective of the mitigation measures is to prevent pollution of surface water.

<u>Actions</u>

In the approved EMP (Metago, 2008), it is outlined that:

- In regard to soil/erosion management, pollution prevention and management, and waste management, the procedures, practices and actions will be implemented.
- The clean and dirty water systems will be implemented and managed in accordance with the provisions of Regulation 704 for water management on mines. In this regard:
  - clean water will be diverted around operational areas;
  - areas in which hazardous and/or polluting substances can be spilled will be minimised and contained. The storage method of all these substances is to contain them in sealed containers within impermeable, bunded areas with sufficient capacity to contain spilled materials (in accordance with SANS 10089-1:2003). All spilled materials must drain to sumps with oil traps that must also be equipped to allow collection and removal of spilled substances; and
  - all other dirty water will be contained in the dirty water run-off and/or process water system that comprises dirty water pipes, channels and dams, and from which dirty water will be reused rather than discharged to the environment. These systems will be routinely inspected to detect possible breaches and implement preventative or corrective action.
- Tharisa will implement a monitoring programme of surface water in the vicinity of its operations and when possible (during the rainfall season) this will include surface water sampling points both up and downstream (where possible) of the mining operations in the following water courses: the perennial Sterkstroom, the unnamed tributaries of the Brakspruit, the Maretlwane and the Elandsdriftspruit.
- Should any contamination be detected the mine will immediately notify DWA. The mine, in consultation with DWA and an appropriately qualified person, will then notify potentially affected users, identify the source of contamination, identify measures for the prevention of this contamination (in the short term and the long term) and then implement these measures.
- The environmental and engineering managers are responsible for implementing these actions from prior to construction through to closure.

These measures will be applied to the project components, where applicable.

In addition, the following measures will be implemented:

- The surface water monitoring programme will be adjusted to cater for the changes in surface infrastructure – refer to Section 21.1
- The revised stormwater management plan outlined in Section 2.7.4.5 will be implemented
- Where water levels within the containment dams do not allow for provision of a 1:50 year 24 hour duration storm event, the daily timestep water balance recommended as part of the detailed design of these facilities should be reviewed and updated.

- Management measures to be inmplemented to address the water contamination risk posed by the use of Hernic Quarry to store contaminated water includes:
  - Flood Protection Measures – a flood protection bund shall be constructed between the river and the quarry, to prevent water within the Sterkstroom from mixing with dirty water within the quarry. The top of the flood bund shall be situated at or above the 1:50 year flood level and include a 800mm freeboard to take into account possible turbulence in the channel during a flood event. The top of the flood bund should be no lower than 1189.96 metres above mean sea level. The flood bund must be designed to ensure that it can withstand erosion during a flood event, that it is structurally stable and does not compromise the integrity of the quarry sidewalls
  - Water Level Management – in order to prevent seepage from the quarry to the river, water levels within the quarry must be maintained lower than the river, ensuring that any seepage is likely to be from the river into the quarry and not from the quarry into the river. In order to achieve this, the following will be implemented:
    - Monitoring of water levels in the quarry
    - A daily timestep water balance model will be developed to assess the capacity of the quarry and inform the inflow and outflow rates.

Emergency situations

Any significant pollution incident is considered an emergency situation.

GROUNDWATER

7.2.10 ISSUE: GROUNDWATER CONTAMINATION

Introduction

There are activities associated with the changes in infrastructure and operations at the mine that have the potential to pollute groundwater. These activities include the the extended TSF, deeper open pit operations, re-alignments, reshaping and addition of the waste rock dumps and diffuse sources such as adhoc spills. Although pollution sources are temporary in nature with the exception of the TSF and waste rock dumps, the potential for pollution may be long term. The operational phase will present more long-term potential sources.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Earthworks Civil works General site management Rehabilitation Transport systems	Transport systems General site management TSF Waste rock dumps	Demolition General site management TSF Waste rock dumps (that remain on surface) Transport systems Rehabilitation	Maintenance and aftercare of final rehabilitated areas including TSF and waste rock dumps

Rating of impacts

Severity / nature

In the approved EIA and EMP report (Metago, 2008), the severity of impacts on groundwater resources associated with the approved operations was rated high in the unmitigated and mitigated scenarios.

The deepening of the open pit mining operations (from 120m to an average of 180m), increase in waste rock and TSF storage and the related increase in size has the potential to increase diffuse pollution that has the potential to seep and enter the groundwater system. According to the groundwater specialist study (SLR, 2014b), there will be localised moulding of groundwater within the mine boundaries with a potential surface-groundwater interaction along drainage systems downstream of the pollution sources. Due to the groundwater mounding effect below the mine residue deposits, there is potential for off-site migration.

A source term concentration of 500mg/l sulphate should be used in this discussion which is in line with what was applied in the approved EIA and EMP report (Metago, 2008).

The simulated pollution plumes predict the following key points (SLR, 2012b):

- The plumes from the TSFs migrate northwards and after 20 years extend around 700 meters, and after 40 years around 1200 meters from their respective footprints and reach the east WRD. Pollution of both the east WRD and TSF has a cumulative impact on the plume migrations. After 150 years the TSF plume migrates northwards together with the associated east WRD's plume. The source concentration after 150 years is less than 30% of the original source concentration associated with the TSFs. The intersection and capturing of any pollution plume by the mine's dewatering activities would reduce the extent of the plume migration.
- The plumes from the WRDs migrate northwards and extend between 600 and 800 meters after 20 years, between 1200 and 1500 meters after 40 years, and more than 3000 meters after 150 years from their respective footprints. After 150 years the source concentration associated with the west WRD is less than 10% and the east WRD is less than 40% of the original source concentration. The higher percentage associated with the east WRD can be attributed to the cumulative impact from the TSFs. The intersection and capturing of any pollution plume by the mine's dewatering activities would reduce the extent of the plume migration.
- It is likely that the seepage plumes emanating from the residue facilities which intercept watercourse headwaters will reach surface watercourses via groundwater flow within the first few years of deposition of waste rock and tailings, which provides the potential for off-site migration (if surface runoff or shallow groundwater flow is not contained). However, contaminant concentrations are expected to become quickly diluted along the surface watercourses.
- The Hernic quarry is located on the western edge of the eastern pit. The western-most edge of the quarry is situated approximately 20 to 30 metres from the Sterkstroom River at its nearest point. The quarry is approximately 16 m deep at its deepest point. The quarry is used as a water overflow or

storage facility by the mine. Actual water levels in the quarry fluctuate according to the mine's requirements, rainfall, and other factors, but are thought to be below the Sterkstroom River bed elevation for most or all of the time. The Hernic quarry will potentially act as a source of pollution of both local groundwater and the Sterkstroom River if its water level exceeds that of the receiving environment. The actual relationship between potential contaminants in the quarry and the local environment (including the river) is more complex since it depends on the relative water levels, the hydraulic characteristics of the surrounding area (and the river bed), and pumping at the nearby pits. It is considered unlikely that the water level in the quarry will exceed the water level in the river for enough time to allow pollutants to move from the quarry to the river.

It should be noted that although the plume modelling assumes that the 2 m layer of in-situ clay-rich soil (residual clay "black turf" soil) would remain under the TSF to inhibit downward movement of leachate, a conservative seepage rate was used. The plume modelling is therefore considered a worst case scenario and assumed a higher rate of seepage from the TSF. The Department of Water Affairs (DWA) has recommended that the in-situ clay layer beneath the TSF walls (consisting of waste rock) be removed so as to avoid differential settlement of the walls and to improve the overall stability of the TSFs (Epoch, 2012b).

The shallow weathered aquifer is the first receptor of contaminants from surface sources and represents the pathway through which contaminants will migrate to surface watercourses downstream of the pollution sources. The pollution plume migration simulation shows that pollution from residue facilities is likely to reach boreholes used by people for domestic use (mainly to the north of the TSF) and surface watercourses. However a concentration of 500mg/l of sulphate is unlikely to extend far beyond the footprint bounadries. At this concentration there is unlikely to be adverse health effects on either livestock or people, but it can cause sensitive people to develop diarrhoea and so should be considered as contamination (Metago, 2008). This represents an impact of high severity in the unmitigated scenario, which is unlikely to be reduced with mitigation because the plumes are predicted to reach other water users at a relatively early phase of the project.

When considering this impact cumulatively with the approved operations, the severity rating for the overall mine is high in the unmitigated and mitigated scenarios.

<u>Duration</u>

In the unmitigated and mitigated scenarios, the potential pollution and in turn the potential for health impacts on third party water users could extend beyond the life of the project.

<u>Spatial scale / extent</u>

Unmitigated groundwater pollution impacts are likely to extend beyond the project boundaries. This is a high spatial scale. With mitigation, groundwater pollution impacts will be prevented by mitigating potential groundwater pollution and undertaking good housekeeping in the mine workings. The spatial scale in the mitigated scenario therefore reduces to medium.

Consequence

The unmitigated consequence is high. With mitigation this reduces to medium.

Probability

In the unmitigated scenario, which assumes no mitigation and no intersection of pollution plumes by the mine's dewatering activities, it is likely that contamination with health-related impacts will reach third party boreholes and surface watercourses. With mitigation measures, including the intersection and capturing of any pollution plume by the mine's dewatering activities the probability of this impact occurring reduces to medium to low. This is dependent on the number of groundwater users within the impact zone.

Significance

In the approved EIA and EMP report (Metago, 2008), the significance of the impact associated with the approved operations was rated high in the unmitigated scenario and was reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine is high in the unmitigated scenario and reduces to medium with mitigation.

Assessment of cumulative on site impacts

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	H	H	M	M	M	M

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

Objective

The objective of the mitigation measures is to prevent pollution of groundwater resources and related harm to water users.

Actions

In the approved EMP (Metago, 2008), it is outlined that:

- Prior to the commencement of the mine, Tharisa will conduct a detailed hydrocencus of all boreholes that are in use in the potentially affected zones to verify whether there are additional boreholes to those that have already been identified. This hydrocencus will confirm the borehole location, water depth, water quality and water use for each identified borehole. All potentially affected boreholes will be included in the water monitoring programme for boreholes located both on and off the mine site as described below.

- Boreholes, adjacent to the tailings facility and between the tailings facility and the potentially affected third party boreholes, the Sterkstroom and any other non-perennial water courses in the potential impact zone, will be part of the monitoring programme. If contamination is detected Tharisa will consult with an appropriate specialist and with DWAF (now DWA) to design and implement a treatment solution. In the short term, this may involve the capturing of the pollution plume by means of scavenger boreholes and the treatment and/or reuse of the polluted water.
- The long term post closure options for pollution prevention and/or water abstraction and treatment will also form part of the management measures that are designed and implemented in the next phase of the project development. In this regard, the groundwater model should be recalibrated to take into account alternative options of preventing long term seepage from the tailings dam. The options available are a covering or a lining. In the scenario where a covering is used, the recalibrated model must take into account the reality that seepage from the tailings dam can be stopped at some point with a cover, once the head of water within the dam has been reduced through seepage over time.
- If any mine related contamination and loss of water supply is experienced by the borehole users, Tharisa will provide compensation which could include an alternative water supply of equivalent water quality.
- The environmental manager is responsible for implementing these actions from prior to construction through to closure.

These measures will be applied to the project components, where applicable.

In addition, the following measures will be implemented:

- The additional WRD, changes to the existing WRDs and TSF will be implemented in accordance with the information provided in the project description (Section 2), on which the contaminant pollution plume modelling was conducted
- The current groundwater monitoring network will be extended to replace boreholes that were lost due to the pit and TSF construction as well as those that neighbouring landowners have requested to be included
- The current groundwater monitoring network will be updated to address the changes to the mine layout – refer to Section 21.1
- The groundwater model will be updated once additional information on water levels, pit inflows, and contaminant source concentrations and seepage rates from the TSFs become available
- Where the Hernic Quarry is used for the transfer or storage of dirty water, the following mitigation measures will be implemented:
  - Seepage Management Measures – an assessment of the groundwater flow directions in the vicinity of the quarry will be undertaken to assess the ultimate fate of any pollutants which will seep from the quarry. Design and implementation of groundwater management measures will be

undertaken and may include installation of a groundwater flow barrier e.g. grout curtain, installation of series of boreholes and active management of pollution plume by pumping.

Emergency situations

Major spillage incidents that have the potential to pollute groundwater both on and off site must be handled in accordance with Tharisa emergency response procedure.

7.2.11 ISSUE: REDUCTION IN GROUNDWATER LEVELS/AVAILABILITY

Introduction

A reduction in ground water levels could impact on the flow of streams as well as groundwater resources used by third parties. Local communities use perennial streams and groundwater in the area for domestic and agricultural (livestock watering and irrigation) purposes. The main activities influencing ground water levels are dewatering to ensure safe operations at the open pits and the abstraction of groundwater for mine water supply. The impacts on biodiversity have been assessed in Section 7.2.7 therefore this section focuses on third party groundwater users and associated land uses.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Mine water supply	Dewatering of open pits Mine water supply	Rehabilitation of open pits	Final void – partially backfilled

Rating of impacts

Severity/nature

In the approved EIA and EMP report (Metago, 2008), the severity of reducing groundwater levels associated with the approved operations was rated high in the unmitigated scenario for both third party users and effects on baseflow of watercourses. This reduced to low and medium, respectively, in the mitigated scenario.

A new model was developed to understand the impacts of the mine as a whole including the project components. As for the previous assessment, limitations exist with regards to the influence of dewatering/abstraction by existing mines and farms in the surrounding area. The discussion below focuses on Tharisa's cumulative on-site impact.

The shallow weathered aquifer (3m to 30m below ground level), as well as the alluvial aquifer (replaces the weathered aquifer in areas close to the Sterkstroom River), is expected to support most irrigation and domestic water-supply boreholes throughout the region. There is believed to be limited connectivity between the shallow weathered aquifer and the deeper fractured aquifer.

The model predicted the following during the operational phase (SLR, 2014b):

- The predicted groundwater inflow rate for both pits combined is 3900m^3/d (about 45L/s). This compares with total inflow rates of 34.1L/s calculated for the approved pit shells (WGC, 2007). The pits capture groundwater, which would have under natural conditions fed springs, discharged into the alluvial aquifers, provided flow to the streams/rivers, or contributed to regional groundwater flow
- Dewatering of the open pits at full depth and at a maximum rate is likely to lead to a cone of depression extending about 0.5 to 2.0 km from the pit boundary elongated in a northerly direction with the regional groundwater flow. The drawdown close to the pits is likely to be substantial but is expected to reduce to within a few metres depth at a distance of 0.5 to 1 km from the pits
- Perched groundwater and poor contact between the two aquifers (upper and lower) in places could however leave the upper aquifer partially or fully saturated whilst the piezometric surface in the lower aquifer drops (i.e. while there may be a drop in water levels in the lower aquifer, there may not be significant water level drop in the upper aquifer in places), therefeby moderating the impact on shallow third-party boreholes in the cone of depression. As a worst-case scenario it should be assumed that all third party groundwater users (i.e. third-party boreholes) falling within the cone of depression could be impacted by the cone of depression.
- It is predicted that for the stretch of the perennial Sterkstroom River, approximately 2km long, that falls within the cone of depression, groundwater baseflow contribution to the river is likely to be reduced or stopped altogether and the river may lose water to the aquifer along this stretch. The exact volume of water lost will depend on the hydraulic characteristics of the river bed as well as the presence of any perched groundwater or surface water (e.g. the quarry) within the cone of depression which could continue to contribute baseflow in places or at certain times (e.g. following rainfall). This volume has not been calculated due to uncertainties about the various parameters, but could be estimated by measuring river flows upstream and downstream of the mining area.
- Make-up water is currently sourced from boreholes located on the mine property. According to the latest water balance (Section 2.7.4.2), between 3,064m^3/month (wet season) and 6,347m^3/month (dry season) of makeup water must be sourced from the wellfield (SLR, 2014a). This is the equivalent of about 1.2L/s (wet season) and 2.4L/s (dry season), if pumping continuously. These volumes are only a small proportion of the anticipated total groundwater inflows into the pits at full depth, and have not been modelled separately because these abstractions are not significant and are not expected to impact on third party water users. Furthermore, at full pit depth, when groundwater inflows into the pits are at their highest, it may not be necessary to abstract water from the wellfield at all at times during the wet season.

After cessation of mining operations the water level in the pits is expected to slowly rebound. It is expected that the pits will be partially backfilled, but it is difficult to predict whether a pit lake will form in the remaining pit portion/s. However, it is expected that due to evaporation exceeding inflow (evapotranspiration is predicted to be greater than rainfall and runoff) the remaining open pit portion/s will act as a sink with an associated zone of depressed water levels.

When considering the overall mine, the severity of the impact on third party users as well as the potential reduction in baseflow contribution to watercourses is rated as high in the unmitigated scenario. This severity can be reduced to low for third parties by providing an alternative water supply of equivalent or better quantity and quality if any mine related loss of water supply is experienced by third parties, or by reaching a compensation agreement with those affected. However, based on the model predictions, the potential reduction to baseflow contributions to watercourses would only be reduced once dewatering and abstraction activities cease i.e. post closure when the groundwater level rebounds to approximate pre-mining levels. This results in a high severity for all phases until closure where it reduces to medium to low depending on how groundwater levels rebound.

<u>Duration</u>

In the unmitigated scenario, assuming the full extent of the open pits is left open, although water levels will rebound once dewatering stops, the pits will act as a sink and water levels will not reach the pre-dewatering level due to evaporation eventually exceeding inflow (rainfall and runoff) in the pits. The potential impact on the nearest groundwater users and the flow of streams will therefore extend beyond closure. With mitigation which involves rehabilitation during the operational phase for the bulk of the open pits and partial backfilling of the final void at decommissioning, water levels post closure will rebound with time to approximate pre-mining water levels. It is therefore expected that flow contributions to watercourses will also approximate pre-mining conditions.

<u>Spatial scale / extent</u>

Dewatering associated with the open pits is likely to lead to a cone of depression extending about 0.5 to 2.0km from the pit boundaries (SLR, 2014b). Without mitigation this could At closure, the water levels are expected to recover and the spatial scale could reduce to somewhere between medium and low.

<u>Consequence</u>

When considering the potential reduction in availablility to other water users, the consequence in the unmitigated scenario is high and in the mitigated scenario it is low. The consequence of the potential reduction to flow contributions to watercourses is high which can only be reduced once dewatering and abstraction activities cease i.e. post closure when the groundwater level rebounds to approximate pre-mining levels.

<u>Probability</u>

The probability of third party groundwater users suffering a loss of water, to varying extents, through the mine's dewatering activities is possible in the unmitigated scenario for all phases. This also applies to a reduction in flow contributions to watercourses. The probability of an impact of a reduction of groundwater availability to other water users can be reduced to low by providing those with an alternative water supply of equivalent or better quantity and quality if any mine related loss of water supply is experienced by third parties, or by reaching a compensation agreement with those affected. However, the probability of the potential reduction in flow contributions to watercourses can only be reduced upon cessation of dewatering and abstraction activities.

<u>Significance</u>

In the approved EIA and EMP report (Metago, 2008), the significance of the impact associated with the reduction of groundwater availability for other water users was rated high in the unmitigated scenario and low in the mitigated scenario. This report rated the significance of the potential reduction of baseflow contribution to watercourses as high in the unmitigated scenario and moderate in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, for the potential reduction in groundwater availability for other water users, the significance rating for the overall mine is high in the unmitigated scenario and reduces to low with mitigation. For the potential reduction in baseflow contribution the cumulative significance is high in the unmitigated scenario. With mitigation that looks at pro-active monitoring of flow in the Sterkstroom River and remediation measures that consider simulating natural flow where flow is affected by mining activities, reduces the significance to medium depending on the effectiveness of these measures.

Assessment of cumulative on site impacts – availability to other water users

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	M	H
Mitigated	L	L	M L (at closure)	L	L	L

Assessment of cumulative on site impacts – contribution to baseflow in the Sterkstroom

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	M	H
Mitigated	H L (at closure)	M	M M-L (at closure)	M L (at closure)	M	M

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19)

<u>Objective</u>

The objective of the mitigation measures is to prevent water losses to third party water users.

<u>Actions</u>

In the approved EMP (Metago, 2008), it is outlined that:

- Prior to the commencement of pit dewatering and borehole abstraction, Tharisa will conduct a detailed hydrocencus of all boreholes that are in use in the potentially affected zones to verify whether there are additional boreholes to those that have already been identified. This hydrocencus will confirm the borehole location, water depth, water quality and water use for each identified borehole. All potentially affected boreholes will be included in the water monitoring programme for boreholes located both on and off the mine site

- Borehole monitoring must also take place between the pit and either side of the Sterkstroom. This will assist in determining the impact of dewatering on the flow of water in the Sterkstroom. If such an impact is observed, measures to compensate for the dewatering impact (such as controlled discharge into the water course) can be tailored to the degree of the dewatering impact in consultation with a specialist, key stakeholders and DWAF (now DWA)
- If any mine related loss of water supply is experienced by the borehole users, Tharisa will provide compensation which could include an alternative water supply of equivalent water quality
- The environmental manager is responsible for implementing these actions from prior to construction through to closure.

These measures will be applied to the project components, where applicable.

In addition, the following measures will be implemented:

- The current groundwater monitoring network will be extended to replace boreholes that were lost due to the pit and TSF construction as well as those that neighbouring landowners have requested to be included
- Groundwater monitoring should be concentrated in the vicinity of the open pits and around the TSFs
- Groundwater monitoring points must be located both up-stream and down-gradient of the potential impacts
- Volumes of water pumped from the open pits should be recorded as accurately as possible. These volumes could be used in future to further calibrate the numerical model, and improve the accuracy of forward predictions
- A transient groundwater flow model should be constructed once groundwater levels over a (hydrological) year become available, which would result in better prediction of local water levels. The model should include updated information on water levels and pit inflows.
- Tharisa will monitor flow in the Sterkstroom to better understand the frequency, magnitude and nature of stream flow events as well as determining the downstream flow rates (Section 21.1.2). Where flow in the Sterkstroom is affected by mining activities, Tharisa will implement a mechanism, the purpose of which will be to discharge correct quality water into the Sterkstroom so as to simulate downstream flows.

Emergency situations

None identified.

AIR QUALITY

7.2.12 ISSUE: AIR POLLUTION THROUGH DUST GENERATION AND GASEOUS EMISSIONS

Introduction

There are activities/infrastructure in all phases that have the potential to generate dust and gaseous emisions. The more significant pollutants associated with mining related operations are total suspended particulates (TSP) and inhalable particulate matter less than 10 microns in size (PM10). In both the construction and decommissioning phases, these activities will be temporary in nature, usually lasting from a few weeks to a few months. The operation phase will present more long term sources of dust as well as gaseous emmissions from vehicles and the operation of the chrome sand drying plant. As the concentration of gasses released by vehicle tailpipe emissions are expected to be negligible, these are not discussed firther below.

Air pollution related impacts on biodiversity have been discussed in Section 7.2.7 and therefore this section focuses on the potential for human health impacts.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Site preparation Earthworks Civil works General site management	General site management Earthworks Transport systems Chrome sand drying plant	Demolition General site management Rehabilitation	Maintenance and aftercare of final rehabilitated areas

Rating of impact

<u>Severity / nature</u>

In the approved EIA and EMP report (Metago, 2008), the severity of air quality impacts associated with the approved operations was rated high in the unmitigated scenario and was reduced to medium in the mitigated scenario.

The results from the air quality study (Airshed 2014) address the cumulative on-site impacts i.e. the project components together with the approved operations.

In the specialist's opinion, emissions during the closure phase of the mine will be negligible compared to the construction, operational and decommissioning phases. Emissions associated with the construction and decommissioning phases of the project components will be similar. It is expected that the construction activities will be masked by the operation of the mine and therefore the air quality study focused on the operational phase (Airshed, 2014).

The operational phase was modelled for two scenarios, a partially mitigated scenario and a mitigated scenario. The partially mitigated scenario included the mitigation that is known to be in use at the mine, whereas the mitigated scenario includes a more involved system of mitigation.

The main findings of the study are outlined below.

- During the operational phase (partially mitigated scenario) of the mine, total PM_{10}, $PM_{2.5}$ and TSP emissions were calculated to be 1083, 657 and 5731 tpa respectively. Vehicle entrainment from unpaved haul roads (excluding in pit roads) was estimated to be the most significant contributor to the total unmitigated PM_{10} and $PM_{2.5}$ emissions contributing approximately 49% and 80% respectively. Crushing operations contributed the most to TSP emissions (56%).
- During the operational phase (mitigated scenario) of the mine, total PM_{10}, $PM_{2.5}$ and TSP emissions were calculated to be 234, 66 and 678 tpa respectively. Open pit sources, unpaved roads and blasting were the most significant sources of emissions during this phase with blasting contributing the most to PM_{10} emissions (43%), open pit sources contributing the most to $PM_{2.5}$ emissions (74%) and unpaved roads contributing the most to TSP emissions (29%).
- Exceedances of the 2015 South African annual average and highest daily average PM_{10} standards were predicted to occur at the mining rights area boundary for the partially mitigated scenario. With additional mitigation applied, these exceedances reduced to be mostly contained within the mining rights boundary with exceedances at on-site receptors such as Mmaditlhokwa/Silver City, the school and Lapologang Village.
- Exceedances of the current South African annual average and highest daily average $PM_{2.5}$ standards were predicted to occur outside the mining rights boundary for the partially mitigatedscenario. The mitigated scenario of the operational phase was predicted to exceed the annual $PM_{2.5}$ standard only slightly outside the mining rights boundary, with marginal exceedances only at Mmaditlhokwa/Silver City and the school.
- Vehicle entrainment from unpaved haul roads (excluding in-pit haul roads) is expected to be the main contributor to predicted PM_{10} and $PM_{2.5}$ exceedances at the mining rights boundary and sensitive receptors for both phases.
- Exceedances of the national dustfall threshold levels for residential and non-residential limits were predicted to be exceeded within the mining rights boundary but not at any of the identified sensitive receptors. The main source group contributor to daily dustfall rates was predicted to be crushing operations.
- CO, NOx, SO_2 and VOC impacts due to the chrome dryer plant is expected to be relatively low. None of the NAAQ gaseous standards were predicted to be exceeded within or outside of the mining rights boundary.

Given the discussion above, when considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine is high in the unmitigated scenario. With increased mitigation as outlined below, the severity either remains high or is reduced to medium depending on the consistent application of the measures proposed.

<u>Duration</u>

In both the unmitigated and mitigated scenario, if human health impacts occur these are potentially long term in nature.

<u>Spatial scale / extent</u>

The spatial scale of the potential impact is directly related to the spatial scale of the dispersion of any air pollution that has the potential to cause human health impacts. In the unmitigated scenario, the potential impacts extend beyond the site boundary.

<u>Consequence</u>

In both the unmitigated and mitigated scenario the consequence is high.

<u>Probability</u>

Whether the predicted air pollution will result in human health impacts depends on the extent of the pollution plume, the concentration of the different pollution components, and the exposure of receptors to exceedances of the relevant evaluation criteria.

In the case of PM_{10} and $PM_{2.5,}$ in the unmitigated scenario the probability is definite. With mitigation, the probability reduces to somewhere between high and medium depending on the application of the measures proposed.

In the case of dust fallout, in the unmitigated scenario the potential for impacts occurring and resulting in a nuisance are possible and can be reduced to low with mitigation.

<u>Significance</u>

The assessment below uses the more conservative case of PM_{10} impacts to assess both PM_{10} impacts and dust fallout impacts collectively.

In the approved EIA and EMP report (Metago, 2008), the significance of the impact associated with the approved operations was rated high in the unmitigated scenario and was reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine is high in the unmitigated scenario and either remains high due to the presence of sensitive receptors within the predicted impact zone or reduces to medium with mitigation depending on the consistent application of the measures proposed.

Assessment of cumulative on site impacts

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	H-M	H	M	H	H-M	H-M

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

Objective

The objective of the mitigation measures is to prevent air pollution health impacts.

Actions

In the approved EMP (June, 2008), it is outlined that:

- Tharisa will purchase sufficient land to extend its site boundary in such a manner that the predicted PM10 impacts in the mitigated scenario (management actions are included below) remain on mine owned property. The recommended zone for the scenario with maximum dust mitigation controls is 500m from emission sources.
- In order to achieve the best case managed scenario, as assessed above, the following specific measures will be implemented:
  - Unpaved roads – target dust control efficiency of 90% - achieved by a combination of water suppression and suppression chemicals;
  - Crushing and screening – target dust control efficiency of 98% – achieved by enclosure of crushing activities and the capture of emissions through dust extraction and associated bag filters; and
  - Materials handling and drilling – target dust control efficiency of 70% – achieved by water sprays and partially enclosing the conveyor.
- In addition to the abovementioned specific actions, Tharisa will develop and implement other key elements of an air quality control system. This system will include:
  - Monitoring in accordance with Section 21; and
  - If monitoring determines that unacceptable dust emissions is occurring, immediate steps will be taken to address the issue in consultation with a suitable air quality specialist.

These measures will be applied to the project components, where applicable.

In addition, the following will be implemented:

- For materials handling – to achieve a 70% control efficiency - enclosure for conveyor loading and off-loading points

- PM10 monitoring will be done in order to understand what the ambient concentrations at the nearest receptors.
- A meteorological station should be established where there will be no influence from infrastructure or topography.
- If measured PM10 results confirm the high PM_{10} and $PM_{2.5}$ concentrations predicted by the modelling during this study, then sensitive receptors within the mine boundary where exceedances of the NAAQ limits are experienced will need to be relocated to where exceedances of the NAAQS does not occur. If relocation is required, this would be done as outlined beloin line with the World Bank Operational Directive on Involuntary Resettlement.

Emergency situations

Not applicable.

NOISE

7.2.13 ISSUE: NOISE POLLUTION

Introduction

Two types of noise are discussed: noise disturbance and noise nuisance. The former is noise that can be registered as a discernible reading on a sound level meter and the latter, although it may not register as a discernible reading on a sound level meter, may cause nuisance because of its tonal character (eg. distant humming noises). Noise as a result of emergency sirens are infrequent and therefore cannot be assessed be included in the noise assessment. Therefore need to add para here similar to that about blast events that they are not frequent etc and not assessed

Based on noise monitoring surveys, noise emissions from the existing mining operations do contribute to the general ambient noise in the area (Section 1.1.9). The project components present the possibility of generating additional noise disturbances and noise nuisances in all project phases as outlined in the table below.

The assessment below focuses on night-time conditions when ambient noise levels are lower and the sensitivity of the environment increases and on the potential human related noise impacts. As a basis for the assessment below, if the specific level of mining noise at an observation point rises to the point where it equals the background level, the ambient level will rise by 3 dB above its initial level. This represents a noise impact of 3 dB, which is still acceptable in terms of noise regulations and SANS 10103 criteria. A significant impact is deemed to occur if the ambient level is increases by 5 dB or more.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Site preparation Earthworks Civil works Transport systems Rehabilitation	Transport systems Chrome drying plant TSF Waste rock dumps Topsoil stockpiling	Transport systems Demolition Rehabilitation	Maintenance activities - negligible

Rating of impact

Severity / nature

Noise pollution can create nuisance that will have different impacts on different receptors because some are very sensitive to noise and others are not. The most noise sensitive receptors around the mine are considered to be the President van Rensburg/ Retief Primary School and residents within 1km of the open pits and associated activities and the concentrator complex and associated activities. The impact on receptors located to the south of the N4 is considered to be less significant under normal operating conditions because it will be masked by the significant stream of traffic and associated noise on the N4.

In the approved EIA and EMP report (Metago, 2008), the severity of noise pollution associated with the approved operations was rated medium in both the unmitigated and mitigated scenarios.

As part of this study, in the unmitigated scenario, the noise specialist concluded the following:

- during the construction phase, project-related activities are not expected to produce noise that will be audible above Tharisa Mine's operational noise
- for the approved mining operations, noise sensitive receptors fall inside the 5 dB and 3 dB night-time impact footprint
- for the President van Rensburg/Piet Retief Primary School, which operates during daytime, the acceptable daytime background reference would be 55 dBA as in Urban Residential areas – the noise impact of the mine on the school during the daytime therefore results in a increase of 2 dB, which is considered negligible
- although an increase in 3 dB is deemed acceptable, receptors within this footprint may experience higher increases at times due to variances in atmospheric conditions
- in a southerly direction from the mine, the mine's noise footprint is pinched off by the effect of N4 traffic noise – in the proximity of the N4 where traffic noise predominates, the increase caused by mining noise is negligible. Notwithstanding this, any construction related activities at the TSF will result in unacceptable impacts south of the N4 for as long as the activities take place
- the project components will not change the noise footprint of the mine and will not result in a noticeable increase in the noise impact on noise-sensitive receptors in the study area
- the contribution of project components to the total noise during decommissioning and closure will be negligible.

When considering the results of the noise specialist study and the discussion above, the following applies:

- Due to the proximity of sensitive receptors, in the unmitigated scenario, during the construction phase of the surface-related project components, impacts will have a medium severity for the nearest receptor sites. This can reduce to low with mitigation which restricts the times during which these activities take place to day time hours.
- The severity of operational impacts has changed from what was indicated in the approved EIA and EMP report (Metago, 2008) mainly due to the approved activities. In this regard, for the operational phase, in the unmitigated scenario, the cumulative severity is high for receptors within the mining rights boundary and medium for receptors outside the mining rights boundary. With the implementation of mitigation measures that focus on restricting operations in the west mine to daytime hours and establishing appropriately positioned and sized noise screening berms, this can be reduced to medium for receptors within the mining rights boundary and low for receptors outside the mining rights boundary.
- For the decommissioning phase, the unmitigated severity rating for the overall mine remains unchanged at medium.

<u>Duration</u>

In the unmitigated scenario, noise sources will occur for the life of the mine. In the mitigated scenario, noise pollution impacts will occur until the closure phase.

<u>Spatial scale / extent</u>

In both the unmitigated and mitigated scenarios, the noise impacts extend beyond the site boundaries to the nearest noise sensitive receptors. This is a medium spatial scale.

<u>Consequence</u>

For the construction and decommissioning phases, the consequence is medium which reduces to low with mitigation. The operational nmitigated consequence is medium which reduces to medium to low with mitigation.

<u>Probability</u>

In the unmitigated scenario, the probability of noise related impacts range from definite to possible depending on the distance of receptors from noise generating activities. With mitigation, the probability ranges from possible to unlikely for the same reason.

<u>Significance</u>

In the approved EIA and EMP report (Metago, 2008) the significance rating for the approved operations was rated high in the unmitigated scenario and reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operation the findings of the specialist study, the significance rating for the overall mine is high to medium in the unmitigated scenario and medium to low in the mitigated scenario depending on the distance of receptors from noise generating activities.

Assessment of cumulative on-site impact

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases, except closure						
Unmitigated	H – M*	M	M	M	H – M*	H – M*
Mitigated	M – L*	M	M	M - L	M – L*	M – L*

** Depends on distance from noise generating activity.*

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

<u>Objective</u>

To prevent unacceptable noise impacts.

<u>Actions</u>

In the approved EMP (Metago, 2008), it is outlined that Tharisa will use waste rock and topsoil stockpiles to maintain a noise berm around the mining operations and associated noise sources. Two key areas include south of the western operations and south of the concentrator complex. The approved EMP limited the height of noise screening berms to 10m, however a height of 30m is planned in line with the specialist's recommendations and in order to act as an effective noise berm. In a specific area, noise berms should form one continuous berm.

In addition, the approved EMP (Metago, 2008) outlines that:

- No blasting will take place at night or on weekends. No crushing, waste rock handling, or earth moving activities will take place between 21h00 and 05h00 in areas where residences may be negatively affected at night. This is particularly relevant in the western part of the mining area.
- Specific noise monitoring will be conducted by an environmental noise professional at the President van Rensburg/Piet Retief Primary School during the day, when the mine is operational. If unacceptable noise disturbance is detected, the specialist, school and mine will collectively determine any associated mitigation measures.
- Noise monitoring will be undertaken in line with Section 21.4.
- Tharisa will record and respond without delay to complaints about disturbing noise. All such complaints will be documented and recorded as incidents. The measures taken to address these complaints will be included in the documentation. These records will be kept for the life of mine.

These measures will be applied to the project components, where applicable.

In addition, the measures listed below will be implemented.

- Any construction-related activities at the TSF and activities associated with the establishment of noise berms will be restricted to daytime hours (between 05h00 and 21h00, excluding Sundays).
- The placement of berms to screen off haul road and other noises affecting the relocated community to the north should be considered. The berms should be high enough as well as wide enough to cut off the line-of-sight between the top of the noise source and the noise receptor.
- Options that can be considered for waste rock handling activities:
  - Construct and maintain an outer shell that acts as a noise screen to on-going dumping operations at a lower working level. Construction of the outer shell must be restricted to daytime hours.
- With respect to reverse alarms and hooters, these should be used in a disciplined manner for purposes of safety only. Consideration should be given to buzzer type alarms (producing a hissing sound) that do not hinder compliance with occupational safety requirements.
- All the diesel-powered equipment and vehicles must be of high quality and at all times well maintained.
- Regular maintenance schedules must include the checking and replacement of exhaust and intake silencers.

The environmental manager will be responsible for implementing these actions from construction through to closure.

Emergency situations

None identified.

VISUAL

7.2.14 ISSUE: NEGATIVE VISUAL IMPACTS

Introduction

Visual impacts will be caused by activities and infrastructure in all project phases. These activities will be visible, to varying degrees from varying distances around the mine site. The more significant impacts are expected during the operational phase as the development of waste rock dumps advances. In addition, there will be residual waste rock dumps at mine closure.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Site preparation Earthworks Civil works General site management	General site management Waste rock dumps Topsoil storage facilties	Demolition General site management	Maintenance and aftercare of final land forms and rehabilitated areas

Rating of impacts

Severity / nature

The severity of visual impacts is determined by assessing the change to the visual landscape as a result of mine and project related infrastructure and activities. In the approved EIA and EMP report (Metago, 2008), the severity of the visual impact associated with the approved operations was rated high in the unmitigated scenario and medium in the mitigated scenario.

When considering the potential change to the visual landscape as a result of the project components the key issues are visual exposure, visual intrusion, and sensitivity of receptors. Each of these is discussed further below.

In the unmitigated scenario:

- The visual intrusion of the project will be low because the infrastructure will be absorbed by existing mining activities, will not change the current landscape character of the area and will result in only minor changes to a few key views.
- Visual exposure is the extent to which project infrastructure and activities will be visible. It follows that the closer the infrastructure and activities, the greater the visual exposure. The main project components that will influence the visibility of the mine are the re-alignment and re-shaping of the waste rock dumps (consolidation and increases in footprint and increases in height by 22m), the addition of the north east WRD (footprint of 95ha and height approximately 70m) as well as the heightening of noise screening berms. The approved operations will mostly shield the remaining project components. Views from local roads, local residences and from south of the mine will present the greatest visual exposure. The heightening of the noise screening berms will shield views from nearby receptors. Overall the infrastructure will form part of the mine structures and contribute to the overall visibility of the mine. The visibility is therefore regarded as moderate
- Sensitivity of receptors relates to the way in which people will view the visual intrusion. In this regard, it is anticipated that receptors east and south of the mine and project components will be highly sensitive due to an increased change in the views from these areas. These receptors include both local residents and local and international visitors.

The project components will have a low severity visual impact because this infrastructure will be absorbed into the overall mine infrastructure.

When considering this impact cumulatively with the approved operations, the severity rating for the overall mine in the unmitigated scenario is high. With mitigation, that focuses on designing and implementing the waste facilities such that the side slopes can be rehabilitated during the operational phase, the severity rating for the overall mine in the mitigated scenario is high to medium depending on the effectiveness of rehabilitation measures.

Duration

The duration of this impact is expected to be long-term for all project phases in the unmitigated scenario because the impacts will extend beyond the life of the project. In the mitigated scenario, the duration will be reduced to the life of the project, and only the rehabilitated residue facilities will remain after closure, which, if correctly rehabilitated, will not be associated with negative visual impacts.

Spatial scale / extent

In all phases, visual impacts are likely to extend beyond the site boundary. This is a medium spatial scale in both the unmitigated and mitigated scenarios.

Consequence

The unmitigated consequence is moderate and reduces to low in the mitigated scenario.

Probability

The unmitigated probability is high in all the phases. With mitigation, the probability is low with effective rehabilitation measures.

Significance

In the approved EIA and EMP report (Metago, 2008) the significance rating for the approved operations was rated as high in the unmitigated scenario and reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operation, the significance rating for the overall mine is high in the unmitigated scenario and reduces to medium with mitigation.

Assessment of cumulative on-site impact

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	H-M	M	M	M	H-M	M

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

Objective

To limit negative visual impacts.

Actions

In the approved EIA and EMP (Metago, 2008), it is outlined that Tharisa will:

- Ensure that the absolute minimum amount of vegetation and land is disturbed during site development and operation. This is extremely important on the boundaries of the mine where vegetation can assist with screening.
- Implement the recommended air pollution control system to avoid plumes of dust that can reduce visibility.
- Paint structures and buildings in colours (browns and greens) that reflect and compliment the natural landscape.
- Building of a noise and visual screening berm to the south of the concentrator complex. This berm will be vegetated with trees and bushes to add to the height of the screen.
- Ensure effective rehabilitation of the tailings dams. Within the first four years of the mine the outer rock wall will be built. Every $100m^2$ a pocket will be excavated in the wall and filled with topsoil for the planting of trees, aloes and bushes. Additional topsoil will also be placed on the rest of the wall to allow growth of grasses. The successful establishment of the vegetation must be demonstrated during the life of the mine so that there is little additional work to be done at closure.
- The overall side slopes of the waste rock dumps will be 1v:4h prior to topsoiling and vegetation establishment. Vegetation will include trees, bushes, aloes and grasses.
- All vegetation that is planted as part of rehabilitation should reflect the natural vegetation of the area.
- Night lighting will be fitted with fixtures to prevent light spillage and focus the light on precise mine activities and infrastructure, fitted as low to the ground as is practicable, and most security lights will be activated with movement sensors.

These measures will be applied to the project components, where applicable.

The following additional management measures will be applied:

- All final landforms (residue facilities) will be rehabilitated in a manner that achieves landscape functionality and limits and/or enhances the long-term visual impact.
- At closure, the residue facilities that will remain in perpetuity will be managed through an aftercare and maintenance programme to limit and/or enhance the long-term post closure visual impacts.

Emergency situations

None identified.

7.2.15 ISSUE: BLASTING IMPACTS

Introduction

Open pit mining at Tharisa requires regular blasting activities in order to remove overburden and mine the resource itself. Blasting activities have the potential to impact on people, animals and structures located in the vicinity of the operation. Blast hazards include ground vibration, airblast, fly rock, blast fumes and dust. Ground vibrations travel directly through the ground and have the potential to cause damage to surrounding structures. Airblasts result from the pressure released during the blast resulting in an air pressure pulse (wave), which travels away from the source and has the potential to damage surrounding structures. Fly rock is the release of pieces of rock over a distance and can be harmful to people and animals and damage structures and property. Blast fumes and dust, caused by the explosion, can be considered significant nuisance factors. Ground vibrations and airblasts have the potential to cause nuisance to people and animals even if blasts occur within legal limits.

The impacts on air quality have been assessed in Section 7.2.12. The impacts on biodiversity have been assessed in Section 7.2.7. This section focuses on the impacts of ground vibration, airblast, flyrock and blast fumes, collectively, as they relate to people.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
Not applicable		Not applicable	Not applicable
	Open pit mining		

Rating of impact

Severity / nature

In the approved EIA and EMP report (Metago, 2008), the severity of potential blasting injury to third parties or animals and damage to third party structures was rated high in the unmitigated scenario, and this was reduced to moderate in the mitigated scenario.

For the east and west pit extension, blasting activities will be undertaken from near surface (5-10m) and up to an average depth of 180m.

Ground vibrations from blasting travel directly through the ground, so any impact on structures (such as buildings) depends on velocity and frequency of vibrations and the integrity of the built structures. The United States Bureau of Mines (USBM) standard of 12mm/s peak particle velocity is applied as a general guideline for blast management in South Africa as a “safe” limit for brick and mortar structures in the usual range of blasting vibration frequencies (4 – 12 Hz). In the unmitigated scenario structures could be at risk outside of the 500m blast zone where peak particle velocities greater than 12mm/s are generated by blasting. In the mitigated scenario, assuming that the blast design will consistently result in a peak particle velocity of 12mm/s being kept within 500m of the blast activity, structures outside the 500m zone should not be damaged. However, the blanket application of this guideline is the subject of debate because permanent displacements along existing cracks in sub standard buildings (often associated with rural houses) can be induced by lower vibrations. As a result the blast design must be specific to manage impacts on surrounding structures.

Airblast is an air pressure pulse that has both a high frequency audible sound and a low frequency inaudible concussion. If the pressure is great enough, damage can be caused to structures. It is the view of the specialist that if airblast is contained to 130 dB or less, then damage should not be caused to surrounding structures.

Most of the blasts set off at Tharisa Mine have been monitored using industry accepted seismographs that record the ground vibration and airblast levels caused by the blasts. The ground vibration levels recorded at the houses to the south of the mine, village and power lines have all been well within the accepted United States Bureau of Mines (USBM) RI8507 suggested limits or the approved Eskom limit (Cambrian, 2014). A number of airblast events have slightly exceeded the 130dB recommended limit but have never reached the levels where damage could result. As the pit deepens so the disturbance levels should decrease.

In terms of the ground vibration disturbances, extension of the pit areas towards the relocated Mmaditlhokwa/Silver City could have a significant impact on the vibration levels experienced at the nearest third party structures. Ground vibration and air blast levels will dimish as distance from the blast sites increases.

Side effects such as fly rock or excessive post blast fumes are undesirable and usually occur unexpectedly, sometimes for unknown reasons. Fly rock typically originates either from the free face or the surface of the blast or possibly from secondary blasting. The main causes are under burdened holes on the free face, geological discontinuities, poor blast timing leading to over confinement of holes and overcharged blastholes that result in vertical cratering of the hole.

Given the discussion above, in the unmitigated scenario, blasting activities are likely to damage infrastructure in close proximity to the open pits. Should injury to people or damage to third party infrastructure occur as a result of blasting, this has a high severity. This cannot be mitigated to a lower level of severity.

When considering the project's impact cumulatively with the approved operations, the severity rating for the overall mine is high in the unmitigated and mitigated scenarios.

Duration

Should injury to people occur as a result of blasting, this could have a long-term duration. This cannot be significantly mitigated.

Spatial scale / extent

To give spatial context to this discussion, the table below provides an indication of the proximity of non-Tharisa (third party) infrastructure to the planned final extent of the open pits. Blast impacts may extend beyond the blast zone in the both the unmitigated and mitigated scenarios.

TABLE 7.4: PROXIMITY OF THIRD PARTY INFRASTUCTURE TO THE OPEN PITS

Third party infrastucture within 500m of the final pit extent	**Third party infrastucture within 1000m of the final pit extent**
Livestock and wild animals	Livestock and wild animals
The dirt roads (including pedestrians and vehicles) on the D1526/D1566, D2565, other smaller gravel roads.	The dirt roads (including pedestrians and vehicles) on the D1526/D1566, D2565, other smaller gravel roads
Formal residences and informal settlements, specifically Tsilong Village and sections of Mmaditlhokwa/Silver City.	Formal residences and informal settlements, specifically Tsilong. Mmaditlhokwa/Silver City and Lapolang Villages.
Boreholes used by farmers and communities	Boreholes used by farmers and communities
President van Rensburg/Piet Retief Primary School	President van Rensburg/Piet Retief Primary School
Graves not already relocated	Graves not already relocated
Rural power and telephone lines	Rural power and telephone lines
The D1325 Marikana Road which will be diverted around the western side of the eastern open pit	The D1325 Marikana Road which will be diverted around the western side of the eastern open pit
The regional Eskom 275KV powerline (Bighorn – Pluto) which was deviated around the eastern side of the eastern open pit	The regional Eskom 275KV powerline (Bighorn – Pluto) which was deviated around the eastern side of the eastern open pit
Agricultural activities and other businesses	Agricultural activities and other businesses
	Buffelspoort irrigation canal/pipelines
	Mining infrastructure at Western Platinum Mine

Consequence

The consequence is high in both the unmitigated and mitigated scenarios.

Probability

The probability of injury to third party or damage to third party infrastructure is considered to be high in the unmitigated scenario because of the proximity of third parties and third party infrastructure to the open pits. With mitigation that caters for evacuation of all houses within the blast zone during each blast, the probability reduces to medium to low. In the absence of effective mitigation that limits

Significance

In the approved EIA and EMP report (Metago, 2008), the significance of the impact associated with the approved operations was rated high in the unmitigated scenario and was reduced to medium in the mitigated scenario.

When considering this impact cumulatively with the approved operations, the significance rating for the overall mine is high in the unmitigated and medium in the mitigated scenarios.

Assessment of cumulative on-site impact

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
Operation only						
Unmitigated	H	H	M	H	H	H
Mitigated	H	H	M	H	L	M

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

<u>Objectives</u>

The objective of the management measures is to prevent harm to people, animals and structures.

<u>Actions</u>

In the approved EMP (June, 2008), it is outlined that:

- The blast design will be, as a minimum standard, ensure that the peak particle velocity from all blasts is less than 12.5mm/s at 500 m from the blast site and that flyrock is contained within 500m of each blast. This will be tracked through the monitoring of blasts
- All structures and services within 1500m of the blast will be marked on a site plan and surveyed photographically in the presence of the owner before surface blasting takes place. All parties that exist and/or that have service infrastructure and/or that provide services within 1500m of the blast sites will be informed, prior to mining, about the blast programme and associated safety precautions. Specific precautions must be taken when educating, informing and managing the students who attend the President van Rensburg/Retief Primary School
- Powerlines, telephone lines, pipelines and canals that could be impeded or damaged by the mining and/or blasting activities must be diverted out of harm’s way prior to mining with the consent of the relevant stakeholders/service providers. The distance between the mining operations and the diverted infrastructure will be determined on a case by case scenario. In addition, the diversion of the infrastructure must be done in a manner that other users relying on this infrastructure are inconvenienced as little as possible. The diversion of the Eskom 275 KV powerline, water supply pipelines and the Buffelspoort irrigation canals are most significant in this regard
- The people that reside in the area where the pit will be developed and those that reside within 500m of the blast locations will be approached by Tharisa either for the purpose of purchasing the land in question and/or for the purposes of temporary vacation or permanent relocation in accordance with the relevant legislation
- Blasting must be planned so as to limit cumulative impacts from blasting activities at surrounding mines

- In deciding whether or not to set off blasts, a procedure must be developed to take temperature inversions, low cloud cover and wind direction into account
- For each blast the mine will observe the following procedural safety steps:
  - the fly rock danger zone of 500m associated with each blast is delineated and people and animals are cleared from this zone before every blast
  - an audible warning is given at least three minutes before the blast is fired
- The mine will respond immediately to any blast related complaints. These complaints and the follow up actions will be dated, documented and kept as records for the life of mine. Where the mine has caused blast related damage it will provide appropriate compensation
- The mine, safety and environmental managers are responsible for implementing these actions before and during the construction phase and during the operational phase.

These measures will be applied to the project components, where applicable.

In addition, the following will be implemented:

- In the absence of relocation, third parties within a minimum of 500m of the blast site will need to be evacuated prior to every blast. During evacuations it will be necessary to provide bus transport and basic amenities such as shelter, toilet facilities and drinks.
- The use of detonating cord is prohibited due to the close proximity. Instead electronic initiation will be required to ensure that individual hole firing is guaranteed, which will ensure that the charge mass per delay is limited to one hole
- As the blasting activity moves closer to Mmaditlhokwa/Silver City, the use of deck charges may be necessary to further limit the charge mass delay. A blasting specialist will be consulted in this regard
- The bulk explosive product will be tested on an ongoing basis to ensure it is of an acceptable quality
- The final approved blast design will be marked, drilled off in the field and audited (once charging commences) to ensure that all stages of the operation are proceeding as per the design. Any problem holes will be corrected. Problem holes could include holes that are under burdened, drilled short of the required depth, surrounded by badly cracked ground and off pattern holes will be identified. The blast pattern, hole depths, charge mass per hole, final stemming lengths and the delay timing of the blast will be checked. Any unusual occurrences will be corrected immediately, documented and noted for future consideration. This is essential to assist with controlling fly rock
- Detailed blast records will be kept including:
  - Date, time and blast location
  - Unusual occurrences such as collapsing holes, runaway explosives, fumes, flyrock
  - Prevailing weather conditions, wind speed and direction
- If fumes occur after a blast then the immediate vicinity of the blast area will be kept clear until these have dissipated. The wind direction and conditions must also be kept in mind to ensure that the fumes do not impact further afield
- Disturbance monitoring will be continued as long as blasting takes place.

Emergency situations

If a person or animal is injured by blasting activities this must be handled in accordance with the Tharisa emergency response procedure.

HERITAGE, PALAEONTOLOGICAL AND CULTURAL RESOURCES

7.2.16 ISSUE: LOSS OF HERITAGE PALAEONTOLOGICAL AND CULTURAL RESOURCES

Introduction

The project has the potential to damage heritage resources and result in the loss of the resource for future generations. Heritage resources include sites of archaeological, cultural or historical importance. The more significant of these are expected to occur during the construction and operational phases when most of the project infrastructure will be established on site and open pit mining advances. No impacts are expected to occur during the decommissioning and closure phases however the potential for uncovering new heritage resources during the operational and decommissioning phases does exist.

Blasting related impacts, on heritage resources, are addressed in Section 7.2.14.

Project phase and link to activities/infrastructure

Construction	Operational	Decommissioning	Closure
			N/A
Site preparation Earthworks Civil works General site management	General site management Open pit operations Waste rock dump	General site management Rehabilitation	

Rating of impact

<u>Severity / nature</u>

In the approved EIA and EMP report (Metago, 2008), the severity of the heritage related impacts associated with the approved operations was rated high in the unmitigated scenario and low in the mitigated scenario.

Heritage resources that will be impacted on by the positioning of project-related infrastructure include graveyards, historical complexes and historical houses. These sites are considered to have a high significance and therefore destruction of these sites without proper mitigation has a high severity. If any heritage resources such as unmarked graves/graveyards are uncovered during the construction, operation and decommissioning of the site, the loss of these resources unmitigated has a high severity. With mitigation any heritage resources of high significance will either be relocated, in the case of graveyards, in accordance with the relevant legislation and/or the information within the sites, in the case of the historical complexes and houses, preserved through further assessment, sample collection and record keeping. In addition, a chance find procedure will be put in place for accidental finds. This reduces the severity in the mitigated scenario to low.

When considering this impact cumulatively with the approved operations, the severity rating for the overall mine in the unmitigated scenario is high and reduces to low with mitigation.

Duration

In the unmitigated scenario, the impact on heritage resources would extend beyond closure. With mitigation this can be avoided and/or reduced to less than the project life.

Spatial scale / extent

Although the actual loss of the resource will be within the site boundary, the unmitigated and mitigated impact will extend beyond the site boundary.

Consequence

In the unmitigated scenario, the consequence is high given the importance of the identified heritage sites. With mitigation, this can be reduced to low because the severity and duration are reduced.

Probability

In the unmitigated scenario, the loss of heritage resources will be definite. With mitigation, the impacts will either be avoided or, where this is not possible, graves will be relocated and the information within heritage sites preserved through further investigation, sameple collection ad record keeping. This is a low probability.

Significance

In the approved EIA and EMP report (Metago, 2008) the significance rating for the approved operations was rated as high in the unmitigated scenario and reduced to low in the mitigated scenario.

When considering the project's impact cumulatively with the approved operation, the significance rating for the overall mine is high in the unmitigated scenario and reduces to low with mitigation.

Assessment of cumulative on-site impact

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases, except closure						
Unmitigated	H	H	M	H	H	H
Mitigated	L	L	M	L	L	L

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

Objective

The objective of the mitigation measures is to protect, where possible, and/or preserve heritage and cultural resources.

Actions

In the approved EIA and EMP (Metago, 2008) it is outlined that:

- Prior to damaging or destroying any of the identified heritage resources Tharisa will engage a heritage specialist to conduct a phase 2 heritage investigation and apply for a permit in terms of the National Heritage Resources Act, 25 of 1999, from SAHRA (North West Province).
- In the case of the graves that will be disturbed, additional permission for the exhumation and relocation of graves must be obtained from the relevant descendants, the National Department of Health, the Provincial Department of Health, the Premier of the Province and the local Police. The exhumation process must comply with the requirements of the Ordinance on Exhumations, 12 of 1980, and the Human Tissues Act, 65 of 1983.

These measures will be applied to the project components, where applicable.

The environmental manager will be responsible for implementing these actions from construction through to closure.

Emergency situations

If any heritage resources of significance are exposed, Tharisa will follow its emergency response procedure (Section 20).

LAND USE

7.2.17 ISSUE: RELOCATION

Although there is third party property including houses and structures within the project footprint, it is assumed in this assessment that these properties will be bought by Tharisa in a fair and amicable process. Therefore relocation due to positioning of project infrastructure is not considered an issue for this project and is not assessed further.

7.2.18 ISSUE: LOSS OF OR CHANGES TO EXISTING LAND USES

Introduction

There are project related activities and infrastructure that may have an impact on other land uses in the project areas in all project phases. This section focuses on potential impacts affecting land use on and surrounding the project sites.

When considering impacts on land use, consideration needs to be given to the range of environmental impacts that could occur as a result of the project. These include: groundwater, noise, visual, air, traffic, heritage, soils, blasting, and socio-economic. With this in mind, the main activity that could have an impact on existing land uses is the development of the project components together with the operation of the approved mine as a whole. These activities will continue for the planned life of the mine. At closure, final land forms will remain on site in perpetuity. This section focuses on the potential loss and/or change of the land uses. Socio-economic related issues are discussed in Sections 7.2.20 and 7.2.21.

Project phase and link to activities/infrastructure

Construction	Operation	Decommissioning	Closure
Construction of project components	Operation of the mine	Decommissioning of project components	Final land forms

Rating of impact

Severity / nature

This impact was not specifically assessed in the approved EIA and EMP report (Metago, 2008) and therefore no assessment exists for the mine.

The project and mine site is located in an area where mining is a dominant land use inter-mixed with agriculture, tourism and residential land use type activities. Current land uses within the project footprints will be lost through the development of the project. When considering surrounding land uses, these land uses may be affected by one or more of the following potential environmental and social impacts: hazardous excavations and structures, disturbance of biodiversity, surface and groundwater quality and quantity, dust generation, noise pollution, blasting, visual and negative socio-economic impacts. In this regard, the severity of the project's unmitigated potential impacts on the surrounding non-mining land uses is medium. With mitigation that is focussed on prevention and/or controls for each environmental and social impact type, the severity reduces to low.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine is high in the unmitigated scenario reducing to somewhere between medium and low in the mitigated scenario.

Duration

In the unmitigated scenario, and using a conservative approach, land use impacts could be experienced after the life of mine. With mitigation, these impacts can be avoided and/or remedied within the life of the project.

Spatial scale / extent

The spatial scale extends beyond the mining footprint, in both the unmitigated and mitigated scenarios.

<u>Consequence</u>

The unmitigated consequence is high in all project phases. The mitigated consequence is mdium to low in all the project phases.

<u>Probability</u>

In the unmitigated scenario, where environmental and social impacts are uncontrolled, the probability that land uses on and surrounding the project sites will be impacted by mining is definite. With mitigation, the probability reduces to medium prior to closure and low post closure.

<u>Significance</u>

When considering the project's impact cumulatively with the operations, the significance rating for the overall mine is high in the unmitigated scenario. With mitigation that is focussed on prevention and/or controls for each environmental and social impact type, the severity reduces to somewhere between medium and low for all phases except closure and low at closure.

Assessment of cumulative on-site impact

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	M-L	M-L	M	M-L	M L (at closure)	M-L L (at closure)

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

<u>Objective</u>

The objective of the mitigation measures is to prevent unacceptable negative impacts on surrounding land uses.

<u>Actions</u>

The following will be implemented:

- Effective implementation of all mitigation measures as outlined in this EMP report to reduce the mine's overall impact on the environment and surrounding land-uses
- Closure planning to incorporate measures to achieve future land use.
- Purchase/lease farms within the mining area where project components will be developed.
- Should the impact on the surrounding land use and/or economic activity still prove unacceptable, Tharisa will compensate the relevant landowners accordingly.

Emergency situations

None identified.

SOCIO-ECONOMIC

7.2.19 ISSUE: ROAD DISTURBANCE AND TRAFFIC SAFETY

Introduction

Traffic will be generated in all phases of the project when trucks, buses, and private vehicles make use of the public and internal transport network in and adjacent to the mine. The key potential traffic related impacts are on road capacity and public safety. These are assessed below.

Project phase and link to activities/infrastructure

Construction	Operation	Decommissioning	Closure
			N/A
Transport systems	Transport systems	Transport systems	

Rating of impact

Severity / nature

In the approved EIA and EMP report (Metago, 2008), the severity of road disturbance and safety associated with the approved operations was rated high in both the unmitigated and mitigated scenarios.

The majority of project-related traffic will be on internal mine roads. Traffic on external roads is expected to be limited to the transport of staff during construction and operation, transport of plant equipment to site during construction for the chrome sand drying plant, and transport of fuel to site during operation for the chrome sand drying plant. The project will not result in the increase of product being transported from site. Although the project will not result in a significant increase in traffic on public roads there will be interaction between the project and public roads at intersections to the mine. This includes the transport of ore to the plant, from the deepening of the West Pit, at an existing intersection on the Marikana Road. This may result in increased safety risks, reduction in road service levels and road condition at this intersection.

Changes to road infrastructure that have taken place at the mine includes a truck parking area with loop to the mine entrance. The additional parking area is aimed at ensuring trucks arriving at the mine have a dedicated place to park prior to entrying the mine thereby reducing the stopping of trucks on the Marikana Road.

In addition to the above, it is planned to re-align the approved road diversion (still to be implemented) to make way for the deepening and extension of the East pit. This re-alignment is to ensure safer travel conditions for third party road users.

Given the discussion above, in the unmitigated scenario, changes to traffic volumes and related safety risks on third party road users are expected to have a moderate severity. In the mitigated scenario the severity reduces to low because the frequency of potential accidents from trucks transporting ore across the Marikana road is expected to reduce.

When considering the project's impact cumulatively with the approved operations, the severity rating for the overall mine remains unchanged in the unmitigated and mitigated scenario.

Duration

Any serious injury or death is a long term impact in both the unmitigated and mitigated scenarios.

Spatial scale / extent

Possible accident sites will be located outside the project areas and the indirect impacts associated with any injuries or fatalities will extend to the communities to which the injured people/animals belong. This is a medium spatial scale in both the unmitigated and mitigated scenarios.

Consequence

The consequence is high in both the unmitigated and mitigated scenarios.

Probability

In the unmitigated scenario there is the possibility of traffic accidents occurring. With mitigation measures in place, this reduces to low.

Significance

In the approved EIA and EMP report (Metago, 2008), the significance of the impact associated with the approved operations was rated high in the unmitigated scenario and was reduced to medium in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine remains unchanged in the unmitigated and mitigated scenario.

Assessment of cumulative on-site impact

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	M	H
Mitigated	H	H	M	H	L	M

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

<u>Objective</u>

The objective of the mitigation measures is to limit mine related road disturbance and traffic safety impacts.

<u>Actions</u>

In the approved EMP (Metago, 2008), it is outlined that:

- The intersections from the D1325 to the mine site must be designed in accordance with the recommendations of the traffic specialist and must be approved by the North West Province Department of Roads and Transport.
- The required upgrade to the Marikana siding must be approved by Transnet. The related alternative route to the Marikana siding that diverts truck traffic around the centre of Marikana town must be approved by the North West Province Department of Roads and Transport and DACE. This will require a separate EIA.
- The temporary diversion of the D1526/1566 to make way for the open pit must be managed in a manner that the existing road users are not inconvenienced. As such, the road diversion must be:
  - as close to the current road route as possible without being too close to pose a safety risk from a blast management perspective
  - advertised 2 weeks before the existing road is temporarily closed
  - constructed to an equivalent standard as the D1526/1566
  - the original D1526/1566 must be reinstated to its current alignment and condition. This must be monitored for a period of five years thereafter to ensure that no subsidence and related problems impact on the re-established road.
- The re-alignment of the D1325 must be approved by the North West Province Department of Roads and Transport. It must be constructed in a manner that there is as little disturbance as possible to road users. This should be possible if the existing alignment is closed only once the new alignment is open for traffic.
- If the decision is made to close the local bridge that crosses the N4 in the eastern part of the project area, then Tharisa must obtain the approval of the North West Province Department of Roads and Transport, and either upgrade the gravel road that links between the bridge and Buffelspoort, or determine and alternative in consultation with key stakeholders and the North West Province Department of Roads and Transport.

These measures will be applied to the project components, where applicable.

In addition, the following will be implemented:

- The mine will monitor the traffic situation at the intersection of the main mine access road and the Marikana road. If the service levels prove to be unacceptable a solution will be identified by the mine in consultation with a traffic specialist and the North West Roads Department.
- Place signage to create awareness.

- Education and awareness training of workers.
- The mine will record and respond, appropriately and without delay, to any complaints about usage of roads by mine vehicles.

Emergency situations

If a person or animal is injured by transport activities this must be handled in accordance with the Tharisa's emergency response procedure.

7.2.20 ISSUE: ECONOMIC IMPACT (POSITIVE AND NEGATIVE)

Introduction

Mining projects in general have the potential to impact on the economy both positively through potential growth in the mining sector and job and income creation and negatively through the potential loss of existing economic activities.

Project phase and link to activities/infrastructure

Construction	Operation	Decommissioning	Closure
			N/A
Construction of project components	Operation of the mine	Decommissioning of project components	

Rating of impact

Severity / nature

In the approved EIA and EMP report (Metago, 2008), the severity of positive socio-economic impacts associated with the approved operations was rated a medium positive in both the unmitigated and mitigated scenarios. The severity of negative impacts on surrounding land values was rated medium in both the unmitigated and mitigated scenarios.

The project comprises a number of changes to the approved mine operations which will result in the mining of additional ore reserves, an increased mine footprint, an increased life of mine from 12 to 18 years and optimisation of the mine's processes. As a result the project components could have the following negative and/or ppositive impacts:

- employment for local communities – although this will be limited to approximately 100 construction phase jobs and 35 operational phase jobs, some of these will be sourced from existing Tharisa workers thereby ensuring continuation of employment
- the local and national economy
- aspects related to the mine's social and labour plan
- impact on land value of properties surrounding the project – this is currently perceived to be a negative impact
- livelihoods of community members who own businesses such as commercial farming activities and/or make use of immediately surrounding land.

For this project, the amount of farm land potentially lost for the establishment of surface infrastructure and expansion of mining activities is approximately 276 hectares. The anticipated investment of the project of approximately R72.5 million and job retention/creation associated with the mine in general is significant. However, the specialist compared the economic benefits of the project to that of agricultural activities over the full life of the project. This was achieved as follows (Strategy4Good, 2014):

- Comparison of the new mining investment with the potential loss of agricultural property values
- Comparing the present value of the net economic value added of the mining project relative to impacted farmland yields
- Comparison of the continuation of mining employment with that potentially lost to agriculture.

Values for the project were obtained from Tharisa and values for the agricultural industry were imputed based on macro-economic databases.

The comparison determined the following (Strategy4Good, 2013):

- The projects' net present value exceeds that of the current agricultural activities by R51.8 million (over six years of mining and 32 years of agriculture)
- The new or retained investment is a net positive R870.3 million with respect to existing and new mining investments compared to potential farm property values lost.

The development of the project components which results in the continuation of the mine will therefore have a high positive severity until closure. This positive impact may be enhanced with the implementation of management and mitigation measures. After closure, the positive economic impact from mining will cease but with rehabilitation, the respective pre-mining activities can resume in appropriate areas.

When considering the project's impact cumulatively with the approved operations, the severity rating for the overall mine is medium positive in both the unmitigated and mitigated scenario.

<u>Duration</u>

The positive economic impacts described above will be limited to the life of project. After closure there may still be some positive impacts through maintenance and aftercare activities.

<u>Spatial scale / extent</u>

The positive economic impacts will be far-reaching in both the unmitigated and mitigated scenarios for all project phases until closure.

<u>Consequence</u>

The consequence has been rated as high in both the unmitigated and mitigated scenarios for all project phases until closure.

<u>Probability</u>

The probability is considered to be high in both the unmitigated and mitigated scenarios for all project phases until closure.

<u>Significance</u>

In the approved EIA and EMP report (Metago, 2008), the significance of the impact associated with the approved operations was rated medium positive in the unmitigated and mitigated scenarios for positive impacts and rated medium in the unmitigated and medium to low in the mitigated scenario for negative impacts on land values.

When considering this impact cumulatively with the approved operations, the significance rating for the overall mine is medium positive in the unmitigated and mitigated scenarios.

Assessment of cumulative on-site impact

Mitigation	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
Construction, operations and decommissioning						
Unmitigated	M+	M+	M+	M+	M+	M+
Mitigated	M+	M+	M+	M+	M+	M+

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Section 19).

<u>Objective</u>

The objective of the mitigation measures is to enhance the positive economic impacts and limit the negative economic impacts. Part of this objective is to enhance the contribution to the local economy in particular.

<u>Actions</u>

In the approved EMP (Metago, 2008) it is outlined that:

- The mine will continue to implement the commitments in its social and labour plan in accordance with the employment, procurement and social investment principles of the Mining Charter.
- The administration/human resource manager is responsible for implementing these actions during all mine phases.
- Tharisa must effectively implement all the management actions set out in Section 6 to ensure that the identified unacceptable impact zones are maintained as close to the mine activities as possible. Land

within these zones should be purchased by the mine as and when necessary. Land outside these zones should not be significantly affected. Taking the various mitigated impact types into account the approximate guideline is 500m.

These measures will be applied to the project components, where applicable.

Emergency situations

None identified.

7.2.21 ISSUE: INWARD MIGRATION AND ASSOCIATED SOCIAL ISSUES

Introduction

Mining projects tend to bring with them an expectation of employment in all project phases prior to closure. This expectation can lead to the influx of job seekers to an area which in turn increases pressure on existing communities, housing, basic service delivery and raises concerns around safety and security. This section focuses on the potential for the inward migration and associated social issues.

Project phase and link to activities/infrastructure

Construction	Operation	Decommissioning	Closure
			N/A
Construction of project components	Operation of the mine	Decommissioning of project components	

Rating of impact

Severity / nature

In the approved EIA and EMP report (Metago, 2008), the severity of negative social impacts associated with the approved operations was rated medium (pressure on housing and services) or high (informal settlements) in the unmitigated scenario and medium in the mitigated scenario.

For the project components, there will be new employment opportunities. The project components will be undertaken as an extension of the approved mining operations. Contractors will also be used where required. The potential exists for inward migration of people seeking employment and the associated social issues and pressures. However, even in the unmitigated scenario, the severity of the impact is estimated to be low and will remain low in the mitigated scenario.

When considering this impact cumulatively with the approved operations, the severity rating for the overall mine remains unchanged as high unmitigated reducing to medium with mitigation.

Duration

In the normal course, social impacts associated with each phase of the project will occur for the life of the project, but negative social issues associated with inward migration can continue beyond the closure of the mine, particularly in the unmitigated scenario.

Spatial scale / extent

In both the unmitigated and mitigated scenarios, the impacts of inward migration and associated social ills and pressure on housing and services could extend beyond the project areas into surrounding communities.

Consequence

In the unmitigated scenario the consequence associated with inward migration is high. In the mitigated scenario, the consequence is reduced to medium.

Probability

In the unmitigated scenario the impact is considered to be possible because this type of pressure has been experienced in the communities around Tharisa. With mitigation, impacts associated with inward migration are considered to be less likely, but they are unlikely to be eliminated.

Significance

In the approved EIA and EMP report (Metago, 2008), the significance of the impact associated with the the approved operations was rated high (informal settlements) and medium (pressure on housing and services) in the unmitigated scenario reducing to medium to low in the mitigated scenario.

When considering the project's impact cumulatively with the approved operations, the significance rating for the overall mine remains high in the unmitigated and medium/low in the mitigated scenario.

Assessment of cumulative on-site impact

Management	Severity / nature	Duration	Spatial scale / extent	Consequence	Probability of Occurrence	Significance
All phases						
Unmitigated	H	H	M	H	M	H
Mitigated	M	M	M	M	L	M/L

Conceptual description of proposed mitigation measures

Conceptual mitigation measures are provided below and tabulated in the EMP (Sections 19).

Objective

The objective of the mitigation measures is to limit inward migration and related social impacts.

Actions

In the approved EMP (Metago, 2008), it is outlined that:

- **Recruitment, training, housing**
    - Clear communication that employment of exclusively local people for the proposed project cannot be guaranteed but Tharisa's aims for as many employees as possible to be sourced from local labour sending areas within the first 5 years of production.
    - Effective and timeous communication with community leaders who can attest to a fair and transparent process amongst the community rather than challenging the mine on the community's behalf over jobs and recruitment.
    - The precise number of job opportunities (permanent and temporary) will be made public together with the required skills and qualifications. The duration of temporary work should be clearly indicated and employees provided with regular reminders and revisions throughout the employment period.
    - The existence and screening of specific skills may be determined through the establishment of a skills register prior to employee selection processes.
    - Good communication with all job seekers will be maintained throughout the recruitment process. The process must be seen and understood to be fair and impartial by all involved.
    - Selection of young local people who possess good educational qualifications for apprenticeship positions. This may involve vocational training at centres in Rustenburg and Gauteng. A programme of targeted youth recruitment and training could generate considerable benefits for both the company and local communities. On the one hand the company will have preferential access to a pool of specifically trained, known employees for staff replacement and advancement purposes. On the other hand, the community will retain young upwardly mobile people who will be able to continue utilisation of, and payment for, infrastructure and services.
    - Urging people to get all their documents and certificates, including valid driving licenses, in order prior to recruitment.
    - Facilitating the recognition of prior learning of those job applicants who do not possess formally documented qualifications.
    - Encouraging the Department of Labour and Local Economic Development Forums to educate potential workers about the recruitment process and providing assistance with the organization of the necessary documentation, as well as keeping an up to date database of unemployed people who are looking for work.
    - Notifying unsuccessful job seekers once the recruitment process is complete.
    - Award bursaries to young people in local communities on condition that these bursary holders are available for vacation employment and apprenticeships. This is one way of securing replacement labour and skills throughout the life of the project.
    - Disclose any social investment plans for the area that may lead to jobs.
    - Emphasise the indirect employment opportunities that will come from local contracting by the mine and from the increased local expenditure by mine employees.

- There will be no recruitment at the construction/operational site. All recruitment will take place on set dates and at an arranged venue - preferably a formal gathering place in a nearby community.
- There will be no *ad hoc* hiring of temporary casual labour, no matter how small and temporary the job (washing of vehicles or litter clearance). A sign clearly indicating that there will be no recruitment at the construction site will be erected at the entrance to the site. Also, a list of available temporary workers in the area will be drawn up and kept by Tharisa in the event that temporary labour is required.
- Recruitment will take place during a prescribed 1-2 day period. Subsequent recruitment of replacement staff will take place at discrete, well-advertised intervals during the year.
- Once the recruitment process is complete, unsuccessful job seekers must be clearly informed as such and understand that there is absolutely no reason to remain in the vicinity of the development.
- Local authorities will be requested to remove any informal settlements in the vicinity of the mine that are occupied by people who are there in the hope of obtaining employment. This must be carried out immediately.
- There will be no worker accommodation on site. All workers who are not resident in the vicinity should be accommodated in a formal accommodation in order to obtain their housing allowance.

- **Safety and security**
  - In regard to crime, Tharisa will communicate with the local police force particularly in the context of developing strategies for combating crime in the vicinity of the project, surrounding communities and surrounding landusers/owners.
- **Hygiene/disease - HIV/AIDS**
  - Disease and particularly HIV/AIDS is not a problem only for Tharisa, its employees and contractors, but it is also a local community problem. As a result, successful mitigation of this impact will also depend on the intensity in which it is addressed by other structures such as the health department, the local municipality, education departments, etc.
  - Tharisa will ensure that its employees and contractors are made aware of the issues surrounding the spread of HIV and AIDS in the area. This awareness will be promoted by initiatives such as training and development, peer education, community interventions and visual awareness campaigns. Prevention and management strategies also need to be introduced. Voluntary Counselling and Testing (VCT) is a vital aspect to any HIV/Aids management programme. All stakeholders at Tharisa need to agree to a rigorous VCT programme. Once a high level of VCT is taking place it is possible to define the magnitude of the problem and begin to develop appropriate strategies for dealing with it.
- **Housing and services**
  - A housing allowance will be provided as part of the wages. A system will be implemented to verify that employees are using the housing allowance for formal houses with appropriate services. It is Tharisa’s strategy to employ as many people as possible from local sending areas and these employees should already have formal housing with appropriate services.

The human resources and mine managers will be responsible for implementing these actions from pre construction to closure.

Emergency situations

The establishment of any informal settlements is considered to be an emergency situation that will be handled in accordance with the Tharisa emergency response procedure.

7.3 DEFINITION OF CRITERIA USED

Both the criteria used to assess the impacts and the method of determining the significance of the impacts is outlined in Table 7.5. This method complies with the method provided in the EIA guideline document. Part A provides the approach for determining impact consequence (combining severity / nature, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D. Unmitigated scenario is considered for each impact.

TABLE 7.5: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of severity / nature, spatial extent and duration**
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action. Irreplaceable loss of resources.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints. Noticeable loss of resources.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. Limited loss of resources.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE/ EXTENT of impacts	**L**	Localised - Within the site/ mine boundary.
	M	Fairly widespread – Beyond the site/ mine boundary. Local
	H	Widespread – Far beyond site/ mine boundary. Regional/ national

PART B: DETERMINING CONSEQUENCE					
SEVERITY / NATURE = L					
DURATION	Long term	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**
SEVERITY / NATURE = M					
DURATION	Long term	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**
SEVERITY / NATURE = H					
DURATION	Long term	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	**M**	**H**
			SPATIAL SCALE / EXTENT		

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**H**	**Medium**	**Medium**	**High**
	Possible/ frequent	**M**	**Medium**	**Medium**	**High**
	Unlikely/ seldom	**L**	**Low**	**Low**	**Medium**
			L	**M**	**H**
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

***H = high, M= medium and L= low and + denotes a positive impact.**

7.4 PHASES AND TIMEFRAMES OF POTENTIAL IMPACTS

An indication of the phases in which impacts could occur is included in Section 7.2. This section also provides an indication of the duration of potential impacts. Potential impacts associated with the project have the potential to occur in almost all project phases and on a continuous basis if unmitigated. With the implementation of the mitigation as presented in Section 7.2 and Section 19, the monitoring programmes as presented in Section 21 and the emergency response procedures as presented in Section 20 the timeframe of potential impacts will be reduced significantly.

8 COMPARATIVE LAND USE ASSESSMENT

8.1 ALTERNATIVE LAND USES WHICH COULD BE IMPACTED ON

The alternative land uses that could be affected have been described and assessed in Section 7.2.18.

8.2 RESULTS OF SPECIALIST COMPARATIVE LAND USE ASSESSMENT

A comparative land use assessment was undertaken by the specialist, based on information provided in this EIA report (Appendix L). Results from the study informed the impact assessments described in Section 7.2.20.

The findings of the specialist study are outlined below (Strategy4Good, 2014).

- The overall post-mitigated weighted average of the development is positive VL, which on average is most often where most mine developments are categorised. Based on this, this development ought to be beneficial on an integrated development basis to society. This rating is based on the ratings provided in Section 7 of this EIA and EMP report however it is this specialist's view that the positive economic and social impacts ought to be rated higher. Thus this final outcome of VL positive on an integrated development basis ought to be seen as very conservative in favour of the socio-environment
- The rating for environmental impacts show major fluctuations from unmitigated to mitigated. This is due to unmitigated impacts being generally high in negative terms, and illustrates the importance of effective mitigation
- A total of 464 full time equivalent employee (FTE) jobs over a six year period relative to very few job-losses in agriculture, and a significant increase in GDP, with a positive integrated development rating, support the development of the project components. The expansion of the mine and increase in the life of mine that results in the retention of jobs (in an optimal year just over 2000), is regarded by the specialist as valuable to society. The economic contribution in GDP to the economy is equally significant in an optimal year (compared to an economic generation's GDP).

9 LIST OF SIGNIFICANT IMPACTS

A list of significant impacts, when considered with mitigation measures, as identified in the assessment conducted in Section 7 is provided below.

- Hazardous excavations and infrastructure (Medium)
- Loss of soil resources and land capability through physical disturbance (Medium-High)
- Physical disturbance of biodiversity (Medium)
- General disturbance of biodiversity (Medium)
- Alteration of drainage patterns (Medium)
- Contamination of groundwater (Medium)
- Reduction in groundwater levels / availability – impacts on baseflow (Medium)
- Air pollution through dust generation (including PM10 and PM2.5) (High-Medium)
- Noise pollution for receptors within the mining rights boundary (Medium)
- Negative visual impacts (Medium)
- Loss of or changes to existing land uses (Medium-Low)
- Blasting damage (Medium)
- Economic impacts (Medium+)
- Imward migration (Medium-Low).

10 STAKEHOLDER ENGAGEMENT PROCESS

This section provides a description of the engagement process with interested and affected persons (IAPs) followed during the course of the environmental assessment process. It outlines how IAPs were identified, confirms the details of the engagement process (with supporting documentation included as appendices), and indicates how issues raised have been addressed.

10.1 IDENTIFICATION OF INTERESTED AND AFFECTED PARTIES

The stakeholder engagement process commenced with a stakeholder analysis that was aimed at identifying parties to be involved during the environmental assessment process and associated communication structures. This was done through a deeds search of the relevant properties within the project site and immediately adjacent portions of land, social scans including site visits in the surrounding areas, networking and direct discussions with IAPs.

Key stakeholders identified for the project include:

- IAPs
  - Landowners on the project sites;
  - Surrounding mines and other surrounding land users to Tharisa; and
  - Non-government organisations and associations.
- Regulatory authorities:
  - North West Department of Mineral Resources (DMR)
  - North West Department of Economic Development, Environment, Conservation and Tourism (DEDECT)
  - North West Department of Water Affairs (DWA)
  - South African Heritage Resource Agency (SAHRA)
  - North West Department of Agriculture (DOA)
  - North West Department of Rural Development and Land Reform (DRDLR)
  - Norh West Parks and Tourism (NWPT)
  - North West Department of Transport Roads and Community Safety (NWDTRCS)
- Local authorities:
  - Bojanala Platinum District Municipality (BPDM)
  - Rustenburg Local Municipality (RLM)
  - Madibeng Local Municipality (MLM).

A full list of landowner names, local communities, other IAPs and non-government organisations consulted is provided in the IAPs and regulatory authorities' database included in Appendix B.

10.2 DETAILS OF ENGAGEMENT PROCESS

Stakeholder engagement is an integral component of any development process. The goal of stakeholder engagement is to facilitate and improve communication between stakeholders (including the applicant) in the interest of facilitating better decision-making and more sustainable development (DEAT, 2002). In accordance with the requirement of Chapter 6 of the EIA Regulations, 2006, a stakeholder engagement programme has been developed to set out a coordinated process through which IAPs are informed of the proposed development and environmental assessment process and provided with an opportunity to provide input into the project plan, the assessment and proposed mitigation measures. By consulting with authorities and IAPs, the range of environmental issues to be considered in the EIA has been given specific context and focus. Included below is an outline of the process followed, and the people engaged. Refer to Section 10.3 for a list of issues that were identified during the engagement process.

This section describes the information sharing process undertaken by SLR to date as part of the environmental assessment process.

10.2.1 SOCIAL SCAN

The stakeholder engagement process commenced with a stakeholder analysis that was aimed at identifying parties to be involved during the environmental assessment process and associated communication structures. This was done through a deeds search of the relevant properties within the project site and immediately adjacent portions of land, social scans including site visits in the surrounding areas, networkinsg and direct discussions with IAPs.

A social scan of the project sites was conducted by Ms Stella Moeketse from SLR and Mr Thulani Ntshanga from Tharisa between 14 and 16 March 2012. The purpose of the social scan was:

- to identify and confirm the relevant landowners, land occupiers, and other IAPs
- to obtain contact details for IAPs
- to identify appropriate communication structures
- inform IAPs of the project, upcoming public process and associated scoping and EIA and EMP processes.

As part of the social scan, notification and information sharing took place through informal discussions, focussed meetings and/or telephonic discussions. One output of the social scan was an updated IAP database (Appendix B).

10.2.2 LETTERS, SITE NOTICES AND NEWSPAPER ADVERTISEMENTS

IAPs (including landowners) were informed of the initial project and change in project scope via telephonic discussions, email and post. Proof of these notifications is provided in Appendix A.

For the initial project scope, site notices in English and Setswana were placed at key conspicuous positions in and around the project area on 20 January 2012. Block advertisements were placed in the Daily Sun and Rustenburg Herald newspapers on 19 January 2012. Copies of the newspaper advertisements and site notices and photographs of where the site notices were placed are included in Appendix A.

For the amended project scope, the same process has been followed in that site notices in English and Setswana were placed at key conspicuous positions in and around the project area on 14 February 2014 and block advertisements were placed in the Daily Sun and Rustenburg Herald newspapers on 14 February 2014. Copies of the newspaper advertisements and site notices and photographs of where the site notices were placed are included in Appendix A.

10.2.3 BACKGROUND INFORMATION DOCUMENT

A background information document (BID) on the initial project scope was compiled and distributed in January 2012 by post, hand, e-mail and/or fax to all IAPs and authorities on the project's public involvement database.

The purpose of the BID was to inform IAPs and authorities about the project, the environmental assessment process, possible environmental impacts, and means of providing input into the environmental assessment process. Attached to the BID was a registration and response form, which provided IAPs with an opportunity to submit their names, contact details and comments on the project. A copy of the BID is provided in Appendix A.

In addition, the relevant municipal ward councillor, local shopping centre and Tharisa Mine were used to disseminate Background Information Documents (BIDs) and invitations to the scoping meetings.

10.2.4 2012/2013 SCOPING MEETINGS

Scoping meetings for the initial project scope were held as per the table below.

Organisation/ Community	Date	Time	Venue
Focussed meeting with Mr H. Bedwell and Mr J van Heerden	2 February 2012	11h15 – 12h15	Mr H. Bedwell's Restaurant
Focussed stakeholder scoping meeting	16 February 2012	11h00 – 13h30	Retief Primary School (Hall)
General public scoping meeting	16 February 2012	16h30 – 19h00	Retief Primary School (Hall)
Regulatory authorities scoping and site meeting	21 February 2012	11h30 – 14h00	Tharisa Mine (Farm House Boardroom)
Focused stakeholder meeting	23 February 2013	09h00 – 12h00	SLR Offices, Rustenburg

Invitations for the meetings were done via telephonic discussions, distribution of the BID and placement of the newspaper advertisements and site notices, where required.

At these meetings a presentation was given which provided information on Tharisa's intention to develop the project components. These meetings were focussed on:

- Informing IAPs about the project
- Providing a description of the key project elements
- Informing IAPs about the stakeholder engagement process and how IAPs can have input into the process
- Providing information about the baseline environment and obtaining IAP input
- Providing information about the potential impacts of the project and obtaining IAP input
- Providing an opportunity for IAPs to raise issues and concerns. These issues and concerns have been documented and used to inform the plan of study for the EIA Phase.

Meeting attendance registers, minutes and the meeting presentation is provided in Appendix A. Issues raised including responses are included in the issues and concerns table (Appendix C).

10.2.5 IAP REVIEW OF INITIAL SCOPING REPORT

The scoping report was made available for public review on 14-15 June 2012 at the following venues:

- Tharisa Minerals, C/o Thulani Ntshanga
- Mmaditlhokwa URC, C/o Mr Motaung
- Hillside B&B Buffelspoort, C/o Reception
- Retief Primary School, C/o Reception
- Local Municipal Ward Councillor, C/o Appearance Ndlovu
- Rustenburg Library
- SLR office (Johannesburg).

Full copies of the report were forwarded to IAP groups as requested (see Issues and Concerns Table in Appendix C).

Summaries of the report were distributed in English and Setswana by post or e-mail to IAPs and regulatory authorities on the project's IAP database. All registered IAPs who have mobile numbers were informed that the scoping report was available for review via short message service (SMS).

The scoping report was made available for public review for a 30-day period. Comments received are included in Appendix A with a summary of the comments including responses provided in the issues and concerns table (Appendix C).

10.2.6 AUTHORITY REVIEW OF INITIAL SCOPING REPORT

The scoping report was distributed to the following regulatory authorities:

- Department of Economic Development, Environment, Conservation and Tourism (DEDECT)
- Department of Mineral Resources (DMR)
- Department of Water Affairs (DWA)
- North West Department of Agriculture (DoA)
- Department of Rural Development and Land Reform (DRDLR)
- South Africa Heritage Resource Agency (SAHRA)
- North West Parks and Tourism Board
- North West Department of Transport, Roads and Community Safety (NWDTRCS)
- Bojanala Platinum District Municipality (BPDM)
- Rustenburg Local Municipality (RLM)
- Madibeng Local Municipality (MLM)

Comments received are included in Appendix A with a summary of the comments including responses provided in the issues and concerns table (Appendix C).

10.2.7 2014 SCOPING MEETINGS

Focussed scoping meetings were held with communities and surrounding landowners' representatives as per the table below.

Organisation/ Community	Date	Time	Venue
Ward 31 and 32 Committees	26 March 2014	09h30 – 11h00	Marikana Regional Community Centre
Marikana Eco-Forum	26 March 2014	11h00 – 13h30	Tharisa Security Boardroom
Landowners Representatives	26 March 2014	16h30 – 19h00	Tharisa Security Boardroom

Telephone discussions with the above-mentioned representatives were made with regard to number of scoping meetings to be held and with whom. It was suggested by the representatives and agreed that due to the nature of the changes to the project scope, there was no need to follow the same approach as in the initial scoping phase and that SLR should only hold meetings with the representatives. The representatives agreed to then share the information with the rest of their respective communities.

At these meetings, SLR gave an outline of the new project scope and the environmental authorisation process being followed as per the presentation. Each attendee was given a copy of the presentation. These meetings were focussed on:

- Providing the above-mentioned representatives with the changes to the project scope
- Providing an update on the environmental process
- Providing information about the baseline environment and obtaining IAP input
- Providing information about the potential impacts of the project and obtaining IAP input
- Providing an opportunity for IAPs to raise issues and concerns.

These issues and concerns have been documented and used to inform the plan of study for the EIA phase.

Meeting attendance registers, minutes and the meeting presentation is provided in Appendix A. Issues raised including responses are included in the issues and concerns table (Appendix C).

10.2.8 IAP REVIEW OF REVISED SCOPING REPORT

Full copies of the scoping report were placed for public review at the following venues:

- Retief primary school (office)
- Marikana community hall
- Hillside B&B
- NG Kerk (Mmaditlhokwa)
- Rustenburg library
- Tharisa Mine
- SLR office (Johannesburg).

Electronic copies (via email or on CD) were also made available to IAPs on request.

Summaries of the report (in English and Setswana) as well as details on the draft scoping report review process were sent by post or e-mail to all IAPs and regulatory authorities on the project's public involvement database. Summaries were also be left for general collection at the same venues where the reports were placed. IAPs were also notified of the availability of the scoping report for review by SMS.

The scoping report was subjected to public review for a 30 day period.

All comments and queries on the draft scoping report were raised in writing.

All comments received during the public and authority review of the scoping report have been recorded and included in the issues table final scoping report for submission to DEDECT.

10.2.9 REGULATORY AUTHORITY REVIEW OF REVISED SCOPING REPORT

The draft scoping report was forwarded to regulatory authorities as follows:

- Six copies of the draft scoping report were forwarded to the DMR in April 2014.
- At the same time a copy of the draft scoping report was forwarded to DEDECT, as required by R543 of the 2010 EIA Regulations, for record keeping.
- At the same time, copies were also be forwarded to other regulatory authorities for review: Department of Water Affairs, North West Department of Agriculture, Department of Rural Development and Land Reform, South Africa Heritage Resource Agency, North West Parks and

Tourism Board, North West Department of Transport, Roads and Community Safety, Bojanala Platinum District Municipality, Rustenburg Local Municipality and Madibeng Local Municipality. These regulatory authorities were given 40 days to review and submit comments in line with the requirements of the NEMA. Comments received from this review process have been included in the issues table (Appendix D).

10.2.10 REVIEW OF EIA AND EMP REPORT BY IAPS

Copies of the EIA and EMP report will be made available for public review as follows:

- Retief primary school (office);
- Marikana community hall;
- Hillside B&B;
- Ng Kerk (Mmaditlhokwa);
- Rustenburg library;
- Tharisa Mine; and
- SLR office (Johannesburg).

Electronic copies of the EIA and EMP report will be made available to IAPs on request (electronically by e-mail or on disk). A summary of the EIA and EMP report (in English and/or Setswana) will be compiled and distributed to all IAPs registered on the project's public involvement database by hand, post and/or e-mail.

IAPs will be notified of the availability of the EIA and EMP report/summary for review as well as review periods via newsletter and through established community leadership and representative structures. IAPs will be given 30 days to review the EIA and EMP report and submit comments in writing to SLR.

10.2.11 REVIEW OF THE EIA AND EMP REPORT FOR BY REGULATORY AUTHORITIES

The EIA and EMP report will be distributed to the DMR and other regulatory authorities for review as follows:

- A copy of the EIA and EMP report will be forwarded to the following regulatory and local authorities: DMR, DEDECT, DWA, NWHRA, DOA, DRDLR, NWDPT, NWDTRCS, BPDM, RLM and MLM.
- Six copies and a CD of the EIA and EMP report will be submitted to the DMR who will distribute to other regulatory authorities as required.
- Following the IAP and regulatory authority review, the comments will becollected, addressed where required and be forwarded to the DMR for consideration.

10.3 MANNER IN WHICH ISSUES RAISED WERE ADDRESSED

Stakeholder meetings and public review of the scoping reports provided IAPs an opportunity to comment on the baseline environment and potential impacts of the project (including social and cultural impacts). **All views, issues and concerns raised have been captured into the comments and response report** (Appendix C)**.** The comments and response report provides responses to issues raised and identifies where the issues have been addressed in the EIA and EMP report.

11 ADEQUACY OF PREDICTIVE METHODS AND ASSUMPTIONS AND UNCERTAINTIES

Assumptions, uncertainties and limitations have been discussed throughout the EIA report and in the various specialist studies. The more significant of these are included below.

11.1 ENVIRONMENTAL ASSESSMENT LIMIT

The EIA focused on third parties only and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards, and that Tharisa will adhere to these.

11.2 PREDICTIVE MODELS IN GENERAL

All predictive models are only as accurate as the input data provided to the modellers. If any of the input data is found to be inaccurate or is not applicable because of project design changes that occur over time, then the model predictions will be less accurate.

11.3 BIODIVERSITY

The fieldwork for the north-east waste rock dump was conducted during the dry season (May 2014) and therefore it is possible that some floral species may have been missed. However, the 2013 fieldwork was conducted during the rainy season and information from this survey was used, as well as desktop research in order to adopt a conservative approach regarding the potential for conservation worthy species to occur in the project area.

11.4 AIR QUALITY

Due to data limitations, some assumptions were made during the assessment. These include:

- As on-site meteorological data was available for use in the current study, use was made of meteorological data modelled by the SAWS Unified Model for the period January 2009 to December 2011.
- In all cases where data or information for the project was limited, use was made of data from similar projects and operations in the area.
- The dispersion model cannot compute real-time mining processes; average mining throughputs were therefore used. Operational locations and periods were selected to reflect the worst case scenarios.
- Gaseous pollutants included in this study include all those related to the spendage of fuel by the dryer plant, other gaseous pollutants i.e. haul truck exhaust fumes were not included as the impacts of these compounds are generally low.

- It is important to note that dispersion modelling done for this study represents the predicted impacts from the Tharisa Minerals mine only. There was not enough information available to do a cumulative assessment of air quality in the area. As the area in which Tharisa is situated is an area where many mines are found (it falls under the Waterberg-Bonjanala Priority Area), air quality is already low and therefore the impacts will most probably be higher than predicted in the specialist report.

With respect to the use of meterological data, there is a sufficient agreement between the measured Klipfontein and Unified Model modelled data and therefore use was made of the more recent modelled data that was available for a longer period. The modelled data was therefore decided by the specialist to be valid for model input. It is important to note that there exists a discrepancy between the calm conditions for the measured data at the Klipfontein station (which averages around 30%) and the modelled data with an average of around 8%. The dispersion model used for the purpose of this study, Aermod, cannot evaluate dispersion potential for calm conditions and thus disregards hours with calm wind conditions. As the measured Klipfontein meteorological data was only available for a period of one year, this means that a third of the one year data would be disregarded by the model. Using Klipfontein modelled data would thus not supply enough data to run the model for the required time (minimum of 3 years) for the purpose of an impact assessment study.

11.5 GROUNDWATER

No field investigations (i.e. drilling, pumping tests, etc.) were conducted specifically for this modelling study, but field data obtained during the 2007 study (WGC, 2007) was used in the development of this model.

No field data was collected for the development of the groundwater flow and contaminant transport model, but Tharisa’s groundwater monitoring reports were used. These include a database of boreholes in the vicinity of Tharisa mine, of which twelve had water levels recorded in 2012. These twelve boreholes were used as observation boreholes to calibrate the numerical groundwater flow model.

Borehole records held in the National Groundwater Archive (NGA) maintained by the Department of Water Affairs (DWA) were also obtained, but these were of limited use since only two boreholes in the catchment are still being monitored by DWA.

The dewatering model assumed a pit depth of 230m. Given that the Tharisa plans to mine to an average depth of 180, up to a maximum depth of 200m, the predicted cone of depression presents a worst case scenario.

The same seepage rate of 0.0000748 m/d was used for groundwater modelling purposes for both the TSF and the WRDs. This seepage rate is expected to be conservative and therefore reflect a worst case scenario.

Existing information indicates that a portion of the north east waste rock dump lies above mined out underground workings. The depth of these workings is expected to be >300m below surface. These mine workings have not been taken into account in the groundwater flow and transport model, since the hydraulic properties of the rock and therefore the capacity of the aquifer to transport pollutants is likely to decrease exponentially with depth. Most groundwater flow will occur well above the mine workings, and it is therefore unlikely that the presence of mined out underground workings below and in the vicinity of the north east waste rock dump would influence any pollution plume potential from this facility to an appreciable extent.

11.6 HERITAGE AND CULTURAL RESOURCES

It is possible that the Phase 1 HIA study has missed heritage resources in the study area as heritage remains may occur in thick clumps of vegetation while others may lie below the surface of the earth and would only be exposed once the project commences. If any heritage resources of significance are exposed during the mine development, the South African Heritage Resources Authority (SAHRA) should be notified immediately, all development activities must be stopped and an archaeologist accredited with the Association for Southern African Professional Archaeologist (ASAPA) should be notified in order to determine appropriate mitigation measures for the discovered finds. This may include obtaining the necessary authorisation (permits) from SAHRA to conduct the mitigation measures.

The methods used and underlying assumptions are based on human effort (search and observe, outcomes of earlier/previous surveys in wider area) and as such is subject to human error.

11.7 NOISE

In the supplementary survey, test stations were set up and ambient noise was monitored at four locations, some of which had also been covered in the main survey. This was the maximum number of points that could be set up and managed within time constraints.

Depending on the time of day or night and on meteorological conditions in particular, noise levels produced by industrial sources over long distances vary by a considerable margin. Noise contours in the specialist study were derived from calculations intended to investigate probable worst-case conditions (Night-time levels and Concawe model Meteorological Category 6). On average, typical levels are expected to be lower. “Probable worst-case” in the context of this study refers to levels that are higher than typical levels. Although less probable than typical levels, they are expected to occur from time to time during the course of the year, sometimes possibly for several days. Occurrence of worst-case conditions is not simplistically related to weather conditions and not limited to any particular season of the year.

It should be noted that predicted noise levels and contours are not to be taken as absolute. Noise maps must be interpreted with caution. Predicted levels are valid for the assumptions made in respect of meteorological and other conditions. Since meteorological conditions in particular are highly variable, levels produced at a distance by a source at a constant acoustic output will vary considerably, even during the course of a single day-time or night-time period. Variance in noise level due to changes in atmospheric conditions increases with distance from the source. It should also be borne in mind that noise propagation is not only affected by distance and wind, but by temperature gradients in the atmosphere as well. The contours in the specialist report represent best estimates of continuous project activity noise levels averaged over a relatively long duration, in this case the nominal night-time period of 8 hours.

11.8 ECONOMIC IMPACT

This study was limited in its scope as mainly “inferred economic data” was used, thus the study was limited to desktop research, telephonic interviews and relied on independent information from the project promotor and the environmental consutants.

12 ARRANGEMENT FOR MONITORING AND MANAGEMENT OF IMPACTS

This section describes the arrangements for monitoring and management of environmental impacts. It identifies the impacts that require monitoring programmes and outlines the functional requirements, roles and responsibilities and timeframes for the monitoring programmes. Further detail on each monitoring programme is included in Section 19.

12.1 IMPACTS THAT REQUIRE MONITORING PROGRAMMES

Impacts that require monitoring include:

- Pollution of surface water resources
- Contamination of groundwater
- Lowering of groundwater levels
- Air pollution
- Blasting activities
- Noise levels in the area.

In addition to the above, the commitments as included in Section 19 will require monitoring to:

- Ensure that they are being implemented; and
- That they are effective in mitigating potential impacts on the environment, socio-economic conditions of third parties and heritage/cultural aspects. This will be done through regular internal auditing by mine personnel.

12.2 FUNCTIONAL REQUIREMENTS OF MONITORING PROGRAMMES

The purpose of the monitoring programmes is to review the mine's impact on various aspects of the environment and to report on changes needed to the management programme.

As a general approach, the mine will ensure that the monitoring programmes comprise the following:

- A formal procedure.
- Appropriately calibrated equipment.
- Where samples require analysis they will be transported to the laboratory as soon as possible.
- An independent, accredited laboratory will undertake sample analyses and/or internal laboratory results will periodically be checked by independent and accredited laboratories.
- Parameters to be monitored will be identified in consultation with a specialist in the field and/or the relevant authority.
- If necessary, following the initial monitoring results, certain parameters may be removed from the monitoring programme in consultation with a specialist and/or the relevant authority.
- Monitoring data will be stored.

- Data will be interpreted and reports on trends in the data will be compiled.
- Both the data and the reports will be kept on record for the life of mine.

12.3 ROLES AND RESPONSIBILITIES

The roles and responsibilities for the execution of the monitoring programmes are defined below.

- Senior Operational Manager and Environmental Department Manager:
  - Ensure that the monitoring programmes are scoped and included in the annual mine budget;
  - Identify and appoint appropriately qualified specialists/engineers to undertake the programmes; and
  - Appoint specialists in a timeous manner to ensure work can be carried out to acceptable standards.

12.4 TIMEFRAMES FOR MONITORING AND REPORTING

The timeframes for monitoring and reporting thereof are detailed in the monitoring programme (see Section 21). A summary is provided below:

Programme	Monitoring: Timeframe and frequency	Reporting
Tailings dams, waste dumps and water dams	All project phases On-going by dam operators and quarterly by professional engineer	On-going by professional engineer
Biodiversity	All project phases	As required by specialist
Groundwater and surface water	All project phases As per requirements of water use license	Monthly and quarterly As per requirements of water license
Air	All project phases As per requirements of the Atmospheric Emissions Licence	Monthly and quarterly As per requirements of the Atmospheric Emissions Licence
Noise	As required (dependant on stakeholder complaints)	Annually and as required
Blasting	Every surface blast	Monthly by specialist
Internal auditing	From start of construction to end of closure On-going	As required
External auditing	From start of construction to end of closure Every two years	Every two years to DMR

13 TECHNICAL SUPPORTING INFORMATION

The following specialist studies are attached as appendices to this report:

- Soils and land capability study (Appendix D)
- Biodiversity studies (Appendix E)
- Hydrological assessment (Appendix F)
- Groundwater study (Appendix F)
- Air quality study (Appendix G)
- Noise study (Appendix H)
- Visual study (Appendix I)
- Blasting report (Appendix J)
- Heritage and cultural study (Appendix K)
- Palaeontological report (Appendix K
- Alternative land use report (Appendix L).

SECTION 2 – ENVIRONMENTAL MANAGEMENT PROGRAMME

14 ENVIRONMENTAL OBJECTIVES AND SPECIFIC GOALS FOR CLOSURE

14.1 ENVIRONMENTAL ASPECTS THAT DESCRIBE THE PRE-MINING ENVIRONMENT

Environmental aspects that describe the pre-mining environment as informed by the baseline description (Section 1) are listed below. This list serves to guide the setting of environmental objectives for mine closure.

- Relatively flat plain with a gentle slope down towards the north and the Magaliesberg Mountian Range to the south
- Pre-mining soil forms that support grazing and wilderness land capabilities and/or uses
- Areas of ecologically sensitive habitats such as rocky outcrops and wetlands
- Perennial and non-perennial drainage patterns
- Good groundwater quality
- Stable water table providing groundwater as a water supply source
- Semi-rural environment.

14.2 MEASURES TO CONTROL OR REMEDY ANY CAUSES OF POLLUTION OR DEGRADATION

Measures required to contain or remedy any causes of pollution or degradation or migration of pollutants, both for closure of the mine and post-closure are listed below.

- Implement a waste management procedure for general and hazardous waste on site
- Ensure immediate clean-up of any spills as per the emergency response procedures (Section 20)
- Establish and maintain dirty stormwater control measures in line with regulatory requirements, until such time as potentially polluting areas are rehabilitated
- Contain pollutants at source by storing and handling potentially polluting substances on impermeable substrates, within bunded areas and with the capacity to contain spills
- Design, construct and/or operation of tailings dams with decant and drainage systems and runoff control measures
- Design, construct and/or operate waste rock dumps with runoff control measures
- Rehabilitate the site in line with a detailed closure plan to be developed at least five years prior to decommissioning.

Further detail on the proposed action plans and mitigation measures is included in Section 19.

15 ENVIRONMENTAL OBJECTIVES AND SPECIFIC GOALS FOR MANAGEMENT OF IDENTIFIED ENVIRONMENTAL IMPACTS

The environmental objectives and specific goals for the management of identified environmental impacts are detailed in this section.

15.1 IMPACTS THAT REQUIRE MONITORING PROGRAMMES

Impacts that require monitoring include:

- Contamination of surface water resources
- Contamination of groundwater
- Dewatering
- Air pollution
- Noise levels
- Blasting activities.

15.2 ACTIVITIES AND INFRASTRUCTURE

The source activities of potential impacts which require management are detailed in Section19 and listed below.

- Site preparation
- Earthworks
- Civil works
- Exploration
- Open pit mining
- Waste rock management
- Mineral processing operations
- Tailings management
- Resource use
- Process and storm water management
- Transport systems
- General and hazardous waste management
- Site support services
- Site / contract management
- Demolition
- Rehabilitation
- Maintenance and aftercare

15.3 MANAGEMENT ACTIVITIES

Management activities which will be conducted to control the project actions, activities or processes which have the potential to pollute or result in environmental degradation are detailed in Section 19.

15.4 ROLES AND RESPONSIBILITIES

The key personnel to ensure compliance to this EMP report will be the senior operations manager, the environmental department manager and the stakeholder engagement manager. As a minimum, these roles as they relate to the implementation of monitoring programmes and management activities will include:

- Group SHE Manager and Environmental Manager:
    - ensure that the monitoring programmes and audits are scoped and included in the annual mine budget
    - identify and appoint appropriately qualified specialists/engineers to undertake the programmes
    - appoint specialists in a timeously manner to ensure work can be carried out to acceptable standards.
- Stakeholder engagement department:
    - Liaise with the relevant structures in terms of the commitments in the SLP;
    - Ensure that commitments in the SLP are developed and implemented timeously
    - Establish and maintain good working relations with surrounding communities and landowners
    - Facilitate stakeholder communication, information sharing and grievance mechanism.

16 ENVIRONMENTAL OBJECTIVES AND SPECIFIC GOALS FOR SOCIO-ECONOMIC CONDITIONS

16.1 ASPECTS OF THE SOCIO-ECONOMIC CONDITIONS

The socio-economic conditions surrounding the proposed project sites are described in Section1.3.3.

16.2 OBJECTIVES AND GOALS

Specific environmental objectives and goals to control, remedy or stop potential impacts emanating from the project components which may impact on communities and IAPs are described below. The information is presented in tabular format (Table 16.1).

TABLE 16.1: ENVIRONMENTAL OBJECTIVES AND GOALS- SOCIO-ECONOMIC CONDITIONS

Aspect	Environmental objective	Goals
Land uses	To prevent unacceptable impacts on surrounding land uses and their economic activity	To co-exist with existing land uses To negatively impact existing land uses as little as possible
Blasting	To minimise the potential for third party damage and/or loss	To protect third party property from mine-related activities, where possible Where damage is unavoidable, to work together with the third parties to achieve a favourable outcome
Traffic	To reduce the potential for safety and vehicle related impacts on road users	To ensure the mine's use of public roads is done in a responsible manner
Socio-economic	To enhance the positive economic impacts and limit the negative economic impacts To limit the impacts associated with inward migration	To work together with existing structures and organisations To establish and maintain a good working relationship with surrounding communities and land owners

17 ENVIRONMENTAL OBJECTIVES AND SPECIFIC GOALS FOR HISTORICAL AND CULTURAL ASPECTS

17.1 ASPECTS OF THE HERITAGE AND CULTURAL CONDITIONS

The heritage/historical and cultural conditions surrounding the proposed project sites are described in Section1.3.

17.2 OBJECTIVES AND GOALS

Specific environmental objectives and goals to control, remedy or stop potential impacts emanating from the proposed projects which may impact on heritage and cultural resources are described below. The information is presented in tabular format (Table 17.1).

TABLE 17.1: ENVIRONMENTAL OBJECTIVES AND GOALS- HERITAGE AND CULTURAL CONDITIONS

Aspect	Environmental objective	Goals
Heritage and cultural	To prevent unacceptable loss of heritage resources and related information	To protect heritage resources where possible If disturbance is unavoidable, then mitigate impact in consultation with a specialist and the SAHRA and in line with regulatory requirements

18 APPROPRIATE TECHNICAL AND MANAGEMENT OPTIONS CHOSEN FOR EACH IMPACT

18.1 PROJECT ACTIONS, ACTIVITIES AND PROCESSES

All activities associated with the project components have the potential to cause pollution and/ or environmental degradation. These are described in Section 2 of this EIA and EMP report.

18.2 TECHNICAL AND MANAGEMENT OPTIONS

Appropriate technical and management options chosen to modify, remedy, control or stop any action, activity or process associated with the proposed projects which will cause significant impacts on the environment, socio-economic conditions and historical and cultural aspects are described in detail in Section 7 and included in the action plans in Section 19.

In addition to these, the mine will continue to implement an environmental management system to assist in the implementing and monitoring of commitments included in this EIA and EMP report.

19 ACTION PLANS TO ACHIEVE OBJECTIVES AND GOALS

Action plans to achieve the objectives and goals set out in Section 15 (bio-physical environment), Section 16 (socio-economic conditions) and Section 17 (historical and cultural) above, are listed in tabular format together with timeframes for each action. The action plans include the timeframes and frequency for implementing the mitigation measures as well identifies the responsible party.

Action plans as described below, include technical and management options for all existing operations currently being undertaken at Tharisa, as well as any new technical and management options that are not currently in place but are however relevant to the project.

TABLE 19.1: ACTION PLAN – LOSS AND STERILIZATION OF MINERAL RESOURCE

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Planning	Mining Placement of infrastructure	-	-	The mine plan and infrastructure layout will be designed to prevent sterilisation of third party minerals. Future planning at the mine will continue to take this into account.	At start	Once off	Mine planner, geologist, environmental manager and mine manager

TABLE 19.2: ACTION PLAN – SURFACE SUBSIDENCE

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Not applicable						
Operation Decommission	Open pit mining Rehabilitation of open pits	M	L	• Backfilling operations must take the possibility of surface subsidence into account. This may require the calculation of a bulking factor and the initial creation of a slight swell above ground level. Final replacement of topsoil onto the backfilled overburden/waste rock material should be done with the understanding that if subsidence occurs thereafter, re-stripping of topsoil and additional backfilling with overburden/waste rock will be required. Thereafter the topsoil will have to be replaced. • Specific backfilling and compaction techniques, in consultation with an appropriately qualified civil engineer, will be used to prevent subsidence for the re-establishment of the D1526/ D1566 road and if possible, the headwaters of the non-perennial drainage lines in the eastern and western open pit sections. • Sudden surface subsidence is considered an emergency situation and will be dealt with in line with Tharisa's emergency response procedure.	• On-Going • On-Going • As Required	• On-Going • On-Going As Required	SHE Manager SHE Manager SHE Manager
Closure	Not applicable			• Sudden surface subsidence is considered an emergency situation and will be dealt with in line with Tharisa's emergency response procedure.	• As Required	• As Required	SHE Manager

TABLE 19.3: ACTION PLAN – HAZARDOUS EXCAVATIONS AND INFRASTRUCTURE

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Earthworks Civil works Rehabilitation	H	M	• Each hazardous excavation will have a barrier around it to prevent access by people and animals. The barrier may be in the form of fences, walls or berms. In addition, the barriers must have warning signs at appropriate intervals. These warning signs must be in picture format and/or written in English, Afrikaans and Tswana.	• On-Going	• On-Going	SHE Manager And Appointed Engineer
Operation	Waste rock dumps TSF Open pits Stockpiling Mineral processing General site management Rehabilitation			• Dams with a safety risk (this includes all dams that hold 50 000m^3 of water and that have a wall of 5m or more) will be monitored by a professional civil engineer.	• On-Going	• Monthly	SHE Manager And Appointed Engineer
				• Implement mitigation measures relating to surface subsidence as per Table 19.2.	• On-Going	• On-Going	SHE Manager And Appointed Engineer
				• Any hazardous structure or excavations will be designed and constructed in a manner to ensure that stability and safety risks to third parties and animals are addressed. These issues will be monitored according to a schedule that is deemed relevant to the type of facility.	• On-Going	• On-Going	SHE Manager And Appointed Engineer
				• Tharisa will update its surface use area map on a routine basis to ensure that the position and extent of all potentially hazardous excavations, infrastructure is known.	• On-Going	• Annually	SHE Manager And Appointed Engineer
				• If people or animals fall off or into hazardous excavations or infrastructure causing injury, the Tharisa emergency response procedure will be initiated.	• As Required	• As Required	SHE Manager
Decommission	Demolition Final land forms Rehabilitation			• Any hazardous structure or excavations will be closed in a manner to ensure that stability and safety risks to third parties and animals are addressed. These issues will be monitored according to a schedule that is deemed relevant to the type of facility.	• On-Going	• On-Going	SHE Manager And Appointed Engineer
				• Where Tharisa has caused injury to third parties and/or animals, appropriate compensation will be provided.	• As Required	• As Required	SHE Manager
				• If people or animals fall off or into hazardous excavations or infrastructure causing injury, the Tharisa emergency response procedure will be initiated.	• As Required	• As required	SHE Manager
Closure	Maintenance and aftercare of final land forms			• Any hazardous structure or excavations will be closed in a manner to ensure that stability and safety risks to third parties and animals are addressed. These issues will be monitored according to a schedule that is deemed relevant to the type of facility.	• On-Going	• On-Going	SHE Manager And Appointed Engineer
				• Where Tharisa has caused injury to third parties and/or animals, appropriate compensation will be provided.	• As Required	As Required	SHE Manager

TABLE 19.4: ACTION PLAN – LOSS OF SOIL RESOURCES AND LAND CAPABILITY THROUGH PHYSICAL DISTURBANCE

Phase of operation	**Activities**	**Sig**		**Technical and management options**	**Action plan**		
		UM	**M**		**Timeframe**	**Frequency**	**Responsible parties**
Construction	Earthworks General site management Transport systems Rehabilitation	H	M-H	• Tharisa will implement the soil conservation procedure as set out in Table 7.1 above. These measures will be applied to the project, where applicable. • The stream diversion will incorporate appropriate energy dissipaters for erosion prevention.	• As Required	• As Required	SHE Manager SHE Manager
Operation	General site management Open pit mining TSF WRD Rehabilitation						
Decommission	Demolition General site management TSF WRD Rehabilitation			• Tharisa will implement the soil conservation procedure as set out in Table 7.1 above. These measures will be applied to the project, where applicable.	• As Required	• As Required	SHE Manager
Closure	Final land forms Maintenance and aftercare of final land forms and rehabilitated areas			• Tharisa will implement the soil conservation procedure as set out in Table 7.1 above. These measures will be applied to the project, where applicable.	• As Required	• As Required	SHE Manager

TABLE 19.5: ACTION PLAN – LOSS OF SOIL RESOURCES AND LAND CAPABILITY THROUGH POLLUTION

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Earthworks Civil works General site management Transport systems Rehabilitation	H	L	• Tharisa will conduct all potentially polluting activities in a manner that pollutants are contained at source. In this regard Tharisa will ensure that: ○ all vehicles and equipment will be serviced in workshops and washbays with contained impermeable, floors, dirty water collection facilities and oil traps ○ all chemical, fuel, oil storage and handling facilities will be designed and operated in a manner that all spillages are contained in impermeable areas and cannot be released into the environment ○ ad hoc spills of potentially polluting substances (whether in dirty areas or in the environment) will be reported to the environmental manager immediately and cleaned up/remediated immediately; ○ a dirty water management system that complies with the requirements of Regulation 704 is implemented ○ the waste management practices, as set out in Table 7.2 above, are implemented (these have been updated to cater for the requirements of the new Waste Classification and Management Regulations, 2013). The waste management measures will be applied to the project components, where applicable. • Major spillage incidents that have the potential to pollute soils both on and off site must be handled in accordance with Tharisa emergency response procedure.	• As Required • As Required • On-Going • As Required • Ongoing • As Required	• As Required • As Required • On-Going • As Required • Ongoing • As Required	SHE Manager SHE Manager
Operation	TSF Waste rock dumps General site management Transport systems Rehabilitation						
Decommission	Demolition General site management Transport systems Rehabilitation						
Closure	Maintenance and aftercare of rehabilitated areas and final land forms	H	L	• Tharisa will conduct all potentially polluting activities in a manner that pollutants are contained at source. In this regard Tharisa will ensure that: ○ a dirty water management system that complies with the requirements of Regulation 704 is implemented ○ the waste management practices, as set out in Table 7.2 above, are implemented (these have been updated to cater for the requirements of the new Waste Classification and Management Regulations, 2013). The waste management measures will be applied to the project components, where applicable. • Major spillage incidents that have the potential to pollute soils both on and off site must be handled in accordance with Tharisa emergency response procedure.	• Ongoing • As Required	• Ongoing • As Required	SHE Manager SHE Manager

TABLE 19.6: ACTION PLAN – PHYSICAL DESTRUCTION OF BIODIVERSITY

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Pre-construction	Site preparation	H	M	• Tharisa will implement a biodiversity action plan (BAP) that will be refined and implemented in consultation with a biodiversity specialist. This action plan will be in place prior to the construction phase of the mine and it will include the following management actions:	• Pre-Construction And Ongoing	• Once Off And Ongoing	SHE Manager
Construction	Site preparation Earthworks General site management Rehabilitation			○ Tharisa will limit mine infrastructure, activities and disturbance to those specifically identified and described in the EIA and EMP report with controlled access and zero tolerance of disturbances to the identified sensitive habitats and associated species. As a general rule, a buffer of 100m will be put in place around sensitive habitats that are not disturbed by the approved activities;	• Ongoing	• Ongoing	SHE Manager
Operation	General site management Rehabilitation						
Decommission	Demolition General site management Rehabilitation			○ If removal of protected vegetation species is required for the establishment of approved project infrastructure this may only be done if the required permits are in place;	• Ongoing	• Ongoing	SHE Manager
				○ The engineering design work of watercourse diversions, rehabilitation of headwaters and river crossings will be completed in consultation with a qualified ecologist with watercourse related expertise to limit the destruction of habitat and species and to promote re-establishment thereof. Where possible, pebbles, rocks and biodiversity will be re-established in diversion and the diversion route will be scanned for sensitive fauna and flora prior to construction;	• Ongoing	• Ongoing	SHE Manager
				○ There will be planning on the removal of fauna and flora (plants and seeds) species prior to disturbance by mine infrastructure and activities. This will include planning on the preservation, cultivation and re-use of these species in ongoing rehabilitation. Links will also be made to the soil conservation procedure and actions; and	• Ongoing	• Ongoing	SHE Manager
				○ An alien/invasive/weed management programme will be implemented in collaboration with DAgric, DWA and Working for Water to control the spread of these plants onto and from disturbed areas. Care will be taken to prevent the encroachment of alien plant species into rehabilitated areas.	• Ongoing	• Ongoing	SHE Manager
				• There will be collaboration with the local land users on community grazing, medicinal plant harvesting, animal harvesting and fuel plant harvesting in a manner that promotes sustainable use of natural resources. This is particularly relevant for the sensitive habitats.	• As Required	• As Required	SHE Manager
Closure	Not Applicable						

TABLE 19.7: ACTION PLAN – GENERAL DISTURBANCE OF BIODIVERSITY

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Site preparation Earthworks General site management Rehabilitation Transport	H	M	• The use of light will be kept to a minimum, and where it is required, yellow lighting will be used where possible • Workers (permanent and temporary) will be trained on the value of biodiversity and the need to conserve the species and ecosystems, as well as fire control and prevention. This will be included in induction training as well as relevant follow-up training. • There will be zero tolerance with respect to the killing or collecting of any biodiversity by anybody working for or on behalf of Tharisa within or adjacent to the mine area • Strict speed control measures will be implemented on access roads and vehicles will be restricted to travel on designated roads • Alien plant species proliferation, which may affect floral and faunal diversity, will be controlled in accordance with legislation and in a manner that no additional loss of indigenous plant species occurs • Effective implementation of the following management plans provided in Section 19: ○ Surface and groundwater management plans ○ Soil management plan ○ Dust management plan ○ Waste management plan ○ Noise management plan ○ Blast management plan • Concurrent and final rehabilitation of the residue facilities • Concurrent rehabilitation of areas no longer required for mining activities with a particular focus on establishing indigenous vegetation cover	• Ongoing • Ongoing • Ongoing • Ongoing • Ongoing • Ongoing • Ongoing • Ongoing	• Ongoing • Quarterly • Ongoing • Ongoing • Ongoing • Ongoing • Ongoing • Ongoing	SHE Manager SHE Manager SHE Manager SHE Manager SHE Manager SHE Manager SHE Manager SHE Manager
Operation	General site management Rehabilitation						
Decommission	Demolition General site management Rehabilitation Transport						
Closure	Not Applicable						

TABLE 19.8: ACTION PLAN – ALTERATION OF SURFACE DRAINAGE PATTERNS

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Earthworks Civil works Genial site management Rehabilitation Transport systems	H	M	• The Elandsdriftspruit stream diversion and conveyor river crossing detailed designs will be in accordance with the requirements of Regulation 704, the requirements of DWA as stipulated in the water licence, and will be designed and implemented by an appropriately qualified engineer • In these designs, considerations will be given to the biodiversity and rehabilitation requirements as outlined in the EIA and EMP report • The footprint and associated catchment of all project infrastructure will be minimised to limit the impact on stream flow reduction. • Tharisa will apply for authorisation with respect to all relevant water uses and R704 exemptions required • At the north east WRD, further work will be undertaken in line with the recommendations of the hydrology specialist (see Section 2.7.4.5) to determine the best means of addressing clean surface water runoff upstream of the site	• At Start And Ongoing • As Required • Ongoing • Before Start Of Construction • Before Start Of Construction	• Once Off And Ongoing • As Required • Ongoing • Before Start Of Construction • Before Start Of Construction	SHE Manager And Design Engineer SHE Manager SHE Manager
Operation	General site management Open pit Waste rock dumps			• In the designs discussed in the construction management above, considerations will be given to the biodiversity and rehabilitation requirements as outlined in the EIA and EMP report. • Clean and dirty water will be separated and clean water will be diverted around dirty areas and allowed to return to its normal flow path as outlined in the stormwater management plan • Site rehabilitation will aim to restore surface drainage patterns as far as practically and economically feasible. • Any significant breach containment facilities is considered an emergency situation.	• As Required • Ongoing • Ongoing • As Required	• As Required • Ongoing • Ongoing • As Required	SHE Manager SHE Manager SHE Manager SHE Manager
Decommission	Demolition General site management Rehabilitation			• Site rehabilitation will aim to restore surface drainage patterns as far as practically and economically feasible. • Any significant breach containment facilities is considered an emergency situation	• Ongoing • As Required	• Ongoing • As Required	SHE Manager SHE Manager
Closure	Maintenance and aftercare of final rehabilitated areas						

TABLE 19.9: ACTION PLAN – CONTAMINATION OF SURFACE WATER RESOURCES

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Earthworks Civil works Genial site management Rehabilitation Transport systems	H	L	• In regard to soil/erosion management, pollution prevention and management, and waste management, the procedures, practices and actions will be implemented.	• At Start And Ongoing	• Ongoing	SHE Manager And Engineering Manager
Operation	Transport systems General site management Chrome sand plant TSF Waste rock dumps			• The clean and dirty water systems will be implemented and managed in accordance with the provisions of Regulation 704 for water management on mines. In this regard: ○ clean water will be diverted around operational areas; ○ areas in which hazardous and/or polluting substances can be spilled will be minimised and contained. The storage method of all these substances is to contain them in sealed containers within impermeable, bunded areas with sufficient capacity to contain spilled materials (in accordance with SANS 10089-1:2003). All spilled materials must drain to sumps with oil traps that must also be equipped to allow collection and removal of spilled substances; and ○ all other dirty water will be contained in the dirty water run-off and/or process water system that comprises dirty water pipes, channels and dams, and from which dirty water will be reused rather than discharged to the environment. These systems will be routinely inspected to detect possible breaches and implement preventative or corrective action.	• At Start And Ongoing	Ongoing	SHE Manager And Engineering Manager
Decommission	Demolition General site management Transport systems Rehabilitation			• Tharisa will implement a monitoring programme of surface water in the vicinity of its operations and when possible (during the rainfall season) this will include surface water sampling points both up and downstream (where possible) of the mining operations in the following water courses: the perennial Sterkstroom, the unnamed tributaries of the Brakspruit, the Maretlwane and the Elandsdriftspruit.	• At Start And Ongoing	• Quarterly	SHE Manager And Engineering Manager
Closure	Maintenance and aftercare of final rehabilitated areas			• Should any contamination be detected the mine will immediately notify DWA. The mine, in consultation with DWA and an appropriately qualified person, will then notify potentially affected users, identify the source of contamination, identify measures for the prevention of this contamination (in the short term and the long term) and then implement these measures.	• As Required	• Immediately When Required	SHE Manager
				• The surface water monitoring programme will be adjusted to cater for the changes in surface infrastructure – refer to Section 21.1	• At Start And Ongoing	• Quarterly	SHE Manager
				• The revised stormwater management plan outlined in Section 2.7.4.5 will be implemented	• At Start And Ongoing	• Ongoing	SHE Manager
				• Where water levels within the containment dams do not allow for provision of a 1:50 year 24 hour duration storm event, the daily timestep water balance recommended as part of the detailed	• As Required	• As Required	SHE Manager And Engineering Manager

<table>
<tr><th rowspan="2">Phase of operation</th><th rowspan="2">Activities</th><th colspan="2">Sig</th><th rowspan="2">Technical and management options</th><th colspan="3">Action plan</th></tr>
<tr><th>UM</th><th>M</th><th>Timeframe</th><th>Frequency</th><th>Responsible parties</th></tr>
<tr><td></td><td></td><td></td><td></td><td>design of these facilities should be reviewed and updated.
• Management measures to be implemented to address the water contamination risk posed by the use of Hernic Quarry to store contaminated water includes:
○ Flood Protection Measures – a flood protection bund shall be constructed between the river and the quarry, to prevent water within the Sterkstroom from mixing with dirty water within the quarry. The top of the flood bund shall be situated at or above the 1:50 year flood level and include a 800mm freeboard to take into account possible turbulence in the channel during a flood event. The top of the flood bund should be no lower than 1189.96 metres above mean sea level. The flood bund must be designed to ensure that it can withstand erosion during a flood event, that it is structurally stable and does not compromise the integrity of the quarry sidewalls
○ Water Level Management – in order to prevent seepage from the quarry to the river, water levels within the quarry must be maintained lower than the river, ensuring that any seepage is likely to be from the river into the quarry and not from the quarry into the river. In order to achieve this, the following will be implemented:
▪ Monitoring of water levels in the quarry
▪ A daily timestep water balance model will be developed to assess the capacity of the quarry and inform the inflow and outflow rates.
• Any significant pollution incident is considered an emergency situation.</td><td>• Ongoing
• During Design And Construction
• Ongoing
• As Required</td><td>• Ongoing
• Ongoing
• Quarterly
• As Required</td><td>SHE Manager
SHE Manager
SHE Manager
SHE Manager</td></tr>
</table>

TABLE 19.10: ACTION PLAN – GROUNDWATER CONTAMINATION

<table>
<tr><th rowspan="3">Phase of operation</th><th rowspan="3">Activities</th><th colspan="2" rowspan="2">Sig</th><th rowspan="3">Technical and management options</th><th colspan="3">Action plan</th></tr>
<tr><th rowspan="2">Timeframe</th><th rowspan="2">Frequency</th><th rowspan="2">Responsible parties</th></tr>
<tr><th>UM</th><th>M</th></tr>
<tr><td>Construction</td><td>Earthworks
Civil works
General site management
Rehabilitation
Transport systems</td><td rowspan="4">H</td><td rowspan="4">M</td><td>• Prior to the commencement of the mine, Tharisa will conduct a detailed hydrocensus of all boreholes that are in use in the potentially affected zones to verify whether there are additional boreholes to those that have already been identified. This hydrocensus will confirm the borehole location, water depth, water quality and water use for each identified borehole. All potentially affected boreholes will be included in the monitoring programme for boreholes located both on and off the mine site.
• Major spillage incidents that have the potential to pollute groundwater both on and off site must be handled in accordance with Tharisa emergency response procedure.</td><td>• Pre-Construction And Ongoing
• As Required</td><td>• Ongoing
• As Required</td><td>SHE Manager
SHE Manager</td></tr>
<tr><td>Operation</td><td>Transport systems
General site management
TSF
Waste rock dumps</td><td rowspan="3">• All potentially affected boreholes will be included in the water monitoring programme for boreholes located both on and off the mine site as described below.
• Boreholes, adjacent to tailings facility and between tailings facility and potentially affected third party boreholes, the Sterkstroom and any other non-perennial water courses in the potential impact zone, will be part of the monitoring programme. If contamination is detected Tharisa will consult with an appropriate specialist and with DWAF (now DWA) to design and implement a treatment solution. In short term, this may involve the capturing of the pollution plume by means of scavenger boreholes and the treatment and/or reuse of the polluted water.
• The long term post closure options for pollution prevention and/or water abstraction and treatment will form part of the management measures that are designed and implemented. In this regard, the groundwater model should be recalibrated to take into account alternative options of preventing long term seepage from the tailings dam. The options available are a covering or a lining. In the scenario where a covering is used, the recalibrated model must take into account the reality that seepage from the tailings dam can be stopped at some point with a cover, once the head of water within the dam has been reduced through seepage over time.
• If any mine related contamination and loss of water supply is experienced by the borehole users, Tharisa will provide compensation which could include an alternative water supply of equivalent water quality.
• Major spillage incidents that have the potential to pollute groundwater both on and off site must be handled in accordance with Tharisa emergency response procedure.</td><td rowspan="3">• Ongoing
• Ongoing
• Ongoing
• Ongoing
• As Required</td><td rowspan="3">• Ongoing
Ongoing
Ongoing
• Ongoing
• As Required</td><td rowspan="3">SHE Manager
SHE Manager
SHE Manager
SHE Manager
SHE Manager</td></tr>
<tr><td>Decommission</td><td>Demolition
General site management
TSF
Waste rock dumps (that remain on surface)
Transport systems
Rehabilitation</td></tr>
<tr><td>Closure</td><td>Maintenance and aftercare of final rehabilitated areas including TSF and waste rock dumps</td></tr>
</table>

TABLE 19.11: ACTION PLAN – REDUCTION IN GROUNDWATER LEVELS/AVAILABILITY

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M*		Timeframe	Frequency	Responsible parties
Construction	Mine water supply	H	L / M	• Prior to the commencement of pit dewatering and borehole abstraction, Tharisa will conduct a detailed hydrocencus of all boreholes that are in use in the potentially affected zones to verify whether there are additional boreholes to those that have already been identified. This hydrocencus will confirm the borehole location, water depth, water quality and water use for each identified borehole. All potentially affected boreholes will be included in the water monitoring programme for boreholes located both on and off the mine site	• Pre-Dewatering	• Once Off	SHE Manager
Operation	Dewatering of open pits Mine water supply			• Borehole monitoring must also take place between the pit and either side of the Sterkstroom. If such an impact is observed, measures to compensate for the dewatering impact (such as controlled discharge into the water course) can be tailored to the degree of the dewatering impact in consultation with a specialist, key stakeholders and DWAF (now DWA)	• Ongoing	• Quarterly	SHE Manager
Decommission	Rehabilitation of open pits			• If any mine related loss of water supply is experienced by the borehole users, Tharisa will provide compensation which could include an alternative water supply of equivalent water quality	• As Required	• As Required	SHE Manager
Closure	Final void – partially backfilled			• The current ground water monitoring network will be extended to replace boreholes that were lost due to the pit and TSF construction as well as those that neighbouring landowners have requested to be included	Ongoing	Ongoing	SHE Manager
				• Groundwater monitoring should be concentrated in the vicinity of the open pits and around the TSFs	Ongoing	Quarterly	SHE Manager
				• Groundwater monitoring points must be located both up-stream and down-gradient of the potential impacts	Pre-Construction	Once Off	SHE Manager
				• Volumes of water pumped from the open pits should be recorded as accurately as possible. These volumes could be used in future to further calibrate the numerical model, and improve the accuracy of forward predictions	Ongoing	For Every Dewatering Event	SHE Manager
				• A transient groundwater flow model should be constructed once groundwater levels over a (hydrological) year become available,. The model should include updated information on water levels and pit inflows.	Ongoing	Annually	SHE Manager
				• Tharisa will monitor flow in Sterkstroom to better understand the frequency, magnitude and nature of stream flow events as well as determining the flow rates. Where flow in Sterkstroom is affected by mining activities, Tharisa will implement a mechanism, purpose of which will be to discharge correct quality water into Sterkstroom to simulate downstream flows.	Ongoing	Quarterly	SHE Manager

** L rating for availability of groundwater to third party users; M for affect on baseflow*

TABLE 19.12: ACTION PLAN – AIR POLLUTION THROUGH DUST GENERATION AND GASEOUS EMISSIONS

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Site preparation Earthworks Civil works General site management	H	M-H	• Tharisa will purchase sufficient land to extend its site boundary in such a manner that the predicted PM10 impacts in the managed scenario (management actions are included below) remain on mine owned property. The recommended zone for the scenario with maximum dust mitigation controls is 500m from emission sources.	• Ongoing	• Quarterly	SHE Manager
Operation	General site management Earthworks Transport systems Chrome sand drying plant			• The following specific measures will be implemented: ○ Unpaved roads – target dust control efficiency of 90% - achieved by a combination of water suppression and suppression chemicals; ○ Crushing and screening – target dust control efficiency of 98% – achieved by enclosure of crushing activities and capture of emissions through dust extraction and associated bag filters; ○ Materials handling and drilling – target dust control efficiency of 70% – achieved by water sprays and partially enclosing the conveyor.	• Ongoing	• Ongoing	SHE Manager
Decommission	Demolition General site management Rehabilitation						
Closure	Maintenance and aftercare of final rehabilitated areas			• In addition to the abovementioned specific actions, Tharisa will develop and implement other key elements of an air quality control system. This system will include: ○ Monitoring in accordance with Section 21; and ○ If monitoring determines that unacceptable dust emissions is occurring, immediate steps will be taken to address the issue in consultation with a suitable air quality specialist.	• Ongoing	• Quarterly	SHE Manager
				• PM10 monitoring will be done in order to understand what the ambient concentrations at the nearest receptors.	• Ongoing	• Quarterly	SHE Manager
				• A meteorological station should be established where there will be no influence from infrastructure or topography.	• Ongoing	• Quarterly	SHE Manager
				• If measured PM10 results confirm the high PM10 and PM2.5 concentrations predicted by the modelling during this study, then sensitive receptors within the mine boundary where exceedances of the NAAQ limits are experienced will need to be relocated to where exceedances of the NAAQS does not occur. If relocation is required, this would be done in line with the World Bank Operational Directive on Involuntary Resettlement.	• Ongoing	• Quarterly	SHE Manager

TABLE 19.13: ACTION PLAN – NOISE POLLUTION

Phase of operation	Activities	Sig		Technical and management options (Refer to Appendix A for further detail on mitigation measures)	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Site preparation Earthworks Civil works Transport systems Rehabilitation	H – M*	M – L*	• In the approved EMP (Metago, 2008), it is outlined that Tharisa will use waste rock and topsoil stockpiles to maintain a noise berm around the mining operations and associated noise sources. Two key areas include south of the western operations and south of the concentrator complex. The approved EMP limited the height of noise screening berms to 10m, however a height of 30m is planned in line with the specialist's recommendations and in order to act as an effective noise berm. In a specific area, noise berms should form one continuous berm. • Specific noise monitoring will be conducted by an environmental noise professional at the President van Rensburg/Piet Retief Primary School during the day, when the mine is operational. If unacceptable noise disturbance is detected, the specialist, school and mine will collectively determine any associated mitigation measures. • Noise monitoring will be undertaken in line with Section 21.4. • Tharisa will record and respond without delay to complaints about disturbing noise. All such complaints will be documented and recorded as incidents. The measures taken to address these complaints will be included in the documentation. These records will be kept for the life of mine.	• Ongoing • Ongoing • Ongoing • As Required	• Ongoing • Annually • Annually • As Required	SHE Manger SHE Manger and Environmental Noise Professional SHE Manger SHE Manger
Operation	Transport systems Chrome drying plant TSF Waste rock dumps Topsoil stockpiling						
Decommission	Transport systems Demolition Rehabilitation						
Closure	Maintenance activities - negligible						

** Depends on distance from noise generating activity*

TABLE 19.14: ACTION PLAN – NEGATIVE VISUAL IMPACTS

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Site preparation Earthworks Civil works General site management	H	M	• Ensure that the absolute minimum amount of vegetation and land is disturbed during site development and operation. This is extremely important on the boundaries of the mine where vegetation can assist with screening. • Implement the recommended air pollution control system to avoid plumes of dust that can reduce visibility. • Paint structures and buildings in colours (browns and greens) that reflect and compliment the natural landscape.	Ongoing Ongoing At Construction	Ongoing Ongoing Once Off	SHE Manager SHE Manager SHE Manager
Operation	General site management Waste rock dumps Topsoil storage facilties			• Building of a noise and visual screening berm to the south of the concentrator complex. This berm will be vegetated with trees and bushes to add to the height of the screen. • Ensure effective rehabilitation of the tailings dams. Within the first four years of the mine the outer rock wall will be built. Every 100m2 a pocket will be excavated in the wall and filled with topsoil for the planting of trees, aloes and bushes. Additional topsoil will also be placed on the rest of the wall to allow growth of grasses. The successful establishment of the vegetation must be demonstrated during the life of the mine so that there is little additional work to be done at closure. • The overall side slopes of the waste rock dumps will be 1v:4h prior to topsoiling and vegetation establishment. Vegetation will include trees, bushes, aloes and grasses. • All vegetation that is planted as part of rehabilitation should reflect the natural vegetation of the area. • Night lighting will be fitted with fixtures to prevent light spillage and focus the light on precise mine activities and infrastructure, fitted as low to the ground as is practicable, and most security lights will be activated with movement sensors.	Ongoing • Ongoing • Ongoing • Ongoing • Ongoing	On Going • Ongoing • Ongoing • Ongoing • Ongoing	SHE Manager SHE Manager SHE Manager SHE Manager SHE Manager
Decommission	Demolition General site management			• All final landforms (residue facilities) will be rehabilitated in a manner that achieves landscape functionality and limits and/or enhances the long-term visual impact.	• As Required	• As Required	SHE Manager
Closure	Maintenance and aftercare of final land forms and rehabilitated areas			• All final landforms (residue facilities) will be rehabilitated in a manner that achieves landscape functionality and limits and/or enhances the long-term visual impact. • At closure, the residue facilities that will remain in perpetuity will be managed through an aftercare and maintenance programme to limit and/or enhance the long-term post closure visual impacts.	• As Required • As Required	• As Required • As Required	SHE Manager SHE Manager

TABLE 19.15: ACTION PLAN – LOSS OF HERITAGE PALAEONTOLOGICAL AND CULTURAL RESOURCES

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Site preparation Earthworks Civil works General site management	H	L	• Prior to damaging or destroying any of the identified heritage resources Tharisa will engage a heritage specialist to conduct a phase 2 heritage investigation and apply for a permit in terms of the National Heritage Resources Act, 25 of 1999, from SAHRA (North West Province). • In the case of the graves that will be disturbed, additional permission for the exhumation and relocation of graves must be obtained from the relevant descendants, the National Department of Health, the Provincial Department of Health, the Premier of the Province and the local Police. The exhumation process must comply with the requirements of the Ordinance on Exhumations, 12 of 1980, and the Human Tissues Act, 65 of 1983. • If any heritage resources of significance are exposed, Tharisa will follow its emergency response procedure (Section 20).	• As Required • As Required • As Required	• As Required • As Required • As Required	SHE Manager SHE Manager SHE Manager
Operation	General site management Open pit operations Waste rock dump						
Decommission	General site management Rehabilitation						
Closure	Not Applicable						

TABLE 19.16: ACTION PLAN – LOSS OF OR CHANGES TO EXISTING LAND USES

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Construction of project components	H	M-L	• Effective implementation of all mitigation measures as outlined in this EMP report to reduce the mine's overall impact on the environment and surrounding land-uses • Purchase/lease farms within the mining area where project components will be developed. • Should the impact on the surrounding land use and/or economic activity still prove unacceptable, Tharisa will compensate the relevant landowners accordingly.	• Ongoing • As required As required	• As Required • Once Off • As required	SHE Manager SHE Manager SHE Manager
Operation	Operation of the mine						
Decommission	Decommissioning of project components						
Closure	Final land forms	H	L	• Should the impact on the surrounding land use and/or economic activity still prove unacceptable, Tharisa will compensate the relevant landowners accordingly.	• As Required	• As Required	SHE Manager

TABLE 19.17: ACTION PLAN – BLASTING IMPACTS

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Not Applicable						
Operation	Open pit mining	H	M	• The blast design will be, as a minimum standard, ensure that the peak particle velocity from all blasts is less than 12.5mm/s at 500 m from the blast site and that flyrock is contained within 500m of each blast. This will be tracked through the monitoring of blasts	• Prior To Blasting And Ongoing	• Ongoing	SHE & Blasting Manager
				• All structures and services within 1500m of the blast will be marked on a site plan and surveyed photographically in the presence of the owner before surface blasting takes place. All parties that exist and/or that have service infrastructure and/or that provide services within 1500m of the blast sites will be informed, prior to mining, about the blast programme and associated safety precautions. Specific precautions must be taken when educating, informing and managing the students who attend the President van Rensburg/Retief Primary School	• Prior To Blasting And Ongoing	• Ongoing	SHE & Blasting Manager
				• Blasting must be planned so as to limit cumulative impacts from blasting activities at surrounding mines	• Prior To Blasting And Ongoing	• Ongoing	SHE & Blasting Manager
				• In deciding whether or not to set off blasts, a procedure must be developed to take temperature inversions, low cloud cover and wind direction into account	• Ongoing	• Ongoing	SHE & Blasting Manager
				• For each blast the mine will observe the following procedural safety steps: ○ the fly rock danger zone of 500m associated with each blast is delineated and people and animals are cleared from this zone before every blast ○ an audible warning is given at least three minutes before the blast is fired	• Ongoing	• Ongoing	SHE Manager
				• The mine will respond immediately to any blast related complaints. These complaints and the follow up actions will be dated, documented and kept as records for the life of mine. Where the mine has caused blast related damage it will provide appropriate compensation	• As required	• As required	SHE Manager
				• In the absence of relocation, third parties within a minimum of 500m of the open pits will need to be evacuated prior to every blast. During evacuations it will be necessary to provide bus transport and basic amenities such as shelter, toilet facilities and drinks.	• Prior To Blasting And Ongoing	• Prior To Blasting	SHE & Blasting Manager
				• The use of detonating cord is prohibited due to the close proximity. Instead electronic initiation will be required to ensure that individual hole firing is guaranteed, which will ensure that the charge mass per delay is limited to one hole	• Prior To Blasting And Ongoing	• Prior To Blasting	SHE & Blasting Manager

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
				• As the blasting activity moves closer to Mmaditlhokwa/Silver City, the use of deck charges may be necessary to further limit the charge mass delay. A blasting specialist will be consulted in this regard	• Prior To Blasting And Ongoing	• Prior To Blasting	SHE & Blasting Manager
				• The bulk explosive product will be tested on an ongoing basis to ensure it is of an acceptable quality	• Ongoing	• Ongoing	SHE & Blasting Manager
				• The final approved blast design will be marked, drilled off in the field and audited (once charging commences) to ensure that all stages of the operation are proceeding as per the design. Any problem holes will be corrected. Problem holes could include holes that are under burdened, drilled short of the required depth, surrounded by badly cracked ground and off pattern holes will be identified. The blast pattern, hole depths, charge mass per hole, final stemming lengths and the delay timing of the blast will be checked. Any unusual occurrences will be corrected immediately, documented and noted for future consideration. This is essential to assist with controlling fly rock	• Prior To Blasting And Ongoing	• Prior To Blasting And Ongoing	SHE & Blasting Manager
				• Detailed blast records will be kept including: ○ Date, time and blast location ○ Unusual occurrences such as collapsing holes, runaway explosives, fumes, flyrock ○ Prevailing weather conditions, wind speed and direction	• Ongoing	• Ongoing	SHE & Blasting Manager
				• If fumes occur after a blast then the immediate vicinity of the blast area will be kept clear until these have dissipated. The wind direction and conditions must also be kept in mind to ensure that the fumes do not impact further afield	• As Required	• As Required	SHE & Blasting Manager
				• Disturbance monitoring will be continued as long as blasting takes place	• Ongoing	• Ongoing	SHE & Blasting Manager
				• Monitoring will be carried out using industry standard seismographs, which are equipped with a triaxial geophone and a separate microphone. This allows ground vibrations and air blast to be measured simultaneously. The vibration measurements should then be plotted directly against an accepted standard, the two most common being the USBM and DIN standards. The USBM is commonly used in South Africa and has by default become the accepted industry norm.	• Ongoing	• Ongoing	SHE & Blasting Manager
				• If a person or animal is injured by blasting activities this must be handled in accordance with the Tharisa emergency response procedure.	• As Required	• As Required	SHE Manager
Decommission	Not Applicable						
Closure	Not Applicable						

TABLE 19.18: ACTION PLAN – ROAD DISTURBANCE AND TRAFFIC SAFETY

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Transport systems	H	M	• The intersections from the D1325 to the mine site must be designed in accordance with the recommendations of the traffic specialist and must be approved by the North West Province Department of Roads and Transport.	• Prior To Construction	• Once Off	SHE Manager
				• The required upgrade to the Marikana siding must be approved by Transnet. The related alternative route to the Marikana siding that diverts truck traffic around the centre of Marikana town must be approved by the North West Province Department of Roads and Transport and DACE.	• Prior To Construction And Ongoing	• Once Off And Ongoing	SHE Manager
				• The temporary diversion of the D1526/1566 to make way for the open pit must be managed in a manner that the existing road users are not inconvenienced. As such, the road diversion must be: ○ as close to the current road route as possible without being too close to pose a safety risk from a blast management perspective ○ advertised 2 weeks before the existing road is temporarily closed ○ constructed to an equivalent standard as D1526/1566 ○ the original D1526/1566 must be reinstated to its current alignment and condition. This must be monitored for a period of five years thereafter to ensure that no subsidence and related problems impact on the re-established road.	• Prior to use and Ongoing	• Once Off And Ongoing	SHE Manager
				• The re-alignment of D1325 must be approved by North West Province Department of Roads and Transport. It must be constructed in a manner that there is as little disturbance as possible to road users. This should be possible if the existing alignment is closed only once the new alignment is open for traffic.	• Prior To Construction	• Once Off	SHE Manager
				• Place signage to create awareness.	• Ongoing	• Ongoing	SHE Manager
				• Education and awareness training of workers.	• Ongoing	• Ongoing	SHE Manager
				• The mine will record and respond, appropriately and without delay, to any complaints about usage of roads by mine vehicles.	• As Required	• As Required	SHE Manager
				• If a person or animal is injured by transport activities this must be handled in accordance with the Tharisa's emergency response procedure.	• As Required	• As Required	SHE Manager

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Operation	Transport systems	H	M	• The mine will monitor the traffic situation at the intersection of the main mine access road and the Marikana road. If the service levels prove to be unacceptable a solution will be identified by the mine in consultation with a traffic specialist and the North West Roads Department. • Place signage to create awareness. • Education and awareness training of workers. • The mine will record and respond, appropriately and without delay, to any complaints about usage of roads by mine vehicles. • If a person or animal is injured by transport activities this must be handled in accordance with the Tharisa's emergency response procedure.	• Ongoing • Ongoing • Ongoing • As Required • As Required	• Ongoing • Ongoing • Ongoing • As Required As Required	SHE Manager SHE Manager SHE Manager SHE Manager SHE Manager
Decommission	Transport systems						
Closure	Not Applicable						

TABLE 19.19: ACTION PLAN - ECONOMIC IMPACT (POSITIVE AND NEGATIVE)

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Construction of project components	M+	M+	• The mine will continue to implement the commitments in its social and labour plan in accordance with the employment, procurement and social investment principles of the Mining Charter. • Tharisa must effectively implement all the management actions set out in Section 6 to ensure that the identified unacceptable impact zones are maintained as close to the mine activities as possible. Land within these zones should be purchased by the mine as and when necessary. Land outside these zones should not be significantly affected. Taking the various mitigated impact types into account the approximate guideline is 500m.	• Ongoing • Ongoing	• Ongoing • Ongoing	Administration/ Human Resource Manager Administration/ Human Resource Manager
Operation	Operation of the mine						
Decommission	Decommissioning of project components						
Closure	Not Applicable						

TABLE 19.20: ACTION PLAN - INWARD MIGRATION AND ASSOCIATED SOCIAL ISSUES

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
Construction	Construction of project components	H	M/L	• Recruitment, training, housing	• Ongoing	• Ongoing	
Operation	Operation of the mine			○ Clear communication that employment of exclusively local people for the proposed project cannot be guaranteed but Tharisa's aims for as many employees as possible to be sourced from local labour sending areas within the first 5 years of production.	• Ongoing	• Ongoing	Human Resource And Mine Manager
Decommission	Decommissioning of project components			○ Effective and timeous communication with community leaders who can attest to a fair and transparent process amongst the community rather than challenging the mine on the community's behalf over jobs and recruitment.	• Ongoing	• Ongoing	Human Resource And Mine Manager
				○ The precise number of job opportunities (permanent and temporary) will be made public together with the required skills and qualifications. The duration of temporary work should be clearly indicated and employees provided with regular reminders and revisions throughout the employment period.	• Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ The existence and screening of specific skills may be determined through the establishment of a skills register prior to employee selection processes.	• Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ Good communication with all job seekers will be maintained throughout the recruitment process. The process must be seen and understood to be fair and impartial by all involved.	• Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ Selection of young local people who possess good educational qualifications for apprenticeship positions. This may involve vocational training at centres in Rustenburg and Gauteng. A programme of targeted youth recruitment and training could generate considerable benefits for both the company and local communities. On the one hand the company will have preferential access to a pool of specifically trained, known employees for staff replacement and advancement purposes. On the other hand, the community will retain young upwardly mobile people who will be able to continue utilisation of, and payment for, infrastructure and services.	• Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ Urging people to get all their documents and certificates, including valid driving licenses, in order prior to recruitment.	• Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ Facilitating the recognition of prior learning of those job applicants who do not possess formally documented qualifications.	• Prior To Construction		
				○ Encouraging the Department of Labour and Local Economic Development Forums to educate potential workers about	• Prior To Construction	• Duration Of Recruitment	Human Resource And

Phase of operation	Activities	Sig		Technical and management options	Action plan		
		UM	M		Timeframe	Frequency	Responsible parties
				the recruitment process and providing assistance with the organization of the necessary documentation, as well as keeping an up to date database of unemployed people who are looking for work.		Process	Mine Manager
				○ Notifying unsuccessful job seekers once the recruitment process is complete. ○ Award bursaries to young people in local communities on condition that these bursary holders are available for vacation employment and apprenticeships. This is one way of securing replacement labour and skills throughout the life of the project.	• Prior To Construction • Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ Disclose any social investment plans for the area that may lead to jobs. ○ Emphasise the indirect employment opportunities that will come from local contracting by the mine and from the increased local expenditure by mine employees.	• Prior To Construction • Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ There will be no recruitment at the construction/operational site. All recruitment will take place on set dates and at an arranged venue - preferably a formal gathering place in a nearby community.	• Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ There will be no ad hoc hiring of temporary casual labour, no matter how small and temporary the job (washing of vehicles or litter clearance). A sign clearly indicating that there will be no recruitment at the construction site will be erected at the entrance to the site. Also, a list of available temporary workers in the area will be drawn up and kept by Tharisa in the event that temporary labour is required.	• Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ Recruitment will take place during a prescribed 1-2 day period. Subsequent recruitment of replacement staff will take place at discrete, well-advertised intervals during the year.	• Prior To Construction	• Duration Of Recruitment Process	Human Resource And Mine Manager
				○ Once the recruitment process is complete, unsuccessful job seekers must be clearly informed as such and understand that there is absolutely no reason to remain in the vicinity of the development.	• Prior To Construction	• Ongoing	Human Resource And Mine Manager
				○ Local authorities will be requested to remove any informal settlements in the vicinity of the mine that are occupied by people who are there in the hope of obtaining employment. This must be carried out immediately.	• Prior To Construction	• Ongoing	Human Resource And Mine Manager
				○ There will be no worker accommodation on site. All workers who are not resident in the vicinity should be accommodated in a formal accommodation in order to obtain their housing allowance.	• Ongoing	• Ongoing	Human Resource And Mine Manager

<table>
<tr><th rowspan="2">Phase of operation</th><th rowspan="2">Activities</th><th colspan="2">Sig</th><th rowspan="2">Technical and management options</th><th colspan="3">Action plan</th></tr>
<tr><th>UM</th><th>M</th><th>Timeframe</th><th>Frequency</th><th>Responsible parties</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Safety and security
In regard to crime, Tharisa will communicate with the local police force particularly in the context of developing strategies for combating crime in the vicinity of the project, surrounding communities and surrounding landusers/owners.
Hygiene/disease - HIV/AIDS
Disease and particularly HIV/AIDS is not a problem only for Tharisa, its employees and contractors, but it is also a local community problem. As a result, successful mitigation of this impact will also depend on the intensity in which it is addressed by other structures such as the health department, the local municipality, education departments, etc.
Tharisa will ensure that its employees and contractors are made aware of the issues surrounding the spread of HIV and AIDS in the area. This awareness will be promoted by initiatives such as training and development, peer education, community interventions and visual awareness campaigns. Prevention and management strategies also need to be introduced. Voluntary Counselling and Testing (VCT) is a vital aspect to any HIV/Aids management programme. All stakeholders at Tharisa need to agree to a rigorous VCT programme. Once a high level of VCT is taking place it is possible to define the magnitude of the problem and begin to develop appropriate strategies for dealing with it.
Housing and services
A housing allowance will be provided as part of the wages. A system will be implemented to verify that employees are using the housing allowance for formal houses with appropriate services. It is Tharisa’s strategy to employ as many people as possible from local sending areas and these employees should already have formal housing with appropriate services.</td><td>Ongoing
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Ongoing</td><td>Human Resource And Mine Manager

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<tr><td>Closure</td><td>Not Applicable</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

20 EMERGENCY RESPONSE PROCEDURES

20.1 ON-GOING MONITORING AND MANAGEMENT MEASURES

The on-going monitoring as described in Section 21 will be undertaken to provide early warning systems necessary to avoid environmental emergencies.

20.2 PROCEDURES IN CASE OF ENVIRONMENTAL EMERGENCIES

Emergency procedures apply to incidents that are unexpected and that may be sudden, and which lead to serious danger to the public and/or potentially serious pollution of, or detriment to the environment (immediate and delayed). Procedures to be followed in case of environmental emergencies are described in the table below (Table 20.1). These procedures are the same as those for the current and approved operations and are deemed adequate for the project components and related activities.

20.2.1 GENERAL EMERGENCY PROCEDURE

The general procedure that should be followed in the event of all emergency situations is as follows.

- Applicable incident controller defined in emergency plans must be notified of an incident upon discovery.
- Area to be cordoned off to prevent unauthorised access and tampering of evidence.
- Undertake actions defined in emergency plant to limit/contain the impact of the emergency.
- If residue facilities/dams, stormwater diversions, etc., are partially or totally failing and this cannot be prevented, the emergency siren is to be sounded (nearest one available). After hours the Operations Engineer on shift must be notified.
- Take photographs and samples as necessary to assist in investigation.
- Report the incident immediately to the environmental department for emergencies involving environmental impacts or to the safely department in the case of injury.
- The Environment department must comply with Section 30 of the National Environmental Management Act (107 of 1998) such that:
  - The Environment department must immediately notify the Director-General (DWA and DEA, DMR and Inspectorate of Mines as appropriate), the South African Police Services, the relevant fire prevention service, the provincial head of DEDECT, the head of the local municipality, the head of the regional DWA office and any persons whose health may be affected of;
    - The nature of the incident;
    - Any risks posed to public health, safety and property;
    - The toxicity of the substances or by-products released by the incident; and
    - Any steps taken to avoid or minimise the effects of the incident on public health and the environment.
  - The Environment department must as soon as is practical after the incident:

  - Take all reasonable measures to contain and minimise the effects of the incident including its effects on the environment and any risks posed by the incident to the health, safety and property of persons;
  - Undertake clean up procedures;
  - Remedy the effects of the incident; and
  - Assess the immediate and long term effects of the incident (environment and public health).
- Within 14 days the Environment department must report to the Director-General DWA and DEA, the provincial head of DEDET, the regional manager of the DMR, the head of the local and district municipality, the head of the regional DWA office such information as is available to enable an initial evaluation of the incident, including:
  - The nature of the incident;
  - The substances involved and an estimation of the quantity released;
  - The possible acute effects of the substances on the persons and the environment (including the data needed to assess these effects);
  - Initial measures taken to minimise the impacts;
  - Causes of the incident, whether direct or indirect, including equipment, technology, system or management failure; and
  - Measures taken to avoid a recurrence of the incident.

20.2.2 IDENTIFICATION OF EMERGENCY SITUATIONS

The site wide emergency situations that have been identified together with specific emergency response procedures are outlined in Table 20.1.

20.3 TECHNICAL, MANAGEMENT AND FINANCIAL OPTIONS

Technical, management and financial options that will be put into place to deal with the remediation of impacts in cases of environmental emergencies are described below.

- The applicant will appoint a competent management team with the appropriate skills to develop and manage a mine of this scale and nature.
- To prevent the occurrence of emergency situations, the mine will implement as a minimum the mine plan and mitigation measures as included in this EIA and EMP report.
- The mine has an environmental management system in place where all operation identify, report, investigate, address and close out environmental incidents.
- As part of its annual budget, the mine will allow a contingency for handling of any risks identified and/or emergency situations.
- Where required, the mine will seek input from appropriately qualified people.

TABLE 20.1: EMERGENCY RESPONSE PROCEDURE

Item	Emergency Situation	Response in Addition to General Procedures
1	Spillage of chemicals, engineering substances and waste	Where there is a risk that contamination will contaminate the land (leading to a loss of resource), surface water and/or groundwater, Tharisa will: 1. Notify residents/users downstream of the pollution incident. 2. Identify and provide alternative resources should contamination impact adversely on the existing environment;. 3. Cut off the source if the spill is originating from a pump, pipeline or valve (e.g. TSF delivery pipeline, refuelling tanker) and the infrastructure ‘made safe’. 4. Contain the spill (e.g. construct temporary earth bund around source such as road tanker). 5. Pump excess hazardous liquids on the surface to temporary containers (e.g. 210 litre drums, mobile tanker, etc.) for appropriate disposal. 6. Remove hazardous substances from damaged infrastructure to an appropriate storage area before it is removed/repaired.
2	Discharge of dirty water to the environment	1. Apply the principals listed for Item 1 above. 2. To stop spillage from the dirty water system the mine will: a. Redirect excess water to other dirty water facilities where possible; b. Pump dirty water to available containment in the clean water system, where there is no capacity in the dirty water system; and c. Carry out an emergency discharge of clean water and redirect the spillage to the emptied facility. 3. Apply for emergency discharge as a last resort.
3	Pollution of surface water	1. Personnel discovering the incident must inform the SHEQ department of the location and contaminant source. 2. Apply the principals listed for Item 1 above. 3. Absorbent booms will be used to absorb surface plumes of hydrocarbon contaminants. 4. Contamination entering the surface water drainage system should be redirected into the dirty water system. 5. The SHEQ department will collect in-stream water samples downstream of the incident to assess the immediate risk posed by contamination.
4	Groundwater contamination	1. Use the groundwater monitoring boreholes as scavenger wells to pump out the polluted groundwater for re-use in the process water circuit (hence containing the contamination and preventing further migration). 2. Investigate the source of contamination and implement control/mitigation measures.
5	Burst water pipes (loss of resource and erosion)	1. Notify authority responsible for the pipeline (if not mine responsibility). 2. Shut off the water flowing through the damaged area and repair the damage (if Tharisa pipeline). 3. Apply the principals listed for Item 1 above if spill is from the dirty/process water circuit.
6	Flooding from failure of surface water control infrastructure	1. Evacuate the area downstream of the failure (e.g. opencast pits). 2. Using the emergency response team, rescue/recover and medically treat any injured personnel. 3. Temporarily reinstate/repair storm water diversions during the storm event (e.g. emergency supply of sandbags). 4. Close the roads affected by localised flooding or where a storm water surge has destroyed crossings/bridges.
7	Risk of drowning from falling into water dams	1. Attempt rescue of individuals from land by throwing lifeline/life saving ring. 2. Get assistance of emergency response team whilst attempting rescue or to carry out rescue of animals. 3. Ensure medical assistance is available to recovered individual.
8	Veld fire	1. Evacuate mine employees from areas at risk. 2. Notify down wind residents and industries of the danger.

Item	Emergency Situation	Response in Addition to General Procedures
		3. Assist those in imminent danger/less able individuals to evacuate until danger has passed. 4. Provide emergency fire fighting assistance with available trained mine personnel and equipment.
9	Overtopping or failure of the tailings dam	1. Sound the alarm to evacuate danger area. 2. Pump water from top of dam and follow redirection of water as indicated in Item 2 above. 3. Stop pumping tailings to the TSF. 4. Recover casualties resulting from dam failure using the emergency response team. 5. Make the remaining structure safe. 6. Apply the principles of Item 1 above.
10	Injury from fly rock	1. The person discovering the incident will contact the mine emergency response personnel to recover the injured party and provide medical assistance. 2. Whilst awaiting arrival of the emergency response personnel, first aid should be administered to the injured party by a qualified first aider if it is safe to do so.
11	Falling into hazardous excavations	1. Personnel discovering the fallen individual or animal must mobilise the emergency response team to the location of the incident and provide a general appraisal of the situation (e.g. human or animal, conscious or unconscious, etc). 2. The injured party should be recovered by trained professionals such as the mine emergency response team. 3. A doctor (or appropriate medical practitioner)/ambulance should be present at the scene to provide first aid and transport individual to hospital.
12	Road traffic accidents (on site)	1. The individual discovering the accident (be it bystander or able casualty) must raise the alarm giving the location of the incident. Able personnel at the scene should shut down vehicles where it is safe to do so. 2. Access to the area should be restricted and access roads cleared for the emergency response team. 3. Vehicles must be made safe first by trained professionals (e.g. crushed or overturned vehicles). 4. Casualties will be moved to safety by trained professionals and provided with medical assistance. 5. Medical centres in the vicinity with appropriate medical capabilities will be notified if multiple seriously injured casualties are expected.
13	Development of informal settlements	The mine will inform the local authorities (municipality and police) that people are illegally occupying the land and ensure that action is taken within 24hrs.
14	Uncovering of graves and sites	Personnel discovering the grave or site must inform the SHEQ department immediately. Prior to damaging or destroying any of the identified graves, permission for the exhumation and relocation of graves must be obtained from the relevant descendants (if known), the National Department of Health, the Provincial Department of Health, the Premier of the Province and the local Police. The exhumation process must comply with the requirements of the relevant Ordinance on Exhumations, and the Human Tissues Act, 65 of 1983.
15	Uncovering of fossils	Personnel discovering the fossil or potential site must inform the SHEQ department immediately. Should any fossils be uncovered during the development of the site, a palaeontologist or palaeoanthropologist will be consulted to identify the possibility for research.

21 PLANNED MONITORING AND EMP PERFORMANCE ASSESSMENT

The specific monitoring measures as per the commitments in the EIA are included below.

As a general approach, the mine will ensure that the monitoring programmes comprise the following:

- A formal procedure and appropriately calibrated equipment.
- Where sample require analysis they will be preserved according to laboratory specifications.
- An accredited, independent, commercial laboratory will undertake sample analyses.
- Parameters to be monitored will be identified in consultation with a specialist in the field and/or the relevant authority.
- If necessary, following the initial monitoring results, certain parameters may be removed from the monitoring programme in consultation with a specialist and/or the relevant authority.
- Monitoring data will be stored in a structured database.
- Data will be interpreted and reports on trends in the data will be compiled by an appropriately qualified person on a quarterly basis.
- Both the data and the reports will be kept on record for the life of mine.

As a general comment, if monitoring points become damaged or redundant then they can be replaced with new points with the input of an appropriately qualified professional.

21.1 WATER

21.1.1 WATER QUALITY AND LEVELS

Table 21.1 and Table 21.2 set out the monitoring points, programme and parameters for both ground and surface water monitoring programme (where relevant) (Figure 21.1). The parameters may be modified on the basis of input from an appropriate specialist and DWA.

If monitoring indicates a mine-related decrease in groundwater supply to third parties or groundwater quality at third party boreholes, appropriate measures will be taken to prevent the decrease from occurring or rectify the contamination situation, and/or to provide the affected third parties with an alternative equivalent water supply.

FIGURE 21.1: COMBINED MONITORING PROGRAMME

TABLE 21.1: WATER MONITORING PROGRAMME

BH reference	Location	Latitude (X)	Longitude(Y)	Quality frequency	Level frequency
Groundwater					
WGC15	East of the tailings dam complex	X2847876	27Y052691	Quarterly	Monthly
55a or b (whichever is accessible for purging and sampling)	East of the tailings dam complex	a:X2847888 b:X2847881	a: 27Y053042 b: 27Y052995	Quarterly	Monthly
WGC11 (and / or WGC12)	North of the tailings dam complex	X2847763 (X2847855)	27Y052521 (27Y051807)	Quarterly	Monthly
TM GW TSF 01 (previously WGC3)	West of the tailings dam complex	X2848595	27Y050720	Quarterly	Monthly
WGC4	South of the tailings dam complex	X2848705	27Y051044	Quarterly	Monthly
TM GW COMM 02 (previously 52 a, b or c)	South of the tailings dam adjacent to the N4 (Glenn Ross)	-25.749025	27.515803	Quarterly	Monthly
WGC1 (and / or WGC2)	North of the plant	X2848268 (X2848335)	27Y049748 (27Y049955)	Quarterly	Monthly
TM GW COMM 01 (previously 17a)	South of the plant (Mrs Potgieter)	X2849225	27Y049478	Quarterly	Monthly
17b	South of the plant	X2849217	27Y049473	-	Monthly
25	South East of the plant	X2849254	27Y049231	Quarterly	Monthly
14	South of the plant and N4	X2849775	27Y050498	Quarterly	Monthly
28	South East of the plant and west of the Sterkstroom	X2849129	27Y049272	-	Monthly
36	North of the western open pit and east of the Sterkstroom	X2847586	27Y048798	Quarterly	Monthly
41	North of the western open pit and west of the Sterkstroom	X2846921	27Y047991	-	Monthly
47a	In vicinity of future waste rock stockpile west 2	X2848078	27Y047907	-	Monthly
WGC10	Western section of the site between the future waste rock stockpile West 1 and the quarry to the north of it	X2847712	27Y048345	Quarterly	Monthly
46	In vicinity of future waste rock stockpile west 2	X2847911	27Y047976	Quarterly	Monthly
20	South of plant, within mine boundary	-25.747987	27.500008	Quarterly	Monthly
TM GW COMM 03	Residents on the South of Plant at N4 (Hettie Le Roux)	-25.752783	27.507124	Quarterly	Monthly
TM GW COMM 05	President van Rensburg / Piet Retief School	-25.73914	27.475829	Quarterly	Monthly
TM GW COMM 06	In line with west mine activities - Harbours	-25.743421	27.479186	Quarterly	Monthly
TM GW COMM 08	In line with west mine activities - Mr Pretorious	-25.739201	27.47145	Quarterly	Monthly
TM GW COMM 09	In line with west mine activities - Maditlokwe Community Centre	-25.725988	27.479469	Quarterly	Monthly
TM GW Dissipator	Dissipater Borehole	TBD	TBD	Quarterly	Monthly
TM GW EM 02	In Line with west mine activities - Training centre	-25.734047	27.486534	Quarterly	Monthly
TM GW EM 03	In line with west mine activities - Farm House	27.491254	-25.740401	Quarterly	Monthly

BH reference	Location	Latitude (X)	Longitude(Y)	Quality frequency	Level frequency
TM GW MCC	Groundwater monitoring Hardpark	-25.74294	27.50267	Quarterly	Monthly
TM GW TP 01	Tharisa Parking 01	-25.741652	27.493708	Quarterly	Monthly
TM GW TSF 02	In line with east mine activities - Near the dissipater	-25.741164	27.502797	Quarterly	Monthly
TM GW01	New Borehole West of Pit Area	TBD	TBD	Quarterly	Monthly
TM GW02	New Borehole South of Central Waste Rock Dump	TBD	TBD	Quarterly	Monthly
TM GW03	New Borehole North of the East Pit Area adjacent to East Waste Rock Dump	TBD	TBD	Quarterly	Monthly
TM GW04	New Borehole North of the East Pit Area adjacent to East Waste Rock Dump	TBD	TBD	Quarterly	Monthly
Surface water					
TM SW01 (previously SW1)	Upstream on Sterkstroom	-25.75298	27.48573	Monthly	
TM SW02 (previously SW2)	Downstream on Sterkstroom	25.72564	27.48302	Monthly	
SW3	Downstream on tributary of Elandsdriftspruit (at stream diversion exit)	TBD	TBD	Monthly	
TM SW04 (previously SW4)	Upstream on tributary of Elandsdriftspruit	TBD	TBD	Monthly	
TM SW05 (previously SW5)	Downstream on tributary of Maretlwane	TBD	TBD	Monthly	
TM SW06 (previously SW6)	Upstream on Brakspruit tributary	TBD	TBD	Monthly	
SW7	Downstream on Brakspruit tributary	TBD	TBD	Monthly	
TM SW03 (previously SW8)	Within Sterkstroom – midstream and adjacent to the Hernic quarry	-25.73682	27.48705	Monthly	
TM SW07	Old Hernic Quarry	-25.7394	27.48812	Monthly	
TM SW08	STP	-25.74148	27.49316	Monthly	
TM SW10	MCC Dam	-25.74162	27.50234	Monthly	
TM SW11	TSF Dissipator	-25.74007	27.5059	Monthly	
TM SW12	Raw Water	-25.74934	27.50218	Monthly	

Note: Groundwater levels to be measured where possible i.e. where boreholes are not equipped
'WGC' boreholes were installed with solid and slotted casing at differing depths accessing different aquifer systems. This needs to be considered when interpreting the quality.
Coordinates are in South African Grid and WGS84 datum.

TABLE 21.2: MONITORING PARAMETERS

Parameters to be monitored			
Groundwater level	Chrome (VI)	Chloride	Mercury
pH	Copper	Nitrate as N	Sodium
Electrical conductivity	Lead	Ammonia as N	Sulphate
Temperature	Zinc	Fluoride	Barium
Dissolved Oxygen	Cadmium	Boron	Iron
Total dissolved salts (TDS)	Selenium	Aluminium	Manganese
Alkalinity as $CaCO_3$	Arsenic	Acidity as H^+	Magnesium
Calcium	Potassium		

21.1.2 SURFACE WATER FLOW

Tharisa will monitor the flow of surface water in the Sterkstroom at points upstream and downstream of the open pit and Hernic quarry. The purpose of this monitoring will be to better understand the frequency, magnitude and nature of stream flow events as well as determining the downstream flow rates. The method and frequency of monitoring will be determined in consultation with an appropriately qualified specialist.

21.1.3 WATER BALANCE

The water balance is updated regularly from recorded flow measurements and production figures. This is done by an appropriately qualified person. The water balance is used to check on an on-going basis that the capacity of the dirty water holding facilities is adequate.

21.1.4 PROCESS WATER

Process water will be monitored in line with the mine's water use license.

21.2 AIR

A network of dust buckets exist at the mine (Figure 21.1). Table 21.1 set out the monitoring points. The buckets should follow the American Society for Testing and Materials standard method for collection and analysis of dust fall (ASTM D1739-98) as per the SANS requirements. Results should be compared to applicable standards and limits at the time of sampling. The buckets will be monitored on a monthly basis. A report will be produced to document the measurement points, the methodology used, the measured results and recommendations, if required, to further minimise the mine's impact.

A PM10 monitoring station is located at the Security offices at the mine. The location of this monitoring station will be reviewed for adequacy in consultation with an appropriately qualified air specialist. In this regard and as per the recommendations of the air quality specialist, PM_{10} ambient monitors should be placed at the Piet Retief/President van Rensburg school and at the Mmaditlhokwa / Silver City village. PM10 will be measured on a daily basis and reported monthly.

The mine will consider the establishment of a meteorological station in the area or on site to record climatic data. The station will record basic hourly average meteorological parameters namely wind speed, wind direction, temperature and rainfall. It is recommended that relative humidity, pressure and solar radiation also be measured.

21.3 BLASTING

Monitoring will be done for each blast to verify that fly rock is being contained within 500m from the blast, that the ground vibration is less than or equal to a peak particle velocity of 12mm/s at a distance of 500m from the blast, and that the airblast is less than or equal to 130 dB.

Monitoring will be carried out using industry standard seismographs, which are equipped with a triaxial geophone and a separate microphone. This allows ground vibrations and air blast to be measured simultaneously. The vibration measurements will then be plotted directly against an accepted standard, the two most common being the USBM and DIN standards. The USBM is commonly used in South Africa and has by default become the accepted industry norm.

Specific locations of the monitoring seismographs will be identified by an appropriate specialist during the pre-blast survey. These points will also move as the open pit mining progresses.

21.4 NOISE

The mine monitors noise on an annual basis. This will continue to be done. Monitoring will be done by an appropriately qualified environmental noise specialist. Equipment, calibration and measurement procedures must comply with the requirements outlined in SANS 10103. Monitoring locations and procedures for annual surveys must be revised prior to each survey taking the findings of previous surveys into account. Measurement points shown in Figure 21.1 will be used as a guideline. The noise measurement points may be modified on the basis of input from an appropriate specialist taking into account the most relevant locations to be used for noise monitoring and the complaints history at the time when the survey is conducted.

If possible, measurements should be conducted during normal operation as well as during a shut-down period. Ideally, such measurements should be conducted on a night during which the mine is temporarily shut down completely for a period of two hours. The A-weighted equivalent continuous noise level in a sequence of 10-minute intervals covering a period of preferably 24 hours, but at least the night-time period from 21:00 to 05:00 must be measured.

A report will be produced to document the measurement points, the methodology used, the measured results, comment on changes in ambient levels caused by the mine, and provide recommendations, if required, to further minimise the mine’s impact.

21.5 BIO MONITORING

The mine monitors the aquatic ecology integrity of water courses in the vicinity of the mining operations as per the water use license. As a minimum the points identified on the monitoring plan (Figure 21.1) will be monitored. Any additional monitoring points, if required, will be determined in consultation with an appropriately qualified specialist who will also conduct the sampling and analysis. Sampling must be done once during the summer season and once during the winter season.

21.6 TAILINGS AND OTHER DAMS WITH A WALL OF 5M OR MORE AND A CAPACITY OF 50 000M^3 OR MORE

In addition to the abovementioned environmental monitoring programmes, the following issues will, as a minimum and where applicable, be monitored by a professional engineer on a quarterly basis:

- Phreatic surface, slope stability, adequacy of freeboard, integrity of walls, the position of the pools, silt trap sediment, presence of seepage, and functioning of drains
- The success of vegetation establishment on the outer side walls
- Trosion damage.

21.7 GENERAL

The environmental manager will conduct internal management audits against the commitments in the EIA/EMP report. During the construction phase, these audits will be conducted bi-monthly. In the operational phase, these audits will be conducted on an annual basis. The audit findings will be documented for both record keeping purposes and for informing continual improvement. In addition, and in accordance with mining regulation R527, an independent professional will conduct an EMP performance assessment every two years. The mine’s compliance with the provisions of the EMP and the adequacy of the EIA and EMP report relative to the on site activities will be assessed in the performance assessment.

21.8 SUBMISSION OF INFORMATION

As a minimum, the following documents will be submitted to the relevant authorities:

- EMP performance assessment, submitted every two years to DMR
- Closure cost update, submitted annually to the DMR
- Tailings, waste rock and DMS waste management and risk report, submitted annually to the DMR
- Dust monitoring reports, submitted annually to the DMR and DEDECT
- Water monitoring reports, submitted annually to DWA.

21.9 MAINTENANCE, DECOMMISSIONING AND CLOSURE

The ongoing operational and maintenance rehabilitation provisions have been covered in the various headings of Section 7 above. Tharisa’s philosophy towards rehabilitation is to do this concurrently with the operational phase to limit the financial, environmental and social impact of the decommissioning and closure stages. The main rehabilitation and closure objective is to restore the pre-mining potential of the land – agricultural land with grazing and wilderness capabilities.

As is required by the relevant mining legislation (Act, 28 of 2002 and Regulation 527), a detailed closure plan will be submitted to the DMR prior to decommissioning and closure. This process will also involve other regulatory authorities and IAPs in a similar fashion to the involvement of people during the EIA process. The detailed closure plan will determine specific closure strategies and action plans taking regulatory, environmental, social, economic and sustainable development principles into account.

An interim closure cost (as at the end of year one from the commencement of construction) has been calculated on the basis of the standard DMR method. Further detail is provided in Section 22.

22 FINANCIAL PROVISION

The information in this section was sourced from the closure cost calculation study completed by SLR (Aug 2014) and is included in Appendix L.

22.1 PLAN SHOWING LOCATION AND AERIAL EXTENT OF PROPOSED OPERATION

A plan showing the location and aerial extent of the entire operations at Tharisa including the project components are included in Figure 2.1.

22.2 ANNUAL FORECASTED FINANCIAL PROVISION

The financial closure liability for all current operations including the project components as at January 2016 will be approximately R145,471,638 (including VAT) – calculated at Current Value (CV) as at August 2014.

The annual forecasted financial provision for the first 10 years of the proposed projects, as well as the scheduled closure amount is provided in Table 22.1 below.

TABLE 22.1: FINANCIAL PROVISION

Date	Year	Financial Liability incurred during the year (incl. VAT)	Progressive Financial Liability (incl. VAT)	Progressive Liability as a % of LOM Liability
Mar '14	n/a	n/a	R 117 384 200	51.2%
Jan '16	1	R 21 752 338	R 145 471 638	63.5%
Jan '17	2	R 33 826 428	R 179 298 066	78.2%
Jan '18	3	R 8 623 513	R 187 921 579	82.0%
Jan '19	4	R 12 473 197	R 200 394 776	87.4%
Jan '20	5	R 4 196 150	R 204 590 926	89.3%
Jan '21	6	R 2 108 931	R 206 699 857	90.2%
Jan '22	7	R 2 218 723	R 208 918 580	91.1%
Jan '23	8	R 2 158 480	R 211 077 060	92.1%
Jan '24	9	R 2 344 214	R 213 421 274	93.1%
Jan '25	10	R 2 344 213	R 215 765 487	94.1%
Mar '34	LOM	R 13 448 786	R 229 214 273	100.0%

22.3 CONFIRMATION OF AMOUNT TO BE PROVIDED

This will be confirmed in consultation with the DMR.

22.4 METHOD OF PROVIDING FINANCIAL PROVISION

The funding method will be in accordance with the DMR methods.

23 ENVIRONMENTAL AWARENESS PLAN

This section includes an environmental awareness plan for the mine. The plan describes how employees will be informed of environmental risks which may result from their work, the manner in which the risk must be dealt with in order to avoid pollution or degradation of the environment and the training required for general environmental awareness and the dealing of emergency situations and remediation measures for such emergencies.

The purpose of the environmental awareness plan is to ensure that all personnel and management understand the general environmental requirements of the site. In addition, greater environmental awareness must be communicated to personnel involved in specific activities which can have a significant impact on the environment and ensure that they are competent to carry out their tasks on the basis of appropriate education, training and/or experience. The environmental awareness plan should enable Tharisa to achieve the objectives of the environmental policy

All contractors that conduct work on behalf of Tharisa Mine are bound by the content of the EMP and a contractual condition to this effect will be included in all such contracts entered into by the mine. If contractors are used, the responsibility for ensuring compliance with the EMP will remain with Tharisa Mine.

23.1 ENVIRONMENTAL POLICY

Tharisa will display the environmental policy. To achieve world class environmental performance in a sustainable manner Tharisa is currently committed to:

- To minimise the impact of Tharisa's mining operations on the environment wherever possible.
- To comply with all applicable environmental legislation and the commitments contained in Tharisa's Environmental Management Programme Report (EMPR).
- To ensure that all Tharisa's employees, contractors and sub-contractors:
  - Are aware of the impact of their activities on the environment;
  - Are informed about the measures required to prevent, mitigate and manage environmental impacts; and
  - Apply these principles whilst carrying out their work.
- To establish and maintain a good relationship with surrounding communities, industries and other interested and affected parties, with regard to Tharisa's activities.
- To develop a localised environmental strategy with the local authority and nearby industries.
- To provide relevant and constructive consultation/public participation on the management of the potential environmental impacts posed by the mine in the future.

23.2 STEPS TO ACHIEVE THE ENVIRONMENTAL POLICY OBJECTIVES

Tharisa's environmental policy will be realised by setting specific and measurable objectives. It is proposed that new objectives are set throughout the life of mine, but initial objectives are as follows:

- Management of environmental responsibilities: Tharisa will establish and appoint an Environmental Manager at senior mine management level, who will be provided with all necessary resources to carry out the management of all environmental aspects of the site as a primary function, for example:
  - Compliance with environmental legislation and EMP commitments;
  - Implementing and maintaining an environmental management system;
  - Developing environmental emergency response procedures and coordinating personnel during incidents;
  - Manage routine environmental monitoring and data interpretation;
  - Environmental trouble shooting and implementation of remediation strategies; and
  - Closure planning.
- Communication of environmental issues and information: meetings, consultations and progress reviews will be carried out, and specifically Tharisa will:
  - Set the discussion of environmental issues and feedback on environmental projects as an agenda item at all company board meetings;
  - Provide progress reports on the achievement of policy objectives and level of compliance with the approved EMPR to the Department of Minerals and Energy;
  - Ensure environmental issues are raised at monthly mine management executive committee meetings and all relevant mine wide meetings at all levels; and
  - Ensure environmental issues are discussed at all general liaison meetings with local communities and other interested and affected parties.
- Environmental awareness training: Tharisa will provide environmental awareness training to individuals at a level of detail specific to the requirements of their job, but will generally comprise:
  - Basic awareness training for all prior to granting access to site (e.g. short video presentation requiring registration once completed). Employees and contractors who have not attended the training will not be allowed on site.
  - General environmental awareness training will be given to all employees and contractors as part of the Safety, Health and Environment induction programme. All non Tharisa personnel who will be on site for more than five days must undergo the SHE induction training.
  - Specific environmental awareness training will be provided to personnel whose work activities can have a significant impact on the environment (e.g. workshops, waste handling and disposal, sanitation, etc).
- Review and update the environmental topics already identified in the EMP which currently includes the following issues:
  - Geology (sterilisation of mineral resource);
  - Topography (hazardous excavations and surface subsidence);

- Soil management (loss of soil resource);
- Land capability (loss of land with agricultural and conservation/ecotourism potential);
- Surrounding land use (traffic management, reduction in land available to livestock grazing, obstruction of proposed heritage park corridors and damage from blasting);
- Management of biodiversity (impacts on land and water related habitats and species);
- Surface water management (alteration of surface drainage and pollution of surface water);
- Groundwater management (reduction in groundwater levels/availability and groundwater contamination);
- Management of air quality (dust generation);
- Noise (specifically management of disturbing noise);
- Visual aspects (reduction of negative visual impacts);
- Heritage resources (management of archaeological, cultural and historical sites);
- Socio-economic impacts (management of positive and negative impacts); and
- Interested and affected parties.

- All mine projects will be designed to minimise impact on the environment and to accomplish closure/rehabilitation objectives.
- Tharisa will maintain records of all environmental training, monitoring, incidents, corrective actions and reports.
- Contractors and employees will be contractually bound to participate in the achievement of environmental policy objectives and compliance with the EMPR.

23.3 TRAINING OBJECTIVES OF THE ENVIRONMENTAL AWARENESS PLAN

The environmental awareness plan ensures that training needs are identified and that appropriate training is provided. The environmental awareness plan should communicate:

- The importance of conformance with the environmental policy, procedures and other requirements of good environmental management.
- The significant environmental impacts and risks of individuals work activities and explain the environmental benefits of improved performance.
- Individuals roles and responsibilities in achieving the aims and objectives of the environmental policy.
- The potential consequences of not complying with environmental procedures.

23.3.1 GENERAL CONTENTS OF THE ENVIRONMENTAL AWARENESS PLAN

To achieve the objectives of the environmental awareness plan the general contents of the training plans are as follows:

- Module 1 – Basic training plan applicable to all personnel entering the site:
  - Short (15min) presentation to indicate the site layout and activities at specific business units together with their environmental aspects and potential impacts

  - Individuals to sign off with site security on completion in order to gain access to the site.
- Module 2 – General training plan applicable to all personnel at the site for longer than five days:
  - General understanding of the environmental setting of the mine (e.g. local communities and industries and proximity to natural resources such as rivers)
  - Understanding the environmental impact of individuals activities on site (e.g. excessive production of waste, poor housekeeping, energy consumption, water use, noise, etc.)
  - Indicate potential site specific environmental aspects and their impacts
  - Tharisa's environmental management strategy
  - Identifying poor environmental management and stopping work which presents significant risks
  - Reporting incidents
  - Examples of poor environmental management and environmental incidents
  - Procedures for emergency response and cleaning up minor leaks and spills.
- Module 3 – Specific training plan:
  - Environmental setting of the workplace (e.g. proximity of watercourses, vulnerability of groundwater, proximity of local communities and industries, etc.)
  - Specific environmental aspects such as:
    - Spillage of hydrocarbons at workshops
    - Spillage of explosive liquids in the open pits
    - Poor waste management such as mixing hazardous and general wastes, inappropriate storage and stockpiling large amounts of waste
    - Poor housekeeping practices
    - Poor working practices (e.g. not carrying out oil changes in designated bunded areas)
    - Excessive noise generation and unnecessary use of hooters
    - Protection of heritage resources (including palaeontological resources).
  - Impact of environmental aspects, for example:
    - Hydrocarbon contamination resulting in loss of resource (soil, water) to downstream users
    - Groundwater contamination also resulting in loss of resource due to potential adverse aesthetic, taste and health effects
    - Dust impacts on local communities (nuisance and health implications).
  - Tharisa's duty of care (specifically with respect to waste management)
  - Purpose and function of Tharisa's environmental management system.

Individuals required to complete Module 3 (Specific training module) will need to complete Modules 1 and 2 first. On completion of the Module 3, individuals will be subject to a short test (written or verbal) to ensure the level of competence has been achieved. Individuals who fail the test will be allowed to re-sit the test after further training by the training department.

The actual contents of the training modules will be developed based on a training needs analysis.

Key personnel will be required to undergo formal, external environmental management training (e.g. how to operate the environmental management system, waste management and legal compliance).

In addition to the above Tharisa will:

- Conduct refresher training/presentations on environmental issues for mine employees (permanent and contractors) at regular intervals.
- Promote environmental awareness using relevant environmental topic posters displayed at strategic locations on the mine. These topics will be changed monthly, and will be reviewed annually by the Environmental Manager to ensure relevance.
- Participate and organise events which promote environmental awareness, some of which will be tied to national initiatives e.g. National Arbour Week, World Environment Day and National Water Week.

24 TECHNICAL SUPPORTING INFORMATION

The following specialist studies are attached as appendices to this report:

- Soils and land capability study (Appendix D)
- Biodiversity studies (Appendix E)
- Hydrological assessment (Appendix F)
- Groundwater study (Appendix F)
- Air quality study (Appendix G)
- Noise study (Appendix H)
- Visual study (Appendix I)
- Blasting report (Appendix J)
- Heritage and cultural study (Appendix K)
- Palaeontological report (Appendix K
- Alternative land use report (Appendix L)
- Financial Provision report (Appendix M).

25 CAPACITY TO MANAGE AND REHABILITATE THE ENVIRONMENT

25.1 AMOUNT REQUIRED TO MANAGE AND REHABILITATE THE ENVIRONMENT

The mine manages the environmental impacts throughout the value chain and puts preventative and mitigating measures in place to achieve this.

Estimated costs for implementing the technical and management options associated with the project components identified in Section 19 are included in the table below (Table 25.1). The costs are either once off costs or an annual cost and have been determined at 2013/2014 rates. .

TABLE 25.1: ESTIMATED COSTS FOR IMPLEMENTING TECHNICAL AND MANAGEMENT OPTIONS ASSOCIATED WITH THE PROJECT COMPONENTS

Potential impact	Technical and management options	Estimated costs	
		Once off	Annual
Detailed design and construction	Includes costs associated with the detailed design and construction of the project components	±R178 million	-
Processing plant capital expenditure	To cover changes to infrastructure within the processing plant footprint	±R19.6 million	-
Annual environmental budget*	To cover ongoing management of the site	-	±R2.6 million
Monitoring*	To cover annual surface water, groundwater, biomonitoring, dust, PM10 and noise monitoring To cover EMP performance assessment and WUL audit To cover annual review of closure cost estimate	-	±R1.5 million
	Total	±R197.6 million ∞	±R4.1 million ∞
∞ excludes any purchase of land, which will be negotiated with the landowners as required			

** These form part of the current mine budget and will also accommodate the project components.*

25.2 AMOUNT PROVIDED FOR

The amount required as per the above budget has been provided for in the Tharisa budgeting period.

26 UNDERTAKING SIGNED BY APPLICANT

COMMITMENT/UNDERTAKING BY APPLICANT

I, THULANI NTSHANGA the undersigned and duly authorised thereto by THARISA MINERALS undertake to adhere to the requirements and to the conditions set out in the approved EMP with the exception of the exemption(s) and amendment(s) agreed to be relevant by the Regional Manager: NORTH WEST (include relevant province).

Signed at: PRETORIA

On: 04 SEPTEMBER 2014

Signature: ....

Designation: ENVIRONMENTAL MANAGER

REGIONAL MANAGER: ____________________ REGION

In terms of the Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) this document of .... is approved subject to the conditions as set out in the letter of approval.

Signed at: ....

On: ....

Signature: ....

Designation: ....

REGIONAL MANAGER: __________________

27 ENVIRONMENTAL IMPACT STATEMENT & CONCLUSION

This document presents the project plan as defined by Tharisa, presents findings of specialist studies, identifies and assesses potential impacts on the receiving environment in both the unmitigated and mitigated scenarios, including cumulative on-site impacts, and identifies measures together with monitoring programmes to monitor and mitigate potential impacts.

A summary of the potential impacts (as per Section 7 of the EIA and EMP report), associated with the project, in the unmitigated and mitigated scenarios is included in Table 27.1 below.

In summary, the assessment of the project components presents the potential for negative impacts to occur (in the unmitigated scenario in particular) on the bio-physical, cultural and socio-economic environments both on the project sites and/or in the surrounding area. In most instances with mitigation these potential impacts can be prevented or reduced to acceptable levels. This assumes that all mitigation measures included in the EMP are effectively implemented by the mine.

Impacts as a result of the project components do contribute to the overall impact of the mine (Table 27.1). When considering the on-site cumulative impact which takes into consideration the approved operations together with the project components the more significant impacts are associated with the physical disturbance of soils and air pollution impacts. In both instances the cumulative on-site significance rating as presented in this report either remains high or reduces to medium depending on the mitigation implemented (Table 27.1). These are discussed further below.

In the case of the loss of soil resources through physical disturbance, the overall rating for the mine with mitigation is influenced by the increase in mine footprint (by 35%) and the need to retain an *in-situ* layer of clay below project-related mineralised waste facilities (which includes the majority of the project footprint).

In the case of air pollution, the model predicts that with mitigation that focuses on minimising pollution at the source there may still be exceedances of the NAAQ limits for PM_{10} and $PM_{2.5}$ (particulate matter with a diameter less than 10 micron and less than 2.5 micron) emissions that could result in health related impacts. If monitoring confirms the model predictions, then relocation of sensitive receptors within the exceedance zone may be required.

The alternative land use assessment and sustainability analysis shows that mining is economically a preferred land use when compared to the loss of existing land uses. Some local negative economic impacts may be experienced in the immediate vicinity of the mine if the mitigation as presented in Section 19 is not effectively implemented. It follows that provided the EMP is effectively implemented there is no environmental, social or economic reason why the project should not proceed. For the overall mine, careful consideration will need to be given to mitigation measures associated with closure planning and minimising health impacts on sensitive receptors within the mining rights boundary.

TABLE 27.1: SUMMARY OF THE SIGNIFICANCE RATING FOR POTENTIAL IMPACTS

Environmental component	**Potential impact**	**Significance of the impact (the ratings are negative unless otherwise specified)**			
		Rating from approved EIA and EMP (Metago, 2008)		**Cumulative on-site rating**	
		Unmitigated	**Mitigated**	**Unmitigated**	**Mitigated**
Geology	Loss and sterilization of mineral resources	No impact expected		No impact expected	
Topography	Hazardous excavations and infrastructure	H	M	H	M
	Surface subsidence	M	L	M	L
Soils and land capability	Loss of soil resources and land capability	H	M	Assessed separately as outlined below	
	Loss of soil resources and land capability through physical disturbance	Not assessed separately in the approved EIA and EMP		H	M-H
	Loss of soil resources and land capability through pollution			H	L
Biodiversity	Physical destruction of biodiversity	H	M	H	M
	General disturbance of biodiversity	H	M	H	M
Surface water	Alteration of surface drainage lines	H	M	H	M
	Contamination ofsurface water resources	H	L	H	L
Groundwater	Groundwater contamination	H	M	H	M
	Reduction in groundwater levels / availability – impacts on third party users	H	L	H	L
	Reduction in groundwater levels / availability – impacts on baseflow	H	M	H	M
Air quality	Air pollution through dust generation (including PM_{10} and $PM_{2.5}$)	H	M	H	H-M
Noise	Noise pollution	H	M	H-M	M-L
Visual	Negative visual impacts	H	M	H	M
Heritage, palaeontological and cultural resources	Loss of heritage, palaeontological and cultural resources	H	L	H	L
Land use	Loss of or changes to existing land uses	Not assessed in the approved EIA and EMP		H	M-L L (at closure)

Environmental component	**Potential impact**	**Significance of the impact (the ratings are negative unless otherwise specified)**			
		Rating from approved EIA and EMP (Metago, 2008)		**Cumulative on-site rating**	
		Unmitigated	**Mitigated**	**Unmitigated**	**Mitigated**
Socio-economic	Blasting impacts	H	M	H	M
	Road disturbance and traffic safety	H	M	Remains unchanged	
	Economic impact (negative)	M+	M+	M+	M+
	Economic impact (positive)	M	M-L		
	Inward migration and associated social issues	H-M	M-L	H	M-L

Interpretation of the significance		
Significance		**Decision guideline**
H	High	It would influence the decision regardless of any possible mitigation.
M	Medium	It should have an influence on the decision unless it is mitigated.
L	Low	It will not have an influence on the decision.
	+	Denotes a positive impact.

Stella Moeketse
Project Manager

Alex Pheiffer
Reviewer

SLR Consulting (Africa) (Pty) Ltd

28 REFERENCES

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RECORD OF REPORT DISTRIBUTION

SLR Project Number:	T014-12
Title:	Environmental impact assessment and management programme report for changes to the pit, tailings dam and waste rock facilities; a chrome sand drying plant and other operational and surface infrastructure changes
Report Number:	5
Proponent:	Tharisa Minerals (Pty) Ltd

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